Waikato Regional Council Technical Report 2012/07

2010 interpretation of geochemical data (REGEMP II) and recommendations for further monitoring

www.waikatoregion.govt.nz
ISSN 2230-4355 (Print)
ISSN 2230-4363 (Online)

Waikato
REGIONAL COUNCIL
Te Kaunihera ā Rohe o Waikato

Prepared by:
J.G. Webster-Brown & K.L. Brown (GEOKEM)

For:
Waikato Regional Council
Private Bag 3038
Waikato Mail Centre
HAMILTON 3240

April 2012

Document #: 1739611

Approved for release by:
Ed Brown   Date April 2012

Disclaimer

This technical report has been prepared for the use of Waikato Regional Council as a reference document and as such does not constitute Council's policy.

Council requests that if excerpts or inferences are drawn from this document for further use by individuals or organisations, due care should be taken to ensure that the appropriate context has been preserved, and is accurately reflected and referenced in any subsequent spoken or written communication.

While Waikato Regional Council has exercised all reasonable skill and care in controlling the contents of this report, Council accepts no liability in contract, tort or otherwise, for any loss, damage, injury or expense (whether direct, indirect or consequential) arising out of the provision of this information or its use by you or any other party.

2010 Interpretation of Geochemical Data (REGEMP II)

and Recommendations for Further Monitoring

Commissioned by

Waikato Regional Council

April 2012

P.O. Box 30125
St Martins
Christchurch, 8246, NZ
jenny@geokem.co.nz

Project:	2010 Interpretation of Geochemical Data (REGEMP II) and Recommendations for Further Monitoring (updating 2008 REGEMP II report with 2009 monitoring data)
Status:	Final Report
Prepared for:	Waikato Regional Council P.O. Box 4010 Hamilton East
Prepared by	J.G. Webster-Brown & K.L. Brown
Date	April 2012

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This report updates the previous assessment made of monitoring data collected from geothermal features in the Waikato Region (Webster-Brown and Brown, 2008). The objectives of this monitoring programme are:

- To understand the nature and vulnerability of the region's warm water resources to change, in order to sustainably manage these resources

- To determine likely changes in the environmental impacts of these features/systems

The 2008 assessment had been based on monitoring data collected in 2005/06, as well as previous data reported in Huser & Jenkinson (1996), and data for features in Tongariro National Park and Tokaanu made available from the GEONET program administered by GNS Science.

In this report, the assessment has now been updated to include:

- 2009 monitoring data for the fluids of 39 geothermal features, analysed for parameters of geothermal relevance

- Spatial and temporal trends in the monitoring data to date

- Interpretation of historic gas data for selected fumaroles and geothermal wells

- A comment on arsenic speciation research undertaken at the University of Surrey, and whether speciation analysis should be incorporated into the monitoring programme

- Recommendations for future monitoring and for incorporation of historic fluid geochemistry data into the monitoring dataset.

Fluid geochemistry

Element correlations have been identified in the updated dataset, using Li as a conservative tracer of the deep geothermal reservoir fluids. From these correlations, elemental indicators of the presence of deep seated geothermal fluids (Li and well correlated elements), steam-heated waters (SO_4, NH_4 and S_{TOT}) and groundwater (Mg) input were derived, to aid in the interpretation of spatial and temporal trends.

The addition of the 2009 monitoring data did not markedly change the 2008 spatial analysis. Geochemical differences across the region were consistent with the presence of high temperature, deep seated geothermal fluid systems in the mid-region Taupo Volcanic Zone (TVZ), low temperature systems in the North, and more steam-heated systems further South at Tongariro National

Park (TNP). Te Aroha, and Tokaanu and a number of high temperature features in the TVZ again stand out as having unusual geochemistry.

Temporal changes were assessed for those features for which 2009 data had been collected. No significant trends, that could herald a change in the level of geothermal activity or output of geothermal contaminants to the environment, were noted, except for the Te Aroha site. This site has apparently experienced an increase in temperature and significant drop in bicarbonate concentration. As this is a regularly discharged bore, the changes may be due to it being sampled at a different stage in its discharge schedule, or to a change in its use. Care should be taken to ensure consistency in sampling times in relation to its discharge cycle, and to determine any change in use
.
Minor changes in chemistry were noted for some features, but ongoing monitoring is required to determine if these are consistent trends or aberrations. Some significant temperature decreases were reported in the 2009 data, but in the absence of associated geochemical changes, this appears likely to reflect a change in sampling point; to a site further away from the upwelling zone for high temperature fluids. Continued monitoring is recommended for all features.

No analysis of stable isotope relationships was undertaken as this data has not been updated for 2009. Silica and cation geothermometers were also not recalculated for the 2009 data, given the problems with their application to low temperature surface features indentified in the 2008 report.

A great deal of historic data for fluid geochemistry (for >1200 samples) had been made available, and incorporated into the Appendix I datasheet. Recommendations for refining and correcting these data so that they can be used as part of this monitoring programme have been made.

Gas geochemistry

Historic geothermal gas analyses, compiled from previously reported results for the major geothermal fields, were assessed to determine whether further monitoring of geothermal gases would be useful for this monitoring programme. While this type of data may be interesting for assessing geothermal reservoir characteristics, the use of such gas data for assessing changes in geothermal features or their effect on the environment is doubtful.

Recommendations

A number of recommendations have been made to optimize the surface features monitoring programme, focus on the objectives, and reduce the expense and effort required in the longer term (Section 8.0).

1 INTRODUCTION

The purpose of the Regional Geothermal Geochemistry Monitoring Programme (REGEMP) is to collate and interpret a representative range of geochemical analyses from surface geothermal features (fluids and gases) from the Waikato Region. Interpretation includes a spatial and temporal analysis, to identify any changes that may be occurring in these features. The purpose of regular review of the programme is to identify trends, and to update recommendations on the frequency of sampling and analysis, features to be sampled, chemical species to be analysed and sampling and analysis methods to be used, in order to create a more focussed, effective monitoring programme.

In May 2010, GEOKEM was asked to provide an updated assessment of the REGEMP II report (Webster-Brown and Brown, 2008). In 2008, all previous REGEMP data (mainly from 1993/94 and 2005/2006) and additional available monitoring data had been compiled into an internally consistent dataset of ca. 290 sample analyses (Appendix 1 of the 2008 REGEMP II report). Irrelevant and incorrect data and sites had been excluded, and this dataset served as the basis for spatial and temporal analysis, and recommendations for rationalising and focussing the monitoring programme.

1.1 Technical brief

In May 2010 GEOKEM was asked to:

- Examine and interpret the sampling results of the 2009 monitoring programme (a further 42 sample analyses), in the context of previous monitoring results.

- Examine and interpret historic data, including data for fluid geochemistry which had been incorporated into REGEMP II database (an additional ca.1230 sample analyses), and for fumaroles and reservoir gas geochemistry (ca. 280 sample analyses). A request was made to also identify any other sources of relevant geochemical analyses, that could provide historic data for inclusion.

- Comment on any unusual results, geographical or temporal trends, and correlations between different chemical species.

- Make recommendations regarding the ongoing acquisition of monitoring data, and on the design of the monitoring programme, including the frequency of sampling and analysis, features to be sampled, chemical species to be analysed and sampling and analysis methods used.

The information provided by Waikato Regional Council for this assessment included;

- A MS excel spreadsheet with 2009 fluid geochemistry monitoring results

- A revised version of the original 2008 REGEMP II Appendix I dataset as a MS Excel spreadsheet including the historic fluid geochemistry data

- A MS Excel spreadsheet of historic gas geochemistry data

- A MS Word document of a postgraduate dissertation study of "Arsenic speciation Analysis of Geothermal waters in New Zealand" (Lord, 2009).

1.2 2009 fluid geochemical monitoring data

The recommendations made for monitoring in the 2008 REGEMP II report had largely been adopted for the 2009 monitoring programme, so these data can be readily incorporated into spatial and temporal trend assessments (refer Sections 4 & 5).

At some sites multiple samples have been collected (e.g., Waiotapu), rather than focussing on a single sample or a single (representative) feature as recommended, and out of catchment sites have been included (Hells Gate at Tikitere). However, we understand that this was in part to support an associated study of arsenic speciation in these geothermal features (Lord, 2009). This study provides more comprehensive information on arsenic speciation (as inorganic As^{III} or As^{V}, or as organic As complexes) and the possible value of including such determinations as part of future monitoring has been assessed.

1.3 Historic data for fluid geochemistry

When received by GEOKEM, the 2008 REGEMP II Appendix I dataset spreadsheet had expanded from 290 to 1500 sample analyses, through the addition of historic data. Not all of these data were relevant to the REGEMP study for a variety of reasons.

Ultimately it was decided to re-evaluate the historic data and incorporate appropriate data, as a separate exercise after completion of this report. A set of guidelines for inclusion of historical data into the main monitoring dataset has been provided in the recommendations (Section 8.0) of this report.

1.4 Historic data for gas geochemistry

Gas geochemistry for fumaroles and for deep geothermal well gases had been compiled for consideration as part of the monitoring programme. For some (inert) gases, deep geothermal well gas data can be usefully compared with fumarole emissions.

The data provided include an initial small monitoring dataset for 1993/94 (34 sample analyses), augmented by historic data collected and reported prior to 1992 (a further ca. 240 sample analyses). The data do not include 2009 monitoring data. Many are repeat analysis on a single feature over a short time period; e.g. for 2 Hipaua bores over 1996-1998 (58 sample analyses) and Wairakei bores (80 sample analyses). There is some confusion in the reporting of concentration units, but this has been largely addressed based on our experience of what these analyses should look like. There is enough data here to make a preliminary assessment of what could be gained by using gas geochemistry data as a monitoring tool.

1.5 Changes relative to the REGEMP II report format

The two dimensional spatial analysis undertaken in the 2008 report (Section 3.1.2) has not been repeated due to the bias that it had shown towards sites of high concentrations, and the fact that contours reflected sampling locations rather than any useful spatial distribution of parameter concentrations. Instead only the one dimensional spatial analysis, along a N-S trend, has been undertaken as this was considered to provide more useful information in REGEMP II.

The interpretation of stable isotope data (Section 5 of the 2008 report) has not been reproduced and updated here, as there is no new data to hand. The calculation of geochemical thermometers (Section 6 of the 2008 report) has not been repeated. The 2008 geothermometry was subject to significant uncertainties. Because of the relatively low temperatures of the surface features, the equilibrium conditions that are assumed in the Na-K, Na-K-Ca and SiO_2 geothermometers may not exist. Also, chemical reactions may occur in the near surface environment that affect the concentrations of Na, K, Ca and SiO_2 so that they do not reflect deep fluid conditions. The precipitation of SiO_2 as silica sinters around hot springs, for example, the precipitation of Ca as calcite, and the reaction of Na and K with feldspars. The latter reaction is kinetically very slow, however, so the Na-K geothermometer is the better option for application in surface geothermal features.

Given the uncertainties of applying these geothermometers, there appeared to be little to be gained by repeating the exercise under the same circumstances but with the inclusion of the 2009 data. However, this should not preclude future use of, (particularly Na-K) geothermometers to estimate reservoir temperatures when a significant body of new data has been collected.

2 DATA COMPILATION AND ASSUMPTIONS

The recently collected 2009 monitoring data have been entered into the original dataset compiled for the 2008 report (Appendix I), subject to the same assumptions and data manipulation as undertaken with the 2008 data. The updated dataset is reproduced as Appendix I of this report. The following specific allowances have been made for the 2009 data;

- Data identified as “Si R” appeared to actually be entered as SiO_2, so this was not changed for entry into the Appendix I spreadsheet

- $Al_{(diss)}$ data has not been included in the Appendix I spreadsheet as aluminium is not a reliable geothermal activity indicator

- ALK (alkalinity) has not been entered into the Appendix I spreadsheet as this is a combined parameter, of which the principal component is usually HCO_3. HCO_3 has been entered as a separate parameter.

- Conductivity data has not been included in Appendix I. Although a very useful *in situ* indicator of general chemical conditions, with the more detailed analysis undertaken here (e.g. for Na and Cl) this parameter does not need to be included in the trend analysis (but should be retained in the monitoring programme).

As in 2008, for the purposes of plotting data it has been assumed that <DL values (<detection limit) are =DL. While this leads to some ambiguity when it comes to analytes for which DL has changed with time or the methods used (e.g., for H_2S, Cs, Rb, As etc.), it is an accepted approach for plotting such data. Data which was consistently below detection limits (e.g., for Tl) has not been included in the trend analysis.

A second spreadsheet has been compiled for just those sites chosen for monitoring in 2009, and is included as Appendix II of this report.

The spreadsheet containing gas geochemistry data from fumaroles and some deep geothermal wells, as compiled by Waikato Regional Council, has been reformatted slightly to be internally consistent (units for example). However, no other changes were made to this data, which is reproduced as Appendix III of this report.

3 FLUID GEOCHEMISTRY DATA CORRELATIONS

Strongly correlated parameters can be a useful indication of the contributions of deep geothermal fluid or steam-heated waters, or of the degree of dilution by cold groundwaters (or seawater) in a geothermal feature.

Previously a correlation matrix for 2005/2006 data compiled by (and reproduced as Appendix II in the 2008 report) identified strong correlations between chemical components present in deep, high temperature geothermal reservoir fluids; Na-Cl-Li-Rb-Cs-As-Sb-B-Br-NH_4, and a weaker correlation with Si. A negative correlation was observed for Mg with all geothermal chemical components, testifying to a different source (e.g., groundwater) for Mg. Little correlation (negative or positive) was observed between components that might reflect a steam-heated water contribution (sulphide (S_{TOT}), SO_4, NH_4) and the other geochemical parameters.

In this report, incorporating the 2009 monitoring data, some of these correlations were confirmed but not all; the strong positive correlations previously reported for Cl-F, Cl-B and Li-Rb were not observed, nor the strong negative correlation between Mg and F.

3.1 Correlations in updated dataset

Table I shows correlations for some of the parameters previously identified as showing a relationship, for the full dataset including 2009 monitoring data (Appendix I of this report). However a new approach has been taken to assessing correlations – emphasising the use of Li as the best indicator of the presence of deep geothermal fluids, given its prevalence in TVZ geothermal reservoir fluids, its lack of volatility (will not separate into gas phase) and its conservative nature, which means it will remain dissolved, resisting reaction or precipitation during geothermal and surface environmental processes.

TABLE 1. Coefficients of determination (R^2 values), for data from all sampling sites except Ketetahi and Soda Springs in the Tongariro Volcanic system, as these features have some magmatic influences on the geochemistry that skew the correlations.

	R^2
Li-Cs	0.961
Li-As	0.941
Li-Sb	0.865
Li-B	0.917*
Li-Br	0.922
Li-Rb	0.617
Li-Si	0.197
Li-Temperature	0.042
Li-NH_4	0.011
Li-S	0.000
Li-SO_4	0.002
Li-Mg	0.002
Li-F	0.015
Log Li-pH	0.025
pH – log SO_4	0.326
pH – log S	0.132
Mg - Temperature	0.044
Mg - F	0.129

*When Te Aroha (a very high B system) is removed from the dataset.

The lack of correlation between pH and sulphide or between pH and SO_4, possibly reflects the variety of process (other than sulphide oxidation) that can affect and buffer pH in a geothermal feature.

Those elements showing a strong correlation with Li (Cs, As, Sb, B and Br) are also going to act as conservative indicators of the presence of deep geothermal fluids. Those that do not are either;

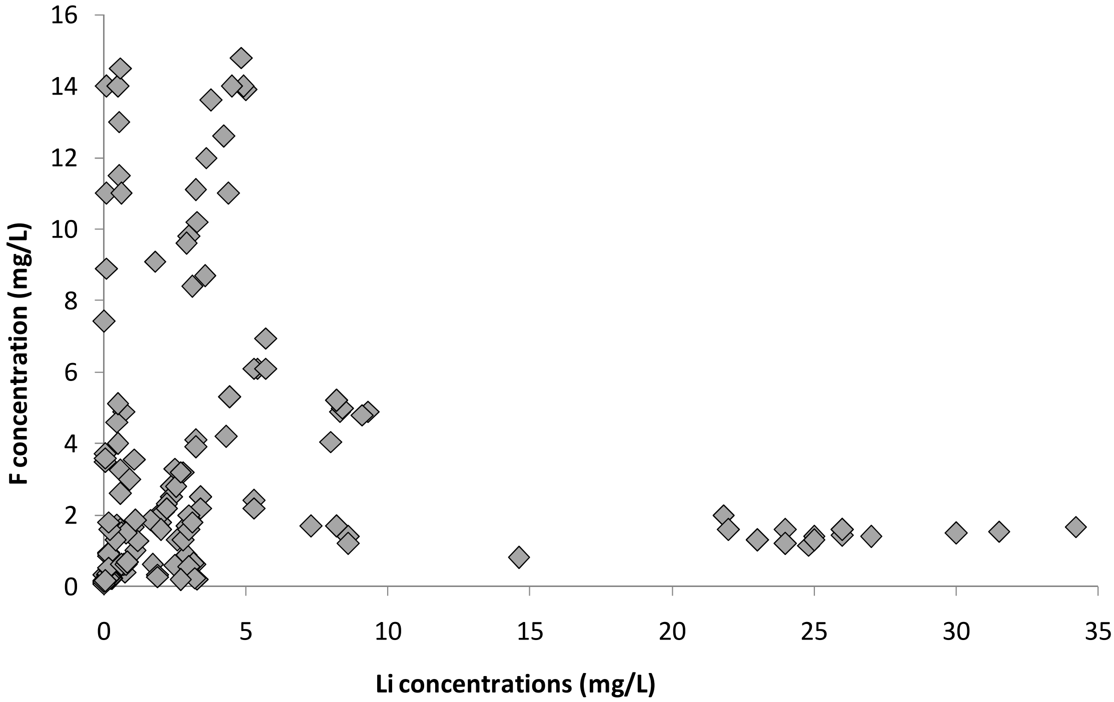
- Present in the deep geothermal fluid, but affected by chemical reactions (e.g., oxidation or precipitation) in the near surface environment. Examples include F precipitation as CaF_2, sulphide oxidation to SO_4 , and SiO_2 precipitation as silica sinter.

- Initially present in the deep geothermal fluid but separated (partially or fully) into the steam phase when the fluid boils. Examples include sulphide (as H_2S), ammonia (NH_4), SO_4 formed by sulphide oxidation processes and the low pH that occurs as a result of this reaction. These parameters can show a mutually exclusive relationship with deep fluid indicators, rather than a strong negative correlation; as observed for Li-NH_4 and Li – F (Figure 1a) and Li-SO_4 for example.

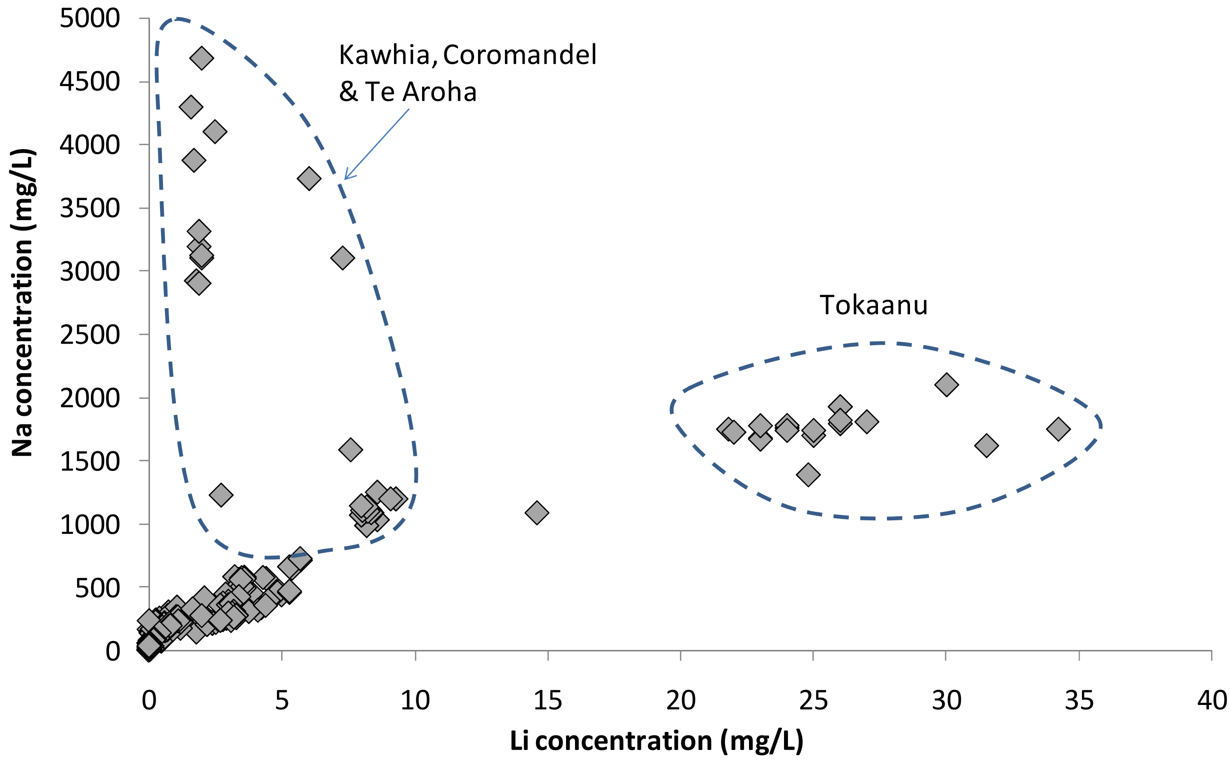
- Not present in the deep reservoir fluid, but coming from another source. Examples include elements such as Mg, and the Na and Cl that come from seawater as in the Kawhia and at Coromandel (Fig 1b). Again, these often these show a mutually exclusive relationship rather than a strong negative correlation.

FIGURE 1. a) An example of a mutually exclusive relationship, in this case between F and Li, and b) a Na - Li correlation showing the influence of seawater input to systems at Coromandel, and the atypical composition of springs at Te Aroha and Tokaanu.

a)



b)



The correlations observed here can be used in the interpretation of spatial trends and temporal trends in the following sections, by using the following associations as indicators of different fluid contributions;

- Li and strongly associated elements - deep geothermal fluid contribution
- S, SO_4, low pH, NH_4 (and high K leached from rocks during acid alteration) - steam-heated water contributions
- Mg - shallow groundwater or other meteoric water contribution
- Na and Cl - seawater (low Li) or geothermal (high Li) contributions

Specific local or regional bedrock/aquifer characteristics may also be reflected in high B or F. The previously suggested use of HCO_3 as an indicator of groundwater contribution has been reviewed. HCO_3 is one of the most variable parameters (refer Section 5) and can be affected by a variety of processes so is not a robust indicator of groundwater presence.

4 SPATIAL TRENDS IN FLUIDS GEOCHEMISTRY

For this trend analysis, all data shown in Appendix I have been included, and a summary of site specifics is shown in Table II. Note that 2009 data collected for sites that are not geothermal features (e.g., at Waiotapu) or are outside the region (e.g., Hells Gate at Tikitere) have not been included in Table I or Appendix II, and are not considered here. Also, two southern sampling sites, Silica Rapids (site 30) and Emerald Lakes (site 32) have been removed (these were previously included in REGEMP II) as they are consistently ambient temperature features.

4.1 One dimensional analysis: North to South

A North-South transect through the Waikato Region has been taken, and features labelled 1 to 32 depending where upon this transect they fall (refer Table II and Appendix I). In this way, general geochemical trends become apparent as one moves from the North (Coromandel-Hot Water Beach features) to the South (Tongariro National Park), as do the individual features with unusual geochemistry. These graphs could equally well be plotted with the Northing as the x coordinate, but this tends to group together many of the TVZ data.

The inclusion of 2009 data in the spatial analysis did not notably change the conclusions reached in the 2008 report. The plots were all very similar (Figure 2) as 2009 data did not fall outside the previous range measured.

TABLE II. Summary table for sampling sites showing the area of the region, the designated zone (1 – 33, describing a roughly N-S trend through the catchment), the time period covered by data collected, and the feature selected for monitoring in 2009.

Region	Zone	Time range covered by data	Selected feature for monitoring in 2009
North Waikato area:			
COROMANDEL	1	1973 - 2009	Hot Water Beach - Old Motor Camp Bore
KAIAUA	2	2006	
MIRANDA	3	1984-2009	Miranda Hot Pools + Kerepehi Hot Springs
NGATEA	4	2006-2009	Kerepehi Hot Spring
L. WAIKARE	5	2004-2005	
TE MAIRE (NAIKE)	6	1969-2009	Te Maire (Naike) Hot Springs
TE AROHA	7	1905-2009	Te Aroha Domain (Moke Geyser)
WAINGARO	8	1981-2009	Waingaro Hot Pool Bore
ABERFOYLE ST	8	2006	
WAITOA	8	1981-2009	Waitoa Spring
WAHAROA	9	2006-2009	Okoroire Spring (Okoroire Hotel Pool 4)
MATAMATA	10	2006	
OKAUIA	11	1981-2009	Opal (Ramaroa or Paruparu) Hot Spring
KAWHIA	12	1981-2006	
WAIKATO R	13	2005	
Taupo Volcanic Zone area:			
HOROHORO	14	1963-2009	Thermal Spring, Waipupumaha
WAIOTAPU	15	1926-2009	Champagne Pool (3 sites) + 2 other
WAIKITE	16	1992-2009	Overflow spring near HT Geyser + 3 other
ATIAMURI	17	1978-2009	Whangapoua West, Northern Pool, 3 other
REPOROA	18	1993-2009	Opaheke Spring + Thermal spring (SE)
TE KOPIA	19	1992-2005	
MOKAI	20	1978-2009	Waipapa Feature + Parekiri Pool
ORAKEIKORAKO	21	1905-2009	Map Of Australia + Manganese Pool
NGATAMARIKI	22	1960-2005	
OHAAKI	23	1994	
ROTOKAWA	24	1994-2009	RK No 4A
WAIRAKEI	50	1984-1994	
TAUPO/TAUHARA	26	1994-2009	Waipahihi Spring, Taharepa
Tong. National Park area:			
WAIHI	27	1966-2005	
TOKAANU	28	1966-2009	Taumatapuhipuhi + Takarea No 5
KETETAHI	29	1989-2007	
SILICA RAPIDS	30	2003-2007	*Removed to non-geothermal list*
SODA SPRINGS	31	2000-2007	
EMERALD LAKES	32	1983-2007	*Removed to non-geothermal list*

Systems with distinctive geochemistry

As noted in REGEMP II, the spatial distribution shows up geothermal features with distinctive geochemistries. The distinctive features include;

- The influence of seawater in the high Na and Cl (and to a lesser degree (Mg, K and SO_4) at Hot Water Beach at Coromandel and at Kawhia (no new 2009 data) where the features are near the coast.

- Te Aroha; a sodium carbonate spring system, high in Na, K, HCO_3, SO_4 and particularly B.

- Larger geothermal systems such as Waiotapu and Rotokawa which display a range of compositions from low pH, high H_2S, SO_4, NH_4 and K (and occasionally Fe) from steam heated waters, as well as Na-Cl-Si-As rich deep seated fluids.

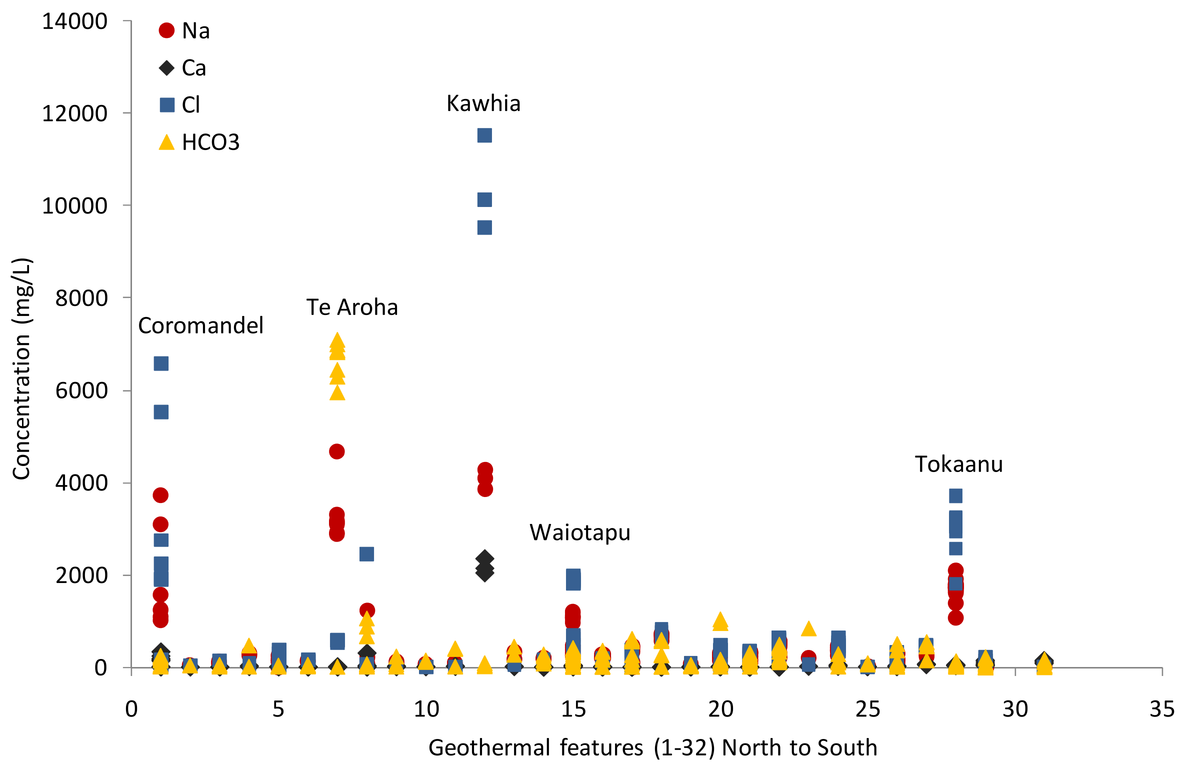
- Features outside or on the edge of the TVZ (Te Maire, Atiamuri, Orakeikorako, and Horohoro) which appear to have consistently higher F, possibly reflecting regional aquifer characteristics or bedrock geology.

- The more magmatic influence at Ketetahi and Soda Springs, with high SO_4, B, H_2S, Rb and Cs. For Cs, very high (up to 1500 mg/L) and very low (<DL) concentrations have been measured at Ketetahi and these data need to be checked. It may reflect an error in the concentration units.

- Tokaanu has high Na-Cl, Li, K and B, As, Cs, effectively a deep seated geothermal fluid assemblage.

FIGURE 2. Concentration of various key parameters as a function of site position, as numbered 1-32 from North to South through the region (refer Table II and Appendix I for data).

a)



b)

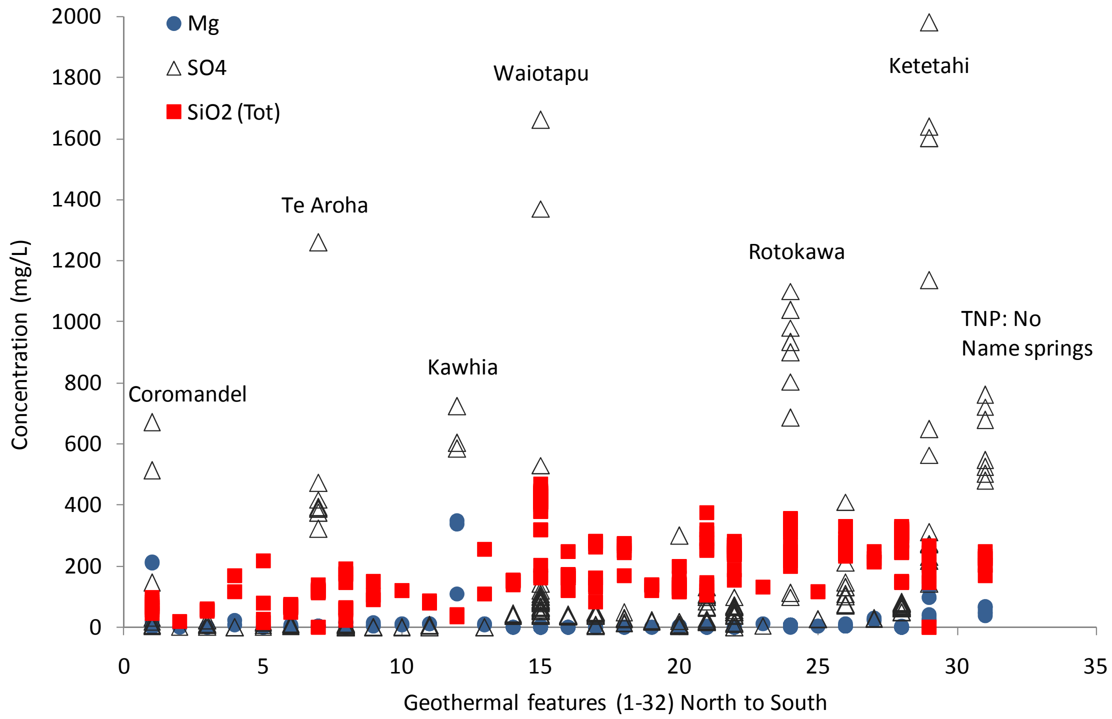
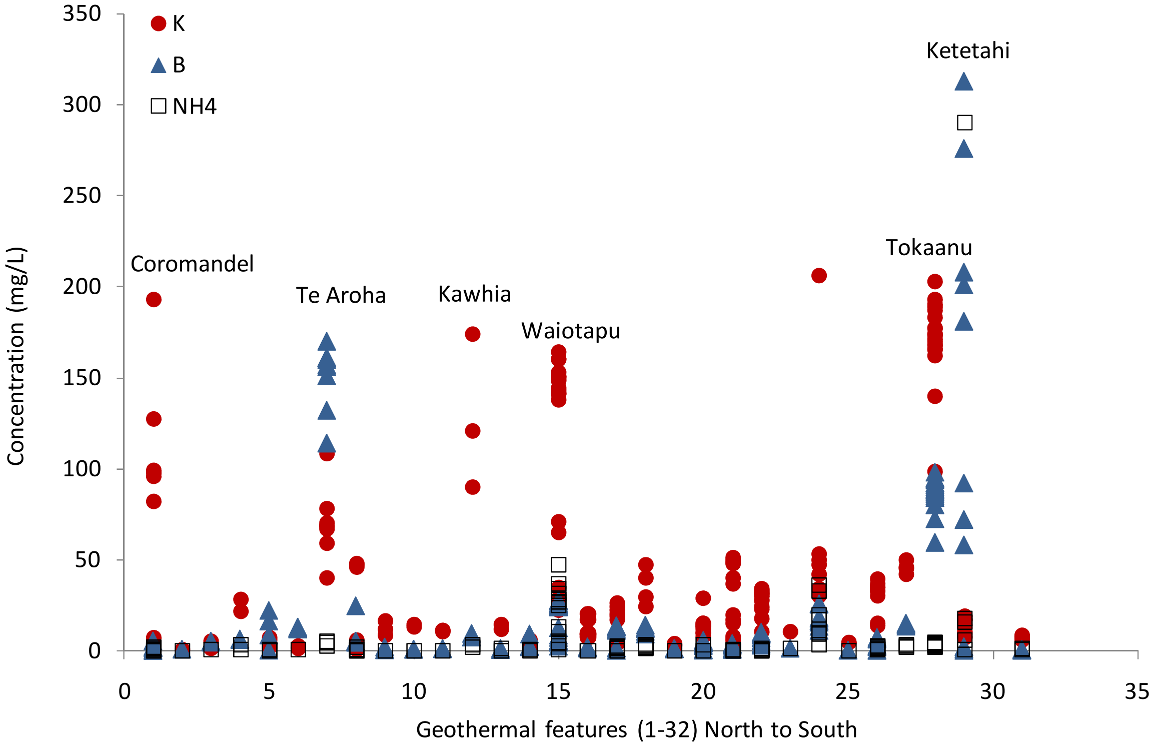


FIGURE 2 cont...

c)



d)

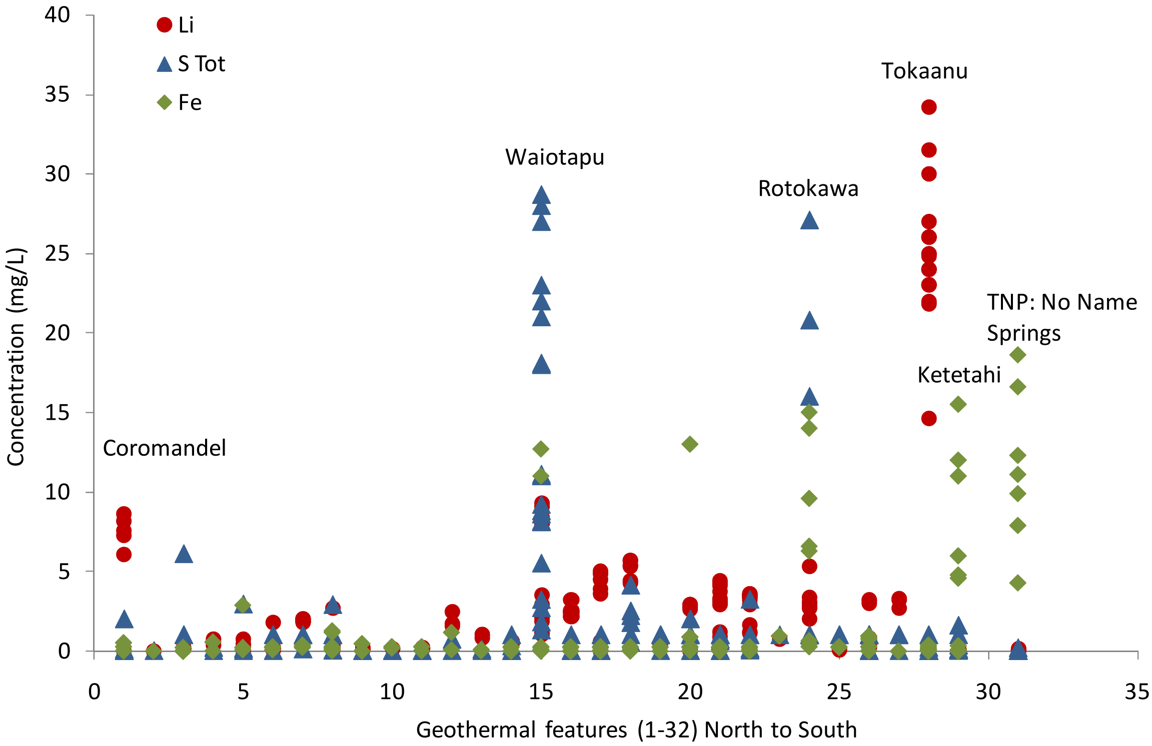
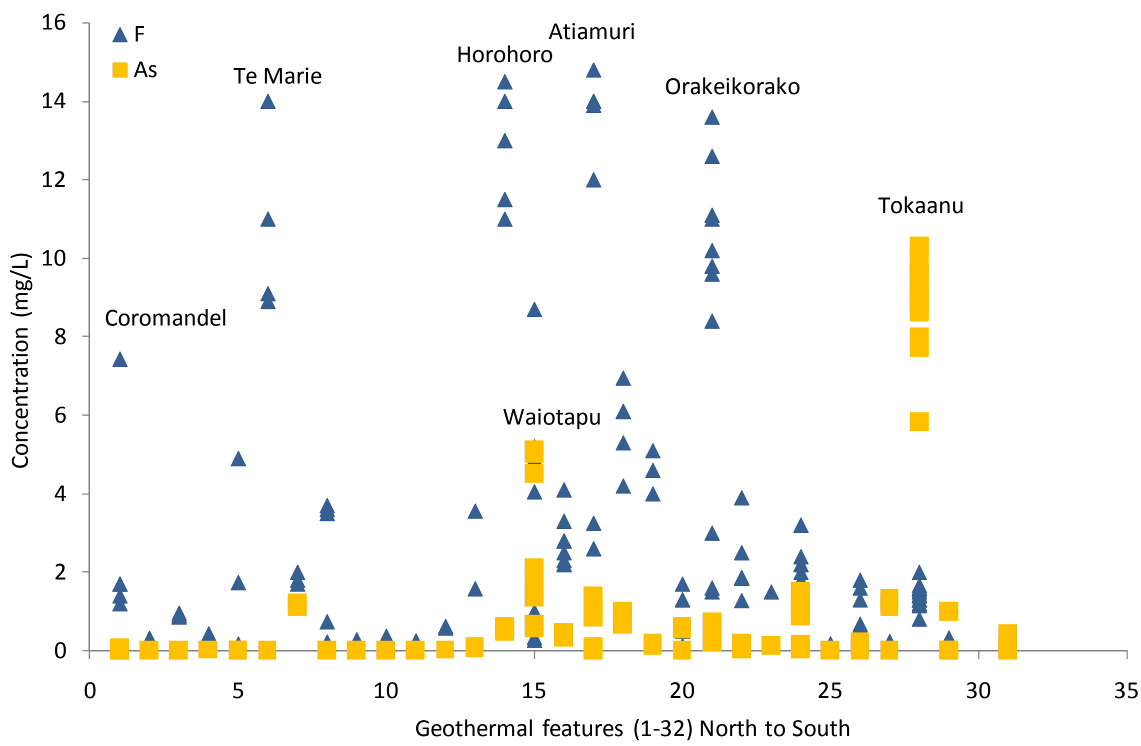
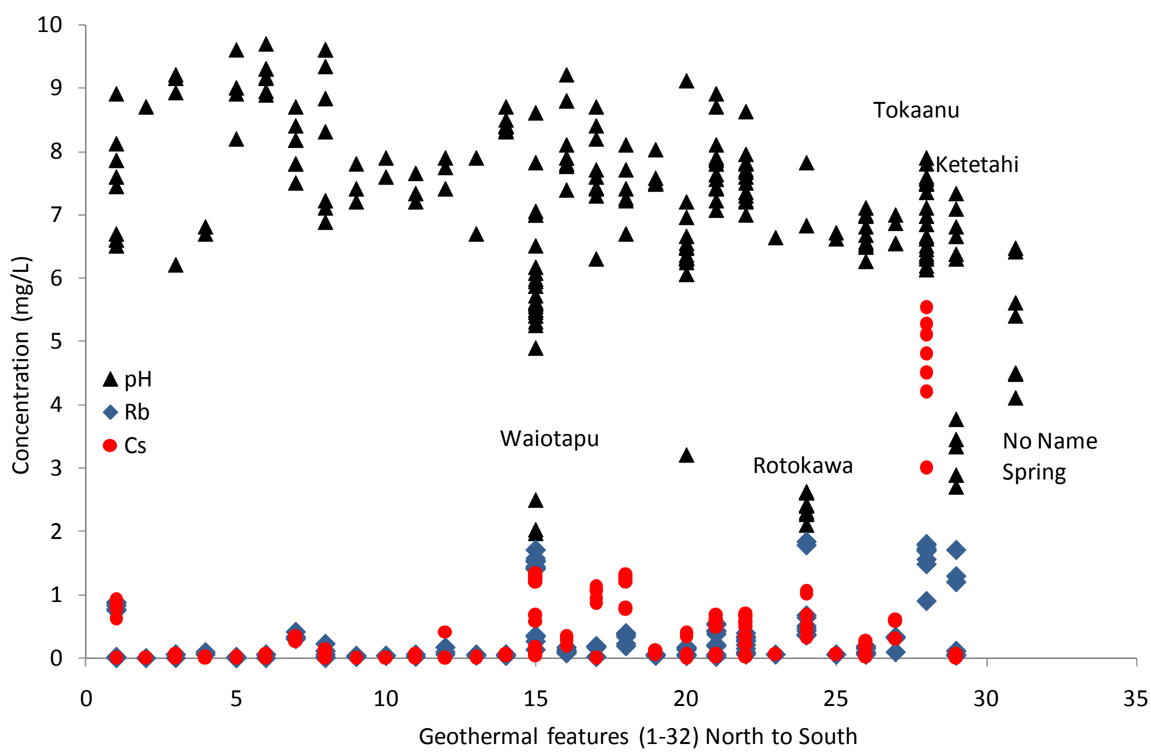


FIGURE 2 (cont...)

e)



f)



General geochemical trends North to South

Incorporating 2009 data made no discernable difference to the log plots shown in the 2008 report (Figure 2), so these plots have not been reproduced here. Plotting concentration on a log scale simply allows general trends to become more apparent, as the influence of the individual, atypical systems is diminished. Data had plotted largely within the range previously observed for each feature.

The only ions that showed a general North to South trend in the 2008 report were;

- pH, which showed gradual decrease from North to South (because pH is a log parameter, this trend is also evident on Figure 2f of this report)

- Na, Cl, HCO_3 and F which showed a decrease to the south of Lake Taupo

- Temperature, SO_4 and SiO_2 all achieved highest values in the TVZ. SiO_2 and temperature decreased in the low temperature features in TNP to the south of Lake Taupo.

- Parameters such as Li, Rb, Cs, and As showed a similar but less obvious trend to SiO_2, achieving maximum concentrations in the TVZ systems.

As noted in the 2008 report, these trends are broadly consistent with the maximum contribution of high temperature, deep seated geothermal fluids in the central part of the region (the TVZ), with low temperature systems to the North, and more steam-heated systems to the South.

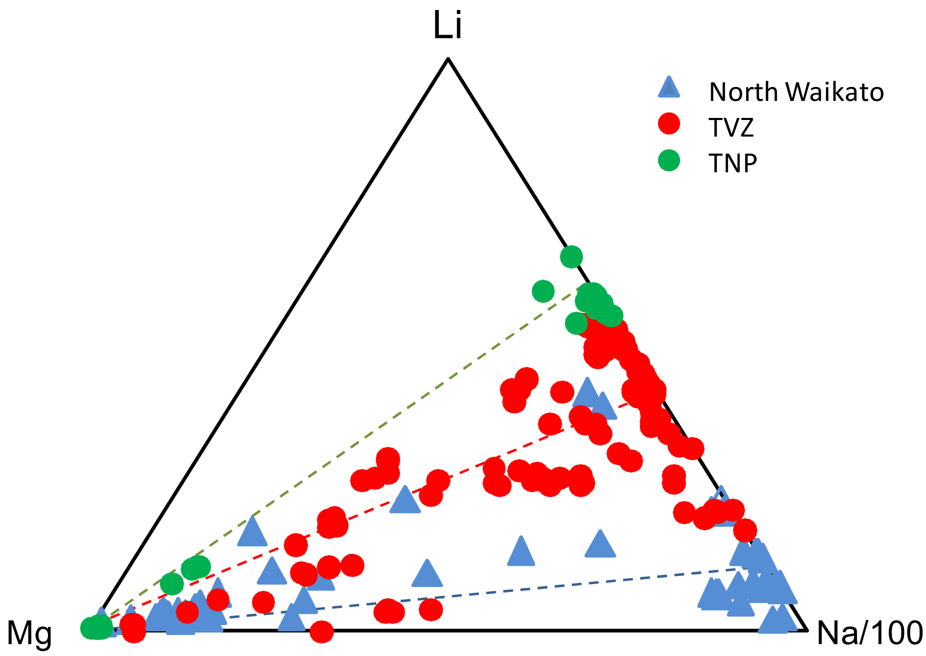
4.2 Variation in fluid geochemistry across the region

As noted previously in the 2008 report, the use of tertiary (trilinear) diagrams can help distinguish geochemical variability across the Waikato region. In the 2008 report conservative geochemical fluid ions Li-B-Cl, and Na-Li-K were used for ternary plots, and when the data were divided into the North Waikato, Taupo Volcanic Zone(TVZ) and Tongariro National Park (TNP) areas, some clear distinctions were evident. The data for the TVZ and TNP plotted along a constant Cl:B ratio, but had variable Li content, and there was also a trend in Na:Li ratio, decreasing towards the South. However, a Li-Cs-As diagram showed no obvious trends.

Given these associations were unlikely to change with the addition of the 2009 data, an alternative ternary plot has been constructed (Figure 3). The Li-Na-Mg plots identify the degree of contribution for each of the different types of source fluids. The previously identified difference in the Na:Li ratio of the 3 different areas was again evident; the ratio becoming less (higher Li) to the south (TNP). The only exceptions are the high Li springs at Hot Water Beach at Coromandel (the 3 data plotting well above the trend line drawn for the North Waikato sites on Figure 3).

The degree of groundwater dilution is represented by the spread of data towards the Mg apex. All three areas show the influence of groundwater on some of their geothermal features. At TNP this is most pronounced with very low Mg Tokaanu features plotting against the Li – Na base line, and the high Mg Ketetahi, Waihi and Soda Springs features plotting near the Mg apex. Fluids in these latter features appear to be predominantly of groundwater origin.

FIGURE 3. Trilinear plot for Li-Na-Mg showing the difference areas of the region.



5 TEMPORAL TRENDS

Not all of the sites for which previous temporal trends had been plotted in the 2008 report were included in the 2009 monitoring programme. Omitted sites include Kawhai, Te Kopia, Ngatamariki and Waihi. As the graphs given in the previous report cannot be updated, they have not been reproduced here.

However, for those that were monitored in 2009, temporal change plots are shown in Figure 4. As noted in the 2008 report, there is still some difficulty in establishing whether the same feature has been sampled throughout, and in some cases this is clearly not the case for 2009 (see comments below). From now on, with better GPS data being collected, this problem should diminish. Co-ordinates prior to 2005 were mainly estimated from maps, not measured directly. Temperature and Li data has been used in many cases to assess whether or not the same feature is being assessed.

The colour scheme on Figure 4 is designed to help visual interpretation, with data prior to 1980s represented as black or grey, through the 1980s by brown and red, through the 1990s by orange, yellow and green, and through the 2000s by cooler colours; blue and purple. A log scale has been used so that all parameters can be shown on the one figure and therefore trends for all data can be viewed at once. Where trends are apparent, data can be replotted without the log scale to examine these trends in more detail (e.g. for Champagne Pool).

Note that for all sites, recent decreases in Rb and Cs concentrations appear to be due to improved detection limits for analysis, so have not been commented upon further.

5.1 Individual features

Hot Water Beach (Coromandel) (Fig 4a)

In the middle years (1983 and 1994), data appear to be quite different from previous and more recent monitoring data, with lower Li, and much higher major ions; Na, Ca, K, Mg, Cl and SO_4 and elevated pH. In 2009 the temperature had decreased markedly: from >50°C to 20°C although ion concentrations were similar to 1973 and 1981 data when temperatures were high. The sample has previously been collected from the motorcamp bore, which is no longer discharged as the motorcamp is now closed.

Recommendation: A new well is clearly needed here, to ensure that to ensure that monitoring of this system can continue. For sampling, ensure that the well is discharged long enough to bring the water to full discharge temperature before sampling. *Miranda (Fig 4b)*

Miranda has relatively constant T, Li and pH, and concentration for most major ions. The apparent decrease in Fe concentration may be due to changes in analytical detection limits. The decrease in SO_4 and increase in S_{TOT}, however, may be significant, indicating a change in redox conditions to a more reduced state.

Recommendation: Continue measurements every 2 years

Te Maire (Naike) (Fig 4c)

Constant T, pH, Na and Cl concentrations suggest that there has been little change in conditions. Sulphide (S_{TOT}) change again appears due to a change in the detection limit for analysis. Mg and Li concentrations were high in 1969, but this may also reflect a change in analytical techniques or errors in the 1969 analysis.

Recommendation: Continue measurements every 2 years

Te Aroha (Fig 4d)

In 2009 there has been a dramatic decrease in HCO_3 (from >6000 to 18 mg/L), and increase in temperature (from 77 to 94°C). A slight increase in Ca concentration is also apparent. It is possible that this sample has been collected from a different sampling point, perhaps after degassing of the spring water. If real, and ongoing, this change could be significant. .

Recommendation: Continue measurements every 2 years, and clarify sampling site location.

Waingaro (Fig 4e)

Marginally lower temperature was measured in 2009, but this may be within natural variability. The decrease in SO_4 and Fe concentrations, accompanied by an increase in sulphide concentrations (which may also reflect improved detection limits) may indicate a shift in redox conditions for this spring.

Recommendation: Continue monitoring every 2 years.

Waitoa (Fig 4f)

Very little change of significance, though the decreased concentration of both SO_4 and sulphide may indicate a decreased steam input (but also improved detection limits in the case of S_{TOT}).

Recommendation: Continue monitoring every 2 years

Okauia (Figure 4g)

There is not yet enough data to identify trends with confidence. The 2009 monitoring data appears to indicate a decrease in SO_4, Fe and HCO_3 concentrations, but further data are needed to confirm this.

Recommendation: Continue monitoring every 2 years

Horohoro (Fig 4h)

Waipupumahana is the same "hot spring" that has been monitored at Horohoro since 1963. In this case the decreasing trends evident in Ca and Mg concentrations, as identified in the previous REGEMP II report, have continued in 2009. The changes in Ca and Mg concentrations suggest less dilution by groundwater sources. The previously identified decreasing HCO_3 concentration trend has recovered slightly in 2009. The Fe and S_{TOT} concentrations appear to be lower in 2009, though this may again reflect improved detection limits for these ions.

Recommendation: Continue monitoring every 2 years.

Waiotapu (Fig 4i & 4j)

There is a great deal of monitoring data for Champagne Pool, the principal feature of the Waiotapu area. Multiple samplings throughout 1983, 1984 and 1994 revealed little variation from month to month, so these data have been averaged to provide a mean for each of these years.

Over the monitoring period (73 yrs), most parameters measured have remained relatively constant, including those indicating the proportion of deep geothermal fluid such as Li, B, Rb, Cs and SiO_2. Temperature has been generally constant but was slightly lower in 2009 (as were As and HCO_3 concentrations) and Li concentrations were slightly increased. Only time will tell whether these are aberrations or trends.

Fig 4j shows these time trends in greater detail: showing the ratio of the concentration (in mg/L) in any particular year relative to the earliest concentrations measured in 1926. Greatest variability was shown for pH, SO_4 and S_{TOT} and NH_4; parameters which all relate to steam input, particularly through 1950s and early 1980s. There has been less variability in these parameters since the 1980s, which may also represent better control over analytical procedures. Major ions such as Na, K, Cl, Ca for which analysis at these levels is more reliable, show little variation.

The Mg & HCO_3 concentrations are not included in Fig 4j as they vary more significantly (ratios of up to 9 for both, and down to 0.1 for Mg). For Mg this may reflect the very low levels of Mg present, which leads to a high analytical error particularly in the earlier analyses. HCO_3 was elevated throughout the 1950-1990 period, but appears to be lower in the 2009 samples.

In summary, the chemistry of Champagne Pool appears to have remained remarkably consistent, showing no consistent trends with time for most major geothermal indicators. Although variation in the degree of steam input to this feature is indicated through 1950-1980s, there is no consistent trend over the longer time period to indicate a gradual increase or decline of this input.

Recommendation: Continue monitoring (from a single point in Champagne Pool) every 2 years.

Waikite *(Fig 4k)*

Manaroa/Hot Pool supply spring:
Three samples were collected from this feature in 2009, but only one of these (ID 72-4228) appear to have been collected from the same point as previous samples as the temperature (97^{o}C) is similar. The other two sampling sites (72-4227 & 72-4229) had lower temperatures (62 & 69^{o}C), but identical fluid chemistry suggesting they are outflows from the main feature. These have not been included in Fig 4K.

The decrease in S_{TOT} and Fe in 2009 is once again likely to be due to recently improved detection limits for these ions. Other than a slight decrease in both Mg and HCO_3 concentrations (a decreased groundwater input perhaps) there has been little change in Waikite fluid geochemistry to date.

Recommendation: Continue monitoring every 2 years, from the site with the highest temperature (72 4228). Do not continue monitoring on outflow sites.

HT Geyser:
Only 2 yrs of data (2005 and 2009) are available for this feature, and the 2009 sample appears to have been taken from the outflow (T = 56.4^{o}C) rather than the main feature (T=97.5^{o}C). The chemistry of the outflow appears quite different from that of the main feature, so comparison between the two datasets is not a useful indication of geothermal activity. These data have not been plotted in Fig 4K.

Recommendation: The geochemistry of this feature is not unlike that of Manuroa Springs from the same system (see above), so its inclusion in the monitoring programme is not strictly warranted. If continued monitoring is desired, then samples should be collected from the highest temperature part of the feature that is accessible.

Atiamuri *(Fig 4l)*

Two features have been monitored at Atiamuri in 2005 & 2009; Whangapoua West (Fig 4l-1) and Matapan Road (Fig 4l-2). These features both have relatively low temperatures (55-69^{o}C), but geochemistry is quite different, with Matapan Rd evidently having a much greater groundwater contribution to the spring, diluting the geothermal fluid input by 5-10x.

Two different pools at Whangapoua West have been sampled (northern and southern pool). These have very similar geochemistry and it is not necessary to continue with monitoring both. Only the northern pool geochemistry has been included on Fig 4l-1).

For both Whangapoua and Matapan Rd, there is too little data to assess trends with time at this stage, but there appears to have been little change in the geochemistry between 2005 and 2009.

Recommendation: Sample only a single pond at Whangapoua West, monitoring every 2 years.

Reporoa (Fig 4m)

Two features have been monitored at Reporoa; SE Spring monitored in 2005 & 2009 (Fig 4m-1), and Opaheke monitored since 1993 (Fig 4m-2). Of these features, Opaheke appears to have more direct geothermal fluid input (higher Li and less Mg). This would be the better feature for ongoing monitoring.

In 2009, however, Opaheke may have been sampled on an outflow as the temperature is considerably less than previously measured (53^{o}C, compared to >95^{o}C) while the geochemistry is only slightly changed. The geochemical changes that are observed; a decrease in HCO_3 and S_{TOT}, and an increase in SO_4 concentration may also be explicable in terms of an outflow sampling site, after time has allowed CO_2 and H_2S gas loss, and sulphide oxidation to occur.

Recommendation: Sample only Opaheke at this site, and target the highest temperature part of the feature that is accessible. Continue monitoring every 2 years.

Mokai (Fig 4n)

A Waipapa spring has been sampled at Mokai, and although it does appear to have been the same feature sampled from 1978, we cannot be sure as there are a number of springs in the Waipapa Stream and its environment. Assuming this is the same feature, geochemistry has been relatively constant and there are no consistent trends in the data. S_{TOT} and Fe concentrations have decreased markedly in 2009, but this is likely to be due to improved detection limits. Slight increases in Na-Cl-SiO_2 and F, accompanied by a decrease in Mg concentrations may indicate an increase in geothermal fluid input, but this is not certain at this stage.

Recommendation: Continue monitoring every 2 years.

Orakeikorako (Fig 4o)

Two features have been monitored at Orakeikorako; Map of Australia pool (Fig 4o-1) and Manganese Pool. (Fig 4o-2). Manganese Pool has the longer monitoring record, extending back to 1983, but has shown quite variable geochemistry and temperature (64-95°C) over this time period. No consistent trends are evident in the data for Manganese Pool, with lower S_{TOT} and Fe concentration in 2009 likely reflecting improved detection limits for these parameters.

Map of Australia Pool has very similar geochemistry to Manganese Pool. Both show decreased SiO_2 and HCO_3 concentrations in 2009, but not accompanied by changes in other geothermal or groundwater indicator parameters. It is difficult to know what this may indicate.

Recommendation: Not strictly necessary to monitor both features as they are of similar nature. Continue monitoring Manganese Pool every 2 years.

Rotokawa (Fig 4p)

The feature at Rotokawa (RK No 4A), has only 2 years of monitoring data available (1994 and 2009), which is insufficient to establish any significant variations or trends. However, there does appear to have been a slight decrease in the concentrations of several geothermal fluid indicators (Li, B, F, As) and an increase in SO_4, perhaps heralding a greater contribution from steam-heated water to this feature.

Recommendation: Continue monitoring every 2 years.

Taupo/Tauhara (Fig 4q)

Two features have been monitored at the Taupo/Tauhara field: Taharepa and Waipahihi Spring. Both have relatively low temperature features (66-68°C), but Waipahihi Spring appears to have a greater geothermal fluid input, with higher Li, B, Rb, Cs, Na and Cl concentrations. Both have experienced a decrease in HCO_3 concentration in 2009, but have otherwise no significant parameter variations over the short monitoring time period. Again progressively lower S_{TOT} concentrations in Taharepa in 2005 and 2009 may reflect improving detection limits for this parameter.

Recommendation: Not strictly necessary to monitor both features as they are of similar nature. Continue monitoring Waipahihi (or Taharepa if preferred) every 2 years.

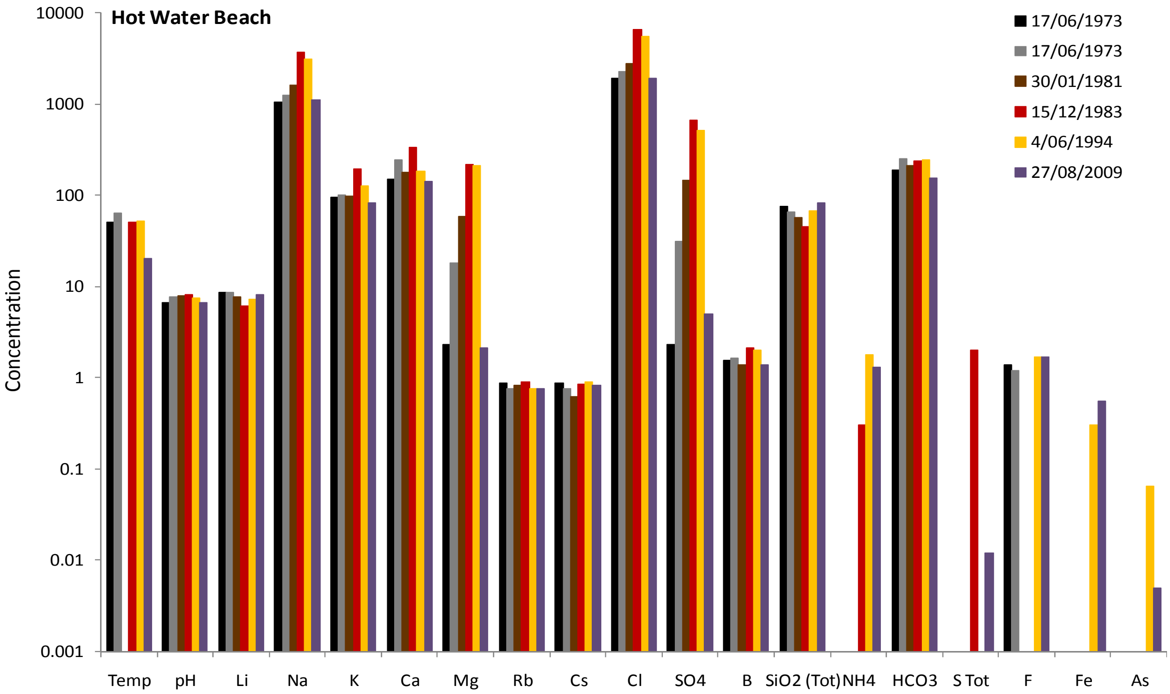
Tokaanu (Fig 4r)

Two features have been monitored at Tokaanu; Taumatapuhipuhi Geyser (Fig 4r-1) and Takarea No 5 (Fig 4r-2). They have only been monitored recently (from 2002 for Taumatapuhipuhi and 2005 for Takarea No 5), but appear to have very similar geochemistry. Takarea No 5 is the lower temperature feature (<60^{o}C) compared to Taumatapuhipuhi (98^{o}C). No consistent trends are evident over this short time period, and further monitoring is required.

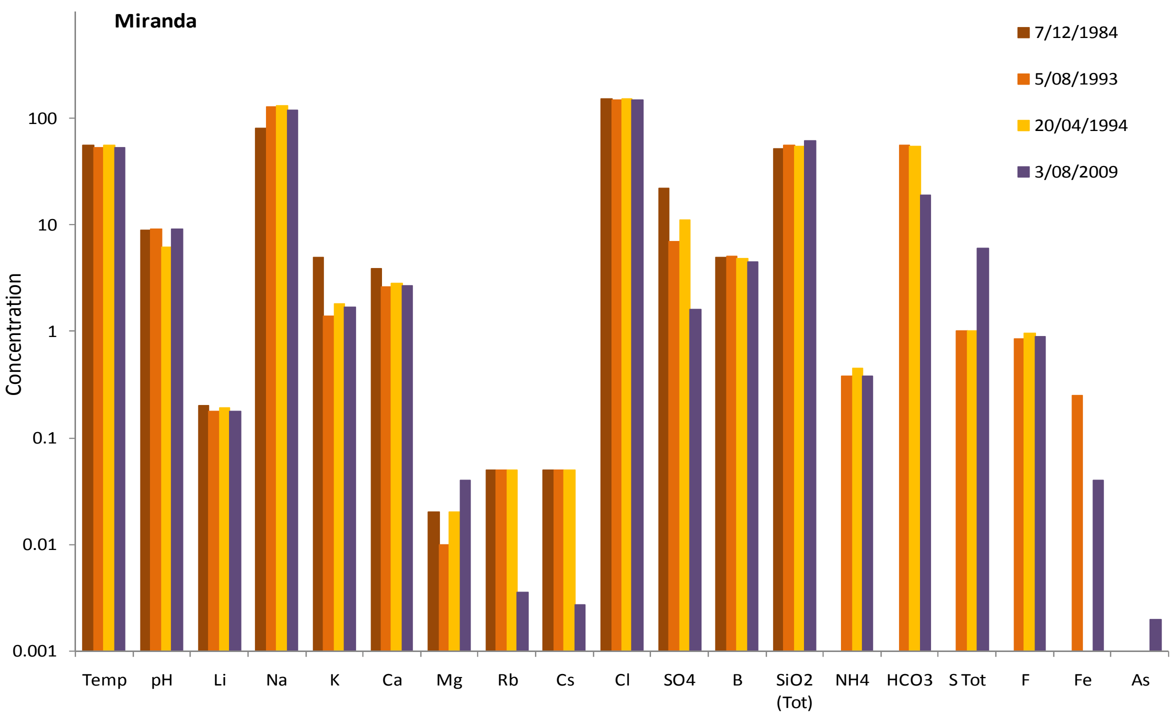
Recommendation: Again, there is no real need to monitor both features. Continue monitoring Taumatapuhipuhi Geyser every 2 years.

FIGURE 4. Temperature, pH and concentration (mg/L) in selected geothermal features as a function of time. Note log scale has been used on vertical axis.

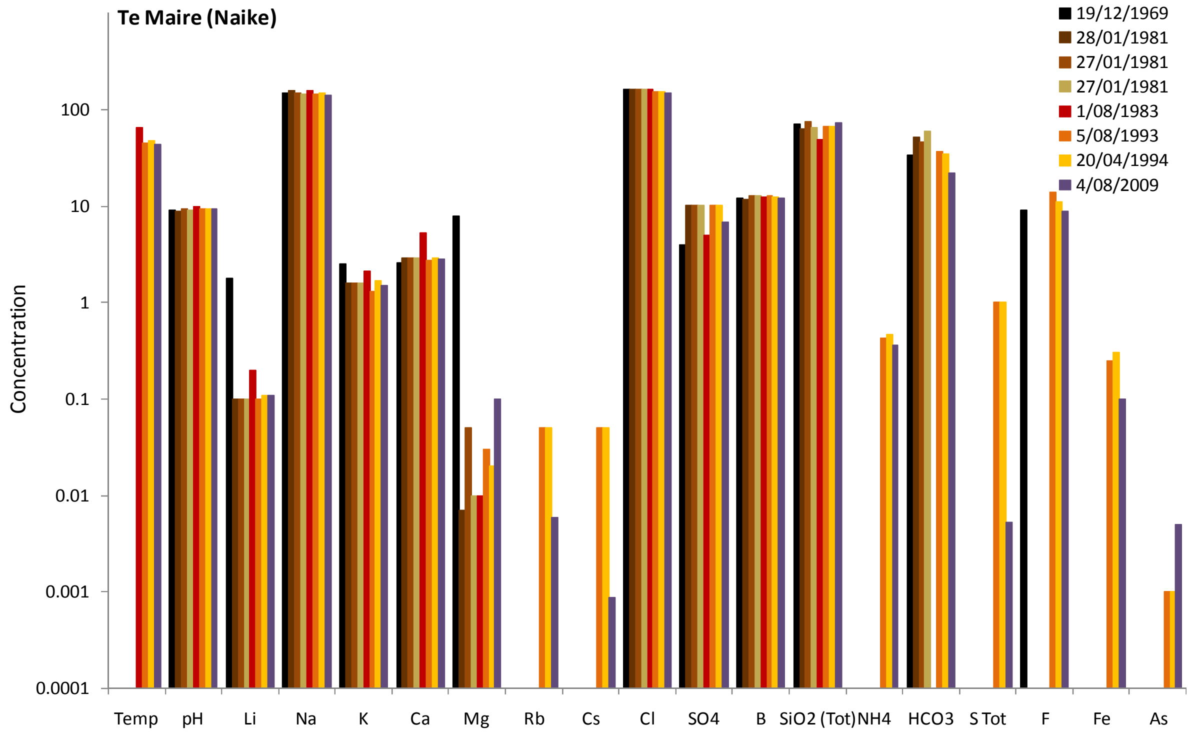
a)



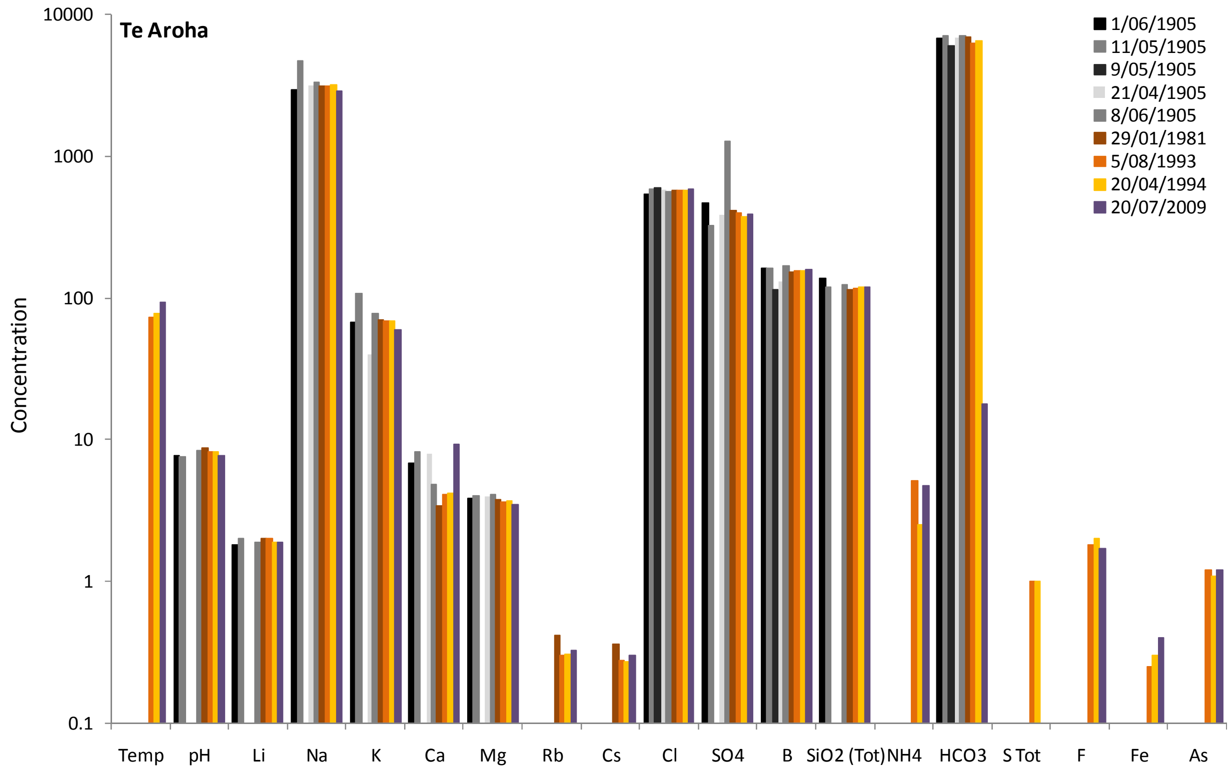
b)



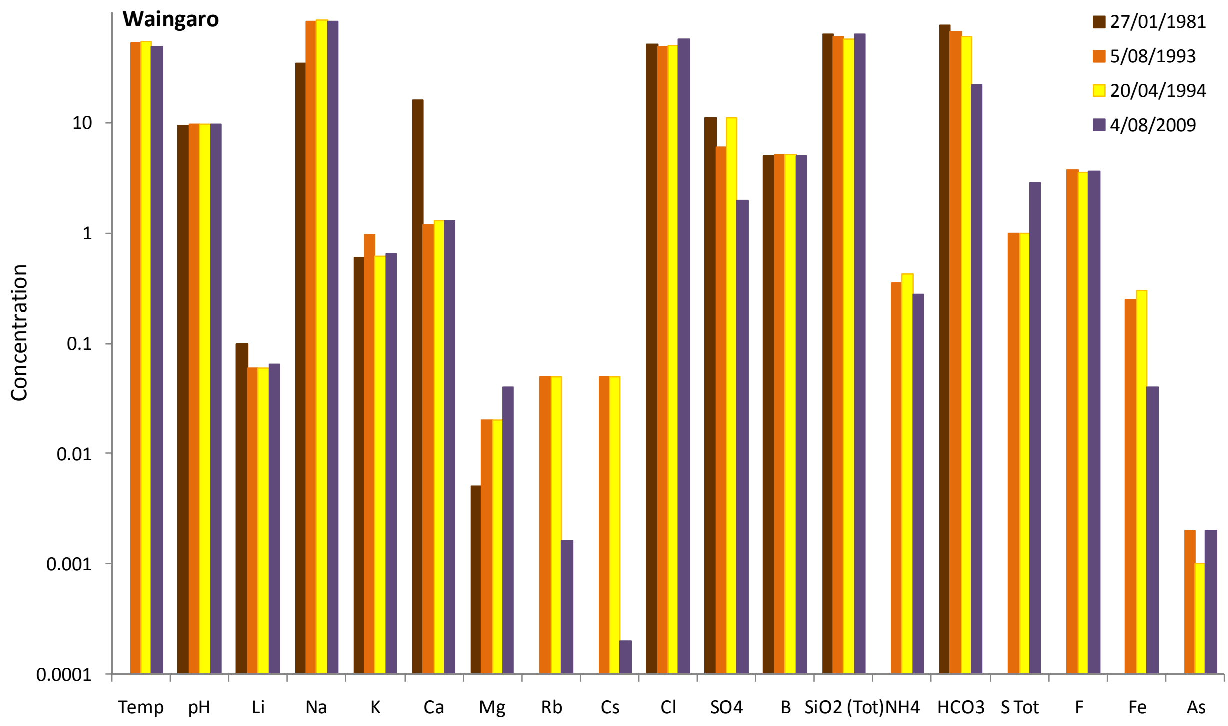
c)


Te Maire (Naike)
19/12/1969
28/01/1981
27/01/1981
27/01/1981
1/08/1983
5/08/1993
20/04/1994
4/08/2009
Concentration
100
10
1
0.1
0.01
0.001
0.0001
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

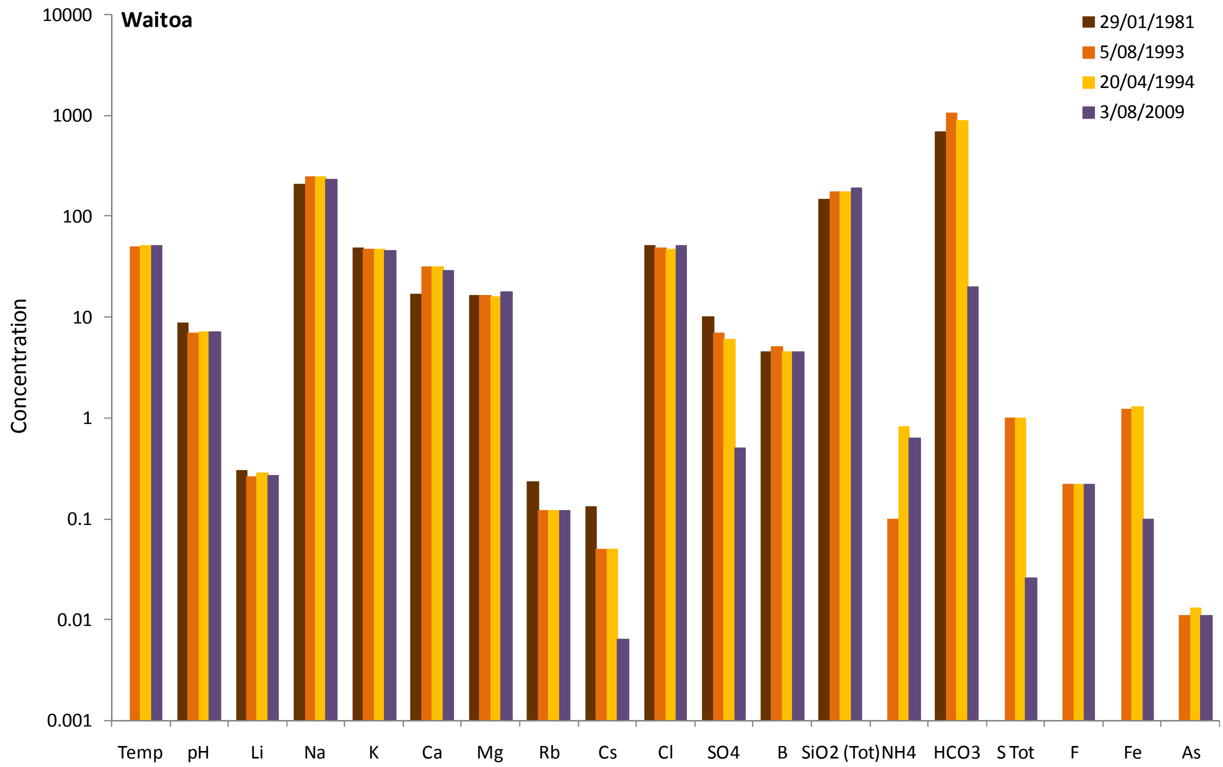
d)


Te Aroha
1/06/1905
11/05/1905
9/05/1905
21/04/1905
8/06/1905
29/01/1981
5/08/1993
20/04/1994
20/07/2009
Concentration
10000
1000
100
10
1
0.1
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

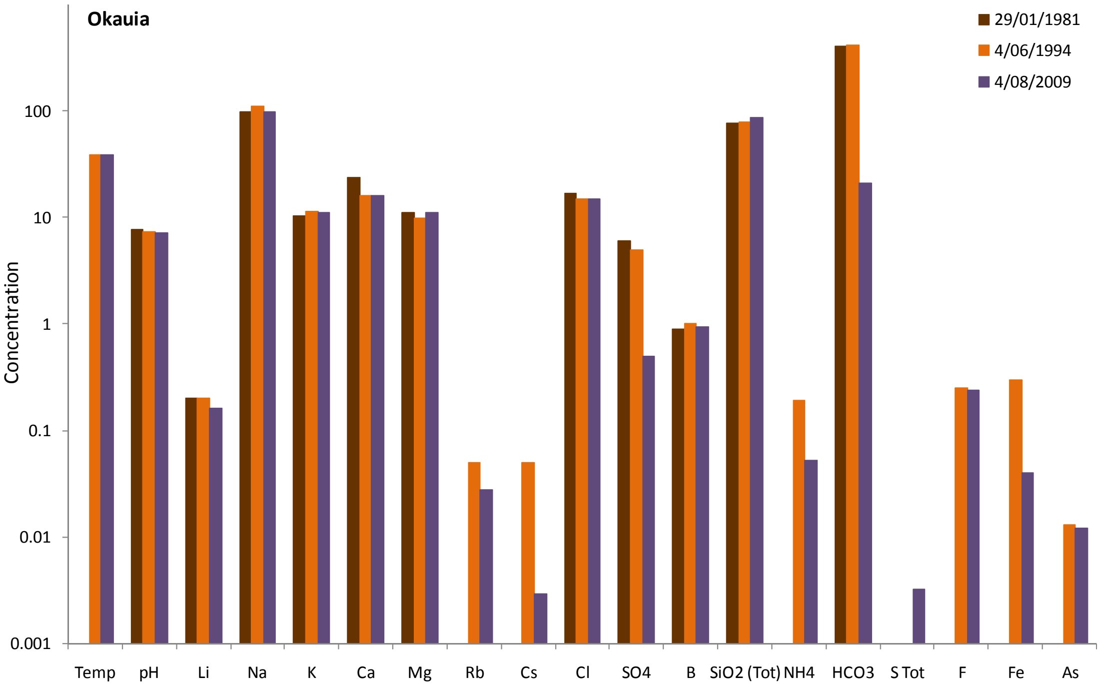
e)


Waingaro
27/01/1981
5/08/1993
20/04/1994
4/08/2009
Concentration
10
1
0.1
0.01
0.001
0.0001
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

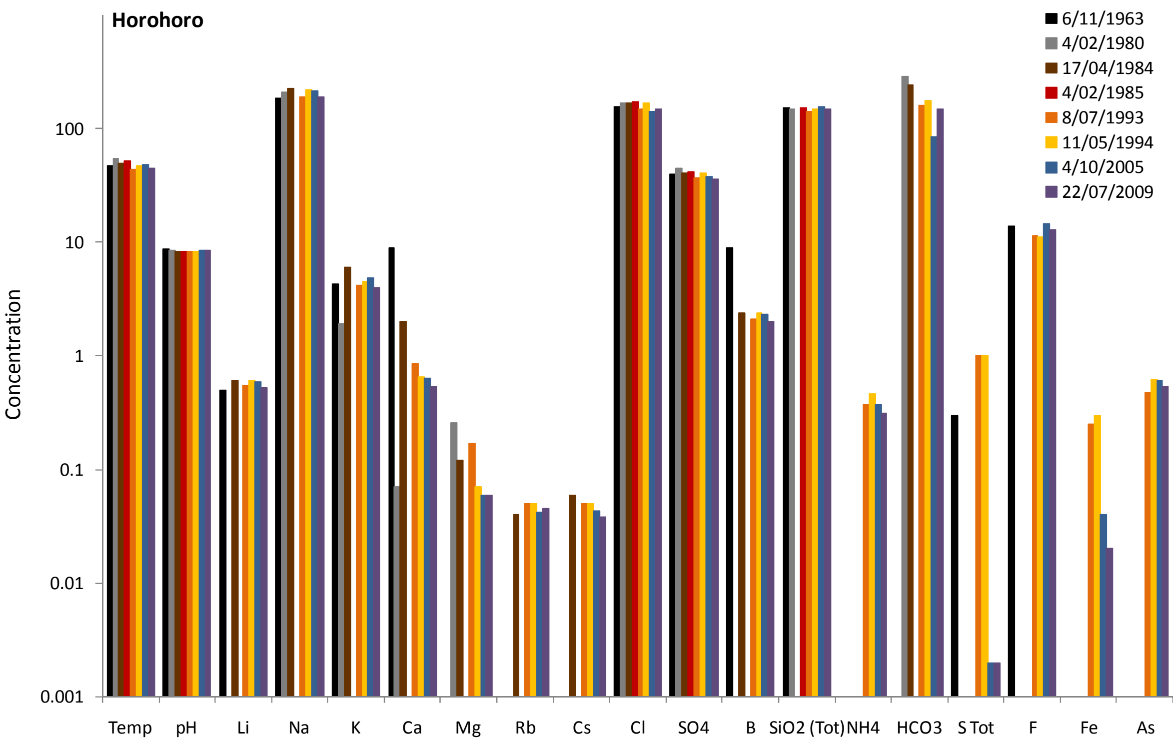
f)


Waitoa
29/01/1981
5/08/1993
20/04/1994
3/08/2009
Concentration
10000
1000
100
10
1
0.1
0.01
0.001
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

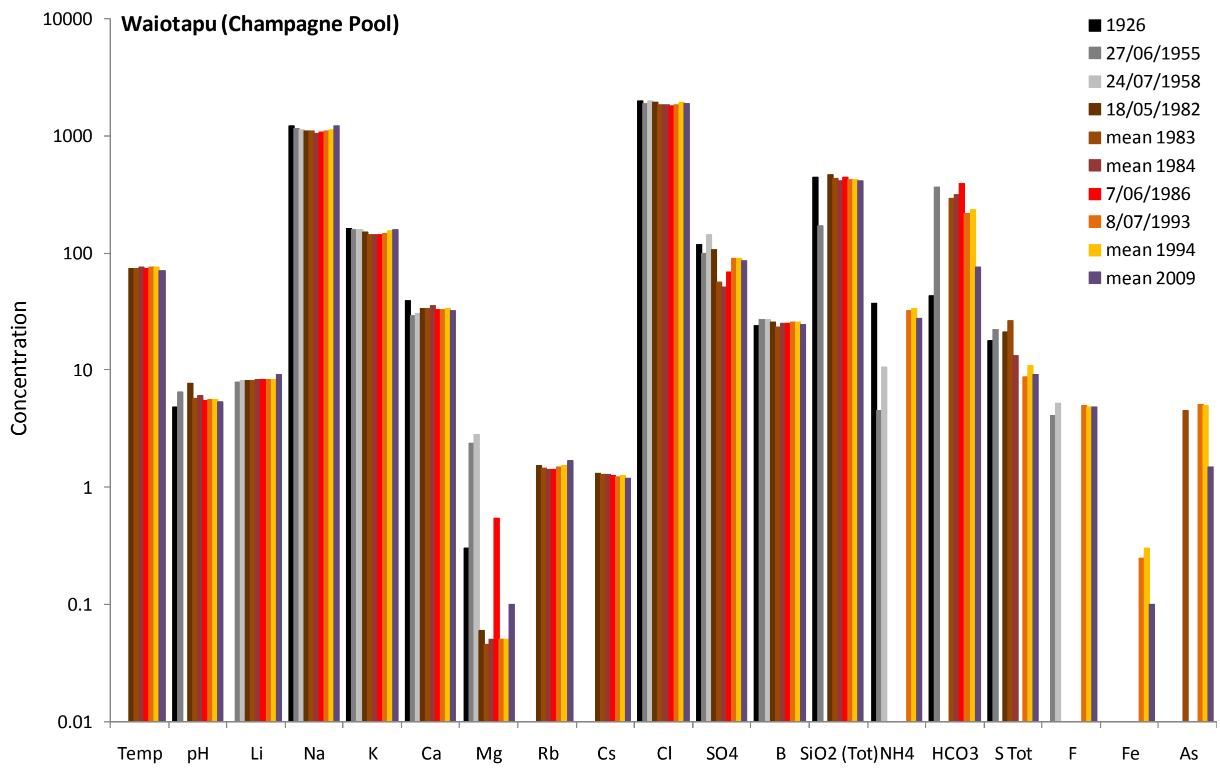
g)


Okauia
29/01/1981
4/06/1994
4/08/2009
Concentration
100
10
1
0.1
0.01
0.001
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

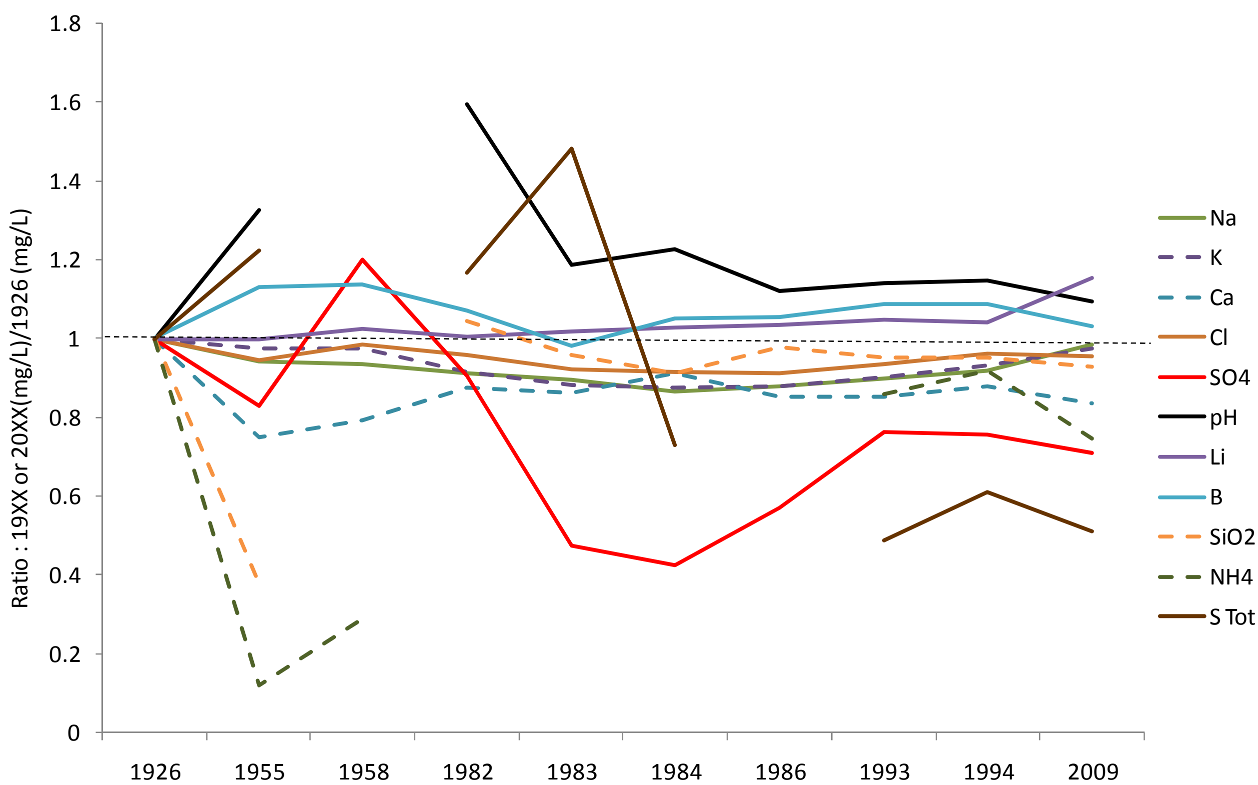
h)


Horohoro
6/11/1963
4/02/1980
17/04/1984
4/02/1985
8/07/1993
11/05/1994
4/10/2005
22/07/2009
Concentration
100
10
1
0.1
0.01
0.001
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

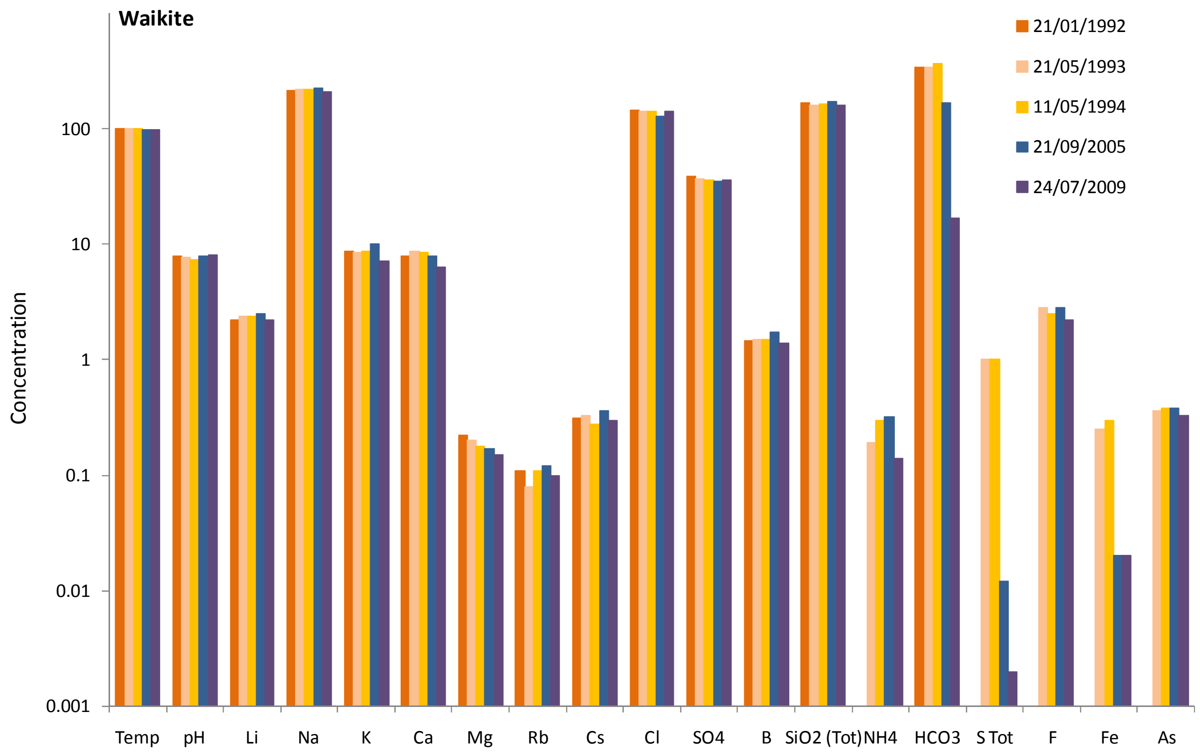
i)


Waiotapu (Champagne Pool)
Concentration
10000
1000
100
10
1
0.1
0.01
1926
27/06/1955
24/07/1958
18/05/1982
mean 1983
mean 1984
7/06/1986
8/07/1993
mean 1994
mean 2009
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

j)


Ratio : 19XX or 20XX(mg/L)/1926 (mg/L)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1926
1955
1958
1982
1983
1984
1986
1993
1994
2009
Na
K
Ca
Cl
SO4
pH
Li
B
SiO2
NH4
S Tot

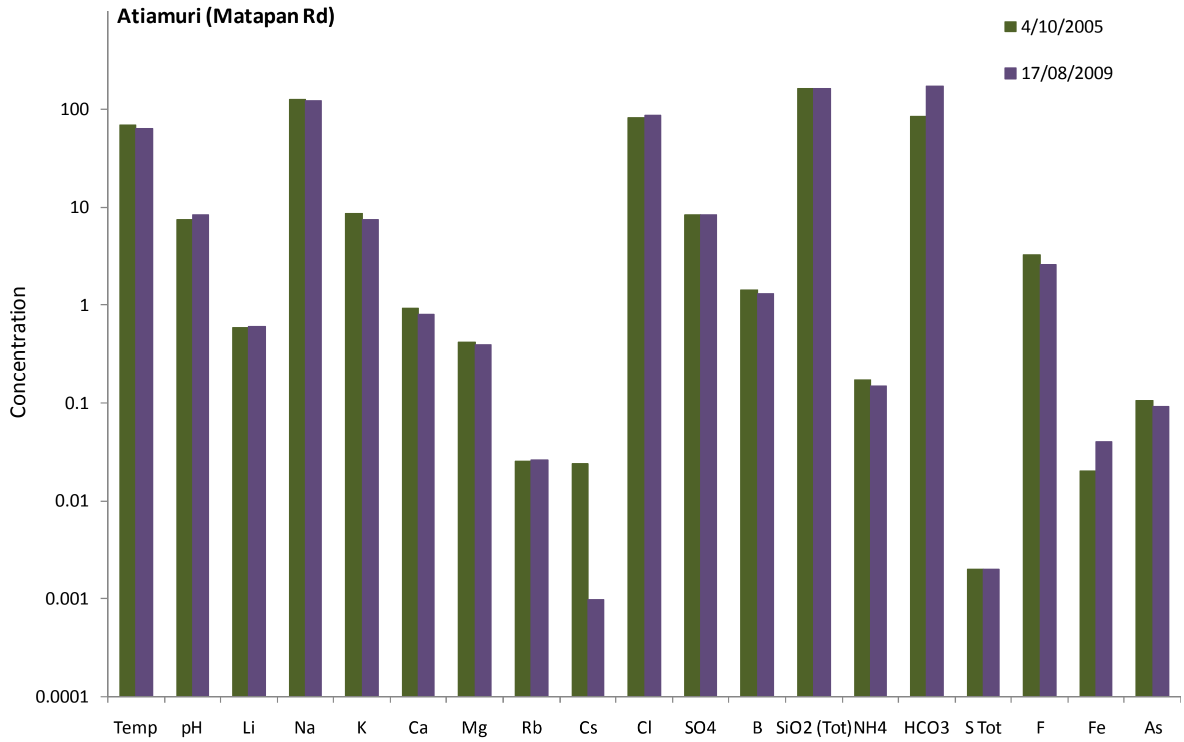
k)


Waikite
21/01/1992
21/05/1993
11/05/1994
21/09/2005
24/07/2009
Concentration
100
10
1
0.1
0.01
0.001
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

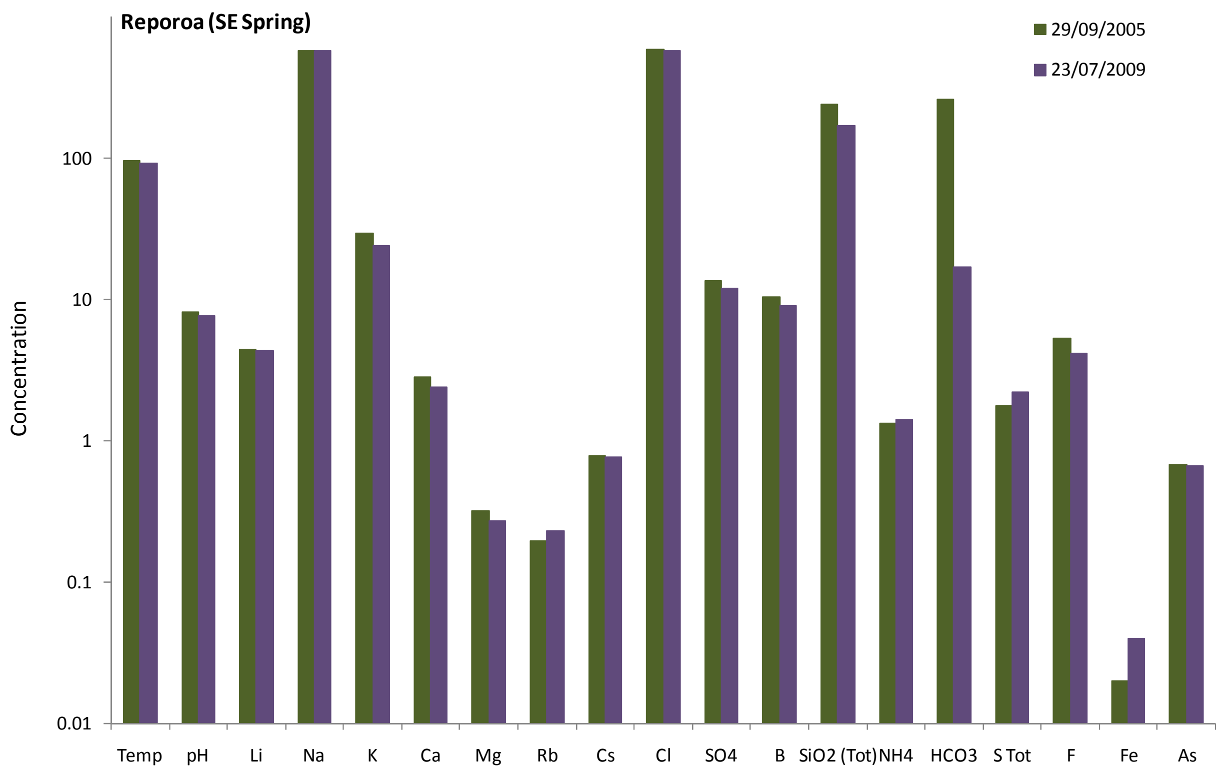
l-1)


Atiamuri (Whangapoua)
4/10/2005
17/08/2009
Concentration
100
10
1
0.1
0.01
0.001
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

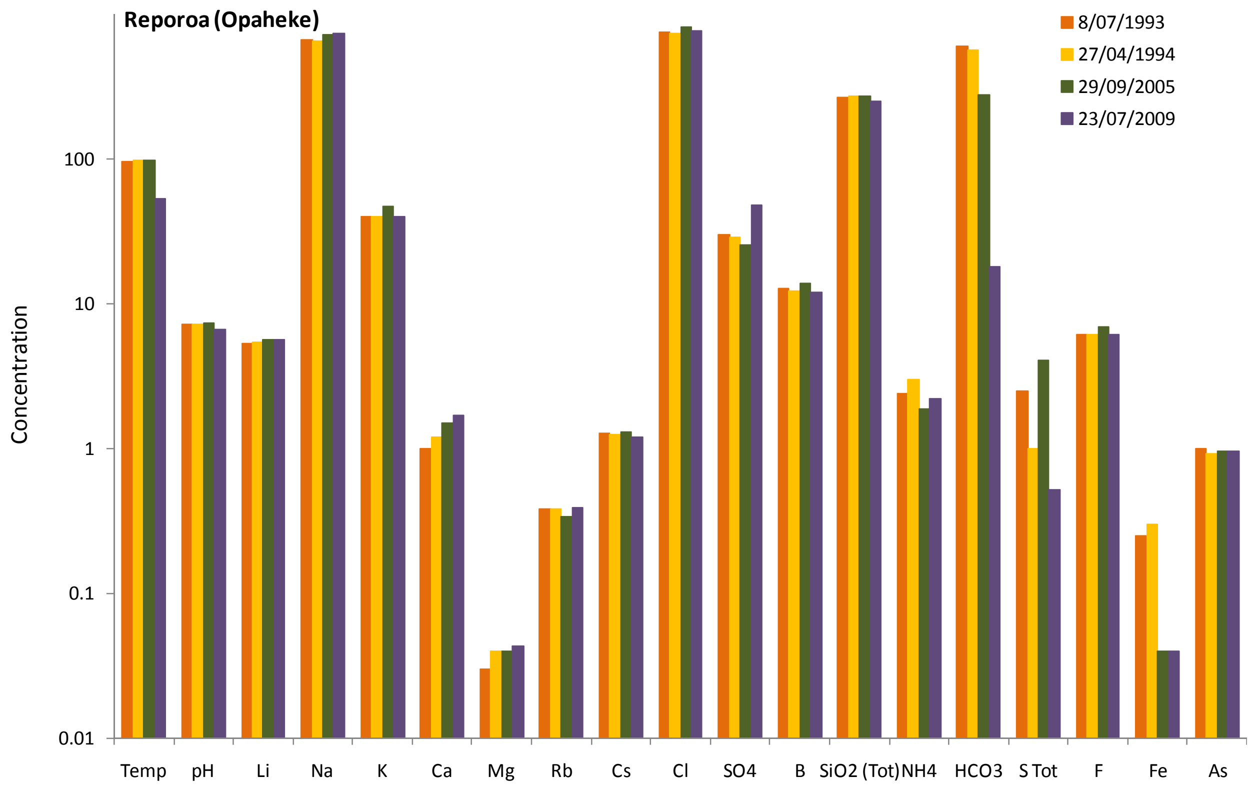
l-2)


Atiamuri (Matapan Rd)
4/10/2005
17/08/2009
Concentration
100
10
1
0.1
0.01
0.001
0.0001
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

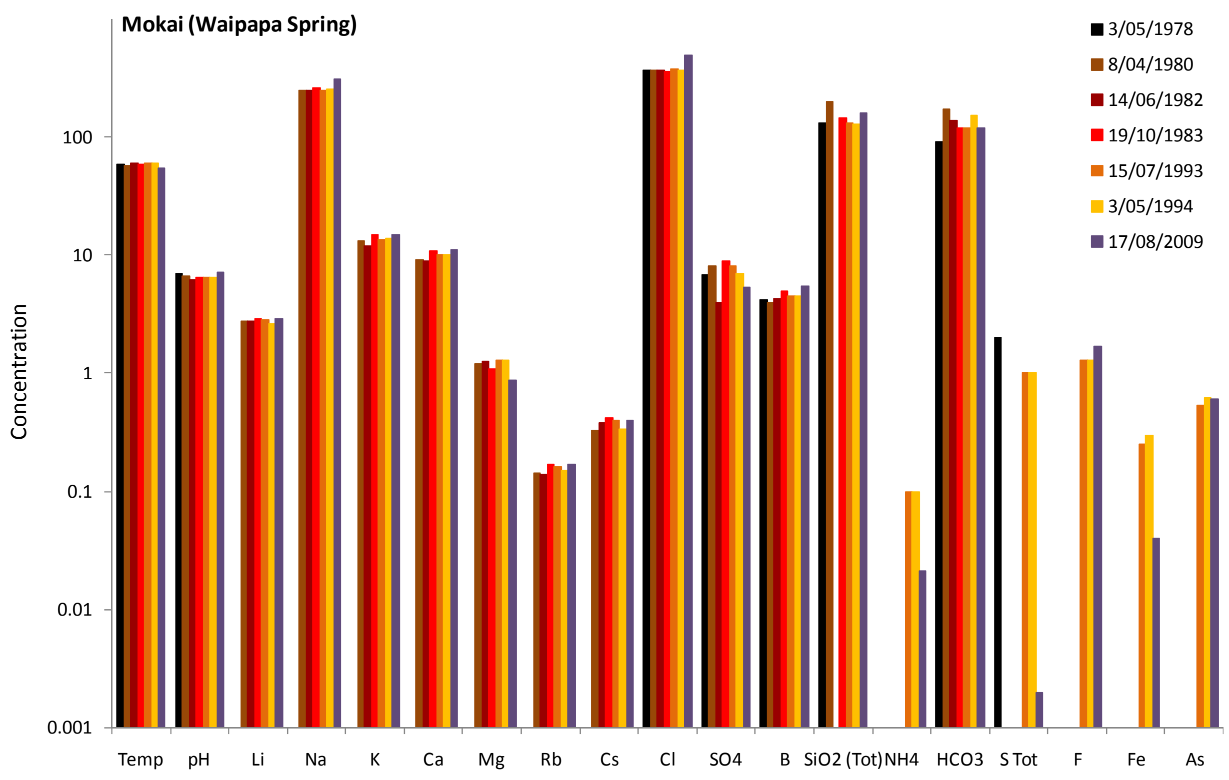
m-1)


Reporoa (SE Spring)
29/09/2005
23/07/2009
Concentration
100
10
1
0.1
0.01
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

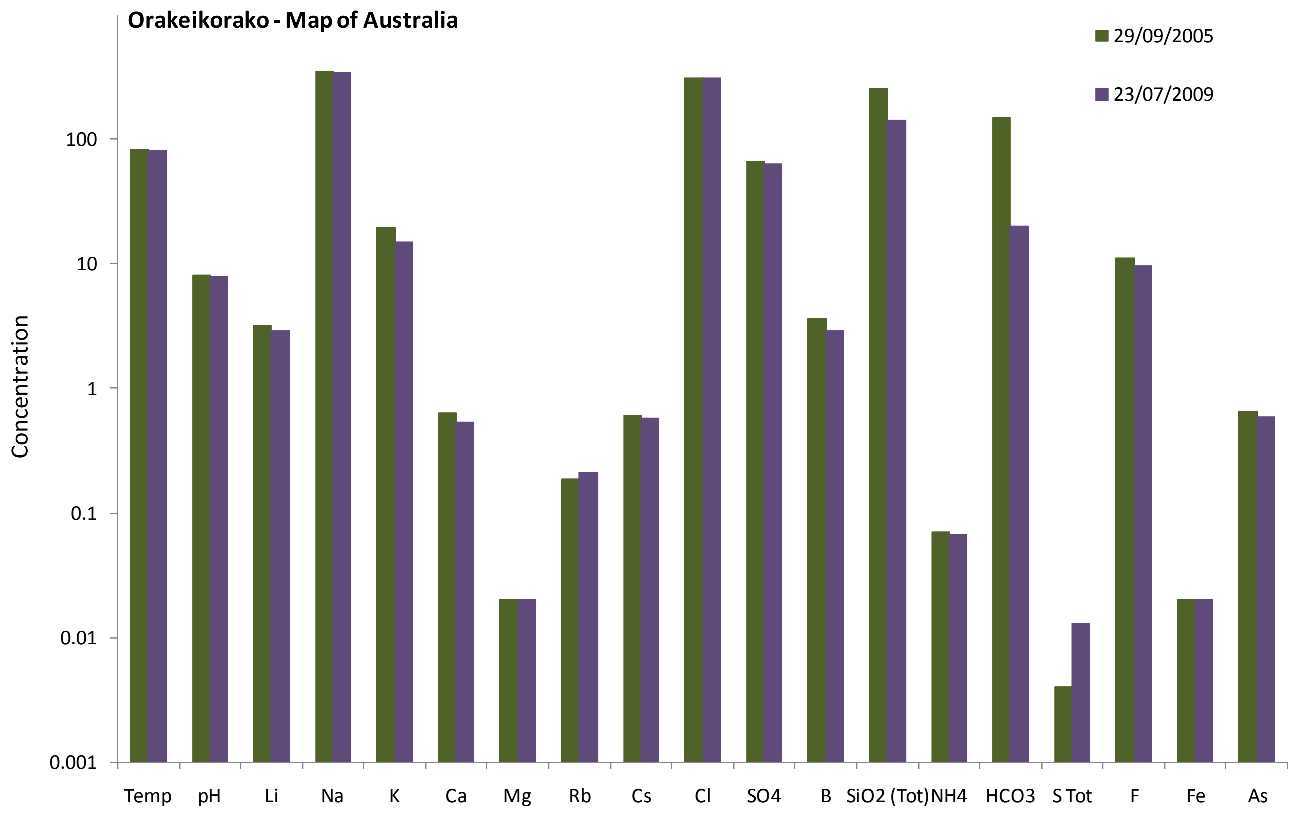
m-2)


Reporoa (Opaheke)
8/07/1993
27/04/1994
29/09/2005
23/07/2009
Concentration
100
10
1
0.1
0.01
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

n)

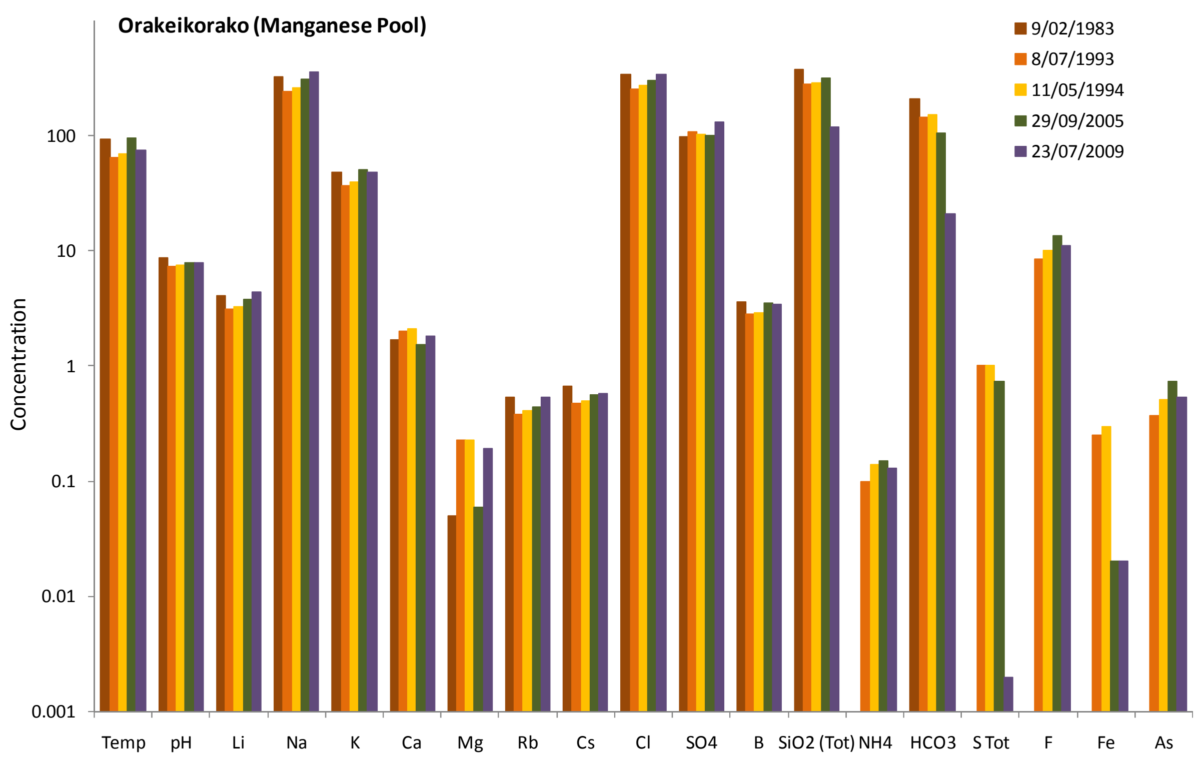

Mokai (Waipapa Spring)
3/05/1978
8/04/1980
14/06/1982
19/10/1983
15/07/1993
3/05/1994
17/08/2009
Concentration
100
10
1
0.1
0.01
0.001
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

o-1)



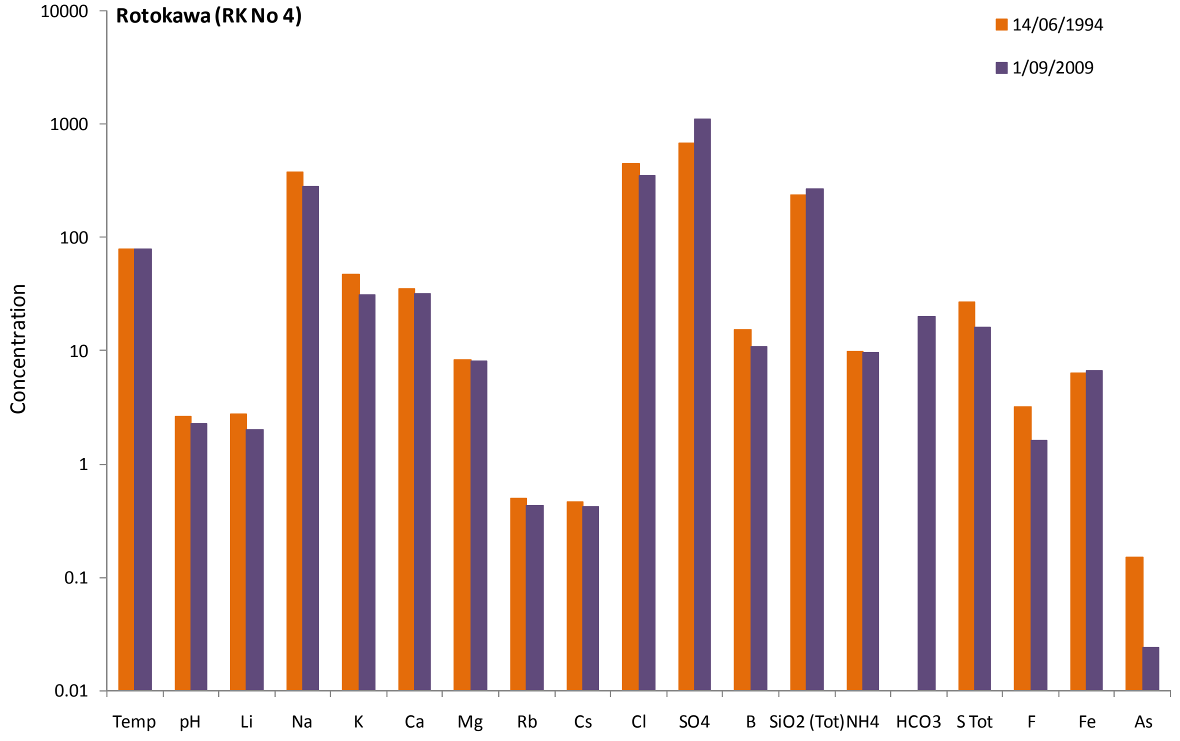
Orakeikorako - Map of Australia
29/09/2005
23/07/2009
Concentration
100
10
1
0.1
0.01
0.001
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

o-2)

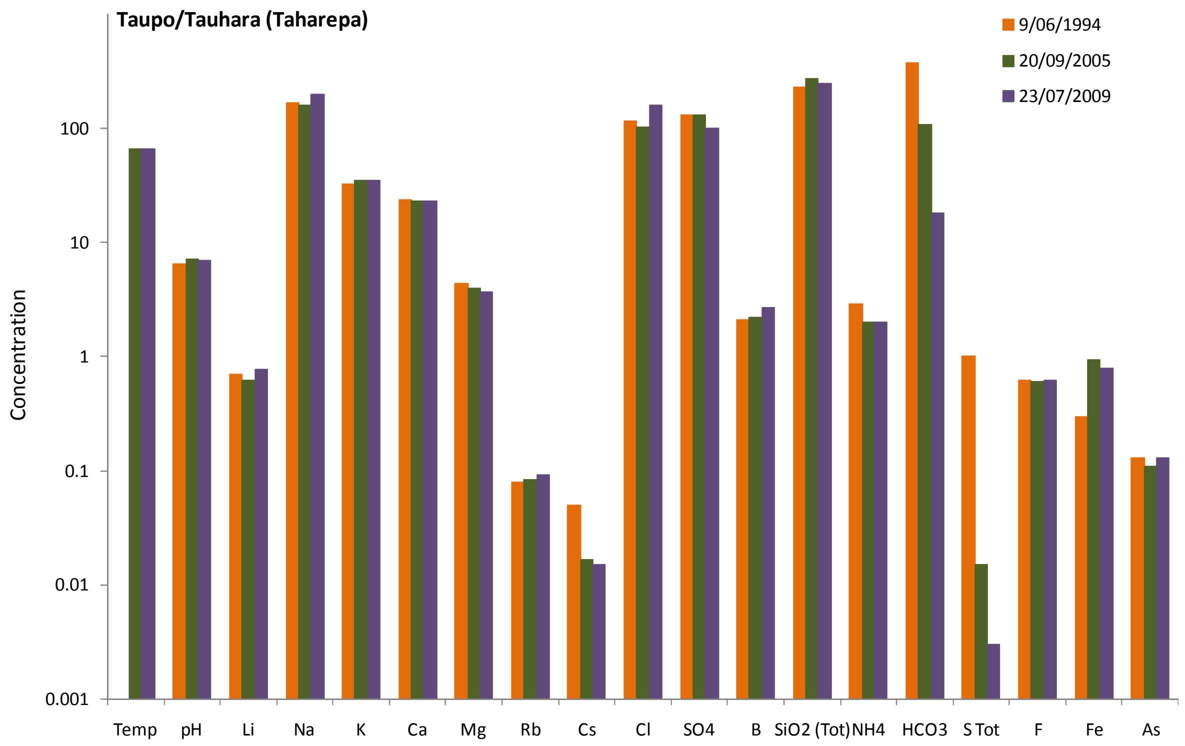


Orakeikorako (Manganese Pool)
9/02/1983
8/07/1993
11/05/1994
29/09/2005
23/07/2009
Concentration
100
10
1
0.1
0.01
0.001
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

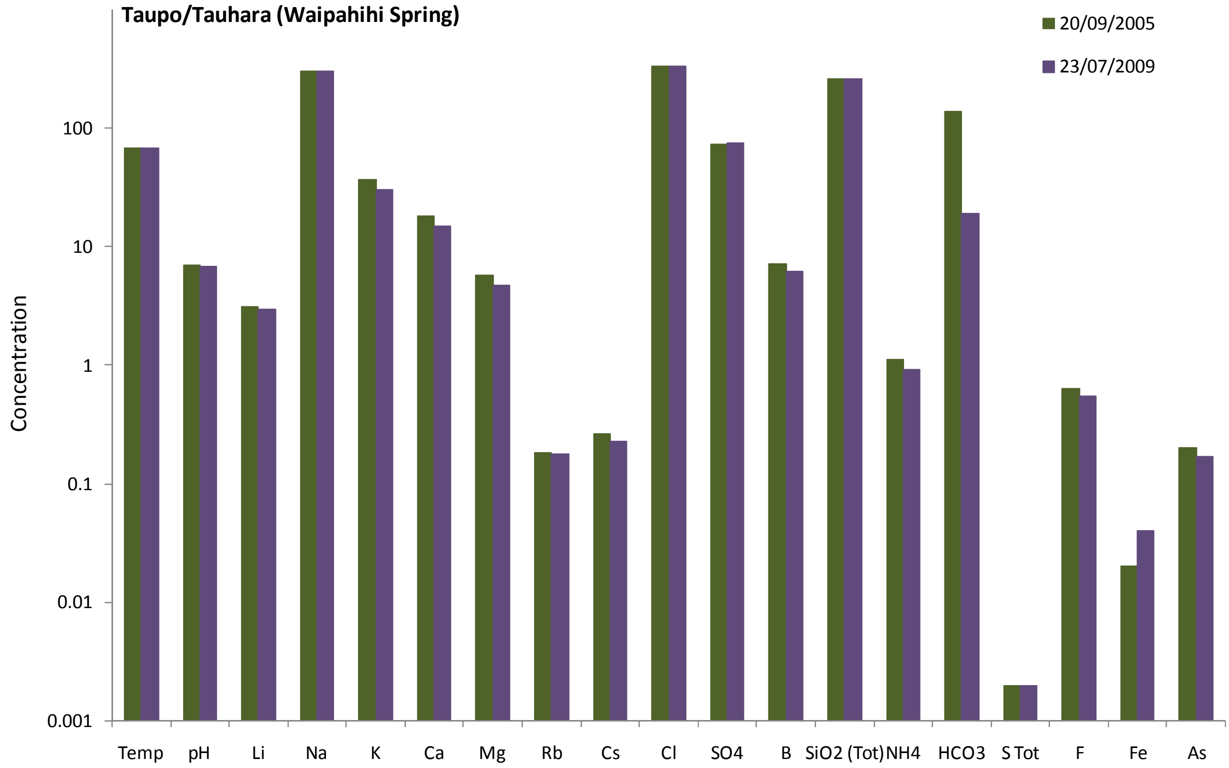
p)


Rotokawa (RK No 4)
14/06/1994
1/09/2009
Concentration
10000
1000
100
10
1
0.1
0.01
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

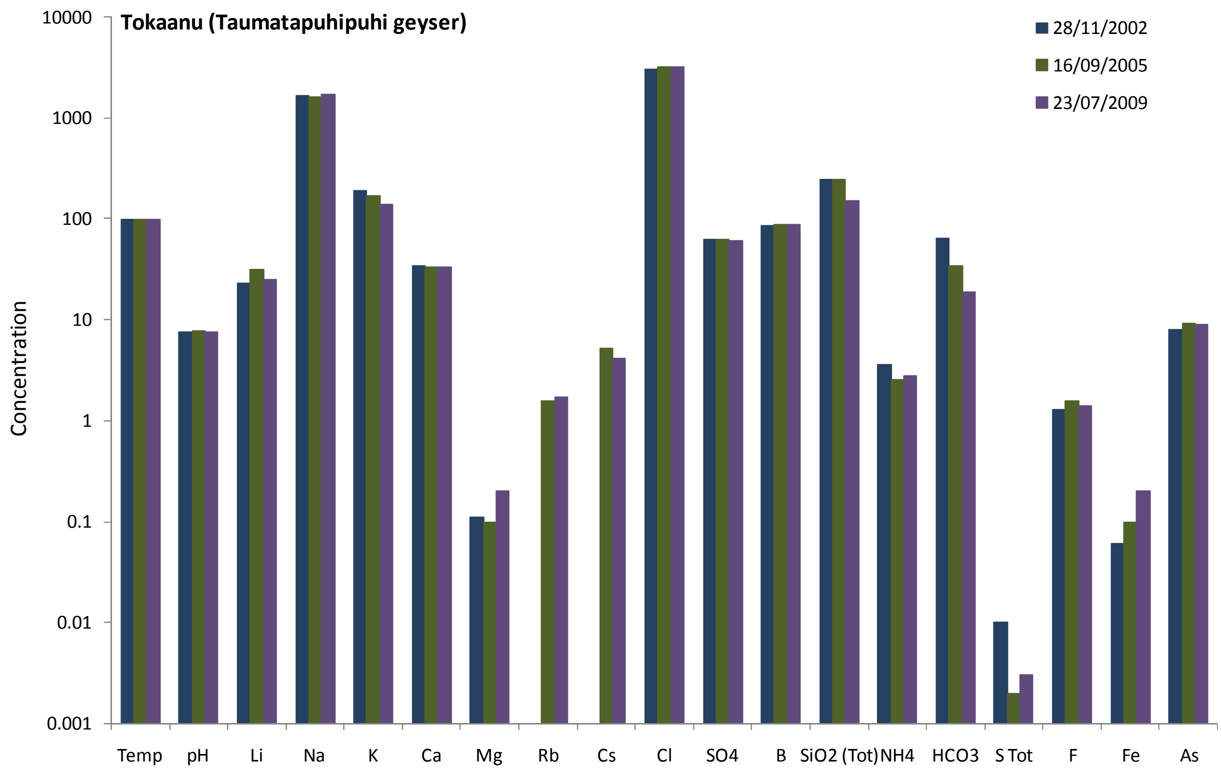
q-1)


Taupo/Tauhara (Taharepa)
9/06/1994
20/09/2005
23/07/2009
Concentration
100
10
1
0.1
0.01
0.001
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

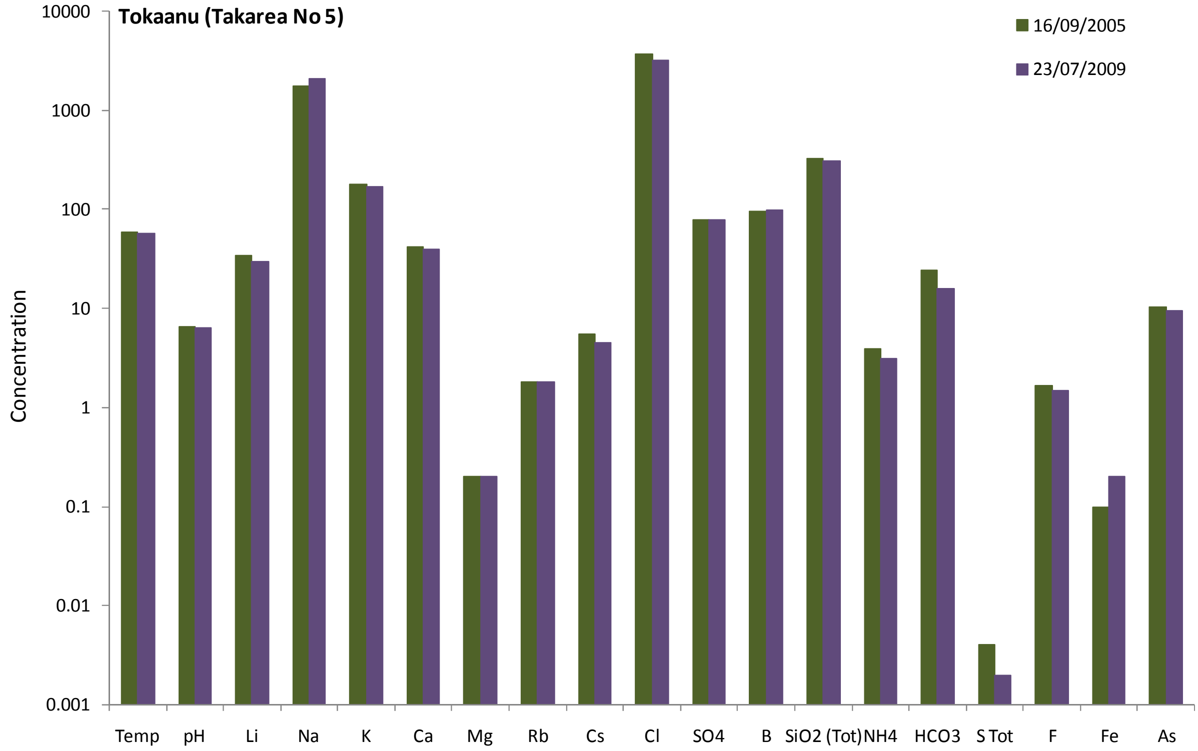
q-2)


Taupo/Tauhara (Waipahihi Spring)
20/09/2005
23/07/2009
Concentration
100
10
1
0.1
0.01
0.001
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

r-1)


Tokaanu (Taumatapuhipuhi geyser)
28/11/2002
16/09/2005
23/07/2009
Concentration
10000
1000
100
10
1
0.1
0.01
0.001
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

r-2)


Tokaanu (Takarea No 5)
16/09/2005
23/07/2009
Concentration
10000
1000
100
10
1
0.1
0.01
0.001
Temp
pH
Li
Na
K
Ca
Mg
Rb
Cs
Cl
SO4
B
SiO2 (Tot)
NH4
HCO3
S Tot
F
Fe
As

6. Arsenic Speciation Study

In 2009 a Master student's dissertation study (Lord, 2009) was undertaken to determine arsenic speciation in geothermal waters in New Zealand. The samples were collected in conjunction with sampling for the REGEMP II monitoring, which led to replicate samples being collected for some features such as Champagne Pool, as noted previously.

Inorganic As^{III} and As^{V} and organic monomethylarsonic (MA) and dimethylarsinic acid (DMA) were determined for the features monitored as part of the REGEMP III study. Inorganic As^{III} was the dominant species present in all except four of the features, which were mainly overflows in which oxidation in air had occurred. Progressive oxidation to As^{V} was also shown for drainage downstream of Champagne Pool at Waiotapu. Very little DMA was detectable, but MA was measured in a number of features, though never more than 28% of the total arsenic present.

This type of arsenic speciation has been undertaken previously for geothermal for the Taupo Volcanic Zone and receiving drainage systems. For the study of arsenic behaviour, fate and toxicity in aquatic environments, this type of study is critical. However, in the context of this monitoring programme, it is not necessary. It could be used to assess redox conditions in the system, but this can also be more directly measured, or assessed from S_{TOT} and SO_4 concentrations, if needed.

7 Gas Data

There was a limited amount of complete gas data, particularly for noble gases, and this was only for the major geothermal fields. There was no data for most of the sites sampled for fluid geochemistry, and none for sites outside the TVZ. There is a combination of data for geothermal wells and for surface features (fumaroles).

Only inert, insoluble gases can be compared between these types of samples. The noble gases can be used in this way to indicate the source of the fluid from which the gases have been derived Giggenbach (1991). A ternary plot of N_2/Ar/He gas concentrations is shown in Figure 5 for all of the gas data provided.

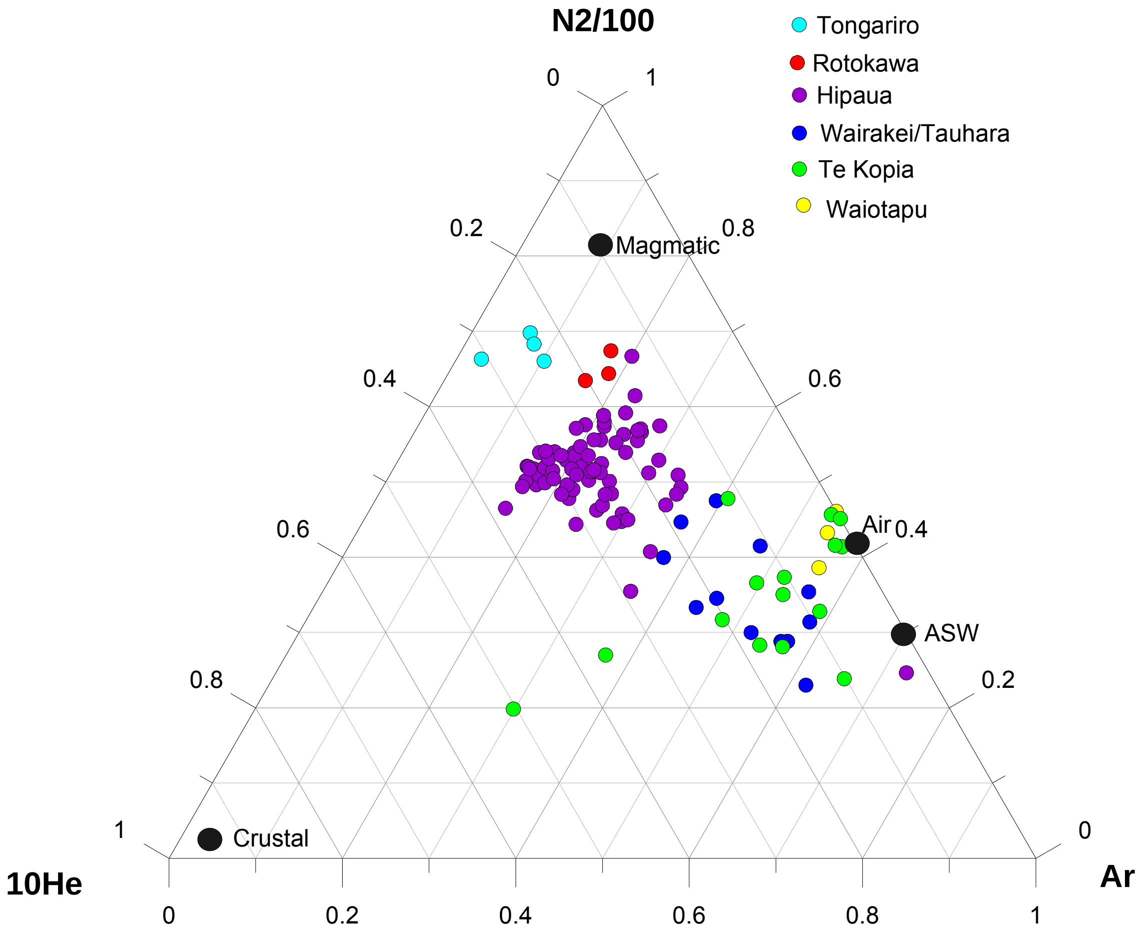


Figure 5: N_2/Ar/He plot for the available gas data

There are three end members which become mixed in geothermal gas emissions. Argon is sourced primarily from the atmosphere and is mainly present in air saturated water (ASW). Helium is sourced primarily from radioactive decay in the crust and nitrogen seems to be sourced mainly from magma. In Figure 5, it can be seen that there is a significant magmatic component in the Tongariro, Hipaua and Rotokawa geothermal gas data, but less so in the Wairakei/Tauhara and Te Kopia data. The gas data from Waiotapu may have been influenced by air contamination, as it plots very close to the signature of air in Figure 5.

Although interesting, this type of interpretation is of little value for monitoring the activity of geothermal features. An alternative use could be to assess environmental impacts of toxic gases such as H_2S and CO_2 which may be a concern if gas flux is significant. However, even then, ambient air monitoring would be a better approach.

8 RECOMMENDATIONS

In the 2008 report it was noted that, if this is to be a viable, ongoing monitoring programme, the programme needed to be more focussed, using a limited number of representative sites, and a consistent set of geothermal parameters from year to year. Our interpretation of the objectives of this programme was:

- To understand the nature and vulnerability of the regions warm water resources, in order to sustainably manage these resources

- To determine likely changes in environmental impacts of these features/systems

The 2009 monitoring programme adopted many of the 2008l recommendations, which has made interpretation of the trends more straight forward. Further recommendations are made below to continue refinement of this programme and to complement this with historic data.

The recommendations made regarding data collection and site choice made in the 2008 report are still valid and will not be repeated here.

8.1 Data collected from each site

A suitable set of geochemical parameters is now being monitored in the fluids. If desired, the option of monitoring a reduced set of parameters every 2 years (as recommended in the 2008 report) may still be adopted.

The justification for collecting gas data is less obvious. The benefits of collecting gas data from deep wells (which is collected anyway as part of field reservoir characterisation) or from surface features (where gas compositions could be highly variable, as well as difficult to sample reliably) need to be carefully considered.

8.2 Recommendations for sites sampled

The following features were not sampled in 2009 due to various reasons. They do have enough historical data to make ongoing monitoring worthwhile, and if they are still physically able to be sampled should be maintained in the monitoring programme, or reconsidered for the future if circumstances change (e.g, access again possible on private land). Those feature that have cooled or dried up should be replaced in the programme by the nearest similar feature:

- Kawhia – staff resourcing issues – 2 hour drive
- Te Kopia– staff resourcing issues- all day trek
- Blue Pool/spring at Ngatamariki – no longer flowing
- Whakatara at Waihi – access denied

- Black Cauldron at Ketetahi – access denied
- Soda Springs, Ruapehu – staff resourcing issues - all day trek
- Waihunuhunu at Orakeikorako – staff resourcing issues – requires boat

Although other features can be monitored at Orakeikorako, Waihunuhunu has a longer data record than the currently monitored features and could be considered for re-inclusion in the monitoring programme. It is unfortunate that there are now no natural deep fluid spring features at Ohaaki, now that Ohaaki Pool is artificially fed from the power station reinjection line. Otherwise spatial coverage of the region is relatively complete with the currently monitored sites.

For long term monitoring purposes, consistency in the choice of sites (and features in this case), type of data and methods used, is crucial. We strongly recommend deleting duplicate features where their geochemistry of the features is very similar (refer Section 5.0 for details) and they are close to each other. Streams and outflows from features should be avoided as these vary with meteoric water dilution and are not helpful for feature monitoring. Features should be sampled from the highest temperature part of the feature safely accessible.

For best use of resources and funding, duplication of samples from a single feature should be avoided (e.g. 3 sites from Champagne Pool included in 2009 sampling), unless being used for the purposes of data quality control. Likewise, data for out of catchment features (Hells Gate Tikitere samples in the 2009 study) should not be included in this monitoring dataset. .

8.3 Recommendations for historic data incorporation

The following recommendations are made to ensure that fluid geochemistry data entered into the database of the REGEMP II programme improve rather than confuse data interpretation. When selecting data for inclusion, and entering this data, the following guidelines may be useful;

- Only add data for sites that are currently monitored or may have some value for monitoring in the future. Low temperature springs and other non-geothermal features should not be included.

- Avoid altering the format of the spreadsheet, e.g., by adding columns for additional information or alternative forms of the same type of information

- Do not include non-geothermal parameters such as I, NO3, PO4, Al etc., in the data base for this monitoring programmes (i.e., include only the recommended parameters). There is no reason why such data can not be collected, however, and stored as supplementary data.

- Make sure the species specified is correct (e.g. SiO_2, not Si; HBO_2 not B etc.), and recalculate if necessary into the correct species.

- Make sure units of concentration are the same (i.e., ppm or mg/L, not ppb or µg/L etc.).

- Maintain the same formats for dates, GPS co-ordinates etc.

- Do not include data for deep geothermal reservoir fluids (e.g., deep samples from geothermal bores).

Other potential sources of historic geochemical data for surface features include the data collected by DSIR at Wairakei. Much of this was included in published DSIR reports, but not all. These files must reside with GNS. Scientific papers will also included useful data, but would require time to find using electronic literature and library archive searches.

9 REFERENCES

Giggenbach Werner F 1991. Chemical techniques in geothermal exploration. In: Franco D'Amore ed. UNITAR / UNDP Handbook on Application of Geochemistry in Geothermal Reservoir Development. Rome UNITAR / UNDP Pp. pp. 119—144.

Huser B, Jenkinson D 1996. Regional Geothermal Features Monitoring Programme. Waikato Regional Council Technical Report 96/18. 42 p.

Lord G 2009. Arsenic speciation analysis of geothermal waters in New Zealand. . Unpublished Dissertation thesis, University of Surrey, Surrey, United Kingdom.

Luketina K 2007. REGEMP II: Regional Geothermal Geochemistry Monitoring Programme Environment Waikato Technical Report 2007/36. 38 p.

Webster-Brown JG, Brown KL 2008. Interpretation of Geochemical Data (REGEMP II) and Recommendations for Further Monitoring. Waikato Regional Council Technical Report 2008/01. 40 p.

APPENDIX I

Full listing of fluid geochemical data used in this report. Sequential numbering beside the name of the area refers to the number allocated in a North-South transect through the region. Oxygen and deuterium isotopes are given relative to SMOW. Values in red for HCO_3 have been calculated from ALK.

Dissolved concentration unless noted as TR (Total Recoverable)

Area:	Easting	Northing	GRID REF:	Site description	LOC KEY	Date Sampled	Temp	pH	Li	Na	K	Ca	Mg	Rb	Cs	Cl	SO4	B	SiO2 (Tot)	NH4	Alk	HCO3	S Tot	F	Fe	As	$d^{18}O$	$d^{2}H$	Cond	Br	Hg TR	Sb	Tl
COROMANDEL (1)	2760658	6479977	T11:606-799*	Wigmore Spring,Ross LC, Orchard Road Hahei	72-2149	21/01/2005	27.8	6.5				5.2				40.9	6.8	0.042		<0.01	40	24							22.6				
	2760658	6479977	T11:606-799*	Wigmore Spring,Ross LC, Orchard Road Hahei	72-2149	9/03/2006	28.1	6.5				5.12				38.2	6.4	< 0.05			39	24							22.3				
	2760658	6479977	T11:606-799*	Wigmore Spring,Ross LC, Orchard Road Hahei	72-2149	21/04/2006	28.1	6.6	0.0222	32.8	7.45	5.11	1.91	0.0172	0.0001	38.7	6.5	0.028	98.4	<0.01	38	23	< 0.002	0.09	< 0.02	0.005	-4.87	-32	21.9	0.117	< 8.E-05	< 0.0002	< 5.E-05
	2751488	6482211	T11:515-822 *	Cook Drive, Buffalo Beach: Golden Apple Trust	72-2942	21/04/2006	32.8	8.9	0.021	171	1.24	4.51	0.05	0.0062	0.0012	174	18.2	5.17	62.5	0.4	92	56	0.102	7.43	0.04	0.002	-6.71	-34.4	83.3	0.402	< 8.E-05	< 0.0002	< 5.E-05
	2762100	6475600	T11:621-756	Hot Water Beach	7323/23	4/06/1994	51.6	7.45	7.3	3100	127	181	209	0.75	0.91	5536	514	2	68	1.8		246		1.7	<0.3	0.064	-4.4	-23.8	1644				
	2762100	6475600			5658	15/12/1983	50	8.11	6.04	3726	193	334	215.3	0.89	0.84	6585	670	2.1	45	0.3		236	2										
	2762100	6475600			4891/24	30/01/1981		7.85	7.6	1587	98	177	58	0.83	0.62	2759	146	1.4	56			211											
	2762100	6475600		Hot Water Beach Well	MI40	17/06/1973	50	6.7	8.6	1035	96	151	2.3	0.87	0.87	1924	2.3	1.53	75			186		1.4									
	2762100	6475600		Hot Water Beach Spring	MI39	17/06/1973	63	7.6	8.6	1253	99	242	18	0.76	0.76	2240	31	1.63	66			254		1.2									
	2761889	6475323		Hot Water Beach Old Motor Camp Bore	72-4389	27/08/2009	20	6.6	8.2	1100	82	140	2.1	0.76	0.82	1900	< 5	1.4	83	1.3	94	152	0.012	1.7	0.55	< .005			627	6.5	< .00008	0.0013	< .00025
KAIAUA (2)	2714244	6455625	S12:142-556*	1337 East Coast Road Kaiaua: Bore Marshall EJ.	72-3009	9/03/2006	24.5	8.7	0.005	62.8	0.59	2.36	0.03	<0.0001	<0.0001	49	0.9	0.666	20.3	0.02	73	44	< 0.002	0.32	< 0.02	0.010	-5.70	-32	30.3	0.110	< 8.E-05	< 0.0002	< 5.E-05
MIRANDA (3)	2717100	6441100	S12: 171-411	Miranda-Bath Source	7323/3	20/04/1994	55.3	6.21	0.19	133	1.8	2.8	0.02	<0.05	<0.05	151	11	4.9	55	0.45		54	<1	0.96		<0.001	-6.01	-35.3	64.6				
	2717100	6441100			7190/3	5/08/1993	53.1	9.15	0.18	127	1.4	2.6	0.01	<0.05	<0.05	150	7	5.1	56	0.38		56	<1	0.86	<0.25	<0.001			65.4				
	2717100	6441100		Miranda HS	5963/6	7/12/1984	56.5	8.93	0.2	80	<5	3.9	<0.02	<0.05	0.05	151	22	<5	52														
	2717315	6441162		Miranda Hot Pools	72-4290	3/08/2009	53.6	9.2	0.18	120	1.7	2.7	< .04	0.0036	0.0027	150	1.6	4.5	61	0.38	81	19	6.1	0.9	< .04	< .002			65.6	0.35	< .00008	< .0004	< .0001
NGATEA (4)	2731790	6433360	T12:317-333 *	Ngatea Gem shop River Road	72-2223	9/03/2006	24.4	6.8	0.749	309	21.3	29.7	22.1	0.0546	0.013	60.7	0.5	5.94	118	0.5	788	476	< 0.002	0.41	0.03	0.023	-5.54	-35	151	0.131	< 8.E-05	< 0.0002	< 5.E-05
	2736843	6432507		Kerepehi Hot Springs	72-2088	3/08/2009	40.7	6.7	0.41	260	28	10	6.8	0.098	0.0059	78	< .5	6.3	170	3.1	580	19	0.2	0.43	0.59	0.026			124	0.2	< .00008	< .0004	< .0001
L. WAIKARE (5)	2706400	6416700	S13:065-167	Lake Waikare @ epilimnion	326-4	30/08/2005	15.7	9.6	0.0218	15.5	3.84	9.76	3.67	0.0074	0.0002	19.9	13.6	0.118	14.3	<0.01	31	19	< 0.002	0.17	0.25	0.006	-4.43	-25	16.5	0.068	< 8.E-05	< 0.0002	< 5.E-05
	2707137	6415506	S13:071-155*	Lake Waikare Vent	326-45	23/04/2004	79.8	8.2	0.275	129	5.84	5.4	1.53			168	19	8.46	216			43	0.122						69.6		0.557		
	2707137	6415506	S13:071-155*	Lake Waikare vent	326-45	30/08/2005	64.5	8.9	0.473	201	7	12	1.3	0.018	0.019	299	7.3	16.1	77.6	0.87	66	40	2.93	1.74	2.9	< 0.02	-5.12	-30	115	0.6	0.00254	< 0.004	< 0.001
	2701679	6413205		Ohinewai Spring	72-2100	3/08/2009	21.3	9	0.72	280	2	6.1	0.14	0.0032	< .0005	390	1.3	22	25	0.87	87	19	0.16	4.9	< .1	< .005			142	0.61	< .00008	< .001	< .00025
TE MAIRE (NAIKE) (6)	2682000	6409800	R13:820-098	Te Maire Naike	7323/2	20/04/1994	46.9	9.3	0.11	150	1.7	2.9	0.02	<0.05	<0.05	153	10	12.2	66	0.46		35	<1	11	<0.3	<0.001	-5.42	-32.1	70				
	2682000	6409800			7190/2	5/08/1993	44	9.29	0.1	145	1.3	2.7	0.03	<0.05	<0.05	151	10	12.6	66	0.43		37	<1	14	<0.25	<0.001			72				
	2682000	6409800		Te Maire Spring #1		1/08/1983	64	9.7	0.2	155	2.1	5.2	0.01			160	5	12.3	48														
	2682000	6409800		Te Maire S	4891/45	28/01/1981		8.88	0.1	158	1.6	2.9	0.007			159	10	11.7	63			51											
	2682000	6409800		Te Maire Bath	4891/28	27/01/1981		9.17	<0.1	149	1.6	2.9	0.05			159	10	12.6	74			46											
	2682000	6409800		Te Maire N	4891/27	27/01/1981		8.94	0.1	144	1.6	2.9	0.01			161	10	12.8	64			59											
	2682000	6409800		Te Maire HS	M49	19/12/1969		9.15	1.8	150	2.5	2.6	7.9			159	4	11.9	70			34		9.1									
	2682104	6409692		Te Maire (Naike) Hot Springs	72-2118	4/08/2009	43.8	9.3	0.11	140	1.5	2.8	< .1	0.0059	0.00087	150	6.8	12	73	0.36	87	22	0.0052	8.9	< .1	< .005			70.8	0.28	0.000089	< .001	< .00025
TE AROHA (7)	2750400	6402900	T13:504-029	Te Aroha Mokena	7323/4	20/04/1994	77.3	8.17	1.9	3190	69	4.2	3.7	0.31	0.27	570	374	156	118	2.5		6450	<1	2	<0.3	1.1	-2.28	-34	1034				
	2750400	6402900			7190/5	5/08/1993	72.9	8.18	2	3100	68	4.1	3.6	0.3	0.28	571	394	157	116	5.19		6300	<1	1.8	<0.25	1.2			1257				
	2750400	6402900				8/06/1905		8.4	1.9	3310	78	4.8	4.1			567	1260	170	123			7100											
	2750400	6402900			4891/31	29/01/1981		8.7	2	3120	70	3.4	3.8	0.42	0.36	575	417	151	114			6880											
	2750400	6402900				1/06/1905		7.8	1.8	2920	67	6.8	3.9			540	472	161	138			6830											
	2750400	6402900				11/05/1905		7.5	2	4675	108	8.2	4			582	321	161	120			7000											
	2750400	6402900				9/05/1905										596		114				5960											
	2750400	6402900				21/04/1905				3162	40	8	4			581	388	132				6860											
	2750244	6402898		Te Aroha Domain (Mokena Geyser)	72-2227	20/07/2009	94	7.8	1.9	2900	59	9.3	3.5	0.33	0.3	580	390	160	120	4.7	5700	18	0.1	1.7	< .4	1.2			1050	1.3	< .00008	0.0084	0.0017
WAINGARO (8)	2686600	6388100	R14:866-881	Waingaro Bore	7323/1	20/04/1994	53.8	9.59	0.06	86	0.62	1.3	0.02	<0.05	<0.05	50	11	5.1	58	0.42		61	<1	3.5	<0.3	<0.001	0.2	-29.2	37.9				
	2686600	6388100			7190/1	5/08/1993	53.3	9.59	0.06	84	0.96	1.2	0.02	<0.05	<0.05	49	6	5.1	61	0.35		67	<1	3.7	<0.25	<0.002			39.4				
	2686600	6388100		Waingaro HS	4891/30	27/01/1981		9.33	<0.1	35	0.6	16	<.005			52	11	5	64			76											
	2686598	6388271		Waingaro Hot Pool Bore	72-4292	4/08/2009	48.6	9.6	0.064	82	0.65	1.3	< .04	0.0016	< .0002	57	2	5	64	0.28	100	22	2.9	3.6	< .04	< .002			38.5	0.11	< .00008	< .0004	< .0001
ABERFOYLE ST (8)	2690600	6399100	S14:906-991??	Bore No 4, Aberfloye street, Perry Waste Services	72-298	30/03/2006	27.4	8.3	2.73	1230	6	306	4.3	0.02	0.016	2450	0.5	24.5	21.9	1.71	47	28	0.036	0.74	< 0.2	< 0.01	-3.83	-32.1		4.7	< 8.E-05	< 0.002	< 0.0005
WAITOA (8)	2738700	6407300	T13: 387-073	Waitoa	7323/5	20/04/1994	50.7	7.22	0.28	246	47	31	16	0.12	<0.05	47	6	4.5	174	0.81		885	<1	0.22	1.3	0.013	-6	-36	130				
	2738700	6407300			7190/4	5/08/1993	50.2	6.88	0.26	244	47	31	16.2	0.12	<0.05	48	7	5	176	<0.10		1063	<1	0.22	1.2	0.011			132				
	2738700	6407300			4891/29	29/01/1981		8.83	0.3	206	48	16.9	16.5	0.23	0.13	51	10	4.5	148			676											
	2738449	6407431		Waitoa Spring	72-4291	3/08/2009	51.1	7.1	0.27	230	46	29	18	0.12	0.0063	51	< .5	4.5	190	0.64	680	20	0.026	0.22	0.1	0.011			132	0.11	< .00008	< .0004	< .0001
WAHAROA (9)	2748100	6377800	T14:481-778	Scherers Road (Waharoa or Walton) Hot Springs	72-2111	9/03/2006	32.8	7.8	0.0587	36.3	8.28	11.5	4.76	0.0284	0.0014	10.5	1.3	0.268	90.9	0.02	120	72	< 0.002	0.15	< 0.02	0.005	-5.70	-33	26.6	0.033	< 8.E-05	< 0.0002	8.00E-05
	2756164	6366951	T15:561-669*	Taihoa South Road Hot Spring	72-2113	9/03/2006	45.7	7.4	0.228	128	16.1	23.1	13.3	0.0435	0.0038	16.3	<0.5	1.84	104	0.07	395	239	< 0.002	0.28	0.03	0.014	-5.82	-36	74.5	0.047	< 8.E-05	< 0.0002	8.00E-05
	2756572	6357344		Okoroire Spring (Okoroire Hotel Pool 4)	72-4294	4/08/2009	35.1	7.2	0.14	79	12	7	9.4	0.026	0.0012	14	< .5	0.45	150	0.11	240	19	0.0022	0.25	0.49	0.0045			47.4	0.035	< .00008	< .0002	< .00005
MATAMATA (10)	2759200	6373400	T14:592-734	Totara Springs: 288c Taihoa North Road	64-758	9/03/2006	39	7.6	0.149	82.2	14.5	10.7	9.82	0.029	0.0016	11.6	<0.5	0.709	121	0.04	252	152	< 0.002	0.34	0.21	0.008	-5.98	-34	49.2	0.032	< 8.E-05	< 0.0002	8.00E-05
	2759200	6373400		Bore at Kidd G	64-842	2/05/2006	35	7.9	0.119	72.3	13.1	8.53	7.94	0.0295	0.0014	11	1.9	0.549	120	0.03	202	122	< 0.002	0.37	0.3	0.006	-5.35	-35.6	40.3	0.031	< 8.E-05	< 0.0002	8.00E-05
OKAUIA (11)	2760200	6375500	T14:602-755	Opal Springs	7323/24	4/06/1994	39	7.32	0.2	110	11.3	16	9.9	<0.05	<0.05	15	<5	1	78	0.19		414		0.25	<0.3	0.013	-5.78	-35.3	60.3				
	2760200	6375500			4891/46	29/01/1981		7.65	0.2	97	10.4	23.5	11.1			17	6	0.89	77			402											
	2760231	6375499		Opal (Ramaroa or Paruparu) Hot Spring	72-2103	4/08/2009	38.5	7.2	0.16	99	11	16	11	0.028	0.0029	15	< .5	0.95	87	0.052	310	21	0.0032	0.24	< .04	0.012			58.5	0.038	< .00008	< .0004	< .0001
KAWHIA (12)	2666216	6347051	R15:663-470*		4891/48	28/01/1981		7.41	1.6	4290	174	2360	350	0.05	0.42	11540	603	9.34	43			93											
	2666216	6347051	R15:663-470*		7323/25	7/06/1994	46	7.75	2.5	4096	90	2050	339	0.17	0.0025	10140	584	7.3	39	3.3		49		0.58	1.2	0.017	-3.62	-20.2	3214				
	2666216	6347051	R15:663-470*	Kawhia (Te Puia) Hot Springs	72-2089	30/03/2006	45.4	7.9	1.71	3870	121	2150	107	0.094	0.004	9540	724	7.5	34.3	2.17	42	25	0.712	0.62	0.1	0.020	-2.66	-21.7		29.6	< 8.E-05	< 0.002	< 0.0005
Waikato R (13)	2793082	6294713	U17:930-947 *	Tahunatapu (btw Mihi & Tutakau bridge)	72-2996	21/09/2005	32.8	7.9	1.07	347	14.6	10.5	8.4	0.0579	0.0013	47.2	0.25	0.47	108	0.06	748	452	< 0.002	3.56	0.12	0.061	-6.11	-41	140.5	0.111	< 8.E-05	0.0005	< 5.E-05
	2798147	6296065	U17:981-960*	Piripiri Road (near Mihi bridge)	72-2987	20/09/2005	36	6.7	0.796	202	11.8	15.8	12	0.0336	0.0221	54.6	0.25	1.15	254	1.28	459	277	0.109	1.58	0.04	0.113	-7.16	-45.9	101	0.167	< 8.E-05	< 0.0004	< 5.E-05

Area:	Easting	Northing	GRID REF:	Site description	LOC KEY	Date Sampled	Temp	pH	Li	Na	K	Ca	Mg	Rb	Cs	Cl	SO4	B	SiO2 (Tot)	NH4	Alk	HCO3	S Tot	F	Fe	As	d^{18}O	d^{2}H	Cond	Br	Hg TR	Sb	Tl
TVZ:																																	
HOROHORO (14)	**2787600**	**6327700**	U16:876-277	Horohoro	1291	6/11/1963	47	8.7	0.5	186	4.3	9				155	40	9	152				0.3	14									
	2787600	**6327700**			4674	4/02/1980	55	8.5		209	1.9	0.07	0.26			168	45		149			285											
	2787600	**6327700**			5717	17/04/1984	49.9	8.38	0.6	224	6	2	0.12	0.04	0.06	169	41	2.4				244											
	2787600	**6327700**		Horohoro Hot Spring	5981/2/m	4/02/1985	52	8.32								172	42		152														
	2787600	**6327700**			7169/1	8/07/1993	43.7	8.3	0.55	188	4.2	0.86	0.17	<0.05	<0.05	150	37	2.1	140	0.37		159	<1	11.5	<0.25	0.48			91				
	2787600	**6327700**			7323/18	11/05/1994	47.2	8.39	0.61	219	4.5	0.65	0.07	<0.05	<0.05	168	41	2.4	150	0.46		177	<1	11	<0.3	0.62	-4.81	-35.4	100				
	2788379	**6323150**	U16:883-231*	Waipupumahana	72-3006	4/10/2005	47.9	8.4	0.584	214	4.85	0.63	0.06	0.0425	0.0432	143	37.6	2.34	155	0.37	141	85	< 0.002	14.5	0.04	0.603	-4.77	-36	90	0.427	0.00011	0.0397	< 5.E-05
	2788379	**6323150**		Waipupumahana	72-3006	22/07/2009	45	8.4	0.52	190	4	0.54	0.06	0.045	0.038	150	36	2	150	0.31	150	150	< .002	13	< .02	0.53			90.8	0.39	< .00008	0.026	< .00005
WAIOTAPU (15)	**2804500**	**6310200**	U16:045-102	Waiotapu #24	7323/8	27/04/1994	92.2	1.97	1.9	318	28	18	2.2	0.36	0.11	475	1370	5.6	319	27			1.3	0.34	11	2.1	-2.78	-33.4	70				
	2804500	**6310200**			7169/5	8/07/1993	90.5	2.03	1.9	279	29	17.7	1.9	0.34	0.16	428	1659	5.1	319	24.9			1.8	0.27	12.7	2			7.8				
	2804500	**6310200**				1978	81	2.5	2.9	384	65	2.5	4.1		0.59	614	530	2.35	412	47				0.88									
	2804491	**6310255**	U16:044-102*	Waiotapu Geyser S70	72-3007	30/09/2005	87.3	7	1.04	272	34.6	9.17	0.22	0.128	0.0682	332	89.9	4.75	377	3.68	89	54	8.16	1.65	< 0.02	0.574	-4.47	-39	142	1.13	0.00014	0.0094	< 5.E-05
	2804491	**6310255**		Wai-O-Tapu Geyser	72-3007	24/07/2009	84	7	1.1	270	29	8.7	0.19	0.14	0.047	340	100	4.4	160	3.8	88	17	9.2	1	< .04	0.58	2.1		150	1.1	0.000088	0.0061	< .0001
	2803781	**6311228**	U16:037-112*	Post Mistress S20	72-3008	30/09/2005	96.2	8.6	3.55	472	22.2	7.6	0.01	0.266	0.668	699	77.5	7.13	204	0.48	65	39	3.22	8.7	< 0.02	1.350	-4.45	-38	192	2.25	< 8.E-05	0.224	0.00045
	2804600	**6310500**	U16:046-105	Champagne Pool WT	7323/7	27/04/1994	76.1	5.54	8.3	1115	153	34	0.05	1.53	1.26	1905	90	26	426	34		237	11	4.9	<0.3	5	3.17	-23.3	616				
	2804600	**6310500**			7289/1	21/01/1994	75.5	5.72	8.4							1929																	
	2804600	**6310500**			7169/6	8/07/1993	74.9	5.6	8.4	1090	148	33	0.05	1.51	1.23	1858	91	26	427	31.8		220	8.8	5	<0.25	5.1			680				
	2804600	**6310500**			6317/m	7/06/1986	74	5.5	8.3	1065	144	33	0.55	1.42	1.27	1814	68	25.2	438			393											
	2804600	**6310500**			5716/2	14/04/1984	75.5	6.07	8.2	990	144	36	0.04	1.41	1.25	1807	64	25.1	380			424	18.1										
	2804600	**6310500**			5720	3/04/1984	75	5.98	8.2	990	142	36	0.05	1.45	1.28	1813	57	25	410			290	11.1										
	2804600	**6310500**			5679/2	31/01/1984	74	6.17	8.33	1109	150	34.2	0.06	1.41	1.28	1839	39	25	433			188.9	5.51										
	2804600	**6310500**			5672/1	10/01/1984	76	5.87	8.23	1113	138	34.7		1.4	1.3	1835	43	25.3	410			344	18										
	2804600	**6310500**			5670/1	15/12/1983	74.2	5.95	8.19	1103	141	33.7	0.05	1.4	1.27	1817	64	25.2	418			416											
	2804600	**6310500**			5653/1	8/12/1983	74.5	5.45	8.37	1091	149	32.3	0.04	1.44	1.31	1845	37	27.6	440			250											
	2804600	**6310500**			5638/1	23/11/1983	76	7.05	8.07	1088	143	32.4	0.03	1.41	1.25	1825	62	25.3	420				28.7										
	2804600	**6310500**			5626	27/10/1983		5.58	8.04	1079	143	32.6	0.04	1.41	1.27	1820	65	12.5	435			170	23										
	2804600	**6310500**			5538/1	3/08/1983	73	5.24	8	1072	143	33.6	0.05	1.57	1.33	1816	63	24.6	429			331				4.5							
	2804600	**6310500**			5428/11	19/05/1983	75			1078	141	33.8	0.06			1820	54		420			220	27										
	2804600	**6310500**			5383/7	17/03/1983	75	5.63	8.25	1102	151	35.1	0.048			1898	52.5	25.4	443			345	28										
	2804600	**6310500**			5126	18/05/1982	73	7.82	8.04	1109	150	33.8	0.06	1.54	1.33	1912	108	25.6	468				21										
	2804600	**6310500**				24/07/1958			8.2	1137	160	30.7	2.8			1961	143	27.2		10.7				5.2									
	2804600	**6310500**				27/06/1955		6.5	8	1146	160	29	2.4			1879	99	27	170	4.5		366	22	4.05									
	2804600	**6310500**				1926		4.9		1215	164	38.6	0.3			1990	119	23.9	448	37		43	18										
	2804468	**6310529**		Champagne Pool Wai-O-Tapu Site 1	72-4217	24/07/2009	71	5.4	9.3	1200	160	32	< .1	1.7	1.2	1900	86	25	430	28	22	100	8.6	4.9	< .1	1.4			614	6.1	0.00076	< .001	< .00025
	2804484	**6310461**		Champagne Pool Wai-O-Tapu Site 2	72-4218	24/07/2009	70	5.3	9.3	1200	160	32	< .1	1.7	1.2	1900	85	24	410	27	22	110	8.1	4.9	< .1	1.5			618	6.1	0.00091	< .001	< .00025
	2804517	**6310483**		Champagne Pool Wai-O-Tapu Site 3	72-4219	24/07/2009	71	5.4	9.1	1200	160	33	< .1	1.7	1.2	1900	83	25	410	28	22	17	11	4.8	< .1	1.6			616	6	0.00071	0.0012	< .00025
	2804514	**6310215**		Oyster Pool,Wai-O-Tapu	72-4225	24/07/2009	71	5.5	2.1	420	71	7.4	0.088	0.26	0.052	670	84	8.4	400	13	15	17	2.7	2.1	< .04	0.67			246	2.1	0.00093	0.003	< .0001
WAIKITE (16)	**2799100**	**6314300**	U16:991-143	Waikite WE1031	6914/32	21/01/1992	99.5	7.8	2.2	215	8.8	7.8	0.22	0.11	0.31	145	39	1.46	167			338											
	2799100	**6314300**			7136	21/05/1993	99.6	7.76	2.4	219	8.6	8.8	0.2	0.08	0.33	143	37	1.5	161	0.19		342	<1	2.8	<0.25	0.36			106				
	2799100	**6314300**			7323/19	11/05/1994	101.2	7.38	2.4	220	8.8	8.5	0.18	0.11	0.28	143	36	1.5	162	0.3		366	<1	2.5	<0.3	0.38	-6.31	-40.7	104				
	2799811	**6315010**	U16:998-150*	HT Geyser	72-2993	21/09/2005	97.5	7.9	3.25	292	20.1	0.95	0.03	0.167	0.266	174	41.2	1.99	249	0.17	373	225	0.006	4.1	< 0.02	0.454	-5.41	-38.2	124	0.509	0.00072	0.0517	0.00024
	2799709	**6314979**		Overflow From Spring Near HT Geyser	72-4393	1/09/2009	56.4	9.2	2.5	250	17	0.58	< .02	0.14	0.18	190	38	1.7	120	0.06	350	21	< .002	3.3	< .02	0.42			135	0.54	< .00008	0.024	0.00016
	2799028	**6314264**	U16:990-142*	Manuroa	72-2994	21/09/2005	97.5	7.8	2.53	226	10.1	7.83	0.17	0.121	0.365	127	35.3	1.73	173	0.32	280	169	0.012	2.8	< 0.02	0.383	-6.00	-40.9	104	0.403	< 8.E-05	0.0398	9.00E-05
	2798917	**6314272**		Top Inlet Spring, Waikite Hot Pools	72-4227	24/07/2009	62	8.8	2.2	210	7.2	4	0.15	0.11	0.31	140	38	1.5	170	0.094	270	17	< .002	2.3	< .02	0.34			104	0.4	< .00008	0.028	< .00005
	2798978	**6314244**		Hot Pools Supply Spring, Waikite Pools	72-4228	24/07/2009	97	8.1	2.2	210	7.1	6.3	0.15	0.1	0.3	140	36	1.4	160	0.14	270	17	< .002	2.2	< .02	0.33			101	0.4	< .00008	0.021	< .00005
	2798856	**6314283**		Waikite Baths Outlet, Waikite Hot Pools	72-4229	24/07/2009	69	8.8	2.2	210	7.8	6.5	0.22	0.11	0.29	140	36	1.5	170	0.11	270	17	< .002	2.2	< .02	0.34			102	0.4	< .00008	0.025	0.000051
ATIAMURI (17)	**2776600**	**6311100**	U16:766-111	Atiamuri Large Spring	3937	15/03/1978	69	8.7	3.93	445	20.1	1	0.01	0.18	1.06	328	41	11.2	280			565											
	2776600	**6311100**		Atiamuri	7169/2	8/07/1993	66	7.43	5	443	22	0.64	0.01	0.18	1.08	354	49	12.9	262	1.6		589	<1	13.9	<0.25	0.95			218				
	2776600	**6311100**			7323/17	11/05/1994	70	7.29	4.9	472	24	0.73	0.02	0.19	1.12	362	49	13.1	272	2.4		620	<1	14	<0.3	1.4	-2.22	-30.3	208				
	2778400	**6314500**		Spring Upper Atiamuri School	66-94	22/07/2009	13	6.3	0.0025	8	3.8	3	1.1	0.012	0.0011	5.4	4.3	0.006	83	< .01	23	19	< .002	0.082	< .02	0.0074			7.4	0.048	< .00008	< .0002	< .00005
	2776588	**6311132**	U16:765-111*	Whangapoua West	72-3004	4/10/2005	55.8	8.4	4.85	462	25.9	0.98	<0.02	0.17	1.05	343	44.9	13.5	280	1.62	442	267	< 0.002	14.8	< 0.02	1.170	-2.08	-32	192	0.936	0.0074	0.282	0.00027
	2776588	**6311132**		Whangapoua West, Northern Pool	72-3004	17/08/2009	60.2	7.7	4.5	400	19	0.67	< .04	0.18	0.93	370	50	12	130	2.2	460	18	0.0029	14	< .04	1			206	1	0.0083	0.16	0.00018
	2776615	**6311082**		Whangapoua West, Southern Pool	72-4387	17/08/2009	60.3	7.6	3.6	360	17	0.63	< .04	0.17	0.86	300	38	11	140	1.4	440	19	< .002	12	< .04	0.84			185	0.87	0.00058	0.13	0.00027
	2779214	**6312031**	U16:792-120*	Matapan Road	72-3005	4/10/2005	69.1	7.4	0.58	126	8.58	0.92	0.42	0.0255	0.0238	80.5	8.2	1.41	162	0.17	139	84	< 0.002	3.25	< 0.02	0.104	-6.44	-43	55.6	0.194	< 8.E-05	0.0169	5.00E-05
	2779198	**6312032**		Matapan Road	72-3005	17/08/2009	62.8	8.2	0.6	120	7.3	0.79	0.39	0.026	0.00099	86	8.2	1.3	160	0.15	160	170	< .002	2.6	< .04	0.091			59.2	0.2	< .00008	0.01	< .0001
REPOROA (18)	**2800943**	**6304321**	U17:009-043*	SE Spring	72-3001	29/09/2005	96.5	8.1	4.42	573	29.5	2.85	0.32	0.197	0.785	588	13.6	10.5	242	1.34	433	262	1.76	5.3	< 0.02	0.680	-4.79	-39	199	1.76	0.00013	0.187	0.00012
	2800943	**6304321**		South (SE) Spring	72-3001	23/07/2009	93	7.7	4.3	580	24	2.4	0.27	0.23	0.77	580	12	9	170	1.4	430	17	2.2	4.2	< .04	0.66			256	1.9	< .00008	0.12	< .0001
	2800900	**6304611**	U17:009-046*	North Maori Opaheke	72-3002	29/09/2005	97.5	7.4	5.71	716	47.3	1.5	<0.04	0.34	1.31	818	25.6	13.9	274	1.9	457	276	4.12	6.95	< 0.04	0.959	-4.01	-35	265	2.53	0.0013	0.279	0.0003
	2801200	**6304300**	U17:012-043	Opaheke #7	7323/6	27/04/1994	97.1	7.26	5.4	654	40	1.2	0.04	0.38	1.26	744	29	12.3	274	3		571	1	6.1	<0.3	0.93	-4.46	-36.8	316				
	2801200	**6304300**			7169/7	8/07/1993	95.3	7.22	5.3	665	40	1	0.03	0.38	1.27	746	30	12.7	268	2.41		601	2.5	6.1	<0.25	1			348				
	2800900	**6304611**		Opaheke Spring	72-4220	23/07/2009	53	6.7	5.7	730	40	1.7	0.043	0.39	1.2	770	48	12	250	2.2	450	18	0.52	6.1	< .04	0.96			328	2.6	0.0013	0.11	0.00018
TE KOPIA (19)	**2790900**	**6306600**	U17:909-066	Murphy's Farm	6997/8	5/03/1992	61.5	7.5	0.41	86	3.4	3.7			0.096	89	18	0.9	140			56											
	2790900	**6306600**			7135	21/05/1993	61	8.02	0.47	82	3.2	3.4	0.4	<0.05	0.11	83	22	0.91	134	<0.10		27	<1	4.6	<0.25	0.18			44.2				
	2790900	**6306600**			7323/20	11/05/1994	53.3	7.48	0.48	78	2.5	4.1	0.44	<0.05	<0.05	79	21	0.85	119	<0.1		48	<1	4	<0.3	0.13	-6.62	-40.8	40.3				
	2790900	**6306600**			7582/2/M	18/10/1995	61	7.57	0.46	80	3.6	3.5	0.54	0.03	0.08	82	19	0.81	139			52	<1										
	2790863	**6307363**	U17:908-073*	Murphy's NW	72-3003	30/09/2005	60.3	7.5	0.481	88	3.32	3.8	0.45	0.0399	0.105	95	20	1.03	137	<0.01	41	25	< 0.002	5.1	< 0.02	0.144	-6.46	-42	43.1	0.219	< 8.E-05	0.0065	5.00E-05
MOKAI (20)	**2767800**	**6300900**	T17:678-009	North Mokai (Waipapa)	7323/13	3/05/1994	60.8	6.46	2.6	253	13.8	10.1	1.3	0.15	0.34	371	7	4.5	129	<0.10		152	<1	1.3	<0.3	0.62	-6.72	-42.1	133				
	2767800	**6300900**			7178/2	15/07/1993	59.6	6.49	2.8	248	13.5	10.1	1.3	0.16	0.4	380	8	4.5	130	<0.10		119	<1	1.3	<0.25	0.53			141				
	2767800	**6300900**			5624/6	19/10/1983	58	6.55	2.93	258	15	10.8	1.1	0.17	0.42	362	9	5	144			119											
	2767800	**6300900**			5194/1	14/06/1982	59.4	6.25	2.76	251	12	9	1.25	0.14	0.38	371	4	4.3				139											
	2767800	**6300900**			4697	8/04/1980	57.5	6.35		252	13.4	9.1	1.1			370	8	4	137			155											
	2767800	**6300900**			4696	8/04/1980	57.5	6.3		243	12.9	8.9	1.2			353	8	3	127			140											
	2767800	**6300900**			4695	8/04/1980	57.5	6.65	2.77	250	13.2	9.2	1.2	0.142	0.33	364	8	4	197			170											
	2767800	**6300900**			3692/a	3/05/1978	58	6.95								370	6.8	4.2	130			90	<2										
	2767868	**6300960**		Waipapa Feature	72-4386	17/08/2009	54.5	7.2	2.9	310	15	11	0.88	0.17	0.4	490	5.4	5.5	160	0.021	110	120	< .002	1.7	< .04	0.6			180	1.3	< .00008	0.012	0.00023
	2766400	**6292900**	T17:664-929	South Mokai	7323/12	3/05/1994	51.5	6.3	0.16	176	9.9	12.3	2.5	<0.05	<0.05	34	<5	<0.1	116	<0.10		1043	<1	0.5	0.92	<0.001	-7.28	-43.8	76.5				
	2766400	**6292900**			7178/1	15/07/1993	49.2	6.31	0.17	170	9.6	11.7	2.4	<0.05	<0.05	31.2	5	0.32	117	<0.10		961	<1	0.54	0.9	<0.001			78.2				
	2766400	**6292900**			5624/6	19/10/1983	49	9.11	0.16	173	7.6	11.6	1.9	0.03	0.03	29.1	20	5	139														
	2766400	**6292900**			5194/2	14/06/1982		6.05	0.15	174	8	11	2.38	0.03	0.03	35	5	0.4															
	2766400	**6292900**			4699	8/04/1980		6.05		175	9.9	11.7	2.1			39	9		118														
	2763297	**6296116**		Parekiri Pool	72-4216	22/07/2009	41	3.2	0.023	240	29	20	4.9	0.14	0.0062	360	300	2.6	200	3.6	< 1	19	0.005	0.14	13	0.0078			181	0.96	< .00008	< .0002	0.00069

Area:	Easting	Northing	GRID REF:	Site description	LOC KEY	Date Sampled	Temp	pH	Li	Na	K	Ca	Mg	Rb	Cs	Cl	SO4	B	SiO2 (Tot)	NH4	Alk	HCO3	S Tot	F	Fe	As	$d^{18}O$	$d^{2}H$	Cond	Br	Hg TR	Sb	Tl
TVZ cont…																																	
ORAKEIKORAKO (21)	**2785500**	**6300800**	U17:855-008	Waihunuhunu - 674		18/05/1905	79.5	7.9	1.2	180	8	4	2			106	16	1.09	130			271											
	2785500	**6300800**			7169/4	8/07/1993	58	7.62	0.58	115	3.1	3.3	0.51	<0.05	<0.05	54.2	20	0.66	105	<0.10		196	<1	1.6	<0.25	0.22			54.1				
	2785500	**6300800**			7323/9	27/04/1994	58.9	7.07	0.61	118	3.5	3.7	0.47	<0.05	<0.05	57	21	0.65	105	<0.10		237	<1	1.5	<0.3	0.24	-6.84	-42.1	53.6				
	2785500	**6300800**			7582/4/M	18/10/1995	52.3	7.21	0.62	113	5.2	3.8	0.53	0.01	<0.05	57	19	0.59	118			229	<1										
	2785381	**6300493**	U17:853-004*	Waihunuhunu S674	72-2995	21/09/2005	80.6	7.4	0.918	170	6.72	3.96	0.31	0.0381	0.0127	93.2	27.9	1.07	148	0.41		207	< 0.002	3	< 0.02	0.493	-6.46	-40.9	62.7	0.232	0.0182	0.0118	< 5.E-05
	2785300	**6300400**		OK Guest House Pool	7323/10	27/04/1994	85.8	7.86	3	346	17	0.7	0.01	0.2	0.6	312	65	3.2	254	0.26		317	<1	9.8	<0.3	0.61	-4.13	-33.8	163				
	2784265	**6298542**	U17:842-985*	Map Of Australia S25	72-2998	29/09/2005	82	8.1	3.22	346	19.7	0.64	<0.02	0.189	0.608	309	66.3	3.58	252	0.07	245	148	0.004	11.1	< 0.02	0.656	-3.92	-35	141	0.786	< 8.E-05	0.0679	0.00053
	2784265	**6298542**		Map Of Australia, Orakei Korako	72-2998	23/07/2009	81	7.8	2.9	340	15	0.54	< .02	0.21	0.58	310	63	2.9	140	0.067	260	20	0.013	9.6	< .02	0.59			163	0.77	< .00008	0.044	0.0004
	2784653	**6298512**	U17:846-985 *	Sapphire S106	72-2999	29/09/2005	97.6	8.9	4.24	342	49.7	1.55	<0.02	0.438	0.577	336	83.3	3.79	306	0.08	229	138	0.627	12.6	< 0.02	0.647	-4.19	-33	151	0.866	< 8.E-05	0.0561	0.00116
	2784750	**6298522**	U17:847-986*	OK Manganese Pool - 120	5352/8	9/02/1983	94.1	8.7	4.11	322	48.6	1.7	0.05	0.53	0.67	339	99	3.6	376			207											
	2784700	**6298600**			7169/3	8/07/1993	64	7.42	3.1	241	37	2	0.23	0.38	0.48	254	108	2.8	278	<0.10		146	<1	8.4	<0.25	0.37			137				
	2784700	**6298600**			7323/21	11/05/1994	70.3	7.55	3.3	263	40	2.1	0.23	0.41	0.5	275	104	2.9	290	0.14		152	<1	10.2	<0.3	0.51	-4.52	-33.7	140				
	2784700	**6298500**	U17:847-985	Manganese S120	72-3000	29/09/2005	94.6	7.9	3.77	312	51.2	1.53	0.06	0.436	0.562	304	99.2	3.54	319	0.15	176	106	0.74	13.6	< 0.02	0.740	-4.31	-34	134	0.808	< 8.E-05	0.0591	0.00064
	2784750	**6298522**		Manganese Pool	72-3000	23/07/2009	75	7.8	4.4	360	48	1.8	0.19	0.54	0.58	340	130	3.4	120	0.13	220	21	< .002	11	< .02	0.54			181	0.85	< .00008	0.028	0.0012
NGATAMARIKI (22)	**2786700**	**6291800**	U17:867-918	New Spring	7137	21/05/1993	88.5	7.3	3.4	553	28	6.4	0.3	0.27	0.54	605	49	9	241	1.16		479	<1	2.5	<0.25	0.15			285				
					7323/22	11/05/1994	89.5	7.21	3.4	565	30	6.8	0.35	0.31	0.59	613	55	9.6	251	1.2		496	<1	2.5	<0.3	0.14	-4.88	-38	264				
	2787097	**6290463**	U17:870-904*	New North Spring	72-2990	20/09/2005	93.6	7.5	1.66	334	17.4	5.13	0.53	0.15	0.335	327	11.8	5.4	187	0.82	269	162	3.23	1.87	< 0.02	0.121	-6.20	-42.5	129	0.961	0.00157	0.028	0.00011
	2787313	**6292575**	U17:873-925*	North Stream Source	72-2991	20/09/2005	69.5	7.2	1.21	229	10.7	4.35	1.07	0.0889	0.206	216	13.3	3.74	153	0.52	188	114	0.134	1.28	< 0.02	0.061	-6.52	-43	113	0.614	0.00051	0.0201	0.00013
	2787933	**6293431**	U17:879-934 *	Waikato River	72-2992	20/09/2005	74.5	7	1.12	238	27.8	4.13	0.77	0.0727	0.0285	171	0.7	2.85	262	0.26	318	192	0.154	1.85	0.12	0.019	-6.64	-43.6	116	0.473	< 8.E-05	0.0008	< 5.E-05
	2786621	**6291710**	U17:866-917*	Southern Spring	72-2997	29/09/2005	72.1	7.6	3.24	587	22.6	1.28	0.17	0.211	0.482	646	49.8	9.6	237	0.56	367	222	0.036	3.9	< 0.02	0.180	-4.20	-39	2.87	1.71	0.00065	0.0631	0.00056
	2786600	**6291700**		Ngatamariki Main Pool	3371/4	1/10/1974	88.5	7.95	3.38	518	31.2	6.44	0.2	0.31	0.56	579	36	8.45	235			343											
	2786600	**6291700**			W/215	1/03/1960		7.34	2.9	450	24	7.5	0.96	0.05	<0.04	461	99	7	250	0.3													
	2786600	**6291700**		Blue Pool	6424/2/m	9/01/1987	71.1	7.8	3.6	583	33.2	6	0.23	0.29	0.67	639	65	9.9	270			437											
	2786600	**6291700**			6356/a	16/07/1986	71.2	7.8	3.5	579	34.2	5.1	0.23	0.31	0.68	638	70	9.5	270			443											
	2786600	**6291700**			6311/a	28/05/1986	71	7.7	3.6	571	32.5	5.1	0.25	0.31	0.7	634	68	9.6	280			456											
	2786600	**6291700**			5960/1	18/12/1984	78	7.67	3.6	498	31.5	4.21	0.16	0.33	0.69	628	69	9.5	244			450											
	2786600	**6291700**			4412	24/07/1979		7.81	3.53	510	32	5.1	0.19	0.39	0.02	597	40	9.1	245			458											
	2786600	**6291700**		Flowing Spring (Blue)	5444/1	7/06/1983	81.5	8.63	3.47	563	29.8	3.9	0.16	0.33	0.66	630	48	9.3	261			408											
OHAAKI (23)	**2798300**	**6296400**	U17:983-964	Ohaaki	7323/11	27/04/1994	32.5	6.64	0.78	219	10.6	17.8	11	<0.05	<0.05	54	<5	1.2	133	1.3		847	<1	1.5	0.97	0.12			105				
ROTOKAWA (24)	**2787900**	**6281300**	U17:879-813	Rotokawa #4	7341/3	14/06/1994	94.2	6.83	3.4	430	34	21	1.6	0.35	0.31	538	99	18.2	198	3.6		155	<1	2.2	0.3	0.91	-5.33	-42.4	231				
	2787900	**6281300**			7291/1	28/01/1994	80.2	7.82	3	393	30	18	1	0.38	0.53	496	112	17.7	218	3.6		115	<1	1.6	<0.3	1.5			197				
	2787910	**6281363**		RK#4A	72-4392	1/09/2009	78.4	2.3	2	280	31	32	8.2	0.43	0.42	350	1100	11	270	9.6	< 1	20	16	1.6	6.6	0.024			442	0.97	0.00069	< .0004	0.00039
	2787900	**6281400**	U17:879-814	Rotokawa #4A	7341/1	14/06/1994	78.4	2.63	2.8	379	47	35	8.3	0.5	0.46	447	685	15.5	238	10			27.1	3.2	6.3	0.15	-3.54	-35.9	355				
	2787900	**6281400**			7291/2	28/01/1994	75	2.4	2.7	362	42	35	8.4	0.47	0.42	418	932	13.2	246	9.5			20.8	3.2	9.6	0.15			401				
	2788600	**6281600**	U17:886-816	Rotokawa #22	7341/4	14/06/1994	90	2.27	3	366	50	43	8.5	0.64	0.66	454	980	16.3	313	20			<1	2	14	0.86	-3.71	-35.9	571				
	2788600	**6281600**			7291/4	28/01/1994	80.1	2.1	3.1	375	53	44	8.5	0.68	0.67	450	1038	16.5	319	17			<1	1.8	15	1.1			558				
	2788400	**6282100**	U17:884-821	Rotokawa #10	7341/5	14/06/1994	74.5	2.6	5.3	462	206	33	7.4	1.79	1.02	629	803	25.7	352	36		290	<1	2.4	0.46	1.2	-0.95	-28.1	485				
	2788400	**6282100**			7291/5	1/02/1994	72.5	2.42	5.3	473	206	33	7.6	1.84	1.05	635	898	25.4	355	33		110	<1	2.2	0.68	1.3			508				
WAIRAKEI (25)	**2779000**	**6280200**	U17:790-802	WK Totara Gut	7323/14	4/05/1994	33.5	6.62	<0.05	25	4.8	9.4	3.7	<0.05	<0.05	8.5	26	0.1	117	<0.1		94	<1	0.18	<0.3	0.012	-6.87	-43.4	19.9				
	2779000	**6280200**			7178/3	15/07/1993	32	6.72	<0.05	24	4.4	9	3.7	<0.05	<0.05	9.2	27	0.1	116	<0.10		64	<1	0.17	<0.25	0.008			19.7				
TAUPO/TAUHARA (26)	**2778331**	**6273570**	U18:783-735*	Taharepa	7323/26	9/06/1994		6.57	0.71	169	33	24	4.4	0.08	<0.05	115	131	2.1	232	2.9		377	<1	0.62	<0.3	0.13	-6.78	-44.8	107				
	2778331	**6273570**	U18:783-735*	Taharepa	72-2988	20/09/2005	66	7.1	0.627	161	35.5	23	4.01	0.0831	0.0167	104	131	2.22	276	1.99	181	109	0.015	0.61	0.94	0.109	-6.63	-44.8	101	0.311	< 8.E-05	0.0061	< 5.E-05
	2778331	**6273570**		Taharepa	72-2988	23/07/2009	66	7	0.78	200	35	23	3.7	0.093	0.015	160	100	2.7	250	2	250	18	0.003	0.62	0.79	0.13			116	0.42	< .00008	0.0062	< .00005
	2778700	**6272700**	U18:787-727	Terraces	7323/27	9/06/1994		6.97	3.2	314	33	17	5.4	0.17	0.17	332	70	6.6	239	0.77		371	<1	0.62	<0.3	0.22	-6.85	-46.8	165				
	2778300	**6273200**	U18:783-732	Lake Front	7323/28	9/06/1994		6.48	0.82	201	39	26	4.3	0.09	<0.05	156	107	2.8	240	2.6		509	<1	0.68	0.98	0.14	-6.84	-45.4	117				
	2779500	**6276500**	U18:795-765	Spa Spring	7338/1	9/06/1994	92.2	6.26	0.41	144	35	25	9.7	0.15	<0.05	9.7	410	0.19	331	2.9		49	<1	1.3		0.062	-5.61	-35.9	96.3				
	2779500	**6276000**	U18:795-760	Primary Spring	7338/2	9/06/1994	78	6.53	0.23	95	15	15	3.1	0.05	<0.05	7.4	211	<0.01	290	1.2		95	<1	1.6		0.01	-7.05	-46.3	59.1				
	2779300	**6276000**	U18:793-760	AC Spring	7338/3	9/06/1994		6.68	0.19	88	14	8.2		0.06	<0.05	7.2	146	0.12	258	1		126	<1	1.8		0.022	-6.92	-47.2	49.8				
	2779908	**6273262**	U18:799-732*	Top Spring De Bretts	72-2989	20/09/2005	67.3	7	3.14	300	36.8	18.1	5.72	0.184	0.264	331	73.7	7.21	262	1.11	229	138	< 0.002	0.64	< 0.02	0.200	-6.71	-46.5	155	0.946	< 8.E-05	0.0783	0.00014
	2779908	**6273262**		Waipahihi Spring	72-2989	23/07/2009	68	6.8	3	300	30	15	4.7	0.18	0.23	330	75	6.2	260	0.91	250	19	< .002	0.55	< .04	0.17			165	0.86	< .00008	0.043	0.00017

Area:	Easting	Northing	GRID REF:	Site description	LOC KEY	Date Sampled	Temp	pH	Li	Na	K	Ca	Mg	Rb	Cs	Cl	SO4	B	SiO2 (Tot)	NH4	Alk	HCO3	S Tot	F	Fe	As	d^{18}O	d^{2}H	Cond	Br	Hg TR	Sb	Tl
TNP & VICINITY																																	
WAIHI (27)	**2747861**	**6246796**	T19479-468*	Waihi #47 Whakatara	7323/29	9/06/1994										469						551					-6.16	-42.2					
	2747861	**6246796**			7323/15	4/05/1994	76	6.86	3.3	284	45		24	0.33	0.58	470	28	14.2	224	3		455	<1	0.21	<0.01	1.2	5.94	-42.1	203				
	2747861	**6246796**			7242/1	18/10/1993	76	6.55	3.3	280	46	52	24	0.32	0.58	477	30	14.8	214	3.1		539	<1	0.21	<0.01	1.1							
	2747861	**6246796**	T19:478-467*	Whakatara S47	72-2982	16/09/2005	75.3	7	3.21	267	49.9	65.6	25	0.326	0.603	467	27.3	14.9	248	2.54	257	155	< 0.002	0.24	< 0.02	1.320	-5.80	-40.5	186	1.55	0.0003	0.118	0.00066
	2747861	**6246796**			1939/14	19/04/1966	75	6.55	2.7	242	42	66	29	0.1	0.3	440	27	13.3	212	2		468		0.2	0.01	0.01							
TOKAANU (28)	**2749400**	**6244900**	T19:494-449	Bathhouse Spg Tokaanu	7323/16	4/05/1994	66	6.37	26	1927	162		0.18	1.68	4.8	3165	76	95	309	4.9		132	<1	1.6	<0.3	10.3	0.18	-33.3	961				
	2749400	**6244900**			7242/2	18/10/1993	66	6.18	26	1927	171	43	0.22	1.72	5.1	3258	82	92	306	4.78		134	<1	1.6		10							
	2749692	**6244929**	T19:496-449*	Tuwhare	72-2983	16/09/2005	79.2	7.5	24.8	1390	166	47.7	3	1.49	4.5	2570	49.9	72.4	285	2.56	168	101	< 0.002	1.15	< 0.1	7.710	-2.15	-36.9	586	7.78	0.00208	0.982	0.0086
	2749633	**6244806**	T19:496-448*	Taumatapuhipuhi	72-2984	16/09/2005	98.1	7.8	31.5	1620	168	33.2	0.1	1.56	5.27	3220	62	88.3	243	2.56	56	34	< 0.002	1.55	< 0.1	9.190	-2.47	-37.4	635	9.55	0.00083	0.896	0.008
	2749636	**6244799**	6244799 N	Taumatapuhipuhi geyser	2201857	28/11/2002	98	7.47	23	1680	187	34	0.11			3056	63	86	248	3.6		64	<0.01	1.3	0.06	8.0	-1.8	-36.9		9.6			
	2749633	**6244806**		Taumatapuhipuhi	72-2984	23/07/2009	98	7.6	25	1700	140	33	< .2	1.7	4.2	3200	61	88	150	2.8	65	19	0.003	1.4	< .2	9			930	9.7	0.00038	0.63	0.0077
	2749459	**6244729**	T19:494-447*	Takarea No.5	72-2985	16/09/2005	59.5	6.5	34.2	1750	177	42.4	0.2	1.79	5.53	3710	77.8	94.5	330	3.87	40	24	0.004	1.67	< 0.1	10.300	0.26	-31.8	768	10.8	0.00389	1.43	0.0079
	2749459	**6244729**		Thermal Spring, Takarea No.5	72-2985	23/07/2009	57	6.3	30	2100	170	40	< .2	1.8	4.5	3200	78	98	310	3.1	40	16	< .002	1.5	< .2	9.6			958	10	0.0013	0.9	0.0077
	2749211	**6244703**	T19:492-447*	Healy Bore No.2	72-2986	16/09/2005	90.5	7.9	14.6	1090	98.2	55	1.5	0.893	3	1810	47.2	59.4	145	4.41	40	24	< 0.002	0.81	< 0.1	5.830	-3.48	-37.2	427	6.09	8.00E-05	0.765	0.0038
	2749211	**6244703**			1939/45	3/05/1966	67	6.85	21.8	1750	165	37				2936	69	89	320	1.7		22		2									
	2749589	**6244772**	6244772 N	#31D Spring(Teretere)	2201858	28/11/2002	72.0	7.10	24	1760	183	42	0.21			3117	77	92	316	3.4		60	0.21	1.2	0.06	8.8	0.5	-30		8.3			
	2749589	**6244772**			2302417	1/12/2003	86	7.55	23	1671	174	36.0	0.43			3128	66.0	87	324	2.7		67	<0.02	1.3	0.4	9.0	-1.4	-36.5		10.2			
	2749589	**6244772**			2402704	22/12/2004	85.3	7.34	24	1779	189	37	0.56			3116	66	84	296	2.7		102	<0.01	1.6	<0.02	9.1	-1.28	-38.6		10.9			
	2749589	**6244772**			2503635	19/12/2005	86.1	7.48	27	1808	203	41	0.56			3099	66	87	307	2.9		107	<0.01	1.4	<0.02	8.9	-1.39	-32.5		102			
	2749589	**6244772**			2700753	17/04/2006	85.5	6.98	26	1793	174	43	0.9			3182	64	92	312	3.1		128	<0.01	1.4	<0.08	9.6	-1.55	-38.8		10.1			
	2749456	**6244722**	6244722 N	#5 Pool	2201859	28/11/2002	32.0	6.33	24	1740	190	37	0.26			3147	64	91	322	3.3		74	<0.01	1.2	0.05	8.6	-1.4	-36.9		10.2			
	2749456	**6244722**			2302416	1/12/2003	61.8	6.62	23	1777	168	39	0.16			3157	78	90	316	3.9		47	<0.02	1.3	<0.02	9.3	0.5	-33.6		12.6			
	2749456	**6244722**			2402705	22/12/2004	63.1	6.65	22	1726	177	34	0.18			3053	70	80	281	3.0		44	<0.01	1.6	<0.02	8.7	0.14	-35.4		10.5			
	2749456	**6244722**			2503634	19/12/2005	62.0	6.45	25	1740	193	38	0.09			3121	75	85	299	4.2		50	<0.01	1.3	<0.02	8.7	0.19	-25.5		9.9			
	2749456	**6244722**			2700754	17/04/2006	59.3	6.13	26	1820	173	41	0.18			3226	77	94	313	4.5		86	0.017	1.6	<0.08	9.7	0.13	-34.7		10.3			
KETETAHI (29)	**2738982**	**6229752**	6229752 N	Ketatahi Stream	8075/2/M	11/06/1998	67	3.77	<0.05	25	10.2	56	25	<0.05	<0.05	1.27	648	58	223				1.6		15.5								
	2738982	**6229752**		Ketatahi Stream Lower)	2503346	1/12/2005	54	3.45	<0.05	28	12.1	41	20	1.2	619	84	230	92	0.01	5.7		10.4	<0.1		0.01		-0.41	-27.6					
	2738994	**6229561**	6229561 N	Ket Stream Headwaters	2503345	1/12/2005	66.1	7.09	<0.05	20	8.9	40	24	1.3	136	1.1	216	208	0.024	0.77		<0.1	<0.1		0.10		-6.91	-44.2					
	2739023	**6229712**	6229712 N	Black Cauldron	9800443	27/11/1998	90	6.37	0.05	63	18.8	147	128	0.12	<0.05	2.9	1638	313	267				0.05		<0.1								
	2739023	**6229712**			2503344	1/12/2005	90.2	6.80	0.06	53	17.0	104	99	1.2	1524	224	275	72	0.59	0.52		<0.1	<0.1		<0.005		4.06	-16.5					
	2739100	**6229500**	T19:391-295		7377/2	14/09/1994	81.2	6.65	<0.05	12.2	8.1	26	15			0.71	1135	201	148	290		192	<1	<0.1	6	0.005							
	2739100	**6229500**			6853/2	30/08/1990		3.34	<0.05	64	17.2	150	135	0.11	>0.05	5.85	1980	181	230			82	<0.05		12	<1							
	2739100	**6229500**			6680/5	4/04/1989	79.1	2.7	0.04	54	17	130	96	0.12	<0.05	29	1600	276	245			102	0.35		11	<1							
	2739000	**6229400**	T19:390-294	Iron Spring	7377/1	14/09/1994	62.3	6.29	0.08	34	10.5	43	25			1.4	564	2.1	243	17.4		225		0.33	4.6	0.005							
	2739000	**6229400**			6853/1	28/08/1990		7.33	<0.05	28	10.2	60	36	0.05	<0.05	1.17	310	<0.05	201			63	<0.05		4.8	<1							
	2739000	**6229400**			6675/1/m	23/04/1989	69		0.02	25	7	36	22	0.04	<0.03	3	141	1	164														
	2739020	**6230057**	6230057 N	Ketatahi Stream at track crossing	2700940	22/05/2007	24.8	2.88	0.03	34	13.4	77	40	1.7	1180	135	271		<0.01	15.8		30	<0.015		0.36		0.55	-22.5					
SODA SPRINGS (31)	**2739662**	**6226652**	6226652 N	No Name Spring	2000890	25/05/2000		5.4	<0.05	32	6.0	83	44			1.4	480	<0.2	170			35			11.1	<0.1	-6.96	-46		<0.03			
	2739662	**6226652**			2101068	7/07/2001	50.4	4.5	0.13	41	8.0	79	38			1.6	501	0.2	204	1.0		<5	<0.01	<0.1	7.9	0.42	-6.16	-45.4		<0.03			
	2739662	**6226652**			2300785	7/05/2003	38.4	5.61	<0.05	46	7.8	136	65			2.0	761	<0.1	201	0.5		129	<0.01	0.12	18.6	<0.1	-6.1	-41.2		<0.10			
	2739662	**6226652**			2400932	17/05/2004	61.0	6.42	<0.05	37	7.3	116	57			1.4	546	0.15	232	0.67		44	<0.01	0.08	4.3	<0.1	-4.86	-38.6		<0.10			
	2739662	**6226652**			2501562	25/05/2005	44.8	4.1	<0.05	39	6.3	146	68			1.1	721	0.56	226	0.35		112	0.19	<0.005	16.6	<0.1	-6.59	-43.9		<0.04			
	2739662	**6226652**			2601370	27/04/2006	65.7	4.48	<0.05	44	7.9	105	47			1.8	525	<0.1	248	0.74		28	<0.01	0.049	12.3	<0.1	-5.5	-40.6		<0.04			
	2739662	**6226652**			2700860	8/05/2007	57	6.47	0.02	42	8.3	144	66			1.9	677	<0.3	224	0.64		173	<0.01	<0.03	9.9	<0.015	-5.47	-43.8		<0.10			

APPENDIX II Sites monitored in the 2009 programme, and all data available for these features.

Area:	Easting	Northing	GRID REF:	Site description	LOC KEY	Date Sampled	Temp	pH	Li	Na	K	Ca	Mg	Rb	Cs	Cl	SO4	B	SiO2 (Tot)	NH4	HCO3	S Tot	F	Fe	As	Cond	Br	Hg TR	Sb	Tl
COROMANDEL (1)	2762100	6475600		Hot Water Beach Well	MI40	17/06/1973	50	6.7	8.6	1035	96	151	2.3	0.87	0.87	1924	2.3	1.53	75		186		1.4							
	2762100	6475600		Hot Water Beach Spring	MI39	17/06/1973	63	7.6	8.6	1253	99	242	18	0.76	0.76	2240	31	1.63	66		254		1.2							
	2762100	6475600			4891/24	30/01/1981		7.85	7.6	1587	98	177	58	0.83	0.62	2759	146	1.4	56		211									
	2762100	6475600			5658	15/12/1983	50	8.11	6.04	3726	193	334	215.3	0.89	0.84	6585	670	2.1	45	0.3	236	2								
	2762100	6475600	T11:621-756	Hot Water Beach	7323/23	4/06/1994	51.6	7.45	7.3	3100	127	181	209	0.75	0.91	5536	514	2	68	1.8	246		1.7	0.3	0.064	1644				
	2761889	6475323		Hot Water Beach Old Motor Camp Bore	72-4389	27/08/2009	20	6.6	8.2	1100	82	140	2.1	0.76	0.82	1900	5	1.4	83	1.3	152	0.012	1.7	0.55	0.005	627	6.5	0.00008	0.0013	0.00025
Area:	Easting	Northing	GRID REF:	Site description	LOC KEY	Date Sampled	Temp	pH	Li	Na	K	Ca	Mg	Rb	Cs	Cl	SO4	B	SiO2 (Tot)	NH4	HCO3	S Tot	F	Fe	As	Cond	Br	Hg TR	Sb	Tl
MIRANDA (3)	2717100	6441100		Miranda HS	5963/6	7/12/1984	56.5	8.93	0.2	80	5	3.9	0.02	0.05	0.05	151	22	5	52											
	2717100	6441100			7190/3	5/08/1993	53.1	9.15	0.18	127	1.4	2.6	0.01	0.05	0.05	150	7	5.1	56	0.38	56	1	0.86	0.25	0.001	65.4				
	2717100	6441100	S12: 171-411	Miranda-Bath Source	7323/3	20/04/1994	55.3	6.21	0.19	133	1.8	2.8	0.02	0.05	0.05	151	11	4.9	55	0.45	54	1	0.96		0.001	64.6				
	2717315	6441162		Miranda Hot Pools	72-4290	3/08/2009	53.6	9.2	0.18	120	1.7	2.7	0.04	0.0036	0.0027	150	1.6	4.5	61	0.38	19	6.1	0.9	0.04	0.002	65.6	0.35	0.00008	0.0004	0.0001
Area:	Easting	Northing	GRID REF:	Site description	LOC KEY	Date Sampled	Temp	pH	Li	Na	K	Ca	Mg	Rb	Cs	Cl	SO4	B	SiO2 (Tot)	NH4	HCO3	S Tot	F	Fe	As	Cond	Br	Hg TR	Sb	Tl
L. WAIKARE (5)	2707137	6415506	S13:071-155*	Lake Waikare Vent	326-45	23/04/2004	79.8	8.2	0.275	129	5.84	5.4	1.53			168	19	8.46	216		43	0.122				69.6		0.557		
	2707137	6415506	S13:071-155*	Lake Waikare vent	326-45	30/08/2005	64.5	8.9	0.473	201	7	12	1.3	0.018	0.019	299	7.3	16.1	77.6	0.87	40	2.93	1.74	2.9	0.020	115	0.6	0.00254	0.004	0.001
	2701679	6413205		Ohinewai Spring	72-2100	3/08/2009	21.3	9	0.72	280	2	6.1	0.14	0.0032	0.0005	390	1.3	22	25	0.87	19	0.16	4.9	0.1	0.005	142	0.61	0.00008	0.001	0.00025
Area:	Easting	Northing	GRID REF:	Site description	LOC KEY	Date Sampled	Temp	pH	Li	Na	K	Ca	Mg	Rb	Cs	Cl	SO4	B	SiO2 (Tot)	NH4	HCO3	S Tot	F	Fe	As	Cond	Br	Hg TR	Sb	Tl
TE MAIRE (NAIKE) (6)	2682000	6409800		Te Maire HS	M49	19/12/1969		9.15	1.8	150	2.5	2.6	7.9			159	4	11.9	70		34		9.1							
	2682000	6409800		Te Maire S	4891/45	28/01/1981		8.88	0.1	158	1.6	2.9	0.007			159	10	11.7	63		51									
	2682000	6409800		Te Maire Bath	4891/28	27/01/1981		9.17	0.1	149	1.6	2.9	0.05			159	10	12.6	74		46									
	2682000	6409800		Te Maire N	4891/27	27/01/1981		8.94	0.1	144	1.6	2.9	0.01			161	10	12.8	64		59									
	2682000	6409800		Te Maire Spring #1		1/08/1983	64	9.7	0.2	155	2.1	5.2	0.01			160	5	12.3	48											
	2682000	6409800			7190/2	5/08/1993	44	9.29	0.1	145	1.3	2.7	0.03	0.05	0.05	151	10	12.6	66	0.43	37	1	14	0.25	0.001	72				
	2682000	6409800	R13:820-098	Te Maire Naike	7323/2	20/04/1994	46.9	9.3	0.11	150	1.7	2.9	0.02	0.05	0.05	153	10	12.2	66	0.46	35	1	11	0.3	0.001	70				
	2682104	6409692		Te Maire (Naike) Hot Springs	72-2118	4/08/2009	43.8	9.3	0.11	140	1.5	2.8	0.1	0.0059	0.00087	150	6.8	12	73	0.36	22	0.0052	8.9	0.1	0.005	70.8	0.28	0.000089	0.001	0.00025
Area:	Easting	Northing	GRID REF:	Site description	LOC KEY	Date Sampled	Temp	pH	Li	Na	K	Ca	Mg	Rb	Cs	Cl	SO4	B	SiO2 (Tot)	NH4	HCO3	S Tot	F	Fe	As	Cond	Br	Hg TR	Sb	Tl
TE AROHA (7)	2750400	6402900				1/06/1905		7.8	1.8	2920	67	6.8	3.9			540	472	161	138		6830									
	2750400	6402900				11/05/1905		7.5	2	4675	108	8.2	4			582	321	161	120		7000									
	2750400	6402900				9/05/1905										596		114			5960									
	2750400	6402900				21/04/1905				3162	40	8	4			581	388	132			6860									
	2750400	6402900				8/06/1905		8.4	1.9	3310	78	4.8	4.1			567	1260	170	123		7100									
	2750400	6402900			4891/31	29/01/1981		8.7	2	3120	70	3.4	3.8	0.42	0.36	575	417	151	114		6880									
	2750400	6402900			7190/5	5/08/1993	72.9	8.18	2	3100	68	4.1	3.6	0.3	0.28	571	394	157	116	5.19	6300	1	1.8	0.25	1.2	1257				
	2750400	6402900	T13:504-029	Te Aroha Mokena	7323/4	20/04/1994	77.3	8.17	1.9	3190	69	4.2	3.7	0.31	0.27	570	374	156	118	2.5	6450	1	2	0.3	1.1	1034				
	2750244	6402898		Te Aroha Domain (Mokena Geyser)	72-2227	20/07/2009	94	7.8	1.9	2900	59	9.3	3.5	0.33	0.3	580	390	160	120	4.7	18	0.1	1.7	0.4	1.2	1050	1.3	0.00008	0.0084	0.0017
Area:	Easting	Northing	GRID REF:	Site description	LOC KEY	Date Sampled	Temp	pH	Li	Na	K	Ca	Mg	Rb	Cs	Cl	SO4	B	SiO2 (Tot)	NH4	HCO3	S Tot	F	Fe	As	Cond	Br	Hg TR	Sb	Tl
	2686600	6388100		Waingaro HS	4891/30	27/01/1981		9.33	0.1	35	0.6	16	0.005			52	11	5	64		76									
	2686600	6388100			7190/1	5/08/1993	53.3	9.59	0.06	84	0.96	1.2	0.02	0.05	0.05	49	6	5.1	61	0.35	67	1	3.7	0.25	0.002	39.4				
WAINGARO (8)	2686600	6388100	R14:866-881	Waingaro Bore	7323/1	20/04/1994	53.8	9.59	0.06	86	0.62	1.3	0.02	0.05	0.05	50	11	5.1	58	0.42	61	1	3.5	0.3	0.001	37.9				
	2686598	6388271		Waingaro Hot Pool Bore	72-4292	4/08/2009	48.6	9.6	0.064	82	0.65	1.3	0.04	0.0016	0.0002	57	2	5	64	0.28	22	2.9	3.6	0.04	0.002	38.5	0.11	0.00008	0.0004	0.0001
Area:	Easting	Northing	GRID REF:	Site description	LOC KEY	Date Sampled	Temp	pH	Li	Na	K	Ca	Mg	Rb	Cs	Cl	SO4	B	SiO2 (Tot)	NH4	HCO3	S Tot	F	Fe	As	Cond	Br	Hg TR	Sb	Tl
WAITOA (8)	2738700	6407300			4891/29	29/01/1981		8.83	0.3	206	48	16.9	16.5	0.23	0.13	51	10	4.5	148		676									
	2738700	6407300			7190/4	5/08/1993	50.2	6.88	0.26	244	47	31	16.2	0.12	0.05	48	7	5	176	0.1	1063	1	0.22	1.2	0.011	132				
	2738700	6407300	T13: 387-073	Waitoa	7323/5	20/04/1994	50.7	7.22	0.28	246	47	31	16	0.12	0.05	47	6	4.5	174	0.81	885	1	0.22	1.3	0.013	130				
	2738449	6407431		Waitoa Spring	72-4291	3/08/2009	51.1	7.1	0.27	230	46	29	18	0.12	0.0063	51	0.5	4.5	190	0.64	20	0.026	0.22	0.1	0.011	132	0.11	0.00008	0.0004	0.0001
Area:	Easting	Northing	GRID REF:	Site description	LOC KEY	Date Sampled	Temp	pH	Li	Na	K	Ca	Mg	Rb	Cs	Cl	SO4	B	SiO2 (Tot)	NH4	HCO3	S Tot	F	Fe	As	Cond	Br	Hg TR	Sb	Tl
	2760200	6375500			4891/46	29/01/1981		7.65	0.2	97	10.4	23.5	11.1			17	6	0.89	77		402									
OKAUIA (11)	2760200	6375500	T14:602-755	Opal Springs	7323/24	4/06/1994	39	7.32	0.2	110	11.3	16	9.9	0.05	0.05	15	5	1	78	0.19	414		0.25	0.3	0.013	60.3				
	2760231	6375499		Opal (Ramaroa or Paruparu) Hot Spring	72-2103	4/08/2009	38.5	7.2	0.16	99	11	16	11	0.028	0.0029	15	0.5	0.95	87	0.052	21	0.0032	0.24	0.04	0.012	58.5	0.038	0.00008	0.0004	0.0001
Area:	Easting	Northing	GRID REF:	Site description	LOC KEY	Date Sampled	Temp	pH	Li	Na	K	Ca	Mg	Rb	Cs	Cl	SO4	B	SiO2 (Tot)	NH4	HCO3	S Tot	F	Fe	As	Cond	Br	Hg TR	Sb	Tl
HOROHORO (14)	2787600	6327700	U16:876-277	Horohoro	1291	6/11/1963	47	8.7	0.5	186	4.3	9				155	40	9	152			0.3	14							
	2787600	6327700			4674	4/02/1980	55	8.5		209	1.9	0.07	0.26			168	45		149		285									
	2787600	6327700			5717	17/04/1984	49.9	8.38	0.6	224	6	2	0.12	0.04	0.06	169	41	2.4			244									
	2787600	6327700		Horohoro Hot Spring	5981/2/m	4/02/1985	52	8.32								172	42		152											
	2787600	6327700			7169/1	8/07/1993	43.7	8.3	0.55	188	4.2	0.86	0.17	0.05	0.05	150	37	2.1	140	0.37	159	1	11.5	0.25	0.48	91				
	2787600	6327700			7323/18	11/05/1994	47.2	8.39	0.61	219	4.5	0.65	0.07	0.05	0.05	168	41	2.4	150	0.46	177	1	11	0.3	0.62	100				
	2788379	6323150	U16:883-231*	Waipupumahana	72-3006	4/10/2005	47.9	8.4	0.584	214	4.85	0.63	0.06	0.0425	0.0432	143	37.6	2.34	155	0.37	85	0.002	14.5	0.04	0.603	90	0.427	0.00011	0.0397	5.00E-05
	2788379	6323150		Waipupumahana	72-3006	22/07/2009	45	8.4	0.52	190	4	0.54	0.06	0.045	0.038	150	36	2	150	0.31	150	0.002	13	0.02	0.53	90.8	0.39	0.00008	0.026	0.00005
Area:	Easting	Northing	GRID REF:	Site description	LOC KEY	Date Sampled	Temp	pH	Li	Na	K	Ca	Mg	Rb	Cs	Cl	SO4	B	SiO2 (Tot)	NH4	HCO3	S Tot	F	Fe	As	Cond	Br	Hg TR	Sb	Tl
WAIOTAPU (15)	2804600	6310500		Champagne Pool -Wai-O-Tapu		1926		4.9		1215	164	38.6	0.3			1990	119	23.9	448	37	43	18								
	2804600	6310500				27/06/1955		6.5	8	1146	160	29	2.4			1879	99	27	170	4.5	366	22	4.05							
	2804600	6310500				24/07/1958			8.2	1137	160	30.7	2.8			1961	143	27.2		10.7			5.2							
	2804600	6310500			5126	18/05/1982	73	7.82	8.04	1109	150	33.8	0.06	1.54	1.33	1912	108	25.6	468			21								
	2804600	6310500			5670/1	15/12/1983	74.2	5.95	8.19	1103	141	33.7	0.05	1.4	1.27	1817	64	25.2	418		416									
	2804600	6310500			5653/1	8/12/1983	74.5	5.45	8.37	1091	149	32.3	0.04	1.44	1.31	1845	37	27.6	440		250									
	2804600	6310500			5638/1	23/11/1983	76	7.05	8.07	1088	143	32.4	0.03	1.41	1.25	1825	62	25.3	420			28.7								
	2804600	6310500			5626	27/10/1983		5.58	8.04	1079	143	32.6	0.04	1.41	1.27	1820	65	12.5	435		170	23								
	2804600	6310500			5538/1	3/08/1983	73	5.24	8	1072	143	33.6	0.05	1.57	1.33	1816	63	24.6	429		331				4.5					
	2804600	6310500			5428/11	19/05/1983	75			1078	141	33.8	0.06			1820	54		420		220	27								
	2804600	6310500			5383/7	17/03/1983	75	5.63	8.25	1102	151	35.1	0.048			1898	52.5	25.4	443		345	28								
	2804600	6310500			5716/2	14/04/1984	75.5	6.07	8.2	990	144	36	0.04	1.41	1.25	1807	64	25.1	380		424	18.1								
	2804600	6310500			5720	3/04/1984	75	5.98	8.2	990	142	36	0.05	1.45	1.28	1813	57	25	410		290	11.1								
	2804600	6310500			5679/2	31/01/1984	74	6.17	8.33	1109	150	34.2	0.06	1.41	1.28	1839	39	25	433		188.9	5.51								
	2804600	6310500			5672/1	10/01/1984	76	5.87	8.23	1113	138	34.7		1.4	1.3	1835	43	25.3	410		344	18								
	2804600	6310500	U16:046-105		7323/7	27/04/1994	76.1	5.54	8.3	1115	153	34	0.05	1.53	1.26	1905	90	26	426	34	237	11	4.9	0.3	5	616				
	2804600	6310500			7289/1	21/01/1994	75.5	5.72	8.4							1929														
	2804468	6310529		Champagne Pool Wai-O-Tapu Site 1	72-4217	24/07/2009	71	5.4	9.3	1200	160	32	0.1	1.7	1.2	1900	86	25	430	28	100	8.6	4.9	0.1	1.4	614	6.1	0.00076	0.001	0.00025
	2804484	6310461		Champagne Pool Wai-O-Tapu Site 2	72-4218	24/07/2009	70	5.3	9.3	1200	160	32	0.1	1.7	1.2	1900	85	24	410	27	110	8.1	4.9	0.1	1.5	618	6.1	0.00091	0.001	0.00025
	2804517	6310483		Champagne Pool Wai-O-Tapu Site 3	72-4219	24/07/2009	71	5.4	9.1	1200	160	33	0.1	1.7	1.2	1900	83	25	410	28	17	11	4.8	0.1	1.6	616	6	0.00071	0.0012	0.00025

Area:	Easting	Northing	GRID REF:	Site description	LOC KEY	Date Sampled	Temp	pH	Li	Na	K	Ca	Mg	Rb	Cs	Cl	SO4	B	SiO2 (Tot)	NH4	HCO3	S Tot	F	Fe	As	Cond	Br	Hg TR	Sb	Tl
WAIOTAPU (15) means	2804600	6310500		Champagne Pool: averaged data		1926		4.9		1215	164	38.6	0.3			1990	119	23.9	448	37	43	18								
	2804600	6310500				27/06/1955		6.5	8	1146	160	29	2.4			1879	99	27	170	4.5	366	22	4.05							
	2804600	6310500				24/07/1958			8.2	1137	160	30.7	2.8			1961	143	27.2		10.7			5.2							
	2804600	6310500			5126	18/05/1982	73	7.82	8.04	1109	150	33.8	0.06	1.54	1.33	1912	108	25.6	468			21								
						mean 1983	74.62	5.82	8.15	1087.57	144.43	33.36	0.05	1.45	1.29	1834.43	56.79	23.43	429.29		288.67	26.68			4.50					
						mean 1984	75.13	6.02	8.24	1050.50	143.50	35.23	0.05	1.42	1.28	1823.50	50.75	25.10	408.25		311.73	13.18								
	2804600	6310500			6317/m	7/06/1986	74	5.5	8.3	1065	144	33	0.55	1.42	1.27	1814	68	25.2	438		393									
	2804600	6310500			7169/6	8/07/1993	74.9	5.6	8.4	1090	148	33	0.05	1.51	1.23	1858	91	26	427	31.8	220	8.8	5	0.25	5.1	680				
						mean 1994	75.8	5.63	8.35	1115	153	34	0.05	1.53	1.26	1917	90	26	426	34	237	11	4.9	0.3	5					
						mean 2009	70.667	5.367	9.233	1200	160	32.33333	0.1	1.7	1.2	1900	84.66667	24.66667	416.6666667	27.66667	75.66667	9.233333	4.866667	0.1	1.5					
Area:	**Easting**	**Northing**	**GRID REF:**	**Site description**	**LOC KEY**	**Date Sampled**	**Temp**	**pH**	**Li**	**Na**	**K**	**Ca**	**Mg**	**Rb**	**Cs**	**Cl**	**SO4**	**B**	**SiO2 (Tot)**	**NH4**	**HCO3**	**S Tot**	**F**	**Fe**	**As**	**Cond**	**Br**	**Hg TR**	**Sb**	**Tl**
WAIKITE (16)	2799100	6314300	U16:991-143	Waikite WE1031	6914/32	21/01/1992	99.5	7.8	2.2	215	8.8	7.8	0.22	0.11	0.31	145	39	1.46	167		338									
	2799100	6314300			7136	21/05/1993	99.6	7.76	2.4	219	8.6	8.8	0.2	0.08	0.33	143	37	1.5	161	0.19	342	1	2.8	0.25	0.36	106				
	2799100	6314300			7323/19	11/05/1994	101.2	7.38	2.4	220	8.8	8.5	0.18	0.11	0.28	143	36	1.5	162	0.3	366	1	2.5	0.3	0.38	104				
	2799028	6314264	U16:990-142*	Manuroa	72-2994	21/09/2005	97.5	7.8	2.53	226	10.1	7.83	0.17	0.121	0.365	127	35.3	1.73	173	0.32	169	0.012	2.8	0.02	0.383	104	0.403	8.00E-05	0.0398	9.00E-05
	2798978	6314244		Hot Pools Supply Spring, Waikite Pools	72-4228	**24/07/2009**	97	8.1	2.2	210	7.1	6.3	0.15	0.1	0.3	140	36	1.4	160	0.14	17	0.002	2.2	0.02	0.33	101	0.4	0.00008	0.021	0.00005
	2798856	6314283		Waikite Baths Outlet, Waikite Hot Pools	72-4229	**24/07/2009**	69	8.8	2.2	210	7.8	6.5	0.22	0.11	0.29	140	36	1.5	170	0.11	17	0.002	2.2	0.02	0.34	102	0.4	0.00008	0.025	0.000051
	2798917	6314272		Top Inlet Spring, Waikite Hot Pools	72-4227	**24/07/2009**	62	8.8	2.2	210	7.2	4	0.15	0.11	0.31	140	38	1.5	170	0.094	17	0.002	2.3	0.02	0.34	104	0.4	0.00008	0.028	0.00005
	2799811	6315010	U16:998-150*	HT Geyser	72-2993	21/09/2005	97.5	7.9	3.25	292	20.1	0.95	0.03	0.167	0.266	174	41.2	1.99	249	0.17	225	0.006	4.1	0.02	0.454	124	0.509	0.00072	0.0517	0.00024
	2799709	6314979		Overflow From Spring Near HT Geyser	72-4393	**1/09/2009**	56.4	9.2	2.5	250	17	0.58	0.02	0.14	0.18	190	38	1.7	120	0.06	21	0.002	3.3	0.02	0.42	135	0.54	0.00008	0.024	0.00016
Area:	**Easting**	**Northing**	**GRID REF:**	**Site description**	**LOC KEY**	**Date Sampled**	**Temp**	**pH**	**Li**	**Na**	**K**	**Ca**	**Mg**	**Rb**	**Cs**	**Cl**	**SO4**	**B**	**SiO2 (Tot)**	**NH4**	**HCO3**	**S Tot**	**F**	**Fe**	**As**	**Cond**	**Br**	**Hg TR**	**Sb**	**Tl**
ATIAMURI (17)	2776588	6311132	U16:765-111*	Whangapoua West	72-3004	4/10/2005	55.8	8.4	4.85	462	25.9	0.98	0.02	0.17	1.05	343	44.9	13.5	280	1.62	267	0.002	14.8	0.02	1.170	192	0.936	0.0074	0.282	0.00027
	2776588	6311132		Whangapoua West, Northern Pool	72-3004	**17/08/2009**	60.2	7.7	4.5	400	19	0.67	0.04	0.18	0.93	370	50	12	130	2.2	18	0.0029	14	0.04	1	206	1	0.0083	0.16	0.00018
	2776615	6311082		Whangapoua West, Southern Pool	72-4387	**17/08/2009**	60.3	7.6	3.6	360	17	0.63	0.04	0.17	0.86	300	38	11	140	1.4	19	0.002	12	0.04	0.84	185	0.87	0.00058	0.13	0.00027
Area:	**Easting**	**Northing**	**GRID REF:**	**Site description**	**LOC KEY**	**Date Sampled**	**Temp**	**pH**	**Li**	**Na**	**K**	**Ca**	**Mg**	**Rb**	**Cs**	**Cl**	**SO4**	**B**	**SiO2 (Tot)**	**NH4**	**HCO3**	**S Tot**	**F**	**Fe**	**As**	**Cond**	**Br**	**Hg TR**	**Sb**	**Tl**
	2779214	6312031	U16:792-120*	Matapan Road	72-3005	4/10/2005	69.1	7.4	0.58	126	8.58	0.92	0.42	0.0255	0.0238	80.5	8.2	1.41	162	0.17	84	0.002	3.25	0.02	0.104	55.6	0.194	8.00E-05	0.0169	5.00E-05
	2779198	6312032		Matapan Road	72-3005	**17/08/2009**	62.8	8.2	0.6	120	7.3	0.79	0.39	0.026	0.00099	86	8.2	1.3	160	0.15	170	0.002	2.6	0.04	0.091	59.2	0.2	0.00008	0.01	0.0001
Area:	**Easting**	**Northing**	**GRID REF:**	**Site description**	**LOC KEY**	**Date Sampled**	**Temp**	**pH**	**Li**	**Na**	**K**	**Ca**	**Mg**	**Rb**	**Cs**	**Cl**	**SO4**	**B**	**SiO2 (Tot)**	**NH4**	**HCO3**	**S Tot**	**F**	**Fe**	**As**	**Cond**	**Br**	**Hg TR**	**Sb**	**Tl**
REPOROA (18)	2800943	6304321	U17:009-043*	SE Spring	72-3001	29/09/2005	96.5	8.1	4.42	573	29.5	2.85	0.32	0.197	0.785	588	13.6	10.5	242	1.34	262	1.76	5.3	0.02	0.680	199	1.76	0.00013	0.187	0.00012
	2800943	6304321		South (SE) Spring	72-3001	**23/07/2009**	93	7.7	4.3	580	24	2.4	0.27	0.23	0.77	580	12	9	170	1.4	17	2.2	4.2	0.04	0.66	256	1.9	0.00008	0.12	0.0001
Area:	**Easting**	**Northing**	**GRID REF:**	**Site description**	**LOC KEY**	**Date Sampled**	**Temp**	**pH**	**Li**	**Na**	**K**	**Ca**	**Mg**	**Rb**	**Cs**	**Cl**	**SO4**	**B**	**SiO2 (Tot)**	**NH4**	**HCO3**	**S Tot**	**F**	**Fe**	**As**	**Cond**	**Br**	**Hg TR**	**Sb**	**Tl**
	2801200	6304300			7169/7	8/07/1993	95.3	7.22	5.3	665	40	1	0.03	0.38	1.27	746	30	12.7	268	2.41	601	2.5	6.1	0.25	1	348				
	2801200	6304300	U17:012-043	Opaheke #7	7323/6	27/04/1994	97.1	7.26	5.4	654	40	1.2	0.04	0.38	1.26	744	29	12.3	274	3	571	1	6.1	0.3	0.93	316				
	2800900	6304611	U17:009-046*	North Maori Opaheke	72-3002	29/09/2005	97.5	7.4	5.71	716	47.3	1.5	0.04	0.34	1.31	818	25.6	13.9	274	1.9	276	4.12	6.95	0.04	0.959	265	2.53	0.0013	0.279	0.0003
	2800900	6304611		Opaheke Spring	72-4220	**23/07/2009**	53	6.7	5.7	730	40	1.7	0.043	0.39	1.2	770	48	12	250	2.2	18	0.52	6.1	0.04	0.96	328	2.6	0.0013	0.11	0.00018
Area:	**Easting**	**Northing**	**GRID REF:**	**Site description**	**LOC KEY**	**Date Sampled**	**Temp**	**pH**	**Li**	**Na**	**K**	**Ca**	**Mg**	**Rb**	**Cs**	**Cl**	**SO4**	**B**	**SiO2 (Tot)**	**NH4**	**HCO3**	**S Tot**	**F**	**Fe**	**As**	**Cond**	**Br**	**Hg TR**	**Sb**	**Tl**
MOKAI (20)	2767800	6300900		Waipapa, Mokai	3692/a	3/05/1978	58	6.95								370	6.8	4.2	130		90	2								
	2767800	6300900			4695	8/04/1980	57.5	6.65	2.77	250	13.2	9.2	1.2	0.142	0.33	364	8	4	197		170									
	2767800	6300900			5194/1	14/06/1982	59.4	6.25	2.76	251	12	9	1.25	0.14	0.38	371	4	4.3			139									
	2767800	6300900			5624/6	19/10/1983	58	6.55	2.93	258	15	10.8	1.1	0.17	0.42	362	9	5	144		119									
	2767800	6300900			7178/2	15/07/1993	59.6	6.49	2.8	248	13.5	10.1	1.3	0.16	0.4	380	8	4.5	130	0.1	119	1	1.3	0.25	0.53	141				
	2767800	6300900	T17:678-009	North Mokai (Waipapa)	7323/13	3/05/1994	60.8	6.46	2.6	253	13.8	10.1	1.3	0.15	0.34	371	7	4.5	129	0.1	152	1	1.3	0.3	0.62	133				
	2767868	6300960		Waipapa Feature	72-4386	**17/08/2009**	54.5	7.2	2.9	310	15	11	0.88	0.17	0.4	490	5.4	5.5	160	0.021	120	0.002	1.7	0.04	0.6	180	1.3	0.00008	0.012	0.00023
Area:	**Easting**	**Northing**	**GRID REF:**	**Site description**	**LOC KEY**	**Date Sampled**	**Temp**	**pH**	**Li**	**Na**	**K**	**Ca**	**Mg**	**Rb**	**Cs**	**Cl**	**SO4**	**B**	**SiO2 (Tot)**	**NH4**	**HCO3**	**S Tot**	**F**	**Fe**	**As**	**Cond**	**Br**	**Hg TR**	**Sb**	**Tl**
ORAKEIKORAKO (21)	2784265	6298542	U17:842-985*	Map Of Australia S25	72-2998	29/09/2005	82	8.1	3.22	346	19.7	0.64	0.02	0.189	0.608	309	66.3	3.58	252	0.07	148	0.004	11.1	0.02	0.656	141	0.786	8.00E-05	0.0679	0.00053
	2784265	6298542		Map Of Australia, Orakei Korako	72-2998	**23/07/2009**	81	7.8	2.9	340	15	0.54	0.02	0.21	0.58	310	63	2.9	140	0.067	20	0.013	9.6	0.02	0.59	163	0.77	0.00008	0.044	0.0004
Area:	**Easting**	**Northing**	**GRID REF:**	**Site description**	**LOC KEY**	**Date Sampled**	**Temp**	**pH**	**Li**	**Na**	**K**	**Ca**	**Mg**	**Rb**	**Cs**	**Cl**	**SO4**	**B**	**SiO2 (Tot)**	**NH4**	**HCO3**	**S Tot**	**F**	**Fe**	**As**	**Cond**	**Br**	**Hg TR**	**Sb**	**Tl**
	2784750	6298522	U17:847-986*	OK Manganese Pool - 120	5352/8	9/02/1983	94.1	8.7	4.11	322	48.6	1.7	0.05	0.53	0.67	339	99	3.6	376		207									
	2784700	6298600			7169/3	8/07/1993	64	7.42	3.1	241	37	2	0.23	0.38	0.48	254	108	2.8	278	0.1	146	1	8.4	0.25	0.37	137				
	2784700	6298600			7323/21	11/05/1994	70.3	7.55	3.3	263	40	2.1	0.23	0.41	0.5	275	104	2.9	290	0.14	152	1	10.2	0.3	0.51	140				
	2784700	6298500	U17:847-985	Manganese S120	72-3000	29/09/2005	94.6	7.9	3.77	312	51.2	1.53	0.06	0.436	0.562	304	99.2	3.54	319	0.15	106	0.74	13.6	0.02	0.740	134	0.808	8.00E-05	0.0591	0.00064
	2784750	6298522		Manganese Pool	72-3000	**23/07/2009**	75	7.8	4.4	360	48	1.8	0.19	0.54	0.58	340	130	3.4	120	0.13	21	0.002	11	0.02	0.54	181	0.85	0.00008	0.028	0.0012
Area:	**Easting**	**Northing**	**GRID REF:**	**Site description**	**LOC KEY**	**Date Sampled**	**Temp**	**pH**	**Li**	**Na**	**K**	**Ca**	**Mg**	**Rb**	**Cs**	**Cl**	**SO4**	**B**	**SiO2 (Tot)**	**NH4**	**HCO3**	**S Tot**	**F**	**Fe**	**As**	**Cond**	**Br**	**Hg TR**	**Sb**	**Tl**
ROTOKAWA (24)	2787900	6281400	U17:879-814	Rotokawa #4A	7341/1	14/06/1994	78.4	2.63	2.8	379	47	35	8.3	0.5	0.46	447	685	15.5	238	10		27.1	3.2	6.3	0.15	355				
	2787910	6281363		RK#4A	72-4392	**1/09/2009**	78.4	2.3	2	280	31	32	8.2	0.43	0.42	350	1100	11	270	9.6	20	16	1.6	6.6	0.024	442	0.97	0.00069	0.0004	0.00039
Area:	**Easting**	**Northing**	**GRID REF:**	**Site description**	**LOC KEY**	**Date Sampled**	**Temp**	**pH**	**Li**	**Na**	**K**	**Ca**	**Mg**	**Rb**	**Cs**	**Cl**	**SO4**	**B**	**SiO2 (Tot)**	**NH4**	**HCO3**	**S Tot**	**F**	**Fe**	**As**	**Cond**	**Br**	**Hg TR**	**Sb**	**Tl**
TAUPO/TAUHARA (26)	2778331	6273570	U18:783-735*	Taharepa	7323/26	9/06/1994		6.57	0.71	169	33	24	4.4	0.08	0.05	115	131	2.1	232	2.9	377	1	0.62	0.3	0.13	107				
	2778331	6273570	U18:783-735*	Taharepa	72-2988	20/09/2005	66	7.1	0.627	161	35.5	23	4.01	0.0831	0.0167	104	131	2.22	276	1.99	109	0.015	0.61	0.94	0.109	101	0.311	8.00E-05	0.0061	5.00E-05
	2778331	6273570		Taharepa	72-2988	**23/07/2009**	66	7	0.78	200	35	23	3.7	0.093	0.015	160	100	2.7	250	2	18	0.003	0.62	0.79	0.13	116	0.42	0.00008	0.0062	0.00005
Area:	**Easting**	**Northing**	**GRID REF:**	**Site description**	**LOC KEY**	**Date Sampled**	**Temp**	**pH**	**Li**	**Na**	**K**	**Ca**	**Mg**	**Rb**	**Cs**	**Cl**	**SO4**	**B**	**SiO2 (Tot)**	**NH4**	**HCO3**	**S Tot**	**F**	**Fe**	**As**	**Cond**	**Br**	**Hg TR**	**Sb**	**Tl**
	2779908	6273262	U18:799-732*	Top Spring De Bretts	72-2989	20/09/2005	67.3	7	3.14	300	36.8	18.1	5.72	0.184	0.264	331	73.7	7.21	262	1.11	138	0.002	0.64	0.02	0.200	155	0.946	8.00E-05	0.0783	0.00014
	2779908	6273262		Waipahihi Spring	72-2989	**23/07/2009**	68	6.8	3	300	30	15	4.7	0.18	0.23	330	75	6.2	260	0.91	19	0.002	0.55	0.04	0.17	165	0.86	0.00008	0.043	0.00017
Area:	**Easting**	**Northing**	**GRID REF:**	**Site description**	**LOC KEY**	**Date Sampled**	**Temp**	**pH**	**Li**	**Na**	**K**	**Ca**	**Mg**	**Rb**	**Cs**	**Cl**	**SO4**	**B**	**SiO2 (Tot)**	**NH4**	**HCO3**	**S Tot**	**F**	**Fe**	**As**	**Cond**	**Br**	**Hg TR**	**Sb**	**Tl**
TOKAANU (28)	2749636	6244799	6244799 N	Taumatapuhipuhi geyser	2201857	28/11/2002	98	7.47	23	1680	187	34	0.11			3056	63	86	248	3.6	64	0.01	1.3	0.06	8.0		9.6			
	2749633	6244806	T19:496-448*	Taumatapuhipuhi	72-2984	16/09/2005	98.1	7.8	31.5	1620	168	33.2	0.1	1.56	5.27	3220	62	88.3	243	2.56	34	0.002	1.55	0.1	9.190	635	9.55	0.00083	0.896	0.008
	2749633	6244806		Taumatapuhipuhi	72-2984	**23/07/2009**	98	7.6	25	1700	140	33	0.2	1.7	4.2	3200	61	88	150	2.8	19	0.003	1.4	0.2	9	930	9.7	0.00038	0.63	0.0077
Area:	**Easting**	**Northing**	**GRID REF:**	**Site description**	**LOC KEY**	**Date Sampled**	**Temp**	**pH**	**Li**	**Na**	**K**	**Ca**	**Mg**	**Rb**	**Cs**	**Cl**	**SO4**	**B**	**SiO2 (Tot)**	**NH4**	**HCO3**	**S Tot**	**F**	**Fe**	**As**	**Cond**	**Br**	**Hg TR**	**Sb**	**Tl**
	2749459	6244729	T19:494-447*	Takarea No.5	72-2985	16/09/2005	59.5	6.5	34.2	1750	177	42.4	0.2	1.79	5.53	3710	77.8	94.5	330	3.87	24	0.004	1.67	0.1	10.300	768	10.8	0.00389	1.43	0.0079
	2749459	6244729		Thermal Spring, Takarea No.5	72-2985	**23/07/2009**	57	6.3	30	2100	170	40	0.2	1.8	4.5	3200	78	98	310	3.1	16	0.002	1.5	0.2	9.6	958	10	0.0013	0.9	0.0077

APPENDIX III Full listing of gas data used in this report.

Field	Feature	UNITS	Code	Date	Sample	CO_2	H_2S	NH_3	He	H_2	O_2	N_2	CH_4	Ar	SO_2	N_2 (air free)	Ar (air free)	N_2/Ar	del ^{18}O	del ^{2}H
ROTOKAWA	Rotokawa	mmoles gas/ 100 moles steam	RK1006	14/06/1994	7341/6/N1A	1718	45		0.0055	3.93		24.2	65.6	0.062		24.20	0.062	390		
		mmoles gas/ 100 moles steam	"	"	7341/6/N1	1720	45.5	0.12	0.0082	3.84	0.013	25.7	63.8	0.066		25.65	0.065	392	-5.67	-38.1
		mmoles gas/ 100 moles steam	"	19/08/1993	7201/N1	1600	41.6	0.035	0.006	3.24	0.024	22.6	59.6	0.065		22.51	0.064	352	-7.1	-46.2
TAUHARA	Hell's Gate	mmoles gas/ 100 moles steam		27/01/1993	7065/5	2930	49.20	11.7	0.021	42.60	0.05	78.7	74.2	0.9					-12.39	-67.3
		mmoles gas/ 100 moles steam		15/02/1989	6656/6	1326	31.80	15.7	0.015	20.80		26.1	27.5	0.242						
		mmoles gas/ 100 moles steam		5/78		840	16.50			16.00		18.6	18.6							
	Pony Club	mmoles gas/ 100 moles steam		27/01/1993	7065/3	534	17.00	0.58	0.0021	2.31	<0.005	7.6	10.2	0.063					-9.06	-54.2
		mmoles gas/ 100 moles steam		15/02/1989	6656/5	575	19.70	0.04	0.0037	2.98		8.88	12.4	0.073						
TE KOPIA	Te Kopia	mmoles gas/ 100 moles steam	TK1001	18/10/1995	7582/1/N	197	6.70		0.0035	0.48	0.002	9.75	1.53	0.208		9.74	0.207	47		
		mmoles gas/ 100 moles steam	"	14/07/1994	7355/N1	212	7.88	0.28	0.0036	0.53	0.066	9.97	1.66	0.212		9.72	0.209	47	-8.24	-45.9
		mmoles gas/ 100 moles steam	"	30/09/1993	7230/N1A	194	16.3			0.53	118	519	1.39	6.02		79.10	0.757	104	-9.01	-47.9
TONGARIRO	Emerald Lake Fumarole	mmoles gas/ 100 moles steam		30/03/1994	133-tnp-lel	3705	120.00	0.11	0.009	0.43		26.8	75.2	0.026	19	26.80	0.026	1030		
	Red Crater	mmoles gas/ 100 moles steam		30/03/1994	132-tnp-rc	4164	98.00	0.95	0.0098	3.38		28.2	77.8	0.0328	21.9	28.20	0.033	854		
	TNP Central Crater	mmoles gas/ 100 moles steam		30/03/1994	134-tnp-cc	4730	35.00	0.19	0.0125	12.20		34.8	92.4	0.054	3	34.80	0.054	644		
	* Ketetahi #2	mmoles gas/ 100 moles steam		14/09/1994	156-kt-2	1862	51.40	14.6	0.0092	30.00		19.8	34.3	0.0086	7.3	19.80	0.009	2300		
WAIKITE	Waikite Scarp	mmoles gas/ 100 moles steam	WE1010	11/07/1994	7351/N1	233	1.57	0.16	0.0016	0.030	0.0033	9.09	0.41	0.201		9.08	0.201	45	-12.23	-69.6
		mmoles gas/ 100 moles steam	"	11/08/1993	7194/N1	225	2.12	0.23	0.0014	0.032	0.001	7.46	0.38	0.185		7.46	0.185	40		
		mmoles gas/ 100 moles steam	"	7/09/1991	6914/11	174	1.60		0.0004	0.013	0.109	2.46	0.126	0.062		2.05	0.057	36		
WAIOTAPU	Maungaongaonga	mmoles gas/ 100 moles steam	WT1066	21/07/1994	7357/N1A	356	8.77		0.0014	1.28	0.82	25	1.93	0.314		21.94	0.277	79		
		mmoles gas/ 100 moles steam	"	"	7357/N1	349	10.00	<.0.02	0.0014	1.30	0.52	9.43	1.99	0.136		7.49	0.113	66	-13.25	-70.9
		mmoles gas/ 100 moles steam	"	11/08/1993	7195/N1A	468	25.30			0.44	196	872	0.94	10.2		141.31	1.458	97		
		mmoles gas/ 100 moles steam	"	"	7195/N1	597	29.70	0.031		0.71	351	1530	1.33	17.8		221.47	2.145	103		
WAIRAKEI	Wairakei Thermal Valley	mmoles gas/ 100 moles steam	WK1054	30/06/1994	7346/3/N1A	96	4.00													
		mmoles gas/ 100 moles steam	"	"	7346/3/N1	102	3.56	0.35	0.00044	0.73	0.165	1.83	0.51	0.029		1.21	0.022	56	-6.29	-38.3
		mmoles gas/ 100 moles steam	"	19/08/1993	7202/N1	104	3.72	0.27	0.0005	0.96	0.01	1.51	0.67	0.028		1.47	0.028	53	-9.51	-57.2
	Karapiti #18	mmoles gas/ 100 moles steam	WK1045	30/06/1994	7346/2/N1A	177	3.58		0.026	0.77	0.042	4.59	1.46	0.061		4.43	0.059	75		
		mmoles gas/ 100 moles steam	"	"	7346/2/N1	167	3.96	0.06	0.0025	0.69	0.0025	3.7	1.36	0.049		3.69	0.049	75	-3.72	-27.2
		mmoles gas/ 100 moles steam	"	11/08/1993	7193/N1	207	3.80	0.28	0.0025	0.73	0.001	4.2	1.72	0.073		4.20	0.073	58		
		mmoles gas/ 100 moles steam	"	3/90 - 6/91		186	5.82	0.48	0.002	0.76			1.62			3.88	0.068	57		
	Karapiti #22	mmoles gas/ 100 moles steam	WK1047	29/06/1994	7346/1/N1A	207	3.14		0.0033	0.70	0.013	5.05	1.38	0.136		5.00	0.135	37		
		mmoles gas/ 100 moles steam	"	"	7346/1/N1	207	4.54	0.48	0.0025	0.62	0.102	5.06	1.38	0.100		4.68	0.095	49	-4.35	-28.8
		mmoles gas/ 100 moles steam	"	10/08/1993	7192/N2	187	3.44		0.0023	0.58	0.001	4.41	1.28	0.086		4.41	0.086	51		
		mmoles gas/ 100 moles steam	"	"	7192/N1	187	3.53	0.48	0.0023	0.58	0.001	4.44	1.3	0.087		4.44	0.087	51		
		mmoles gas/ 100 moles steam	"	3/90-6/91		218	5.66	0.48	0.0026	0.74			1.65			5.34	0.100	53		
TAUPO	Tauhara	millimoles gas/100 moles H2O (total disch)	TH1	Oct-64		14.9	1.02													
		millimoles gas/100 moles H2O (total disch)	TH1	1966		13.5	1.03													
		millimoles gas/100 moles H2O (total disch)	TH2	Dec-67		27.6	1.40													
		millimoles gas/100 moles H2O (total disch)	TH3	Dec-67		54.7	2.04													
		millimoles gas/100 moles H2O (total disch)	THM1	Oct-66		737	17.00													
		millimoles gas/100 moles H2O (total disch)	PN	Jul-61		361	7.30													
		millimoles gas/100 moles H2O (total disch)	PN	May-78		900	30.40	0.53		21.10		21.8	24.9							
		millimoles gas/100 moles H2O (total disch)	SH	1964		667	26.00													
		millimoles gas/100 moles H2O (total disch)	SH	May-78		780	32.80	0.59		14.90		24.9	7.8							
		millimoles gas/100 moles H2O (total disch)	Spa Fumerole	May-78		840	16.50	1.3		16.00		18.6	18.6							
		millimoles gas/100 moles H2O (total disch)	Miro St Well	May-78		816	26.90	1.6		3.96		12.8	17.7							
		millimoles gas/100 moles H2O (total disch)	Reids Farm Fumerole	May-78		2117	23.00	1.4		47.60		59.6	70.8							
		millimoles gas/100 moles H2O (total disch)	Invergarry Rd (a)	May-79		924	2.30			9.20		37.6	53.3							
		millimoles gas/100 moles H2O (total disch)	Invergarry Rd (b)	May-79		3309	44.30			14.60		33.8	51.6							
TOKAANU	Hipaua	mmole/mole (mole fraction)	H1	2/10/1996		955.8	5.4		0.006	0.6		10.9	27.2	0.05			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	5/10/1996		955.2	5.9		0.006	0.6		10.4	27.8	0.03			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	10/10/1996		952.2	5.5		0.004	1.0		9.6	31.6	0.03			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	30/10/1996		956.7	5.1		0.007	0.8		10.8	26.5	0.04			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	30/10/1996		959.2	5.2		0.006	0.6		10.1	24.8	0.03			999.9			
	Hipaua	mmole/mole (mole fraction)	H1	1/11/1996		953.2	5.6		0.007	0.7		10.8	28.2	0.03			998.5			
	Hipaua	mmole/mole (mole fraction)	H1	3/11/1996		959.3	4.1		0.000	2.6		6.6	27.4	0.02			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	5/11/1996		963.7	4.7		0.004	0.3		8.1	23.1	0.04			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	10/11/1996		960.8	5.6		0.006	0.6		9.5	23.4	0.04			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	12/11/1996		959.9	6.6		0.006	0.7		9.2	23.5	0.03			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	16/11/1996		961.9	4.8		0.006	0.7		9.9	22.6	0.06			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	16/11/1996		954.8	6.6		0.007	0.9		12.1	25.6	0.05			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	18/11/1996		964.8	4.2		0.000	0.5		8.3	22.0	0.04			1000.0			

Field	Feature	UNITS	Code	Date	Sample	CO_2	H_2S	NH_3	He	H_2	O_2	N_2	CH_4	Ar	SO_2	N_2	Ar	N_2/Ar	del ^{18}O	del ^{2}H
TOKAANU cont…	Hipaua	mmole/mole (mole fraction)	H1	24/02/1997		958.7	4.5		0.006	0.6		11.9	24.1	0.07			999.9			
	Hipaua	mmole/mole (mole fraction)	H1	24/02/1997		956.6	5.1		0.000	0.7		10.5	27.1	0.06			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	3/03/1997		957.8	4.3		0.005	0.8		11.9	25.0	0.05			999.9			
	Hipaua	mmole/mole (mole fraction)	H1	17/03/1997		957.4	3.8		0.007	0.6		11.4	26.8	0.04			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	17/03/1997		962.8	4.5		0.004	0.5		10.0	22.1	0.03			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	3/04/1997		953.0	4.4		0.007	0.7		12.1	29.8	0.04			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	9/04/1997		962.3	4.5		0.003	0.3		10.1	22.8	0.04			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	3/05/1997		965.1	5.6		0.004	0.6		8.4	20.2	0.03			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	19/05/1997		954.7	4.3		0.007	0.8		12.6	27.5	0.06			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	25/05/1997		962.6	1.1		0.005	0.6		10.6	25.0	0.05			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	22/06/1997		938.9	5.3		0.004	0.3		14.1	41.4	0.07			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	22/06/1997		936.0	4.4		0.005	0.3		15.9	43.3	0.08			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	19/08/1997		951.1	4.7		0.006	0.7		13.3	30.2	0.05			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	22/09/1997		947.6	6.2		0.006	0.6		10.4	35.2	0.06			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	18/11/1997		965.4	4.8		0.005	0.6		8.5	20.7	0.03			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	18/11/1997		959.4	4.1		0.006	0.6		10.7	25.2	0.04			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	29/01/1998		956.0	5.2		0.005	0.6		11.2	27.0	0.04			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	22/02/1998		944.3	6.4		0.004	0.3		14.3	34.7	0.09			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	27/03/1998		945.8	6.5		0.006	0.3		15.0	32.4	0.06			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	17/04/1998		949.7	5.6		0.003	0.2		14.0	30.5	0.04			1000.0			
	Hipaua	mmole/mole (mole fraction)	H1	16/05/1998		946.7	6.0		0.008	1.0		13.3	32.9	0.05			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	2-Oct-96		949.9	3.3		0.006	0.7		10.3	35.3	0.07			999.5			
	Hipaua	mmole/mole (mole fraction)	H2	10-Oct-96		949.2	4.7		0.006	0.8		12.2	32.9	0.04			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	1-Nov-96		955.8	5.5		0.007	0.8		11.0	26.9	0.03			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	3-Nov-96		958.6	6.1		0.006	0.8		9.9	24.5	0.03			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	3-Nov-96		959.2	4.1		0.006	0.8		10.4	25.5	0.03			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	5-Nov-96		964.6	5.6		0.005	0.6		8.4	20.7	0.02			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	5-Nov-96		959.9	4.8		0.006	0.7		10.5	23.7	0.07			999.6			
	Hipaua	mmole/mole (mole fraction)	H2	10-Nov-96		949.3	4.3		0.004	0.4		10.1	35.9	0.04			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	12-Nov-96		953.9	8.0		0.006	0.8		10.2	26.0	0.03			998.9			
	Hipaua	mmole/mole (mole fraction)	H2	18-Nov-96		961.4	5.2		0.006	0.8		7.9	24.7	0.03			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	24-Feb-97		955.7	6.1		0.006	0.8		10.1	26.9	0.07			999.6			
	Hipaua	mmole/mole (mole fraction)	H2	17-Mar-97		958.6	3.6		0.004	0.7		6.2	30.8	0.03			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	3-Apr-97		953.8	4.3		0.007	0.9		11.7	29.3	0.04			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	3-May-97		964.0	4.9		0.005	0.5		8.9	21.7	0.00			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	19-May-97		946.7	6.0		0.008	1.0		13.3	32.9	0.05			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	25-May-97		957.0	2.3		0.006	0.7		11.8	28.1	0.05			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	25-May-97		955.7	4.3		0.006	0.6		11.9	27.4	0.06			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	22-Jun-97		947.5	3.6		0.004	0.3		13.1	35.6	0.06			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	19-Aug-97		961.4	6.3		0.005	0.7		9.3	22.2	0.03			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	19-Aug-97		959.3	3.9		0.005	0.8		10.7	25.3	0.04			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	22-Sep-97		965.2	3.3		0.005	0.7		9.3	21.5	0.05			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	18-Nov-97		956.8	4.4		0.006	0.8		11.5	26.5	0.05			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	29-Jan-98		960.5	4.0		0.005	0.8		10.3	24.4	0.04			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	22-Feb-98		966.2	4.4		0.003	0.6		8.4	20.3	0.03			1000.0			
	Hipaua	mmole/mole (mole fraction)	H2	16-May-98		960.8	6.7		0.004	0.6		8.0	23.8	0.05			1000.0			

Field	Feature	UNITS	Code	Date	Sample	CO_2	H_2S	NH_3	He	H_2	O_2	N_2	CH_4	Ar	SO_2	N_2	Ar	N_2/Ar	del ^{18}O	del ^{2}H
TOKAANU	Tokaanu stream	mmole/mole (mole fraction)	TK1	5-Oct-96		960.4	4.1		0.004	0.3		7.2	27.9	0.03			1000.0			
cont…		mmole/mole (mole fraction)	TK1	10-Oct-96		947.1	4.4		0.004	0.4		12.3	35.1	0.05			999.3			
		mmole/mole (mole fraction)	TK1	30-Oct-96		931.6	13.1		0.005	0.3		14.2	40.0	0.06			999.3			
		mmole/mole (mole fraction)	TK1	1-Nov-96		942.0	2.7		0.004	0.3		14.6	40.3	0.06			1000.0			
		mmole/mole (mole fraction)	TK1	3-Nov-96		956.2	2.8		0.005	0.2		10.4	30.3	0.04			1000.0			
		mmole/mole (mole fraction)	TK1	5-Nov-96		946.8	3.3		0.004	0.3		12.7	36.7	0.04			999.8			
		mmole/mole (mole fraction)	TK1	10-Nov-96		951.7	1.6		0.005	0.2		12.2	34.0	0.05			999.8			
		mmole/mole (mole fraction)	TK1	16-Nov-96		945.3	4.7		0.006	0.7		13.8	35.4	0.06			1000.0			
		mmole/mole (mole fraction)	TK1	18-Nov-96		962.2	1.4		0.005	0.2		9.5	26.3	0.04			999.6			
		mmole/mole (mole fraction)	TK1	3-Apr-97		939.4	2.3		0.008	0.5		12.7	45.1	0.06			1000.0			
		mmole/mole (mole fraction)	TK1	9-Apr-97		954.0	1.8		0.006	0.4		10.3	33.4	0.09			1000.0			
		mmole/mole (mole fraction)	TK1	3-May-97		951.8	2.0		0.005	0.3		12.3	33.3	0.06			999.8			
		mmole/mole (mole fraction)	TK1	19-May-97		954.2	1.8		0.003	0.3		11.2	32.0	0.05			999.6			
		mmole/mole (mole fraction)	TK1	25-May-97		962.6	1.1		0.005	0.6		10.6	25.0	0.05			1000.0			
		mmole/mole (mole fraction)	TK1	25-May-97		957.7	1.1		0.006	0.3		13.7	27.0	0.10			1000.0			
		mmole/mole (mole fraction)	TK1	22-Jun-97		961.3	1.2		0.004	0.3		10.9	26.3	0.06			1000.0			
		mmole/mole (mole fraction)	TK1	22-Jun-97		963.4	1.2		0.004	0.2		9.8	25.4	0.06			1000.0			
		mmole/mole (mole fraction)	TK1	19-Aug-97		951.0	1.0		0.003	0.3		10.1	37.6	0.07			1000.0			
		mmole/mole (mole fraction)	TK1	18-Nov-97		941.6	2.1		0.005	0.2		13.8	42.2	0.10			1000.0			
		mmole/mole (mole fraction)	TK1	29-Jan-98		951.5	3.7		0.010	0.6		11.9	32.1	0.12			1000.0			
		mmole/mole (mole fraction)	TK1	27-Mar-98		948.7	2.5		0.007	0.5		13.0	35.2	0.05			1000.0			
		mmole/mole (mole fraction)	TK1	16-May-98		947.3	2.1		0.003	0.3		13.6	36.7	0.07			1000.0			
		mmole/mole (mole fraction)	1A	1979		745.0	38.1	0.51	<0.04	<0.05		214.0	<0.16	2.70			1000.3			
		mmole/mole (mole fraction)	5	1979		985.0	2.4	0.025	0.004	0.448		37.6	23.7	1.11			1050.3			
		mmole/mole (mole fraction)	5	1978		936.0	1.5	0.014	0.005	0.378		42.9	18.9				999.7			
		?	6	1966		503.0							86.0				589.0			
		?	23B	1966		431.0							73.0				504.0			
		?	48	1934		249.0					10.8		8.0				267.8			
		?	49A	1934		399.0					8.2		7.0				414.2			
		?	49	1934		935.0	5.0				4		34.0				978.0			
		?	50	1934		928.0	5.0			3.000	3		36.0				975.0			
		?	58B	1979		938.0	9.3	0.05	0.009	0.915	0.003	16.5	35.3	0.05			1000.1			
		?	68	1976		774.0		163		24.500	0.056	23.8	14.3	0.19			999.8			
	Grange 48 & A8A	% by volume	48	1937		24.9					10.8		0.8		0.1		36.5			
	Grange 48 & A8A	% by volume	48A	1937		39.9					8.2		0.7		0.1		48.8			
	Grange 49 (spring on Waihi Scarp)	% by volume	49	1937		93.5	0.5				0.4		3.4				97.8			
	Grange 50 (spring on Waihi Scarp)	% by volume	50	1937		92.8	0.5			0.300	0.3		3.6				97.5			
	Tokaanu	% by volume	6	1966		50.3							8.6				58.9			
	Tokaanu	% by volume	23B	1966		43.1							7.3				50.4			
	Motuoapa	% by volume		19-May-05		92.5							4.5				97.0			
																	0.0			
WAIRAKEI	Well Discharges & Natural Features	millimole/100moles steam	WB107	Jun-67		22.0	1.9										23.9			
		millimole/100moles steam	WB107	Apr-68		17.0	2.0										19.0			
		millimole/100moles steam	WB107	Feb-69		20.0	1.9										21.9			
		millimole/100moles steam	WB107	Feb-71		18.0	2.2										20.2			
		millimole/100moles steam	WB107	Dec-74		16.0	1.7										17.7			
		millimole/100moles steam	WB107	26/02/1982		16.2	1.9										18.1			
		millimole/100moles steam	WB108	Sep-65		100.0	4.0										104.0			
		millimole/100moles steam	WB108	Jun-66		84.0	3.5										87.5			
		millimole/100moles steam	WB108	Jun-67		92.0	3.7													
		millimole/100moles steam	WB108	Dec-67		93.0	3.7													
		millimole/100moles steam	WB108	Feb-68		85.0	4.1													
		millimole/100moles steam	WB108	Apr-68		71.0	3.3													
		millimole/100moles steam	WB108	Feb-69		74.0	3.5													
		millimole/100moles steam	WB108	Feb-71		73.0	3.4													
		millimole/100moles steam	WB108	Nov-74		61.0	3.0													
		millimole/100moles steam	WB109	Jun-66		90.0	4.1													
		millimole/100moles steam	WB109	Jun-67		73.0	3.8													
		millimole/100moles steam	WB109	Apr-68		83.0	4.0													
		millimole/100moles steam	WB109	Feb-69		72.0	4.0													
		millimole/100moles steam	WB109	Feb-71		69.0	3.5													
		millimole/100moles steam	WB109	Nov-74		86.0	3.3													

Field	Feature	UNITS	Code	Date	Sample	CO_2	H_2S	NH_3	He	H_2	O_2	N_2	CH_4	Ar	SO_2	N_2	Ar	N_2/Ar	del ^{18}O	del ^{2}H
WAIRAKEI		millimole/100moles steam	WB116	Jun-67		19.0	1.9													
Cont…		millimole/100moles steam	WB116	Apr-68		18.0	2.3													
		millimole/100moles steam	WB116	Feb-69		18.0	1.9													
		millimole/100moles steam	WB116	Feb-71		15.0	2.0													
		millimole/100moles steam	WB116	Nov-74		13.0	1.8													
		millimole/100moles steam	WB116	10/02/1982		15.9	1.8													
		millimole/100moles steam	WB118	Sep-65		45.0	2.9													
		millimole/100moles steam	WB118	Jun-66		44.0	2.8													
		millimole/100moles steam	WB118	Jun-67		65.0	3.6													
		millimole/100moles steam	WB118	Apr-68		94.0	5.9													
		millimole/100moles steam	WB118	Feb-69		191.0	6.9													
		millimole/100moles steam	WB118	Feb-71		201.0	6.7													
		millimole/100moles steam	WB118	Nov-74		212.0	6.6													
		millimole/100moles steam	WB121	26/05/1969		136.0	7.8													
		millimole/100moles steam	WB203	Jan-60		418.0	9.2													
		millimole/100moles steam	WB203	Oct-60		323.0	11.2													
		millimole/100moles steam	WB203	May-61		321.0	9.7													
		millimole/100moles steam	WB203	Apr-62		306.0	9.8													
		millimole/100moles steam	WB203	Sep-62		250.0	8.9													
		millimole/100moles steam	WB203	Apr-63		221.0	8.5													
		millimole/100moles steam	WB203	Apr-64		276.0	8.0													
		millimole/100moles steam	WB203	Mar-69		242.0	6.7													
		millimole/100moles steam	WB205	Jun-61		191.0	5.0													
		millimole/100moles steam	WB205	Apr-62		157.0	4.6													
		millimole/100moles steam	WB205	Oct-62		118.0	3.5													
		millimole/100moles steam	WB205	Feb-63		96.0	3.2													
		millimole/100moles steam	WB205	Nov-63		112.0	3.5													
		millimole/100moles steam	WB206	May-61		153.0	4.0													
		millimole/100moles steam	WB206	Nov-63		616.0	8.3													
		millimole/100moles steam	WB206	Feb-64		564.0	7.7													
		millimole/100moles steam	WB207	Sep-61		156.0	4.0													
		millimole/100moles steam	WB207	Apr-62		111.0	2.9													
		millimole/100moles steam	WB207	Sep-62		133.0	3.6													
		millimole/100moles steam	WB207	Mar-63		104.0	2.9													
		millimole/100moles steam	WB207	Nov-63		114.0	3.2													
		millimole/100moles steam	WB211	Jan-60		142.0	3.3													
		millimole/100moles steam	WB211	Oct-60		138.0	8.8													
		millimole/100moles steam	WB211	May-61		169.0	7.9													
		millimole/100moles steam	WB211	Apr-62		204.0	9.0													
		millimole/100moles steam	WB211	Oct-62		207.0	8.8													
		millimole/100moles steam	WB211	Nov-63		159.0	6.4													
		millimole/100moles steam	WB212	Mar-63		76.0	2.5													
		millimole/100moles steam	WB212	Mar-64		89.0	2.9													
		millimole/100moles steam	WB214	May-63		331.0	6.6													
		millimole/100moles steam	WB214	Nov-63		398.0	10.6													
		millimole/100moles steam	WB215	Aug-61		137.0	3.8													
		millimole/100moles steam	WB215	Oct-62		140.0	3.8													
		millimole/100moles steam	WB215	Mar-63		130.0	3.6													
		millimole/100moles steam	WB215	Feb-64		159.0	4.3													
		millimole/100moles steam	WB216	Aug-61		263.0	9.8													
		millimole/100moles steam	WB216	Mar-63		166.0	8.2													
		millimole/100moles steam	WB216	Apr-64		174.0	8.0													
		millimole/100moles steam	WB216	Sep-65		139.0	6.7													
		millimole/100moles steam	WB216	Jun-66		123.0	6.1													
		millimole/100moles steam	WB216	Jun-67		116.0	5.9													
		millimole/100moles steam	WB216	Dec-67		113.0	5.8													
		millimole/100moles steam	WB216	Feb-68		83.0	5.9													
		millimole/100moles steam	WB216	Mar-68		84.0	5.8													
		millimole/100moles steam	WB216	Apr-68		85.0	5.6													
		millimole/100moles steam	WB216	Feb-69		105.0	5.6													

Field	Feature	UNITS	Code	Date	Sample	CO_2	H_2S	NH_3	He	H_2	O_2	N_2	CH_4	Ar	SO_2	N_2	Ar	N_2/Ar	del ^{18}O	del ^{2}H
BROADLANDS	Hole/Well	millimole/100moles steam	Hole 1	28/02/1966		2770.0	7.0													
		millimole/100moles steam	Hole 2	30/09/1966		918.0	25.5													
		millimole/100moles steam	Hole 2	19/01/1968		2738.0	49.1													
		millimole/100moles steam	Hole 3	28/04/1967		5050.0	60.0													
		millimole/100moles steam	Hole 3	1/03/1968		5749.0	59.8													
		millimole/100moles steam	Hole 4	29/02/1968		2133.0	33.3													
		millimole/100moles steam	Hole 4	26/03/1968		1988.0	31.5													
		millimole/100moles steam	Hole 7	2/04/1968		2615.0	21.0													
		millimole/100moles steam	Hole 7	15/05/1968		2663.0	20.0													
		millimole/100moles steam	Hole 8	15/01/1968		1952.0	38.4													
		millimole/100moles steam	Hole 8*	26/03/1968		2070.0	38.2													
		millimole/100moles steam	Hole 9	22/04/1968		924.0	18.5													
		millimole/100moles steam	Hole 9	22/04/1968		691.0	14.5													
		millimole/100moles steam	Hole 9	15/05/1968		1700.0	31.0													
		millimole/100moles steam	Hole 10	11/05/1968		3094.0	24.3													
		millimole/100moles steam	Hole 10	18/10/1968		3058.0	22.4													
		millimole/100moles steam	Hole 11	29/08/1968		1005.0	22.5													
		millimole/100moles steam	Hole 11	4/09/1968		1388.0	26.9													
		millimole/100moles steam	Hole 11	17/09/1968		1020.0	24.1													
		millimole/100moles steam	Hole 12	5/12/1968		11500.0	53.7													
		millimole/100moles steam	Hole 13	18/10/1968		1420.0	25.4													
		millimole/100moles steam	Hole 14	6/02/1969		3835.0	45.2													
		millimole/100moles steam	Hole 14	12/05/1969		1870.0	25.6													
		millimole/100moles steam	Hole 15	15/12/1969		714.0	18.6													
		millimole/100moles steam	Hole 15	16/12/1969		1078.0	15.0													
		millimole/100moles steam	Hole 17	2/02/1970		1269.0	27.3													
		millimole/100moles steam	Hole 17	2/03/1970		1703.0	34.8													
		millimole/100moles steam	Hole 18	31/03/1970		3209.0	37.0													
		millimole/100moles steam	Hole 18	7/04/1970		3640.0	45.3													
		millimole/100moles steam	Hole 19	2/04/1970		1317.0	24.1													
		millimole/100moles steam	Hole 19	2/04/1970		1461.0	26.5													
TE KOPIA	Southern Pool	mmol/mol	36	12/05/1979		246.0					29	697 (incl Ar +He)	28							
	Northern Area, Boiling Mud	mmol/mol	79/G101	12/05/1979		915.0	5.1	0.01	0.04	2.63	<0.003	64	11.8	1.22						
	Northern Area, Steam Vent	mmol/mol	79/G102	26/06/1981		930.0	232.0	0.13	0.025	0.82	0.006	39	6.9	0.59						
	Fumarole	mmol/mol	81/G29	26/06/1981		895.0	56.2	0.1	0.098	4.01	0.022	38.6	5.73	0.58						
	Red Pool	mmol/mol	81/G30	26/06/1981		688.0	44.8	0.27	0.063	2.28	0.33	259	4.82	2.2						
	Blue Pool	mmol/mol	81/G31	30/11/1981		719.0	44.8	0.015	0.064	2.84	8	246	18.9	4.4						
	Adj. Blue Pool	mmol/mol	81/G93	30/11/1981		926.0	16.6	0.13	0.018	2.08	0.021	47.3	7.13	0.64						
	Large Fumarole, North #1	mmol/mol	81/G94	30/11/1981		902.0	21.3	0.33	0.021	3.6	0.013	63.1	8.75	0.96						
	Large Fumarole, North #2	mmol/mol	81/G95	30/11/1981		894.0	22.6	0.73	0.019	3.63	0.0068	68.5	9.23	0.96						
	Large Fumarole	mmol/mol	81/G96	19/01/1982		869.0	39.1	0.44	0.102	3.81	0.053	76.2	9.8	1.04						
	Large Fumarole	mmol/mol	82/G1	19/01/1982		410.0	17.2	0.49	0.018	0.55	122	444		6.11						
	Large Fumarole	mmol/mol	82/G2	7/12/1991		408.0	16.3	0.24	0.008	0.12	106	462	2	5.42						
	Northern Area	mmol/mol	WFG	13/02/1992		898.0	18.4	0.03	0.029	2.63	<0.03	68	10.4	1.88						
	Mud Hole, Southern Pool	mmol/mol	TK5	13/02/1992		346.0	13.6			0.63	113	518	2.5	6.3						
	Crest Fumarole	mmol/mol	TK6	13/02/1992		747.0	28.8		0.011	2.15	20.1	193	5.9	2.6						
	Fumarole, Foot of Slide	mmol/mol	TK7			424.0	23.7		0.023	0.98	0.35	42.6	7.7	0.86						