Eruption! Discovering New Zealand's Volcanoes

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ABOUT THE AUTHOR

Maria Gill lives within eyesight of a very old volcanic island, Hauturu/Little Barrier. She's always had a fascination for volcanoes ever since she went on a junior school trip to Rangitoto. This is her third book on volcanoes. The others include *Rangitoto: Te toka tu moana (The rock standing in the ocean)*, illustrated by Heather Arnold; and *Volcanic Eruptions*.

This is Maria's twenty-seventh book (10 trade, 17 educational)! You can see inside some of those books on her website (www.mariagill.co.nz). Feel free to ask her any volcanic questions on her Facebook fan-page, 'Maria Gill Children's Books'.

STYLE OF WRITING AND PRESENTATION

Eruption! is presented in a lively, and moderately edgy, illustrated style designed to engage the reader's attention and help make learning an exciting process. Diagrams are stylised, in keeping with the overall look, and simplified as much as possible so as not to overload the reader. *Eruption!* does not shy away from tackling big science, but delivers it in bite-size units and uses familiar, everyday analogies where possible.

The fictional character of Volcanica, cub reporter for the *Magmatic Press* (all the news that's hot!) appears at intervals to present topical background information. On most pages, links lead students to online resources (facts, film footage, photos, animations, etc.), connecting them with the latest news and science and extending the functionality of the book.

Another element that runs through the book is Maoritopia, a source of creation stories and legends connected with each volcanic site.

GNS Science makes a major contribution in the form of consultant Dr Gill Jolly,

volcanologist, and through the use of its photography.

THE SCIENCE BEHIND *ERUPTION!*

Volcanoes: a platform for science teaching

Volcanoes are the surface expression of Earth's geological forces; more than that, they involve violent and dramatic chemistry and physics. And they're found right here, in New Zealand! As such, they serve as the ideal platform for teaching a wide range of scientific principles.

While New Zealand children generally well understand that these shaky isles are geologically active, how much do they really know about the 'why' and 'how'?

The long Chapter 1 of *Eruption!* communicates the key scientific points, which can be summed up as follows. Included here are some underlying themes, many of which are broached in the book, as well as some starter points for class discussion.

1) • Principle: *Earth is a geologically active planet with a hot core.*
   • Underlying themes: the effects of heat and pressure; radioactive decay (which causes the heat).
   • Class discussion points: New Zealand's ongoing volcanoes are explosive evidence of the heat within the planet.

2) • Principle: *Earth's crust is made up of several discrete plates in constant motion.*
   • Underlying themes: heat convection; plate tectonics.
   • Discussion points: a) The 'jigsaw' effect of plate tectonics, and how the major coastlines can be seen to fit one another. b) The shifting land masses are of particular interest in New Zealand, given that it was once part of the ancient southern supercontinent Gondwana.

3) • Principle: *Where plates meet, volcanism takes place.*
   • Underlying themes: subducting/diverging/collision/transform boundaries; storage and release of energy.
   • Discussion points: a) New Zealand sits astride a plate boundary, which is why we have so many earthquakes and volcanoes. b) Interplate volcanism is particularly evident around the Pacific Rim, and students may have learned about some of the recently deadly earthquakes and tsunami in overseas countries. c) What else happens at plate boundaries? Mountains are formed, rifts open up, land masses sink, etc.

4) • Principle: *Magma, the key ingredient of volcanism, is rock made molten by pressure/heat.*
   • Underlying themes: the effects of heat and pressure (again) on the state of matter, which may change between fluid, solid and gas; the varying consistency of mantle rock.
   • Discussion points: a) When is rock 'magma' and when is it 'lava'? b) Earth is like a really big egg! It has a brittle crust (shell), softer mantle (like the white), and a distinct core (yolk), which is part liquid, part solid.

Links to Curriculum: Planet Earth and Beyond
Students will:

1. Describe how natural features are changed and how resources are affected by natural events (Levels 1 and 2)
2. Explore and describe nature features and resources (Levels 1 and 2)
3. Investigate the external and internal processes that shape and change the surface features of New Zealand (Level 6)

Connected principles
While these principles can be discussed separately, they are of course also interconnected. In the classroom, just as in the book, it may be useful to present them in sequence to show how they connect. For instance:

Earth's interior matter is hot and
subject to heat convection.

This keeps the brittle crust plates in
constant motion over the planet's surface.

The plates jostle one another – sometimes colliding,
sometimes grinding past one another,
sometimes one diving under its neighbour.

The colliding, grinding and diving processes at the
plate boundaries result in earthquakes and volcanoes.

Located over a plate boundary, New Zealand
is subject to ongoing volcanism.

Volcanoes are therefore the evidence of
volcanism, plate tectonics and Earth's heat.

In addition to these basic ideas, several others may be explored, such as:

• Lava may be sticky or runny depending upon its composition, and this affects the degree of violence in an eruption and the physical aspects of a volcano (chemistry).

• The violence of an eruption is also governed by the presence or absence of groundwater (chemistry/physics).

• Specialised seabed animals have evolved to survive in the lightless conditions of hydrothermal vents (biology/chemistry).

- Volcanoes alter our landscapes, producing mountains and lakes (geology).
- Volcanoes alter soil composition, enriching it with nutrients (geology/geography).

SYNOPSIS OF THE BOOK

Introduction
Meet Volcanica, the reporter who will pop up throughout the book to explain volcanic terms. You will also find a key to symbols giving students an element of game playing or code cracking that may be applied to the later chapters.

Chapter One: Our Shaky Isles
Chapter One sets out the basic scientific principles behind volcanism:
• plate tectonics and the Pacific Ring of Fire
• subduction, transform, collision and divergent boundaries
• the landscaping effects of tectonic movement
• the properties of magma
• the cross-sectional composition of planet Earth
• the effects of pressure upon rock
• a comparative table of the major types of volcano (which are expanded upon in the following chapters): stratovolcanoes, shield volcanoes, calderas and volcanic fields.

Later chapters build further on the basic principles (for instance, the explosive qualities of groundwater are explained in Explosive Finds, pp. 38–9).

Chapter Two: Stratovolcanoes
These classic cone-shaped volcanoes are built up layer by layer from lava and ash. New Zealand examples are Taranaki, Tongariro and Ngauruhoe, Ruapehu, and Whakaari/White Island. The 1914 eruption of White Island and the 1953 Tangiwai disaster, covered in *Magmatic Press bulletins*, provide a powerful human angle.

Chapter Three: Shield Volcanoes
Shield volcanoes in New Zealand include Mt Cargill, Lyttelton and Akaroa. This chapter covers the special properties of the runny lava that produces shield volcanoes and lava tubes.

Chapter Four: Caldera Volcanoes
Rotorua, Taupo and Tarawera are included in this chapter on our most destructive kind of volcano. Taupo's events of 27,000 and 1700 years ago were two of the biggest eruptions in human history, while the 1886 Tarawera eruption remains one of New Zealand's most catastrophic natural disasters.

Chapter Five: Volcanic Fields
Volcanic fields comprise scattered eruptions over a localised area. Examples include Auckland, where volcanoes (including the shield volcano Rangitoto) contribute so much to the local landscape, and Kaikohe/Bay of Islands. Smaller volcanic features such as maars, tuff cones, domes and scoria cones are also explained.

Chapter Six: Submarine Volcanoes and Seamounts
Though they're hidden from view in places like the Kermadec Arc, submarine volcanoes are some of Zealandia's most awesome natural formations. Now, thanks to seabed mapping and submersibles, their secrets are being brought to light.

Chapter Seven: In the Field

What do volcanologists actually do – and how do they keep tabs on our volcanoes? This chapter explains some of the tools and techniques they use. It also gives advice on visiting New Zealand's volcanic sites and thermal areas, and lists the best field trips (including websites, contact details, etc.) Personal safety – including what to do in the event of an eruption – is also covered.

A GUIDE TO THE ACTIVITIES

The activities are written up in a style that addresses the students directly.

A Day in the Life of a Volcanologist introduces them to a real-life volcano scientist and gets them thinking about what such a job might involve.

Use the **Quiz** as a preliminary test to see how much your students know about New Zealand's volcanoes. Or make it a comprehension activity after they have read the book.

The **Become a Reporter** activity enables your students to put what they've learnt into a news article. It could be used as a language activity or just a creative revision exercise.

The **Maoritopia** activities encourage students to look closely at the Maori legends in the book and devise some of their own.

The **Focus Research** is an opportunity for your students to study a volcano, perhaps even one that is not in the book. It could be a volcano near where you live, a place you are intending to take the students on a field trip or give the choice to the students and let them choose their own volcano. Volcanoes are pretty hot stuff!

The **Stuff to Make** is a tactile activity for all those kinaesthetic learners in your class. Each activity could be done in an afternoon or used as an 'action station' series of lessons. You would need to set up the activities one at each big table (or group of tables), with its resources. Give the students 30 minutes (or longer) for each activity, then have them tidy up, then move to the next activity. You could also encourage students to write what they've learnt from that activity in a reflective journal.

The **Mindbenders** provide a learning centre to test their thinking skills. You could put each activity up on the wall and let the students choose or have it as a fast finishing activity while doing the other lessons.

Lastly, a small **What to do!** quiz tests whether students know what to do in an emergency.

Links to other resources are provided at the end.

I hope you enjoy the book and these activities!

Maria Volcanica

MEET THE EXPERT: DR GILL JOLLY

Dr Gill Jolly is a volcanologist (volcano scientist) for GNS Science, New Zealand's leading provider of geoscience research. She lives and works in the volcanic centre of New Zealand – Taupo – where she heads the Volcanology Department of the Wairakei Research Centre.

Dr Jolly checked the book to make sure it was factually correct and up-to-date with its information. She has written two children's book before: *The Volcano Book: Erupting near you*, and *The Tsunami Book: Killer waves*.

Below is a day in the life of Dr Jolly that has been formulated to cover the many different ways in which she researches and reports on New Zealand's volcanoes. Following are some classroom activities.

A day in the life of a volcanologist

8.00 Dr Jolly drives to the nearest heliport to meet her team.
9.00 She checks her equipment to see she has everything.
9.30 They fly by helicopter to White Island volcano.
10.15 When they land on White Island they put on hard hats and gas masks. They tramp up to the caldera to take rock, gas and water samples. They measure temperatures of fumaroles and the lake or puddles. They use levelling surveys to record altitudes.
2.00 They fly back to the mainland.
3.00 Dr Jolly drives to her office in Taupo.
4.00 She logs samples into the computer, and sends them off to the laboratory. She analyses data to check for ground movement or changes in temperature. Dr Jolly emails scientists to update them on White Island.
5.15 She works on a scientific report she is writing.
6.00 Dr Jolly finishes work for the day, and heads home.

ACTIVITIES

1) Prepare questions for a volcanologist using the information above, then pair up with one of your classmates. Take turns to role-play being an interviewer and a volcanologist, inventing your responses but basing them on facts.

2) With your classmates, role-play being scientists on White Island and feeling a rumble or see lava erupt out of the crater. What do you do?

3) Investigate what you need to study at school to become a volcanologist. Afterwards, write a JOB WANTED advertisement for a volcanologist.

ERUPTION QUIZ!

1. What are the names of the two tectonic plates whose boundary goes right through New Zealand?

2. Name four major types of volcano that are found in New Zealand.

3. Name three stratovolcanoes in New Zealand.

4. What is the name of New Zealand's youngest and most active volcano?

5. What is the difference between a volcanic bomb and a volcanic block?

6. Name the nearest shield volcano to where you live.

7. What is the name of New Zealand's only supervolcano?

8. What volcano erupted on 10 June 1886?

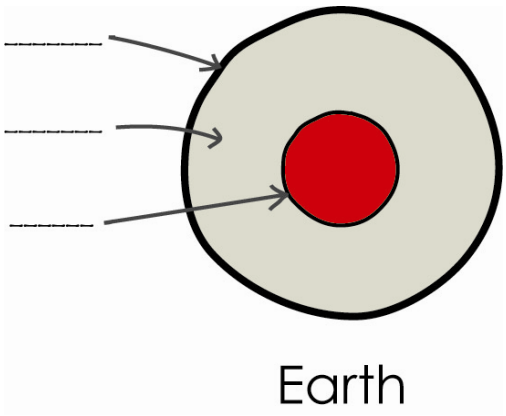
9. Name the biggest volcanic field in the North Island.

10. What is the name of the submarine volcano that was more than five times larger than Ruapehu and Tongariro?

11. Name five things you should do if a volcano erupts near you.

12. Name two scientific instruments volcanologists use to monitor volcanoes.

13. Label the parts of planet Earth.



. . . AND NOW A PHOTO QUIZ

While writing the book Maria felt compelled to visit some of the volcanoes she wrote about. Luckily, she took her camera. See if you can match the pictures of volcanoes with their names: Taupo, Rotorua, Ngauruhoe, White Island.

14. This is New Zealand's most active volcano.

15. This is a supervolcano.

16. This volcano last erupted in 1975.

17. The mud pools are near a caldera.

BECOME A REPORTER!

Throughout *Eruption!* you will find numerous news articles about volcanoes. Our cub reporter, Volcanica, penned those ones – now it is your turn to write your own. You could find something interesting about one of the volcanoes, or write about a trip you made to a volcano.

In a news story the reporter's goal is to answer the following questions: WHO, WHAT, WHEN, WHERE, WHY and HOW at the beginning of the article. The body of the article contains interesting facts, quotes and colourful details. The ending contains the least important information.

1. Draw a triangle and divide it into thirds – like this one
2. Write in the top third the most important information (this is your 'who, what, when, where, why, how').
3. In the middle put supporting facts and background detail.
4. In the bottom third include the least important information.

That's your draft. Now write your news article with a catchy heading then follow with your sentences using the above format. Present your article on a newspaper template (http://newspapertemplate.net/) or make your own template.

Here's an example:

MAGMATIC PRESS

www.magmaticpress.com THE WORLD'S HOTTEST NEWSPAPER - Since 1879

PERILOUS CROSSING

Author Maria Gill trekked the Tongariro Crossing in nine hours.

"It must be a record for the longest time to walk the track," said Ms Gill.

Armed with camera and walking stick she set off at 7.30am. She had many short breaks but kept plodding on until the finish.

"The journey was dangerous at the top. Loose rubble threatened to cause a landslide but I managed to navigate it without falling."

The weather started off sunny but at the summit wind and black clouds increased the chill factor. Ms Gill kept warm wearing a woollen hat and zipped up her jacket.

"I didn't want to get hypothermia," said Ms Gill.

Ms Gill limped to the finish at 4.30pm. "I thought it was never going to end."

She felt she had overcome a personal obstacle to complete it.

MAORITOPIA

Throughout the book are Maori legends about how the volcanoes were created.

Page 4 – Learn the Maori word for volcano.

Page 9 – How Maori used family relationships to explain changing landscapes.

Page 11 – The legend of the family break-up between Ranginui and Papatuanuku.

Page 14 – The legend about the sad Taranaki volcano.

Page 17 – The legend of Ngatoroirangi and how he named Ngauruhoe.

Page 21 – How Maui shaped Whakaari (White Island).

Page 29 – Legend of when Ngatoroirangi made Lake Taupo.

Page 31 – Ngatoroirangi creates Lake Taupo.

Page 35 – Fire goddess Mahuika teaches two giants a lesson.

Activities with the legends

1. Students pick one of the legends in the book and turn it into a picture book.
2. Students pick one of the volcanoes without a Maori legend and make up their own legend for it.
3. Students turn one of the Maori legends into a cartoon either by drawing by hand or drawing it on the computer.
4. Students investigate one of the legends and see how many versions they can find of it. They then compare the different versions.
5. Students act out one of the Maori legends.

VOLCANIC INQUIRY PROJECT

Pick a volcano to research. As a class, write a main focus question. Then choose three questions you would like to research. Write your notes in the middle and say where you got that information under 'source'. Lastly, summarise (put in your own words) what you have learnt about your volcano.

Here's an example to get you going.

Main focus question: How do volcanoes change the landscape?
Specific focus questions:
1) How did my volcano form?
2) What type of volcano is it?
3) Will my volcano erupt again … and why?

VOLCANIC INQUIRY PROJECT		
VOLCANO: …….. TYPE: …….. STATUS: …… MAIN FOCUS QUESTION: ……		
FOCUS QUESTIONS	RESEARCH	SOURCE
1.		
2.		
3.		

SUMMARY:

VOLCANIC STUFF TO MAKE AND DO

EXPLODING VOLCANO

You will need: large piece of stiff card, plastic canister*, sticky tape or glue, newspaper, tinfoil, vinegar, baking soda, dishwashing liquid, red dye

*** (about 10–16 cm long, like the type you buy bubble-blowing liquid in. You don't need the lid.)**

1. Lay the card down and tape or glue the canister (open end up) in the middle.
2. Crumble newspaper balls and arrange them in a 'volcano' around the container.
3. Lay tinfoil over the top and tape it down underneath the edges of the card.
4. Make a hole (your 'crater') over the mouth of the container. Put in 1 teaspoon of baking soda, a few drops of dishwashing liquid and dye, then fill canister with vinegar.

EXPANDING GASES

This is a messy experiment, so it's best you do it outside, or wear protective clothing!
You will need: a bottle or can of raspberry soda

Shake the bottle or can a few times, then take the lid off. What happens? The rising bubbles are a bit like magma rising from deep inside Earth to the crust. When magma rises, it moves from a high-pressure environment to a lower-pressure environment. This
allows the gases inside it to expand and be released.

TECTONIC PLATE JIGSAW

You will need: paper, glue card, scissors

Go to: http://scienceonline.tki.org.nz/Nature-of-science/Nature-of-Science-Teaching-Activities/Plate-tectonics-2-2-evolution-of-a-theory#Jigsaw and find the jigsaw puzzle PDF.
Print out the jigsaw puzzle, glue the back, and mount it on card. When dry, cut it out, and erase the names with correction fluid. Then jumble up the pieces and give them to someone else to put back together again. Can they name the plates?

OTHER IDEAS:

• Paint, draw or create a new look for Ngauruhoe if it blew its top.

• Invent a new way to monitor volcanoes.

• Design and build a cutaway papier-mâché model of a volcano. Name the various parts.

- Make an A–Z list of volcanic information!

QUICKFIRE MINDBENDERS

And finally, here are some questions and discussion points to get you thinking!

UPLIFT . . .
What if most of mainland Zealandia had not sunk into the Pacific? What would New Zealand be like?

WHAT IF?
What if Taupo exploded again? What would happen to your home town? What are some of the disadvantages of living near the Wellington fault line?

PREDICT . . .
What would be the consequences if a volcano erupted in Auckland?

ENERGISE!
Make a list of ways in which we might use crater lakes, volcano slopes and geothermal energy.

WHAT TO DO!

At the back of the book are ideas of what to do if there is a volcanic explosion near you. Take the multi-choice quiz to see if you can remember what you need to do in an emergency.

If a volcano erupts you should:

a) Grab your camera and get as close as possible to take photographs
b) Ring all your friends to tell them all about it
c) Stay indoors, close windows and doors
d) Wear protective clothing and have a volcano party.

If you need to go outside you should:

a) Wear a helmet and gas mask
b) Wear protective clothing and a mask
c) Wear your best clothes – you never know whom you'll meet!
d) Wear your old clothes so you can throw them away afterwards.

If a lahar moves towards you, you should:

a) Run as fast as you can
b) Hide behind a rock
c) Run sideways out of its path
d) Grab your surfboard and ride it out.

Now play the Awesome Forces game to see if you're ready: http://goo.gl/npDBX

LINKS

http://www.sciencenewzealand.org/Volcanoes
Resources.

http://www.tepapa.govt.nz/WhatsOn/exhibitions/ADayInPompeii/Volcanoes/Pages/DrGrahamLeonardsTopTenVolcanoLinks.aspx
A volcanologist lists 10 top volcano sites.

http://nhb-arcims.si.edu/ThisDynamicPlanet/index.html
Check out this interactive volcano world map.

www.gns.co.nz
Teaching resources, photographs and videos.

www.whatstheplanstan.govt.nz
Teaching resource with safety information for primary schools.

ANSWERS

Quiz

1. Australian and Pacific plates
2. Stratovolcano, shield, caldera, volcano field
3. Taranaki, Tongariro, Ruapehu, White Island
4. Ngauruhoe
5. Volcanic bombs: lava cools and turns solid while still in air.
   Volcanic blocks: lava so thick it blocks up a vent.
6. Lyttelton? Akaroa? Rangitoto?
7. Taupo
8. Tarawera
9. South Auckland Volcanic Field
10. Waitakere Volcano
11. Stay indoors, close windows and doors, wear protective clothing if go out, wear mask over your mouth and nose, find shelter if outside.
12. Seismometer, GPS unit, lake levelling tool, webcam
13. [top to bottom] crust, mantle (or asthenosphere), core
14. White Island
15. Ngauruhoe
16. Rotorua
17. Ruapehu
18. C
19. B
20. C