2. Geological History Activities				
Activity title	**Curriculum level**	**Curriculum link**	**Environmental education aspect**	**Page**
2a Formation of the Rotorua lakes	L 3–5	Science		37
2b Silent Card Shuffle	L 3–5	Science		39
2c Mt Ngongotaha	L 3–5	Science	About, In	42
2d Looking at Sediment	Any level	Science	About, In	53
2e How Wet is your Sediment?	Any level	Science		55
2f What is in your Sediment?	L 5	Science		58

Relevant resources:

- Rotorua's Volcanic Past – video – hire from Rotorua Public Library
- Rotorua Museum Education Resources
  - » Te Arawa – Mai Maketu ki Tongariro
  - » Legends, Landforms and Learning
  - » Tarawera photo kit
  - » Tarawera Resource kit
- Pollution Busters newsletter # 5 Volcanoes
- Learning Media - Building Science Concepts
- Book 12 – Volcanoes: Hot Rock in a Cool World Levels: 3–4
- Book 52 – The Land Changes: Keeping Earth's Systems in Balance: Levels: 3–4
- Learning Media – Readers
  - » The Changing Land, Jane Buxton, ISBN 0478214162, explores how the elements can affect Earth and change its shape

Activity 2a Formation of the Rotorua Lakes

Curriculum links **Science**

Any level
2
Science

Resources required

- PowerPoint presentation by Will Esler, University of Waikato (on CD)
- The Life and Times of Lake Rotorua and Lake Rotoiti (see background notes)
- Graphic of Rotorua lake edge 9000 years ago

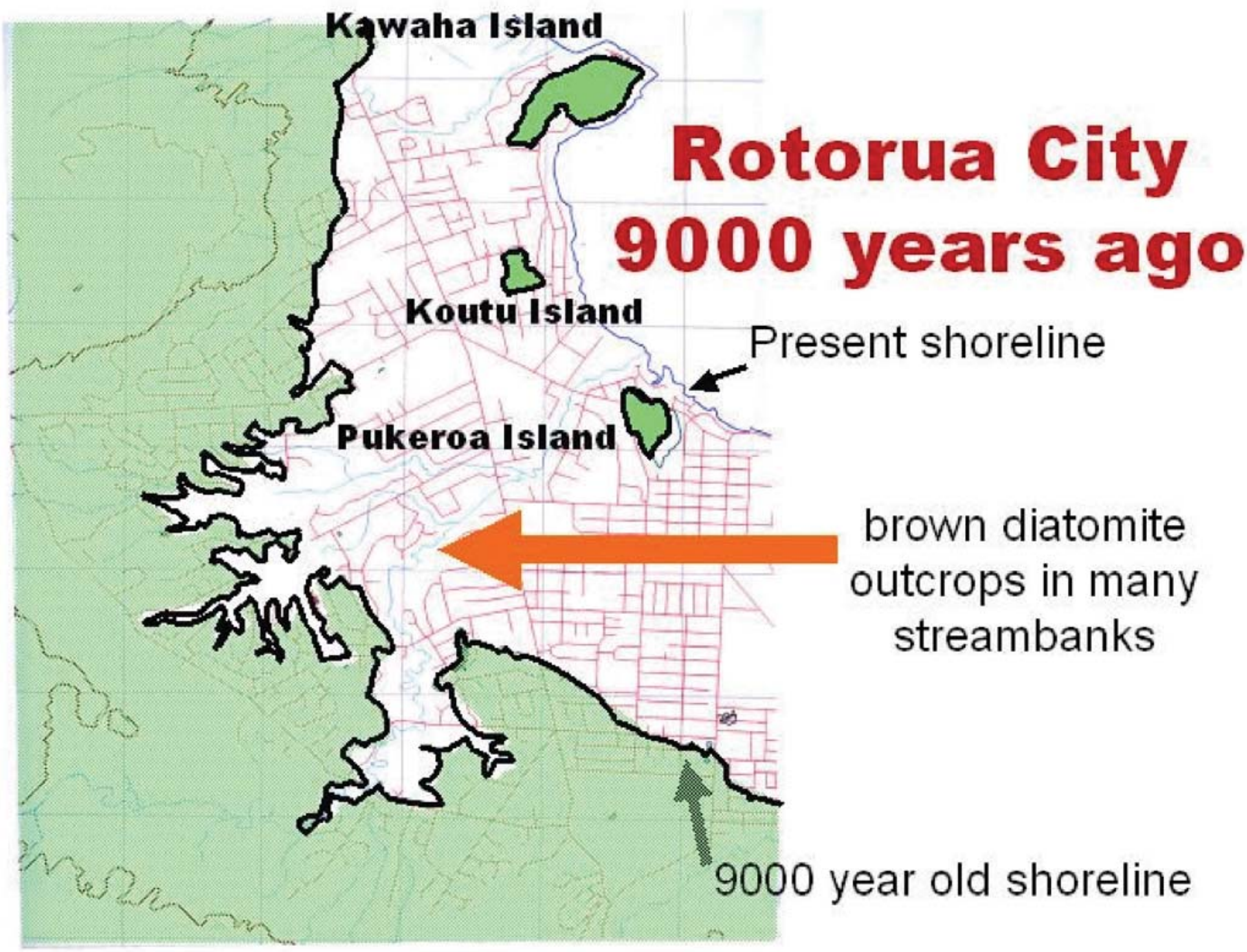
Method

1. View the PowerPoint (ppt) before using it with the class, or set a small group this responsibility. Identify good stopping places for discussion or questions. Have some questions already identified e.g. What was the significant event during this time? Why was it significant? Who/what was responsible for this event occurring? If a small group has previewed the ppt then they can act as a lead questioner/facilitator for one of the groups below.
2. View the ppt as a whole class (or in small groups with a student facilitator) and create a mind map of new learning. You could also have the class split into groups based on a period of time – if using this example the class will view the whole ppt then go back and concentrate on the period of time allocated to their group.
3. Collate the views of the class on significant events surrounding the history of the lakes.
4. Reflection:
    - What new learning has come out of this session?
    - What do you think has been the most significant factor in change for the lakes – Why?

Possible next steps

- A timeline might be created and added to when new information is found.
- Students could express their opinion of possible negative and positive events in the future, depending on the action taken now to save our lakes. (You could use the PMI strategy for this)
- 2b Silent Card Shuffle – Timeline activity on the history of the Rotorua Lakes.

Formation of the Lake Rotorua lake edge 9,000 years ago



Activity 2b Silent Card Shuffle

Curriculum links **Science**

Any level
2
Science

Resources required

- Fact cards – photocopy one set per group
- Lakes in the Rotorua District poster and Saving the Lakes fact sheet from the file box

Method

1. Using the cards provided, put the events into order along a timeline. Some decisions will need to be made – refer to posters for guidance.
2. An alternative is to match the fact cards with the appropriate answer card.
3. Reflection:
   - What would it have been like to be alive during the Tarawera eruption? Imagine no radio, television, phone contact – let alone cellphones!
   - The eruption was visible from a long way away and you wouldn't know what was happening. Compare that to a catastrophic event during today's times e.g. the tsunami in Asia. Do you think that you would feel differently not knowing what was happening?

Answers to fact cards

- Lake Rotorua was formed 140,000 years ago
- Lake Rotoiti was formed 8,500 years ago
- Lake Rotorua lake edge was beside Rotorua Girls' High School 9,000 years ago
- The Kaharoa eruption was in approximately 1300
- The Pink and White Terraces were destroyed in 1886
- Lake Okaro was formed 800 years ago
- Lake Okataina was formed 7,500 years ago
- Lake Rotomahana changed due to the Tarawera eruption in 1886
- Lake Rotoma was formed by the Rotoma eruption 8,500 years ago
- Lake Rotoehu was formed 8,500 years ago, the same time as Lake Rotoma
- Lake Tikitapu, often called Blue Lake, was formed 13,500 years ago
- Lake Rotokakahi, often called Green Lake, was formed 13,300 years ago
- Lake Okareka was formed 19,000 years ago
- Lake Rerewhakaaitu was formed 700 years ago

Fact Cards

Lake Rotorua formed ___________ years ago.	Lake Rotoiti formed ___________ years ago.	Lake Rotorua lake edge was beside Rotorua Girls' High School ___________ years ago.
The Kaharoa eruption was in approximately ___________.	The Pink and White Terraces were destroyed in ___________ during the Tarawera eruption.	Lake Okaro was formed ___________ years ago.
Lake Okataina formed ___________ years ago.	Lake Rotomahana changed due to the ___________ in 1886.	Lake Rotoehu was formed 8,500 years ago, the same time as Lake ___________.
Lake Rotoma was formed by the Rotoma eruption ___________ years ago.	Lake Tikitapu, often called ___________ Lake, was formed 13,500 years ago.	Lake Rotokakahi, often called ___________ Lake, was formed 13,300 years ago.
Lake Okareka was formed ___________ years ago.	Lake Rerewhakaaitu was formed ___________ years ago.	Lake Tarawera was formed ___________ years ago.

Answer Cards

140,000	**8,500**	**9,000**
1300	**1886**	**800**
7,500	**Tarawera eruption**	**8,500**
Lake Rotoma	**Blue Lake**	**Green Lake**
19,000	**700**	**5,000**

Activity 2c Mount Ngongotaha

Curriculum links	
	Science
	Maths
	Social Studies
	Environmental Education – about and in

Level 3–5
2
Science/Maths/ Social Studies

Resources required

- Education Outside The Classroom (EOTC) – organised visit to Skyline Skyrides in Rotorua
- Skyline Skyrides Education Pack
- Maps and compasses for orienteering activity

Prior learning

- Compass use
- Research places we will visit via websites/brochures/books
- View video 'From Pongakawa to Mokoia Island'

Method

1. Visit Rotorua's Skyline Skyrides to collect information and view the Rotorua Lakes.
2. During the gondola ride up the mountain, students are asked to look out for and identify specific geographical features (Worksheet 1 – Activity 1).
3. At the viewing area, in front of the Skyline Restaurant on Mount Ngongotaha, students can view and sketch the Rotorua caldera. Identifying and labelling. (Worksheet 2 – Activity 2)
4. Students can carry out the orienteering activity (Worksheet three – Viewing the Rotorua caldera from Mt Ngongotaha) from the viewing area outside the Skyline Restaurant. Locate points in and around the Rotorua caldera including the natural and cultural (man-made) features of the landscape.
5. View and discuss the natural landforms mentioned in the landforms notes included in the Skyline Skyride Education Pack.
6. Finish the visit with a ride on the luge to experience the natural contours of this ancient volcanic dome!

Possible next steps

- Invite an expert to speak
- Follow up worksheet
- Other possible field trips
  - » Rainbow Mountain
  - » Sulphur Point – see www.doc.govt.nz
  - » Rotorua Museum
  - » Whakarewarewa
  - » Waiotapu

Visit to Skyline Skyrides to view the Rotorua caldera

Activity 1

During the gondola ride up the mountain, look out for and identify the following geographical features:

a The flat area travelled over that was once a lake terrace. The lake in early times came to this level.

b The two ridges were old lava flows. Some exposed rock boulders show the folds of the material as it rolled down the slope and hardened. Look closely as some of the trees have grown over these rocks, boulders (lava flows).

Activity 2

At the viewing area in front of the Skyline Restaurant on Mount Ngongotaha, you can view the Rotorua caldera. Sketch the Rotorua caldera.

Include and label:

a The five volcanic domes

b The two fault areas

c The higher lake level and the current lake level

Visit or follow-up activities

Maths – Measurement/Geometry/ Problem Solving

Using the map provided, find answers to the following questions:

1 The restaurant observation area is ________ metres above sea level?

2 How high is Mount Ngongotaha? ________

3 About how many degrees does the restaurant's viewing area cover? ________

4 Lake Rotorua is ________ metres above sea level?

5 The gondola reaches a height of 497 m at the end of the ride. How high is the rise from the bottom?

____

Earth Science

Answer the following questions:

1 The flat area was once a ________ ________.

2 In early times the ________ came to this level.

3 The two ridges were old ________ ________.

4 What do some of the exposed rock boulders show?

5 What are the natural features within the Rotorua caldera?

6 Make an illustrated sequence of the formation of the Rotorua caldera. Label your diagrams clearly.

Viewing the Rotorua Caldera from Mount Ngongotaha

Use a compass to locate the following points, which are set out in a clockwise direction from the observation area in front of the Skyline Restaurant.

Find north and set your compass so that north is set to 0º.

1	**325º**	**Henderson's Quarry:** The rock in the quarry is a rhyolite lava flow now used in local roads. How has the quarry affected the landscape?
2	**335º**	**Ngongotaha Township:** A growing rural suburb. Its name means?
3	**2º**	**Hamurana District:** A line above the hill shows the original height of Lake Rotorua over 20,000 years ago. Can you see Hamurana Springs?
4	**30º**	**Ohau Channel:** This low-lying area was originally much higher and this caused Lake Rotorua to be higher. Over time it gradually eroded away and the channel became the only outlet for Lake Rotorua. It flows into Lake Rotoiti (which can be seen in the distance) and out to sea through the Kaituna River. The lake is 280 metres above sea level.
5	**38º**	**Mokoia Island:** This is an old volcanic dome, which has important Maori history. It is one of the early pa sites and fortresses of the Arawa people. It is now a new habitat for endangered birds.
6	**42º**	**Tikitere:** A geothermal area. In the distance, look for rising steam.
7	**52º**	**Kawaha Point:** This is another old volcanic dome and now a very beautiful, residential suburb of Rotorua.
8	**70º**	**Rotorua Airport:** On the eastern side of the lake at Rotokawa.
9	**85º**	**Hinemoa Point:** Also an old volcanic dome and the point from where Hinemoa swam to Mokoia Island to meet Tutanekai.
10	**90º**	**Sulphur Point:** A point of land projecting into the lake. The museum, Government Gardens, Blue Baths and Sportsdrome are in this area.
11	**95º**	**Pukeroa Hill:** The Rotorua Hospital stands on this hill, which is also an old volcanic dome and ancient pa site of the Ngati Whakaue tribe. Ohinemutu settlement with Tamatekapua Meeting House and St Faith's Church are on the left below the hospital. The Rotorua Museum is in the background and Lynmore beyond the lake.
12	**102º**	**Fairy Springs Corner:** An important road junction.

13	**106º**	**Rotorua City:** Central shopping and business area.
14	**110º**	**Kuirau Park:** Geothermal reserve with sports field, hot springs, mud pools, adventure playground and previously the well known “Toot ‘n Whistle”.
15	**116º**	**Whakarewarewa Forest Park** in the distance. Scion, formerly the Forest Research Institute, buildings can be seen among the trees.
16	**120º**	**Industrial area** of Rotorua along Old Taupo Road.
17	**122º**	**Park Heritage Hotel and Whakarewarewa Village** show the entrance to the Whakarewarewa thermal area. Its size can be estimated by the clouds of steam rising on the edge of the forest, beyond the city to the lakefront.
18	**126º**	**Pohutu Geyser** may be seen ‘blowing’. Fenton Street runs in a straight line from Pohutu Geyser right through the city to the lakefront.
19	**128º**	**Pohaturoa Hill:** Above the stream is this lookout which is 433 m high.
20	**134º**	**Hemo Gorge:** The gap in the hills, which is the main traffic route to Taupo and Reporoa. In front is the Waiariki Institute of Technology. In the distant background are the bluffs of Tumunui Hill (762 m).
21	**140º**	**International Stadium and Smallbone Park** in the Springfield suburb.

Rotorua caldera – cloze activity

Read the article. Using words from the box on the following page fill in the gaps.

Geological study

Lake Rotorua and the surrounding low lying area are part of the Rotorua caldera. The caldera dates back 140,000 years when major ______________ eruptions formed the Mamaku Plateau of ______________ deposits. Ignimbrites are blocks of ______________, which solidify after cooling following an ______________.

The caldera resulted from ______________ (molten rock) erupting through underground ______________ and ______________ erupted material (the ignimbrite) on surrounding ______________. This left a huge underground ______________ and the ground ______________ into the cavern, leaving a huge ______________ which filled with water and formed Lake ______________. This was 15 km wide from Hamurana in the north to Whakarewarewa in the south.

During eruptions from several vents, ______________ flowed out (similar to toothpaste being squeezed from a tube). These formed volcanic ______________. Mount Ngongotaha, Mokoia Island, Pukeroa Hill (Hospital Hill), Kawaha Point and Hinemoa Point are all examples of these domes. The lake during this period was 80 ______________ higher than it is now. The line of the old lake ______________ can be seen in some places.

Approximately 22,000 years ago an outlet called the Ohau ______________ formed and the lake quickly dropped to 30 m. It continued to ______________ over the next 5,000 years to a level 3 m below its present level, and a ______________ grew to the lake edge. Seven hundred years ago the Mamaku ash eruption partially ______________ the channel again and the lake rose to 13 m above its present level, drowning the forest and covering most of what is now Rotorua. As the ______________ Channel eroded open, the lake dropped to its ______________ level.

Useful words/vocabulary for Earth Science

volcanic	Ohinemutu	delta	molten
caldera	Tikitere	outlet	scoria
eruption	viscous	terraces	Rotomahana
basin	mound	shelves	Pohutu
poured	dome	tectonic	active
cooled	geologist	ash	thermal
solidify	Ngongotaha	heat	Te Wairoa
Mamaku	Hinemoa Point	streams	cavern
plateau	Mokoia Island	gullies	Buried Village
mountain	Pukeroa Hill	deposits	seismograph
erosion	Ohau Channel	horizontal	igneous
weathering	Rotoiti	cutting	rhyolite
crater	level	crack	magma
collapse	sediment	Mount Tarawera	sulphur
seep	lahar	geothermal	ignimbrite
pressure	composite	particle	magnitude
steam	Wairakei	summit	dormant
geyser	Taupo	pumice	vulcanologist
fault	gravel	fissures	cone
Whakarewarewa	fumarole	basalt	temperature
channel	metres	vents	country-side
drop	Rotorua	Ohau	forest
blocked	domes	subsided	lave

Bathymetry map of Lake Rotorua

Use the information to help answer the questions on the following page.

- Lake Rotorua is 11.2 km (north to south) and 9.6 km (east to west).
- The lake occupies a basin, which is a caldera, following the eruption of ignimbrite approximately 100,000 years ago.
- The lake appears to have stayed a steady 280.6 m above sea level for at least 13,000 years, and is fairly shallow for its size.

Approximately 40,000 years ago a series of pumice ash flow eruptions from nearby Rotoiti buried the outlet. The lake rose to a level of 370 m above sea level, 90 m higher than now. The Haroharo caldera (pictured on the next page) drained east towards the sea through the valley now occupied by the Tarawera River. A gully cut back by headward erosion towards Mourea captured the waters of Lake Rotorua and flowed to the sea. Further eruptions in the Okataina caldera blocked the way to the sea and once more the water in Lake Rotorua was impounded and rose. This time the lake overflowed through the Kaituna River. The lake gradually fell again as the river cut down to its present level, more than 13,000 years ago.

Lake Rotorua

The deepest parts of Lake Rotorua are just west of *Mokoia Island* and north of Sulphur Point. A number of rhyolitic lava domes project through the slopes at *Hinemoa Point, Pukeroa Hill* at *Ohinemutu, Kawaha Point* on the south east, and *Mokoia Island.*

Using maps 1 and 2, answer these questions:

1 Find meanings for the following words:
- caldera
- ignimbrite
- rhyolitic lava dome

2 Where are the lava domes:
- Mokoia Island
- Sulphur Point
- Hinemoa Point
- Pukeroa Hill
- Ohinemutu
- Kawaha Point

Map 1

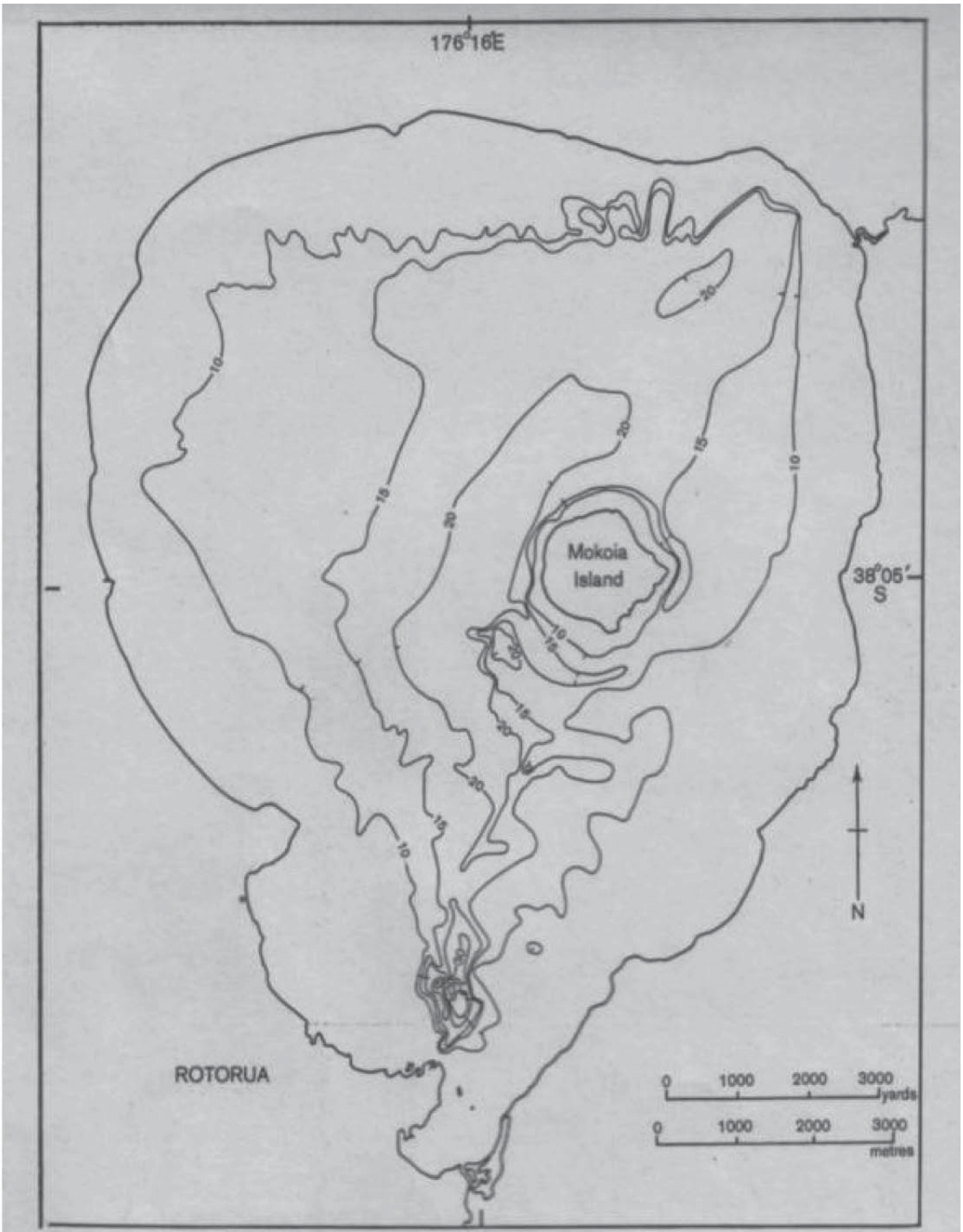


Fig. 1.2. Lake Rotorua. Bathymetry (m).

Map 2

Kawaha Point
Kawaha Point
Ngunguru Point
Hannahs Bay
Jetty and boat ramp
Holdens Bay
Hinemoa Point
Owhata Marae
Holdens Bay
Hannah Bay
Koutu
Thermal Area
Ohinemutu
Jetty
76511
281m
Rotorua Hospital
Hospital
Motutara Golf Course
Motutara Point
Kuirau Park
Sulphur Point
Rocky Point
ROTORUA
Utuhina
Ngapuna
Owhata
High School
Int School
Masonic Village
Spring
VAUGHAN ROAD
OWHATA ROAD
GALVIN RD
LEE ROAD
WHARENUI ROAD
RAILWAY
BRANCH
317
284m
290m
280
281
290

Activity 2d Looking at Sediment

Curriculum links **Science**

Environmental Education – about

Any level
2
Science

Resources required

- Environment Bay of Plenty Water Monitoring Kit from the Rotorua Office

Prior learning

- Discussion on factors associated with sample handling and processing (see teacher notes).
- Gathering information, recording observations and taking measurements.
- Using appropriate instruments to enhance observation.

Method

1 With the whole class, work through any relevant discussion points and issues in the background teacher notes on sedimentation.

2 Organise a field trip to collect sediment samples. Gather sediment samples.

3 Look carefully at the sediment core sample using magnifying glasses or microscopes.

4 Write a physical description of your core sample noting any layering, colour, texture, objects present and odours of the sample.

5 Good describing words – dark/light, smooth, gravelly, narrow thick, pockets, soupy, soft, firm, stiff, packed, loose, gravel, sand, silt, clay etc.

6 Reflection:

- What did we find out? What does this tell us about sediment surrounding the lake?

Background Information on Sedimentation

Factors associated with sampling, sample handling and processing are important. Contamination may enter – i.e. opened sample jars are susceptible to foreign objects like pens/rubbers falling in, or the original contents changing if they're left out in the heat/sun. An effective quality control programme must be in place.

Discuss with the students (this can be before in the classroom or in situ) about sample handling and sample preservation. Hopefully, they will list factors that can influence results and decide on suitable techniques.

Factors	**Techniques**
Disturbance to the surrounding environment and sediment	No running, splashing, in the water
Disturbance of the sample	No shaking and tipping of the sample container. Keep as upright and as still as possible
Evaporation and/or oxidation of the sample	Choose an appropriate container with an airtight lid. Although clear plastic is desirable for observations, keep out of sunlight and store with a dark cover/bag
Introduction of foreign bodies/contamination	Keep container closed. Container and sampling equipment has been prewashed.
Sample deterioration	Store away from light and at 40ºC

Sediment cores can be a record of stream/river/lake life. Material carried in the water (although temporarily in the water) can be laid down permanently in the sediment, i.e. algae growth, fossil pigment, sewage, runoff from the street etc.

Activity 2e How Wet is your Sediment?

Any level
2
Science

Curriculum links Science

Resources required

- Sediment sample (collected in 2d Looking at Sediment)
- Scales
- Oven or dehydrator
- Raisin and grape
- Teacher notes

Method

1 Class discussion on how grapes become raisins (see Wet versus Dry).

2 Will a raisin weigh more than a grape? Have students hypothesise and explain why they think so. Weigh grape and raisin and check hypothesis.

3 How can we work out how much moisture the raisin has lost from being a grape to becoming a raisin? Students briefly explain how you can measure water loss. Carry out weighing activities to work out moisture difference.

4 In groups describe how you might find the moisture content of your sediment sample.

5 A possible method for finding moisture content:

   a Weigh a sample of your sediment. Record the weight.

   b Place the sample in a mild heating environment, like an oven, dehydrator or warm shelf.

   c Leave for one or two days.

   d Cool and re-weigh. Record the new weight.

6 Extension: Calculating the % of water in the sediment sample (see Wet versus Dry)

7 Reflection:

   - What happened to your sample?
   - What differences were there – before and after heating?
   - How do you explain these differences?
   - Compare your results with other group/individual results: Are your results the same?
   - List factors that could contribute to differing results.

Extension

Class results

a Record class results

b Graph the results on a bar graph

c Calculate the average moisture content for all samples (add up all the results and divide by the number of samples you had recorded)

Extra for experts

We can also express the dry content of our samples as a percentage.

Help: $$\frac{\textbf{Dry sediment weight (in grams)}}{\textbf{Wet sediment weight (in grams)}} \textbf{ X 100 =}$$

========= %

Have a go at the calculations!

Evaluation

Look at your dry sediment percentage and compare this to your moisture content percentage.

Can you see any patterns or correlations?

Wet versus Dry

Sediment contains water. We can remove and calculate the amount of water/moisture. This is called the 'moisture content' of our sample. We can also work out the 'dry content' of our sample.

Class discussion

When is a grape not a grape?

When it is dried – the water/moisture removed – to be a raisin!

A grape contains water → The water is removed (dehydration or gentle warming) → The dry grape is now a raisin

Moisture content can be related to making raisins from grapes:

Amount of water/moisture level in sediment sample

Sediment wet weight =__________ g   Sediment dry weight =___________ g

Sediment wet weight *minus* Sediment dry weight equals the *amount of water lost*!

Now, let's express this as a percentage (%)

Amount of water lost _________ g

____________________________________ (divided by) X 100 ============ %

Sediment wet weight _________ g =

Activity 2f What is in your Sediment?

Curriculum links **Science**

Any level
2
Science

Resources required

- Experiment equipment – crucible, bunsen burner, clay triangle, tripod, desiccator (if available), spectroscope (if available)
- Teacher notes

Teacher's notes

The dried sediment is used in this activity to tell the amount of minerals and the organic percentage of our sample. In this analysis, we will use the property of combustibility.

Organic compounds will combust (which means burn) in air (more precisely oxygen). Therefore, if we can burn away the organic part, we will be left with the part that does not burn. This is mostly silica compounds and minerals.

Method

A Organic component

1 Reweigh your dried sediment into a crucible. Note the weight.

2 Assemble a tripod, bunsen burner and clay triangle.

3 Set the crucible into the clay triangle, light the bunsen burner and heat with a blue flame.

4 After a few minutes, carefully hold the bunsen burner and heat the sediment from above. This is to help burn off the organic compounds on the top of the sediment sample.

5 Continue until there is no more change.

6 Turn the bunsen burner off and allow to cool. If there is a desiccator available the crucibles may be carried carefully, and allowed to cool in a desiccator.

7 Reweigh when cool. Note this dry weight.

8 Express these results as percentages (%).

Hint:

weight before combustion (g) - weight after combustion (g) = organic part (g)

[Organic part (g)/weight before combustion] X 100 = ____________%

This is the organic % or volatile amount.

Discussion

- What is the amount of minerals? (Have a go)
- Is there a difference between before and after the experiment?
- How can this be explained?

B Inorganic (mineral) component

Investigate what minerals/compounds are present in the sediment. We will use flame colours and visible spectra!

1. Place a sample of the compound onto the spatula or evaporating dish.
2. Heat over a bunsen flame – blue flame with the air hole open.
3. Note the colour of the flame produced and observe the flame using a spectroscope (if available). Note the emission spectra as a series of coloured lines.
4. Complete the following table, repeating steps 1–3 for each sample.

Compound	**Flame colour**	**Emission Spectra**
Barium Carbonate		
Calcium Carbonate		
Potassium Carbonate		
Copper Carbonate		
Sodium Carbonate		
Iron Chloride		
Cobalt Chloride		
Cadmium Chloride		
Dry Sediment Sample		

Discussion

1. The characteristic light produced is due to the electrons. Why couldn't it be due to changes involving protons or neutrons?
2. Which is a better test for the metallic compounds – flame colour or emission spectra?
3. Identify the metallic element(s) in the sediment sample.
4. Can you identify any chemicals present in your sample?

C More minerals: Station activities

Sediments may contain undesirable chemicals and metals that have entered the water table/cycle naturally e.g. thermal activity or by man-made activities like industrial run-off.

We can use a system of monitoring the water quality and using identification testing to help determine what is present or absent in the waterway, and the origins of the compounds present. This identification is qualitative. Once we have identified a compound we need to perform further tests to determine the amounts or quantities of it.

Testing Time

We will test for:

- Metal compounds – lead, copper, iron
- Non-metal compounds – sulphur, chloride, bromide, iodide, carbonates, sulphates

Materials required

All stations need test tubes, test tube racks and test tube cleaners.

Station 1

- lead nitrate solution
- potassium iodide solution (labelled: Test Solution)

Station 2

- copper sulphate solution
- sodium hydroxide solution (labelled: Test Solution)

Station 3

- iron nitrate solution
- sodium hydroxide (labelled: Test Solution)

Station 4

- sodium chloride solution
- sodium bromide solution
- sodium iodide solution
- silver nitrate solution (labelled: Test Solution)

Station 1 – Lead

1. You have two solutions at this station. Write down their names, formula, description
2. In a clean test tube place $5cm^3$ of **lead nitrate.**
3. Now add **3 drops** of the test solution to your test tube. Watch carefully.
4. Write a sentence describing the **change,** and the **resulting appearance.**

Good words to use are: from, to, …er, more, less

Example: My…………….. ……………….. solution turned ………………… ………….
when I added ………………….

5. Write a sentence describing a positive test for lead ions. You must include:
   - the name of the test solution
   - the change and resulting appearance
   - the metal compound you are testing for
6. **Using your test for lead ions, now test the water/sediment sample.**
7. Write down any observations and/or conclusions you make.
8. Carefully dispose of the mixtures as instructed by the teacher, and clean the test tubes.
9. Clean up, and wipe the bench down.

Station 2 – Copper

1. You have two solutions at this station. Write down their names, formula, description
2. In a clean test tube place $5cm^3$ of copper sulphate.
3. Now add 3 drops of the test solution to your test tube. Watch carefully.
4. Write a sentence describing the change, and the resulting appearance.

Good words to use are: from, to, …er, more, less

Example: My…………….. ……………….. solution turned ………………… ………….
when I added ………………….

5. Write a sentence describing a positive test for lead ions. You must include:
   - the name of the test solution
   - the change and resulting appearance
   - the metal compound you are testing for
6. **Using your test for copper ions, now test the water/sediment sample.**
7. Write down any observations and/or conclusions you make.
8. Carefully dispose of the mixtures as instructed by the teacher, and clean the test tubes.
9. Clean up, and wipe the bench down.

Station 3 – Iron

1 You have two solutions at this station. Write down their names, formula, description.
2 In a clean test tube place $5cm^3$ of **iron nitrate.**
3 Now add **3 drops** of the test solution to your test tube. Watch carefully.
4 Write a sentence describing the **change,** and the **resulting appearance.**

Good words to use are: from, to, …er, more, less

Example: My……………. ………………. solution turned ………………… ………….
when I added ………………….

5 Write a sentence describing a positive test for lead ions. You must include:
- the name of the test solution
- the change and resulting appearance
- the metal compound you are testing for

6 **Using your test for iron ions, now test the water/sediment sample.**
7 Write down any observations and/or conclusions you make.
8 Carefully dispose of the mixtures as instructed by the teacher, and clean the test tubes.
9 Clean up, and wipe the bench down.

Station 4 – Halides

At this station – Halides, we will be looking for chlorides, bromides, iodides.

These are compounds/ions, and are present on the periodic table as chlorine, bromine, iodine.

1. Find these on your periodic table and write down their symbol and atomic number.

Chlorine:	Symbol ________	Atomic Number ________
Bromine:	Symbol ________	Atomic Number ________
Iodine:	Symbol ________	Atomic Number ________

2. Write down the names and formula of the solutions at this station.
3. Into three separate test tubes place $5cm^3$ each of the Halides.
4. Now add **3 drops** of the test solution to your test tube. Watch carefully.
5. Write down what happened in each of the three test tubes.

Good words to use are: from, to, …er, more, less

Example: The iodide went from clear/cloudy/colourless/coloured? *to* clear/cloudy/colourless/coloured?

6 Write a few sentences explaining the test for Halides. Remember to include:

- the name of the test solution
- the change and resulting appearance i.e. from………. to……….. for each

7 **Using your test for Halides, test the water/sediment sample.**

8 Write a conclusion about your results, add any observations you make.

9 Carefully dispose of the mixtures as instructed by the teacher, and clean the test tubes.

10 Clean up, and wipe the bench down.

Extension/Homework

A Lead

Research the answers to these questions:

- Find lead and write down its symbol and atomic number.
- Write down the symbol and name of an element that is in the same group.
- Write down the symbol and name of an element that is on the same row.
- Write down a two word rhyme/saying/'ditty' that stands for the letters in the symbol for lead – this will help you to remember it.
- Lead is not good for the environment or animals that live in it. What are the effects of lead on living things?
- How can lead enter our waterways? Give possible contaminants and their entry.
- Give some solutions to help minimise this pollutant in our waterways.

B Copper

Research the answers to these questions:

- Find copper and write down its symbol and atomic number.
- Write down the symbol and name of an element that is in the same group.
- Write down the symbol and name of an element that is on the same row.
- Write down a two word rhyme/saying/'ditty' that stands for the letters in the symbol for copper – this will help you to remember it.
- Copper is not good for the environment or animals that live in it. What are the effects of copper on living things?
- How can copper enter our waterways? Give possible contaminants and their entry.
- Give some solutions to help minimise this pollutant in our waterways.

C Iron

C1 Research the answers to these questions:

- Find iron and write down its symbol and atomic number.
- Write down the symbol and name of an element that is in the same group.
- Write down the symbol and name of an element that is on the same row.
- Write down a two word rhyme/saying/'ditty' that stands for the letters in the symbol for iron – this will help you to remember it.

- Iron is not good for the environment or animals that live in it. What are the effects of iron on living things?
- How can iron enter our waterways? Give possible contaminants and their entry.
- Give some solutions to help minimise this pollutant in our waterways.

C2 Extension

Planning: Iron metal will rust when it is in contact with water and air.

Plan an experiment/fair test to show that these conditions are both needed for metal iron to rust. Remember to include a control.

Practical: Corroding iron metal will firstly form a green residue, then the characteristic orange colour we call rust. The green residue is due to iron forming an iron compound called ‘ferrous’ (sort of like a monarch caterpillar that forms a chrysalis). The green ‘ferrous’ changes to a different iron compound called ‘ferric’ (like the chrysalis turning to a butterfly). We can test for the green and orange iron compounds separately.

1. Place $3cm^3$ each of Ferrous Nitrate and Ferric Nitrate into separate test tubes.
2. Add 3 drops of Potassium Thiocyanate to each. Watch carefully.
3. Write down what you observe in each test tube. Can you positively identify between ferrous and ferric?

   Ferrous Nitrate stayed/changed ____.

   Ferric Nitrate stayed/changed ____.

4. Write a sentence describing a test to identify between a ferrous and a ferric iron compound.
5. Wash the test tubes, replace in the rack and wipe the bench down.

Background Information

The Life and Times of Lake Rotorua and Lake Rotoiti

Will Esler: May 2005 – Ideas presented to Lakes Education Forum

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Introduction and take home message

Lake Rotorua is one of the oldest permanent lakes in the North Island. It occupies an unusually simple caldera, inactive for perhaps 200,000 years. This simple, volcanically dead landform is being overlaid by new regional fault structures. PhD studies by the author have shown that the history of Lake Rotorua's changing size and depth is much more complex than previously thought. This complexity is due to only a few processes. Damming by neighbouring volcanic activity and releasing by fault movement or huge geothermal explosions are the recurring theme. Lake Rotorua has drained underground and probably dried up several times. The Rotorua Basin contains a very detailed sedimentary record of North Island volcanism.

Early history of the Rotorua Basin

Lake Rotorua first formed soon after the caldera-forming eruption of Mamaku Ignimbrite 225,000 years ago. About half the magma linked to this enormous gassy eruption probably remains as slowly crystallising granite. This acts as a 200 billion m^3 size hangi stone powering the Rotorua geothermal system. Geothermal waters are a complex mix of alkaline-chloride magmatic water and acid-sulphate steam-heated groundwater. The Rotorua caldera subsided in an untidy, piecemeal fashion by up to 1.2 km during and after the Mamaku Ignimbrite eruption. The caldera was partly backfilled with ignimbrite, and degassed magma remnants erupted as Ngongotaha, Pukehangi and Rotorua city rhyolite lavas. Major subsidence long after caldera formation was perhaps caused by the large intersecting NW/SE graben extending into the south of the basin. This was active about 150–50 thousand years ago, and seems to pre-date the currently active Tikitere graben in the NE of the basin. The Rotorua Basin is still seismically active. These minor earthquakes are nothing to do with the long-dead Rotorua caldera per se, which is being overprinted with new structures associated with the Taupo Volcanic Zone.

Huge lakes

A series of big lakes between Taupo and Rotorua may have been joined at times > 225,000 to about 80,000 years ago. Faulting, tilting, and ryegrass make these old lakes very hard to map. Lake level in the Rotorua Basin was well over 360 m above sea level (ASL) at times. From about 145,000 years ago, volcanism in the NW/SE fault structure between Waimangu and Hinemoa Point dumped huge volumes of glassy silt into the lake, especially south of Hemo Gorge. A large mysterious magnetic anomaly centred near Lakes High School may be linked with this volcanism. The foundering of the Tikitere graben between Lakes Rotorua and Rotoiti (and maybe the eruption of Mokoia Island) roughly 80,000 years ago spelt the end of the biggest Rotorua-Taupo lakes.

This northern spillway drained Lake Rotorua to below 220m ASL (present lake level is ~280m ASL). This era lasted long enough for large groundwater-bearing alluvial fans and several metres of peat to build up 60 metres below Rotorua City.

Rotoiti Ignimbrite

Rotoiti Ignimbrite eruptions took place about 55,000 years ago. The first explosion involved lots of water; a big lake somewhere around Lake Okataina got used up very suddenly. The result was wide dispersion of much very fine tephra; the Rotoehu Ash. This layer controls groundwater flows in some places. Rotoiti Ignimbrite then covered all the Rotorua Basin. It flowed around but not over Mt Ngongotaha. Rotoiti Ignimbrite back-filled the Tikitere graben, causing a plumbing crisis. The Earthquake Flat Ignimbrite erupted very soon after. This blocked possible drainage from the south end of the Lake Rotorua catchment. Lake water would otherwise have overflowed into the Ohakuri or Atiamuri catchments, potentially forming a smaller version of the old giant lake. 'Southern drainage' of Lake Rotorua is a myth. As it happens, a separate lake did re-form further south, about 40 m lower than Lake Rotorua. Lake Rotorua rose 180 m to around 400 m ASL, and stabilised at high level for the next 10,000 years or so. Lake Rotorua extended well south of the Hemo Gorge after the Earthquake Flat Ignimbrite eruption. This southern arm of the lake was about 38 km2; a little larger than present Lake Rotoiti, but mostly very shallow. Some oozings would have gone south, but not a major stream. Drainage was probably underground during this period; mainly in the north. The high lake extended a little east of the Ruahine Springs in the Tikitere area. The Rotoiti Ignimbrite dam had its crest near the Manupirua Springs on Lake Rotoiti.

Pulling the plug

About 37,000 years ago, Lake Rotorua drained to below its present level, leaving intact the Rotoiti Ignimbrite dam at Tikitere. The lake water drained underground and probably emerged from fissures in the Kaituna valley. Tutea's Cave and nearby burial caves seem to have been 'penstocks' similar to the present Tarawera Falls. Huge hydrothermal eruptions at Tikitere marked the fall in confining pressure. Lake level rose again just before the big Maketu /Te Mahoe/ Hauparu tephra eruptions, and fell again soon after, for reasons as yet unknown.

Sock in the plughole

This time around, a major lobe of the 'Kawerau Ignimbrite' travelled west from the Okataina Volcanic Centre and blocked the plughole. The flow overwhelmed and carbonised a forest; now charred logs in the Microsilica quarry at Tikitere. The ignimbrite is about 10 m thick at Hells Gate where it forms Te-mimi-o-kakahi waterfall. Its multiple surge beds are more than 7 m thick 3 km from Lynmore and would have had the Pompeii effect on the city area. Lake Rotorua gradually rose to its former height of 380 m ASL only briefly; from about 31–28,000 years ago. The obvious high terrace in the Rotorua Basin dates from this time. It cannibalised the earlier higher terrace that is now barely visible.

Dam busters

Headward erosion of the Rotoiti ignimbrite dam by the proto-Kaituna River in the Okere Falls area seems to have drained the high level lake about 28,000 years ago.

The spectacular main break-out flood was down the Kaituna; not to the Rotoiti Basin, and certainly not to the south. The lake overflow very soon abandoned the Kaituna and drained through the present Rotoiti basin into the Haroharo caldera and ultimately the Tarawera River. A major hydrothermal explosion at Wharetata Bay on Lake Rotoiti seems to have finally destroyed the Rotoiti Ignimbrite dam and permitted this diversion. Lake Rotorua fell to an unknown depth below present for nearly 20,000 years and possibly drained completely for a while.

Lake Rotoiti

Geophysical data collected before the recent accumulation of foul, gassy sediments suggest that Lake Rotoiti formed at a lower level 22,000 years ago by partial damming of the river into the Haroharo caldera by lavas of the Te Rere eruptive episode.

The Maiden’s Rest

The Rotoma eruptive episode 9,000 years ago decisively impounded drainage from Lake Rotoiti with lava flows in the Hongi’s Track area between Rotoiti and Rotoehu. Water level rose immediately, and Rotorua got its lake back. The rapidly rising lake drowned a mature mixed podocarp-broadleaf forest by more than 20 m. Hinemoa took a breather in the exposed branches of one of these old submerged trees during her swim to Mokoia Island. This tree was later named Hinewhata = ’Maiden’s Rest’, and later still seems to have been dynamited as a hazard to navigation. Canoeists soon become aware of the many other 9,000 year old barely submerged stumps in parts of Lake Rotorua.

Lake Rotoiti and Rotorua were joined as a single lake a few metres above present level at this time, and overflow at Okere Falls resumed. Lake Rotorua then had a much longer and more convoluted shoreline than at present, with five small, but charming islands in the city area; Kawaha, Koutu, Pukeroa, Owhatiura, and Owhata (Hinemoa Point). The RGHS rose bed was one of the bikini-beaches of the day: local climate was like Papamoa of the present. Brown diatomite of this age is readily accessible in many Rotorua city streambanks. The diatoms require about 400X magnification, but are beautiful enough to be well worth the effort of preparation; grubby finger wiped on a slide.

The Okere Falls outlet has not changed in elevation, but episodic uplift has since tilted the floor of the Rotorua Basin northward, giving the impression of a former 14m higher lake level 9,000 years ago. The corresponding (bikini) beach is well submerged at the far end of Lake Rotoiti, also due to tilting. The Tikitere graben has subsided by about 30m in the last 30,000 years during earthquakes, rather than at a steady 1 mm per year.

Comments

Resource material for secondary school use should include discussion of the Maori explanation of natural features. Few legends seem to be recorded about the ‘origin’ of the lakes. The lake names themselves are not a rich seam, given ongoing doubt over translation; e.g. Rotorua =‘second lake’ or ‘lake in a hole’. The Ngato-i-rangi geological /geothermal story is very important, and is really more about his rescue by powerful big sister Kuiwai, local founder of the ‘long lunch’ and originator of the ‘geothermal’ smell near Te Hemo-a-Kuiwai (Hemo Gorge) = ‘the mighty flatulence of Kuiwai’.

Ferdinand von Hochstetter is credited by mainstream geologists with the discovery of the Taupo Volcanic Zone. Hochstetter himself gave the honour to Ernst Dieffenbach (with most uncharacteristic modesty). Dieffenbach unhesitatingly credited Maori with the observation that volcanoes and associated thermal activity extend in a line from White Island to Ruapehu. Kuiwai, dispatcher of the taniwha that ‘caused’ the phenomena could therefore fittingly narrate a video account of Rotorua’s natural features. Geologist and Black Fern rugby player Mel Ngatai (Melodie) would be a terrific ‘Kuiwai’.