N.Z. GEOMECHANICS NEWS

No. 20

JUNE 1980

A NEWSLETTER OF THE N.Z. GEOMECHANICS SOCIETY

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No. 20, June 1980

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CONTENTS

THIS IS A RESTRICTED PUBLICATION

"N.Z. Geomechanics News" is a newsletter issued to members of the N.Z. Geomechanics Society. It is designed to keep members in touch with recent developments. Authors must be consulted before papers are cited in other publications.

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 $10.00 and is supplemented according to which of the International Societies, namely Soil Mechanics ($4.50), Rock Mechanics ($7.00), or Engineering Geology ($3.00) the member wishes to be affiliated. Members of the Society are required to affiliate to at least one International Society.

EDITOR'S NOTES

1. Article on Sensitivity

The article by Dr Ian Smalley from Soil Bureau, D.S.I.R. and Dr S.P. Bentley from the University of Wales Institute of Science and Technology, gives an interesting review of the question of sensitivity. As a result of the recognition of soils in New Zealand with high sensitivities, a programme of investigations into sensitive soils is starting up at Soil Bureau. If any member of the Geomechanics Society would like to be involved in the programme or has some useful data on New Zealand sensitive soils, Dr Smalley would appreciate their contacting him at Soil Bureau, Private Bag, Lower Hutt. A parallel programme of investigations is under way at the University of Wales under Dr Bentley. The ultimate aims of these programmes are the recognition and definition of these potentially dangerous soils and a general theory on sensitivity.

2. Soil Description

This issue contains another letter on the description of soils, in particular fine grained soils. In response to this concern, a committee headed Management Secretary is being formed and as a supplement to the November 1980 issue of Geomechanics News a possible soil description method - one based largely on that of the Engineering Geology Section, N.Z. Geological Survey, with suitable modifications (e.g. organic soils) - will be circulated to all members of the Society. Comments from Society members will be reviewed by the committee, who will represent a wide range of practitioners, e.g. consultants, central and local government agencies and universities. The aim is to produce a method of soil description generally accepted for New Zealand conditions by geotechnical practitioners published as a Geomechanics Society sponsored document.

3. Membership Application

To assist Society members in recruiting new members, an application form can be found at the back of this issue. Please note that to facilitate the management committee's task of scrutinising the applications, prospective members are required to be nominated by existing financial members of the Society.

4. Change of Address

Members are reminded that changes of address should be notified to the Institution Secretary, using the form provided in the back of this newsletter.

5. Contributions Wanted

Contributions to N.Z. Geomechanics News may be in the form of technical articles, notes of general interest, letters to the Editor, or book reviews, and may cover any subject within the fields of Soil Mechanics, Rock Mechanics and Engineering Geology. Articles on site investigations, construction techniques or design methods which have been successfully used in New Zealand, and which would be of help to other members, would be particularly welcome. All contributions should be sent to: The Editor, N.Z. Geomechanics News, c/o N.Z. Geomechanics Society, P.O. Box 12-241, Wellington North.

S.A.L. Read
Editor.

PUBLICATIONS OF THE SOCIETY

The following publications of the Society are available:

(a) From the Secretary, N.Z.I.E., P.O. Box 12-241, Wellington North:

- Proceedings of the Third Australia-New Zealand Conference on Geomechanics, Wellington, May 1980. (These will be available when the Third Volume is printed later in 1980. Cost to be advised.)

- Proceedings of the Hamilton Symposium "Tunnelling in New Zealand" November 1977. Cost $18.00 to members, $20.00 non-members.

- Proceedings of the Second Australia-New Zealand Conference on Geomechanics, Brisbane, July 1975. Cost $25.00 but as a special offer this is discounted to $15.00

- Proceedings of the Wanganui Symposium "Using Geomechanics in Foundation Engineering", September 1972. Cost $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. A limited reprinting is available at $8.00 to members, $10.00 to non-members

- Copies of all back-issues of "New Zealand Geomechanics News" are available to members at a nominal cost of $2.00 per copy

(b) From Government Bookshops:

- "Slope Stability in Urban Development" (D.S.I.R. Information Series No. 122) Cost $2.00

T.J. Kayes
Publications Officer

3RD AUSTRALIA - NEW ZEALAND CONFERENCE IN GEOMECHANICS

WELLINGTON, 12-16 MAY 1980

The conference which was held at Victoria University continued the sequence of conferences previously held in Melbourne (1971) and Brisbane (1975). Organised by the NZ Geomechanics Society and sponsored with the New Zealand Institution of Engineers, the Institution of Engineers (Australia) and the Australasian Institute of Mining and Metallurgy, the conference was recognized as a Regional Conference of the three International Societies (I.S.S. M.F.E., I.S.R.M. and I.A.E.G.). 171 registrants attended the conference.

The conference was opened by the Hon. W. Young, Minister of Works and Development, and the technical programme was given a stimulating start in the keynote address entitled "Stop the Computor, I Want to Get Off" given by Prof. T. Brekke (Prof. Geological Engineering at the University of California, at Berkeley). The address outlined the properties of "soft" sedimentary rocks (e.g. shales, sandstones) and the problems encountered in underground openings in these rocks - squeezing and squeeze time, groundwater flows near fault zones in sandstones, low rock modulii of deformation, gases (both heavier and lighter than air) and ventilation. While emphasizing the need to correctly recognize ground conditions as a means of solving problems, Prof. Brekke finally commented on the need for contract documents to include information on geology, materials, geotechnical interpretation and design philosophy, including the risk of changed conditions.

Papers (2-4 each session) were presented in two concurrent 90 minute sessions (see p 5 for programme and p6-8 for the titles of preprinted papers). They covered topics ranging from rock blasting, determination of rock mass modulii, relief of negative skin friction on piles to hazards from lahars, use of reinforced earth and the geomechanics of soil conservation. Many of the papers illustrated the differences in materials and nature of geomechanical problems encountered in Australia compared to those in New Zealand (e.g. mine openings in hard rocks v colluvium derived from soft rocks). Discussion from quite a number of the papers was very stimulating (e.g. point load test). However, it is considered a pity that more construction case histories, particularly from New Zealand, were not presented to the Conference.

In the forum session the geotechnical data already presented to the Commission of Inquiry into the Abbotsford Landslip Disaster was presented. These included an outline of the geology, sampling of critical materials, their laboratory testing, and results of slope stability calculations.

Dr R.D. Northey (Soil Bureau, D.S.I.R.) in recognition of his services to geomechanics in New Zealand, gave an invited address on "The Acceptibility of Geotechnical Risk." Dr Northey questioned the use of the traditional Factor of Safety approach in the geotechnical analyses as the certainty of the input data used in calculations is not considered. He introduced the concept of the probability or risk of failure and then drew attention to the fact that the incidence of failures due to human errors is significantly greater than the risk of failure calculated by probability theory. Dr Northey next pointed out that voluntary risks with a high probability (e.g. driving a car) are accepted far more readily than those which are involuntary (e.g. flooding) or imposed by society (e.g. dam failure) with a much lower probability. Discussion of the address illustrated the wide concern among geotechnical practitioners about acceptability of risk.

The John Jaegar Memorial Medal, an award recently formulated by the Australian Geomechanics Society in respect of the services of the late Prof. John Jaegar to Geomechanics - particularly in Rock Mechanics, was presented for the first time. The recipient of the award, Prof. E.H. Davis, gave an address on "Some Plasticity Solutions Relative to the Bearing Capacity of Rock and Fissured Clay". In a high level address, Dr Davis initially developed a model to calculate bearing capacity in a homogenous medium using plasticity theory; subsequently extending it to include the influences of defects or fissures, considered as plastic.

Wellington weather was at its sunniest, windless best during the conference, only showing its vagaries during the technical tours causing the cancellation of one and dampening the success of some of the others. The social programme was very successful, reaching a peak at the conference dinner with John Webster's amazing, well-illustrated account of early geomechanics activities from Stonehenge through history to the bridges of Venice.

The conference was closed by the President of the I.S.S.M.F.E., Prof. M. Fukuoka after addresses from each Australasian vice-president of the international societies (S.S.M.F.E. - A.D. Hosking; I.S.R.M. - W.E. Bamford and I.A.E.G. - Prof. D.H. Stapledon). The president of the NZ Geomechanics Society (Dr I.M. Parton) then farewelled the conference.

The conference was well organised and proved to be most successful both technically and socially, particularly when judged on comments heard during the week. I am sure all those who attended would like to thank the organizing committee - Dr J.A. Webster, J.H.H. Galloway, Dr M.J. Pender, Dr G. Ramsay, P.E. Salt, T.J. Kayes and P. Millar, in particular John Webster and John Galloway - for the tremendous amount of work they put in to ensure the success of the conference.

The 4th Australia-New Zealand Geomechanics Conference in 1984 will be held in Perth.

S.A.L. Read

TECHNICAL PROGRAMME

Monday 12 May

Opening Ceremony	
Keynote Address	Prof. T.L. Brekke

Lunch

Rock Fill	Engineering Geology
House Foundations/Settlement	Rock Mechanics

Tuesday 13 May

Buried Structure	Landslides
Piles	Landslides

Lunch

Piles	Rock Slope Stability
Forum	

Wednesday 14 May

Soft Ground	Soil Slope Stability
Reinforced Earth	Stress/ Strain models

TECHNICAL TOURS

Thursday 15 May

Invited Address	Dr R.D. Northey
Soil Properties	Mining

Lunch

Soil Properties	Underground Work
Underground Work	

Friday 15 May

Tests and Specifications	Foundation Design
In Situ Test Methods	

Lunch

Final Address - John Jaeger Award - Prof. E.H. Davis
Final Addresses - Closure

CONFERENCE PROCEEDINGS

The proceedings are published as the New Zealand Institution of Engineers, Proceedings of Technical Groups. Volume 6 Issue 1 (G).

VOLUME ONE - PAPERS

VOLUME TWO - PAPERS

VOLUME THREE

Volume 3 will include reports of discussion at the Conference sessions and keynote addresses delivered by invited speakers.

3RD A-NZ GEOMECHANICS CONFERENCE, WELLINGTON, MAY 1980

... A personal view

What are conferences for? You pays your money and takes your choice. There certainly was plenty of choice in the way of papers at the recent gathering in Wellington of geomechanicists / geomechanicians / geomechanics, from many parts of the globe. Throughout the week two concurrent technical sessions allowed for individual interests to be followed though for some, no doubt there were the inevitable conflicts.

Professor Tor L. Brekke got proceedings off to a stimulating start with his keynote address. His message was another timely reminder of how most geotechnical problems cannot be solved just by detailed analysis of testing. Solutions invariably lie in proper appreciation of the geological conditions which give rise to a particular problem. Geomechanics will have come of age when it is no longer necessary to re-emphasise this fundamental point.

The variety of papers presented in the technical sessions reflected the diversity of interest which geomechanics now embraces, although one or two might have been regarded as "beyond the fringe", and could well have been culled from the final programme. However, general conferences such as this still have a valuable role to play in conjunction with the growing number of specialist ones.

I wonder whether future conferences might benefit from the inclusion of "poster sessions" in the programme - displays of recent work explained at appropriate times by anyone wishing to have direct interchange of ideas with small groups of those with similar interests.

Apart from the lack of a list indicating what organisations registrants came from - essential if one is to increase one's contacts - the organisation of the conference was most impressive. This was readily apparent in the general spirit in which the meeting was held. Clearly, geomechanics are alive and well in Australasia.

B.W. Riddolls

LETTERS TO THE EDITOR

The following items of correspondence have been received by the Editor:

Sir

Mr L.D. Wesley in issue No. 18 of Geomechanics News and Mr J.H.H. Galloway in issue No. 19 have mentioned the November 1978 TELARC Soil Testing Symposium, and have discussed TELARC's role in relation to geomechanics testing in general. It is evident from this correspondence there exists a basic misunderstanding of the purpose of TELARC.

The Testing Laboratory Registration Act 1972 states that "The general functions of the Council shall be to promote the development and maintenance of good laboratory practice in testing and to establish and maintain a scheme for the registration of testing laboratories in respect of which application is made for registration and which comply with that practice".

The registration scheme involves the satisfaction of five basic criteria (reference 1):-

(1) The person in direct charge of the laboratory and all officers having technical supervisory responsibilities in the conduct of the laboratory are properly qualified for and have had adequate experience in the testing work concerned.

(2) The other members of the laboratory staff are suitably qualified for the work on which they are engaged and the proportion of partially trained members is not more than that which is deemed appropriate for such a laboratory.

(3) The laboratory practice, including the supervision of staff, the conduct of tests, the checking of calculations and results, and the keeping of records, is satisfactory.

(4) The measuring and testing equipment maintained by the laboratory together with any appropriate auxiliary equipment is in a satisfactory condition and has, at a sufficiently recent date, been calibrated in terms of the relevant national standards.

(5) The laboratory equipment and facilities are appropriately housed, properly maintained and adequate for the performance of the testing work.

These are the basic criteria for the effective operation of a testing laboratory in any field of testing. The question of what is "adequate" and what is "satisfactory" is decided by the assessors on the basis of detailed criteria (references 1 and 2) which have been drawn up by the Mechanical Testing Registration Advisory Committee. The detailed criteria are what is generally accepted as good practice in laboratory testing.

The Council has appointed Registration Advisory Committees to establish and maintain criteria for registration and to supervise the assessment of laboratories. Members of these Committees are specialists in the various types of testing. Each Advisory Committee maintains a panel of specialist assessors who are selected for their own personal expertise and do not represent any particular organisation. Assessors assist the Council on a voluntary basis. Advisory Committee members and assessors are drawn from the ranks of government departments, academic institutions, consultants, commercial and industrial laboratories.

The field of Mechanical Testing covers a wide range of tests and includes mechanical tests on soils. No laboratory, however, has an open-ended registration for tests on soils. Each laboratory's registration is described in terms of the type of testing subdivided by reference to specific tests which the laboratory itself nominates when applying for registration. For example, a typical soil testing laboratory might have the following terms of registration:-

MECHANICAL TESTS ON SOILS

The following tests in accordance with NZS 4402P: Part 1:1976

Water content
Liquid limit
Plastic limit
Plasticity index
Linear shrinkage
Particle size distribution (methods 9A and 9B only)

The following tests in accordance with own methods:

Organic matter content
Triaxial compression with pore pressure measurement
Permeability (falling head method)
Penetration resistance using the Scala Penetrometer

As outlined in reference 2, TELARC does not insist on particular methods of test being used. There are numerous standard methods of test for soils in New Zealand and TELARC is prepared to consider registration for any of these. Laboratories claiming to test to specific standard methods are normally required to adhere rigidly to the details of these methods. In certain circumstances a laboratory may need to make minor variations to specific standard methods, perhaps at the request of a client. Such variations must be clearly stated on the test reports. This policy leaves room for the application of judgement and commonsense. Mr Wesley would surely agree, however, that a laboratory cannot make significant departures from a standard method and still claim to be testing in accordance with that standard method?

An example of such a variation long since accepted by TELARC relates to test 12 of BS 1377:1975 "Determination of the dry density/moisture content relationship". The New Zealand practice of not complying with the BS 1377 requirement to start the test with air dried soil regardless of the natural moisture content of the soil is acceptable because over-drying has been found to affect the compaction characteristics of some New Zealand soils.

TELARC discourages laboratories from seeking registration for in-house test methods which involve major departures from standard methods. If approval for such departures is sought the following information must be provided prior to the assessment of the laboratory:

1. Origin of the in-house method
2. Departures from standard methods
3. Reasons for departures
4. Effects of departures
5. Results of comparative tests with standard methods

If no standard test methods exist a laboratory can be registered for in-house methods. If approval for such in-house test methods is sought the following information must be provided prior to the assessment of the laboratory.

1. Origin of the in-house method
2. Full details of the in-house method

The assessors must approve the in-house methods and copies must be made available to clients upon request.

When a laboratory is registered it has the right to use the TELARC endorsement on relevant test reports. Endorsement involves the use of the emblem of the Council (TELARC) with the following words appended:-

> "This laboratory is registered by the Testing Laboratory Registration Council of New Zealand. The tests reported herein have been performed in accordance with its terms of registration."

Each endorsement must be confined to the tests for the performance of which the laboratory is registered, and no other form of endorsement can be used. A test document can be endorsed if, in addition to report the results of tests, it also includes factual statements in amplification of such results limited

(i) where a sample is tested to specification requirements, to whether or not the sample complies and the manner or degree in which it departments from specification requirements, or

(ii) where a sample is not tested to specification requirements, to such explanation of the test results as is necessary to interpret their meaning.

An endorsed document must not include either any expression of expert opinion or any other statements other than those referred to previously. If required, such prohibited statements may be furnished in a separate unendorsed document. Mr Galloway's suggested disclaimer is therefore unnecessary.

Registration by TELARC is a formal recognition that a testing laboratory is capable of work to a standard which is acceptable to leading experts in its particular field. It implied that tests carried out in accordance with a laboratory's terms of registration, and which are endorsed as such, are likely to have been performed carefully and conscientiously in accordance with the methods claimed, and in that sense the results are likely to be reliable.

There is no warranty, however, implied or otherwise. It is certainly true, as outlined above, that TELARC registration is relevant only to laboratory test results, and this does include choice of the most appropriate test methods when methods are not specified by the Client. Interpretation of the test results is an aspect of engineering judgement (in the case of soils testing), however, and is not within the relevancy of TELARC registration.

A "continuing education programme in the concepts of quality assurance" is also outside the functions of TELARC. The New Zealand Organisation for Quality Assurance (NZOQA) has been established for this purpose. I strongly recommend that Mr Galloway and like-minded geomechanics practitioners should join this organisation without delay (TELARC is already a member).

Mr Galloway's belief that TELARC is only a tool "whose value in practice is never more than the skill with which (it) is used" is insupportable. This implies the possibility of variation in the use of TELARC. Such variation cannot exist. A laboratory is either registered (for a particular test or tests) or it is not registered. Mr Galloway's confusion here stems from his error in treating two totally different things (TELARC registration and testing standards) as if they were two aspects of the same thing. Therefore whether or not it may sometimes be inappropriate to specify that "all tests shall be in accordance with NZS 4402", it will always be appropriate (and very sound) to specify that "all tests shall be carried out in a TELARC registered laboratory".

A geomechanics practitioner has a straightforward choice. He can either have his tests performed by a laboratory which has subjected itself to an independent audit of its operations and has demonstrated that it is capable of complying with what is generally accepted as good laboratory practice in testing, or he can take a chance on some other laboratory.

<u>References</u> (both published by TELARC, P.O. Box 37-042, Auckland)

1. "Criteria for Registration in Mechanical Testing"
2. Technical Note No. 3 "Testing of Soils"

Yours faithfully,
J.C. Wydenbach.

Sir,
At the risk of boring your readers I would like to reply to Messrs Read and Macfarlane's comments on my earlier letter regarding the description and classification of fine grained soils. It seems that many geologists (and perhaps not a few engineers) do not have a clear understanding of the correct usage of the terms silt and clay or of the basis in the Unified Soil Classification System for differentiating between silt and clay. It may be helpful to quote some comments by several of the "founding fathers" of soil mechanics on the usage of the terms silt and clay by engineers.

In reference 1 Cooling made the following comments.

> Silts exhibit the properties of cohesion and plasticity to a certain extent. They can be rolled into threads between the fingers, but the threads tend to crumble as drying proceeds. The material, which dries on the hand, can be dusted off readily. If a small sample in the wet state is shaken in the hand the surface becomes wet and shiny. If it is then compressed between the fingers the water disappears and the surface becomes dry and dull, whilst the material tends to tighten up and give increased resistance to compression. This property is known as dilatancy. When dry a silt may possess appreciable cohesion, but a lump can be easily broken up and powdered by hand.
>
> A clay is a soil which contains a sufficient proportion of very fine grains (less than 0.002 millimetre diameter and produced by the chemical weathering of rocks) to impart to it the typical characteristics of plasticity and cohesion. So important is the influence of the fine "clay" fraction that a soil containing more than 30 per cent would be classed as a clay. When fairly moist, clay has a smooth greasy touch. It is plastic and can be moulded or rolled into threads over a considerable range of water content. The thread possesses sufficient tensile strength to support its own weight if held by one end. (A silt will not do this). It does not show dilatancy. It dries slowly on the hands and will not dust off easily, but cracks and breaks off in flakes. It exhibits considerable shrinkage on drying. When dry it forms very hard lumps which cannot readily be broken in the fingers or powdered.

In reference 2 Skempton and Bishop state the following:

> A careful distinction must be made between "clay" and "clay fraction". The former is a descriptive term applied to fine grained cohesive soils, while the latter refers only to the proportion by weight of the particles in a soil, finer than 2 microns. Many clays contain only 15 or 20% "clay fraction".
>
> Similarly many silts contain only about 50% by weight of particles actually lying within the "silt fraction". The silts are also cohesive, but unlike clays they can readily be powdered in the dry state by rubbing between the fingers. Sands and gravels are non-cohesive when dry and their particles are visible to the naked eye; while water will drain more or less readily from these soils by gravity.
>
> At present no great practical significance can be attached to the shape of the granulometric curve of clays, especially since, in order to obtain this curve, the natural aggregates of the particles are broken down by dispersion.

In reference 3 Terzaghi and Peck state:

> However, any system of classification based on grain size alone is likely to be misleading, because the physical properties of the finest soil fractions depend on many factors other than grain size.
>
> For example, according to any one of the commonly used conventions (for particle size classification), a soil consisting of quartz grains of colloidal size should be called a clay, whereas in reality it does not possess even a remote resemblance to clay. Hence, if the words "silt" or "clay" are used to express grain size, they should be combined with the word "size", as in the expression "clay-size particle."

It should be clear from the above that the terms silt and clay, in correct engineering suage, imply nothing definite about particle size apart from the fact that the majority of particles are finer than the minimum dimension considered to be sand (normally 0.06 mm).

I think Messrs Read and Macfarlane have misunderstood the Unified System as this system takes no account of particle size distribution below 0.06 mm, and for field or laboratory classification it is quite unnecessary to measure particle size below this limit. The quotation "use the grain size curve in identifying the soil fractions as given under field identification" refers only to the grain size from fine sand upwards, as the distinction into silt or clay is made from the plasticity chart above. In the example quoted (CLAYEY SILT), the only information about particle size implicit in the name is that the majority of particles are finer than 0.06 mm. It in no way implies that the silt fraction is larger than the clay fraction. It is simply a soil which exhibits properties intermediate between these of clay and silt (but somewhat closer to silt), and which plots close to the A-line on the plasticity chart. There should be no difficulty in recognising such a soil from field identification tests, which is why such tests are described in detail in the Unified System.

The soil description method used by the Engineering Geology Section of the NZ Geological Survey appears very vague with respect to fine grained soils and unless the version I have is out of date it does not appear to be based on the Unified System. I am not myself in favour of the actual letter designation procedure of the Unified System, but I certainly think the principles of the system are sound and should be incorporated in any proposed NZ system.

With regard to the suggestion that it is standard practice for most civil engineering laboratories to carry out grading determinations on fine grained soils I would comment that in my experience it is only universities (whose interest is research) or government laboratories who regularly carry out such particle size tests. The information from such tests is generally irrelevant to engineering needs and the money spent on such tests would normally be much better spent elsewhere. Perhaps John Galloway's pertinent comments (letter in Nov 1979 N.Z. Geomechanics News) on relevant and irrelevant tests apply here.

Yours faithfully,
L.D. Wesley.

References:

1. Cooling, L.F. (1946) Development and Scope of Soil Mechanics. I.C.E. Publication: The Principles and Application of Soil Mechanics.

2. Skempton, A.W., and Bishop, A.W. (1954) Soils. Chapter X of Building Materials: Their Elasticity and Inelasticity, Edited by M. Reiner.

3. Terzaghi, K. and Peck, R.B. (1948) Soil Mechanics in Engineering Practise. J. Wiley & Sons.

NEWS FROM THE MANAGEMENT SECRETARY

1. Management Committee

The Management Committee for 1980 is:

I.M. Parton	(Chairman)	Auckland
A.J. Olsen	(Secretary)	Auckland
D.M. Bell	(Vice-Chairman, Eng. Geol.)	Christchurch
J.P. Blakeley		Auckland
J.H.H. Galloway		Wellington
J.G. Hawley		Palmerston North
T.J. Kayes		Wellington
R.D. Northey	(Vice-Chairman, Soil Mechanics)	Wellington
M.J. Pender	(Vice-Chairman, Rock Mechanics)	Auckland
S.A.L. Read	(Editor, Geomechanics News)	Wellington
D.K. Taylor		Auckland

2. 1981 Subscriptions

In setting the basic membership subscription for 1980 at $10.00, the Management Committee was concerned at the size of the increase from 1979 and discussed at length means of reducing costs of running the Society. The increase was largely due to the removal of certain subsidies by N.Z.I.E. and also because the parent body now levies technical groups for secretarial services on a per capita basis. Our Society's operations are subsidised to a degree by profits from sale of publications.

3. Forthcoming Conferences

16-20 September 1980:	"Eurotunnel 80 - 2nd International Exhibition and Conference for the Tunnelling Industries": Basle, Switzerland.
20-25 October 1980:	"23rd Annual Meeting of the Association of Engineering Geologists": Dallas, Texas, USA.
16-18 March 1981:	"4th Australian Tunnelling Conference": Melbourne, Australia.
29 June - 2 July 1981:	"22nd U.S. Symposium on Rock Mechanics": Cambridge, Massachusetts, USA
1983 :	"ISRM 5th International Congress on Rock Mechanics", Melbourne, Australia.

Further information on these conferences may be obtained by writing to the Management Secretary.

A.J. Olsen
Management Secretary

FORTHCOMING CONFERENCES IN NEW ZEALAND

"Geomechanics in Urban Planning"

Palmerston North 29th April - 1 May 1981

The aim of the symposium will be to examine in detail how geotechnical considerations can best be integrated into urban planning. Emphasis will be on dealing with the common problem situations - significant rather than extreme compressibility, instability etc. Several recent urban planning exercises will be described by people closely involved with them - both geotechnical engineers and planners.

The first address will be given on the evening of Wednesday 29th April and the programme will finish at about 4 p.m. on Friday 1st May.

The symposium is being organised by the N.Z. Geomechanics Society and the Manawatu branch of the N.Z.I.E. in association with the N.Z. Planning Institute. It continues the sequence of symposia staged by the Geomechanics Society on specific geotechnical topics, the most recent being the "Stability of Natural Slopes" in Nelson 1974 and "Tunnelling in New Zealand" in Hamilton 1977.

In order to assist the organisers, interested persons are asked to complete the "Intention to Register" form below and post it, preferably before 1 October to:

Ms P.M. Hayden
Aokautere Science Centre
Ministry of Works and Development
Private Bag
PALMERSTON NORTH

J.G. Hawley

- -

INTENTION TO REGISTER

I and / or .... persons from my company / organisation will probably attend the symposium "Geomechanics in Urban Planning" to be held in Palmerston North from 29 April to 1 May 1981.

Please put my name on your mailing list for further information.

NAME: .... PROBABLE No. OF PARTICIPANTS ....

ADDRESS: .... No. of WIVES /HUSBANDS ....

....

Business Telephone: ....

COMPANY / ORGANISATION ....

Conference of the Geological Society of New Zealand
Christchurch, 24-27 November 1980

Engineering Geology will form one of the three themes for the Conference, though the conference will cover all aspects of geology. The previous conference with an Engineering Geology theme was held in 1975 at Kaikoura and since then there has been a rapid increase in both the use of engineering geological principles and in the expertise of the available practitioners. It is planned to have a full day of papers and two relevant half-day field trips, though the response from potential contributors will determine the success or otherwise of the session. The conference will be held at the University of Canterbury and accommodation will be available at the Halls of Residence.

Intending contributors are requested to submit abstracts which will be published prior to the conference and formal papers are not required. Further information may be obtained from the Session Convener. Abstracts and completed registration forms are requested by 15 August 1980.

Mr B.R. Paterson,
Session Convener,
New Zealand Geological Survey
University of Canterbury
Private Bag, CHRISTCHURCH

D.H. Bell

Annual Conference of the New Zealand Institution of Engineers
Auckland, 9-13 February, 1981

The conference theme is "Engineering Strategy for a Creative Future". As in past years, the Geomechanics Society will contribute to the conference by nominating papers for technical sessions on Geomechanics.

Members wishing to put forward papers for consideration are asked to submit synopses to the Management Secretary by 31 July 1980. The deadline for submission of draft papers for preprinting will be 31 October 1980.

A.J. Olsen

FORTHCOMING CONFERENCES OF THE INTERNATIONAL SOCIETIES

1. I.S.S.M.F.E.: 10th International Conference on Soil Mechanics and Foundation Engineering Stockholm, 15-19 June 1981

The conference, which is organized by the Swedish National Committee of the International Society of Soil Mechanics and Foundation Engineering, is concerned with the advance in the theory and practice of soil mechanics and foundation engineering on the following themes:

- Prediction and performance
- Tunnelling in soils
- Groundwater and seepage problems
- Laboratory testing
- Soil/structure interaction
- Environmental control (including waste materials)
- Soil exploration and sampling
- Pile foundations
- Saving cities and old buildings
- Soil dynamics
- Slope stability
- Soil improvement

7 summaries of papers from New Zealand papers were received by the N.Z. Geomechanics Society and submitted to the conference. The second bulletin has been circulated and the third bulletin which will contain the detailed program and final registration form, hotel accommodation, technical visits and tours, technical exhibition etc. will be sent to the National societies for distribution in September 1980. Correspondence pertaining to the 10th conference should be sent to:

Secretary General X ICSMFE
Jakobs Torg 3
S-111 52 Stockholm
SWEDEN

2. I.S.R.M.: International Symposium on Weak Rock Tokyo, September 1981

The symposium which is organized by the Japanese Society on Rock Mechanics is to bring together recent work and knowledge of weak rock and to discuss the engineering efforts to overcome the unfavourable geological conditions which are often encountered in dam, underground openings, undersea tunnels, mining, foundations of nuclear power stations, large suspension bridges and transmission tower, excavated slopes etc.

Weak rock - soft, fractured and weathered rock - is characterised by rock mechanical aspects such as swelling, slaking, disintegration, creep, consolidation, non-linear deformation, permeability and faulting in hard rock masses. The preliminary themes for the symposium are:

- Engineering properties of weak rock
- In situ investigation of weak rock
- Specialized theory and analysis of weak rock
- Adequate design and construction practice in weak rock
- Dynamics and tectonics of weak rock

Abstracts, which should not consist of more than 300 words, should reach the symposium secretariat by 30 September 1980. If accepted, the full texts will need to be prepared by 31 May 1981.

The preliminary announcement of the symposium has been circulated and further information can be obtained from:

Secretariat of the International Rock Mechanics
Symposium on Weak Rock
c/o Japan Convention Services Inc.
Nippon Press Centre Building
2-2-1, Uchisaiwai-cho, Chiyoda-ku
Tokyo 100, JAPAN Telex 222 9025 JCS J

3. <u>I.A.E.G.: 4th International Congress of the International Association of Engineering Geology</u>
<u>New Delhi, 1-6 December 1982</u>

The congress which is organised by the Indian Society of Engineering Geology will be concerned with presentation, comparison and discussion of research highlights, ideas, experiences and information obtained in selected field of Engineering Geology.

The selected themes are:

- Engineering geological studies for environmental evaluation and development
- Engineering geological problems of tunnelling and excavation of cavities
- Soil and rock as construction material
- Engineering geological problems of natural and man-made lakes
- Engineering geological problems of sea-coast and shelf areas
- Seismic and seismo-tectonic investigations of engineering projects
- History and development of engineering geology

Abstracts of papers, which should not consist of more than 300 words, should reach the management secretary by 30 May 1981. Full texts of accepted papers (with abstracts in French and English) will be required by 31 December 1981 for turning over to the secretary of the congress.

The first circular for the congress which includes details of pre and post congress tours and cultural activities has been circulated together with an information and registration card. Correspondence in connection with the congress should be addressed to:

Srivastava, K.N.
Secretary, Organising Committee
Secretariat of the IV International Congress of
Engineering Geology, INDIA-1982
47-48 Pragati House
Nehru Place, New Delhi - 110019 Telex 31-3248 INDIA

S.A.L. Read.

INTERNATIONAL TUNNELLING ASSOCIATION NEWS

The 1979 General Assembly of the International Tunnelling Association was held on 16th and 17th June 1979 at the 4th Rapid Excavation and Tunnelling Conference in Atlanta, U.S.A. Although New Zealand was not represented, the 1978 Annual Report (Geomechanics News 18, p. 17) had been submitted.

The following new officers were elected (each for 3 years):

Vice President	-	Mr G. Girnau (Federal Republic of Germany)
Secretary General	-	Prof. V. Roisin (Belgium)
Executive Council Members	-	Mr L. Lupiac (France)
		Mr J.K. Lemley (U.S.A.)

Poland and The People's Republic of China were admitted as member nations to the I.T.A.

All the working groups, of which there were 8 - standardization, research, contractural sharing of risks, subsurface planning, safety in work, maintenance and repair, structural design models, catalogue des travanx - presented reports. Points of interest from the groups include:

- A preliminary general report on "Development and Future trends of shield tunnelling". Japan, with 353 km, is the world leader in this type of tunnel, it commonly having a 11-20 m^2 section and used in sewers.

- "Tunnelling Research", I.T.A. publication No.1, is being updated during 1979/80.

- Four recommendations on the contractural sharing of risks are given in I.T.A. publication No. 3.

A new working group on the "Seismic Effects on Underground Structures" has been formed. Dr R.W.G. Blakeley has since been nominated as corresponding member for New Zealand.

The 6th Annual Meeting of I.T.A. took place in Brussels, Belgium during an International Conference on "Safety of Underground Works" held between 19th and 23rd May 1980. A representative from New Zealand was not able to attend. The 7th Annual Meeting will take place during a Symposium on "Cost Cutting Research in Tunnelling" to be held in Nice, France between 11th and 15th May 1981.

S.A.L. Read.

TOWARDS A GENERAL THEORY OF SENSITIVITY

I.J. Smalley and S.P. Bentley

The idea of soil sensitivity seemed to creep into the world of soil engineering almost by accident. Though the concept of clay soils losing strength on disturbance had been earlier discussed by the Swedish State Railways, the first precise definition of the sensitivity parameter appears to have been made by Terzaghi in 1944 in a paper entitled "Ends and Means in Soil Mechanics". Terzaghi's paper, which is a very general study of the field of soil mechanics, appeared in the Canadaian 'Engineering Journal' - not really a front rank publication. The concept of sensitivity was introduced very casually and defined in a brief and minor section well into the paper giving the reader the impression that the concept was already usual and accepted - yet no earlier literature appears to exist.

Terzaghi's definition of sensitivity was:

$$S_t = \frac{q_u}{q_{ur}}$$

where q_u is the unconfined compressive strength of the undisturbed soil

q_{ur} is the unconfined compressive strength of remoulded soil at the same water content

As pointed out by Soderblom (1969), the unconfined compressive strength may have some meaning with respect to soils of moderate sensitivity but a remoulded quickclay is a liquid and therefore the sensitivity of extremely sensitive materials is usually determined by a dropping cone method. This method was used by Penner (1963) to measure sensitivities of 1500 in Canadian clays - as far as we know the highest value of sensitivity ever measured.

The clays of extremely high sensitivity were often known as quickclay, a term which is still used in Scandinavia but appears to have fallen from favour in North America. It is an attractive term because it allows the identification of a very special type of soil material; one which presents remarkable problems to the soil engineer. The definition of a quickclay presents a problem; it being a clay with S_t >16 in the classification of Skempton and Northey (1952) while according to Rosenqvist (1953) quickness has a range of values from slightly quick at $S_t = 8$ to extra quick at S_t >64. We propose that the Swedish definition (via Soderblom) should be adopted, in which sensitivity is defined as:

$$S_t = \frac{H_3}{H_1}$$

where H_1 represents the relative strength value determined by means of the Swedish fall-cone test on completely remoulded clay (Hansko 1957)

H_3 represents the relative strength value determined by the same test on undisturbed clay.

For a soil to qualify as a quickclay H_3/H_1 >50.

Soderblom (1974) later refined the definition of sensitive soils by introducing the parameter of rapidity. This indicates the amount of energy which has to be put into the soil to achieve the remoulded state. Some soils remould very easily but some require a considerable energy input; for example the quickclays at Utby in Sweden have a very high sensitivity (H_3/H_1 up to 450) but require a great amount of working to be completely remoulded. The Utby clays may be initially classified as non-quick but after several minutes of intense remoulding the H_1 values drop substantially. These materials of low rapidity are less dangerous than the rapid quickclays.

Having disposed of the definitions we can approach the main purpose of this article, which is to take a quick overview of some recent developments in the investigation of sensitive soils and to see if a general theory of sensitive soils might be emerging. This has some relevance to engineering practice in New Zealand since we do have some sensitive soils, and we hope to show that these might, in fact, have a critical role to play in determining how sensitivity arises in soils.

The paper which can be thought of as initiating the scientific study of sensitivity is that by Skempton and Northey (1952) entitled "The sensitivity of clays". The paper did more than bring sensitivity to people's notice, it contained a reference to a paper by Rosenqvist - the beginnings of the leaching theory of sensitivity.

The leaching theory, first published in English in 1953, basically required that cations be removed from a marine clay by freshwater leaching and that this led to a metastable structure with little inherent strength. The very elegant theory was widely accepted and most textbooks on soil mechanics, which only mention sensitivity in passing, usually ascribe high sensitivities to the leaching process. Rosenqvist (1979) has recently revised his theory of sensitivity and now presents the development of sensitivity by leaching as part of a more comprehensive theory of sensitivity. However, as the Rosenqvist approach is very much identified with the idea of leaching, it will be quite a while before the modifications pass into the system.

Pusch and Arnold (1969), working at Chalmers University in Gothenburg, cast a real doubt on the leaching theory when they tried to produce an artificial quickclay using Grundite illite- and failed. Failed in fact to even produce a modest sensitivity and have failed subsequently in repeated attempts. In addition, indications were coming from Canada that perhaps the leaching theory could not explain all quickclay occurrences. Initial mineralogical analyses indicated that the Canadian quickclays appeared to contain very little clay mineral material (Beland 1956). This is in contrast to a prime requirement of Rosenqvist's earlier (and later) theories that the properties of the soil were determined by the clay mineral materials.

One response to the observations of Pusch and Arnold (1969) was the formulation of the inactive-particle, short-range-bond theory (Smalley 1971). This theory attempted to show that the extreme sensitivity of quickclays was due essentially to the lack of clay mineral material; the major requirement being a predominance of inactive particles and a lack of long range interparticle bonding forces. The approach, which was the direct opposite of that of Rosenqvist, required quickclays to be normally glacial materials composed largely of clay-sized quartz and feldspar particles. Soderblom on the other hand was suggesting that the presence of dispersing agents was critical for high sensitivities, and Liebling and Kerr (1965) were promoting the action of clay minerals, and requiring high clay mineral contents- which were patently absent in the Canadian soils.

Mitchell and Houston (1969) in a review of the causes of clay sensitivity, listed eight possible causes but were able to reach few conclusions apart from listing the suggestions which had been made to account for sensitivity.

We see the next major step forward as the proposals that emanated from McGill University in which interparticle cementation had a critical role to play in sensitivie soils and that the Canadian soils contained a substantial proportion of amorphous material(McKeys, Sethi & Yong 1974). Not only did the amorphous material possibly have a role to play in determining the properties of problem soils but it also interfered with the processes of mineralogical analysis. Precise quantitative mineralogical analysis of clay soils is difficult and very little was actually carried out on very sensitivie soils before Gillott (1971) published his study of the Canadian Leda Clay.

1971 was actually a critical date in Canadian studies because in that year the St Jean Vianney landslide occurred with the result of extensive property damage and the loss of more than 30 lives. This event graphically demonstrated just how dangerous quickclays can be and prompted a renewed interest in the sensitive soils in Canada including substantial studies of the St Jean Vianney material ($S_t \simeq 200$). Some of these studies illustrated once again, the difficulties of mineralogical analysis; the Leeds University thermobalances recorded about 9% of clay mineral material believed to be illite (Smalley, Bentley & Moon 1975) whereas the Norwegian Geotechnical Institute detected 30% of illite using X-ray diffraction techniques. Viscometric studies on the St Jean Vianney material have shown it to have a fundamentally different nature from other St Lawrence valley clays with a much lower sensitivity (Bentley 1979, Bentley & Smalley 1979).

The active regions in the study of sensitive soils appear to be (in scientific rather than geographical terms) the nature and properties of amorphous material - looking mostly to Canadian materials; developments of the leaching theory, emphasizing the role of clay minerals - looking mostly to the Norwegian material; and the inactive particle theory which claims some relevance to the Scandinavian and Canadian soils. And this is where New Zealand comes in; one of the problems of studying very sensitive soils is their extreme rarity (lucky for engineers) which makes comparative studies difficult.

To develop a general theory of sensitivity more samples, more occurrences of sensitive soils with sensitivites approaching the quickclay level are needed and these do exist in New Zealand. The landslide at Omokoroa near Tauranga in August 1979 had many of the characteristics of a flowslide failure (Chris Gulliver; pers. comm.) with soil sensitivities of around 40 having been measured (Tonkin & Taylor 1980). So here we have a new window on the sensitivity problem; another set of observations with which to test the various theories.

Initial investigations have shown that the soil involved in the Tauranga slide consisted largely of halloysite (> 80%). Scanning electron microscope studies have indicated that the halloysite is of the spherical variety and that any iron-manganese concretions present are very localised and there is no sign of cementation. At first sight it is difficult to reconcile these observations with any of the existing sensitivity theories but closer examination suggests that a compromise might be reached with the inactive particle theory. In its fully developed form (Cabrera & Smalley 1973) the inactive particle theory requires the soil to consist of particles which do not possess the capacity to form long range interparticle bonds, i.e. a very low plasticity index is required. The low PI is achieved in northern hemisphere materials by specifying a low clay mineral content, but of course in New Zealand there are a whole range of exotic clay minerals which behave very differently from the active northern hemisphere materials. Thus we can have a low PI soil with an 80% halloysite content; a clay mineral soil without significant long range bonding - and a material which one might expect to be sensitive.

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N.Z.I.E. CONFERENCE, DUNEDIN

11-15 February 1980

At the 1980 N.Z.I.E. Conference the Geomechanics Society sponsored four technical sessions and held its Annual General Meeting on Wednesday, 13 February.

Technical Session 1: "Recent development in Pavement Evaluation for the Practitioner"

Mr N.G. Major who chaired the workshop session, gave an introduction on the principal modes of distress and presented a series of eight pavement sections, using colour slide illustrations and supporting information from the road controlling authority records.

Eight cases (four urban, four rural, largely from the Wellington and Dunedin urban and Otago rural areas) were then presented. Each person attending was expected to complete a survey sheet recording the pavement conditions and distress symptoms, mode of distress, and list alternative maintenance or rehabilitation treatments, indicating the most appropriate. Upon completion each case was reviewed by a representative of the road controlling authority.

While in discussion there was some disagreement about which would be the most appropriate treatment, the main concern was that "Three minutes isn't enough to decide on best treatment". It was argued in response that in fact the decision on the choice of treatment for most of the sections shown had been made (in 1979) in the time it took to drive the section - usually about one and a half minutes.

The attendance of 55 over-filled the venue. Repeat sessions have been run in the following 2 months at Auckland (2), Dunedin and Invercargill.

Technical Session 2: "Control of Pile Driving Operations using the Pile Driving Analyser"

Mr Trow, in presenting his paper, spoke of the development of the pile driving analyser. The analyser is essentially a mini-computer which solves the wave equation and computes the resistance to penetration at each blow of the pile driver. Strain gauges and sensors, fastened to the pile prior to driving, allow wave travel times and elastic movements of the pile to be measured with each hammer blow giving accurate solution to the wave equation.

The analyser is not used routinely on a site but may be used at the beginning of a large pile driving job to measure the resistance to driving for 2-3 piles in place of a conventional load test. The analyser has also been used to determine pile capacites in arbitration cases where dispute has arisen over pile capacities or driving conditions.

Technical Session 3: "Urban Slope Instability"

Dr J.G. Hawley chaired a discussion session with Messrs G.A. Hutchinson and D.K. Taylor answering questions from the floor. Rather than the technicalities of slope failure, the discussion focused on legislative and organisational measures to ensure wise use of land upon which evidence of instability had been produced.

Opinion varied from extreme caution to avoid loss or distress to any land-owner (and consequent "finger pointing" at any local authorities), to a reluctance to see areas of potentially very useful land written off by suspicion only.

One of the problems is that the technical adviser at the Land Zoning and Scheme Planning Stage has no direct contact with the eventual sufferer so he cannot guide him in terms specific to his proposed use of the land. Advance judgements therefore have to take cognisance of a very wide variety of building and site development possibilities.

Technical Session 4: "Huntly Power Station Cooling Water Intake Structure"

The paper, presented by D.K. Taylor, described the investigations and studies that led to the development and successful use of an open caisson at the 1000 MW Huntley Thermal Power Station for the construction of the cooling water intake. The intake is founded 19 m below ground level and 14 m below groundwater level in very permeable sands.

Questions about the sinking process were answered by Mr A.S. Brown who, earlier in the day had presented a paper by himself, and Mr D.D. Cox describing the design and sinking of the caisson. A significant point made was that a flow of water from outside the caisson is not necessary to assist sinking, and in fact a severe restriction had to be placed upon drawdown inside the caisson in order to maintain control of ground stability.

Annual General Meeting of the Geomechanics Society

The meeting, which followed session 4, was attended by only 13 members of the Society. The election of the management committee by the earlier postal ballot was confirmed.

The matter of poor attendances at Annual General Meetings was discussed and it was suggested that the meetings might be held during a technical session. A request was made that this possibility be considered for the 1981 N.Z.I.E. conference in Auckland.

Dr Aspden expressed pleasure at the public statement made by the Society, through the Chairman, on the Abbotsford landslide, and said that the N.Z.I.E. hoped that more involvement of technical groups in issues of public interest would occur.

D.K. Taylor

LOCAL GROUP ACTIVITIES

1. WELLINGTON GROUP

1.1 The use of Geophysics at Engineering Sites:

On Tuesday October 9, 1979, Mr C.E. Ingham of the DSIR Geophysics Division gave a most interesting illustrated talk to an audience of 35 people.

This talk emphasised the essential differences between the seismic refraction technique as applied to engineering problems and the same technique applied to structural geology. Textbooks without exception offer solutions in terms of critically refracted rays where the angle of refraction at any boundary is 90° and ray paths are along sub-surface interfaces. The best of these methods fail to yield valid solutions when departure from plane layering is only moderate.

Almost always in oil exploration and frequently in other structural geology problems it is possible to site the survey to avoid river gorges and other situations which involve rapid gradient changes in refractor surfaces. This is not so in engineering work where reservoirs are established in river gorges and heavy structures are deliberately sited on rock outcrops often with steep buried flanks, so that the more general refraction interpretation problem involving shortest time ray paths which penetrate deeply into the body of the refractor, has to be faced.

Iterative modification of a subsurface model until ray times scaled from it match simultaneously to time/distance curves obtained by shooting at either end of a line of geophones on the ground surface is one approach to solving these problems, and cross-sections showing a somewhat spectacular configuration of 'high velocity' bedrock beneath DG7 damsite on the Clutha River were used to illustrate the technique. An attempt was made to explain the cross sections in terms of the original fault which led to the formation of the gorge and mass transport of rock caused by sliding on schistosity planes which appear to have been inclined downwards towards the river by drag on the fault. Based on time/distance data alone, these solutions are further from being unique than are the critical ray ones; but it is in favour of engineering work that drillhole depths and other controls can usually be incorporated in the model.

1.2 Active Earth Deformation in General with Specific Reference to the Wellington Region

On Thursday April 10, 1980, Mr G. Lensen of the DSIR Geological Survey spoke on the above topic. His talk included a review of the New Zealand Geological Survey Report 89 (1979) "Active Earth Deformation", and resulted in lively discussion.

This report consists of four parts:

In Part I the New Zealand Geological Survey states its policy and practice on active earth deformation and emphasises the standardisation and uniformity in the treatment of data and presentation of the interpretation.

Part II defines the terminology relating to earth deformation, it classifies active faults and folds by strictly adhering to the available evidence of their past geological history of activity. Where evidence of past activity is missing, but the structure can be geologically identified <u>and</u> the absence of evidence can be shown to have been destroyed or obscured, criteria for classification as "Potentially Active" are presented.

The periodicity of movement and the risk of future movement are briefly discussed.

Part III stresses the need to separate data from interpretation and these are discussed separately.

Part IV - Town Planning and Engineering Implication discusses the criteria for separate presentation of a Data Map and an Interpretative Map, and concise rules to achieve standardisation of interpretations are listed.

The report ends with a brief and general discussion on the engineering implications of active earth deformation.

T.J. Kayes

2. CHRISTCHURCH GROUP

The following meetings have been held in a relatively active start to 1980 - attendances given in brackets.

12 March - Joint meeting with NZIE Canterbury Branch
G L Evans and D H Bell on "Erosion Problems and Chemical Stabilisation in Port Hills Loess" (about 50)

23 April - W Dudding and D H Bell on "Railway Stability Problems and Remedial Options in the Kaikoura Area" (about 30)

4 May - one-day field trip to inspect railway stability problems between Claverley and Oaro (Leaders: D H Bell and W Dudding) (9)

19 May - Special meeting. Professor Yamanouchi on "Aspects of engineering practice in Japan, with particular reference to stability problems in volcanic ash soils" (9)

Two further evening lectures are planned for 1980, to be held at times to be determined. These talks are:

1. Dr R.D. Northey on "Geotechnical Aspects of the Abbotsford Landslip"
2. Mr P. Kerr (MWD Greymouth) on "Highway Stability Problems in the Arthurs Pass and Haast Pass areas".

There are, of course, several ways in which to interpret the attendance records at our meetings so far this year. The simplest of these is that interest in geomechanics wanes as winter approaches, and is asymptotic to a residual value of about 10: if the shape of the curve is in fact parabolic, then we can clearly expect an upsurge in attendance in the spring. On a more serious note, however, the Christchurch Section is still having major problems in arousing the interest of those engineers engaged in foundation work. We have no shortage of interest from surveyors and engineering geologists and the like: in fact, those engineers with only a peripheral interest in geomechanics seem to give us far greater support than those directly involved.

I wonder if this is not some sort of "universal truth"; which I won't attempt to explore any further. More likely it reflects the fact that the organising committee in Christchurch remains unchanged from previous years, namely D H Bell, G L Evans and B R Patterson.

D H Bell.

ENGINEERING GEOLOGY AT THE UNIVERSITY OF CANTERBURY - CHANGES TO THE MSc DEGREE

Background

Undergraduate *Engineering Geology* courses at the University of Canterbury are taught as part of both the BE and BSc degrees - BE at the second and third Professional (Civil) levels; BSc as part of the first, second and third year geology course work. It is at MSc level that the "real" teaching of *Engineering Geology* is undertaken, and the University of Canterbury offers the only MSc (Eng Geol) degree in New Zealand.

It has been becoming increasingly clear that changes were desirable both in the MSc course content and its structure, particularly a facility whereby ME (Civil) and MSc (Eng Geol) students could take restricted papers from either course. The new proposals have now reached the stage (June 1980) where only Professorial Board approval is required before the revised course becomes available in 1981.

New MSc Course

The course consists of 8 subjects taught over 2 terms with a project occupying the third term. Each of ENGE 651 - ENGE 658 has a nominal 10 2-hour contact sessions, with additional laboratory and project work. The limited substitution of ME (Civil) papers by way of ENGE Special Topics, exists although normally a student would be expected to take ENGE 651-8 course. Certain of the ENGE papers may also be available to ME (Civil) students with the approval of the Head of Civil Engineering Department. A thesis on an approved topic is prepared during the following year.

ENGE 651 Advanced Rock Mechanics

intact rock materials; rock defect studies; in situ testing of rock masses; rock mass reinforcement; applications and case histories.

ENGE 652 Introductory Soil Mechanics

classification and origin of soils; clay mineralogy; strength of soils; consolidation and settlement; permeability and seepage; design methods in soils; applications and case histories

ENGE 653 Advanced Site Investigations

engineering geology and construction projects; engineering geological mapping, drilling and logging methods; engineering geophysics methods

ENGE 654 Applied Hydrology

snow hydrology; runoff-infiltration studies; open-channel and pipe flow; sediment-yield studies; coastal processes; groundwater flow

ENGE 655 Underground Excavations

stress distribution around underground openings; tunnel excavation and support estimation methods; logging of underground openings; case histories

ENGE 656 Surface Constructions

aggregate resources; canals and lining materials; dam and reservoir geology; bridge sites and transportation route studies; urban construction practices

ENGE 657 Slope Stability

mass movement terminology and classification; landslide investigation methods; remedial measures; case histories

ENGE 658 Geological Hazards

environmental law in New Zealand; hazard assessment and land-use planning; engineering pedology; seismology and neotectonics; tsunami, volcanic, avalanche and flood hazards

ENGE 659 Special Topic

ENGE 660 Special Topic

ENGE 670 Engineering Geology Project

5 week literature/field/laboratory study, with written report (limit 10,000 words) and oral examination.

Discussion

Our main objective in developing this new course format is to provide a basic grounding in *Engineering Geology*, and at the same time to build on undergraduate training in the subject. We believe that an engineering geologist is primarily a geologist, but with additional training in soil and rock mechanics principles and practice. We are attempting in one year (in fact, in two terms) to provide as complete as possible a coverage of *Engineering Geology*, and depth of treatment of all topics has to be sacrificed to some extent. Nevertheless, we believe that the recognition given to hydrology and soil mechanics, and to the applied aspects of these subjects, will produce a much more broadly-based graduate than did the previous MSc degree.

Although the new courses are to be taught in the Geology Department, significant teaching input will be coming from the Civil Engineering Department (especially in Soil Mechanics), and to a lesser extent from the Geography Department and from invited speakers outside the University organisation (e.g. practising engineers and engineering geologists). A possible development from this new format is a one-year Diploma in Engineering Geology based essentially on the MSc papers year, and with the experience gained in 1981 this further development may follow in 1982.

D H Bell
Senior Lecturer in Engineering Geology

J R Pettinga
Lecturer in Engineering Geology

SMALL-SCALE ENGINEERING SEISMIC REFRACTION SURVEYS

R.A.E. Atkins

1.0 Introduction

Small scale seismic refraction surveys provide a quick and inexpensive method of determining subsurface geology, and can also give a qualitative assessment of the rock mass properties. This paper describes the method and gives several examples of its application.

The seismic refraction technique makes use of a high speed recorder, vibration sensors and explosives. The equipment required consists of: a seismograph comprising a high speed multichannel photographic recorder, a geophone for each channel of the recorder and a multicore cable to connect the geophones to the seismograph; blaster and explosives. Present day interpretation techniques have been developed from those used in early oil and mineral surveys.

On the site of a refraction survey several seismic lines may be required. Each line may consist of a number of spreads of geophones - in the case of the M.W.D. Central Laboratories equipment 12 or 24 geophones are used. The geophones are placed at equal horizontal spacings in a straight line, and locations are indicated by pegs surveyed before the seismic investigation begins.

Explosive charges are detonated one at a time along the line, and off each end. Charges usually range from 0.1 to 5.0 kilograms and are placed in shallow (up to 1 metre) holes. The charges are fired electrically by a blaster connected to the recorder which gives a 'pip' on one trace of the record to indicate the instant of detonation. The generated soundwaves travel through the ground to the geophones and are recorded on photographic paper by the seismograph.

The records are read by measuring the time from the instant of shot detonation to the arrival of the first wave at each geophone. Timing lines are marked on the record at the time the recording is made. The travel time between shot and geophone is plotted against the geophone location on a time distance graph. If the geophone line is of sufficient length and seismic wave velocity increases in successively deeper rock layers then these time/distance curves can be used to obtain apparent wave velocities in all of the layers. The apparent wave velocity in a particular layer varies with the dips of all the interfaces above it. If the up-dip and down-dip apparent velocities are known for a particular layer then the true wave velocity can be calculated and the depths to the various interfaces can be determined. For an example of the method see Hagedoorn 1959, or Musgrave 1967. Correlation of boundaries with borehole data should also be made.

The accuracy of the refraction technique may be limited by: steep boundaries small velocity contrasts, focussing affects, high velocity layers resting on low velocity layers, surface topography, noise and the depth of the refractor.

2.0 Velocity Case Studies

2.1 Maniototo

At the middle weir site, Maniototo irrigation scheme, a measurement of seismic rock velocity was required to facilitate calculations of deformation expected in the abutments from the pressure of the lake behind the dam. The P wave velocity was found to range from 0.7 km/s to 4.0 km/s on the right abutment, and from 0.7 km/s to 4.6 km/s on the left abutment (Atkins 1976). This range is considered to be due to differences in weathering and jointing. Several shots were also fired within a 14 metre diameter ring of geophones at the top of the left bank. Data from the shots produced a velocity ellipse with a minor axis of 0.7 km/s and a major axis of 1.0 km/s. The direction of the major axis correlated well (within 5°) with the alignment of the schist outcrops. A larger ring of geophones would have produced higher velocities because of deeper penetration to sounder rock.

2.2 Mangaweka

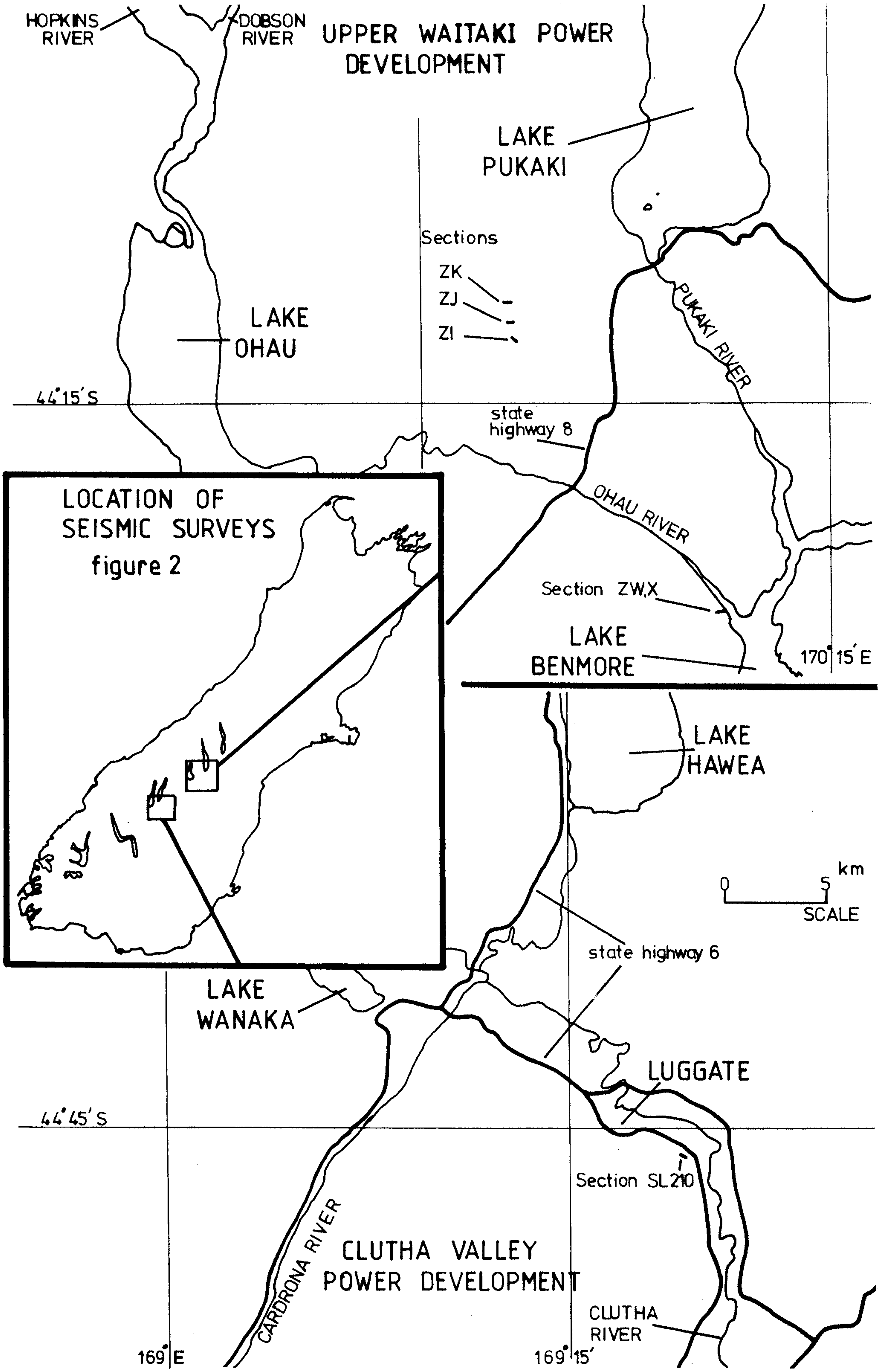
Two locations on the stage III of the Mangaweka Deviation on State Highway 1 in the Central North Island were investigated to determine if the sandstone could be ripped. Ripping for a road cutting was preferred to the more expensive conventional (explosive) technique. At both sites the lines were placed in the form of a cross, to give an indication of velocity anistropy. At a third site one line was placed on a mudstone outcrop known to be rippable to obtain a local correlation.

The rippability of rock is dependent on rock type, joint spacing, dip and strike of bedding, presence of boulders, weathering, and tractor and tyne size (Weaver 1975). In general a velocity of 2.5 km/s is the upper limit for ripping using the largest equipment available.

The seismic velocities obtained (Figure 1) indicated that the sandstone could be ripped without resorting to costly explosives. However, during ripping, hard concretionary and abrasive bands were encountered. These were not detected seismically because of their discontinuous nature, but as they were able to be ripped, did not cause the need for an alternative excavation method.

Site	NZMS 1. Sheet N139 Mangaweka grid reference	Azimuth of Line	Velocity of Rock km/s
1. Sandstone	287 076	30°	1.3
		146°	1.6
2. Sandstone	307 077	99°	2.1
		188°	1.9
3. Mudstone	282 068	94°	2.3

Figure 1 - Seismic Velocities from Mangaweka


HOPKINS RIVER
DOBSON RIVER
UPPER WAITAKI POWER DEVELOPMENT
LAKE PUKAKI
Sections
ZK
ZJ
ZI
LAKE OHAU
PUKAKI RIVER
44°15′S
state highway 8
OHAU RIVER
LOCATION OF SEISMIC SURVEYS
figure 2
Section ZW,X
LAKE BENMORE
170°15′E
LAKE HAWEA
0
5
km
SCALE
state highway 6
LAKE WANAKA
LUGGATE
44°45′S
Section SL210
CARDRONA RIVER
CLUTHA VALLEY POWER DEVELOPMENT
CLUTHA RIVER
169°E
169°15′

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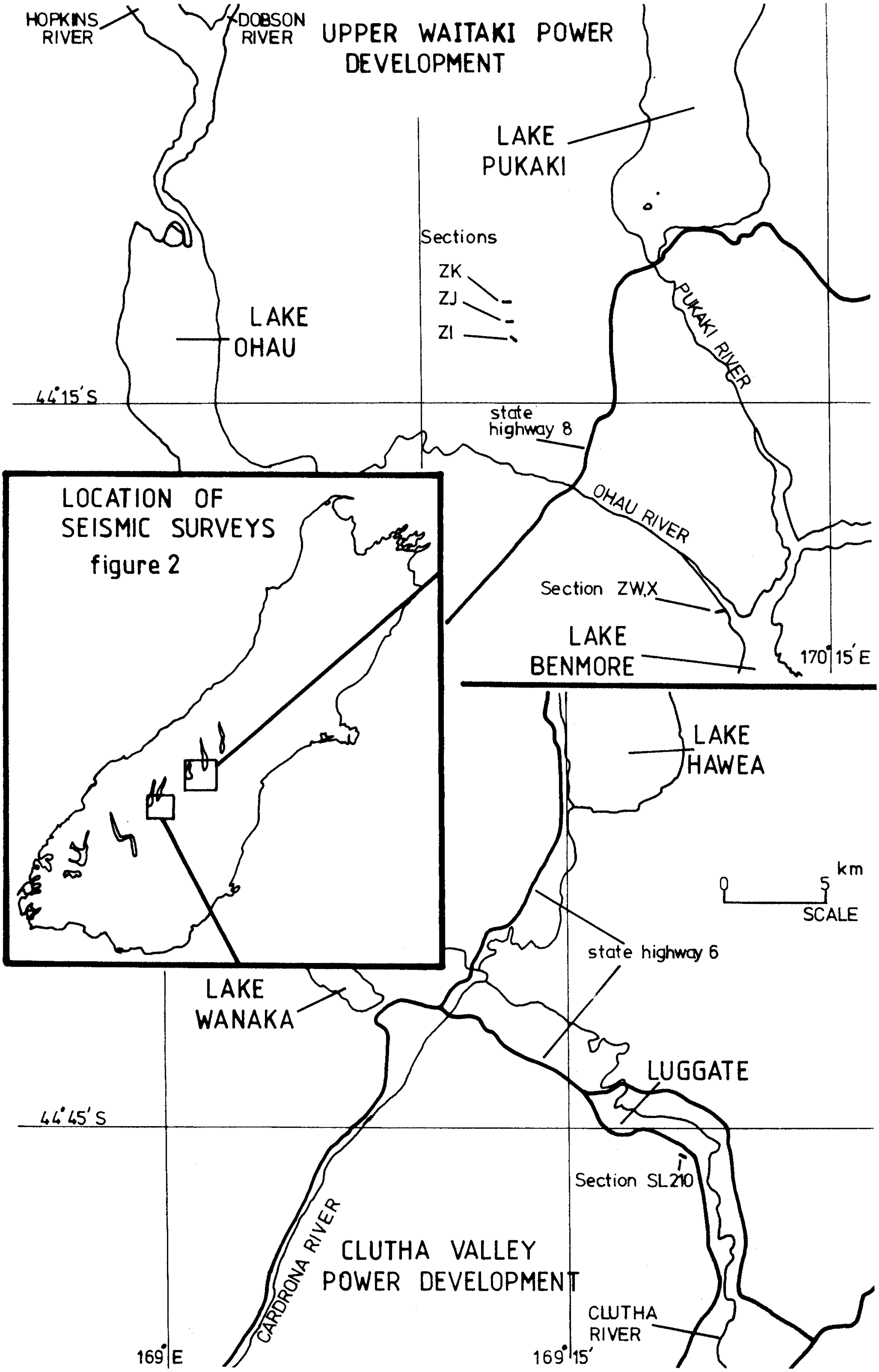
HOPKINS RIVER
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UPPER WAITAKI POWER DEVELOPMENT
LAKE PUKAKI
Sections
ZK
ZJ
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state highway 8
PUKAKI RIVER
OHAU RIVER
LOCATION OF SEISMIC SURVEYS
figure 2
Section ZW,X
LAKE BENMORE
170°15'E
LAKE HAWEA
0
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CLUTHA RIVER
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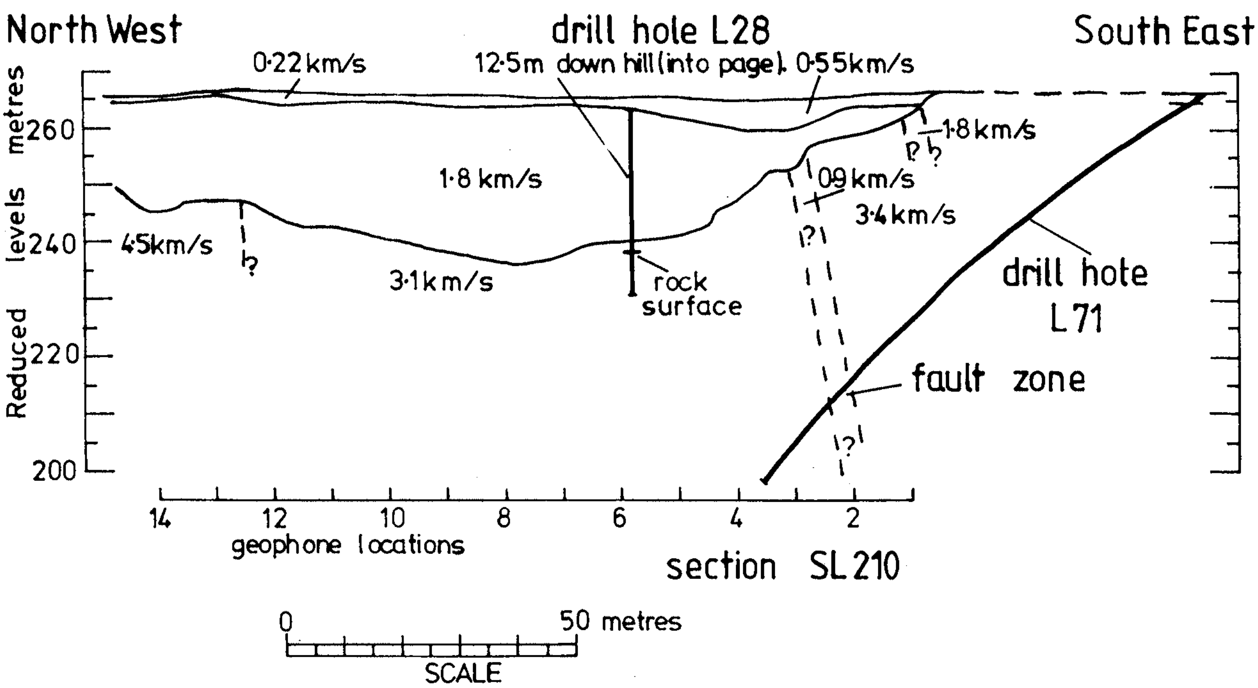
169°15'



LUGGATE SECTION figure 5

4.0 Discussion

The seismic refraction technique provides useful information about rock and other lithological boundaries, water table levels and rock mass quality on many sites, and it will continue to be an essential tool supplementing other side investigation techniques. The use of the technique may be limited on some sites by the presence of perched water tables and low velocity layers under high velocity layers. Some of the limitations can be overcome if seismic refraction is used in conjunction with electrical resistivity soundings (now also undertaken by Central Laboratories).

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APPLICATION FOR MEMBERSHIP

of

New Zealand Geomechanics Society

A TECHNICAL GROUP OF THE NEW ZEALAND INSTITUTION OF ENGINEERS

The Secretary,
N.Z. Institution of Engineers,
P.O. Box 12-241,
WELLINGTON

I believe myself to be a proper person to be a member of the N.Z. Geomechanics Society and do hereby promise that, in the event of my admission, I will be governed by the Rules of the Society for the time being in force or as they may hereafter be amended and that I will promote the objects of the Society as far as may be in my power.

I hereby apply for membership of the New Zealand Geomechanics Society and supply the following details:

NAME ____
(to be set out in full in block letters, surname last)

PERMANENT ADDRESS ____

____

QUALIFICATIONS AND EXPERIENCE ____

____

NAME OF PRESENT EMPLOYER ____

NATURE OF DUTIES ____

Affiliation to International Societies: (All members are required to be affiliated to at least one Society, and applicants are to indicate below the Society(ies) to which they wish to affiliate.)

I wish to affiliate to:

International Society for Soil Mechanics and Foundation Engineering (ISSMFE) Yes/No($4.50)

International Society for Rock Mechanics (ISRM) Yes/No($7.00)

International Association of Engineering Geology (IAEG) Yes/No ($3. $7 with Bulletin)

Signature of Applicant ______________________

Date ______________ 19 ____

N.B. Affiliation fees are in addition to the Geomechanics Society membership fee of $10.00

Nomination:

I ______________________ being a financial member of the N.Z. Geomechanics Society hereby nominate ______________________ for membership of the above Society.

Signed ______________________ Date ______________ 19 ____

NEW ZEALAND GEOMECHANICS SOCIETY

NOTIFICATION OF CHANGE OF ADDRESS

The Secretary,
N.Z. Institution of Engineers,
P.O. Box 12-241,
WELLINGTON

Dear Sir,

CHANGE OF ADDRESS

Could you please record my address for all New Zealand Geomechanics Society correspondence as follows:

____

____

____

Name: ____

Address to which present correspondence is being sent:

____

____

____

Signature ________________________

Date ________________________