Proceedings 20th NZ Geothermal Workshop 1998

NOTES ON THE EARLY HISTORY OF WAIRAKEI

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SUMMARY

These notes outline the major circumstances and events influencing the decision to investigate the geothermal resources of New Zealand, together with problems faced in the early days of the development of Wairakei. They cover the period from 1918 when the first suggestion for the investigation of the resource appeared until early 1953 when Wairakei's development began in earnest.

1. INTRODUCTION

1.1. Early Interest in the Resource

Eighty years ago, on 2 February, 1918, the Masterton Chamber of Commerce requested the Minister of Public Works to enquire into the utilization of thermal energy for industrial and other purposes, pointing out that the Italians were generating electrical energy from thermal districts and were using it for lighting, traction and munitions manufacture with great success. (PWD, 1918). However, another four decades passed before New Zealand could say with some truth that it was using electricity from the thermal district "with great success".

Among a number of similar suggestions which appeared over the next two decades, perhaps the most unusual came from New Zealand's High Commissioner in London. Following discussions with Prince Ginoro di Conti after the first World Power Conference in 1924, the High Commissioner suggested to Government that New Zealand should investigate both the generation of electricity and the recovery of helium from the thermal regions. The reason was that this would be of national interest should an Imperial Airship Fleet be formed.

In his reply, the Prime Minister said that water power schemes under construction had sufficient capacity to meet power requirements for at least twenty years. Somewhat prophetically, he added that "At the end of that time it may possibly be worth careful investigation to see whether the use of natural steam for the generation of extra power would be more economical than the further use of water." (PWD, 1924)

Coincidentally, in 1925, a 250 kw generator was operating at the Geysers. However, no further development was being carried out because of the competition from hydro and natural gas. (DiPippo, 1980). In other words, although now the most intensively developed geothermal field in the world, the Geyser's early development was inhibited for much the same reasons as was New Zealand's.

The geothermal literature from this period is sparse, but one publication of significance is Geological Survey Bulletin 37. (Grange, 1937). This is the first detailed description of the geology of the Taupo Volcanic Zone and made an important contribution to the subsequent investigation and development of the resource.

1.2. The Beginning of Serious Interest

Early in 1940, the Council of Scientific and Industrial Research recommended that the utilization of the thermal resources should be investigated. (Hamilton, 1954). Although at the time, the most promising prospect appeared to be power generation, hydro resources were still considered to be sufficient for some years ahead. Nevertheless, at the request of the DSIR, Captain F.E.N. Tuck, a Public Works Department engineer with the 2nd NZEF, accompanied by Trooper D.E. Jobley (B.Sc.), visited Larderello in 1944.

Although a substantial part of the plant had been systematically destroyed by the retreating German Army, Tuck produced a well illustrated report on the power and chemical facilities at Larderello. While reflecting Italian practices prior to the war, there is little doubt that his report had a significant influence on subsequent decisions to investigate the geothermal resources of New Zealand (Tuck, 1944).

Systematic investigation began with the appointment of Jim Healy as Government Volcanologist in 1945, followed early in 1946 by a DSIR meeting in Rotorua at which a five year programme covering the whole thexmal region was agreed. Receipt of Cabinet approval enabled the work to begin without delay.

By the mid to late 1940's, there were strong doubts as to whether sufficient hydro would, in fact, be available to meet the North Island's needs. The problem was compounded by serious delays in obtaining plant, by shortages of skilled staff, labour and materials, by a continuing shortage of hydrocarbons to supply the steam stations and by *two* abnormally *dry* years. Interest in the resource quickened and in 1948, as well as accelerating hydro investigations, the Minister advised Parliament that the DSIR were investigating the use of geothermal steam for power (AJHR, 1948).

13. The Final Commitment

By the end of 1948, the power situation had deteriorated to such an extent that Government required little persuasion to initiate a more focussed investigation programme involving the MOW and the SHD as well as the DSIR. For this purpose, the Geothermal Advisory Committee (GAC) was set up in mid-1949. Composed of the Commissioner of Works, the Secretary of the DSIR, the General Manager of the State Hydro-electric Department (SHD) and the Director of the N.Z. Geological Survey, the Committee reported to Cabinet through the Minister in Charge of the DSIR. By making the Committee responsible *to* Cabinet, Govemment gave a clear indication of the importance attached to the investigation and development of the resource.

2 THE INVESTIGATION PHASE

2.1. Setting Up

The Committee was faced with the usual problems in setting up a new activity, assembling staff, plant and equipment and obtaining finance, all of which were in short supply. There was also the need to work with and develop a technology which was very much in its infancy and, in some areas, nonexistent. Overshadowing everything else was the frequently expressed emphasis on urgency arising from Government's wish to be seen to be doing everything possible to overcome the shortage of power.

The pressure was evident ficm the first weeks of the Committee's operations. Initially, the wider investigation programme already under way was to be replaced with a concentrated examination of the 13 mile by 13 mile area surrounding Wairakei. The drilling programme would then be based on the information fiom these investigations. Cabinet approval for .10,500 to establish a camp and procure seismic equipment for the revised programme was received on 23rd November, 1949.

However, only a fortnight later, the continued pressure resulted in a major change. Drilling was to commence at Wairakei as soon as possible, the initial holes being sited on the basis of the information already available.

A problem arose over control of the work in the field. The DSIR had been leading the investigations to that time but, with the focus now on power development, the SHD expected geothermal investigations to be handled in the same way as were hydro investigations. This meant that although the GAC were in overall control, the Wairakei work should be the Ministry of Works' responsibility. For this reason, Wairakei was placed under the control of the Project Engineer Mangakino.

In effect, a two part programme resulted. The DSIR continued to investigate the whole of the thermal regions on an orthodox scientific basis while the investigations at Wairakei specifically for power were continued under the control of the MOW. Each organization assisted the other as required, but Wairakei was to receive priority.

Dissension over the accelerated programme for Wairakei persisted. In correspondence with John Banwell later in the year, Sir Ernest Marsden suggested that it didn't matter much where the first bores were sited, as long as there were surface indications of steam close by. His advice was to go ahead drilling a small hole without much more science. He agreed that this was a 'bull at a gate' approach and that the scientific work should continue in parallel with any drilling, but he considered that, in view of the urgency, the need to take risks should be accepted.

Ongley, Director of the N.Z. Geological Survey, was strongly of the opinion that hole siting should be based on more scientific input. He considered the advice "irresponsible and dangerous to the uninformed" but, in view of the pressures on the Committee, had little choice but to accept the situation.

2.2. The Selection of Wairakei for Development

Although not based on a detailed examination of the resource as a whole, the decision to go to Wairakei was not made lightly.

The thermal area at Wairakei was extensive with one of the largest estimated natural heat outflows in the thermal regions. The steam field and potential power station sites were on Crown land and the topography of the area, together with the availability of ample cooling water indicated a relatively straightforward power development. The proximity of the MOW hydro project at Mangakino suggested a significant reduction should be possible in the time required to set up and begin work. Finally, the supply for the Wairakei Hotel was an encouraging sign regarding future drawoff from the field.

Given the urgency with which answers were required, these were compelling reasons for the selection of Wairakei for the investigations.

2.3. The Agreed Programme for Wairakei

On the 9th March 1950, a meeting at the Wairakei Hotel of both DSIR and MOW personnel and chaired by the Engineer-in-Chief agreed on the general programme for the Wairakei investigations. This comprised three separate but concurrent activities, geophysical surveying, prospecting drilling and development drilling, all to begin as soon as practicable.

The geophysical surveying was essentially an intensification of the DSIR work already under way and, for the first few months, dominated the DSIR effort within the 13 m x 13 m area. The "prospecting" drilling comprised a series of holes sited at approximately quarter mile intervals on a line fiom the river below the Wairakei Hotel, up to the Atiamuri road and across to the Wairakei Valley above the geysers. This became known as "D" line and was the focus of the initial investigations.

With as little delay as possible, "development" holes would then be drilled around good prospecting bores. Up to six were considered necessary at each location to ensure that it was thoroughly explored. While the "development" bore concept had a significant influence on the drilling programme, only one such group, the "4 Group", was drilled and this only partly. Both prospecting and development holes were programmed to be drilled in two stages, the first to 500-600 feet, with target depth for the second stage in the range 1000 to 1500 feet. Deepening any particular bore was dependent on the results of the first stage drilling.

2.4. Rigs and Drilling Personnel

At their initial meetings, the only rigs the Committee were aware of were two DSIR Sullivan 37 rigs already working at Wairakei, a 1500 foot capacity rig owned by the MOW and a large oil exploration rig which had been moth balled for 10 years. On inspection, neither of the latter proved to be suitable for the work and the Committee was in something of a quandary. This was resolved by denuding the Waikato hydro project of their investigation rigs, namely, three Sullivan 37s. Geothermal energy was given top priority!

The problem of how to handle the expected high pressures and temperatures with a lack of appropriate equipment and trained personnel also had to be resolved urgently. Mines Department drillers frequently encountered high pressures when drilling investigation holes for coal. With their experience in mind, the Under-Secretary of Mines was approached for assistance. As a result, Bob McMillan, the Drilling Superintendent fi-om Greymouth, together with a Failing 1500 rig and crew, were released initially on secondment, but later by transfer.

2.5. Drilling Techniques

One of McMillan's first tasks was to report on the procedures and techniques he intended following. Safety of both the drill crews and the finished bores was his primary concern with particular reference to the provision of equipment to control the bores when drilling and discharging under pressure.

Blow out preventers (BOP) were required for the Sullivans. McMillan prepared a set of sketches fiom which working drawings were prepared and the BOP's were built in the project workshops at Mangakino. This BOP equipment was used with only minor modifications on all the early investigation holes.

The rigs, both Sullivan and Failing, were set up on heavy timber beams spanning timber lined cellars. A relatively primitive mud circulating and cooling system was provided but there was no consolidation grouting. Two strings of casing were programmed, a 6" surface or anchor string and a 4" production string. On a few occasions, an additional short string was required in the upper levels when caving occurred. Open hole completions were standard. The casing was Class "C" steam pipe.

The holes were cored full length using double tube core barrels, casing depth being based on

formation strength as assessed fiom the cores. Deepening was carried with both the Sullivan and the Failing rigs. The Sullivans were taken beyond their nominal capacity of 750 feet by a combination of progressive reaming and the use of smaller diameter drill pipe.

Particular problems encountered and overcome arose from the precision required in setting casing, fkom the initial restricted core barrel length, from the effect of temperature on cement setting times, from mud flocculation and high temperature gelation and fiom sand packing. Single shift, five day weeks were worked for almost the whole of the investigation period.

Modem drilling is not without its moments of tension, but drilling those early holes tended to be even more of an adventure.

2.6. Drilling Progress

Following the Wairakei Hotel meeting, being on the spot, the DSIR rigs were able to spud in with a minimum of delay. However, the MOW Sullivans could not be released until completion of the Waipa hydro investigations and the Mines Department Failing rig had to be shipped up fiom the South Island. Nevertheless, by the end of the 1950, drill crews had been trained and eight "D" line holes had been completed, or were being drilled.

Further rigs were obtained and at the peak, seven were working on the job. However, there were a number of factors which slowed the drilling. The open hole completions resulted in many blockages requiring a regular maintenance programme to ensure that the essential discharge and downhole infoxmation was obtained. A second factor was the amount of coring required. Initially, continuous coring over the fill depth was, for obvious reasons, the natural choice. However, as the work progressed, the value of the fresh information tended to lessen, leading to a clash with the need for urgency.

One other difficulty arose when the need for seismic information became an imperative. *On* occasions, to meet this need, the DSIR rigs would be moved fkom the investigation drilling, sometimes without notification. This problem was resolved by the Ministry of Works hiring private contractors for the seismic work on an as required basis while the DSIR rigs concentrated on the "D" line drilling. If *this* were not possible, then, by agreement, the DSIR rigs were transferred temporarily to seismic drilling.

A total of 17 bores were drilled during the initial investigation phase, 15 on "D" line and 2 on "N" (Karapiti) line. This includes two replacement bores on "D" line. Indicative of the results obtained, formation temperatures ranged fiom 1800C to 2200C and all wells discharged some steam The best flowed over 100,000 lbs/hr from 4" casing for short bursts and at over 50,000 lbs/hr on a more sustained discharge.

2.7. Deep Drilling Equipment

At a relatively early stage, the need for deeper drilling than was possible with the existing equipment became apparent if the resource was to be investigated properly. The GAC therefore recommended the purchase of two portable drilling rigs capable of drilling 6" hole to 2,500 feet, the initial target depth for future prospecting.

Included in the recommendation was the purchase of four rigs for use elsewhere in the Department to replace those which had been commandeered for Wairakei together with the "mothballed rig" to provide a supply of spare parts and equipment. Cabinet approved the purchase of this equipment in April 1951 at a total cost of .217,500. With this approval, Government had accepted a relatively long term commitment to the investigation and possible development of the geothermal resource.

The contract for the larger rigs went to the National Supply Company for two of their National Ideal T12 rigs, the first of which spudded in during November 1952, some time after Wairakei had been committed for power development. In the interim, a further two Failing 1500 rigs had also been purchased, enabling the return of the Mines Department rig and the DSIR Sullivans.

2.8. Downhole and Output Measurements

A maximum thermometer run in a weighted pocket on a wire line was the first instrument used to measure downhole temperatures. The instrument was useful in providing spot foxmation temperatures and in determining casing setting depths. However, multiple runs were required to obtain temperature profiles making this a time consuming operation, with results of doubtful reliability. Resistance thermometers gave little better results due to repeated failure of the cables then available.

The most satisfactory instrument was the geothemograph designed and built by the DSIR. The temperature range was 200C to 3000C with an accuracy of plus or minus 20C and enabled a profile revealing details in the temperature gradient to be obtained on one run.

For many years, downhole pressures were estimated fiom water level measurements and the wellhead pressure gauge reading, with an adjustment for the density of the hot water.

Initially, well outputs were measured using a swinging arm calorimeter. The main drawback was the very short flow period possible. Nevertheless, the method gave a reasonable indication of output, particularly for the smaller bores. The most accurate method of measurement then as now, was to separate the steam and water and measure each phase separately. Despite requiring a cumbersome amount of equipment, the technique was used extensively until the arrival of the sampling calorimeter.

The' sampling calorimeter, designed by John Banwell and the Dominion Physical Laboratory, came into use in early 1953. The system gave results in good agreement with other methods and for many years was the standard method of measuring outputs.

3. COMMITTAL FOR POWER

3.1. The Initial Installation of 20 MW

As early as September 1950, the results of the investigations were clearly influencing energy policy. The Minister of Works, in a statement on electricity supply, was quoted as saying that until it was known whether geothermal steam could be used for power generation, he could not recommend that Government consider a large scale coal or oil-fired power station programme. (Board & Council, 1950.)

However, it was not until 1952 that the Minister in Charge of the SHD announced that the work at Wairakei was being extended with the objective of justifying the installation of a 20,000 kW plant. Also, the General Manager advised that a 20 MW plant in the area would be valuable but that he needed to know within twelve months whether this would be available from geothermal energy.

With a definite power requirement and a specific time limit in mind, the investigations now required a completely different approach. The main features of the new programme were:

- Sixteen holes were to be drilled adjacent to "D" line at its hottest part. This number was based on a steam consumption of 20 lbs/kw, an output of 100,000 lbs/hr/bore total flow and a dryness fraction of 25%;
- The establishment of Wairakei as a normal Ministry of Works project already being discussed was to be implemented immediately; and
- The drilling should be carried out on a three shift per day, six days a week basis.

The GAC accepted this programme at its meeting on 16 June 1952, following which, it voted itself out of existence.

3.2. Wairakei Established as a Project

A change of status for the MOW's operations at Wairakei had been discussed for some time prior to the GAC's final meeting. A substantial increase in the work load was expected following the arrival of the new rigs when, potentially, up to ten, some on three shift operation, could be operating at the same time. Additionally, all routine downhole and surface measurements were being transferred from the DSIR to enable them to concentrate on the increasing requirements for research. *Also,* the Waikato River hydro site investigation parties working from Taupo to Aratiatia, were attached to Wairakei.

This required a substantial increase in support facilities and staff together with a more direct contact with Head Office for accounting purposes. The change in focus to a 20 MW power installation then became the catalyst in establishing Wairakei as a project. No doubt, the advent of the heavy water and the pulp and paper proposals also influenced thinking in this direction.

The establishment of Wairakei as a project was effective from 30 July 1952. Lindsay Fooks was appointed project engineer, but was unable to take up the position until September. Mangakino was having staffing difficulties and so, for a brief period, Jack Smith provided the on site administration, stationed part time at Wairakei and part time in Head Office. In this situation, he was often in the happy (?) position of having to answer his own letters.

At Head Office insistence, supported by Fooks but against the advice of the Project Engineer, Mangakino, who preferred Wairakei, the camp and offices were located in Taupo. The reasons were that there was already the nucleus of an organization there, the availability of services, and a belief on the Engineer-in-Chief's part, that once in a vehicle, it didn't matter whether the distance travelled was one mile or four. The camp, office and store were set up in what is now the Taupo camping ground.

The Wairakei office took full control of the project from the beginning of November although Mangakino continued to provide assistance until all facilities were established.

4. HEAVY WATER PROPOSAL

4.1. The Formal Request

The formal request from the United Kingdom Atomic Energy Authority (UKAEA) for a joint investigation into the use of geothermal energy in the production of heavy water was received in March 1952. The proposal originated some years previously when Sir Ernest Marsden, New Zealand's Scientific Liaison Officer in London suggested the possibility to the Director of the Atomic Energy Research Establishment (AERE) at Harwell, Sir John Cockcroft.

During a visit to New Zealand to present the Rutherford Memorial Lectures, Cockcroft briefed officials on the heavy water proposals. The Commonwealth's demand was expected to increase, but there was uncertainty of that demand being met. From initial estimates, production costs per ton from a geothermally based plant would be significantly lower than the cost from both the UKAEA's existing supplier and altemative sources. There was also a preference for the supply to come from the Commonwealth.

Cockcroft is also reported as having told the Government that the real object of the UKAEA programme was the production of plutonium rather than electricity (Martin, 1991).

4.2. The Search for a Location

When first discussed, the heavy water was to be produced at Wairakei in conjunction with power production. However, the DSIR, who were responsible for the heavy water project, concluded that, on the basis of the information available, there would be insufficient energy available for both purposes concurrently. Wairakei being committed for power production, the location of a separate site for the heavy water became urgent. The search was hampered by a shortage of resources to carry out the necessary investigations, by land ownership difficulties and by requirements imposed by the Geothermal Steam Act (1952).

Te Teko (Kawerau) was suggested as a possible location but had already been committed to the pulp and paper project. Ohaaki was considered next. The SHD agreed to its release, but, with more than 200 owners, obtaining access by lease or purchase was seen as a major problem and the search continued. In some desperation, Te Kopia was considered but for obvious reasons, was discarded. Finally, an area of unalienated Crown land located behind the Waiotapu Hotel adjacent to the Waikite Valley Road was selected. The SHD agreed to this location provided that not more than 10,000 kw equivalent was used for heavy water.

At this stage, with a better understanding of the heavy water process and a better knowledge of Wairakei's capability, the idea of a combined plant was revived. Wairakei was producing 20 MW equivalent and there was every confidence that the field could produce the full 50 MW required for a combined plant. There was also more than a little concern over committing the substantial expenditure involved in a pilot heavy water project without a more exhaustive examination of the field's potential.

Hence, the wheel turned full circle when, in May 1953, Cabinet approved in principle the construction of a combined power and heavy water plant at Wairakei.

The search for the site for the heavy water plant coincided with the establishment of the project, with the preparatory work for the drilling for the 20 MW and with the demands fiom the Kawerau investigations. Political pressure for this had required a significant diversion of effort from Wairakei. Although Waiotapu was finally selected as the location for the plant and preliminary work had begun, there was little capability for a third urgent concurrent investigation programme. Hence, while the decision to locate the heavy water plant at Wairakei had some far reaching effects, one of the lesser known but very welcome outcomes was the easing of the very considerable pressure on the organizations at Wairakei.

43. The Proposal

The proposal comprised a 6 ton/year capacity heavy water distillation plant with an associated 35 MW installed capacity power plant. Revised estimates for the heavy water had risen to .50,000 per ton, still significantly lower than the .75,000 for the alternative source. This was important because, although nominally a pilot plant, the heavy water operation had to be economically viable.

In late 1953, the United Kingdom re-examined the place of heavy water in their atomic programme. This resulted in a prolonged hiatus during which little information reached New Zealand. Both the sale of the second T12 rig and a reduction in the size of the Wairakei establishment were being seriously considered when word that the combined project was to go ahead came, at the end of June 1954. The decision was made public by the Prime Minister in his budget speech in July and for many of the participants both in New Zealand and the United Kingdom, this was the first they knew that the project was to commence. It is not unreasonable to assume that imminent elections had much to do with the Government's timing of the release of the news.

Although the story of the heavy water project by no means finishes here, the remainder is beyond the time frame for these notes. There is, however, one further aspect worth mentioning.

Security was an important factor fiom the outset. All technical details of the processes involved in the production of heavy water, particularly plant outputs, were to be kept secret although there was no objection to making known the general nature of the project.

To meet secrecy requirements, the DSIR adopted the title "Heat Exchange Research" for the project. Also, the Parliamentary Armed Services and Press Committee issued a Defence Notice which limited public discussion on heavy water production in New Zealand to generalities. The security classifications, including the Defence Notice, were maintained until November 1954 when, on the advice of the UK authorities, the full security classification was dropped, the project continuing on a "commercially confidential" basis only.

5. CONCLUSION

In a brief history such as this, many aspects have to be omitted. Some, such as our overseas involvement and, closer to home, the preparation of legislation originated fiom this period, but eventually developed into major activities of their own. However, in concluding these notes, there are two aspects of which mention should be made, our relationship with the Wairakei Hotel and our contacts with Larderello.

5.1. Wairakei Hotel

A well established tourist centre in the 1890's, the Wairakei Hotel subsequently went through a number of traumatic episodes in its history, includmg fire and a brief period as a mental hospital (Stokes, 1991). However, at the time the Project began, the Hotel had been restored to pre-war standards as the leading tourist hotel in the country. Its proximity to the project resulted in a close, although informal relationship between the two.

This relationship varied fiom day to day, but was, on the whole, cordial even though the file on the Wairakei Hotel was the most active in the office. Among other things, the early development of silencers was certainly influenced by the nocturnal comfort of the guests. Also, wind direction was an important factor when discharging the adjacent bores if a major cleanup of guests cars and of the swimming pool was to be avoided. And, of course, the Project was closely involved with the maintenance of the Hotel's steam supply.

The Hotel was, for many years, the headquarters for visitors fiom Head Office and there were more than a few important decisions taken over the dinner table and afterwards. Also, it probably goes without saying that the Hotel was the venue for many of the Project's social occasions, not the least of which was the celebration of the official opening of the Station on November 13, 1958. The old Hotel with its elegant dining room and lounge and its ambience fkom a previous era is long gone, but its memory lingers.

5.2. Contacts With Larderello

The First World Power Conference in 1924 was, in effect, our earliest contact with Larderello. As already mentioned, the High Commissioner in London met the Prince di Conti following the conference. Also, several engineers prominent in the fledgling electrical industry in New Zealand were present at the conference and contributed to the discussion on Conti's paper on Larderello. (Conti, 1924)

In his paper, Conti had referred to the possibilities inherent in thermal regions in other parts of the world including Rotorua. An unnamed delegate from New Zealand agreed that this energy source in New Zealand was very considerable, saying, among other things, that "The most noticeable steam outlet in New Zealand occurred, as far as he remembered, near the shores of Lake Talbot, at a place called Wirrawacka". It is to be hoped that, in referring to the Karapiti Blowhole, he was misreported.

During an extensive overseas trip in 1926, F.W.Furkert, the Engineer-in-Chief of the Public Works Department visited Larderello where he and his party were received and entertained by the Prince di Conti. The party was impressed by the speed with which they were driven from Volterra to Larderello (adversely) and the lunch they were given (very favourably). Furkert was also impressed by the fact that electric power had been fed fiom Larderello to Volterra many years before there was any hydro power available in that part of Italy (Furkert, 1924).

Overseas travel in the early days of Wairakei's development was both financially and physically difficult. Consequently, the only visits subsequent to that by Tuck and Jobley in 1944 were by Ongley and McKillop on separate occasions in 1948, McKillop again in 1951 and Fisher and McMillan at the end of 1951. They all looked at Larderello fiom different perspectives, but the one common theme was an enthusiasm that New Zealand could emulate the Larderello Company's example, an enthusiasm they were able to transmit to their political masters.

There was, of course, no direct involvement. At that time, the Larderello Company was still recovering from the war and, concurrently, expanding their own plant. By the time they were in a position to be of assistance, the Wairakei organization was established and was well on the way to obtaining the steam for the initial installation. Nevertheless, on his 1948 visit, McKillop did discuss with Dr. Mazzoni, the then head of the Larderello Company the possibility of a visit by some experts from the Company. The Minister considered that it was a little premature and the visit never eventuated.

While the Larderello Company may not have had any direct input to our activities, their example and the information gained from them had a very marked influence on New Zealand's decision to investigate and develop our geothermal resources. Without the Inspiration which began with the efforts of Prince Ginoro di Conti and his colleagues, it is difficult to imagine where the development of our resource would now be or, indeed, whether it would ever have got off the ground.

6. ACKNOWLEDGEMENTS

Much of the source material for these notes came fiom the files of the Power Division of the Ministry of Works and Development. My thanks are due to Works Consultancy Services, now Opus International Ltd. who, as temporary custodians, gave me every assistance in gaining access to the relevant files.

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