HISTORICAL STUDIES

GROUP

NEWSLETTER

No 18

March 1999

GEOLOGICAL SOCIETY OF NEW ZEALAND

R. Dinfhuly
Prof. Dr. F. v. Hochstetter
James Hector

F.W. Hutton
Alexr McKay
Julius Haast

S. Herbert Cox
James Park

R. Speight
Edw. C. Clarke

Algernon P. Thomas
James Mackintosh Bell

Henry Suter
Colin Fraser
P. Marshall

J. Malcolm Maclaren
J.A. Bartrum

J. Allan Thomson
P.G. Morgan

C.A. Cotton

Hartley T. Ferrar
W.N. Benson

L.C. King
C.K. Hawes

J. Henderson
L.I. Grange
J. Marwick

Robin S. Allan
F.J. Turner
M. Ongley

H.J. Finlay
C.O. Hutton

R.W. Willett
Charles Fleming

A student of science without imagination (of course controlled and regulated by a basis of sound data) is not a true scientist;...he must be able to formulate an hypothesis or he is only an ineffectual tabulator of facts; furthermore he must have the power of mental visualisation to reconstruct from his data, to bridge any gap from facts which are known to those facts but yet dimly discerned.

– G. Leslie Adkin

EDITORIAL

This is a special issue in that it contains contributions from nine different authors. Furthermore, it includes articles from three of our Australian members - David Branagan, David Oldroyd and Robin Oliver. It is unfortunate that we could not print David Oldroyd's maps in colour in our newsletter but the coloured versions can be supplied at $4 per map plus postage of 80 cents. Another pleasing feature of this issue is that several of the notes are 'feed-backs' on articles in our last number.

New Zealand was well served by its pioneer geologists and Heather Halcrow Nicholson's detailed study of the varying views of three of them on the New Zealand pre-Cretaceous is a significant contribution to the history of New Zealand geology.

'The Discovery of the New Zealand Cambrian' published in our September issue resulted in the award of the Society's Wellman prize to Malcolm Simpson, fifty years after the discovery. Malcolm is a member of our Group and we congratulate him on the award.

Subscriptions for 1999 are now due ; a notice is sent with this newsletter.

The Historical Studies Group has lost another of its senior members with the death of Arnold Lillie in February this year. There is an obituary in this issue.

Alan Mason
75A Argyle St.
Herne Bay
Auckland.

* * * * * * * * * * * * * * * * * * *

Our Introductory Quotation

This comes from a letter written by Adkin and published in The Journal of the Polynesian Society Volume 70, No.2, June 1961. Adkin was a self-taught geologist and in this and other characteristics he came from the same mould as Alexander McKay. His career was in farming but a lifelong interest in geology culminated in 1946 when at the age of 58 he joined the New Zealand Geological Survey. A perceptive and comprehensive account of Adkin's life is given in An Eye for Country by Anthony Dreaver published in 1997.

ARNOLD LILLIE

With the death of Arnold Lillie in February this year the Historical Studies Group lost another of its members and New Zealand geology one of its best loved and most respected teachers. A tribute to Arnold on the occasion of his eightieth birthday was published in Geological Society of New Zealand Newsletter no 89. August 1990 and at the time of writing an obituary has been prepared by Philippa Black for the same Newsletter.

These give a full account of Arnold's life and contribution to New Zealand geology so all that is required here are a summary and a few extra notes.

Arnold Robert Lillie was born in Buenos Aires on 20 March 1909. At the age of 14 the family moved to Glasgow and it was here that excursions into the Highlands of Scotland first introduced him to geology and the attractions of mountaineering. Arnold spent two years apprenticed to a mining engineer and then, at the age of 20, entered Cambridge University. In HSG Newsletter 6, pp.16-20, Arnold gave an interesting account of his Cambridge days.

With a love of both mountains and geology it was only natural that Arnold should do his postgraduate study in Switzerland and so it was that, shortly after their marriage, he and Rhoda moved to Geneva where Arnold began his studies for a doctorate under Leon Collet. It is interesting to note that thirty years previous Collet had been an unsuccessful applicant for the position of Director of the New Zealand Geological Survey.

After a year or so with the Shell Company in the Hague Arnold decided that oil company work was not for him and an instruction to move to Borneo - without his family- and the gathering war clouds induced him to take up a position with the New Zealand Geological Survey.

In April 1939 Arnold, Rhoda, and two small daughters arrived in New Zealand where culture shock awaited them in places such as Dannevirke, Ohai, Otautau and Kaitangata.

In 1946 Arnold was appointed the first full-time geologist at Auckland Museum and the family moved to Auckland. Regrettably, his short period in Auckland (less than twelve months) did not allow him time to implement his idea, in advance of its time, of changing the geology hall from a display of specimens to a display of themes.

Arnold resigned from the Museum in February 1947 to become Senior Lecturer under Cotton at Victoria University College in Wellington. Here he had to start from scratch in building up the petrology and paleontology sections, but these were no sooner established than he moved back to Auckland to take up the Chair of Geology.

Appointed Professor at Auckland in 1951, Arnold was Head of Department until 1970 and he retired, as Professor Emeritus, in 1974. When he joined the department he was assisted by one full-time lecturer, one part-time lecturer, and one part - time demonstrator and there were three M.Sc. students. By the time he retired the staff had grown to 23 and the graduate school to 52.

Arnold matched this increase in staff and student numbers with an increase in courses offered and the acquisition of new equipment of ever increasing complexity. Yet throughout he maintained an emphasis on instruction in field work and mapping. (When, in his interview for the Auckland Chair, Arnold was asked what equipment he would require, it is said that his reply was "I have a good hammer").

The foundations of New Zealand geology were laid by men from

Britain and the Continent and the science developed along European lines. It was left to Alexander McKay to form a 'New Zealand mode' for geological research in this country. But, such was the influence of McKay on the next generation of geologists, nearly all trained in New Zealand, that an inbred state developed. It was Arnold Lillie's arrival in 1939 that initiated a balanced approach, subsequently built on, after the war, by overseas arrivals and the return of New Zealand postgraduate students.

Arnold applied methods and techniques that were new to New Zealand geologists and pioneered structural research in the Southern Alps. It was typical of his humility that his important papers on the Southern Alps were not published in prestigious overseas journals; one of them appeared in the New Zealand Alpine Journal. It came as no surprise when, on his retirement, Arnold returned to the mountains which he had studied for his doctorate forty years before. He was a visiting professor at his old university, the University of Geneva.

Arnold was widely read, not only in geology and not only in the English language. When the writer visited him in hospital six days before his death the book beside his bed was one on Napoleon.

With his mane of white hair, a unique drawl, and an incompatability with things mechanical, Arnold was to his students the typical 'absent-minded professor' but through his innate kindness he was to many of them also a 'locum parentis'

He was not unique in having the respect of his students but few geology teachers in this country can have experienced the affection that was given to Professor Arnold Lillie by his Auckland students.

Arnold Lillie died in Auckland Hospital on 11 February 1999, five weeks before his 90th birthday and a few months after his 65th wedding anniversary.

Alan Mason

* * * * * * * * * * * * * * * * * * * *

Henri Filhol (1843-1902), and Campbell Island

by Robin L. Oliver

My interest in Henri Filhol (Fig 1) stems from the fact that he and I both spent time studying the geology of Campbell Island, Lat. 52° S., Long. 169° E. Filhol's sojourn was from 9 September to 28 December, 1874, as a naturalist accompanying the French Academy of Science Mission to Campbell I. to observe the Transit of Venus. My sojourn on the Island was for 14 months in 1944-45 as a N.Z military coast watcher, with time to spare.

The death of Filhol, Professor-Administrator of Comparative Anatomy at the Musum of Natural History, Paris, 1894-1902, Member of the Institute (Academy of Science), Member of the Academy of Medicine, in 1902 was a severe blow to French palaeontology (Osborne, 1902). From the bibliography of his 166 published papers (Anon., 1902) particularly noteworthy are those resulting from his research on the famous mammaliferous phosphorite deposits of Quercy (research which earned him a Doctorate of Science in 1876) and of Saint-Gérard-le-Puy. These, plus others, greatly contributed to palaeontological knowledge, especially of the Oligocene fossil fauna of France. His bibliography includes also, however, descriptions of fossils in

Figure 1. Henri Filhol

other countries, e.g. New Caledonian rhinoceri, a new marine mammal from near Cairo, observations on the relationship of fossil-bearing strata between Europe and America, hippopotomi in Madagascar. Fossil mammals were obviously his speciality but his publications include descriptions of fossilised insects, Crustacea and birds. Towards the end of his career, presumably during his time in the Museum of Natural History, Paris, he concentrated on the compilation of an all-encompassing global collection of comparative osteology, particularly of mammalian skeletons.

It is not surprising that Filhol's broad palaeontological interests and capabilities, outlined above, already evident at an age of 31 years, led the French Academy of Science to invite him to accompany, as naturalist, the Academy Mission to Campbell Island to view the 1874 Transit of Venus. Filhol accepted.

The expedition arrived at Campbell Island on September 9, after calling briefly at Sydney, on the transport frigate *La Vire* , captained by Monsieur Jacquemart. Other Mission personnel on board, and their duties, were Monsieur Bouquet de la Grye, hydrographic engineer and leader of the Mission, *astronomer* ; Monsieur Hatt, assistant hydrographic engineer, *astronomer* ; Monsieur Courrejolles, ship's bosun in charge of the sailors, *photographer* ; and Monsieur Filhol, doctor, *naturalist* .

The location on Campbell Island chosen for a base was near the head of Perseverance Harbour (see Fig 2). Here were erected, presumably from material brought on the ship, living quarters, cabins for scientific study, storehouses and supports for instruments.

The latitude and longitude of the base was determined from two moon shots. Magnetic inclination, declination and intensity, and the diurnal variation of the declination (the latter measured hourly for the period of stay) were preciserly determined. A tide guage indicated the daily tidal changes during the same period. The gravity anomaly was measured several times. Oscillations of the sun were registered by means of a pendulum multiplicator (?).

The transit of Venus was partially observed on 9 December (1874).

Mission thus semi-completed, the frigate *La Vire* departed on December 28, destination New Zealand. No one on board (except, perhaps, Filhol) expressed regret at leaving Campbell Island; officers and sailors complained, for example, of the island's desolateness and miserable climate, the softness of the extensive peat cover which made walking difficult, and the unpleasant-to-drink brown peat-stained water. In Dunedin, however, the ship's company was received warmly by some of the anglo-scottish New Zealanders, including members of the Provincial Institute, who helped and cooperated with Filhol in his subsequent researches. I do not know how long Filhol spent in New Zealand at this stage but it was long enough for him to traverse the country from north to south and to meet and confer with a number of New Zealand's natural scientists.

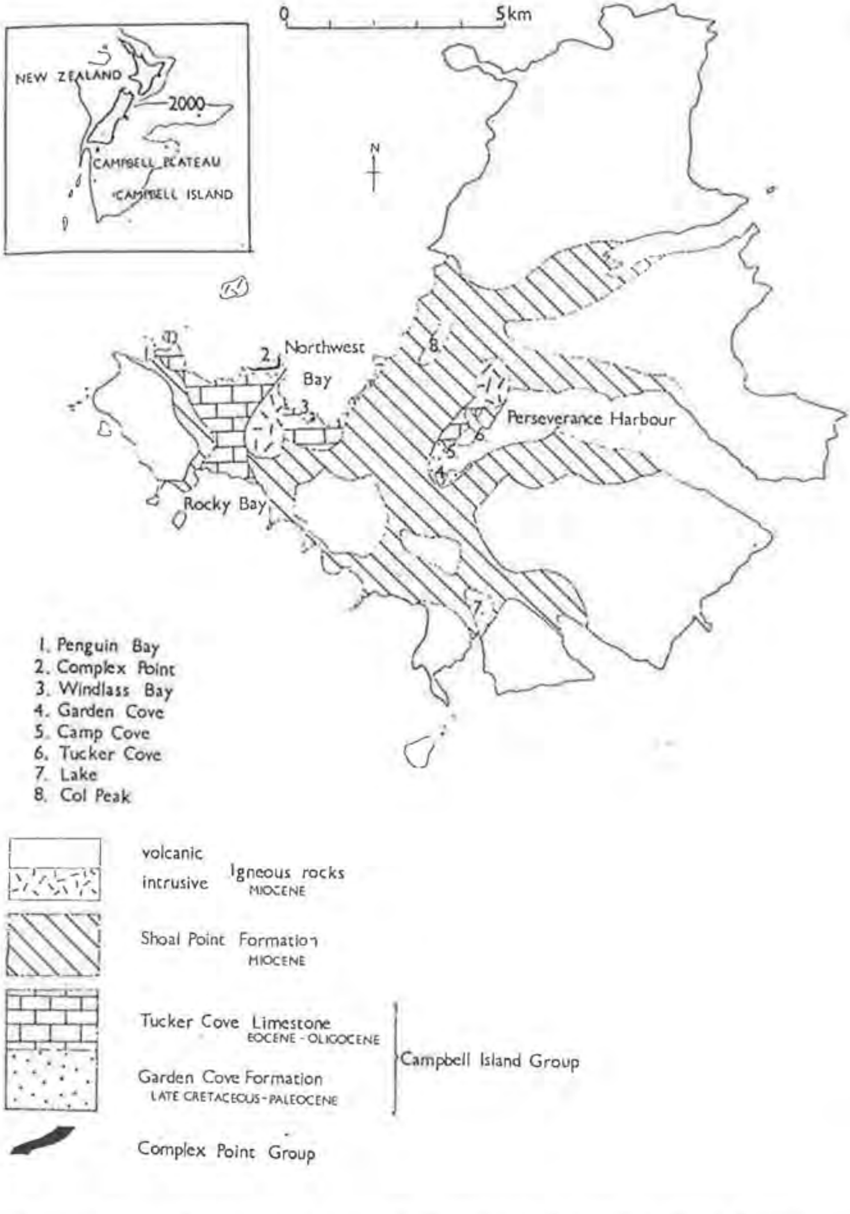


Figure 2. Geological map of Campbell Island (from Beggs, 1978 - simplified from Oliver et al, 1950)

A summary of the geology of Campbell Island appeared in Comptes Rendus, 1876, soon after his presumed return to France.

This publication was followed in 1878, also in Comptes Rendus, by a short account of marine molluscs from New Zealand (particularly Stewart Island) coastal outcrops and off-shore dredgings, and a comparison of these (179 species from Stewart Island and vicinity, 99 species from near Auckland, 134 species from Cook Strait) with similar species on Campbell Island, Auckland and Chatham Island.

Yet again in Comptes Rendus, in 1880, Filhol described his collection of marine mollusca from the shores of Campbell Island - a list of 1 Cephalopod species, 16 Gasteropod species (including 10 new species), and several new Lamellibranch species - and compared these with species in New Zealand and in other parts of the Pacific.

The above mentioned publications are an indication of Filhol's desire to record his observations and describe his collected material from Cambell Island and from these to "introduce some new ideas into the discussion relating to the geographical extensions which New Zealand seems to have possessed during different geological periods" . (Filhol, 1882; 82-83). Filhol refers to evidence submitted by Prof M. M. Hutton , M. A. Milne Edwards, and Wallace supporting the existence, questionably in the Pliocene, of a great Austral land, of which New Zealand, Norfolk Island, Chatham Islands, Macquarie Island and Auckland were likely parts, and puts the question "has Campbell Island ever formed part of this pliocene New Zealand continent?".

1885 saw the publication of the presumed official academy record of the mission to Campbell Island to observe the transit of Venus, viz "Recueil de mémoires, de rapports et documents relatifs à l'observation du passage de Venus sur le Soleil du 9 Decembre 1874", consisting of nine volumes (tomes). Tome III, part 2, comprises the results of Filhol's monumental research on the zoology, botany and geology of Campbell Island and their NZ association - 739 pages of text and 68 photographic plates. Tome III, part 2 is introduced by Filhol to Monsieur Dumas, President of the Commission, in the nature of a summary of the former's "mission to Campbell Island". In this introduction (1885a, pp 3-13), Filhol outlines the historical background to the expedition and emphasises the desirability of relating fauna and flora in, and the geology of, the fragments of the great austral land. There follows a detailed, comprehensive and accurate account of the geology of Campbell Island (Filhol, 1885b) which is an amplification and modification of his earlier preliminary descriptions.

This account, though without a map, was of immense value during my 1944 survey (cf Oliver et al, 1950) and of great assistance in my production of a geological map (cf Fig 2).

More recent work has added detail, for example that of Beggs (1978) and of Ireland et al (1995); the latter show a similar age pattern from detrital zircons from the Campbell I basement schist (Complex Point Group) and from a number of localities in southeastern Australia, New Zealand and Antarctica, suggesting correlation of deposition at these localities in the Cambro-Ordovician.

The Miocene Campbell Island volcanism (see Morris, 1984) also can be correlated, petrogenetically and chronologically, with that of Auckland Islands, the Dunedin area and Banks Peninsula in New Zealand, and central Marie Byrd Land in West Antarctica, a manifestation, however, of intra-plate volcanism accompanying fast spreading of the southwest Pacific in late Cenozoic time (Adams et al, 1979).

In brief, it can be said that Filhol's geological observations and his interpretations of their significance comprise a remarkably complete contribution to our knowledge of the geology of Campbell Island, and certainly justified his appointment by the French Academy of Science as naturalist on their Mission to observe, there, the Transit of Venus.

References

Adams, C. J., Morris, P. A., and Beggs, J.M., 1979. *Age and correlation of volcanic rocks of Campbell Island and metamorphic basement of the Campbell Plateau, south-west Pacific.* N.Z. Journal of Geology and Geophysics, vol 22, pp 679-91.

Anon, 1902. *Liste des ouvrages et mémoires publiés de 1863 à 1901 par Henri Filhol.* Nouv. Archs. Mus. Hist. nat. Paris, vol 4, pp III-XVI.

Beggs, J. M., 1978. *Geology of the metamorphic basement and Late Cretaceous to Oligocene sedimentary sequence of Campbell Island, southwest Pacific Ocean.* Journal of the Royal Society of New Zealand, 8, pp 161-177.

Filhol, H. F., 1876. *Mission de l'île Campbell: constitution géologique de l'isle.* Comptes rendus de l'Acad. des sc., t. LXXXII, p 202-205.

Filhol, H. F., 1878. *Sur les Mollusques marins de l'île Stewart (Nouvelle- Zelande).* Comptes rendus de l'Acad. des sc., t. LXXXVI, p 702-703.

Filhol, H. F., 1880. *Mollusques marins vivant sur les côtes de l'île Campbell.* Comptes rendus de l'Acad. des sc., t. XCI, p 1094-1095.

Filhol, H. F., 1882. *Rapports géologiques et zoolologiques de l'île Campbell avec les terres australes avoisinantes.* Comptes rendus de l'Acad de sc., t. XCIV, 563-566.

Filhol, H. F., 1882-1883. *Geological and zoological relations of Campbell Island with the neighbouring southern lands.* N.Z. Journal of Science 1, 259- 262.

Filhol, H. F., 1885a. *Mission de l'isle Campbell* (introduction) in Recueil de mémoires, de rapports et documents relatifs à l'observation du passage de Venus sur le Soleil du 9 Décembre 1874, 3-13. Paris.

Filhol, H. F., 1885b. *Constitution geologique de l'sle Campbell.* Chapter II, Mission de l'sle Campbell in Recueil de mémoires, de rapports et documents relatifs a l'observation du passage de Venus sur le Soleil du 9 Décembre 1874, 141-180. Paris.

Ireland, T. R., Fanning, C. M., Flöttman, T., Weaver, S. D., Bradshaw, J. D. & Adams, C., 1995. *Continental structure on the Pacific margin of Gondwana: detrital zircon ages from Lachlan Fold Belt, Kanmantoo Group and Adelaide Fold Belt of Australia, and Victoria Land correlatives* in VII International Symposium on Antarctic Earth Sciences, 1995, ABSTRACTS, p. 202.

Morris, P. A., 1984. *Petrology of Campbell Island volcanics, southwest Pacific Ocean.* Journal of Volcanology and Geothermal Research, 119-148.

Oliver, R. L., Finlay, H.J. and Fleming, C. A., 1950. *The geology of Campbell Island.* N.Z. DSIR Cape Expedition Series, Bulletin 3, 1-62.

Osborn, H. F., 1902. *Henri Filhol, paleontologist.* Science, N.Y., n.s., vol 15, p 912.

Addendum :

After Robin had submitted his manuscript he came across the following additional publications by Filhol relative to his article. All were published in Bulletin de la Societie philomat(h)ique :

1878 - Note on a species of *Urile (Urile campbelli)* from Campbell Island.
Bull. Soc. phil., t. 2, p. 132.

1880 - Note on a new species of *Helix (Helix Campbellica).*
Bull. Soc. phil., t. 4, p. 126.

1884 - Observations relating to species of the genus *Paramithrax* living in New Zealand.
Bull. Soc. phil., t. 9, p. 26.

1884 - Descriptions of new species of Crustacaea belonging to the genus *Hymenicus,* from New Zealand.
Bull. Soc. phil., t. 9, p. 43.

1884 - New description of a species of *Crustaceae* belonging to the genus *Hymenicus* from Stewart Island (New Zealand).
Bull. Soc. phil., t. 9, p. 45.

1884 - Thoughts on the ornithological fauna of Campbell Island.
Bull. Soc phil., t. 9, p. 49.

* *

Little Rangitoto Volcano

Justin Franklin

Rangitoto Island is one of the best known landmarks in the Auckland region. There is, however, a less well known volcano in the Auckland Volcanic Field which also bears the name Rangitoto – Little Rangitoto. Little Rangitoto was a small scoria cone (figs. 1 & 2) situated approximately 600 m south of the southern edge of the Orakei Basin crater. The cone was quarried away long ago, and now the site between Ventnor Rd and Benson Rd in Remuera is a 2 hectare reserve called 'Little Rangitoto Reserve'. Only a small portion of Little Rangitoto's southern flank remains (covered by housing), and a minor lava flow extends down into the mangrove swamp in Hobson Bay, with most of the flow also being covered by residential housing. Little Rangitoto is one of the smallest volcanoes in the Auckland Volcanic Field.

The Maori name for Little Rangitoto is 'Maungarahiri' which means 'Rahiri's hill'. Rahiri was an important ancestor of the Ngapuhi and other northern tribes, however no record of why the hill was named after Rahiri remains (Simmons 1987). The European name 'Little Rangitoto' arose from the resemblance of the hill to Rangitoto Island (Simmons 1987). Other names for Little Rangitoto have been 'Mount' or 'Rangitoto' (Hochstetter 1864 ; 1959 ; Hochstetter & Petermann 1863 ; 1864), and 'Benson's Hill' (Wong 1946).

The slopes of Little Rangitoto were formerly the site of a Maori pa known as 'Maungarahiri pa' or 'Rangitoto pa' (fig. 2). This pa and others in the area were home to the Waiohua tribe until the Ngati Whatua from Kaipara conquered the Auckland Isthmus in 1750 (Jackson 1976). After 1750 the area was not always inhabited by the Ngati Whatua due to tribal warfare, especially the Ngapuhi musket invasions of the 1820's. The chief Te Tinana (who signed the Treaty of Waitangi in 1840) returned to Rangitoto pa in 1835 with about 200 Ngati Whatua.

Little Rangitoto was examined in early 1859 during Ferdinand von Hochstetter's survey of the volcanic cones and craters of Auckland. During this exploration of Auckland Hochstetter was accompanied and assisted by the artist and Government Surveyor Charles Heaphy. The following year Heaphy (1860) published a paper on the Auckland Volcanic Field, including a map of the cones and craters. A geological map entitled 'The Istmus of Auckland with its extinct Volcanoes' (fig. 3) appeared in Hochstetter (1864) and in Hochstetter & Petermann (1863 ; 1864). Hochstetter (1864) was later translated to English by Fleming (Hochstetter 1959), and included a reproduction of the Auckland map. Quarrying of Little Rangitoto before 1859 was unlikely to have destroyed much of the original features of the cone, therefore Hochstetter's brief description below is possibly the only remaining description of a largely intact Little Rangitoto.

"*Rangitoto, south of Orakei Bay, not to be confused with Rangitoto Mountain in Hauraki Gulf, is a low eruptive cone with very imperfectly preserved crater, breached to the north-west. In this direction, towards Hobson Bay, insignificant lava flows have discharged, below which springs of fresh water bubble up on the beach. To the south-east is the cinder cone, surrounded by a tuff cone, in contact with the tuff crater of Orakei Bay*" (Hochstetter 1959, page 197).

On the map Little Rangitoto is called 'Mount or Rangitoto', and is depicted as being surrounded by a tuff cone, with a lava flow extending towards Hobson Bay. Peter Wong briefly studied Little Rangitoto in the mid-1940's as part of his MSc thesis on the Auckland Volcanic Field. Wong (1946) noted the absence of a tuff ring, while Ernest Searle makes no mention of a tuff ring surrounding Little Rangitoto in any of his publications concerning the Auckland Volcanic Field. Kermode *et al.* (1992) mentioned 'an insignificant tuff ring remnant in the SW'. Little Rangitoto may have followed Allen's (1992) generalised Auckland eruption sequence of initial explosive phreatomagmatic activity (forming a tuff 'cone' or ring), followed by less explosive, magmatic activity (forming a 'cinder' or scoria cone with lava flows). Later workers may have just failed to see

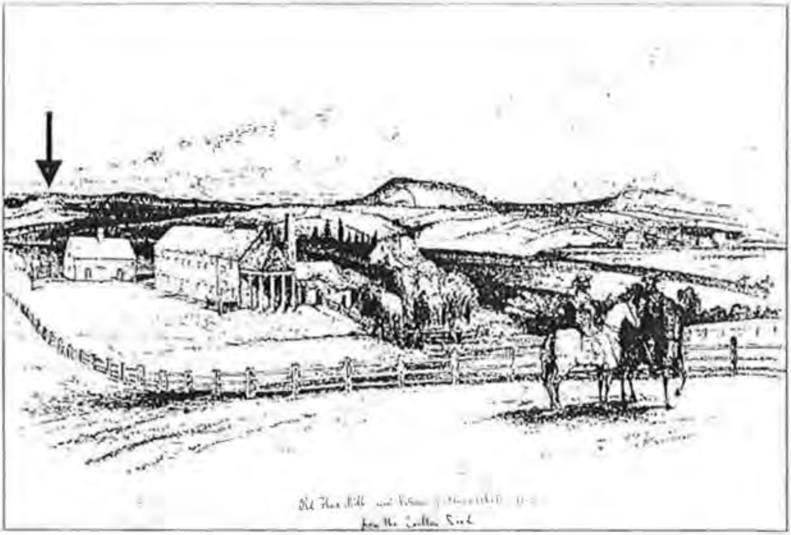


Fig. 1 View of the old flax mill and village at Newmarket in 1858 looking south-east from Carlton Gore Rd. Little Rangitoto is indicated by the arrow, Mt Hobson is centre, and Mt St John is right (sketch courtesy of Auckland City Libraries).

Fig. 2 Little Rangitoto volcano and Rangitoto pa in 1899. The photograph is looking along Upland Rd, and the pa is at the intersection of Upland Rd and Benson Rd (photograph from the Boscawen Album, Auckland Institute and Museum).

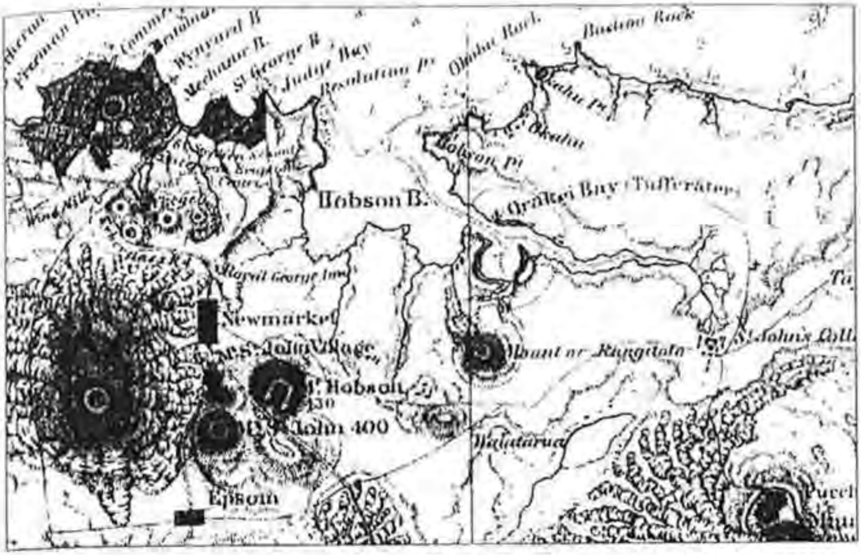


Fig. 3 An enlarged portion of Hochstetter's map of the Auckland Isthmus showing the Little Rangitoto "cinder cone, surrounded by a tuff cone, in contact with the tuff crater of Orakei Bay" (from Hochstetter & Petermann 1864).

Hochstetter's tuff cone due to residential modification. Conversely, Hochstetter may have misinterpreted the undulating Waitemata Group topography as a tuff cone.

The Little Rangitoto lava flow on Hochstetter's map ends some distance before Hobson Bay, while his description of the flow suggests that it reached Hobson Bay, having freshwater bubbling up through it on the beach. Later geological maps by Kermode & Searle (1966) and Kermode (1991, 1992) also have the lava flow ending before the mangrove swamp in Hobson Bay (probably as the flow in Hobson Bay is very minor). Thus it is possible that Hochstetter also considered the part of the lava flow extending into Hobson Bay as too minor to be included on his map.

The area around Little Rangitoto was explored by geologist James Park in 1885 for the Geological Survey of New Zealand. Park (1886) briefly described the Little Rangitoto lava flow and Orakei Basin tuff beds. "*At the small bay east of Morrin's Point the lava streams and scoria of the neighbouring crater – Little Rangitoto – extend to the beach, and, as the ground rises to the east, lie upon a volcanic ash or tuff beds* (Orakei Basin tuff), *consisting of fine-bedded trachyte sands and grits, with large angular masses of lava and scoria, and in the lower beds large fragments of sandstone derived from the underlying Waitemata beds*" (Park 1886, page 150).

Quarrying of Little Rangitoto started mid-19th century, with scoria being taken from 1845 onwards to cover the newly created road from Tamaki to Newmarket (Macdonald 1984). Much of the cone had been removed for roading by 1914 (Kermode *et al.* 1992). A 1928 report by the Auckland Town planning Association (Fowlds 1928) noted that the small hill had practically disappeared, with intermittent quarrying still being carried out at different levels. The report stated that Little Rangitoto was an educational reserve which was sold to the Auckland City Council, and recommended 'that further excavating should be done to a plan for its eventual use as a recreation reserve and a rockery'. Wong (1946) mentioned that quarrying operations had advanced so far that it was hard to tell that a volcano once occupied the site. A report by the Historic Auckland Society (Golson 1957) said quarrying had stopped, and that the site was currently a council depot and district dump. The report also said the Auckland City Council would rehabilitate the site as a recreation ground. Searle & Mayhill (1981) noted that the former scoria quarry was being developed as a family park.

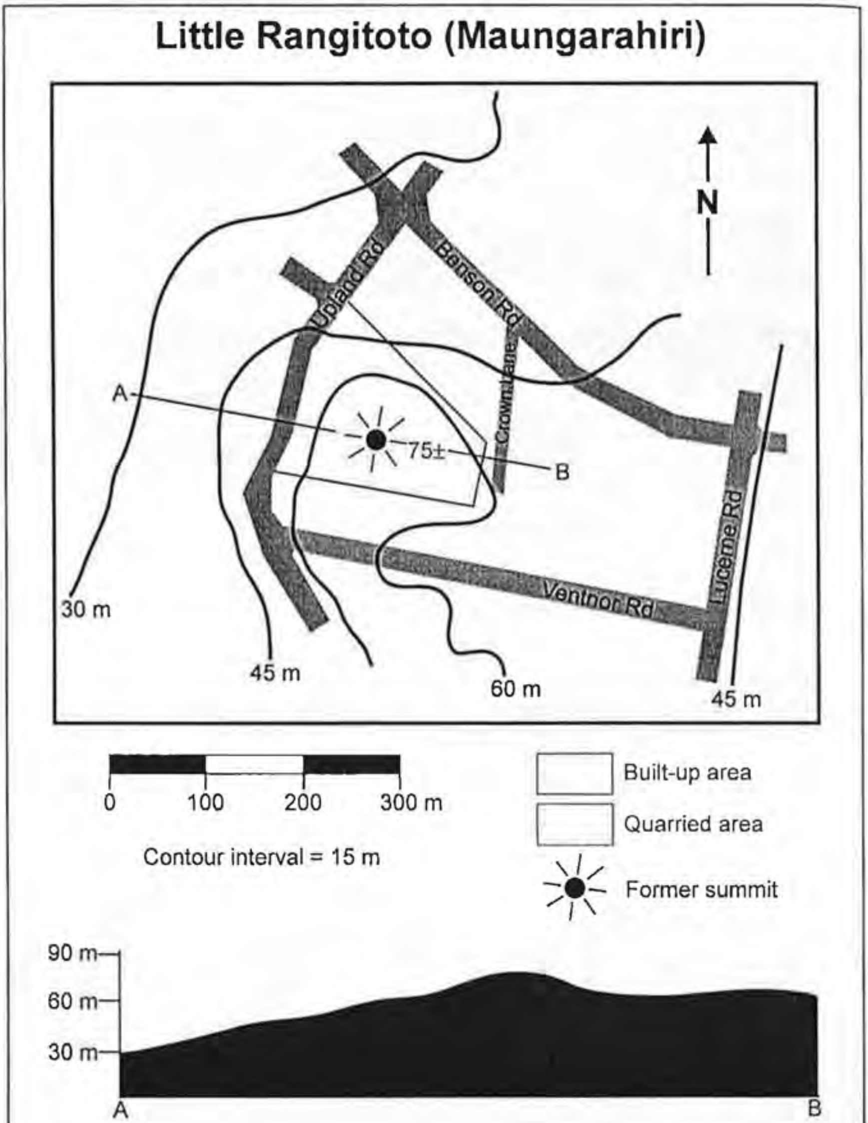


Fig. 4 A recreation of the topography of Little Rangitoto (modified from Searle & Mayhill 1981).

Wong (1946) wrote that the highest point of the quarry rim is 226 feet (69 m) above sea level, thus the original summit of Little Rangitoto must have been considerably higher. Searle & Mayhill (1981) gave an original cone height of approximately 75 m above sea level, and this value was used by Allen (1992) and Allen & Smith (1994) for calculation purposes. Allen (1992) and Allen & Smith (1994) estimated that the cone was 13 m above the pre-volcanic terrain and had a basal extent of 40 000 m^2. Fig. 4 is a recreation of the original topography of Little Rangitoto.

No absolute age exists for Little Rangitoto. The deposits from Little Rangitoto and Orakei Basin are isolated from other deposits in the Auckland Volcanic Field, making it very difficult to include them in a relative stratigraphic sequence (Allen 1992). The scoria cone and lava flow of Little Rangitoto overlies the south-west portion of the Orakei Basin tuff ring, therefore Little Rangitoto is the younger of the pair. Based on physiographic evidence and erosional geomorphology Searle (1961 ; 1964a ; 1964b) and Searle & Mayhill (1981) classified Little Rangitoto as being less than 20 000 years old. Allen (1992) and Allen & Smith (1994) compiled a relative age order for the 49 Auckland volcanoes based on known dates and superposition. Little Rangitoto was considered to be less than 20 000 years old, and the list placed Little Rangitoto as the 45th eruption.

References

Allen, S.R. 1992: *Volcanic Hazards in the Auckland Volcanic Field.* Unpublished MSc thesis, University of Auckland. ix + 153 pp.

Allen, S.R. ; Smith, I.E.M. 1994: Eruption styles and volcanic hazard in the Auckland Volcanic Field, New Zealand. *Geoscience Reports of Shizuoka University 20*: 5 – 14.

Fowlds, G.M. 1928: *Auckland's Unique Heritage, 63 Wonderful Volcanic Cones and Craters: an appeal to save them.* Report on Preservation of Volcanic Cones and Craters by the Auckland Town Planning Association, Inc., NZ. 26 pp.

Golson, J. *ed.* 1957: *Auckland's Volcanic Cones: a report on their condition and a plea for their preservation.* Historic Auckland Society. 32 pp.

Heaphy, C. 1860: On the volcanic country of Auckland. *Quarterly Journal of the Geological Society of London 14*: 242 – 252.

Hochstetter, F. von ; Petermann, A. 1863: *Geologisch-topographischer Atlas von Neu-Seeland.* Sechs Karten, hauptsächlich Gebiete der Provinzen Auckland und Nelson umfassend: mit kurzen Erläuterungen. Gotha, Justus Perthes. 20 pp., 6 maps.

Hochstetter, F. von ; Petermann, A. 1864: *Geological and Topographical Atlas of New Zealand.* Six maps of the Provinces of Auckland and Nelson. Auckland, T. Dalattre.

Hochstetter, F. von 1864: *Geologie von Neu-Seeland.* Beiträge zur Geologie der Provinzen Auckland und Nelson. Reise der Österreichischen Fregatte Novara um die Erde in den Jahren 1857, 1858, 1859 unter den Befehlen des Commodore B. von Wüllerstorf-Urbair. Geologischer Theil, Erster Band, Erster Abtheilung. Wein, Aus der Kaiserlich-Königlichen Hof- und Staatsdruckerei. xlvii + 274 pp. mit 6 geologischen karten in farbendruck.

Hochstetter, F. von 1959: *Geology of New Zealand.* Contributions to the Geology of the Provinces of Auckland and Nelson. Translated and edited by Fleming, C.A., Wellington, Government Printer. xxiii + 320 pp. with 5 geological maps.

Jackson, E.T. 1976: *Delving into the Past of Auckland's Eastern Suburbs: Section 1 From Ancient Times to 1842 and Section 2 Orakei.* Auckland, Elizabeth T. Jackson. 50 + 85 pp.

Kermode, L.O. ; Searle, E.J. 1966: *Eden*. New Zealand Geological Survey Industrial Map Series 1:25 000, Sheet N42/5. Wellington, New Zealand Department of Scientific and Industrial Research.

Kermode, L.O. 1991: *Whangaporoa – Auckland*. Infomap 290 Sheet R10/11 1:100 000, New Zealand Land Inventory, Rock Types. Wellington, Department of Survey and Land Information.

Kermode, L.O. 1992: *Geology of the Auckland Urban Area*. Scale 1:50 000. Institute of Geological and Nuclear Sciences Geological Map 2. Lower Hutt, IGNS. 1 sheet + 63 pp.

Kermode, L.O. ; Smith, I.E.M. ; Moore, C.L. ; Stewart, R.B. ; Ashcroft, J. ; Nowell, S.B. ; Hayward, B.W. 1992: *Inventory of Quaternary Volcanics and Volcanic Features of Northland, Auckland, South Auckland and Taranaki*. Lower Hutt, Geological Society of New Zealand Miscellaneous Publication 61. 99 pp.

Macdonald, W. 1984: *Recollections 1850 – 1920: A Sketch History of Early Remuera*. Remuera, Milnes. 38 pp.

Park, J. 1886: *Auckland Provincial District*. *In*: Hector, J. *ed*. New Zealand Geological Survey Reports of Geological Exploration During 1885. Wellington, New Zealand Geological Survey. Pp.136 – 64.

Searle, E.J. 1961: The Age of the Auckland Volcanoes. *New Zealand Geographer 17*: 52 – 63.

Searle, E.J. 1964a: *City of Volcanoes: a geology of Auckland*. Auckland, Paul's Book Arcade. xiv + 112 pp.

Searle, E.J. 1964b: Volcanic Risk in the Auckland Metropolitan District. *New Zealand Journal of Geology and Geophysics* 7: 94 – 100.

Searle, E.J. ; Mayhill, R.D. 1981: *City of Volcanoes: a geology of Auckland*. Revised edition. Auckland, Longman Paul. x + 195 pp.

Simmons, D. 1987: *Maori Auckland: including the Maori Place Names of Auckland collected by George Graham*. Auckland, The Bush Press. 96 pp.

Wong, P. 1946: *Some Aspects of the Post-Tertiary Volcanic Phenomena at Auckland*. Unpublished MSc thesis, University of Auckland. 97 pp.

* *

What might have been – or was it wishful thinking ?

An invitation has been extended to the International Geological Congress to hold its 22nd meeting in New Zealand in 1964, also to mark the centenrial of the N.Z.G.S. The Government is reported to have regarded this proposal favourably, and, if the invitation is accepted, the stimulus to New Zealand geology will be considerable. The I.G.C. has only once previously met in the Southern Hemisphere - Pretoria, 1929.

-Geol. Soc. N.Z. Newsletter No.3.January 1957

Ami Boué and the First Geological Map of New Zealand

David Oldroyd
The University of New South wales

Newsletter No. 10 (March, 1995) and *Newsletter* No. 12 (March, 1996) provide some information about the possible first geological maps of New Zealand. *Bulletin* No. 66 of the Geological Survey of New Zealand (*The Geological Map of New Zealand*, 1959) contained a mention (p. 2) by the then Survey Director, R.W. Willett, of a geological map of the South Pacific, dated 1843, which included New Zealand. It was supposedly produced by the French geologist Alcide d'Orbigny (1802–1857) and was said to have been published in his *Voyage dans l'Amérique Méridionale* (7 vols + atlas of 2 vols, Paris, 1835–47). But Willett stated that he had not actually seen the map and my own efforts to locate it some years ago proved unsuccessful (see *Newsletters* 10 and 12, mentioned above).

In my London University MSc thesis, 'Geology in New Zealand Prior to 1900' (1967), I suggested that there would have been insufficient information for anyone to have produced a geological map of the whole of New Zealand in 1843, and I maintained that the first such map must have been that of W.B.D. Mantell, the two rolls of which were kept at the Geological Survey, Lower Hutt, in the 1960s and are, I suppose/hope, still there. I hazarded that the two rolls of hand-coloured map must have been prepared in the latter part of the 1850s. It was difficult to know how Mantell had enough information, even then, to produce the maps as he did, and the dates are, so far as I am aware, still unfixed. But that is a problem that does not concern us here.

The note in *Newsletter* No. 10 mentions a reference to a geological map of the world by the geologist Ami Boué (1794–1881), given on p. 593 of the English translation of Eduard Suess's *The Face of the Earth* (1904). Boué published his *Essai d'une carte géologique du globe terrestre* in Paris in 1845. I have not myself seen this work, but it would indeed appear to be related to a version of the item that Willett had in mind when he referred to a very early geological map of New Zealand, from the 1840s; for the *first* appearance of Boué's map was indeed prepared in 1843, as explained below.

Recently new light has been thrown on the problem by a publication of the French geologist, academician, and historian of geology, Michel Durand-Delga: 'Des premières cartes géologiques du globe par Ami Boué (1843) et Jules Marcou (1861) à l'atlas géologique du monde de 1984', in: Gabriel Gohau (ed.), *De la géologie à son histoire: Ouvrage en hommage à François Ellenberger* (Paris: Comité des Travaux Historiques et Scientifiques, 1997, pp. 193–205) (issued 1998). This paper discusses Boué's work and refers to his publication: 'Mémoire à l'appui d'un essai de Carte géologique du globe terrestre, présenté le 22 septembre 1843, à la réunion des naturalistes d'Allemagne à Gratz [= Graz, Austria]', *Bulletin de la Société géologique de France*, 2nd Series, 1844, *1*, 296–371. Moreover, Professor Durand-Delga has kindly supplied me with laser colour copies of parts of the two maps (1843 and 1845), for the areas of New Zealand, Australia, Papua New Guinea, and Indonesia:

1. The map that Boué displayed at Graz in his lecture of 1843, geologically hand-coloured onto a printed map 'Die Erde in Mercator's Projection' by C.F. Weiland, Weimar, 1841, Scale 1:58,000,000 [Document B 256, in the library of the Geological Society of France];
2. The revised map, as published in Boué's monograph of 1845 [Document C 256 bis, Geological Society of France].

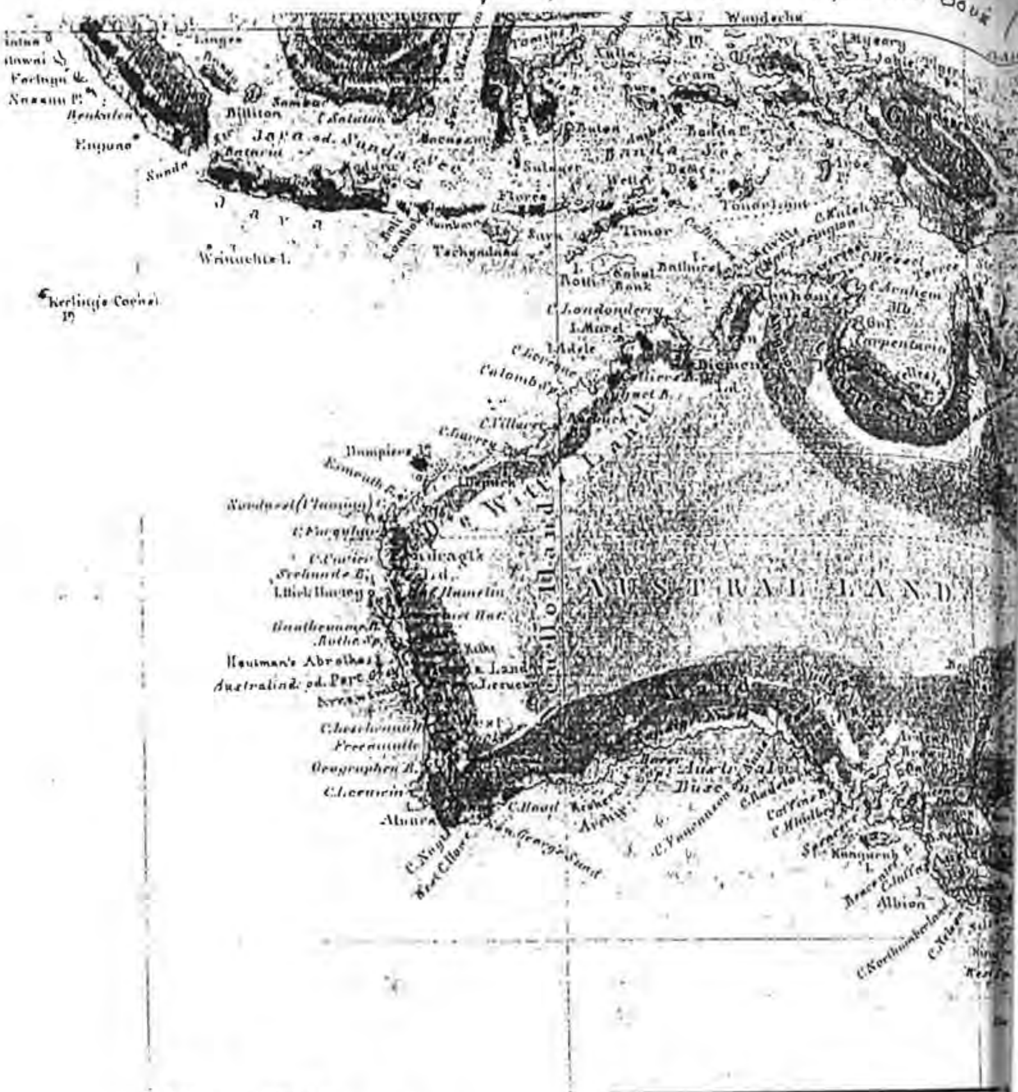
These are reproduced (Figures 1 and 2) below, bearing Durand-Delga's annotations.*

The question then remains as to how Boué had sufficient geological information to enable him to provide any sort of geological map of New Zealand in 1843. The only possible significant sources of information would appear to have been Dr Ernst Dieffenbach's *Travels in New Zealand* (London, 1843), this German naturalist having visited New Zealand in 1839 on behalf of The New Zealand Company; and information that may have been gleaned from James Dwight Dana, who visited New Zealand briefly from Sydney in 1840, during the United States

* If readers wish to receive colour copies of the Australasian parts of the maps, they may do so at cost by application to the editor of this *Newsletter*, Alan Mason.

($4-00 per map plus postage 80 cents - APM)

Original présenté à Grätz en 1843 par Ami Boué



Echelle initiale
(= 1/58 000 000)

Echelle de cette reproduction (amplifiée)

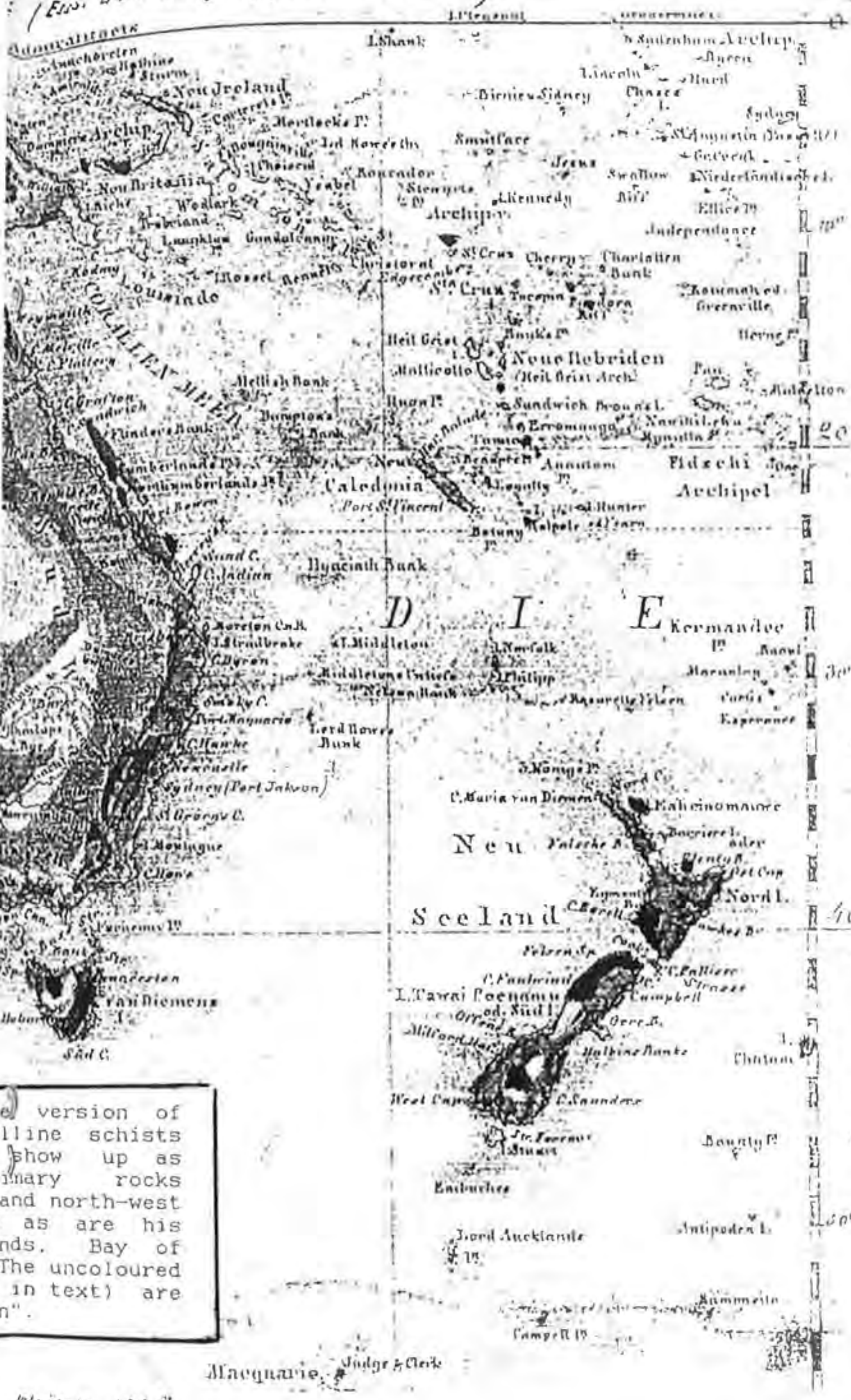
In this black and white
Boue's map, his crystal
(most of the country)
dark-grey. His Pr
(south-west North Island
South Island) are black
volcanics (Bay of Islan
Plenty, Central Otago).
areas (Item 5 of table
"Alluvial/Modern or unknown

[Fond topographique : "Die Erde in Mercator's Projection", von C. F. Weiland

Figure 1 -

(Essai d'une Carte géologique du Globe terrestre)

- Document 3 #56
"Sergius' Erasmus"



← green-gray
Flötz-Gebirge
[= Secondary]

← yellow:
Tertiäre Gebirge

← violet:
Kristallinische
Schiefer Gebirge

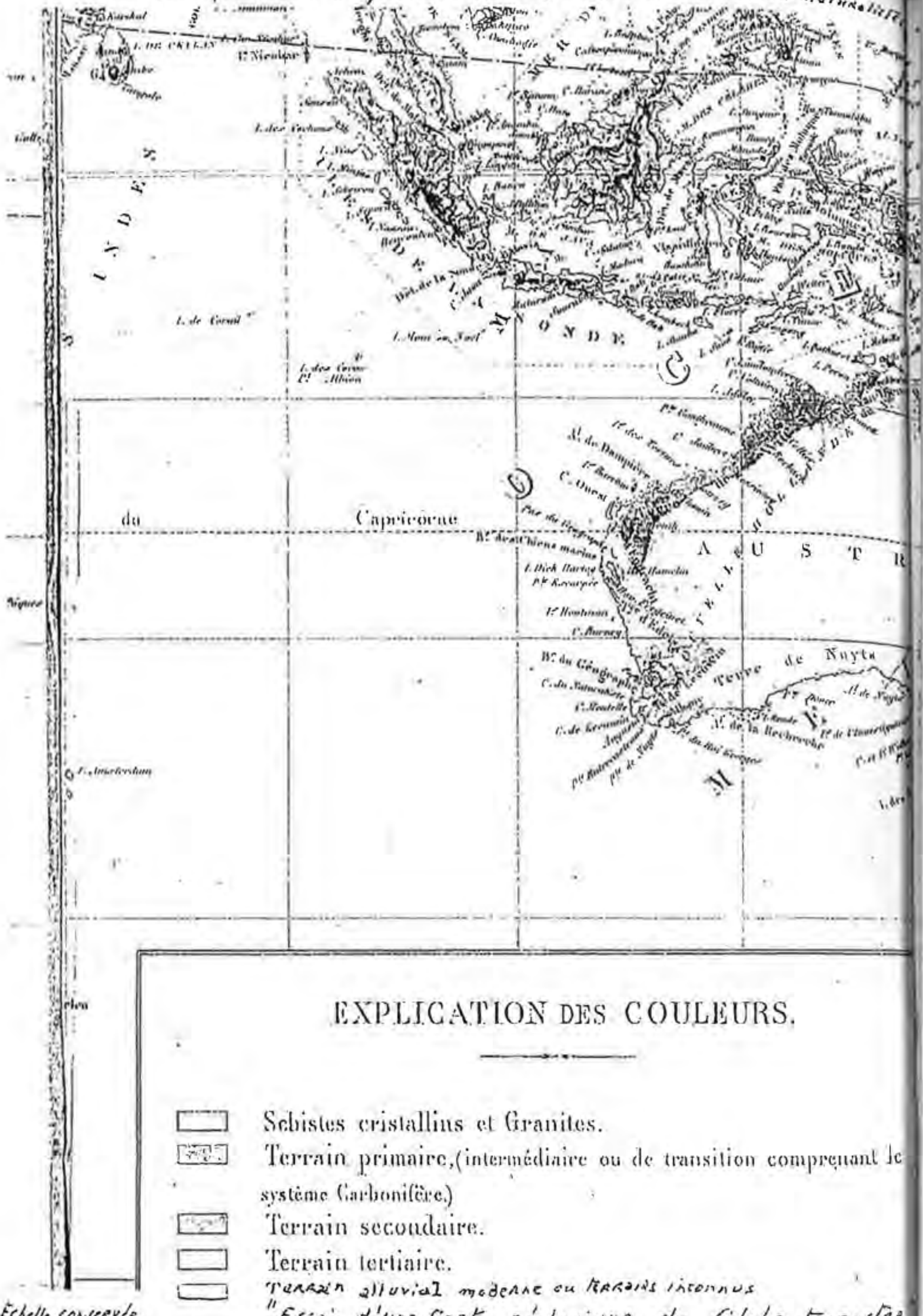
← blue
Urgebirge
(= Primary !)

red (pointe!)
← "Vulkane,
plutonische Gebilde

...e version of
...lline schists
...show up as
...imary rocks
...and north-west
... as are his
...nds. Bay of
...The uncoloured
... in text) are
...n".

[... Weimar, 1841]
1843 Map

La Maquette avait été présentée le 22 sept. 1843 à la Réunion des Naturalistes

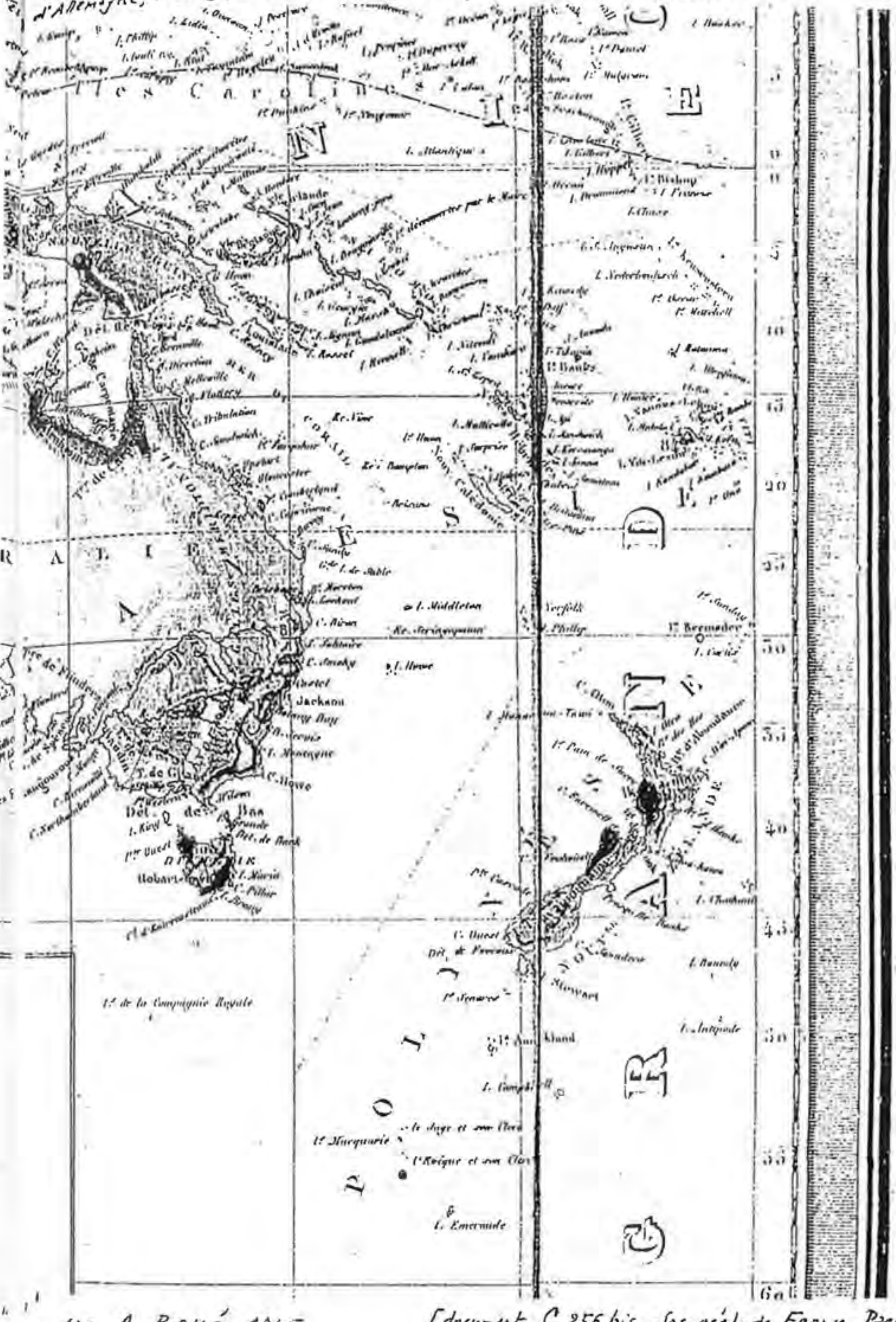


Echelle conservée

"Essai d'une Carte géologique du Globe Terrestre

Figure 2 -

d'Allemagne, à Grätz [= Graz, Österreich] - cf. Bull. Soc. géol. France, (2), t. I, 1844



, par A. BOUÉ, 1845

[document C 256 bis, Soc. géol. de France, Paris]

1845 Map

Exploring Expedition under the command of Charles Wilkes. But Dana's published account of New Zealand geology did not appear until 1849 and when it did he relied on Dieffenbach for information outside the Auckland region and the Bay of Islands. Darwin's geological observations on New Zealand also came too late (1844), at least for the first version of Boué's map; and in any case there is but little on New Zealand beyond a list of a few rocks collected at the Bay of Islands. Boué's name does not appear in the relevant volumes of the Darwin *Correspondence*.

Regarding Dieffenbach, his biographer Gerda Bell (*Ernest Dieffenbach Rebel and Humanist* (Palmerston North: The Dunmore Press, 1976, p. 147) demonstrates that his *Travels* appeared early in 1843, so it *would* have been possible for news of his book to have reached Boué by September, 1843; and quite possibly it did. (I thank Alan Mason for this reference.)

However, according to Durand-Delga's examination of Boué's work, most of what he depicted in geological colours for the parts of the world that he did not visit was based on what he thought might reasonably be there, according to his geological experience elsewhere and his theorising. His experience was in fact considerable. Boué came from a French-speaking Huguenot family in Hamburg, was educated in Switzerland and Paris, studied medicine in Edinburgh and travelled widely in Scotland, producing the first geological map of that country (1808). He resided in Paris for twenty years and was active in establishing the Société géologique de France. Finally, he settled in Vienna, travelling extensively in the Balkans and Turkey. Apparently he collected information for many years (1815 to 1843) from every possible source, from the writings of geologists and other travellers, with a view to compiling a world map.

Boué's maps had six colours:

1.	Pink:	Crystalline schists or granites
2.	Dark Blue:	Primary, including the Carboniferous System [sic]
3.	Blue/green:	Secondary
4.	Yellowish:	Tertiary
5.	White:	Alluvial/Modern or unknown
6.	Orange/red:	Volcanoes; plutonic/igneous rocks.

As Durand-Delga points out, it was the very simplicity of Boué's classificatory system and his *lack* of knowledge that made his compilation possible, since he could cheerfully colour in his map according to the flimsiest of evidence or information. (Needless to say, however, his map was more satisfactory for Europe than for Australasia.)

It would appear that for Boué most of New Zealand consisted of crystalline schists, with some 'Primary' rock in the northwest of the South Island (approximately Nelson Province) and the southwest of the North Island (approximately Taranaki Province), with volcanics in the Bay of Islands, the Bay of Plenty, and (for some obscure reason) Central Otago. It is difficult to know what he meant by 'Primary', but, as can be seen from the key to Figure 2, it apparently had equivalents in 'Intermediate' or 'Transition' rocks. Thus we might tentatively and approximately equate Boué's 'Primaries' with Palaeozoics—a term introduced by John Phillips in 1841, but not used by Boué.

As Durand-Delga explains, much of Boué's reasoning was based on analogies. Rocks might be expected to be similar in situations that were supposedly analogous (such as Sicily and Calabria and Tierra del Fuego and South America?); and mountain ranges that had similar alignments might be expected to be geologically similar. It is possible, then, that there was some intended analogy between the rocks of the South Island of New Zealand and Tasmania in the 1843 map, and possibly more generally for the east coast of Australia and New Zealand as a whole. This supposed similarity seems to have increased rather than decreased in the 1845 version, and eastern Australia seems to have become rather more like a 'standard' Wernerian map, with 'Transition' rocks butting against both sides of a central crystalline core for a mountain chain (the Great Dividing Range of eastern Australia). The supposed close resemblance between Tasmania and mainland Australia had a parallel, for example, in Spain and Morocco, across the Straits of Gibraltar. It may be noted that the volcanic or igneous rocks somehow 'disappeared' from both Tasmania and Otago between 1843 and 1845, which was a backward step at least so far as Tasmania was concerned where there are large outcrops of dolerite.

I speculate somewhat, of course—probably as much as Boué himself! It may be remarked, however, that analogies somewhat similar to those proposed by Boué were used by other geologists of the period. The influential French theorist, Léonce Élie de Beaumont was at that time actively promoting the idea that there were certain preferred directions for mountain ranges, and that those with similar alignments were of similar age, all supposedly being produced by the contraction of a cooling earth. The no less influential British geologist, Roderick Murchison, predicted the presence of gold in eastern Australia on the basis of the similarity of rock samples he had himself collected in the Urals and specimens sent to him from Australia by Paul Strzelecki and the similar meridional alignment of the Great Dividing Range and the Urals. (See R.I. Murchison, *Siluria*, London, 1854, pp. 450 and 452–53.) Indeed, Murchison thought that this was one of his most profound geological prognostications, and he patted himself on the back for assisting in the Australian gold rush, and thus aiding and abetting British imperialism and the gain of British wealth through colonization.

It would be fair to say, I think, that modern geology is still keen to establish tectonic and other generalizations—fortunately with more evidence than that which Boué had available to him. If Boué's extrapolations were excessive, or even wild, his notion of a global geology—rather than many 'parochial' stratigraphies—was a valuable one, at a time when the gradual assemblage of geological knowledge from piecemeal observations was the norm. Amongst the stratigraphic synthesizers, Boué's attempted generalizations, depicted graphically, were perhaps on a scale grander than those of anyone else in the 1840s.

Thus the geological mapping of New Zealand began!

Acknowledgements

I am most grateful to Professor Michel Durand-Delga for providing me with annotated colour copies of parts of Boué's world maps of 1843 and 1845; and to Alan Mason for information about Dieffenbach.

From the days when geology was even more exciting than it is now _

> "Admitted in his infancy to the Order of the Knights of Malta, he killed a brother knight in a duel, was condemned to death but, in consideration of his youth, was pardoned after nine months in prison, which he spent studying the natural sciences. He made an exhaustive study of the Alps, and in 1791 described the mineral dolomite, to which he gave his name. Captured on his way home from Napoleon's Egyptian campaign, he was imprisoned in Messina, in a pestilential dungeon. Forbidden writing material, he made a pen from a piece of wood and, with the smoke of a lamp for ink, he wrote his treatise, Sur la philosophie mineralogique et sur l'espece mineral (1801) on the margins of a Bible, the only book he possessed."

The subject of this quotation is Dieudonne Dolomieu (1750-1801) and the quotation comes from The Pick and the Pen by A.J.Wilson

THE DISCOVERY OF THE NEW ZEALAND CAMBRIAN

(Newsletter 17)

I can add a little to the Cambrian trilobite saga. When I set out in August 1949 for England to start my PhD work in the Department of Mineralogy and Petrology at Cambridge, I was commissioned by Professor Benson to take with me the main mass of the Cobb trilobite limestone collection and to pass it on to Dr Stubblefield at the British Geological Survey. I can still vividly remember innumerable wooden crates, all very weighty with Cobb material, which had to be added to my own collections of specimens from the Otama Complex and the Taringatura district and conveyed to Napier for embarkation before even starting on the voyage. I had mapped the Otama Complex with the intention of working on it for my PhD, and took along the Taringatura material merely to finish off a petrographic follow-up paper from my MSc at Otago. In the event, all my time at Cambridge was spent on Taringatura and related work, and on feldspar studies, but that is another story.

I recall visiting Stubblefield in his office. I think that Professor Benson was expecting that Stubblefield would personally monograph the fauna. In fact, Stubblefield passed it on to Owen Singleton (later of the University of Melbourne), who was working on trilobites in the Geology Department at Cambridge for his PhD. I do not know to what extent Benson was consulted about this, but I suspect there was little he could have done apart from accepting the advice of Stubblefield. Presumably Singleton already had a PhD topic, and it would seem quite unrealistic to have expected him to monograph the Cobb fauna, unless he had some burning desire to do so. Beyond making some identifications, he did comparatively little with the collection, and on my return to Otago, I found Professor Benson becoming increasingly frustrated and seeking other options for the monographing of what was a truly major discovery in New Zealand geology. Benson's expectations were no doubt unrealistic, the key issue surely being an unequivocal dermination of the fauna's age, but in his declining years the failure of potential collaborators to monograph the fauna appeared to weigh even more on his mind than his increasing inability to finalise the Dunedin Memoir. It was distressing to see someone who had achieved so much in his lifetime saddened and exasperated in this way.

Doug Coombs

A Milestone in New Zealand University Geology

In 1905, Algernon Thomas persuaded the Senate of the University of New Zealand to add 'The Geology of New Zealand' to the prescription in Pass Geology. Previously students had been questioned only on overseas topics.

(We found this gem in M.J. O'Sullivan's privately published biography of Thomas)

LESTER KING. JOHN BRADLEY AND OTHERS

A response to Newsletter No. 17, September, 1998. Concerning Charles Cotton, Lester King and John Bradley, a few personal additions.

When I was leaving London to sail to New Zealand, at the beginning of 1960, a number of people asked to be remembered to Charles Cotton. I must confess that at the time I had not heard of Cotton.

Lester King came to London to give the Geological Society's William Smith Lecture in the mid-50's. While there he also lectured to London University students in one of the series of inter-collegiate lectures (London geology students were scattered among 5 or 6 different Colleges). Physical Geography students also attended, and my wife was one of those, so we both heard King. He talked to us about continental drift, and as I recall we were a receptive audience. I'd certainly been attracted to continental drift since reading the first edition of Holmes, which I received as a school prize.

My recollection of the William Smith lecture is quite vivid. King talked about the large-scale geomorphology of Africa, and the various major surfaces. What stuck most in my mind was an item during the discussion following the paper. The Burlington House chambers in those days still had the old arrangement of the lecture hall, where the President, Secretary and Treasurer sat at one end, beneath a portrait of William "Strata" Smith, the speaker stood at the other end, and the seats in tiers faced the central aisleway from either side. The audience chose to sit with neck twisted either to left or right during the talk. The heavyweights of the British geological world tended to sit on the front row, and to dominate the discussions (Sir Edward Bailey, for example, almost always had something to say, and he would be wearing a tweed plus-four suit, with his one arm and one eye, and he would go to the dais and begin by saying "My name is Bailey ....." The loss of arm and eye were a result of military service in the 1914-18 war, and he held the Military Cross).

There was always a large coterie of grey-haired Fellows sitting opposite me, and I never had any idea who they were, but on this occasion one of them got up and said "It's all very well for Professor King to talk about surfaces separated by thousands of feet, but on the hillside near where I live in Nottinghamshire there are three terraces within a hundred feet".

One thing about John Bradley always puzzled me greatly. He had, as Graeme Stevens mentioned, been an ardent advocate for continental drift for many years. Plate tectonics came along in the late 60's, and for me things finally fell into place during a UNESCO conference at Victoria University in February 1972. Among others, Jeffrey Weissel and Dennis Hayes presented the new seafloor spreading data from the Tasman, and for the first time we had some concrete data with which to address New Zealand geology. Not just some, lots of it. However, despite the conference being held just along the corridor from his room, I don't recall John showing his face at any time. I never heard him mention continental drift after Plate Tectonics came along.

Peter Ballance

LESTER KING AND CONTINENTAL DRIFT

Your article on Lester King in the previous issue (No. 17) prompts me to add a small, largely irrelevant note.

In 1964 I was spending some nine months on sabbatical at Indiana University (Indiana Geological Survey), working on non-Permian coal measures.

Larry Harrington, at the same time, was at the University of Illinois (Champaign-Urbana).

He telephoned me one day to say that Lester King was to lecture on Gondwana at Cincinatti University, and suggested we make the trip to hear him, which we did.

I don't remember much of the lecture, although it was certainly well presented. However it was the reaction of the American crowd which remains with me. It was almost total rejection of King's suggestion of drift. They thought it was sad to see a top geologist/geomorphologist so deranged!

They were even more amazed when both Larry and I got up to support King! All southern hemisphere geologists must be mad!

Larry and I also attended the annual meeting of the Geological Society of America in Miami (welcomed by an ad in the local paper by a popular strippers club), where we learnt something of modern-day coal-forming processes on a visit with Alan Voisey and Sam Friedman (then Indiana Survey) to the Everglades.

My residence at a non-conference motel enabled us to have unrestricted access to a pool late at night, ideal facilities for a gathering of like souls for a discussion away from the formal proceedings, and (probably) too much liquor. I think it was at one of these get-togethers that Larry Harrington had the idea (enthusiastically taken up) which began the International Correlation Project.

David Branagan
University of Sydney

* *

In his memoirs, Professor Alan Voisey tells of the time when he, Dr. W.R.Browne and Professor L.A.Cotton were in the field in 1938

After examining a glacial till, they moved to the nearest town where they ran into an accommodation problem. However the local policeman came to the rescue by providing beds for the night - in the police station cells!

Back on campus, Browne's answer to the question as to why they had been put in gaol was "because we had broken into the till".

The Settler Geologists, the Maitai and the Axial Rocks

When gold was discovered in New Zealand during the 1850s the provincial governments were encouraged to set up geological surveys of their districts. The young settler geologists were fit, enthusiastic and ambitious, although sometimes only half-trained and with little experience. For many young scientists the British 'empire constituted an employment frontier' (Stafford, 1989, p.200). In addition, scientific talent flowed into the 'gigantic laboratory of the colonies' from those other European countries with oppressive political climates (Stafford, pp.55-63). Emigration promised the chance for adventure and exploration, as well as the opportunity to claim geological territory by assigning names and ages and being the very first to interpret the geological succession in a new land. Although hard times in Britain had forced many settler scientists to emigrate they saw themselves as loyal members of the wider Empire (Stafford, p.201).

The settler geologists

Geologist	Birth-Death	Educated	Qualifications and experience	Arrived Departed	Age
James Coutts Crawford	1817-1889	Royal Naval College	Amateur	1839	22
Julius Haast	1822-87	Bonn	Obscure. Did not graduate	1858	36
James Hector	1834-1907	Edinburgh Canada	MD; Exploration and organisation experience	1862	28
E.Heydelbach Davis	Drowned 1871		British Geological Survey?		
Frederick Wollaston Hutton	1836-1905	Royal Navy Academy, Gosport; King's College, London; Sandhurst	Active service, Army engineer, and geologist	1866	29
S.Herbert Cox	1852-1920	Royal School of Mines	Associateship 1874	1874-84	22
Alexander McKay	1841-1917	Primary school in Scotland	On the job training and self-education	1863	22
James Park	1857-1946	Royal School of Mines	1873-74. Did not graduate.	1875	18
Patrick Marshall	1869-1950	Canterbury, Otago, Auckland	BA, BSc Senior Scholar, MA DSc 1900	1876-79, 1882	6 12

The theoretical background

In Britain of the 1860s geology was becoming professionalised with the growth of the Geological Survey and the development of specific training courses, notably that at the Royal School of Mines (1851). Traditionally, stratigraphy, paleontology and mapping were paramount while petrology was neglected. Darwin had recently published *The Origin of Species*. Catastrophism was quickly dying out in the face of Lyellian uniformitarianism or various forms of gradualist progressivism, and the theory of a past ice age was generally accepted. Metamorphism of pre-existing rocks was recognised, the term having been proposed in Lyell's *Principles of Geology* (1833). Diluvialism and Wernerism were long gone although some important elements of Neptunism remained in mineralogy and petrography with assumptions about the great age of crystalline rocks, and in the assumption of an orderly stratigraphic column. Europeans were developing thin-section petrography and also becoming deeply involved in the burgeoning arguments about mountain building and continents. Americans were puzzled about the very thick layers of rocks in their mountain ranges compared with the relatively thin layers of rocks of similar age elsewhere.

Several of the settler geologists arrived in New Zealand equipped with useful guiding theories based on learning and experience in lands half the world away. They presumed that the earth is extremely old, and that geological processes take place gradually. They believed, with Lyell, that continents and ocean basins rise and sink in turn, and that rivers carry debris from the continents into the oceans where it is deposited in layers of sediment. These were later uplifted to form new continents. The geologists were, then, mindful that:

- Layered rocks come in definable, discoverable packages.
- Rocks are arranged vertically in chronological order with younger beds above older beds.
- Relative age is associated with fossil content.
- Lithology may be used for correlations if fossils are not present.
- A well-defined break exists between Cretaceous and Tertiary rocks, and between Permian and Triassic rocks.
- Coal is Carboniferous in age.
- Hard, grey, highly disturbed rocks that look old ARE old, and are probably Silurian or older.
- Relatively undisturbed, fossiliferous rocks are younger than Devonian.
- Igneous rocks may intrude older rocks.
- Fault movements are approximately vertical.

High level theories on the origin of mountains scarcely touched the everyday field observations made by the colonial geologists. Indeed, the British tradition of empirical natural history generally discouraged speculation. Hector's first assistant geologist, E. Heydelbach Davis (1871), asserted that 'I have confined myself to bare facts, and abstained from all generalisations: the system worked on is that adopted by the officers of the Geological Survey of Great Britain which I believe is calculated to give the most reliable results'.

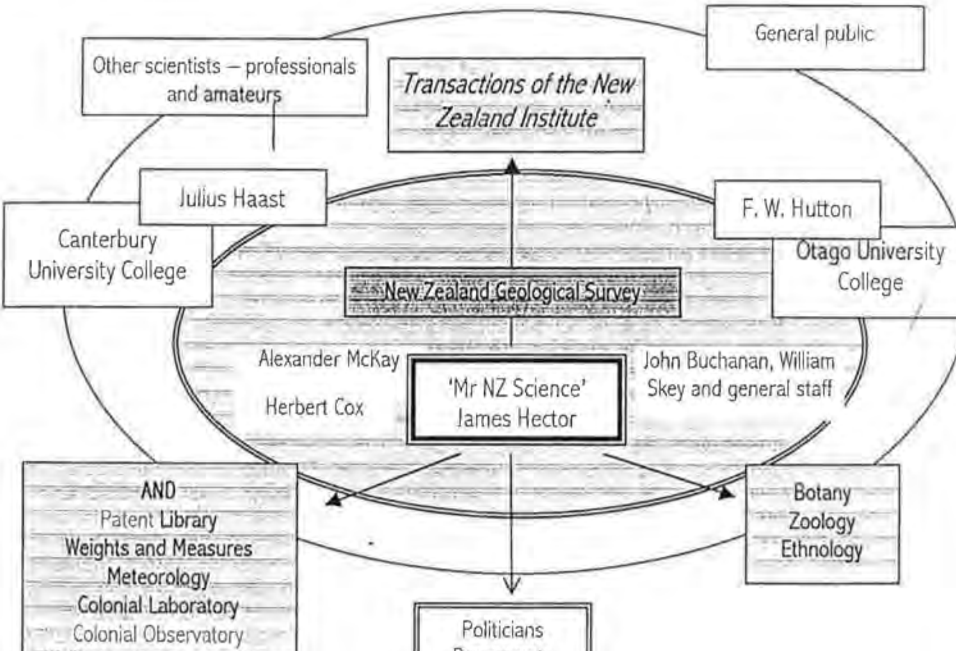
The geologists naturally had some difficulties in adjusting to the new land. Perhaps it was the presence of small seams of coal in the Malvern Hills district that caused Haast (1862) to decide on a Carboniferous age for those and other inland Canterbury rocks and refuse to accept Professor McCoy's determination of a Jurassic age of the plant beds. After falling out with McKay and Hector in 1874, Haast's attachment to a Carboniferous age for his rocks complicated an already uncertain relationship with the Geological Survey, which had arisen from a number of factors, notably the celebrated Moa Hunter controversy (Haast, H.F., 1949).

The scientific community in 19th century New Zealand

The contrasting characters and styles, and the friendships and enmities between the three major protagonists in the construction of New Zealand's stratigraphic column are well known (Haast, H.F., 1949; Oldroyd 1967, 1972). Although the three leading geologists are remembered as kind and courteous (Evans, 1949), they were all strong, assertive characters who fiercely guarded their status as elite scientists, and each man firmly believed he was right. Both Hector and Haast were guided by several ruling theories which had to be defended, whereas Hutton was more prepared to modify his ideas in the face of new data. These men formed a contentious little geological trio at the heart of the wider community of nineteenth century New Zealand scientists.

Figure 1. New Zealand's scientific community 1865-1885.

James Hector was at the centre of and controlled much of the scientific activity in New Zealand 1865-1885. However, Julius Haast and F.W. Hutton operated independently by virtue of their positions at the two university colleges[1]. Hector may have modelled himself on his formidable old patron, Sir Roderick Murchison, who controlled the geological community in Britain.



[1] Auckland and Wellington University Colleges not established until 1883 and 1899.

After Hutton left the Geological Survey he and Haast worked for Hector on contract until 1873, and both upset the latter by persisting in maintaining their own stratigraphical opinions in their geological reports, contrary to some of the Survey's 'official' determinations. In contrast, the closely knit members of Hector's permanent staff, including Herbert Cox, Alexander McKay and James Park, were loyal supporters of Hector and rarely if ever challenged his views, especially his concept of a Cretaceo-Tertiary system in New Zealand (Oldroyd, 1972). Meantime, Haast and Hutton continued to run their provincial museums and maintain their academic careers in Otago and Canterbury. These two men kept up a long friendship that was punctuated by occasional quarrels usually set off by Hutton's outspoken and pungent criticisms (Haast, H.F., 1949, p.667).

The argillites and greywacke sandstones of the axial ranges

The primary tasks of the Geological Survey were to compile maps, find coal, gold and other materials of economic importance, and to inspect mines. To begin with, the argillites, clay slates, greywacke sandstones, flints, jaspers and aphanites forming the axial mountain ranges (Hochstetter, 1864, 1959, pp. 17-18) of both islands were usually called 'Paleozoic slates' and ignored. Serious work on the stratigraphy of these Paleozoic and Mesozoic rocks could not begin until the late 1860s when Hector and John Buchanan examined the strata of southern Otago, including the Hokonui Hills, with a view to finding Carboniferous coal. The search was disappointing but it led directly to new examinations of Paleozoic and Mesozoic rocks at Hokonui and also in Nelson (Hector, 1869).

Problems with the interpretation of the axial rocks began when Davis (1871) reviewed Hochstetter's famous Nelson section containing the Richmond Sandstone and the red and green Maitai Slates. As early as 1875, Hutton commented on the many ups and downs experienced by the Maitai Formation (Hutton and Ulrich, 1875, p.39), as did J.B.Waterhouse ninety years later (1965 p.956). For over twenty years Hector and Hutton apparently took turns at re-arranging each other's stratigraphic columns, while Haast steadily insisted on a Carboniferous age for his inland Canterbury rocks.

Why, besides an increase in data, were so many changes made in the pre-Cretaceous portion of the New Zealand stratigraphic column? Why the 'ups and downs' for the Maitai Formation? The geologists had immense problems trying to fit the assortment of axial rocks into a rational tidy arrangement, with one rock layer neatly ordered on top of the one before (e.g. McKay 1878, p.158). There was continuing difficulty in establishing relative ages by fossil control. There was no resident paleontological expert, and in any case few useful diagnostic fossils were found in the axial rocks. This meant that a great deal of reliance was placed on lithologies for the purposes of correlation. In addition, the great mass and variety of rocks within the assemblages, their highly disturbed structure and the lack of well-defined horizons made the task enormously difficult because the geologists could not even depend on the principle of superposition. However, in their efforts to identify and follow horizons both Haast and McKay made a series of outstanding lithological studies of the rocks to be found in the vast sequences of axial mountain-building rocks of Canterbury and Wellington (e.g., Haast 1872, 1877; McKay 1877, 1879).

Meantime, the geologists regarded the Otago and Canterbury schists as continuous with those of north-west Nelson and Westland, and all were seen as separate from and somewhat older than the upper Paleozoic sedimentary rocks of Nelson and inland Canterbury (Waterhouse, 1965, Part II). All the geologists remarked on the way in which the unaltered axial rocks appeared to pass into the schists, but none could find the expected unconformity between them. It was left to Marshall to see the connection between the Otago-Canterbury-Nelson schists and the argillites and greywackes, and in 1912 place them together in his Trias-Jura Maitai System.

I began this study by drawing timelines to trace the various age allocations given to the pre-Cretaceous rocks between 1865 and 1900, expecting to see how the stratigraphical column of New Zealand was constructed, developed and modified by the combined efforts of Hector and his Survey assistants, along with Hutton, and Haast. My drawing resembled a confused street-map, complete with intersections and blind alleys, marking many changes in the classifications of the various rocks. No identifiable pattern of progress in the geological knowledge of New Zealand could be made out. I then drew three separate timelines (Figures 2, 3, 4):

- James Hector's New Zealand Geological Survey scheme,
- F.W. Hutton's scheme,
- Julius Haast's Canterbury scheme.

The separate timelines show quite plainly that each geologist's scheme was clear, coherent, consistent, rational and independent. There was no confusion because each man was focussed on his own version of the New Zealand stratigraphic column. Although the three rivals used each other's data and conclusions when it suited, they did not go out of their way to assist each other.

Based on his own and Davis's work in Nelson, Hector erected his Triassic Maitai Series, which contained a bed with annelid tracks. Because the Canterbury and Wellington axial rocks also contained traces of annelids they were later correlated with this Maitai Series (Figure 2). From 1873 Hector began moving his Maitai Series steadily down the stratigraphic column to the Lower Carboniferous partly on lithological similarity with the rocks of Nuggets in Otago and at Mount Potts in Canterbury, and partly on paleontology. Although Hector suspected that many of the axial rocks were of Mesozoic age (1880, Crawford 1865), he incorporated the inland Canterbury sequences and Wellington's Rimutaka Series into the Maitai Series which now took a large 'share ... of the great mountain ranges' (1873 map, 1877). Hector's position ensured that his stratigraphic scheme was used by the Survey.

Also in 1873, Hutton moved his own Maitai Formation in the opposite direction up the stratigraphic column to the Lower Jurassic (1877) partly on superposition and partly on Hector's *Inoceramus* (1869), but on Hector's insistence, this move was reversed, also on grounds of superposition (Figure 3). After Hutton left the Survey he began developing his own stratigraphic column by grouping the various rocks into several large formations (1875). His new Triassic Maitai Formation included Hector's Kaihiku Series, Wairoa Series and Otapiri Series, while the vast sequences of axial rocks along with Hector's Te Anau Series were placed in the Carboniferous-Devonian Kaikoura Formation. Ten years later, Hutton boldly went so far as to erect a comprehensive set of major systems quite different from those of Europe. The name 'Maitai' was removed from Hutton's Mesozoic rocks and used for his new Upper Paleozoic Maitai System, which incorporated all the axial rocks (1885). Hutton re-adjusted his systems in 1899 with the Maitai System placed neatly in the Permo-Carboniferous and a revision of the schists. The name 'Hokanui' was applied to Hutton's Triassic-Jurassic System in 1885, and changed to 'Hokonui' in 1899.

While Haast made no attempt to develop a New Zealand-wide stratigraphical column, or to use the name 'Maitai' he clashed with Hector on how his Canterbury axial rocks should be classified. Haast had long been convinced that the Malvern Hills and Clent Hills plant beds were the same age as the Carboniferous Mount Potts shell beds. In 1886 he gracefully accepted a Triassic age for all the fossils on the authority of Baron von Ettingshausen. Meantime, Hector repeatedly sent Cox and McKay to Canterbury to check on Haast's reports (Haast, H.F., 1948, p.747) and, presumably, to find evidence for dividing the axial rocks into mappable Paleozoic and Mesozoic sequences. Haast already regarded the large tracts of Canterbury's axial rocks as belonging to several different periods from the Carboniferous through to the Jurassic, but from experience believed that it was not yet possible to divide them 'for want of fossils' (1879, p.279). His daring, all-inclusive Mount Torlesse Formation for the Canterbury rocks (Figure 4) took in Hector's Kaihiku, Te Anau, Maitai and Rimutaka Series as well as Hutton's Putataka, Maitai, and Kaikoura Formations.

When Hector published his 1884 map of the geology of New Zealand, Haast was greatly upset when his Mount Torlesse Formation was ignored while a division was shown between the Canterbury Mesozoic and Paleozoic rocks. Haast's protest and Hector's answer appeared in the same issue of *Transactions* (1885). Because Haast was in charge of the New Zealand Court at the 1886 Colonial and Indian exhibition in London he had no opportunity to further defend his Mount Torlesse Formation before his death in 1887. In 1885, Hutton split the Mount Torlesse formation between his Hokanui and Maitai Systems.

The name 'Maitai' has indeed had its 'ups and downs'. Between 1875 and 1899 three different Maitais were erected: Hector's Carboniferous Maitai Series and Hutton's Permo-Triassic Maitai Formation, followed by his Upper Paleozoic Maitai System. At the same time the axial, mountain-building rocks, later known as 'the greywackes' were classified and re-classified into at least five different rock groups including Hector's Maitai Series and Hutton's Maitai System (figure 5).

Since 1900, elements of all three schemes have been used in New Zealand stratigraphy. Park enlarged the Permian-Jurassic Hokonui System to include the axial greywackes as the Aorangi Series, while his Maitai Series and Te Anau Series formed his Carboniferous Te Anau System (1910). Patrick Marshall (1912) erected a very contentious Triassic-Jurassic Maitai System that included all of Hutton's Hokonui rocks, as well as the axial greywackes and all the schists. In 1961, R. P. Suggate resurrected Haast's Mount Torlesse Formation to form a similarly encompassing Torlesse Group for the axial greywackes that had been known since 1948 only as the 'Undifferentiated Jurassic-Triassic-Permian'.

Acknowledgements

My grateful thanks go to Alan Mason, David Oldroyd and Bernhard Spörli for generously giving much time and helpful advice in the preparation of this article.

References

Crawford, J Coutts 1865: Essay on the Geology of the North Island of New Zealand. 27pp. (Printed for the New Zealand Exhibition, Dunedin, 1865).

Davis, E Heydelbach 1871: Notes on the Thames Gold Fields. *New Zealand Geological Survey Reports of Geological Explorations*, 1870-71, 6: 56-70.

Evans, W.P. 1949: Scraps from the Society's Earlier Days. *New Zealand Science Review* Nov-Dec. 20: 202-208.

Haast, H.F. von 1948: *The Life and Times of Sir Julius von Haast: Explorer, Geologist, Museum-Builder*. Wellington.

Haast, Julius 1862: Notes on the Geology of the Province of Canterbury. *New Zealand Government Gazette Province of Canterbury* 9: 121-131

Haast, Julius, 1872: Report on the Geology of the Malvern Hills, Canterbury, *New Zealand Geological Survey Reports on Geological Exploration*, 1871-72, pp.1-88.

Haast, Julius von, 1877: Notes on the Geology of the Clent Hills and Mount Somers Districts. *New Zealand Geological Survey Reports on Geological Exploration*, 1873-74, 8, pp. 1-19.

Haast, Julius von, 1879: *Geology of the Provinces of Canterbury and Westland, New Zealand.* Christchurch.

Haast, Julius von, 1885: On the Geological Structure of the Southern Alps of New Zealand, in the Provincial Districts of Canterbury and Westland, *Transactions of the New Zealand Institute*, 17, 332-337.

Haast, Julius von, 1886: Notes on the Age and Subdivisions of the Sedimentary Rocks of the Canterbury Mountains, based upon the Palaeontological Researches of Professor Dr. C. Baron von Ettingshausen in Gratz (Austria). *Transactions of the New Zealand Institute*, 19, 449-451.

Hector, James, 1869: Progress Report. *New Zealand Geological Survey Reports on Geological Explorations*, 1868-69, 5, i-xiii.

Hector, James, 1877: Progress Report, *New Zealand Geological Survey Reports of Geological Explorations*, 1876-77, 10, i-xx.

Hector, James, 1880: Progress Report, *New Zealand Geological Survey Reports of Geological Explorations*, 12, 1-41.

Hector, James, 1884: Sketch Map of the Geology of New Zealand. New Zealand Geological Survey. Scale 1:4,625,000. Progress Report, *New Zealand Geological Survey Reports of Geological Explorations*, 1883-84, 16:ix-xxxviii.)

Hector, James, 1885: Note on Geological Structure of Canterbury Mountains. *Transactions of the New Zealand Institute*, 17, 337-340.

Hochstetter, Ferdinand von, 1864. *Geology of New Zealand: Contributions to the Geology of the Provinces of Auckland and Nelson.* Translated from the German and edited by C.A. Fleming 1959. R.E.Owen, Government Printer, Wellington.

Hutton, F.W.; Ulrich, G.H.F. 1875: *Report on the Geology and Goldfields of Otago*, Mills and Dick, Dunedin.

Hutton, F.W., 1877: Report on the geology of the north-east portion of the South Island from Cook's Straits to the Rakaia, *New Zealand Geological Survey Reports of Geological Explorations*, 1873-74, 8, pp.27-58.

Hutton, F.W., 1885: Sketch of the Geology of New Zealand, *Quarterly Journal of the Geological Society*, London, 41, pp.191-220

Hutton, F.W., 1899: The Geological History of New Zealand, *Transactions of the New Zealand Institute*, 32, pp.159-183.

Lyell, Charles, 1833 *Principles of Geology: Being an inquiry how far the former changes of the earth's surface are referable to causes now in operation*, 1st edition, vol.3.

McKay,Alexander, 1877: Report relative to the collection of fossils from the Mount Potts Spirifer beds. *New Zealand Geological Survey Reports of Geological Explorations*, 1877, pp.98-105.

McKay, Alexander, 1878: Report on the Wairoa and Dun Mountain districts. *New Zealand*

Geological Survey Reports of Geological Explorations 1877-78, 11: 119-159.

McKay, Alexander, (1879): Geology of the Neighbourhood of Wellington. *New Zealand Geological Survey Reports of Geological Explorations*, 1878-79, 12, pp.131-135.

Marshall, P., 1912: *Geology of New Zealand*. Government Printer, Wellington.

Oldroyd, D.R., 1967. Geology in New Zealand prior to 1900. Thesis for M.Sc. in History and Philosophy of Science, University of London. (Copies at University of Canterbury and Institute of Geological and Nuclear Sciences).

Oldroyd, David R. 1972: Nineteenth century controversies concerning the Mesozoic Tertiary Boundary in New Zealand. *Annals of Science*, 29 (1): 39-57.

Park, James, 1910. *The Geology of New Zealand: an introduction to the historical, structural, and economic geology*. Whitcombe & Tombs Ltd.

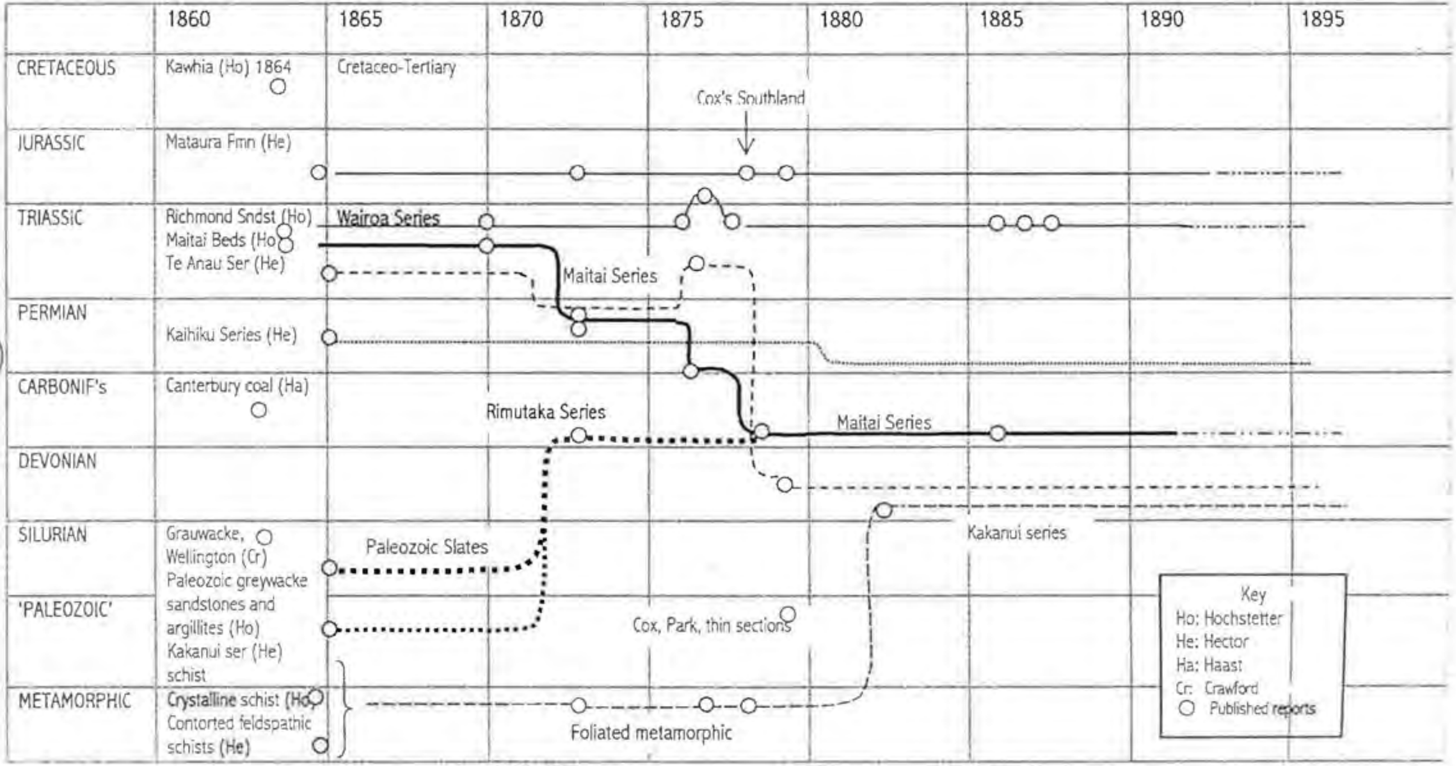
Stafford, Robert A (1989): *Scientist of Empire: Sir Roderick Murchison, scientific exploration and Victorian imperialism*. Cambridge University Press, Cambridge.

Suggate, R.P., 1961: Rock stratigraphic names for the South Island schists and undifferentiated sediments of the New Zealand geosyncline. *New Zealand Journal of Geology and Geophysics*, 4, (4), pp. 392-399.

Waterhouse, J.B. 1965: A historical survey of the pre-Cretaceous geology of New Zealand, Parts I and II. *New Zealand Journal of Geology and Geophysics*, 8 (6): 931-998.

Heather Nicholson
Department of Geology
University of Auckland
Email: hnich@xtra.co.nz

Figure 2. The Maitai: Hector and his Survey's Scheme



37

38

Figure 3. The Maitai: Hutton's Scheme

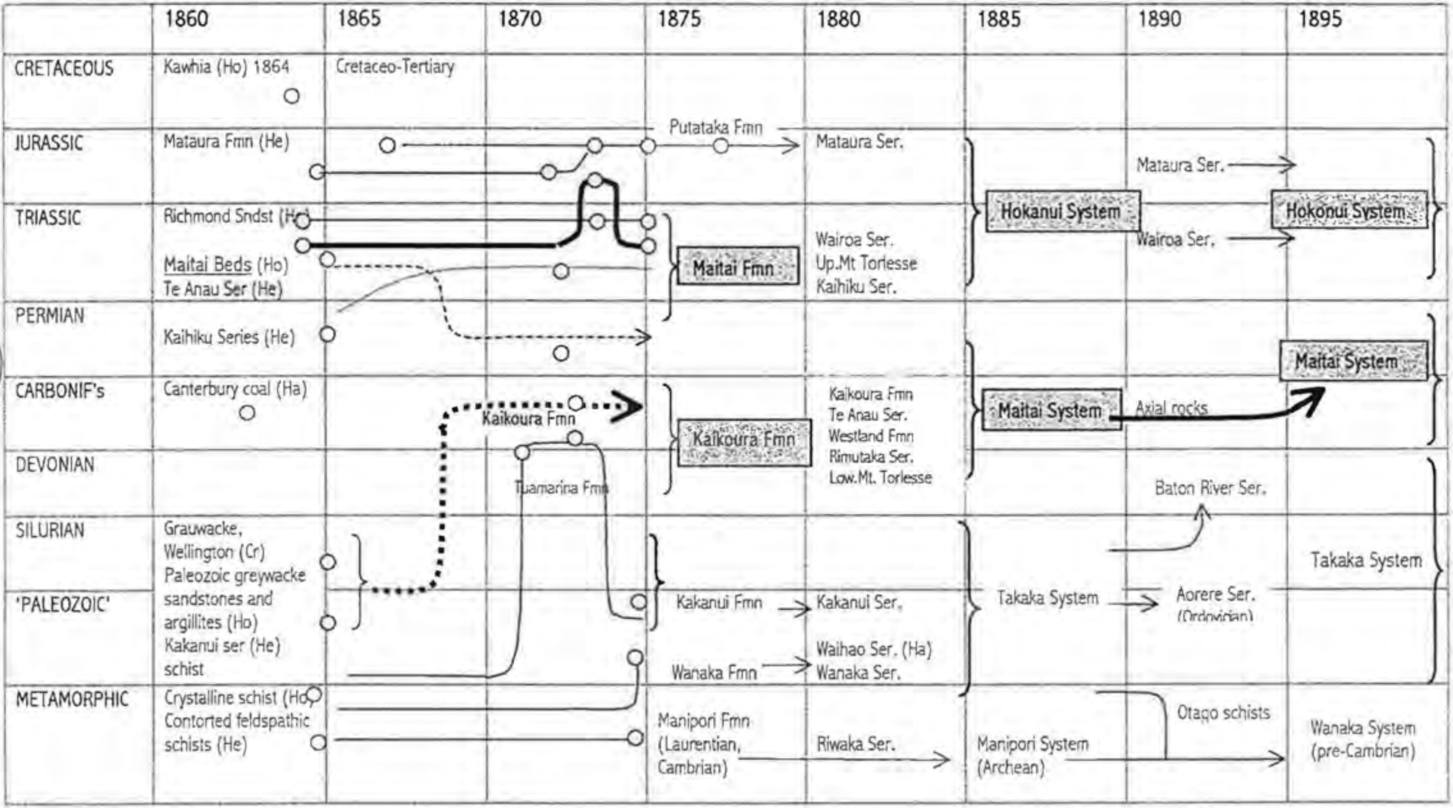
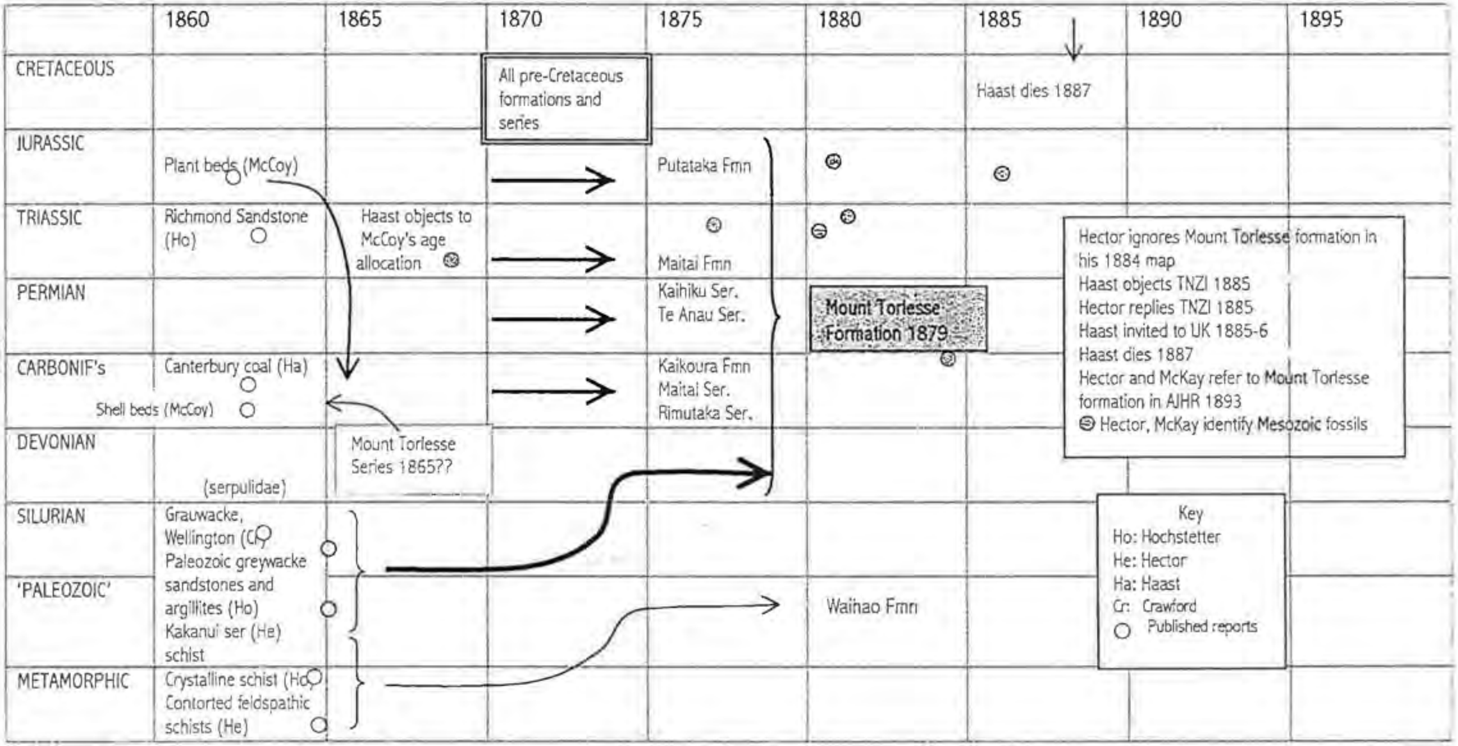
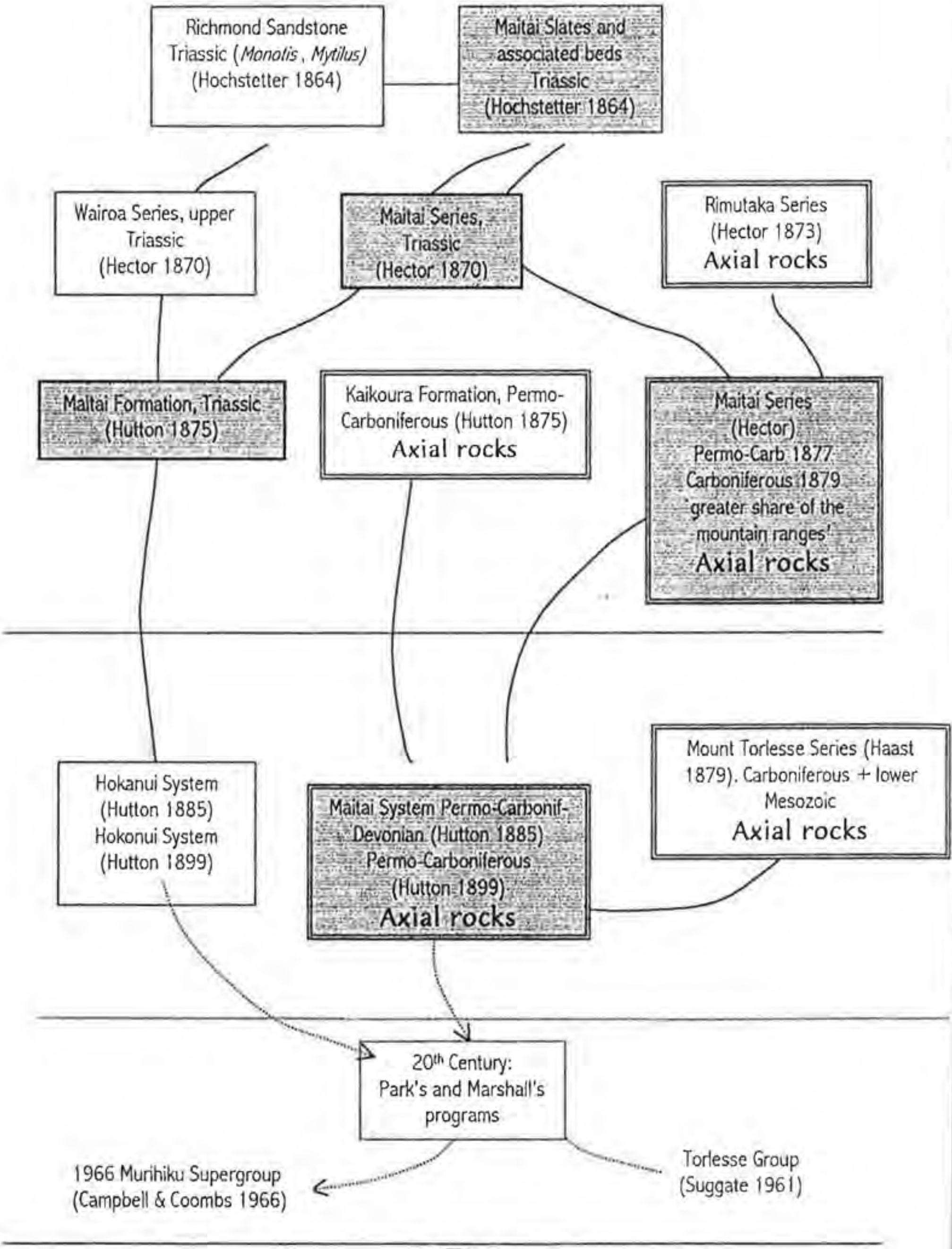


Figure 4. Haast's Scheme and his Mount Torlesse Formation



39

Figure 5: The name 'Maitai' and the Axial Rocks



LA CRÉATION

ET SES

MYSTÈRES DÉVOILÉS

... clairement la Nature de tous les Êtres

LA NATURE ET ... SITUATION DU FEU DU SOLEIL.

L'ORIGINE DE L'AMERIQUE

Avec Dix Gravures

PAR A. SNIDER

PARIS

LIBRAIRIE E. DENTU

1859

510. — La plus grande, la plus long[illegible] portante crevasse se trouvait du nord [illegible] bien visible et déjà large à l'aurore du sixième jour, n'empêchait pas la communication des [illegible] l'autre. Cette crevasse aura été peut-être [illegible] largeur; elle divisait la terre presqu'à moitié dans la direction indiquée. On pouvait pressentir qu'une séparation [illegible] manquable; que la masse la plus grande [illegible] en raison de sa pesanteur, et que la [illegible] serait repoussée à une distance [illegible] un équilibre proportionnel.

511. — La masse la plus forte était à l'est, et elle y est restée.

Nous ne savons pas de quel nom on appelait, à l'aurore du sixième jour, le continent de cette masse : après Noé, on l'appela, comme de nos jours, l'Asie, l'Afrique et l'Europe.

La grosse masse partielle, dont la crevasse s'étendait du nord au sud de l'aride, était à l'ouest, et dans l'écartement violent qu'elle a subi, sa surface s'est portée plus à l'ouest encore; cette masse forma elle-même un grand continent, que nous appelons aujourd'hui l'**Amérique**.

Preuves de la formation de l'Amérique.

SOMMAIRE. — Les faits toujours appuyés de leurs preuves, 522. — *Preuves physiques*; correspondance des caps et des golfes, 523. — Preuve tirée du système des volcans, 524. — Nomenclature des principaux volcans, *note* U, *id.* — Tremblement de terre de Lisbonne, 525. — Tremblement au Pérou, 526. — Cataclysme au Kamtschatka, 527. — Cataclysmes partiels; effets à attendre du prochain cataclysme général, 528. —

Portraits from 'The Dark Side of the Moon' by Robert Muir Wood

HISTORICAL STUDIES GROUP NEWSLETTER

Number 18 March 1999

Editorial		2
Arnold Lillie	Alan Mason	3
Henri Filhol (1843-1902), and Campbell Island...........................	Robin L. Oliver	7
Little Rangitoto Volcano.................	Justin Franklin	13
Ami Boue and the First Geological map of New Zealand.....................	David Oldroyd	19
The Discovery of the New Zealand Cambrian	Doug Coombs	26
Lester King, John Bradley and Others.....	Peter Ballance	27
Lester King and Continental Drift........	David Branagan	28
The Settler Geologists, the Maitai and the Axial Rocks...............	Heather Nicholson	29