Newsletter of

The Geological Society of NEW ZEALAND

GEOLOGICAL SOCIETY OF NEW ZEALAND

N E W S L E T T E R

No. 6 May 1959

CONTENTS

THE SOCIETY

The Geological Society of New Zealand was founded in May 1955. Its objects include fostering investigations into the varying fields of earth science and serving as a medium for the expression of the views of New Zealand geologists. Membership is open to all those interested in the earth sciences, including all branches of geology, paleontology, mineralogy, glaciology, geophysics, seismology, oceanography, pedology, hydrology, mining, and the utilization of minerals and rock products. There is only one class of members, and the annual subscription is at present 2/6d.

OFFICERS

May 1958 to May 1959

President	Professor D.S. Coombs
Vice President	Mr. D. Kear
Secretary	Mr. G.C. Shaw
Treasurer	Dr. J. Van der Syp
Editor	Dr. H.W. Wellman
Committee	Professor R.H. Clark
	Professor A.R. Lillie
	Dr. J.T. Kingma
	Mr. R. Dibble

Officers for the next year will be elected at the Annual General Meeting to be held at New Plymouth on 27th May, 1959.

THE NEWSLETTER

The Society publishes a Newsletter at irregular intervals; it is hoped about twice a year.

Contributions in the form of personal notes, short items of geological or geophysical interest, news of the mineral industries, suggestions for Society activities, reports of meetings, descriptions of field trips, reviews or criticisms of recent publications, and similar items will be welcomed.

Unless specifically indicated, opinions expressed in the Newsletter are not to be regarded as the official views of the Society.

This Newsletter is published for the information of members by the Geological Society of New Zealand, c/o New Zealand Geological Survey, P.O. Box 368, Lower Hutt.

MINUTES OF THE THIRD ANNUAL GENERAL MEETING OF THE GEOLOGICAL SOCIETY OF NEW ZEALAND HELD IN THE REEFTON SCHOOL AT 8 P.M. ON WEDNESDAY, 14th MAY, 1958.

WELCOME: The President, Dr. J.T. Kingma, welcomed members and thanked the Director of the N.Z. Geological Survey (Mr. R.T. Tillett) for inviting members of the Society to attend the Geological Survey Staff Conference.

APOLOGIES: Apologies for absence were received from Drs. M. Gage, J. Irving and N.E. Odell and Messrs. C.O. Clinton, G. Eiby, G.D. Innes and B.J. Collins.

PRESENT: Dr. J.T. Kingma presided over the meeting which was attended by 50 members.

MINUTES: Minutes of the Second Annual General Meeting held at Dunedin on January 16th, 1957 were taken as read and confirmed.

ANNUAL REPORT: The Annual Report and Accounts were received and adopted. As a result of a motion moved by Dr. Coombs, the Secretary was instructed to write a letter thanking Mesdames Brown and White for their part in the preparation of the Sherry party at Dunedin during the A.N.Z.A.A.S. meeting.

McKAY HAMMER AWARD: The president announced that Mr. G.R. Stevens had been awarded the McKay Hammer Award for 1956.

The sub-committee appointed to judge the 1957 award reported that it had pleasure in recommending that the award be made to Dr. C.A. Fleming. In making this recommendation the sub-committee had in mind the publication of Paleontological Bulletin 26, "The Genus Pecten in New Zealand" which, in its opinion, is of outstanding merit.

RECOMMENDATIONS BY THE RETIRING COMMITTEE:

(1) That the Secretary, Treasurer, and at least two other office bearers or committee members be from the same city so that frequent committee meetings can be held and matters of importance to the Society can be discussed: committee meetings by post have not, in the past, proved very satisfactory.

(2) That the incoming committee recommend to the sub-committee appointed to judge the 1958 McKay Hammer Award, that publications released in 1958, but dated 1957, be included for consideration with those published in 1958.

(3) That subscriptions in the future be accepted for one year only, but that an unlimited amount of money be accepted as credit towards future subscriptions.

REPRESENTATIVE TO A.N.Z.A.A.S. IN ADELAIDE 1958: The appointment of a member to represent the Society at the 33rd meeting of A.N.Z.A.A.S. in Adelaide in 1958 was left to the incoming executive and committee to decide when they knew which members would be attending.

NEWSLETTER: A motion by Dr. C.A. Fleming that the Newsletter should not publish scientific and technical names that are nomina nuda was carried.

An amendment by Mr. D. Kear to add formation names to Dr. Fleming's motion was defeated.

The editor of Newsletter No. 5, Mr. L.E. Oborn apologised to the Society and to Dr. H.W. Wellman for allowing a manuscript name to be published.

ELECTION OF OFFICERS: The following officers were elected:-

President	Prof. D.S. Coombs
Vice President	Mr. D. Kear
Secretary	Mr. G.C. Shaw
Treasurer	Dr. H.W. Wellman
Committee	Prof. R.H. Clark
	Prof. A.R. Lillie
	Dr. J.T. Kingma
	Mr. R. Dibble
	Dr. J. Van der Sijp

POST OFFICE SAVINGS ACCOUNT: Mr. D.G. Gregg moved, and Mr. L.E. Oborn seconded, that the Society's Post Office Savings Account be transferred to trustees appointed by the newly elected officers and committee.

CARRIED.

There was a vote of thanks to the retiring officers and committee, after which Dr. Coombs, President, took the chair.

MINUTES OF THE MEETING OF THE COMMITTEE OF THE GEOLOGICAL SOCIETY OF NEW ZEALAND HELD AT WILSON'S HOTEL, REEFTON, AT 7.30 P.M., SATURDAY, 17th MAY, 1958.

Present:

Prof. D. Coombs in Chair
Dr. J.T. Kingma
Dr. J. Van der Sijp
Dr. H.W. Wellman
Mr. D. Kear

Messrs. G.C. Shaw and L. Oborn (co-opted members).

Business:

(1) McKay Hammer Award

Mr. Oborn reported that 4 hammers had been bought, one had been inscribed for presentation to G.R. Stevens, and another needed to be inscribed for Dr. C.A. Fleming.

Custody of the original McKay Hammer was discussed. It was resolved that the recipient of the award would not have custody of the original Hammer, and that the Director of the Geological Survey be asked if the Survey could house it safely, and preferably display it.

The following sub committee was set up to select the next recipient of the Award:-

Prof. D. Coombs (Convener), Dr. D.A. Brown, Mr. I.C. McKellar.

(2) Subscriptions

It was resolved that it be announced in the Newsletter that subscriptions cannot be paid in advance, but extra money paid would be credited to future subscriptions. Subscriptions already "paid in advance" would be honoured.

(3) Reprinting Newsletter

As several requests had come in for previous issues of Newsletter it was resolved that 50 copies of Vol. 1, Parts 1 - 4, be run off.

(4) Appointments

Treasurer	-	Dr. J. Van der Sijp
Editor	-	Dr. H.W. Wellman
Trustees	-	Dr. J. Van der Sijp
		Dr. H.W. Wellman

(5) Appointment of A.N.Z.A.A.S. Representative

Left in hands of Wellington and Lower Hutt members. Suggested that Dr. A. Lillie be approached, and Mr. B.L. Wood if Dr. Lillie unable to accept.

(6) Next Annual Meeting

The next A.G.M. will be held wherever the next Geological Survey Conference is held. Dr. Kingma to report on this.

(7) Commercial cyclostyling of Newsletter

The possibility of having the Newsletter commercially cyclostyled, assembled and distributed was discussed. The committee in general approved the idea, but it was realised that the subscription would have to be raised if this were done. This will be discussed at the next Annual General Meeting. Dr. Wellman was authorised to get some commercial help with the newsletter within the limits of the Society's funds.

(8) Contents of Newsletter

Dr. Wellman suggested ideas for the future content of the Newsletter.

(9) N.Z. Archaeological Society

Because New Zealand archaeologists and geologists have many interests in common it was resolved that the acting-secretary send a copy of the last issue of the Newsletter to the Chairman of the N.Z. Archaeological Society, Dr. J. Golson, with a letter offering to publish news and announcements of his society's activities.

(10) International Co-operation in Mineralogy

Professor Coombs reported on recent moves to promote international co-operation in mineralogy, including an agreement between the British and American Mineralogical Societies for publishing an enlarged "Mineralogical Abstracts" and the setting up of an International Mineralogical Association.

G.C. SHAW.

FINANCIAL STATEMENT FOR THE YEAR ENDING DECEMBER 1958

Expenditure	£ s. d.	Income	£ s. d.
Sundry expenses (stamps stationery, etc.)	4.19. 6	Balance brought forward from 1957	36.17. 1½
Printing Certificates for McKay Award	10.18. -	Subscriptions received during 1958	33.18. 7
Total expenditure	15.17. 6	Total income	70.15. 8½
P.O. Savings Bank	51.17. 5		
Petty Cash	3. - 9½		
	£70.15. 8½		

(J. Van der Sijp)
Hon. Treasurer.

OVERSEAS MEMBERSHIP

An article by B.W. Collins entitled "Geology Down Under" published in "GeoTimes" last August described the activities of the Geological Society of New Zealand, and summarised geological work in this country. As a result, we are pleased to announce that the Society has had several applications for membership from North American geologists.

The American Geological Institute (2101 Constitution Avenue, Washington 25, D.C.) which publishes "GeoTimes" has forwarded three of its publications:

"Glossary of Geology and Related Sciences" (edited by J.V. Howell)

"Directory of Geological Material in North America" by J.V. Howell and A.I. Levorsen.

"Earth for the Layman" by Mark W. Pengborn Jr. (a list of nearly 1400 books and pamphlets of popular interest on geology, mining, oil, maps and related subjects).

Members may borrow these books from the Secretary.

The Executive Director of the American Geological Institute will be pleased to receive notes and articles of interest to their members from New Zealand geologists.

PERSONAL NOTES

DR. D.A. BROWN, formerly Reader in Paleontology, Otago University, is now Professor of Geology at the University of Canberra, Australia.

MR. J.D. CAMPBELL, formerly Lecturer at the University of Canterbury, is now Senior Lecturer in Geology at the University of Otago.

DR. R.A. COUPER, formerly of the Geological Survey at Lower Hutt, is now with N.V. de Bataafsche Petroleum Maatschappij, Holland.

The GEOLOGICAL SURVEY BRANCH OFFICE AT INVERCARGILL was closed at the end of 1958 and transferred to Dunedin. Messrs. I.C. McKellar, B.L. Wood, and A.R. Mutch are now stationed at Dunedin.

DR. H.J. HARRINGTON of the Geological Survey has accepted a position at the University of New England, Armadale, N.S.W., and has left New Zealand.

DR. F. KISINCKI of the British Petroleum Company, formerly at Gisborne, is now at Papua.

MR. A. MOORE, formerly with Todd Brothers, is now with BP Shell and Todd Petroleum Development at Gisborne.

MR. M. PICK, formerly of Todd Brothers, is now at Stanford University, California.

MR. P.P. VELLA, formerly of Mangaorapa, is now at Victoria University, Wellington.

DR. H.W. WELLMAN, formerly with the British Petroleum Company at Gisborne, is now Senior Lecturer at Victoria University, Wellington.

GEOLOGICAL NOTES FROM THE UNIVERSITY OF OTAGO

Congratulations and best wishes are extended to Dr. D.A. Brown on his appointment as the first Professor of Geology at Canberra University College. Dr. Brown took up his appointment as Senior Lecturer at the University of Otago in 1950 and became Reader in Geology and Paleontology in 1956. While at Dunedin he published 8 papers and memoirs on Polyzoa as well as other works. He entered fully into University activities and was a hard-working member of numerous committees. His place is being taken by Mr. J.D. Campbell as a Senior Lecturer.

Another loss is that of Dr. W.S. Fyfe, until recently Reader in Chemistry, who took up his duties in mid-January as Associate Professor of Geology in the University of California, Berkeley. Ample tribute to Dr. Fyfe's energy and the inspiration he transmits to his students lies in the number of papers and theses which have been published or completed in the three years since he started to set up his high-temperature high-pressure laboratory in the University of Otago. They cover such topics as calcite-wollastonite equilibrium, chemical equilibrium in magmatic gases (A.J. Ellis), analcime-jadeite-albite equilibria, the use of vapour pressure measurements to determine the dissociation temperature of brucite, kinetic studies and an experimental and field review of the zeolite facies, the latter being a joint publication by members of the Chemistry and Geology Departments. The laboratory is now in the hands of Mr. R.M. Carr, Assistant Lecturer in Chemistry, co-author with Dr. Fyfe in a recent paper on the mechanism of the hydrothermal recrystallization of amorphous silica to quartz through intervening cristobalite and keatite stages. He is continuing his work on kaolin-mica-aluminium silicate stability.

Members of the Geology Department welcome the transfer of the Invercargill Office of the Geological Survey to Dunedin, and now look forward to close contact with their Survey colleagues. This should be particularly stimulating in view of the current interests of both groups in schist problems.

Following a recent study by Mr. P. Robinson, Fulbright Scholar, of the schist, particularly the "mesoscopic" structures, exposed on the coast from Brighton to Akatore, other Honours students are studying the schist south of Akatore and that of the Maungatua block on the west side of the Taieri Plain, while Dr. White has commenced a study of the Central Otago schist. His collaboration with Mr. B.L. Wood of the N.Z. Geological Survey already appears to be fruitful.

Delays in preparation make it impossible to forecast a publication date for the late Professor W.N. Benson's Memoir on the geology of the Dunedin district. As part of the paleomagnetism project, the ages of the various eruptive phases of the Dunedin Volcanic Complex have been

reviewed. In a forthcoming paper it will be shown that the earliest tuffs and flows in the Dowling and Waipuna Bay inlier are interbedded in Waiauan marine sediments, and that the concept of a late Tertiary peneplain over East Otago has to be modified.

Studies on Mesozoic stratigraphy and petrography are being continued, a recent result of interest being that the Anisian sediments at Kaka Point were transported from the east or north-east. For his Ph.D. Mr. B.M. Gunn proposes to make a detailed petrological study of the Ferrar Dolerites and of some of the metamorphic rocks of Victoria Land.

A welcome development in the Department has been the construction of a library, and a map and draughting room in the attic. The former temporary reading room, once Professor Benson's study, has been converted into studies. The library now contains a fair range of geological literature.

N.Z. GEOLOGICAL SURVEY ONE TO TWO MILLION GEOLOGICAL MAP OF NEW ZEALAND

One of the main geological events of last year was the publication of the new geological map of New Zealand. We would like to congratulate Mr. Cedric Webb on the excellence of the reproduction, which ranks high as a geological map, and is by far the best geological map yet produced in this country. It is worth noting that although the topographic base map was reduced, the geological data was originally drawn on the same scale as the final map.

DISCOUNT ON GEOLOGICAL MAPS

The Director of the Geological Survey has agreed to allow Geological Society members the same discount on maps (33⅓%) as that allowed by Lands & Survey Department. Current membership receipt will need to be presented.

Mr. Willett regrets that it will not be possible to allow a discount on bulletins and other publications.

GEOLOGY AT VICTORIA UNIVERSITY OF WELLINGTON

The number of geology students has increased considerably during the last few years. Classes are now generally large and about 16 or so research students are on our books, including two from overseas universities. The staff now consists of: Professor Clark, Mr. Bradley, Dr. Wellman, Mr. Laudor and Mr. Vella.

Student projects include:

Detailed stratigraphic mapping at Wairarapa, Awatere and Clarence Valleys and Nelson city

Petrological studies of North Island Volcanics and of igneous rocks near Takaka in New Zealand, and geological and topographic surveys of the Wright-Taylor-Victoria "dry" valleys in Antarctica.

Students are encouraged to publish their research, and instead of the conventional lengthy thesis, material is expected to be presented in a form suitable for publication, with supplementary material in appendix form.

Considerable changes have taken place in the Department in the past year. We now occupy the whole of the fifth floor and part of the sixth, a total of about 11,000 square feet, in the new Science Building, very different from the "temporary" huts of the past 10 years. The rooms include laboratories for paleontology; mineralogy and petrology; stratigraphy and mapping; and smaller laboratories for micropalcontology, sedimentary petrology, silicate analysis, optical techniques and photography. There is also a large lecture room, research rooms for senior students and a well equipped grinding room and workshop.

The Departmental Geology Library, with a separate room for New Zealand publications, is an important advance of the greatest benefit to students and staff. Generous gifts of geological literature have been made by Professor Emeritus C.A. Cotton.

The Onekaka Field Station - formerly the Mine Manager's House - is conveniently placed for field training.

The V.U.W. Geological Society, formed several years ago, has regular meetings and makes a week's field excursion each year in addition to those normally held by the department.

GEOLOGICAL MAPPING IN THE CLARENCE VALLEY

by

W.D.M. Hall

The Clarence Valley, situated between the Inland and Seaward Kaikouras in "back country" Marlborough, has long been a source of geological discussion. An area of about 50 square miles, between Mead River and Coverham, is at present being mapped by Graham Gibson and Michael Hall of V.U.W. as part of a thesis for M.Sc. A preliminary visit was made to the area, with Dr. H.W. Wellman, from 26th March to 5th April, 1959.

The formations are entirely marine, and range from pre-Cretaceous greywacke and argillite to Miocene conglomerate. Rocks of the Inland Kaikouras are highly indurated greywackes and argillites, from which no fossils have yet been collected. They are intruded by dykes and sills of an alkali-basic petrographic province, of presumably Cretaceous age. Similar but less-indurated greywackes and argillites have been mapped in the Seaward Kaikouras, where they are believed to be U. Jurassic or L. Cretaceous.

The stages of the Mata and Raukumara Series are well -established on the East Coast of the North Island, and mapping of these stages in the area described has been based on fossiliferous North Island sections. The top two stages of the Clarence Series, Ngaterian and Matuan, are also well-established in the area, but the stratigraphic position of the lower two stages is uncertain, since it now appears that the Coverian is younger than it was previously considered to be. Numerous fossils, including 6 ammonites which have been sent to Mr. C.W. Wright of London for identification, have been collected from sequences of Clarentian rocks, and will help to fix the stratigraphic position of the Clarence Series.

Pre-Clarentian and Lower Clarentian formations consist dominantly of redeposited sediments, while stages higher in the Cretaceous are represented by shelf and transitional deposits. Igneous rocks have been found associated with sediments of Ngaterian and Teratan age.

Tertiary formations in the area include the well-known Flint Beds (Dannevirke), Amuri Limestone (Dannevirke and Arnold), Weka Pass Stone (Landon), Grey Marls (Parcora), and Great Marlborough Conglomerate (Southland). The Tertiary thickens towards the N.E., and the deposits change from shelf to deep-water in the same direction. One Tertiary section was measured, but it is intended to examine others, in order to establish more definitely the change in thickness and facies.

The well-exposed sections in the area indicate that the structure, originally believed to be a simple fault-angle depression, is complicated by folds and recently active faults.

NOTES ON THE N.Z.G.S. CONFERENCE AT REEFTON, MAY 1958

By

H.W. Wellman

Regional Geology

D. Kear (N.Z.G.S. Otara, Auckland) compared recent drilling results near Kaitaia, in which Eocene marine sediments rest directly on undermass, probably Tangihua volcanics, with drill results in the coalfields to the west where Eocene coal measures also rest directly on greywacke undermass, and emphasised the absence of lower Eocene and Cretaceous rocks. He suggested that this absence at depth of lower Eocene and Cretaceous is a regional feature, the outcrops of these rocks being merely superficial. If this were so, he thought the geology would be simpler than it appears to be. There was little support for the suggestion, it being considered that the Cretaceous is too extensive to be superficial, and that the explanation raises more problems than it solves.

I.G. Speden (N.Z.G.S., Wellington) presented an abstract outlining his work in south-west Otago (S.184).

H.J. Harrington outlined the results of eight weeks' field work by the N.Z.G.S. in the Cape Hallett district of Victoria Land. The Beacon Sandstone has been eroded from the district. The exposed rocks are biotite schist and granulite that still show graded and current bedding. West-north-west fold axes have been intersected by sheets of granodiorite. A peneplain on which the Beacon Sandstone may have once rested has been strongly uplifted and deeply eroded in the Admiralty Mountains to the west and depressed beneath the Ross Sea to the east. Olivine and hornblende-basalt volcanoes, mainly of Pleistocene age, cover part of the depressed peneplain. During the main ice advance in the late Pleistocene glaciers carved the 5,000 ft. cliffs along the coast and deposited granitic boulders high up on the volcanoes.

K.W. Glennie (Shell Oil Company) described redeposited (graded bedded) sediments of the Mahoenui Formation (upper Oligocene) and presented a map showing flute cast directions. About 20 directions were measured along a southward widening belt with a central line from 20 miles north of Ongarue to Raurimu. The directions were stated to be remarkably consistent and not to deviate more than 20° from due south. The inferred southward flow is from shelf sediments of the same age to the north and suggests that the depositional trough was deepest to the south where beds of this age are now hidden.

Sedimentation

Wellman briefly described the characters of graded bedded

geosynclinal beds - rhythmic cycles of muddy sandstone grading up to siltstone with flute casts at abrupt break at base of sandstone and a convolute layer in the gradation between the sandstone and siltstone - and described their New Zealand distribution. It was generally agreed that the Waiuta greywackes as exposed near Reefton were graded, but no convolute layers were seen. The Greenland greywacke is similar. The Devonian of Reefton and the other fossiliferous Devonian and lower Paleozoic sediments are probably not redeposited. Maps were presented showing the distribution of graded and non-graded sediments for (1) Permo-Carboniferous, (2) Triassic, (3) Jurassic, (4) lower and middle Cretaceous, (5) upper Cretaceous, (6) Eocene and upper Oligocene, (7) upper Oligocene and lower Miocene, (8) middle Miocene, and (9) upper Miocene. The shifting pattern of the sedimentary basins showed a gradual decrease in amount of graded sediments until the Eocene, a sudden increase in Upper Oligocene and lower Miocene and then a gradual decrease until the upper Miocene after which time no graded bedded sediments are known. Graded bedded sediments usually accumulate rapidly, and their distribution and extent may provide a measure of the rate of diatrophism at different times.

Maps were also presented showing flute cast directions for the upper Cretaceous that indicated north-east current flow over the present Raukumara Peninsula and easterly flow over the east coast south of Hawkes Bay suggesting an intervening ridge and for the middle and upper Miocene that indicated flow towards a geosyncline with an axis from Pongaroa to Mahia Peninsula. The Miocene axis is not far from the Cretaceous ridge and a complete topographic reversal in the Oligocene or lower Miocene seems more likely than continuous deposition in the same basin, as is suggested by the use of Macpherson's term "East Coast Geosyncline".

Tectonics

G.J. Lensen (N.Z.G.S., Lower Hutt, Wellington) showed from simple volumetric considerations that "horsts" and grabens" will be formed where two active transcurrent faults join or where an active transcurrent fault is sinuous. Illustrations were taken from the Ruahine Range and from the northern part of the South Island. Similar features had previously been explained by buckling or by purely vertical movement caused by tension or compression at right angles to the faults.

W.A. Watters (N.Z.G.S., Lower Hutt, Wellington) described volcanic explosion pipes of about upper Pliocene age at Chatham Islands. About 20 pipes are known. They have near-vertical contacts with the country rock which is not disturbed or metamorphosed and are filled with vesicular limburgite agglomerate or with a breccia of limburgite, gabbro, hornblende crystals, and fragments of Eocene limestone. The brecciation of the filling and the lack of contact

metamorphism are suggestive of a violent but short-lived eruption. At the few places where the filling is bedded it appears to have collapsed back into the pipe after eruption. Surface expression ranges from low inconspicuous cones to bold rugged hills several hundred feet high. Comparison was made with similar features elsewhere that have been termed "diatremes".

Petrology

H.C. Arnold (Shell Oil Co.) presented a map showing the igneous flow structure defined by the orientation of platy felspar and hornblende crystals in the Sugarloaves dacite volcanics of New Plymouth. The flow patterns are concentric around several centres and he inferred that the magma was an almost solid plug when it reached the surface. The intrusion is late Pleistocene - post-lower Pouakai and just before or during upper Pouakai time. Oil seepages that led to the discovery of the New Plymouth Oil Field were first found near the volcanics, which have had considerable interest to petroleum geologists. They had been described by C.A. Hutton as ring dykes and considered by petrological correlation in the Coromandel to be of Miocene age.

J.J. Reed (N.Z.G.S., Lower Hutt, Wellington) considered that the petrological contrast between the Hokonui and Alpine facies, as redefined by Wellman in 1956, is not as extreme as had previously been thought. Volcanic and feldspathic types were recognized by him within the Alpine Facies but they intergraded and many volcanic sediments contain quartz, microcline, and biotite, and many of the feldspathic sediments contain rhyolitic and andesitic grains. The volcanic type intergrades with rocks of the Hokonui Facies. The rocks described are of upper Paleozoic and lower Mesozoic age and are almost entirely of marine origin. The Ohika group, of upper Jurassic age, is entirely non-marine but it contains vitric tuffs and arkositic sediments and is thus similar to marine sediments of the same age.

H.J. Harrington (N.Z.G.S., Lower Hutt, Wellington) in an abstract only, considered the igneous rocks of New Zealand in terms of modern ideas on age and structural relations and proposed the following petrographic provinces:-

A. Provinces of Poutini Region (West of Fyfe's Line)

1. Haupiri Ophiolitic Province
2. Fiordland-Rotoroa Metamorphosed Complexes
3. Tuhua Granite Province
4. Westland Lamprophyre Province

B. Ophiolite Provinces of the New Zealand Geosyncline

1. Brook Street Sub-Province
2. Dun Mountain Sub-Province
3. Alpine Sub-Province

C. Upper Jurassic to Early Senonian Provinces

1. Tangihua and Matakaoa Basalt Provinces
2. Mount Camel Andesite-Rhyolite Province
3. Mount Somers Andesite-Rhyolite Province
4. Tapuaenuku Province
5. Paparoa Basalt Province

D. Basalt Provinces of the Tertiary Marine Transgression

E. Provinces of Lower Miocene to Recent Age

1. North Island Volcanic Province
   (a) Manakau Andesite Sub-Province
   (b) Auckland Basalt Sub-Province
   (c) Coromandel Andesite-Rhyolite Sub-Province

2. South Island Volcanic Province
   (a) Otago Olivine Basalt Sub-Province
   (b) Solander Andesite Sub-Province

Of the Ophiolite Province he noted that the igneous rock series, from spilites to keratophyres, consisted of the same minerals with progressively less pyroxene.

By plotting K_2O against SiO_2, two Andesite-Rhyolite associations were compared with greywackes. The trend is direct for the igneous rocks and inverse for the sediments. He inferred that the igneous rocks are of primary igneous origin and were not forced by fusion of greywacke, But the minimum transfer of mass that would be achieved by the addition of K_2O by magmatic solutions is not considered as possible.

A.N.Z.A.A.S. CONFERENCE, ADELAIDE, SEPTEMBER 1958

by

D. Kear, N.Z.G.S.

Four New Zealand geologists attended the meeting - Professors C.A. Cotton and G.J. Williams, Mr. B.L. Wood and the writer. The themes most stressed in formal papers and informal discussion of Section C were: the setting up of a relative and an absolute chronology for the Australian Precambrian rocks, the permanency and boundaries of the Australian "shield", the Australian inland sedimentary basins, and the arid cycle of erosion. Abstracts of all papers, and a few full papers, have been deposited in the N.Z. Geological Survey library; and notes on geological topics have been circulated within the Survey.

Northern Flinders Fieldtrip

The party of 15 flew to Leigh Creek, initially over cloud, but subsequently over some magnificently exposed structures. The only need to land seemed to be to discover what the individual beds were made of - the detailed distribution and complex structure of each was easily seen from the air. Leigh Creek mining township is wholly owned by the South Australia Electricity Trust, who work the 6000 B.t.u./lb. "brown coal".

During the following four days we crossed and recrossed the Flinders Ranges in three landrovers and two cars. The geology was magnificently exposed, just as it had appeared from the air. Many beds could have been traced for miles. The lack of weathering and the absence of vegetation were quite staggering. We passed through sheep stations but saw more kangaroos (and even emus) than sheep. The absence of the latter was hardly surprising, for there was little or no grass, and the number of minute green plants per square foot would only exceptionally reach double figures. Most of the ground was stony, and the rock fragments were commonly highly limonitised. Yet one owner told us, enthusiastically, that the land had never looked better, and, sadly, that his wool cheque was down by £25,000 last year!

Trees (usually eucalyptus) were virtually restricted to the dry creek beds - only twice did we see running water - although low flowering shrubs were more common in some areas, as for example around the Mt. Flinders talc mine which has reserves measurable in very many billions of babies.

The rocks we were seeing were dominantly Precambrian. These had been subdivided into two major groupings - Archean granite, gneisses, and meta-sediments; and Proterozoic sediments. Recent research is

showing that the age differences, that are implicit in this essentially metamorphic classification, are not valid for Australia as a whole. The Proterozoic rocks were again subdivided in a time-rock sense by a middle unit of glacial beds. The tillites were most convincing as such, but their upper and lower boundaries were difficult to define. The rock fragments they contained were apparently locally derived; and the increase in granite pebbles towards one unconformable contact had led to one interpretation that the tillite had been granitized. There is an undoubted moral here that one should not indulge in "flogging" a newly popular theory without adequate fieldwork behind it.

Our accommodation consisted of shearers' quarters where hot showers, hot meals, and electric light welcomed us. Our sleeping bags were the only reminder that we were "camping" , but even these were supported on wire-wove mattresses. Everyone piled into landrovers when the cars had to give up, and we covered 350 miles of rough country in 4 days as a result, seeing all the important contacts. Rare walks of two or three miles were much appreciated.

Victorian Basalts

My major interest, apart from the ANZAAS sessions, was in the extremely widespread Victorian basalts. All are Tertiary, but two broad ages can be distinguished. The older group underlie, and are interbedded with, the well-known and fabulously thick Victorian brown coal. They are thus of Eocene-Oligocene age, and the original cones have either been completely destroyed, or have been eroded down until only the plug remains.

The younger group are well weathered in part, but some cones and flows are remarkably fresh and uneroded. The physiographic methods of dating such volcanic rocks, that have been developed in New Zealand and Samoa, were applied to these Australian examples. Obviously a fair range of ages exists. No definite evidence of a Pliocene age was obtained, although the oldest eruptions could be as old as that. Clearly the volcanism was well under way in the mid-Pleistocene and continued through into the Holocene. The youngest eruptions would be about 5,000 years old in round figures, and these are concentrated in western Victoria and eastern South Australia. As in Auckland, the late date of the last eruption makes further eruptions possible. A far greater variety of cone form is present than in Auckland, but cones are generally many miles apart.

The ages inferred by comparison with equally eroded New Zealand examples conflicted in no case with the presumed age ranges in Australia, although the Australian datings were apparently more precise. Whilst this does not prove that the methods are widely applicable without any local adjustments, extremely broad datings by them appear likely to be valid outside New Zealand and Samoa.

PAPERS

Instead of discussing each paper in detail, some of the more interesting and contentious points that emerged from conversations, and during field trips, have been collected together under the following headings:

1. PRE-CAMBRIAN FOSSILS
2. DATING THE PRE-CAMBRIAN
3. THE AUSTRALIAN SHIELD
4. MINERALIZATION
5. BASIN EXPLORATION
6. QUATERNARY
7. THE ARID CYCLE
8. NUEES ARDENTES AT MANAM
9. STRATIGRAPHIC NOMENCLATURE
10. DETERMINATION OF ROCK STRESSES
11. TECTONIC MAP

PRE-CAMBRIAN FOSSILS

Dr. M.F. Glaessner illustrated several Pre-Cambrian fossils from a "rich marine fauna" that has been discovered in recent years. They include jellyfish and annelid worms, but generally their affinities are uncertain. Their interest lies not so much in themselves as in the reasons for considering them Pre-Cambrian (which have obviously been developing in Dr. Glaessner's mind to some extent since he wrote the abstract of his paper).

The fossils occur in the Pound Quartzite which intervenes conformably between fossiliferous Cambrian, and the Adelaide System of generally presumed Pre-Cambrian age. The Cambrian includes an Archaeocyatha limestone (elsewhere in the world close to the base of the Cambrian) and has a bed with Hyolithes virtually at its base. Although basal Cambrian Trilobites are absent, Dr. Glaessner considers this bed to be equivalent to basal Cambrian faunas elsewhere. That all the underlying fossils in the Pound Quartzite represent soft-bodied organisms adds weight to his argument that they should be considered as Pre-Cambrian. A few such fossils might be considered as part of a Cambrian fauna, with shelly species being accidentally absent; but the number of species indicates that the fauna is significantly different from the type and standard Cambrian, and therefore probably Pre-Cambrian.

DATING AND SUBDIVIDING THE PRE-CAMBRIAN

One Symposium covered the U-Th-Pb, Rb-Sr and K-A methods for age determinations which are being increasingly used by the Bureau of Mineral Resources at Canberra and the University of Perth.

The internal checks possible with the U-Th-Pb method compensate in large measure for their greater tendency for loss of lead compared with that of strontium in the Rb-Sr method. The results of these two methods, however, are often in agreement; but do not necessarily check with K-A determinations, although the latter may be consistent in themselves.

The granites of southwest Western Australia are in the main 2,800 M years old, although a minor belt exists of about half that age. Others in the Northern Territory, that intrude "Lower Proterozoic" and underlie "Upper Proterozoic" are dated as 1,800 M years (± 20%). Since the Archean-Proterozoic boundary had been arbitrarily placed at 1,200 M years, some reassessment was obviously required.

There is a growing agreement that the Pound Quartzite is the highest formation of the Pre-Cambrian; but below that, agreement fails. The old basis of major subdivision into "Proterozoic" and "Archean" was based upon degree of metamorphism. Workers in the Northern Territory subdivided their non-gneissic rocks into "upper" and "lower" Proterozoic; but clearly their lower Proterozoic (1,800 M years plus) may well be equivalent to, or older than, the Archean of South Australia.

Although dating of the Pre-Cambrian must await further fossil discoveries, or more probably more radioisotope results, South Australian geologists have already proposed some rock-time units. By New Zealand standards, there seems little justification for proposing other than rock units, although one can sympathise with some of their points of view. The Adelaide System was reasonably proposed (although without a base) to precede the Cambrian. It has been subdivided on the assumption that a major glaciation affected large areas at the same time. Thus the Marinoan (post-glacial), Sturtian (glacial) and Torrensian (pre-glacial) stages were proposed. The pre-Torrensian Willouran stage, however, can hardly be claimed to be based on any time concept at all.

THE AUSTRALIAN SHIELD

A symposium covered several aspects (rock content, age, stability, limits) of the Australian Shield.

MINERALIZATION

The Presidential Address by Dr. Raggart reviewed the search for mineral deposits in certain fields. He stressed that in Australia prospecting methods based upon conventional concepts of the granite-related hydrothermal origin of minerals found nothing; whilst prospecting of similar structures, in the same formations as existing deposits, did produce results. He did not ally himself 100% with syngeneticists, however.

The Nairne pyrite-pyrrhotite deposit was spoken of widely as syngenetic (although a few remained unconvinced); and the presence of small quantities of galena and sphalerite there no doubt hearten those few who are beginning to consider a hydrothermal origin for Broken Hill.

BASIN EXPLORATION

Many Australian geologists in the past have apparently looked upon most of their continent as a Pre-Cambrian and Lower Paleozoic rock, which has acquired a very thin film of "dirt" in the Mesozoic and Tertiary. This view is very understandable when one sees how superficial the Permian glacials are, and especially in some of the central plains. There, relatively flat basins, looking very alluvial and Quaternary, are flanked by the old rocks. Most New Zealanders would probably have mapped the plains as Quaternary, and would have been right for the top few feet. Thereafter, however, Triassic beds (e.g.) might be encountered in spite of an otherwise complete absence of those beds in the region. The earlier oil drilling similarly found many thousands of feet of Jurassic in areas of Western Australia where surface Jurassic is virtually unknown. Further oil drilling there has similarly found other sequences that are entirely confined to sub-surface occurrence.

Some oil geologists are therefore very enthusiastic about some thick concealed sequences that have been confirmed by drilling (e.g. Cretaceous in the Great Artesian Basin), have been inferred from geophysical prospecting, or have been inferred from broad assumptions.

QUATERNARY

It is odd that near coastal terraces in an unstable country like New Zealand are often considered eustatic, whilst in the relatively more stable Australia they tend to be considered as tectonic.

Pleistocene geology is commonly ignored in Australia, and uncertain deposits that would generally be put in a "Quaternary" bag in New Zealand are put in a "Tertiary" bag in Australia.

As an example, some workers consider that some presumed glacial deposits at Canberra, and the local topography there, are Permian in age. The evidence that they are not Pleistocene would convince few New Zealanders. It is: (1) that they are not lateritized (lateritization is thought generally to be a Pliocene event - but cf. our modern placing of the Castlecliffian and Nukumaruan), (2) that the level of 2,000 ft, as opposed to a considered downward Pleistocene glaciation limit of 4,600 ft. in the mountain areas there, is too low, and (3) that Pleistocene beds should be undissected. It is especially odd when one considers the supposedly immediately-post-Permian topography, since the nearby admittedly Tertiary basalts have had their cones eroded away. One feels that palynology should provide the answer.

Eustatic terraces at Flandrian, 50 ft. and 100 ft. levels are well developed locally, and an approximate 200 ft. level probably exists. The 45 and 25 fathom off-shore benches are also probably present. Our + 350 and + 550 ft. levels, however, appear to be missing. They would, admittedly, be far inland, but corresponding marine Pleistocene deposits that should be present, are apparently missing. This is particularly worrying in view of the absence of marine deposits on these levels in New Zealand, and the problem of obtaining much more than say 200 ft. of water by melting the present day ice caps. These high level terraces should be reviewed critically in New Zealand from the point of view of whether their origin was related to a sea level at that height.

THE ARID CYCLE OF EROSION

Increasing interest in the "arid cycle of erosion" resulted in a symposium introduced by Dr. Campana. His most interesting paper is given in full in the "Abstracts" included in the Congress handouts.

Apart from the formation of near surface laterites, and silicification, there is much rock towards the desert areas that is surprisingly fresh at the ground surface. Chemical weathering is absent (judged by New Zealand standards) in the Northern Flinders Ranges of South Australia.

NUEES ARDENTES AT MANAM

Manam, an active-volcanic island off the north coast of New

Guinea, has entered an eruptive phase (1957-8) of an apparently unprecedented magnitude (for the known period of human inhabitation). The eruptions included Nuees Ardentes. The rock is on the boundary of basalt and andesite as far as is known; its shape is reminiscent of White Island.

STRATIGRAPHIC NOMENCLATURE

New stratigraphic names are submitted via State committees to a national body for checking (as to validity and necessity). It was interesting that a request for one new name was made because there was a 2-mile break in the continuity of exposures. It was declined.

DETERMINATION OF ROCK STRESSES

Thin slots have been cut from Snowy River scheme tunnels, into which a flat metal container can be inserted which can have an internal hydraulic pressure applied to it. The distance apart from two points in the rock, which is measured prior to cutting the slot, decreases when the slot is cut, and is restored by hydraulic pressure. Thus the rock stresses can theoretically be measured, and measurements have been made of both horizontal and vertical stress by using differently-orientated slots.

The results showed a vertical stress equal to the load of the rock cover, but a horizontal stress of about $2\frac{1}{2}$ times that amount.

TECTONIC MAP

Draft copies of the Tectonic Maps of all states were pieced together at ANZAAS. From the final maps a Tectonic Map of Australia will be produced by the Geological Society of Australia. The Society has been asked by the International committee to prepare a map for Australasia.

APPENDIX

List of Papers distributed during the Congress (deposited in N.Z.G.S. library, Wellington):

(* indicates abstracts only).

Vol. 1

*COTTON, C.A.: Eustatic River Terraces Complicated by Seaward Downflexure.

*WOOD, B.L.: The Schist Tors and Periglacial Desert Forms of Central Otago, N.Z.

* _____ : The Geology of Fiordland, Southwest N.Z.

* _____ : Recent Advance in Geological Mapping, Ross Dependency, Antarctica.

*KEAR, D.: Stratigraphy of New Zealand's Cenozoic Volcanism Northwest of the Volcanic Belt.

*GUNN, B.M., WARREN, G.: Investigations by the N.Z. Party of the Trans-Antarctic Expedition.

*MOYE, D.G.: Measurement of Stresses in Rock Masses at Depth.

*HORWITZ, R.: Faults and Folds of Tertiary and Recent Age in the Lake Frome and Gulf St. Vincent Regions of South Australia.

*GILL, E.D.: Dating of Cainozoic Non-Marine Rocks in Australia.

*LAGANZA, R.F.: Unusual Forms of Secondary Iron Sulphide at Nairne, South Australia.

*HILL, D.: The Palaeontology of the Clarke River 4-Mile Sheet, North Queensland.

*VEEVERS, J.J.: Fossil Zones in the Devonian Rocks of the Fitzroy Basin Western Australia.

*CRESPIN, I.: Foraminifera in Australian Permian Stratigraphy.

*GLAESSNER, M.F.: Fossils from the Base of the Cambrian in South Australia.

*THOMAS, G.A.: Stratigraphy and Paleontology of the Port Keats Area, Northern Territory.

*BANKS, M.R.: A General Permian Succession for Tasmania.

*PARRY, L.G.: Thermomagnetic and X-Ray Investigations on Iron Oxides in some Igneous Series.

*SCOTT, B.: A Preliminary Interpretation of the Pre-Cambrian - Palaeozoic Geology of S.W. Tasmania.

*GREEN, R.: The Use of Rock Magnetism for Correlation Purposes in an Igneous Rock Sequence.

*BOLT, B.A.: The Broad Limits to the Physical Properties of the Earth's Mantle.

*IRVING, E.: Polar Wandering Relative to Australia since the Carboniferous Period.

Vol. 2

COTTON, C.A.: Eustatic River Terraces Complicated by Seaward Downflexure.

SCOTT, B.: A Preliminary Interpretation of the Pre-Cambrian - Paleozoic Geology of S.W. Tasmania.

MOYE, D.G.: Measurement of Stresses in Rock Masses at Depth.

GILL, E.D.: Dating of Cainozoic Non-Marine Rocks in Australia.

HORWITZ, R.: Faults and Folds of Tertiary and Recent Age in the Lake Frome and Gulf St. Vincent Regions of South Australia.

LAGANZA, R.F.: Unusual Forms of Secondary Iron Sulphide at Nairne, South Australia.

*TAYLOR, G.: Notes on the Current Eruption at Manam.

VEEVERS, J.J.: Fossil Zones in the Devonian Rocks of the Fitzroy Basin, Western Australia.

THOMAS, G.A.: Stratigraphy and Palaeontology of the Port Keats area, Northern Territory.

*OPIK, A.A.: The Australian Shield in Early Palaeozoic Time.

*WILSON, A.F.: The Pre-Cambrian Structures of South-Western Australia.

*WAIPOLE, B.P.: The Pre-Cambrian Shield of North Western Australia.

*McWHAE, J.R.H.: The Western Margin of the Pre-Cambrian Shield.

*WEBB, B.P.: The Australian Shield in Early Palaeozoic Time. Evidence from the Northern Flinders Ranges.

*THOMSON, B.P.: The Australian Shield in Early Palaeozoic Time. Evidence from the Mt. Lofty Ranges and Olary-Broken Hill Provinces.

*SPRIGG, R.C.: The Eastern Margin of the Australian "Crystalline" Pre-Cambrian Shield.

*FISHER, N.H.: The Australian Pre-Cambrian Shield - Introduction to Age Determinations.

*JEFFERY, P.M.: Mineral Dating by the K^{40} Method.

*WHITTLE, A.W.: Contributions to Age Determinations by S.A. Mines Department.

WAIPOLE, B.P.: Bureau of Mineral Resources Sampling Programme for Age Determination.

*SPRIGG, R.C.: The Great Australian Artesian Basin.

*WOPFNER, H.: Geological Structures in the Central and Western Portion of the Great Australian Artesian Basin.

*TRAVES, D.M.: The Carpentaria Sub-Basin.

*MOTT, W.D.: The Northern Portion of the Great Australian Artesian Basin.

*JENKINS, T.B.H.: The Great Australian Artesian Basin Thallon Sub-Basin.

*RUDD, E.A.: The Murray Basin.

*LUDBROOK, N.H.: Palaeogeography of the Tertiary in the Murray Basin.

*O'DRISCOLL, E.P.E.: Hydrology of South Australian Portion of the Murray Basin.

CAMPANA, P.: Introduction to the Session on "The Arid Cycle".

*KING, D.: The Sandridge Deserts of South Australia and Related Aeolian Landforms of the Recent Arid Cycle.

*JESSUP, R.W.: Erosional Phenomena Associated with Quaternary Aridites in the Arid Zone of Australia.

STEWART, G.A.: Hardened Siliceous Layers in Deeply Weathered Materials.

COTTON, C.A.: Remarks on Landscapes Produced by Arid and Other Erosion.

CONDON, M.A. (convenor): Australian Sub-Committee on Sedimentary Rock Nomenclature.

REED, J.J. (convenor): New Zealand Sub-Committee on Sedimentary Rock Nomenclature.

Loose

CARTER, A.N.: Pelagic Foraminifera in Southern Victoria and the Murray Basin.

JENKIN, J.J.: Some Aspects of the Hydrogeology of the Murray Artesian Basin in Victoria.

*KEAR, D.: Stratigraphy of New Zealand's Cenozoic Volcanism Northeast of the Volcanic Belt (Abstract and Table 1 only).

V.U.W. GEOLOGICAL SOCIETY

The Victoria University Geological Society (founded 1955) at a general meeting in June last year, decided to ask for affiliation with the N.Z. Geological Society. We therefore welcomed this opportunity to tell members of the N.Z. Geological Society about the activities of our society.

Present membership of the V.U.W. Geological Society is over 60, and comprises students, research students and staff. Meetings with guest speakers are held about once a month, last year's speakers including Dr. H.W. Wellman on "Oil Exploration - New Zealand", Messrs. McKelvey and Webb on "Recent Work in Antarctica" and Mr. McQuistan on "Origin of the Universe".

In addition to regular meetings, the Society holds one major field trip each year. Last year, 16 members spent a week in the Middle Awatere Valley, mapping and collecting fossils for the V.U.W. Geology Department. We were very fortunate to have Dr. Wellman with us on this trip (although nobody thought so on those icy cold, pitch dark mornings) and his enthusiasm made up for our general lack of experience. The success of the trip is proved by the fact that two students are now working on theses in the area visited.

1959 Annual General Meeting - This was held on 22nd April, the guest speaker being Mr. N. Taylor of the Soil Bureau. Mr. Taylor visited Russia last year with the aim of seeing the original soil zones described in Dokachiev's classic work. The talk was superbly illustrated by colour slides of Russia - the Russia the tourist doesn't see! The tour started north of St. Petersburg, and for 400 miles we travelled south by colour slides through the unbroken pine forest of North Russia - the zone of the podsol with great difficulties for agriculture in the leached soil. Then gradually the pine forest gave way to deciduous trees, oak and birch; the soils became the yellow-brown soil familiar in many parts of New Zealand. Suddenly, the forest stopped, and there was the gently rolling open steppe country.

The steppe is the zone of the chernozem - the famous black earth of Russia. What a difference! Acres of grain, large dairy herds, fruit, flowers, and, particularly striking, the fields of enormous sunflowers grown for the oil from the seeds. Climate in the steppes is a problem; short, hot summers and very cold winters when the ground is frozen. Parts are very arid and problems of drought and erosion occur. The lower areas of the steppes are too alkaline for agriculture as evaporation during the hot summers leaves salt deposits; a recent remedy has been to cover the salt earth with fresh earth brought in from outside the area. Aridity is combatted with shelter belts, plantations of trees which help to hold some of the

moisture and break the hot dry winds. Erosion is particularly severe in spring, when the frozen ground melts and water runs off into steep sided gullies which rapidly enlarge in the soft earth. Control of both erosion and aridity has been achieved by damming these ravines and conserving the water from the spring melt for irrigation. In addition, the banks of the ravine are planted with low shrubs.

The tour ended at the Black Sea in the Caucasus.

Mr. Taylor commented on the fact that the Russians were first in the field of soil science - one of the audience retorted that this was because they couldn't see any rocks. Anyone who has seen Mr. Taylor's slides will realise that this is the probable explanation, as from Leningrad to the beginning of the Caucasus there isn't a piece of rock to be seen - thick soil covers all - and when you get to the Caucasus only limestone!

Finally, a warm invitation is extended to all members of the N.Z. Geological Society to attend our meetings. Full information on time, place and subject will be sent to your secretary before each meeting or may be obtained from Dr. H.W. Wellman, Geology Department, V.U.W.

G.A. Challis,
Secretary, V.U.W. Geol. Soc.

IGNEOUS GEOLOGY OF THE MIDDLE AWATERE

The igneous rocks of the Middle Awatere Valley are at present being investigated by Alva Challis of V.U.W. as part of a thesis for M.A.

The valley is notable for dyke swarms occurring in the inland Kaikouras between Blue Mountain and the Tone River and also for the very thick sequence of Cretaceous (Cn) basalts between the Winterton and the Castle Rivers. These were mentioned by McKay in 1889 and by Mason in 1958, but have never been fully described.

There are two distinct trends in the dykes, E-west and N-south. Dykes of the inland Kaikouras trend N.S. and include lamprophyric types such as camptonites, and are generally believed to be older, while the E.W. trending dykes represent the feeding dykes for the thick Ngaterian basalts in the upper part of the valley.

The Ngaterian basalts in the Upper Middle Awatere reach a total thickness of over 1,500 ft. The alternation of terrestrial porphyritic basalts with columnar jointing, and fine-grained spilitic types indicates the general instability of this region during the Cretaceous. The basal flows are terrestrial and overlie carbonaceous deposits.

The structure is dominated by active transcurrent faults.

FORMATION OF GEOLOGICAL GROUP IN CHRISTCHURCH

For some time the need has been felt at Christchurch for more technical geological talks and discussions than those suitable for the existing non-specialized scientific bodies.

With this in mind, the University and Geological Survey geologists invited members of the Society and others known to be interested in geology to meet and discuss the formation of such a group, and to hear a talk given on Monday, 22nd September, 1958, by Mr. R.P. Suggate, of the N.Z. Geological Survey, on the Quaternary. Twenty-four people attended.

It was decided that the "group" should be kept as informal as possible, and that, at present, it should have no affiliation with already established national organizations, no constitution, officers or subscription, and that about four evening meetings and several field excursions be held each year. One representative from the University of Canterbury (Mr. J.D. Campbell) and one from the Christchurch office of the Geological Survey (Mr. L.E. Oborn) were asked to act as "co-ordinators".

NOTES ON THE STRUCTURE OF THE SOUTHERN ALPS

by

Brian Mason

On Boxing Day 1957 I flew from Wellington to Christchurch to begin four months of fieldwork in the Southern Alps. The mountains were shrouded in cloud; a northwest gale raised dust clouds 20,000 feet above the plains, the Canterbury rivers were in high flood - an inauspicious beginning, which, alas, was continued in the wettest and stormiest summer on record in the mountains. However, geologists who work in mountain country in the "roaring forties" must accept such conditions, philosophically if possible!

The 1958 expedition (a pretentious description for a one-man outfit, assisted occasionally by friends such as Max Gage and Arnold Lillie) was planned to fill in gaps and do more detailed work in critical areas revealed during a field season in 1954 and earlier wanderings through the region. The earlier work had confirmed the overall picture of a continuous transition from greywacke and argillite on the Main Divide through progressively more metamorphosed rocks to

coarsely crystalline schists and gneisses along the western edge of the Alps. This picture was established in its broad outlines already by Haast, and the mineralogical and petrological features worked out by Turner and Hutton in their studies in northwest Otago and southern Westland in the 1930's. My primary interest has been in applying the criteria for progressive metamorphism worked out by Turner and Hutton to the regional mapping of the Southern Alps on a scale of four miles to the inch - a scale dictated by the maps available and the capacity of one man working on a large area of country, much of which is difficult of access.

Field mapping of metamorphic rocks like those of the Southern Alps presents special problems. A study of New Zealand geological maps will show how difficult it is to devise mapping criteria even for unmetamorphosed greywackes and argillites. These difficulties are increased when these rocks have been metamorphosed. It is conceivable that one might go into the field and collect localized specimens, leaving the problem of finding distinctive features to an examination of thin sections in the laboratory. I have found it preferable to develop criteria for distinguishing different mappable rock types already in the field, thereby building up a map as one goes along; this map is then modified if necessary through the more subtle distinctions revealed by microscopic examination of the rocks. The divisions used are as follows:

I. Greywacke, indurated but apparently unmetamorphosed;

II. Sheared greywacke (shows a preferred fracture due to shearing);

III. Schistose greywacke (good plane-parallel schistosity, but not foliated, and greywacke character still visible);

IV. Foliated chlorite-muscovite schist (the individual minerals are now segregated into foliae, and little or no trace of sedimentary characters remain);

V. Biotite schist (biotite appears as lustrous brown-black flakes, usually visible to the unaided eye);

VI. Biotite-garnet schist and gneiss (red crystals of almandine garnet appear).

Of these six divisions, I, II, III, and IV are approximately equivalent to Turner and Hutton's Chlorite 1, 2, 3, 4 subzones. Zone IV covers large areas in central and western Otago, but it is often absent in the Southern Alps, zone III rocks passing directly into zone V rocks by the incoming biotite.

The above scheme has been found satisfactory for field mapping

throughout the Alps from the Maruia River to southernmost Westland. In the laboratory, zone VI rocks can be divided into a lower-grade zone in which the feldspar is albite and a higher-grade zone in which it is oligoclase or andesine, but this distinction cannot be made in the field, although the oligoclase-bearing rocks are often more "gneissic" in appearance than the lower-grade schists. In the field it may also be difficult to establish the presence of zone VI as distinct from zone V, since the occurrence of garnet is sporadic; biotite, however, is always present in sufficiently metamorphosed rocks of greywacke composition.

The fieldwork confirmed the transition from greywacke on the Main Divide to biotite-garnet schist and gneiss along the Alpine Fault in all sections from the Maruia River south to the Copland Valley. South of the Copland Valley this simple picture is complicated by post-metamorphic folding. This folding is well shown by a section from Lake Chau westward to the Alpine Fault in the Haast Valley, along which the zone sequence is I, II, III, IV, III, II, III, IV, V, VI, V, VI; this can be interpreted as an anticline with a core of zone IV, followed by a syncline with a core of zone II, followed by an anticline with a core of zone VI and a syncline with a core of zone V. (The sequence of anticline and syncline along the Haast Valley was recorded in an unpublished report by George Grindley in 1950). This folding is tied in with the relation of the Otago schists to the Alpine schists. These folds fan out and pitch to the southeast, the strike of the schistosity planes swings from northeast in the Alps to northwest in western Otago, and the dip flattens. The pitch of the folds carries the high-grade metamorphic rocks of zones V and VI below the surface in western Otago; they are presumably present at depth below the broad belt of zone IV schists in central Otago. The field mapping showed that current geological maps of northwest Otago, based on Turner's work in 1929-30, need to be revised; in this region biotite schists are not confined to the western side of the Main Divide, but persist in a broad belt as far as the Wilkin Valley, northwest of Lake Wanaka.

An interesting feature in northwest Otago and south Westland is the widespread distribution of post-metamorphism dykes and sills of camptonites and tinguinites. They are confined to the eastern limb of an anticline whose axis runs in a broad arc from the Paringa Valley through the Haast to the upper Wilkin and Matukituki Valleys. Gabbro boulders were also collected from the Paringa and the Haast Valleys.

A reconnaissance survey of a large area usually raises more questions than it solves, and this one is no exception. Some of these questions are:

What is the age of the rocks?

What is the thickness of the sedimentary succession?

What is the age of the metamorphism, and its cause?

What has been the history and evolution of the Southern Alps as a mountain range?

The sparse fossils in the Southern Alps are all Triassic, and as the metamorphic rocks appear to be in conformable sequence with the fossiliferous greywackes, the logical deduction is that the metamorphic rocks are also Triassic. They could be older; no unconformity has been recognized in the sequence from unmetamorphosed to metamorphosed rocks, but no perfectly continuous section has been examined, and in any event an unconformity could be obliterated or converted to pseudo-conformity by the deformation accompanying metamorphism. It can even be argued that the metamorphic rocks may be younger than the fossiliferous Triassic rocks; no a priori reason can be adduced for stating that in such a sequence the more metamorphic rocks are necessarily older.

This question is to some degree linked with the second one, the thickness of the sedimentary succession. How much has been repeated by folding, how much cut out by faulting? Visual observation shows that the greywackes and argillites of the Southern Alps are isoclinally folded. This is confirmed by careful examination of sedimentary features such as graded bedding, which show that in some places the beds are right side up, in other places inverted. In one of the best-exposed sections, that up the western wall of the Hooker Valley on the ascent to Copland Pass, the beds appear to be right side up, dipping west at about 60°. If this sequence continued, the more metamorphic rocks west of the pass would be younger; however, I believe that the isoclinal folding causes many repetitions and inversions of the sequence. One of the consequences of the isoclinal folding is that measurements across the strike cannot give the true stratigraphic thickness.

The age of the metamorphism has been a recurring question in New Zealand geology. Opinion has crystallized around two possibilities: (1) the schists are Triassic rocks, metamorphosed during the Hokonui orogeny in Lower Cretaceous times; (2) the schists are Palaeozoic sediments, metamorphosed in pre-Triassic times. The fieldwork has not resolved these conflicting viewpoints. However, I hope the problem will be solved by physical dating of the metamorphic recrystallization. Separation of biotite from the biotite schists and gneisses, and its analysis for potassium and for radiogenically produced argon ($K^{40} \rightarrow A^{40}$, half-life of $K^{40} = 1.3 \times 10^9$ years) will give the time since the formation of the biotite, and hence the time of the metamorphic recrystallization.

The cause of the metamorphism is a separate problem again. Turner and Hutton adduced a number of reasons for ascribing the metamorphism of the Otago schists to the heating effect of a subjacent granite batholith. However, throughout the Otago and the Alpine schists this granite is nowhere exposed. The only possible physical manifestation

of it are the pegmatites of the Paringa - Blue River area in south Westland, which can also be explained as the products of local remelting. It seems unlikely to me that in this extensive region of strong relief a granite batholith large enough to cause this regional metamorphism would be nowhere exposed, even in the most highly metamorphosed rocks. Of course, it can be argued that this metamorphosing granite lay to the west of the Alpine Fault and has been transported far to the north by the horizontal movement on the fault. I find this explanation unconvincing. I am inclined to postulate the piling-up of a great thickness of material by the isoclinal folding and the depression of the lower part of this pile to a depth in the crust where temperatures of 300° - 500° C existed - depths of the order of 10 - 20 km. Under these conditions recrystallization to biotite schists and gneisses would readily take place.

All these questions lead to the final one, which is basic to an understanding of the geological history of New Zealand, and which is probably significant in the regional picture of the southwest Pacific Ocean. What has been the history and evolution of the Southern Alps as a mountain range? An answer to this question requires a far wider survey than I have made. Certain aspects have been considered. Evidence can be found for the presence of an ancestral Southern Alps in late Cretaceous and early Tertiary times. This mountain range was probably eroded away by late Oligocene, if we can judge by the general absence of terrigenous sediments in the rocks of that age in Westland and Canterbury. Miocene times saw the beginning of a new period of uplift, manifested by thick series of sandy and muddy sediments on both sides of the Alps. The sediments became coarser in the Pliocene and culminate in the glacial and fluvio-glacial deposits of the Pleistocene. The detailed study of these Pliocene and Pleistocene sediments should give valuable information regarding the uplift of the Alps. Cursory examination of the gravels and moraines in Westland indicate that debris from biotite schists and gneisses first appears in the Pleistocene moraines. If this is true these rocks have only recently been exposed to erosion. The probable implication is that the Kaikoura orogeny affected the Southern Alps mainly by a predominant vertical uplift along the line of the Alpine Fault.

GLACIATION AND THE DEPOSITION OF ALLUVIAL GOLD IN WESTLAND

by

W.F. Heinz

In the main West Coast gold field a continuous line of gold workings extends for some 80 miles, from Ross to Reefton. This long stretch of alluvial workings was named 'The Golden Line' but as it has an average width of four miles, it is perhaps best named 'the Golden Belt'! The initial concentration appears to have been in outwash deposits from moraines along the eastern margin of the belt. It is of interest that Gage and Suggate have recently described three glacial stages with interglacials in this area.

Bonanzas were discovered along the east side of the belt at Ross, Kanieri, Goldsborough, Kumara, and Greenstone, in Westland Province; and towards Reefton at Nelson Creek and Napoleon's Hill close to the moraines of the Ahaura Glacier in the Nelson Province. It is noteworthy that the coarsest gold and the richest deposits were always close to the frontal moraine. Although these Bonanzas had small extent, Kumara for instance being no more than four miles by two miles in area, millions of pounds worth of gold was taken from them.

The Kumara field, opened in 1876 to become one of the greatest hydraulic mining areas in the world, was discovered by accident by moonshiners (illicit whisky makers) who were pushed back into the undisturbed forest by the extension of the Waimea goldfield.

Apart from the deep-level gold-leads under the township of Ross, which cannot be discussed here, the Kumara field is typical of those mentioned. Early geologists - Haast and Cox - thought the gold was derived from the Moutere gravels - the Brighton Bottom of the miners. The first direct reference to the importance of the old glaciers was made by McKay in his report in 1893 'On geological explorations of the Northern part of Westland' which records his observations when hydraulic mining was at its zenith. He visited the Kumara, Waimea, and Ross fields, traced the courses of the Hokitika, Arahura and Taramakau glaciers, and defined the great fanning lobes of the Taramakau and Arahura glaciers. He speculated on the vast treasure found at Maori Point in the upper Greenstone, where the discovery of the first gold in 1864 triggered off the great rush of 1865.

In 1908, Bell (N.Z.G.S. Bull. I) gave an eastward source for part of the gold but was cautious in not describing the whole as coming from the Alpine greywackes. He thought that the first rough concentrations by streams within the glaciers was followed by further concentration within the outwash gravels with final concentration by the torrential streams of the retreating glaciers.

McKay (1893) noted that the principal gold deposit of the Kumara field was in a coarse river wash under a capping of moranic hills and above subangular gravels that lie on the marine blue bottom - the true "bottom". The line of demarcation between moraine and outwash can still be followed in some of the Kumara workings. Old miners say that gold was never rich on the true bottom at Kumara, but was found on "false bottoms" - mostly lenses of muddy sand - throughout the gravels. I consider these gold bearing gravels "true outwash", for at the Callery River, a short swift stream in South Westland that flows from an active glacier, muddy lenses formed by the heavily charged silt of the melt water can hold even pennyweight lumps of gold in favourable situations.

In conclusion, I would suggest that it was not the furthest seaward extension of the glaciers which brought the bulk of the gold to the bonanza areas, rather an earlier advance which was followed by an interglacial phase that gave sufficient time for the outwash deposits to be concentrated. The main advance that came later gave the capping of frontal moraine as seen today.

If further work strengthens this assumption, there will be some reason to believe that undiscovered bonanza areas may be hidden further back below the frontal moraine.

NEW ZEALAND GEOLOGICAL SURVEY ANTARCTIC EXPEDITION 1958-59

By

H.J. Harrington

This summer a twelve man party, including three geologists from the N.Z. Geological Survey, A.C. Beck, I.G. Speden, and the writer, had as its major objective the topographic and geological mapping of unexplored districts at Terra Nova and Wood bays on the coast of Victoria Land, midway between Scott Base and Hallett Station, but the ice-breakers U.S.S. Glacier and U.S.S. Staten Island were unable to penetrate heavy pressured pack ice along the coast and these surveys could not be made. After making a survey of Coulman Island and a large newly-discovered Emperor penguin rookery on sea-ice, the party established astro-survey stations for air photo control over the wide region at McMurdo Sound between Granite Harbour, Beaufort Island, Cape Crozier and Minna Bluff. The U.S. Navy Hydrographic office and U.S. Geological Survey propose to use this ground control for a detailed topographic map of the McMurdo Sound region. At times with U.S.G.S. geologists several previously unexamined ice-free districts, mainly in the McMurdo Volcanics and associated Quaternary moraines, were studied. Most moraines to heights of 2000 ft. contain shells derived from the floor of the Ross Sea, and lumps of sediments similar to the Lower Tertiary Abbotsford Mudstone and Amuri Limestone of New Zealand.