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Whakarewarewa a Living Thermal Village –Rotorua, New Zealand

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ABSTRACT

Whakarewarewa is an iconic centre of Māori culture and of geothermal features in the New Zealand. Residents at Whakarewarewa over the decades have witnessed an evolution in geothermal and cultural tourism, now encompassing 200 years of traditional knowledge, guiding and innovation, and have developed guidelines to ensure sustainable energy resource and economic development opportunities will continue to flourish in the future.

This paper combines the indigenous and western science perspectives of the Whakarewarewa geothermal area. This approach aims to ensure that any geothermal developments are sustainable, and that the integrity of the geothermal taonga (treasures) remain and live on for future generations.

1. INTRODUCTION

1.1 Whakarewarewa

Whakarewarewa (or, correctly, Te Whakarewarewatanga O Te Ope Taua A Wāhiao, meaning The uprising of the warriors (war party) of Wāhiao) is a geothermal area within the environs of Rotorua City (New Zealand), Figure 1. It is also the site of the Māori fortress of Te Puia, first occupied c.f. 1325, and known as an impenetrable stronghold never taken in battle. Māori have lived here ever since, taking advantage of the thermal waters for heating and cooking.

In the words of the local Māori people; Nau mai, haere mai, "Welcome to our World" a living culture, utilising the gifts of Papatūānuku (earth mother) to provide sustenance to ourselves and our guests. With 200 years of traditional knowledge and innovation in geothermal tourism, Whakarewarewa is the iconic centre of Māori culture in the New Zealand, set amidst a landscape of dynamic thermal activity, hot springs, bubbling mud pools and the World famous Pohūtu (and other) geysers.

Ancient proverbs of New Zealand's indigenous Māori people reflect on the inevitability of change and innovation in the world we live, and nowhere is the sentiment more palpable than in the steamy realm of Whakarewarewa. Since the 1800's, "geothermal tourism" has been a major economic contributor to Rotorua and New Zealand. The "Whakarewarewa thermal experience" showcases the Māori relationship with geothermal taonga (treasures). Each year, several hundred thousand tourists are welcomed to Whakarewarewa Village and the associated thermal area. The village has a well earned reputation for gracious hospitality, and by the work of its internationally renowned guides, such as the late guides Maggie, Sophia and Rangi. The sustainability of these endeavours' is governed by continued tourism through the village, but also by the sustainable management of activities within the thermal area.

1.2 Tāngata Whenua (People of the Land)

The Tuhourangi/Ngāti Wāhiao people have lived in and around the thermal area at Whakarewarewa for more than 200 years. An opportunity arose in 1997 for the people of Tuhourangi/Ngāti Wāhiao to initiate an independent tourism experience through Whakarewarewa, and consequently established The Whakarewarewa Thermal Village Tours (in 1998) under the umbrella of the Whakarewarewa Village Charitable Trust.

The village experience is not 'owned' by an organisation or individual, rather it is a way of life, a legacy passed down through the generations. The land upon which the tours are guided belong to numerous family groups, who generously allow visitors to participate in their communal lifestyle of Māori culture and tradition. The people at Whakarewarewa have been welcoming guests into their homes since the early 1800's. The Tuhourangi / Ngāti Wāhiao people have a proud heritage which they share with visitors from around the world. The Whakarewarewa Thermal Village Tours continues to grow, with profits supporting growth within the village environment. In this way, present Tuhourangi/Ngāti Wāhiao are following in the footsteps of their ancestors, and continue to be leaders in the tourism industry.



Figure 1: Rotorua Geothermal Field, as defined by electrical resistivity surveys (Gordon et al., 2005). Surface geothermal activity, including at Whakarewarewa, and the 1.5 km Rotorua Geothermal Exclusion zone are also shown.

2. MĀORI VIEW OF GEOTHERMAL

Geothermal (energy) is a taonga (treasure) with intrinsic value in the traditional Māori world (Figure 2), and the contemporary Māori world. To understand the value of geothermal in the traditional Māori world and its place in early Māori economics, we must go back to the origins, to whakapapa (history). Through many centuries, stories and histories have been handed down orally from one generation to the next.

2.1 Māori Oratory of Geothermal Origins

Māori conceive the arrival of geothermal waters, heat and energy as being quite separate in time from the creation of the land. There is acceptance amongst Māori historians, especially those that whakapapa (are related) to the story's descendants, whenua and taonga, that the origin of geothermal activity in the volcanic plateau is from Ngātoroirangi and his sisters, Kuiwai and Haungaroa, and the goddesses Te Pupu and Te Hoata.

According to the late tohunga whakairo (master carver) and historian Te Keepa (Marsh et al, 2003), geothermal origins are credited to Te Pupu and Te Hoata who bought "fire to the shores of these islands":

"It was because of the great Ariki (high chief) and Tohunga (skilled expert) of the Arawa canoe, Ngātoroirangi, that the volcanic fire arrived here on these shores, forming the many geysers, hot springs and boiling mud pools that are found in this area. When the Arawa canoe made landing at a beach near the outlet of the Tarawera River called Te Kopu a Kuku, Ngātoroirangi disembarked and started on his journey inland to Taupo. Gazing upward, Ngātoroirangi longed to ascend the virgin peak and so he spoke to his companions, "You will all remain here while I and Ngāuruhoe climb to the top of that mountain. You will know when I have reached the top for you will see my tohu (proof) which will be lightning, thunder and rain, then you will know that the mana (prestige) of the mountain has come under my authority".

Ngātoroirangi knew the great mana of the mountain, and the elements that surrounded him. Those beings were (frost), Hukapapa (ice), Hukarere (snow), and Hautonga (cold south winds). His mission was to ensure the survival of his people and their food sources that were bought from a warm climatic homeland. The new land revealed great challenges ahead. It was then that Ngātoroirangi instructed his followers, "After I leave do not eat until I have climbed to the peak of the first of those mountains, for this will give me strength and the Gods will be with me. If I do not climb, the power of the mountains ice will increase and the cold will rule over all mankind, hence all will die. But if I succeed man and food will flourish, and when I return, we will eat together and I shall share what I have learnt from that mountain."

As they climbed, the elements slowly but surely took hold, biting into their hands and feet, freezing their faces and blurring their view. It was here, his companions became restless and spoke amongst themselves, "Why have we not seen the tohu of Ngātoroirangi's yet?", one asked. Another said, "Maybe he is dead, lets eat for we have waited a long time". At this time on the peak of (Mt.) Tongariro, the cold pierced through Ngātoroirangi's heart. As he fell into the snow, looking upwards and facing towards Hawaīki, he cried to his sisters Kuiwai and Haungaroa to send fire to warm him for death was near. In agony he said "Ka riro rau i te tonga".

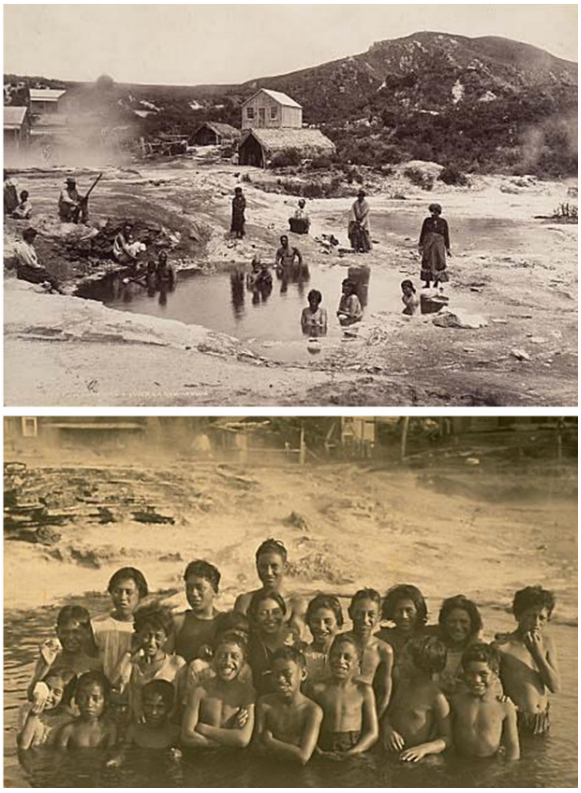


Figure 2: Images of Whakarewaarewa, circa. 1860.

On hearing, feeling and sensing their brother's (Ngātoroirangi) anguish, Kuiwai and Haungaroa ran from their village in Hawaīki to the beach of Tātaiwhenuakura and called on Te Pupu and Te Hoata, the subterranean goddesses of fire, to help and assist their brother in the land of Aotearoa. Te Pupu and Te Hoata knowing that time was of the essence plunged into the waters of Kiwa, beneath the crust of the seabed, heating the ocean floor. At great speed they made their way to Aotearoa. Traveling over three thousand miles under the seabed, raising their heads, they burst through the surface at a place called "Whacker", White Island. The earth burst into flames as they emerged through the crust, leaving the great flaming fire, the volcano, Te Ahi Tupua. Here they rested awhile from their journey. Then they ploughed once more into the earth's crust, into the ocean floor and emerged at a place called "Moutohorā", Whale Island, just off the east coast of Whakatane, leaving waiwera (hot water).

They then traveled to Okakaru, near Mount Putauakī, then on to Rotoma, Rotoehu, Rotoiti, resting for a short while at "Tikitere", Hells Gate, then on to Rotorua. Here the sisters separated, one going to Mokoia, Ohinemutu and to Kuirau. The other went to Waikawa, Ngāpuna, Tarawera and Rotomahana. Finding that their brother was not at any of these places they converged on Whakarewarewa, and rested on a hill called "Te Puke a Te Ruahine" in the thermal valley. Whilst regaining their strength every breath inhaled and exhaled they gradually formed the many pūia, geysers, ngāwha, hot springs, waiparu, mud pools which are exclusive to this region. Onwards the sisters journeyed, to Waiotāpu, Reporoa, Orakei korako, Paeroa, Taupo and Tankan. Sensing their destination was near, they surged through the base of the mountain emerging through the peak of (Mt.) Tongariro, beneath 'his' feet, saving Ngātoroirangi's life - giving life to Ngātoroirangi's frozen body, warming his blood and restoring him back to health.

(Mt.) Tongariro, received his name when Ngātoroirangi had told his sisters that he was being carried off by the southerly cold winds, “Ka riro au i te tonga”. The name “waiariki” came to be because it had taken an Ariki like Ngātoroirangi to call for fire and heat to be sent. That is why the people of that area called it “Waiariki” not waiwera (hot water). Te Pupu and Te Hoata emerging at Whacker, and whilst having a well-deserved rest, a large mass of energy, born by them caused volcanic ash, molten lava and gases. At Whakarewarewa, inhaling and exhaling, geysers and many hot pools were created, making it possible today for people to visit and take in the wonderful geothermal landscape.”

2.2 Ongoing Connectedness with Geothermal

With the 19th century move from up to townships, oral traditions continue to inform current and future generations about the geothermal and volcanic activity, and creates an aura of importance about these treasures so they are respected and protected into the future.

To this day, Māori have retained much of the customs, beliefs and practices (tikanga) of their ancestors, including a belief in the intrinsic value of the geothermal taonga. Some of these are detailed below (Bradshaw and Ions, 2004).

Kaitiakitanga is guardianship, protection and preservation. Just as Kuiwai and Haungaroa were the guardians of Te Pupu and Te Hoata, the Whakarewarewa guides are the kaitiaki (guardians) of knowledge and information pertaining to the histories and traditions. All of the staff in the geothermal tourism industry are guardians of the geothermal area. This includes those involved in guiding, marketing, administrating, retailing or maintaining geothermal products, and those who are hosts to visitors or simply live in the thermal area. The people take care to protect the environment and habitat, provide service and hospitality, build positive relationships between networks in the local, national and international communities, and spread information to a wide audience via traditional and modern technology.

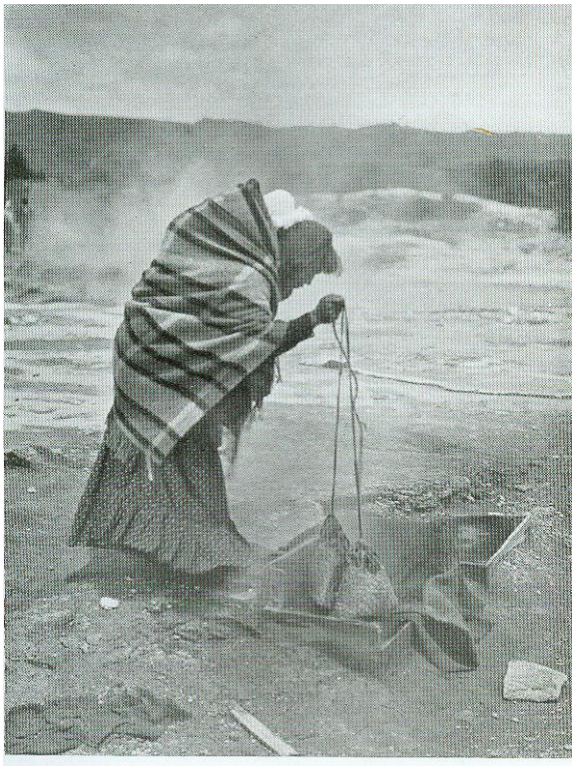


Figure 3: Whakarewarewa, circa. 1860.



Figure 4: Whakarewarewa thermal area in 2009, with the village (centre right), Pohutu geyser (left). Photo: Brad Scott (GNS).

Manākitanga is hospitality, kindness-of-heart, generosity, warmth and caring. Pupu and Hoata traveled, and came in search of Ngātoroirangi with the intent to help, assist and bring forth the heat and warmth. Manāki means to express love and hospitality toward people. The most important attributes are for the hosts to provide an abundance of food, a place to rest, and to speak nicely to visitors, so that peace prevails during the gathering. If these principles are implemented a hui (meeting) will more likely be a memorable occasion.

Whenua is the land, placenta and its significance. The land (whenua) reveals the quality of the kaitiakitanga (guardianship) by supplying the natural resources, such as geysers, hot springs and mud pools, and habitat. Through the eyes of Māori, the geothermal valley expresses arohatanga (love) by maintaining the oranga (wellbeing) of its people within this environment. It is said that arohatanga dwells within the thermal valley, and its essence can be captured when fauna, flora and geothermal activity coexist in the natural environment, and provide natural medicines. An example is Pohutu Geyser, which 'plays', whilst vegetation grows around it and Puarenga (stream) flows. Hot springs provide cooking (Figure 3) and bathing facilities, heat and warmth therapy. Mud pools provide healing through their therapeutic elements.

3. WHAKAREWAREWA THERMAL AREA

3.1 Regional Geology

Whakarewarewa Village (Figure 4) is situated in the Whakarewarewa thermal area, which is part of the Rotorua Geothermal Field. Rotorua City lies at the southern edge of the Rotorua Caldera, a ~15 km diameter, near circular volcanic centre (Figure 5) associated with the (220-200ka) Mamaku ignimbrite eruption and caldera collapse. A series of marginal and concentric ring faults delineate the caldera. Lake Rotorua occupies part of the ring-faulted depression, and is filled with fine ash and pumice-rich lake sediments.

Several rhyolite domes, including Hamurana, Pukehangi and Pohaturoa Rhyolite Domes were extruded along the caldera margin, and may be contemporaneous with structural collapse. Intracaldera domes, including un-dated Ngongotaha formed later. Following the Mamaku eruption, another explosive event occurred from a caldera SE of Rotorua, which produced pyroclastic deposits of the Ohakuri Group (Gravely et al., 2003). It is possible that faulting during and following the Mamaku eruption triggered the Ohakuri event.

The Rotorua Geothermal Field covers a surface area of ~12 km^2 (Wood, 1992), but extends to 20-28 km^2 at 500 m depth (Bibby et al., 1992). The surface area of geothermal activity has varied over time, as evidenced by hydrothermally altered rock and sinter on the northern side of Pukehangi and in the Utuhina Valley (deposited between 50-22 ka; Wood, 1992). Extensive hydrothermal eruption breccias (42 ka, Lloyd, 1975; and 26.5 ka, Cody, 2003), crop out to the south and southwest of the village.

The Whakarewarewa thermal area occurs in the southern part of the Rotorua Geothermal Field, inside the margin of the Rotorua Caldera and beneath Pohaturoa rhyolite dome (Lloyd, 1975). The dominant structural fabric comprises NE-trending faults (e.g. Whakarewarewa and Pohaturoa Faults) which are probably related to emplacement of the rhyolite dome. The faults provide permeable pathways for geothermal fluids to ascend and discharge at the surface.

3.2 Surface Geothermal Activity

Whakarewarewa is renowned for its geothermal activity, particularly its geysers. Lloyd (1975) produced a detailed geological map of the Whakarewarewa area that locates more than 500 geothermal features, ranging from geysers, steam vents, boiling mud pools, effervescent and boiling springs and turbid pools (Figures 4, 6). The Whakarewarewa Village is characterised by surface features that discharge acidic (low pH) geothermal fluids in warm muddy (acid-sulphate) pools (e.g. Te Haroharo and Ngungukai), deeper derived alkali-chloride thermal waters in near-boiling springs (e.g. Parekohoru, near the main bathing area), mixed waters, steam and gas flows, and areas of steaming ground, in places associated with collapse holes.

Fluid derived from the deep primary geothermal reservoir, which has ascended directly to the surface with minimal mixing and dilution with local groundwater, steam and gases, forms springs of clear, hot (70-100 °C), neutral to alkaline (pH 6.5-8) chloride water. This water is saturated with respect to silica, so the springs typically have aprons of pale grey silica sinter. The distribution of these chloride springs is largely controlled by fault structures, and at Whakarewarewa they are concentrated at Roto-a-Tamaheke, Whakarewarewa Village, Geyser Flat, and near Waikite and Papakura geysers.

Acidic features such as mud pools and ponds of turbid water occur away from faults at raised elevation. Hydrogen sulphide (H_2S) gas, derived from the boiling of geothermal fluids (between 10–100 m below ground surface), mixes with oxidised meteoric ground water to produce acid sulphate waters that dissolve the surrounding rock and alters rock forming minerals to clays and sulphates. These processes result in the degradation of ground, forming the mud pools and collapse holes that are common at Whakarewarewa.

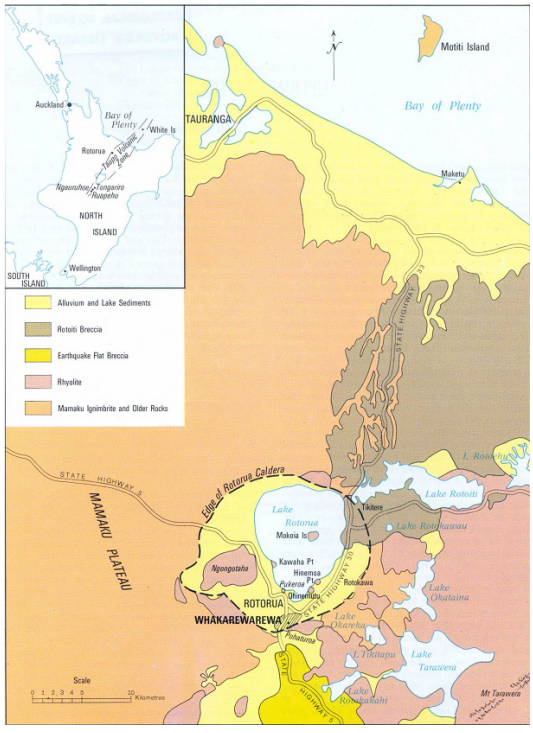


Figure 5: Geological map showing the geology of the Rotorua region, and Whakarewarewa Geothermal Field (from Lloyd, 1975).

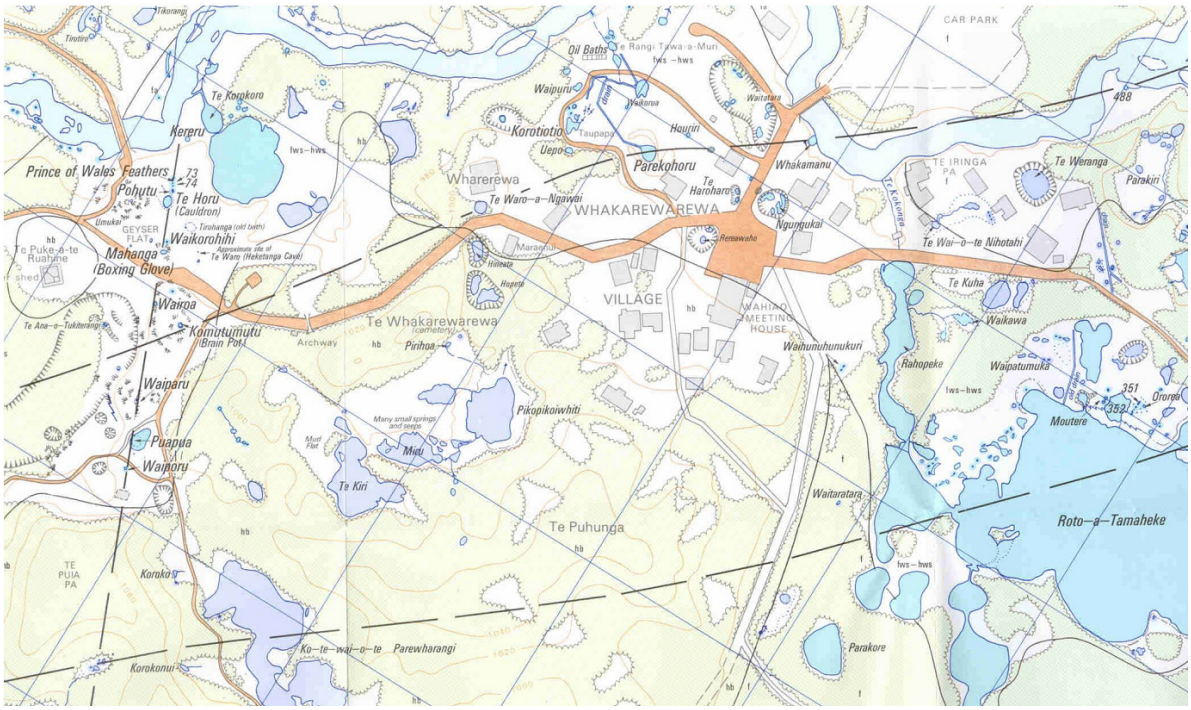


Figure 6: Whakarewarewa Village, showing the location of thermal springs, pools and faults (Lloyd, 1975).

3.3 Geothermal Fluid Chemistry

Discharging waters in the Whakarewarewa thermal area correspond to mixtures between (low pH) acid-sulphate and (near neutral) alkali-chloride waters. Table 1 shows representative water chemistry data for the six pools sampled at Whakarewarewa. In terms of normalized chloride, sulphate and bicarbonate ratios, Ngungukai, Te Haroharo, Waitāara, and Rereawhao all contain mixed acid sulphate-chloride waters. Water from Hineata pool (pH 1.67) has a close to end-member acid sulphate composition. Water from Parekohoru has an end-member alkali-chloride composition that is characteristic of an up flowing fluid, sourced from the deep geothermal reservoir. The chemical geothermometer temperature estimate of this water indicates the reservoir to have a temperature of 220-240 °C.

4. UTILISATION OF GEOTHERMAL RESOURCES

To review the historical perspective on Māori geothermal resource management, it is useful to look to the mid nineteenth century. Recorded evidence from Māori and Europeans, in the form of photographs and written documentation, show how Māori lived and used geothermal energy - not only in everyday living, but also commercial business enterprises. Since that time, Whakarewarewa village has earned a reputation for gracious hospitality, lead by the work of its internationally renowned guides, such as the late guides Maggie, Sophia and Rangi.

The sustainability of these endeavors is dependent on the continued arrival of tourists through the village, but also the sustainable management of activities within the thermal area. It wasn't until the early nineteenth century that stories by Māori chiefs or authorities were recorded and written down by the early European settlers to New Zealand.

4.1 Traditional Uses

Geothermal areas have historically been used by Māori for their curative properties, especially for skin diseases and rheumatism. Since firewood was not easily found in the central volcanic region, hot springs were also essential for cooking. Indeed, from time immemorial Māori have used thermal springs as a natural kitchen, whilst housing around the volcanic regions were deliberately built over hot springs as a form of natural central heating

Settlement patterns were determined by access to surface geothermal activity because they were essential for daily activities, such as cooking, bathing and curing ailments, in a region that was otherwise agriculturally deficient. It is unsurprising, that Māori developed a strong spiritual and cultural connection with the geothermal areas.

Table 1: Representative water chemistry data (ppm) for six springs in the Whakarewarewa geothermal area (* HCO_3 total)

Geothermal Pool	pH	Meas. T (°C)	Li	Na	K	Cs	Rb	Ca	Cl	SO_4	HCO_3*	B	SiO_2	Mg	H_2S
Ngungukai	5.77	86.3	3.2	395	37	0.33	0.30	4.5	481	229	34	4.6	323	0.65	4.2
Te Haroharo	6.54	75.6	3.7	436	43	0.37	0.35	2.4	529	181	97	5.1	317	0.17	4.8
Waitātara	2.91	83.5	3.3	385	38	0.36	0.34	6.6	463	389	<20	4.5	333	0.69	0.23
Rereawaho	5.35	53.4	3.3	394	39	0.32	0.31	3.6	467	261	<20	4.5	283	0.41	0.084
Hineata	1.67	54.9	0.05	9.9	9.8	0.09	0.12	4.9	5.7	1726	79	0.13	202	1.1	0.13
Parekohoru	9.25	95.6	4.2	462	52	0.48	0.44	1.5	580	75	148	5.7	405	0.02	20

5. FUTURE GEOTHERMAL INNOVATION AND USE

In recent years, it has become clear that the Rotorua geothermal system has struggled to meet demands imposed on it by private and commercial (bore) users. These demands have had an adverse effect, both on the surface thermal features, and on the management of the reservoir. Scientific assessments indicate the supply of hot thermal water to the Rotorua Geothermal Field is not unlimited, and close controls on allocation will in future be necessary to maintain the thermal aquifer. If not, new developments may put surface geothermal features at risk of irreparable damage.

Past development initiatives in the Rotorua area have involved activities that have impacted, or even destroyed, the geothermal features. Even small-scale activities, undertaken over long periods of time, can be damaging to the resource. For example, Queen Elizabeth Hospital extracted ~15 m3 mud from Tianakore (near boiling mud pool) from the Arikikapakapa golf course over a ten year period for balneological treatments, but ultimately damaged the mud cones and surrounding thermal vegetation.

As a result of the New Zealand Resource Management Act (1991), regional councils are now responsible for the management of geothermal resources in their administrative area. Environment Bay of Plenty (EBoP) has developed a regional geothermal plan, in response to the possibility of damage to natural thermal features in the Rotorua Geothermal Field as a consequence of development. The geothermal system is important to Rotorua City and its people, in terms of economic health and growth, recreational activity, history, prestige and culture, potential energy generation and scientific value.

The unique nature of the Rotorua Geothermal Field is under threat from possible inappropriate over-development, and corresponding negative impact on surface thermal activity. There are two underlining issues: (1) geothermal health and safety (visitor safety is a high priority); and (2) cultural and commercial issues, which will dictate the sustainability and future level of tourism and field development.

The retention of cultural heritage for Māori is linked to geothermal resource sustainability, and is a priority for residents of Whakarewarewa Village and the wider community. The loss of thermal features at Whakarewarewa, resulting from unsustainable geothermal resource development would be an unacceptable price. It would extinguish a whakapapa that has existed for >500 years, and impact the way of life for generations of Tuhourangi / Ngāti Wāhiao. From a tourism perspective, the loss of the field would have a devastating effect on the social structure and economy of Rotorua, and New Zealand's "brand image".

Future resource utilisation at Whakarewarewa must be consistent with the Whakarewarewa Village Charitable Trusts' (and Whakarewarewa residents') long-term aspirations (e.g. increasing tourism and related development initiatives), and custodial responsibility. Ongoing scientific investigations at Whakarewarewa are aimed to provide a starting point to establish business opportunities, and identify what technologies and support needs to develop new commercial initiatives in the Whakarewarewa Village.

Over time, the extraction demand on the geothermal resource at Whakarewarewa has had a significant adverse effect on its surface features (particularly the geysers). If fluid extraction is not controlled at sustainable levels, there is a real risk that the remaining surface manifestations may be lost. The Whakarewarewa thermal area supports a number of tourism activities, with operators keen to diversify their commercial interests and partnerships beyond the current capacity of the area. The successful diversification of Whakarewarewa's economic base requires a greater level of investigation to reduce development risk and mitigate hazards. The presence of a resource capable of supporting a range of commercial operations has given the Trust confidence in utilizing the geothermal resource. However, commercial decisions are hampered by a lack of knowledge of the thermal reservoir, and the effect resource use might have on surface features.

6. CONCLUSIONS

Despite the devastating impact on Māori of past colonisation, that alienated many Māori from their whenua (land) and taonga (treasures), there is a resilience and tenacity of present day Māori to connect with the values and spirituality that their ancestors associated with geothermal taonga. There is a commitment too, to ensure any geothermal developments are sustainable, and that the integrity of the geothermal taonga remains and lives on for future generations. At Whakarewarewa, residents over the decades have witnessed an evolution in geothermal and cultural tourism, now encompassing 200 years of traditional knowledge, guiding and innovation, and have developed guidelines to ensure sustainable energy resource and economic development opportunities will continue to flourish in the future.

ACKNOWLEDGEMENTS

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MĀORI GLOSSARY OF TERMS

Aotearoa - Common Māori name for New Zealand

Ariki - High chief

Arohatanga - Love, compassion

Arawa - Māori iwi (tribe) in the Bay of Plenty

Atua - God, deity, supernatural being

Awa - River or stream

Hapū - Sub-tribe, organised kin group, extended families

Hautonga- Colds South winds

Hui - Meeting - gathering, place for discussions

Hukapapa – Ice

Hukarere - Snow

Iwi - Tribe, people, large socio-political grouping

Kai - Food

Kāinga -Village, settlement

Kāitiakitanga - Guardianship of the environment

Karakia - Prayer

Kiwa - Ocean

Koha - Gift, offering

Māna - Prestige, authority, status

Manākitanga Acts of giving, generosity, kindness

Māori - Indigenous people of New Zealand

Maunga – Mountain, sacred peak, high point

Marae - Māori social centre, ancestral site

Mātauranga Māori knowledge, traditional knowledge

Mauri - A life force, life principle, internal element

Oranga - Health

Pā - Fortified settlement

Papatūānuku - The earth mother

Puke Hill - ridge, high point

Rangatira - Chief

Tangata whenua - People of the land, or people from the land,

Taonga - Treasured or precious, highly valued

Tipuna - Ancestor

Tohu – Proof of acknowledgement

Tikanga - Customary values and practices

Tohunga Whakairo - Expert carving in wood or story telling

Wai Ariki – Water of the Gods

Waiwera – Hot water

Wairua - Spiritual dimension, spiritual qualities

Waiata - Song

Whānau - Family, birth, extended family, relationships

Whakapapa - Genealogy, ancestral lineage

Whare -House

Whakatauaki - Proverb, saying

Whenua - Land, placenta, afterbirth