

Wairakei 60 years

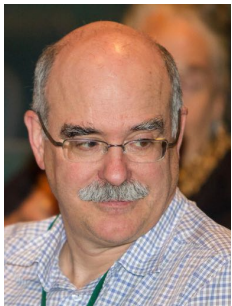
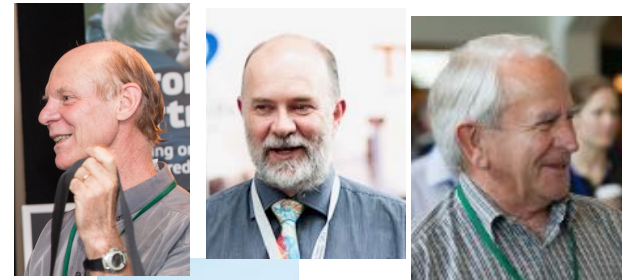
the people who made it successful

Andy Bloomer, Geothermal Engineering Ltd, Taupo, New Zealand

He aha te mea nui o te ao? He tāngata, he tāngata, he tāngata

What is the most important thing in the world?

It is people, it is people, it is people.



Andy Bloomer

- Civil engineer, like many in the geothermal industry have working in many areas
- Started work with the Ministry of Works and Development, Wellington 1975
- Transferred to MWD Wairakei November 1977



The early scientists

Ernst Dieffenbach, 1842

- A naturalist with the New Zealand Company, described thermal areas including Wairakei Valley.

Christian Hochstetter, 1859

- Laid the basis for the geological mapping of New Zealand. Visited Karapiti.

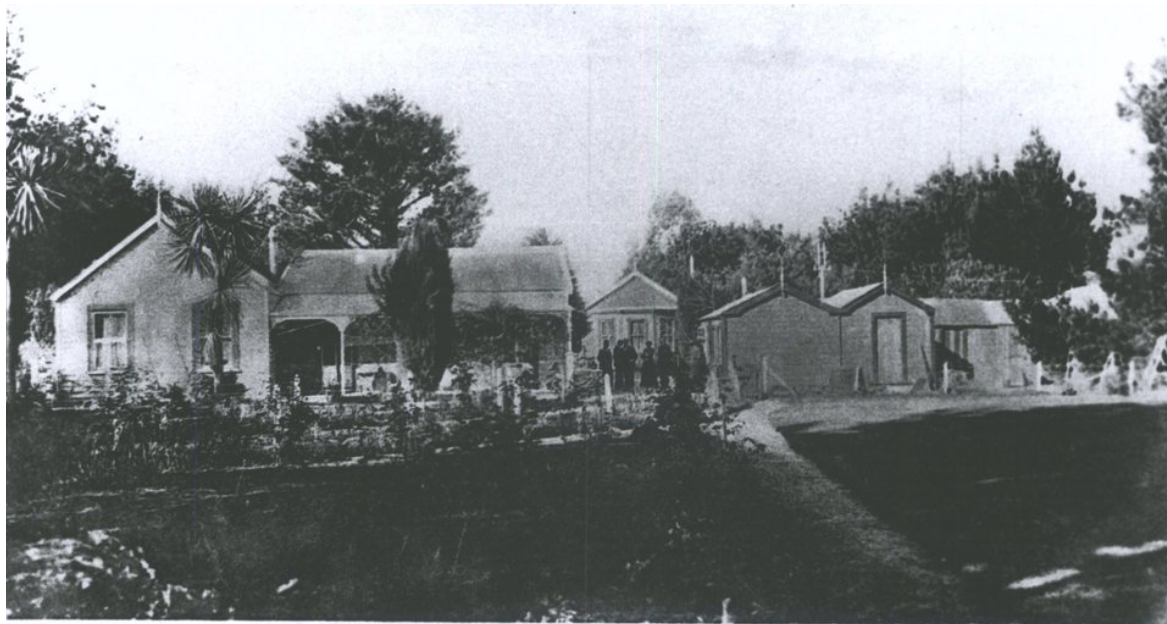
"I may consider my observations of this very extensive district only as the beginning of studies of the manifold phenomena of this remarkable volcanic zone."



Wairakei tourism

Graham's accommodation from 1886.

Rudyard Kipling visited 1891 "One Lady at Wairakei"



484 P. GRAHAM'S ACCOMMODATION HOUSE, WAIRAKEI. Muir & Moodie

When Rudyard Kipling, the talented and forceful writer who has bounded into fame and won so brilliant a reputation in the world of letters, was travelling through these colonies, he received numerous tempting offers from the press to contribute a series of articles, all of which, however, he declined. He had, he said, made up his mind to abstain from all literary work, and enjoy a much-needed holiday. But this resolution was broken when he was in New Zealand, a colony which seems to exercise a strange fascination over every distinguished writer who visits it. When at Wairakei Mr. Rudyard Kipling had a singular and original adventure. He saw there what, as he says, no tourist had ever seen before. What he saw and heard he felt impelled to set down in writing for the **NEW ZEALAND HERALD**. It is the only piece of literary work relating to the colonies that he has done, and the proprietors of the **HERALD** have much pleasure in announcing that this interesting and novel contribution from the pen of the gifted novelist will appear in the columns of that journal on Saturday next, January 30. It is entitled "One Lady at Wairakei," the name of the lady being familiar

NZ Herald January 1892

Wairakei Hotel (circa 1952)



Rapid progress

July 1949 Geothermal Advisory Committee (GAC) was established

- the Director of the New Zealand Geological Survey
- the Secretary of the Department of Scientific and Industrial Research (DSIR)
- the General Manager of the State Hydro Electric Department (SHED)
- the Commissioner of Works or the Engineer-in-Chief of the Ministry of Works (MOW)

March 1950

- First meeting of scientists and engineers at Wairakei Hotel to discuss the investigation programme

February 1952

- 20 MW steam proven by drilling, GAC dis-established, project committed

November 1958 geothermally generated power to the grid

- New people with new ideas willing and able to try

Political / public pressure



The first meeting of scientists and engineers March 1950

- F.A. Langbein, Engineer-in-Chief, MOW (Chairman)
- C.W.O. Turner, Assistant Engineer-in-Chief (Hydro), MOW
- J.T. Gilkison, Inspecting Engineer (hydro), MOW
- W.M. Fisher, Inspecting Engineer (Hydro), MOW
- A.E. Clark, Project Engineer, Mangakino, MOW
- J.W. Grindley, Investigations Engineer, Mangakino, MOW
- R. McMillan, Drill Superintendent, Mines Department,
- J. Healy, Superintending Geologist, Rotorua, DSIR
- E.I. Robertson, Geophysicist, DSIR
- N. Modriniack, Geophysicist, DSIR
- F.E. Studt, Geophysicist, DSIR
- S.H.J. Wilson, Senior Chemist, DSIR

“With the possible exception of the war years, this was perhaps the largest collection of scientific staff of different disciplines gathered together for a long period, to solve a particular set of problems in New Zealand. As can be imagined it was a pretty exciting time. With the exception of the discipline leaders and Peter Burke, all the DSIR personnel were young (under 30) and all were enthusiastic. Few days went by without something new or interesting happening”.

Gordon Dawson

Gordon Dawson

February 1950 running levels for gravity surveys

Experimental work with DPL in Lower Hutt

1955 developing ground temperature measurement surveys – surveyed all the Wairakei-Poihipi-Taupo area (& Waiotapu)

Developed a method for measuring steam flow from open ground.

Calibrated steam/heat flow against 1m ground temperatures – published 3 papers with Frank Studt, John Banwell, Eddie Robertson. Method later adapted by Rick Allis.

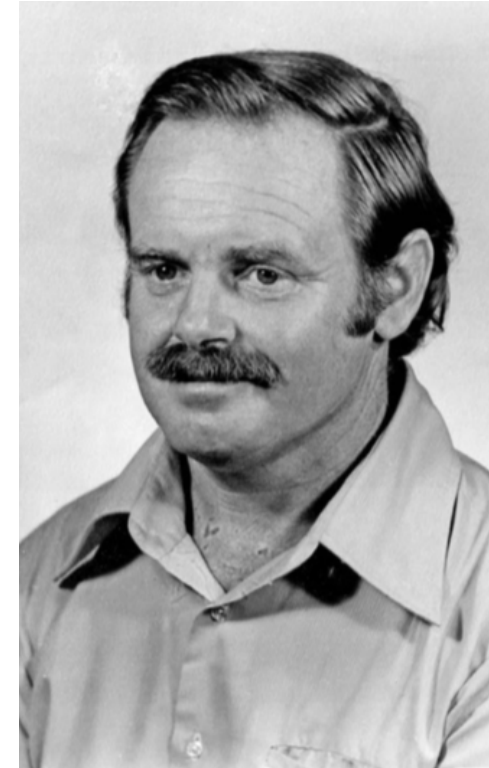
Calibrated heat flow with vegetation – could be interpreted from aerial photographs – with Dave Dickinson, later Mike Mongillo.

Developed direct current ground resistivity – Peter McDonald, George Risk; Harry Rayner, George Keller.

Retired 1991

2017: NZGA Contribution Award:

“For his work toward the development of geophysical exploration methods, having worked in the field since the 1950s”



Colleagues recalled by Gordon Dawson

Norbert Modriniak	Superintendent of the Geophysical Survey (part of NZ Geological Survey at the time)
Frank Studt	Geologist with the Geological Survey who interviewed Gordon in 1949
Jim Healey	Geological Survey, Rotorua
Peter MacDonald	Geological Survey, Rotorua – vacuum tube voltmeter for accurate resistivity measurements
John Banwell	Physicist, Director Dominion Physical Laboratory, Gracefield (DPL) later part of DSIR
Stewart Wilson, Jim Ellis	pioneering work in geothermal chemistry, particularly Na/K ratios and their significance
Geoff Thompson, Rob Fisher, Dave Currie	Physicists, DPL, measuring surface water flows with v-notch weirs
Don Anson	DPL measuring rock permeability
Willem Stuiver	DPL, measuring two-phase flow using air-water mixtures
Rudy Belin, Fred Knox	alpha and gamma ray absorption to measure the dryness fraction of steam-water mixtures
Roy Benseman	calorimetry box to measure heat flow from the ground surface
Eddie Robertson	Physicist. Director of Geophysics Division, later Director General of DSIR. Produced the original Wairakei geophysical programme
Russell James, Gordon McDowell	two-phase flow experiments
Harry Rayner	developing ground resistivity measurement methods

John Banwell

Director: Dominion Physical Laboratory (DPL) later part of DSIR, then GNS.

"DSIR was very fortunate to have a person with the brains of John Banwell. He was an outstanding physicist. I think he remembered every law of physics in the book. He devised methods of measuring the output of bores and so forth".
(Gordon Dawson).

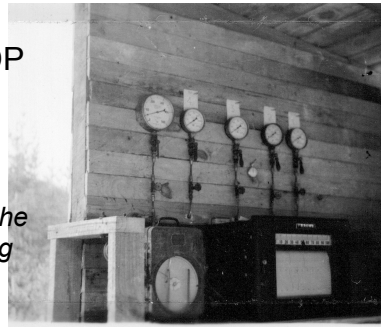
In the 1960s Banwell went to the UN to run the UNDP geothermal energy programme.

Banwell reporting on initial trials of a sampler:

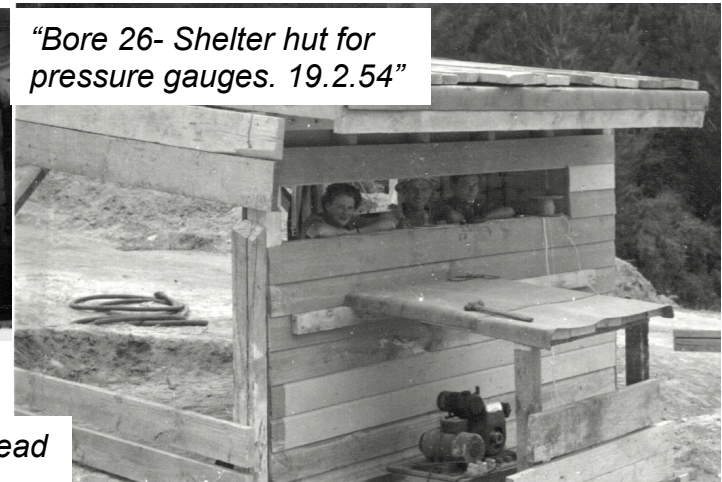
"The vibration of the hut caused by the high noise level made the zero of the potentiometer extremely unsteady, so that balancing operations were unduly slow and difficult, and accuracy was impaired somewhat.

"The location of the calorimeter outside the hut was unsatisfactory, as both operator and calorimeter were showered with cold water from the bore in certain conditions. Also the operator often became extremely wet, and had difficulty in adjusting the potentiometer, taking notes etc. afterwards.

*"The sampler diverted some of the steam and water jet in a downward direction. This came through the hut door in some wind conditions and filled the hut with steam, leading to frequent difficulties in reading the instruments or **finding the hut.**"*



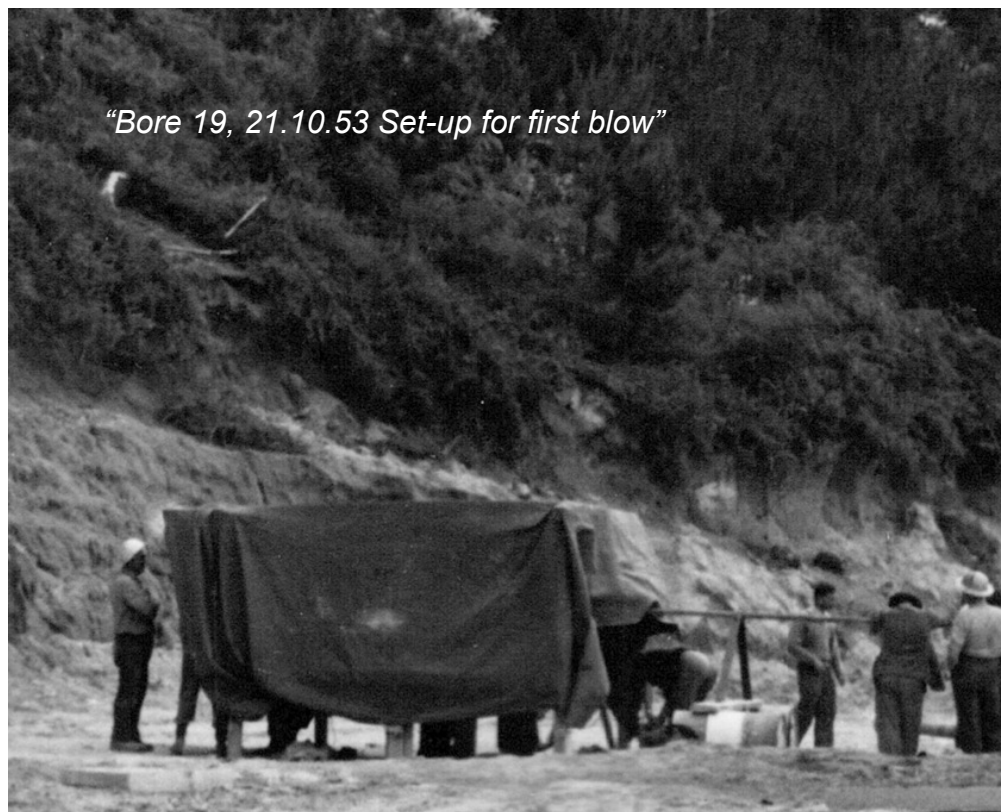
"Bore 26- Shelter hut for pressure gauges. 19.2.54"



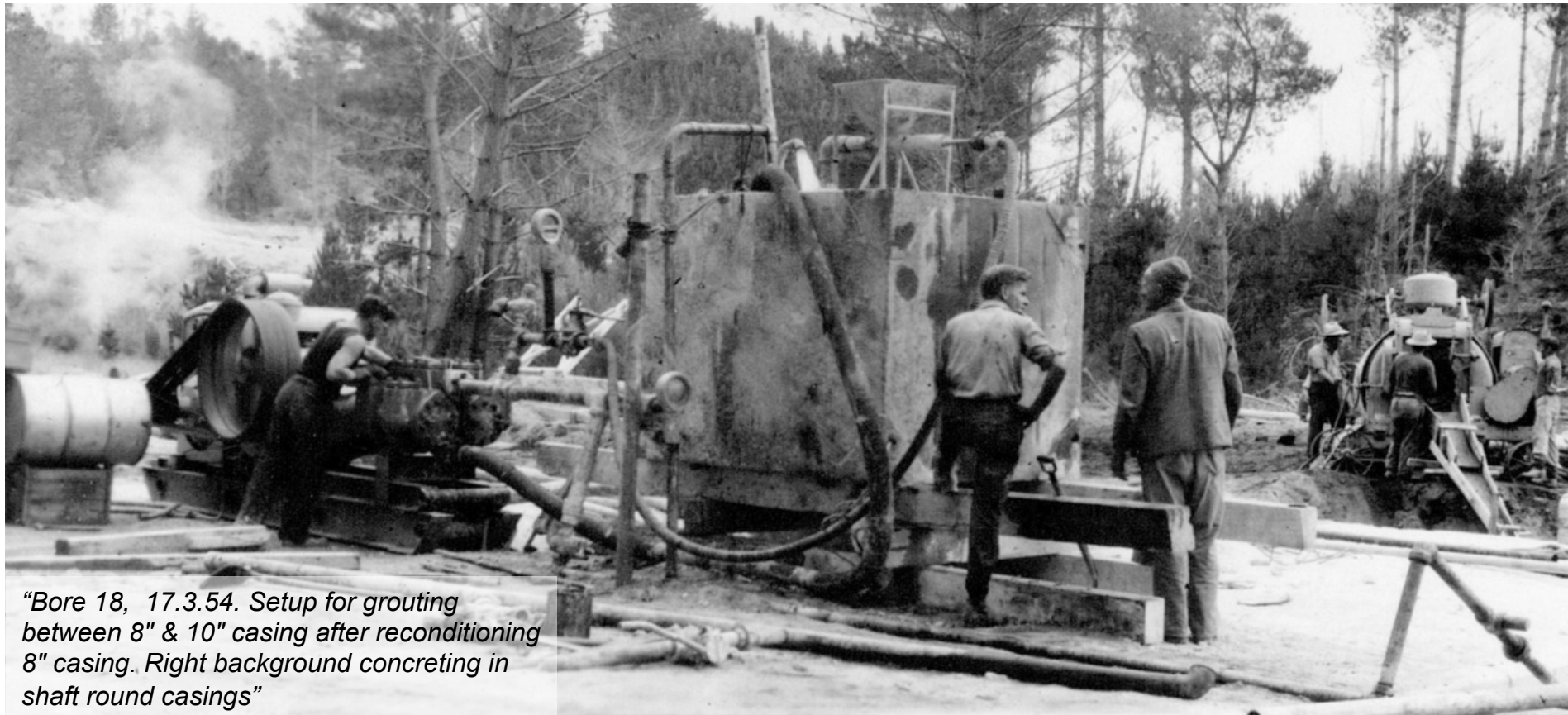
"Bore 26- Wellhead setup. 19.2.54"



Work conditions



Work conditions



"Bore 18, 17.3.54. Setup for grouting between 8" & 10" casing after reconditioning 8" casing. Right background concreting in shaft round casings"

SURROUNDED by onlookers, ears plugged with their fingers, the bore roars up in a crescendo of sound that makes it impossible to remain near it for more than minutes. Valves control blast



*"1955, Test 549.
Fitting deflector"*

Eddie Robertson

PhD in Geophysics. Produced the original Wairakei geophysical programme.

Director of Geophysics Division of DSIR 1951-1964, Director General of DSIR 1971-1980, until retirement.

OBE 1963, CBE 1981 for scientific service to NZ.

Developed mathematics for boiling point for depth (BPD). Paper with Gordon Dawson.

Developed mathematics for ground heat flow. Paper with Gordon Dawson



Wairakei 50th, 2008



The young **DSIR** geophysicist **E.I. Robertson** (left) with the eminent American seismologist B. Gutenberg (right) at the 7th Pacific Science Congress in Christchurch in 1949. This was the first large international scientific conference in New Zealand, and it provided a major stimulus for local scientists and brought them into contact with many leaders of science. Robertson subsequently (1951–64) headed the new Geophysics Division, and later (1971–80) became Director-General of **DSIR**.
Alexander Turnbull Library, Wellington

Bob McMillan

1949-50(?): Wairakei drilling superintendent

(ex Mines Department Drilling Superintendent from Greymouth).

Supervised all drilling including drilling techniques.

He developed BOP equipment, which was manufactured in the MoW Mangakino workshops.

“The glanded blow-out prevention (BOP) equipment built under Mr McMillan’s supervision prior to the initial investigations is still used today”. (King, Robson)

Trained drill crews.

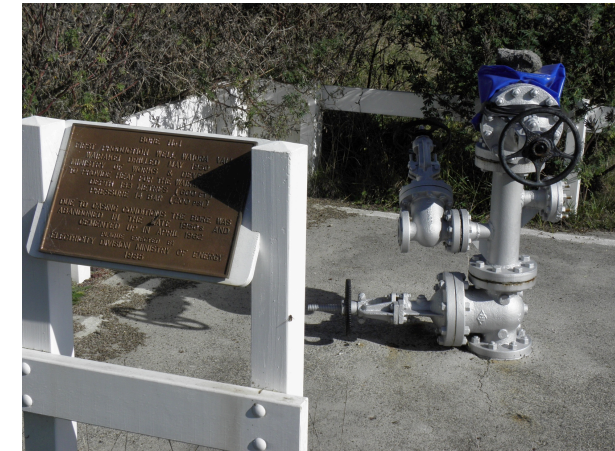
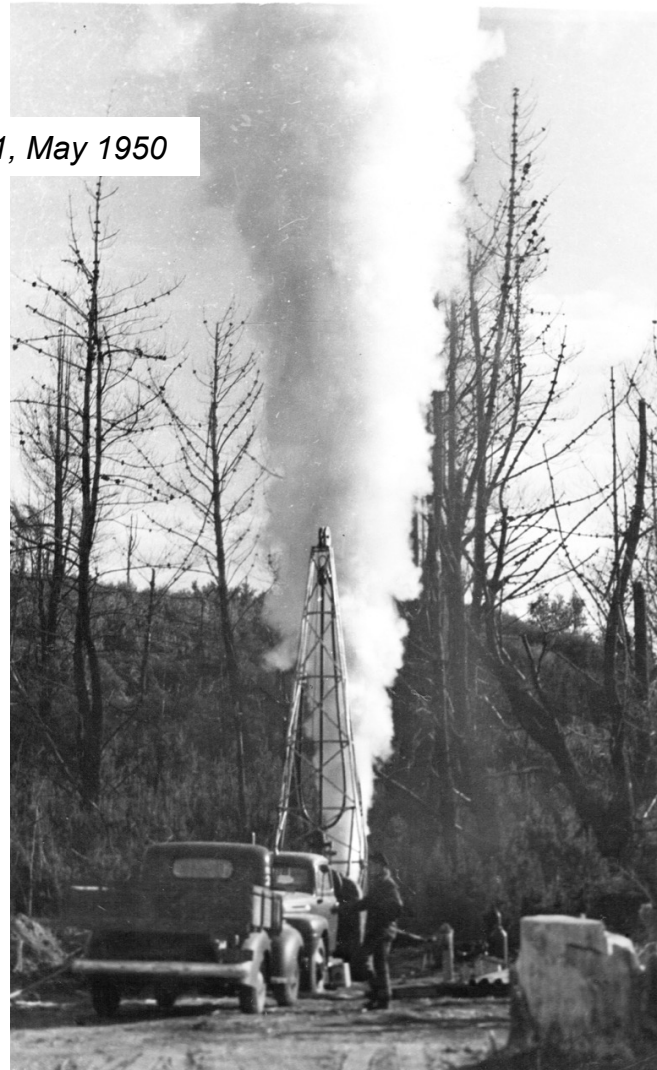


May 1951

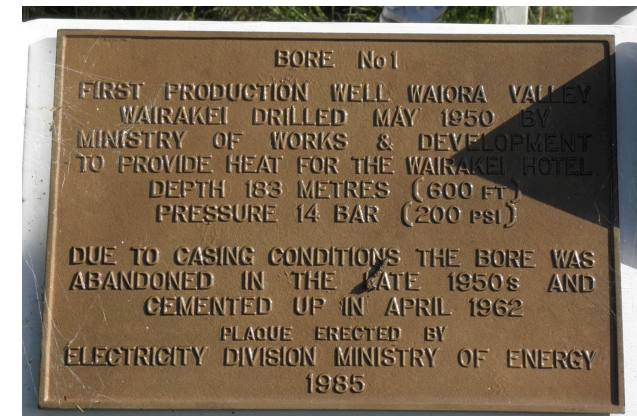
Drilling May 1951



Testing Wairakei Bore No. 1, May 1950



WK1, May 2010



*"Wairakei Geothermal Project. Bore No. 20.
16.5.53. Rigging up 10" valve & assembly"*



*"Bore 20 16.5.53. Emergency closure.
Placing 10" valve and casing (6)"*



WK20 - blow out

"Bore 20 16.5.53. Emergency closure. Placing 10" valve and casing (2, 3)"

84

82

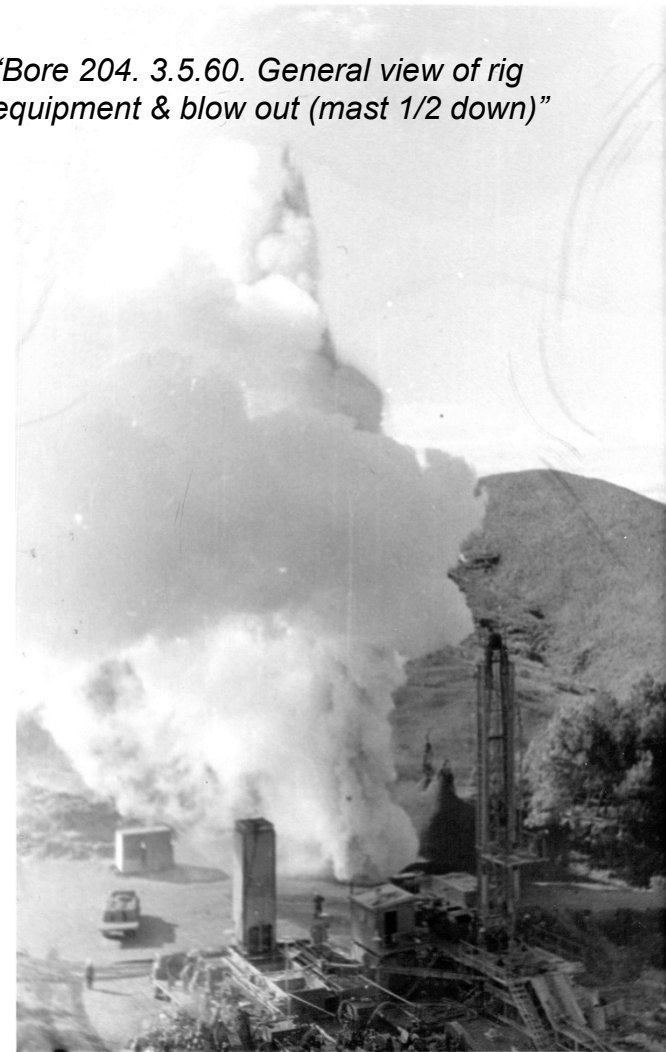
"Wairakei Geothermal Project. Bore No. 20. 17.5.53. Closing bore with emergency set-up"

89

WK204 blow out, “the Rogue Bore”.



“Bore 204. 3.5.60. General view of rig equipment & blow out (mast 1/2 down)”



W 3434.

WK204 blow out, “the Rogue Bore”.



“Bore 204. 3.5.60. Grouting operations at night”.



“Bore 204. 3.5.60. General view of rig equipment & blowout. (Ready to shift rig)”.

WK204 blow out, “the Rogue Bore”.

*“WK204 Wellhead
equipment after
removal of rig, 4.5.60”*



*“Bore 204.
4.5.60. (cellar
arrowed)”*

4.5.60 cellar 10341

Russell James

1952: DSIR Wairakei, Chemical Engineering section. Retired from the DSIR in 1989.

Trained as an engineer

Two-phase flow measurement.

“The James’ Lip Pressure” method for measuring two phase flow.

Cooper Medal, Royal Society of NZ, 1968

Angus Award , IPENZ, 1970

Special Achievement Award, GRC, 2002

The James’ Formula

$$Q \cdot h^{1.102} / (A \cdot P^{0.96}) = 6.63 \times 10^6$$

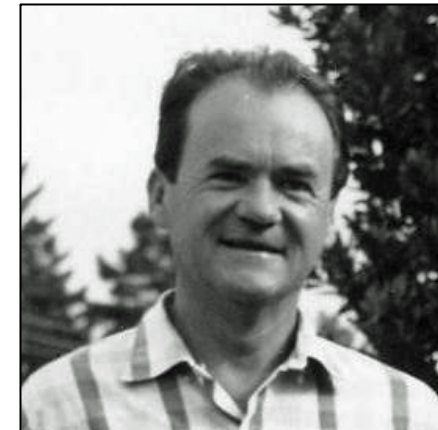
Where

Q = mass flow, t/hr

A = Area of pipe, m²

h = enthalpy, kJ/kg

P = lip pressure, bar.a



United Nations Rome Conference on New Sources of Energy

August 1961

An open exchange of experience and ideas

Geothermal Energy was the first on the agenda

Larderello was generating 300 MW(e) by then.

Wairakei was mentioned next

About 30 papers were published on the New Zealand experience – primarily Wairakei



Geothermal electricity production, preceded by about a century of recovery of boric acid and other chemicals, dates back to experiments in 1904 and particularly to 1912 when the first turbine, with a capacity of a mere 250 kilowatts, was installed at Larderello in Tuscany, Italy. It has been followed there by gradual, and of late very rapid, expansion of electricity production. With auxiliaries, the total Larderello capacity exceeds 300,000 kilowatts, spread over about a dozen plants ranging in size from 3,500 to 118,000 kilowatts; they produce over 2 billion kilowatt-hours per year, or enough to run the Italian railway system, which, in fact, gets some two-thirds of its power from these sources; the remaining third of the Larderello output is used for industrial and other purposes. The dependability and high output of the source is demonstrated by the fact that the biggest plant with a net capacity of 100,000 kilowatts has been running continuously with a utilization factor of over 98 per cent for more than a decade (G/72).

Other countries have followed the Italian example in recent years and more plants are in various stages of preparation. A geothermal power plant with a capacity of 69,000 kilowatts went into production in March 1960 at Wairakei on New Zealand's North Island, which draws about 10 per cent of its power from this source; the gross capacity is currently being expanded to 192,200 kilowatts, to supply about one-fifth of the power requirements of the North Island by 1963, and plans have been drawn for a further expansion of 90,000 kilowatts in a third stage (G/4). The United States also became a geothermal power producer in June 1960, when a plant of 12,500 kilowatts was completed at The Geysers, California; it is planned to double its capacity by 1963 now that favourable experience

United Nations Rome Conference on New Sources of Energy

NZ Papers

Topics of the Wairakei papers included:

- prospecting and investigation programmes
- geophysics
- chemistry, including mineral recovery
- drilling techniques and safety
- casings and failures
- cores: mineralogy, permeability
- downhole measurements
- discharge flow and temperature measurements,
- ground heat flow measurements,
- silencers and separators
- two-phase flow and measurement
- corrosion
- operations

Authors included:

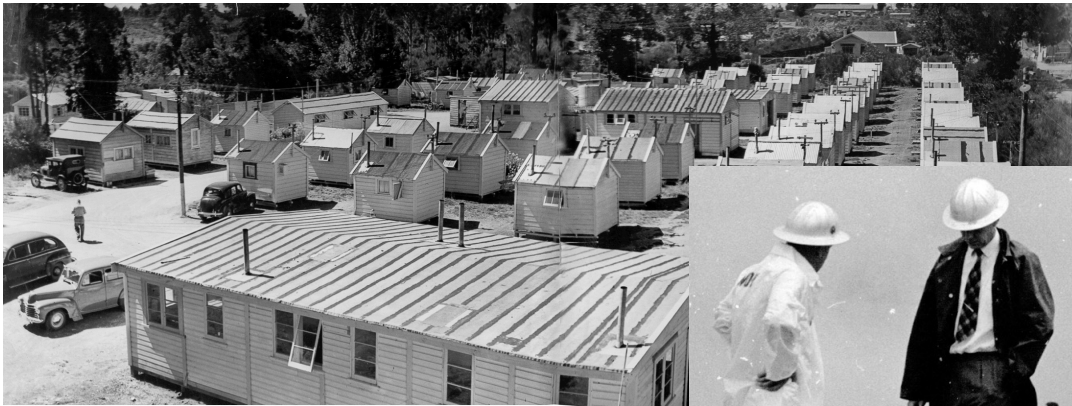
- C J Banwell,
- N D Dench,
- F E Studt,
- A C L Fooks,
- G W Grindley,
- J Healey,
- R James,
- R S Bolton
- W A J Mahon,
- G B Dawson,
- D J Dickinson,
- S H Wilson
- I A Innes

ACL (Lindsay) Fooks (snr)

June 1952: MoW Wairakei, Project Engineer until retirement in 1972

Managed the investigations, drilling, power station construction.

Papers at the Rome Conference on investigations and casing design



*Workers' camp, office and store
– originally located in Taupo.*

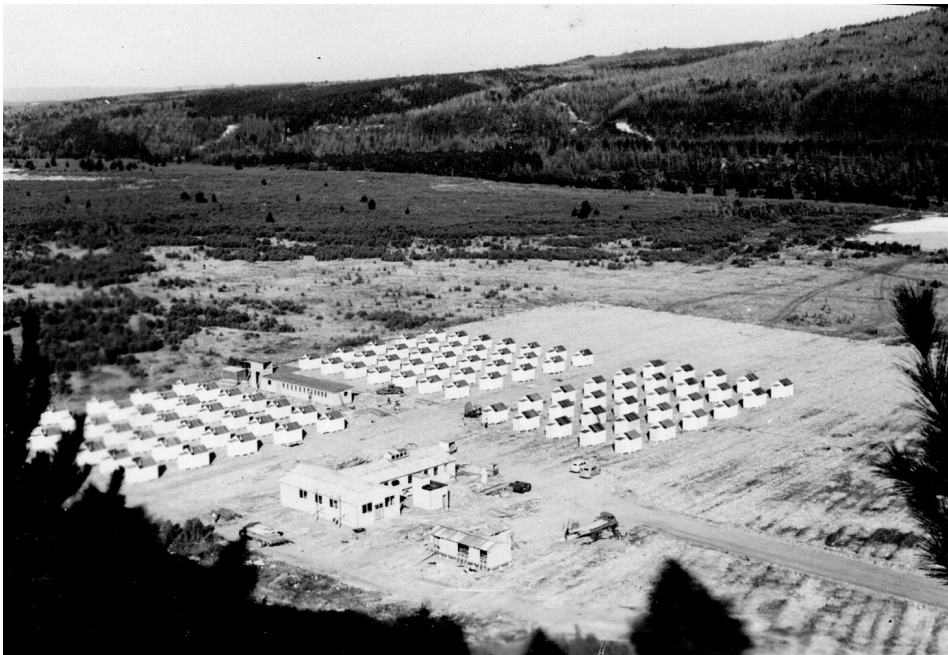


The Boss (Lindsay Fooks)

Jan. 1971

*Lindsay Fooks
David Wainwright
Dick Glover
Jan. 1966*

Wairakei development



"Station 'A' Powerhouse. 16/3/56. 100 Man construction camp".

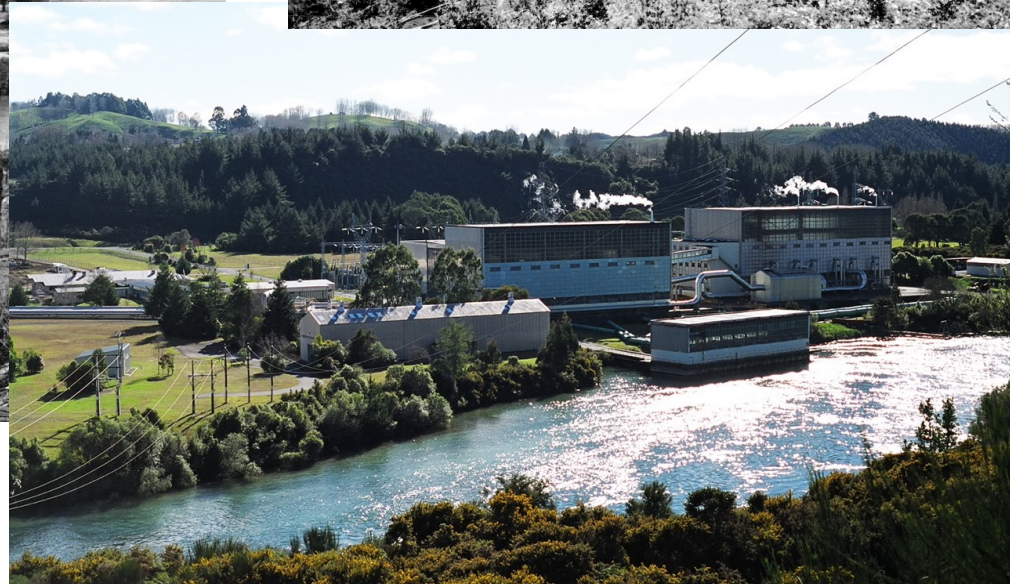


"Station 'A' Powerhouse 1/10/57. Electrical Annex left, outdoor station right, excavation to cable tunnel foreground"

Wairakei development



"Station 'A'. View over Pumphouse Powerhouse & flat from right bank of river 2/12/57".



'A' and 'B' Stations, 14.9.05

Tony Mahon

1956 - 1985 head of Chemistry section of Wairakei Research Centre of DSIR. Later the DSIR Geothermal Co-ordinator.

With Jim Ellis produced several papers on their experiments on water and rock interaction and the chemistry of New Zealand geothermal systems

1977 classic textbook: *Chemistry and Geothermal Systems*

1985 left DSIR, Wairakei for Geothermal Energy NZ (GENZL)

IGA formed in 1989: Tony was Director and Secretary 1991-95

1995 received the Joseph W. Aidlin Award for outstanding contributions to geothermal research and the development of geothermal energy

Lifetime Honorary Member of the NZGA:
Nov 2000 to Oct 2006



Dick Bolton

1956: MoW Wairakei liaison engineer with consultants and contractors working on the Wairakei Project.

Involved in all aspects of the novel work associated with the construction of the power plant.

1959: moved to Wellington as assistant to the MoW's Chief Geothermal Engineer, responsible for carrying out investigations into the development and utilisation of New Zealand's geothermal resources.

1974 appointed MWD's Chief Geothermal Engineer, until his retirement from the department in 1983.

Then joined the NZ Ministry of Foreign Affairs as an aid adviser attached to the NZ Embassy in Jakarta, later UNDP in El Salvador, Chile, Philippines.

1978: a key to establishing the Geothermal Institute at the U of A; on the inaugural Board of Directors



Neville Dench

1954: MoW Wairakei, civil engineer; responsible for measurements, quality control and engineering research.

Designed the distinctive twin tower silencers for noise & water control

1964: MoW Wellington; planning, costing and assessment of projects within the geothermal programme.

1971: planning UNDP investigations for El Tatio Chile

1975: GM of Geothermal Energy (NZ) Ltd (GENZL) - Kamojang

1984: Resigned as Director, part time work for GENZL, retired in 2004.

On the committee developing the Code of Practice for Deep Geothermal Wells - NZ Standard 2403: 1991

Founding Committee for the Geothermal Institute: over 500 students benefited from his block lecture "Introduction to Well Siting and Field Development Strategies."



*"Bore 42 23-11-56.
Twin cyclone silencer".*



Silencer development



Geologists and Petrologists

Thanks to Pat Browne

Drilling at Wairakei resulted in the recovery of many cores that yielded much important stratigraphic information.

Staff of the New Zealand Geological Survey of the Department of Scientific and Industrial Research (DSIR) studied these cores, notably:

- George Grindley,
- Jim Healy
- Alfred Steiner (petrologist).

Assisted by

- Bill Watters
- Ted Lloyd
- Don Rishworth.

George and Jim had many healthy disagreements, especially about the role of faults in providing permeability.



"Bore 25. 3.12.54. T12 rig running in drill pipe to get core"

Chemists

DSIR chemists made a major contribution to the Wairakei investigation:

- Jim Ellis, with
- Tony Mahon.
- Richard Glover

Their careful observations, analyses, measurements and experiments have worldwide importance. Established links between fluids and minerals. Later:

- Byron Weissberg
- Dick Henley
- Kevin Brown
- Terry Seward.

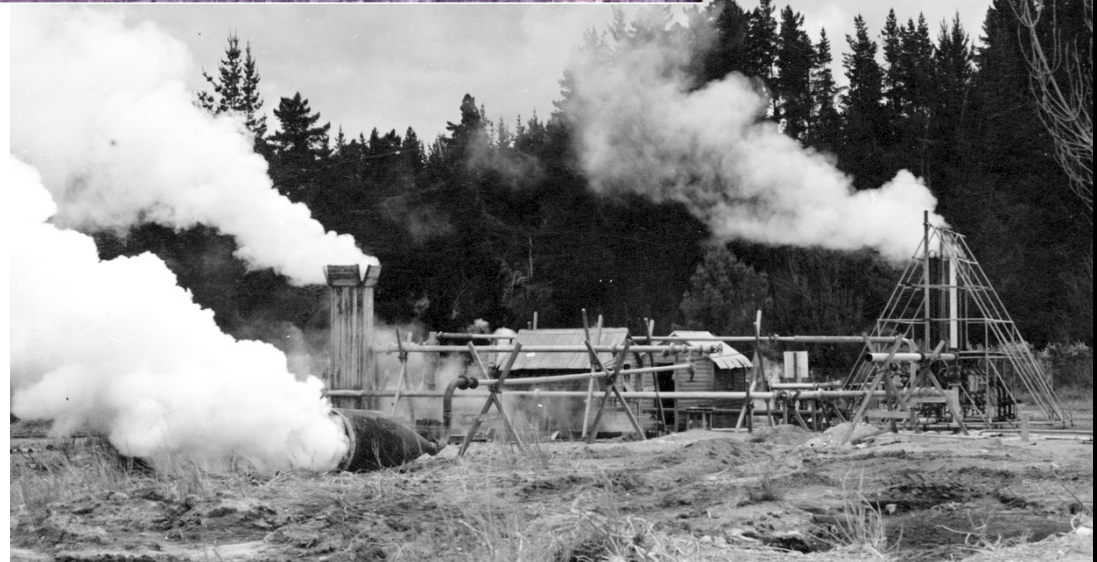
Demonstrated that most epithermal mineral deposits are really dead geothermal systems.

Corrosion chemistry:

- Keith Lichti et al



*DSIR chemist
sampling 1960*



*DSIR corrosion
test rig WK9 1954*

Chemists

Stable isotope analyses: thermal fluids; hydrothermal minerals - Institute of Nuclear Sciences:

- Athol Rafter, and later
- Bill McCabe
- Peter Blattner
- Brian Robinson

*"Bore 226: Neutron
"bomb". 21/8/64"*

Gamma ray logging WK208 May 1961



Dick Glover

1961: Wairakei DSIR.

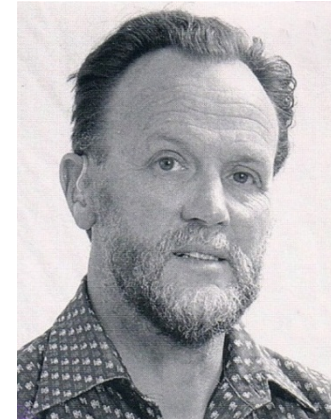
Worked on changes to reservoir chemistry caused by development

First to make the connection between geyser decline and fluid extraction (UN Pisa Conference paper 1970)

Set up the first gas chromatographs in the DSIR laboratory at Wairakei and put gas analyses on a firm foundation

Refined the sampling procedures for gas and water from geothermal systems.

Lifetime Honorary Member of the NZGA: Nov. 2011 to June 2015



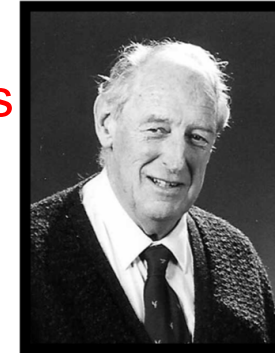
Continuing to lead: formation of the International Geothermal Association



Geothermal industry representatives meeting Wairakei 14 October 1986.

New Zealand Geothermal Association (NZGA): Lifetime Members and Contribution Award recipients

Past members	
Name	Tenure
Dick Bolton	Nov 2000 to Dec 2009
Tony Mahon	Nov 2000 to Oct 2006
Derek Freeston	Nov. 2004 to Oct. 2010
Dick Glover	Nov. 2011 to June 2015
Russell James	to Dec 2014
Basil Stilwell	to Sep 2013
Brian Jones	2005 to 2018
Current members	
Name	Year awarded
Trevor Hunt	2004
Manfred Hochstein	2004
Ian Thain	2005
Pat Browne	2006
Colin Harvey	2010
Jim Lawless	2013
Mike O'Sullivan	2015
Arnold Watson	2016
Paul Bixley	2017



CONTINUING THE LEGACY

New people with new ideas willing and able to try

An environment that encourages new ideas and understands and allows risks

Try new ideas, take risks, be prepared for failures
but don't forget what we have already learnt.

Then Wairakei will be well set up for its Centenary.



ACKNOWLEDGEMENTS

Thanks to many people for the previous work on Wairakei history.

Paul Bixley for providing photos and background and interviews.

Gordon Dawson for his memoir

Chris Morris for photographs and historic documents

Ed Mroczek for advice about early chemistry

Dick Bolton had done a lot of work collating the early history



He tangata
he tangata
he tangata

