Introduction to geothermal environmental considerations

The Geothermal Institute
University of Auckland

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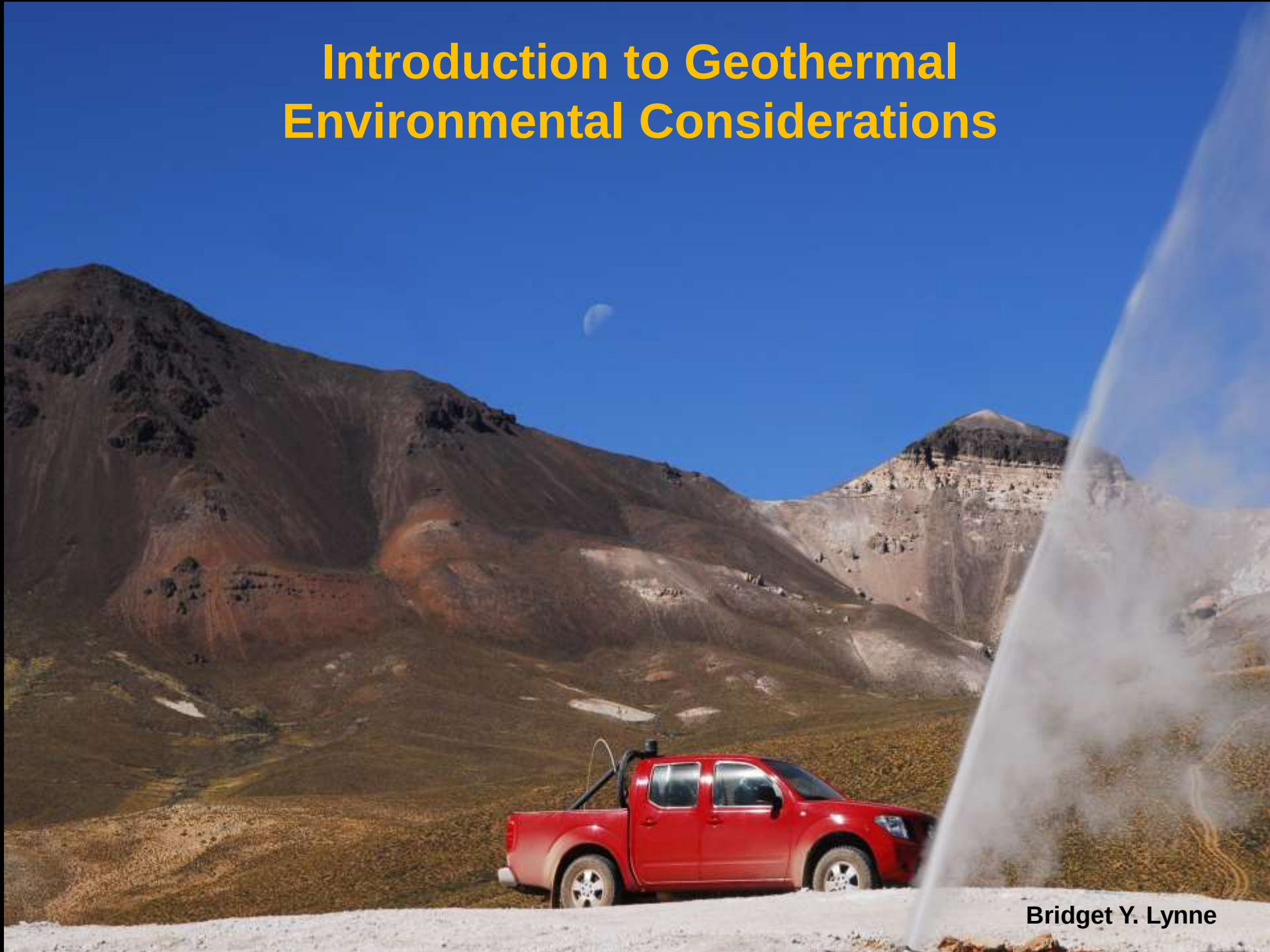
Santiago de Chile, 26-29 May 2014

GEOTHERMAL INSTITUTE

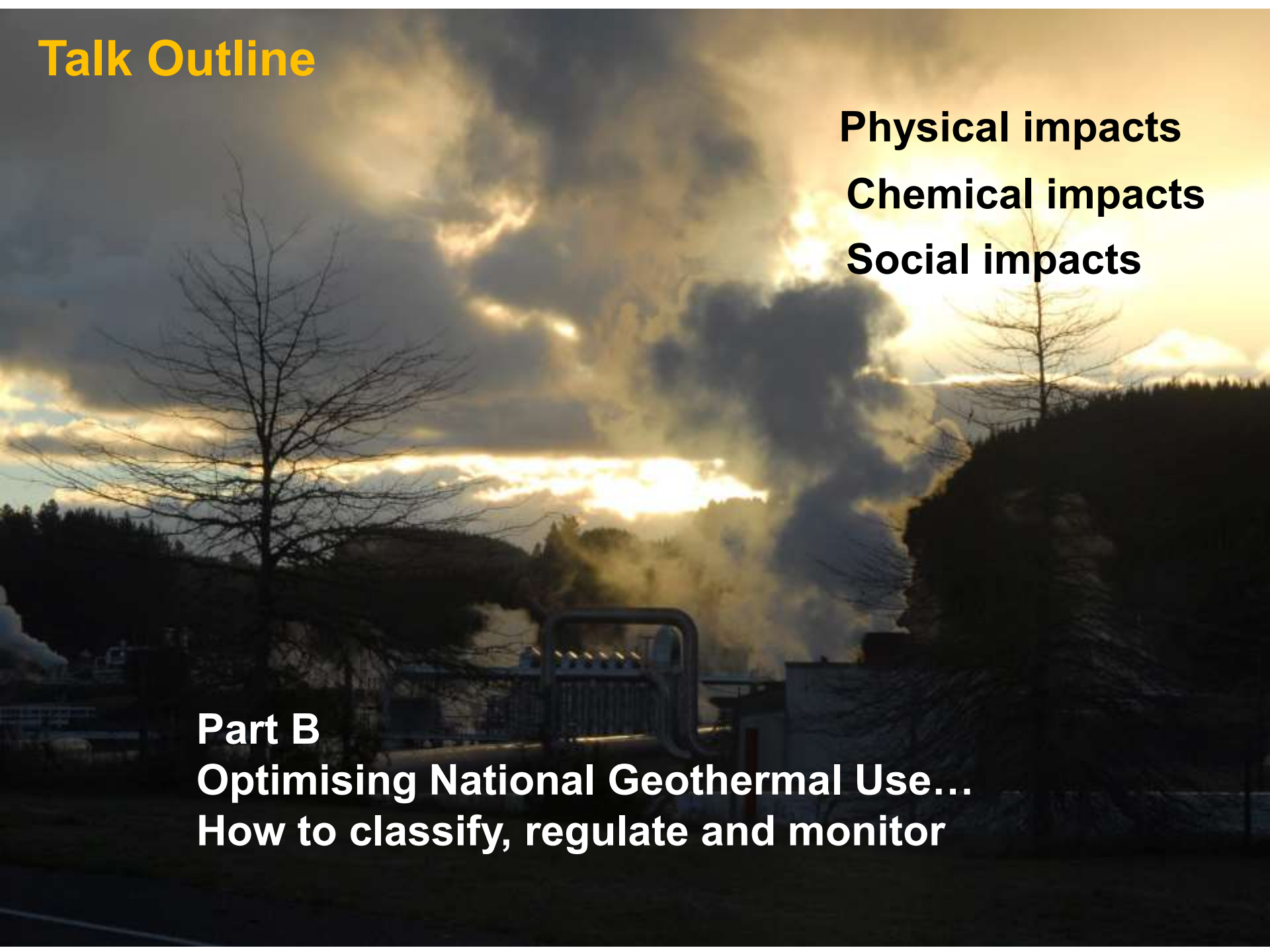
THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

Introduction to Geothermal Environmental Considerations



Bridget Y. Lynne

Talk Outline



Physical impacts

Chemical impacts

Social impacts

Part B
Optimising National Geothermal Use…
How to classify, regulate and monitor


All aspects of environmental development must be given careful consideration

Physical impacts

Alkali chloride fluids are targeted for geothermal power

Withdrawal of fluid reduces subsurface pressure

Less pressure – numerous physical effects

Physical impacts

Less pressure results in …..

Increased boiling

Increased steaming ground

Weakening of ground

Changes to surface activity

Hydrothermal eruptions

Reduction in pore pressure

Compaction of sediments

subsidence

Changes in surface activity

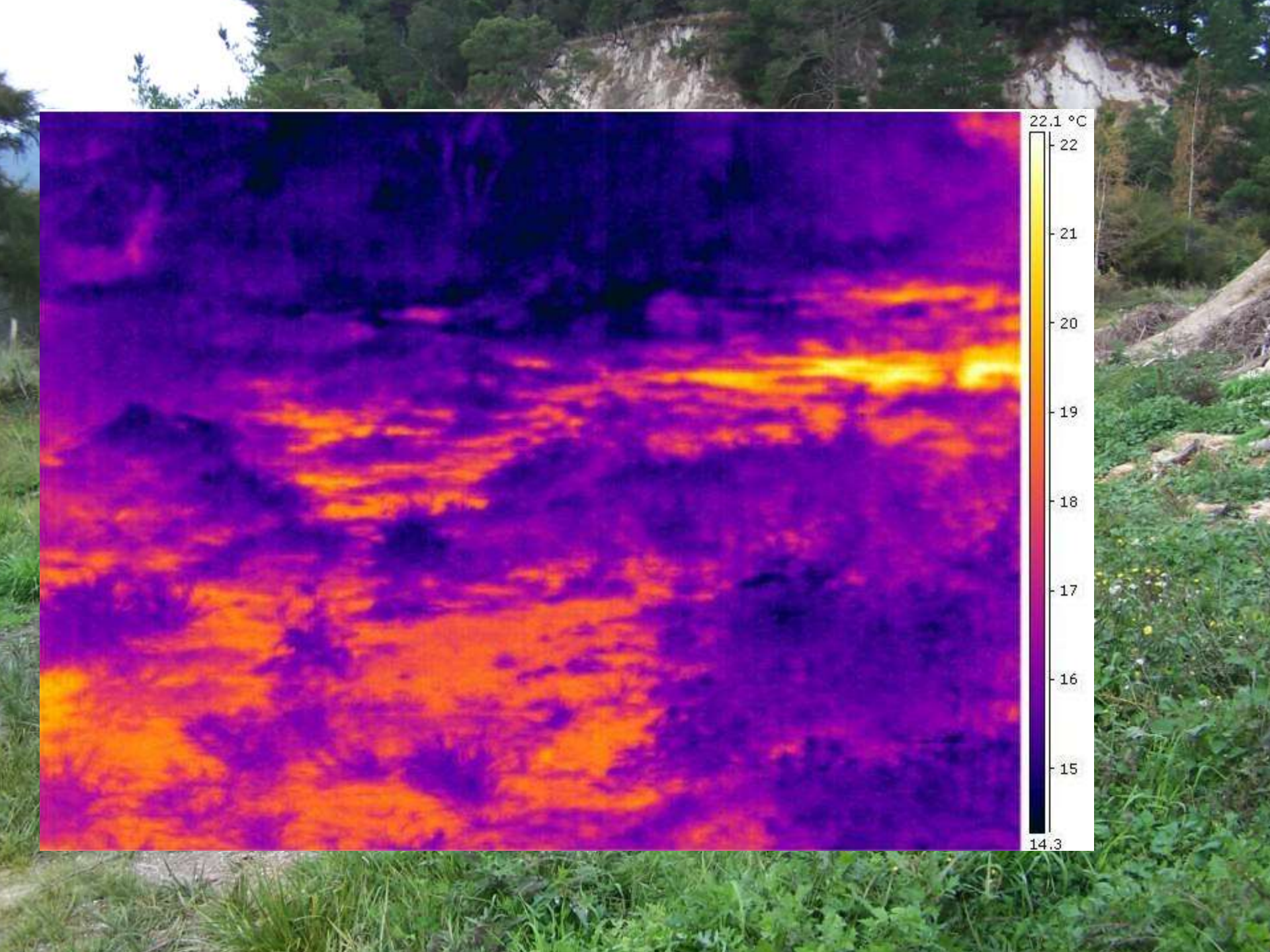
due to changes in subsurface pressure

Physical impacts

Thermally stressed grass = warm ground

Appearance of new thermal features

Not always where we want them


22.1 °C
22
21
20
19
18
17
16
15
14.3

Dissolution or collapse craters (no volcanism)

Ascending gases dissolve rock causing collapse

Waiotapu


Rainbow Mountain, Waiotapu

LANDSLIDES

Acidic steam condensate overprinting

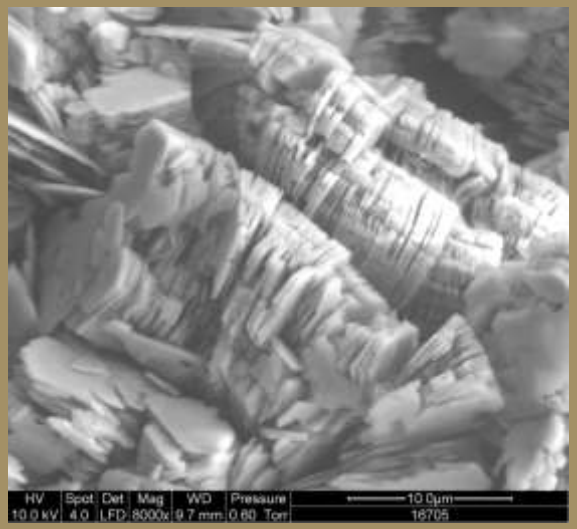
-thermally stressed vegetation
-kaolinite clay


Te Kopia landslide

ALTERATION via ACIDIC STEAM CONDENSATE

Acidic steam condensate overprinting

pH 3-4
Temp < 120 °C



Physical impacts

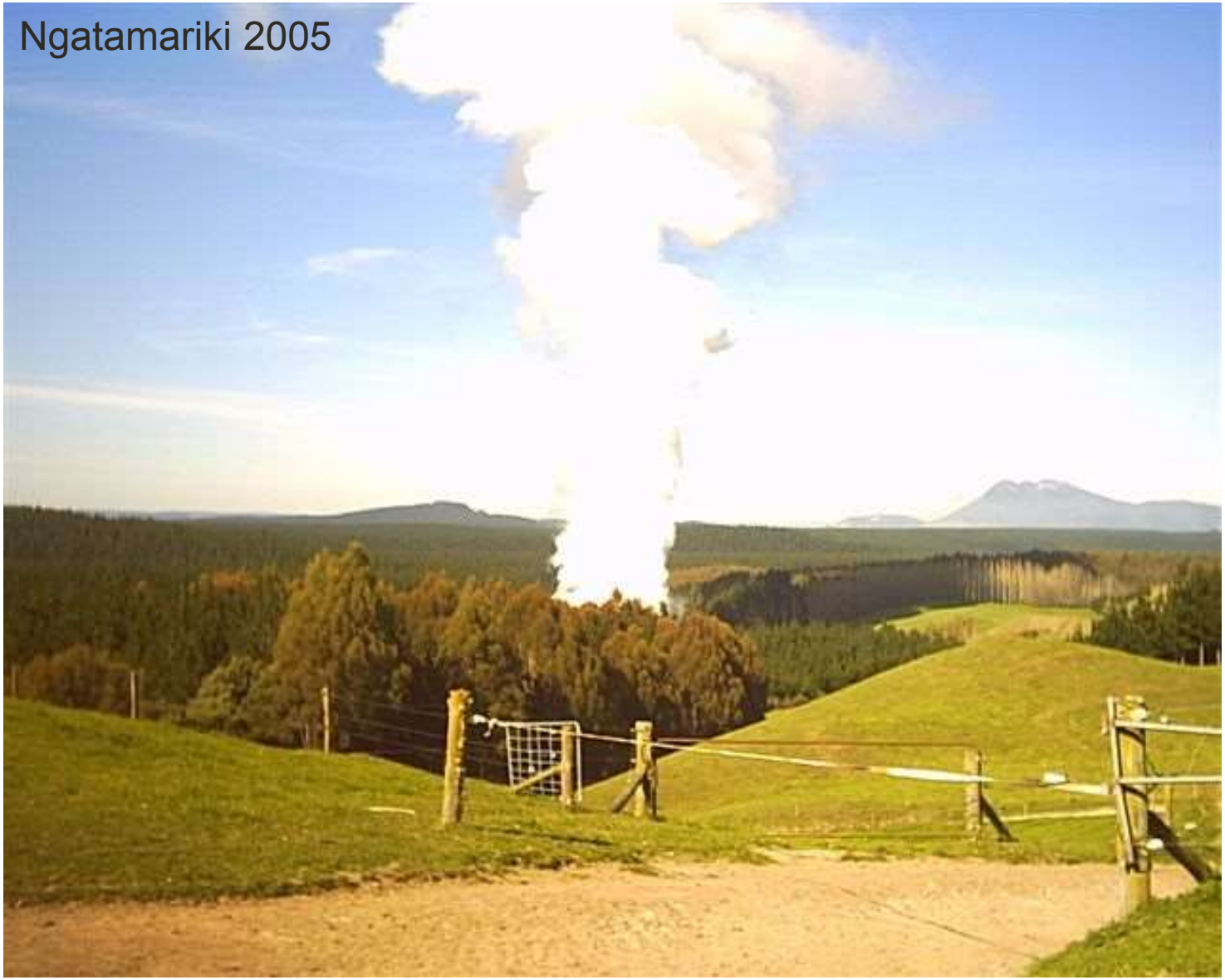
Changes in pressure can result in …

Hydrothermal eruptions

Hydrothermal eruptions can occur anywhere

Hydrothermal Eruptions occur ….

- Without warning
- No magma involved
- Sudden change in subsurface pressure
- Flashing to steam and steam provides uplift of rocks for eruption
- Can be catastrophic


Ngatamariki 2005

Ngatamariki 2005


Ngatamariki 2005
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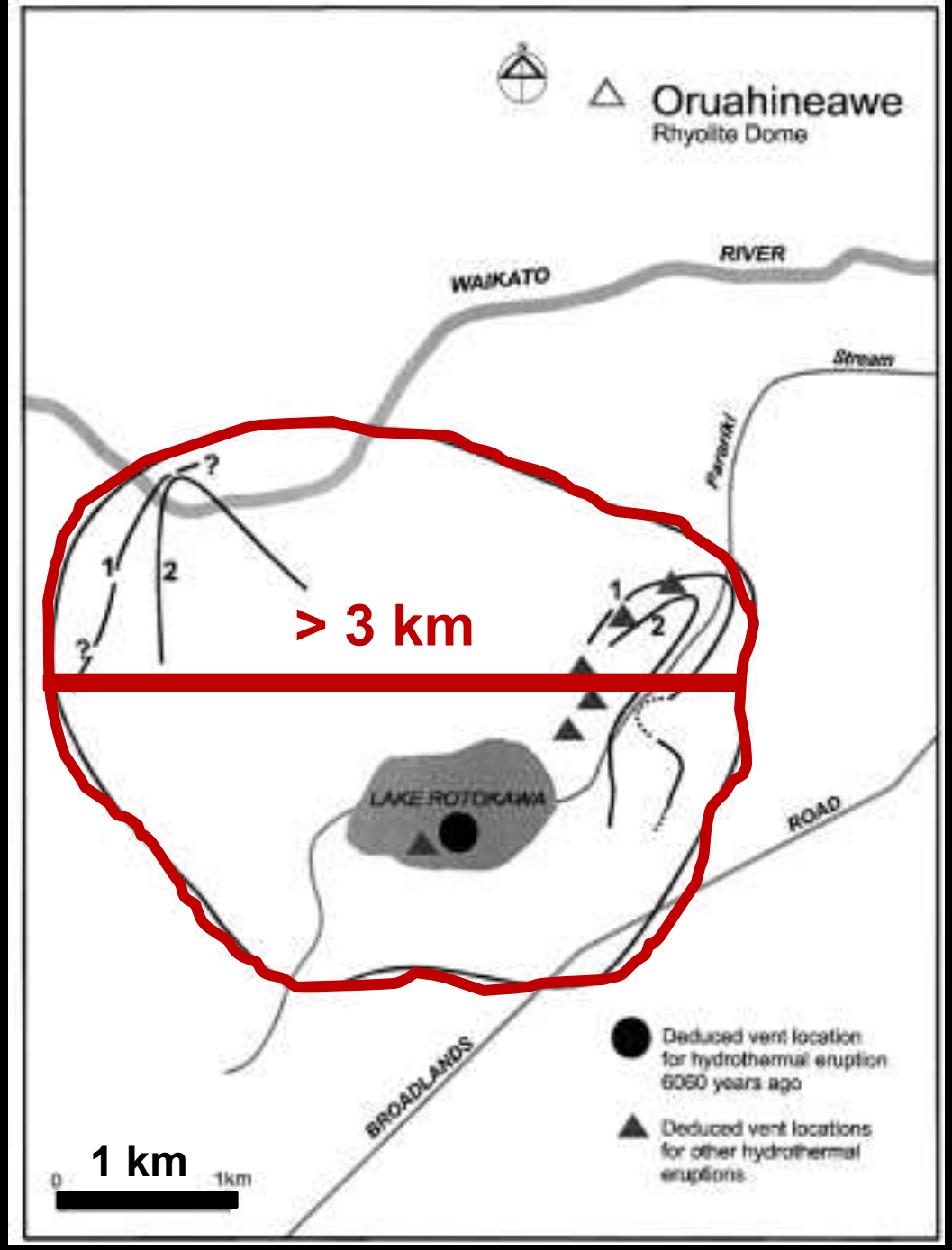
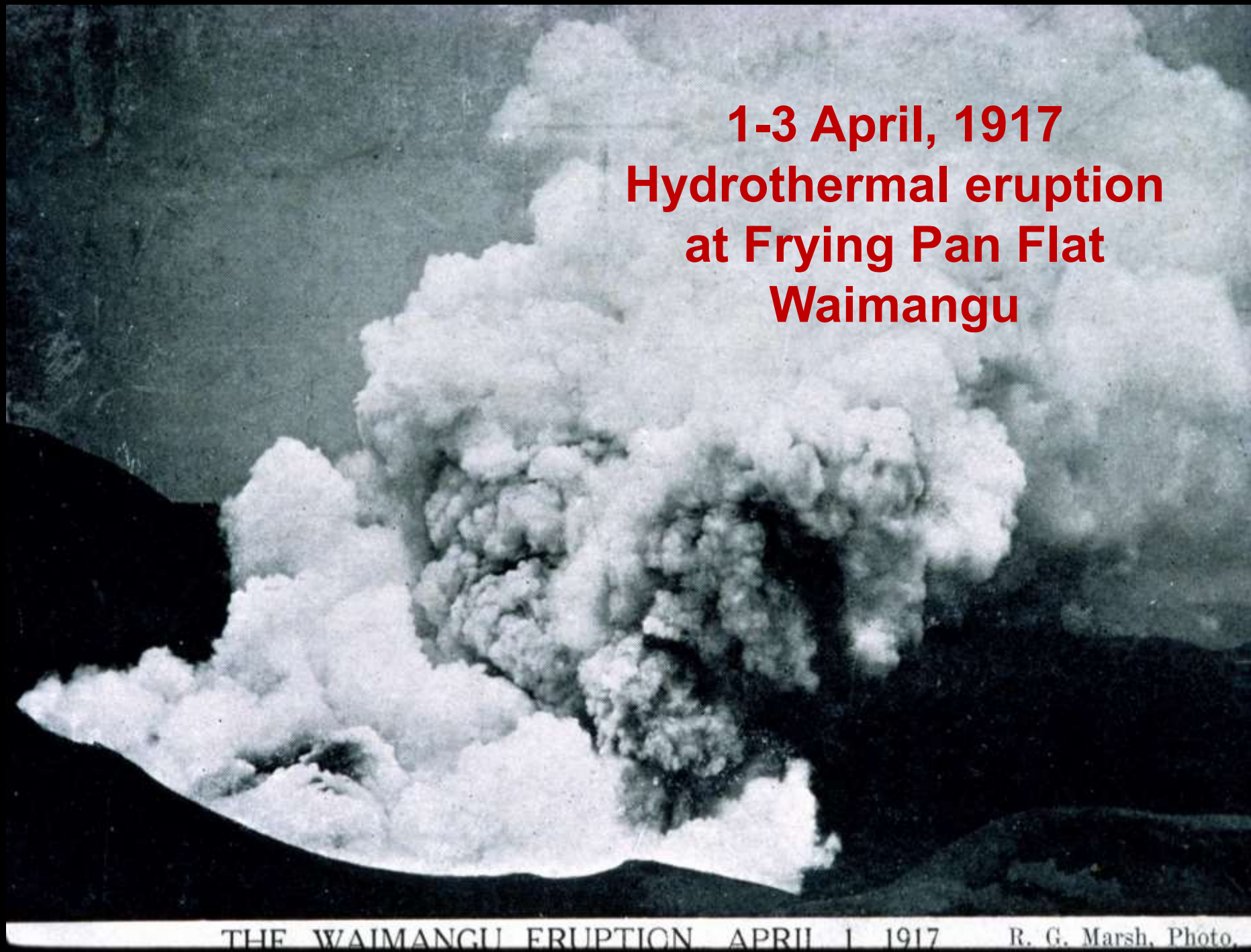


Rotokawa:

Extent of deposits from hydrothermal eruption 6060 years ago


1-3 April, 1917
Hydrothermal eruption
at Frying Pan Flat
Waimangu
THE WAIMANGU ERUPTION APRIL 1 1917 R. G. Marsh, Photo.


Post-hydrothermal eruption-tourist house
1917


~1925: aerial view looking NE
Lake Rotomahana
Frying Pan Flat Lake
Extent of 1917 breccia


1917 hydrothermal eruption crater
as it looks today

Small but dangerous hydrothermal eruptions behind residential property, Kuirau Park

Hydrothermal eruption breccia deposit

Physical impacts

Changes in pressure can result in …

Subsidence

SUBSIDENCE

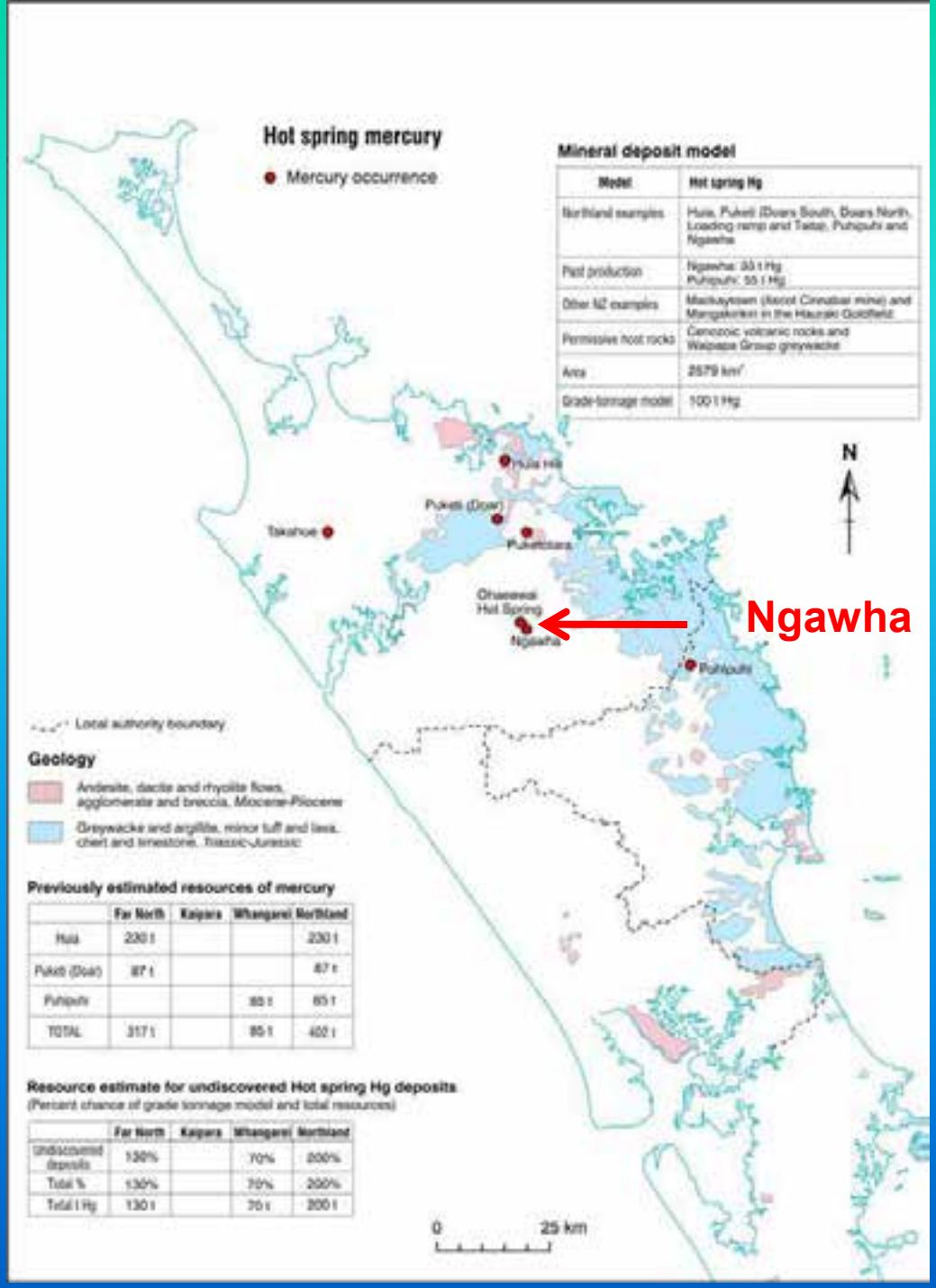
CAUSES

1. Acidic steam condensate –corrosive, weakens ground
2. Extraction of fluids – reduces pore pressure = compaction

Even minor subsidence is a problem
Kawerau pulp and paper mill has zero tolerance for ground subsidence

Subsidence of a netball court, Rotorua

Chemical Impacts



Chemical impacts

Geothermal sources of mercury

Not common

Hazard:

Inorganic mercury accumulates in river sediments, soil etc

- Food chain
- Ecological systems

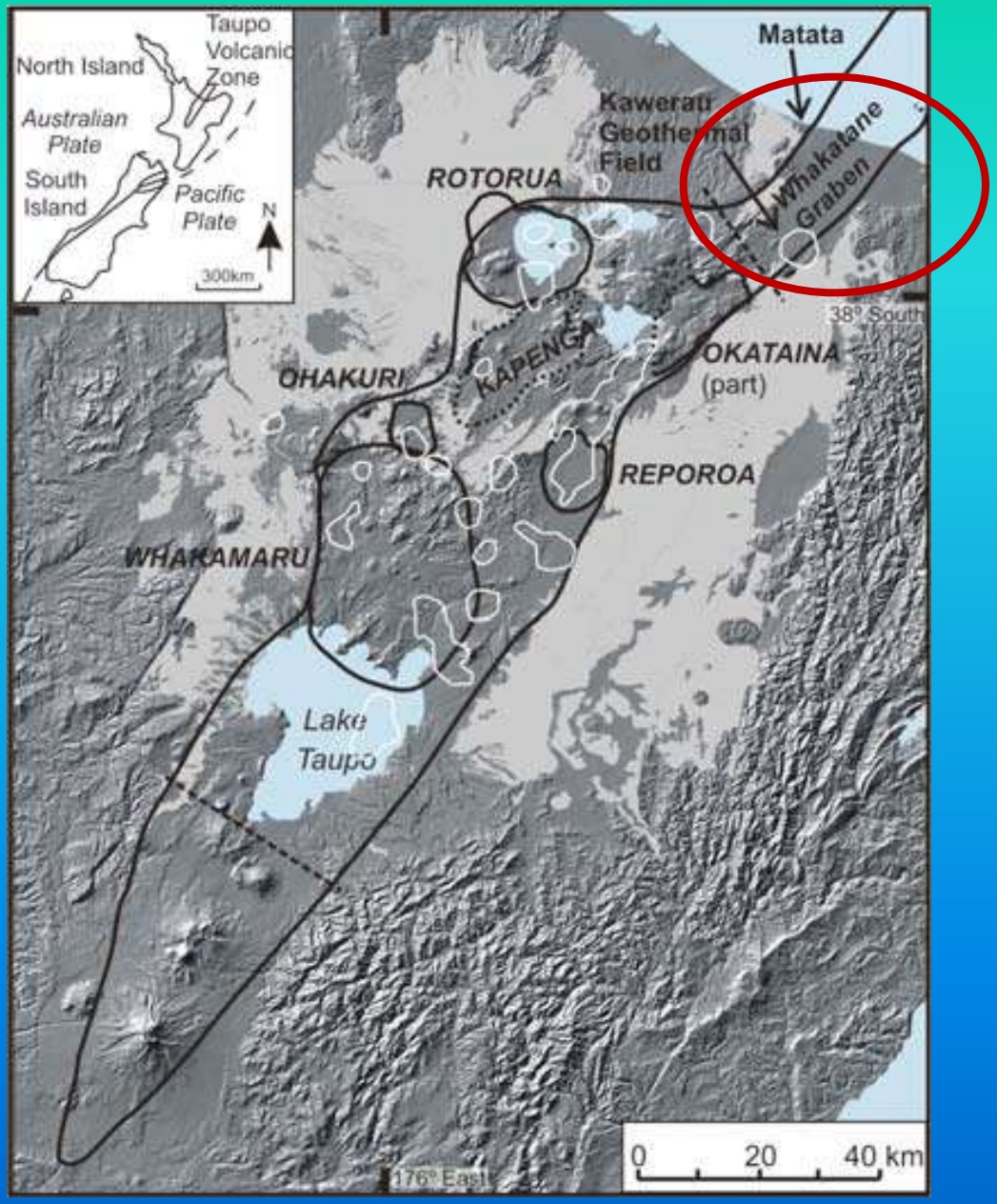
Reported that:

Iron spades held in fumes become covered in metallic mercury after a few minutes exposure.

Lead and zinc house gutterings become coated with metallic mercury on cool nights

(Rly. Publicity photo.)

A recent view of the Ngawha Hot Springs, North Auckland, New Zealand.



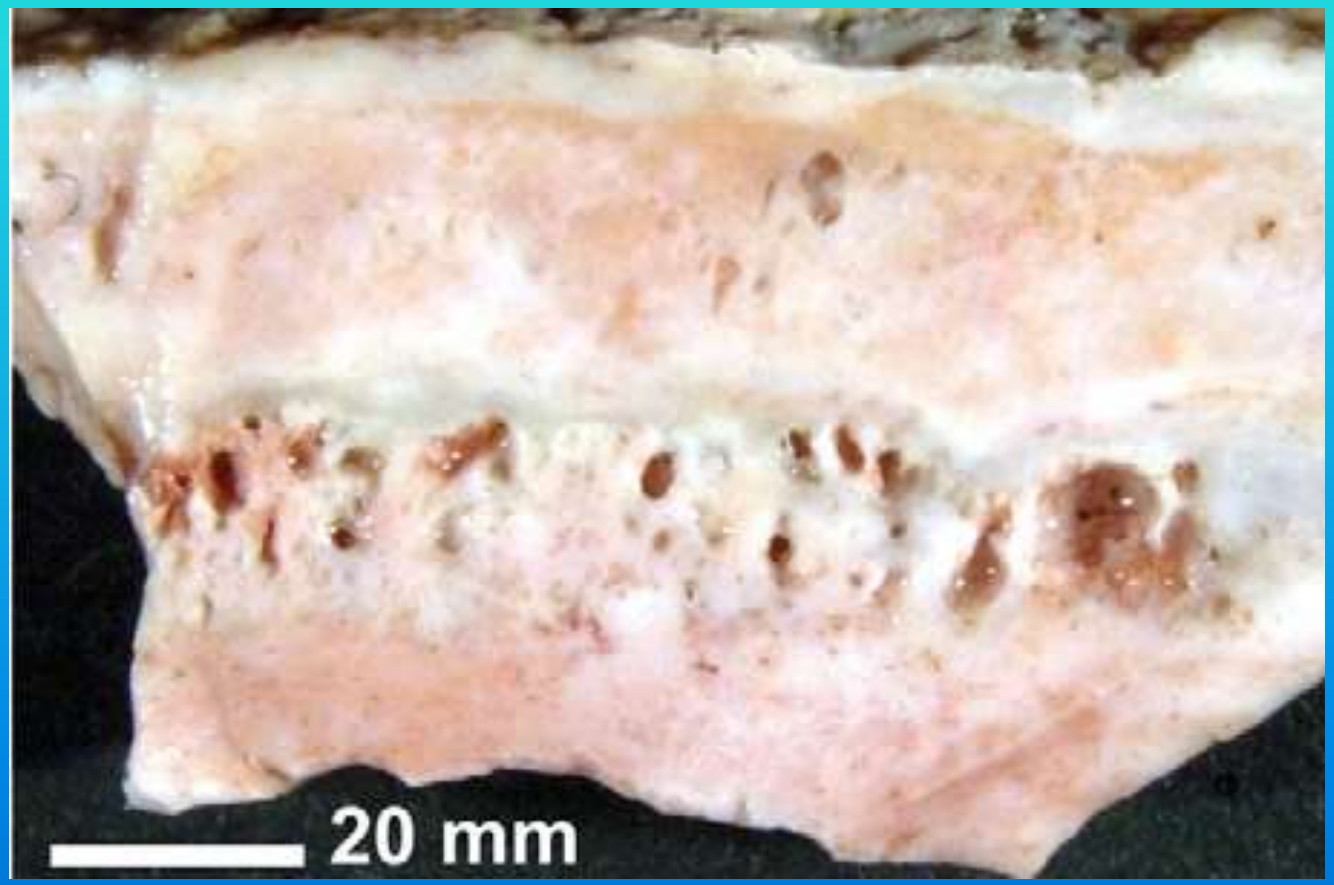
Whakatane Graben

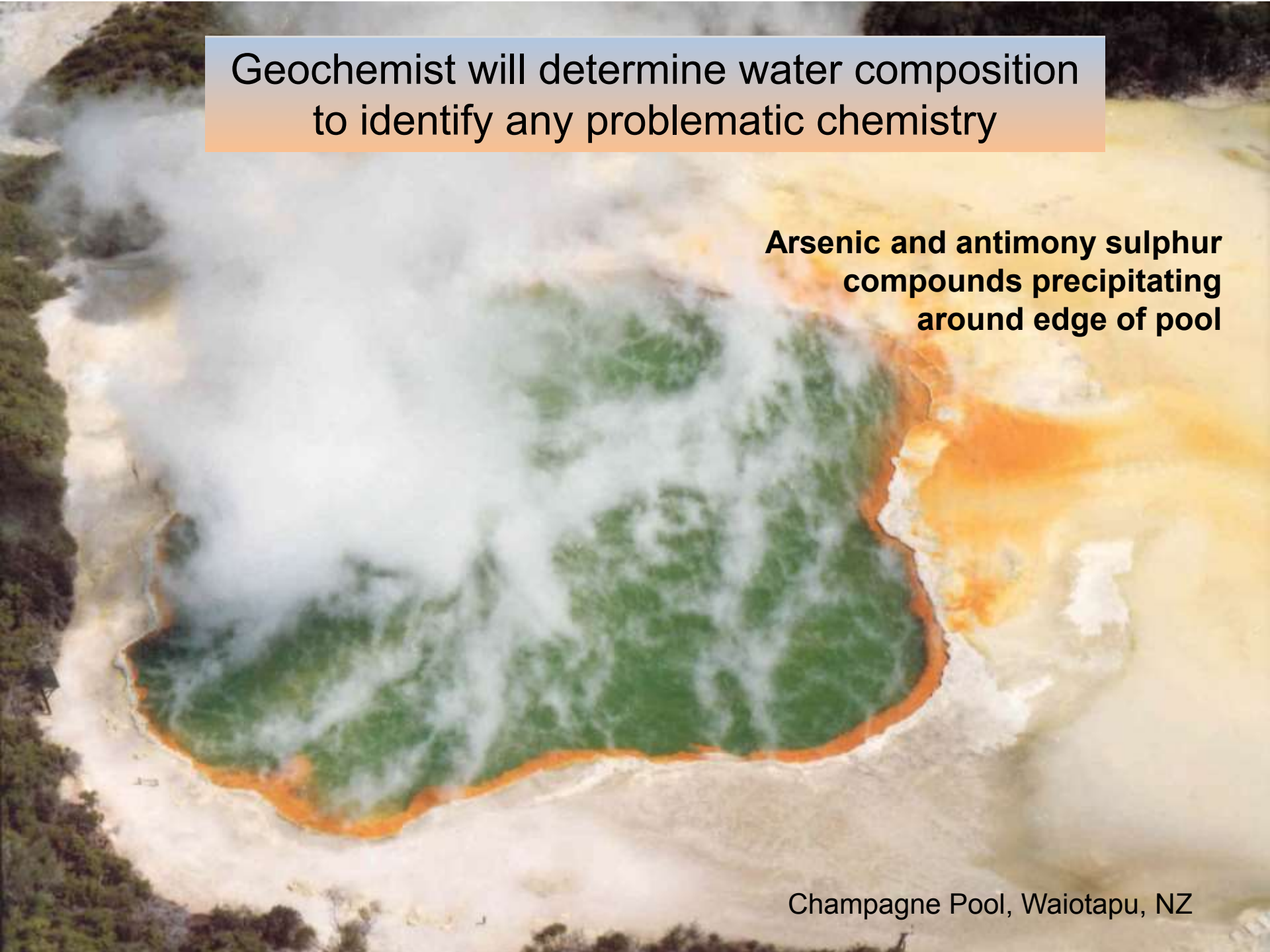
Offshore hot springs

Globules of liquid mercury in discharging hot springs on the sea floor in the Whakatane Graben, NZ

Mercury droplets on cinnibar-rich (red) amorphous silica (Hg/silica hot spring rock)

Mercury-rich hot spring rock from Steamboat Springs, USA




Geochemist will determine water composition to identify any problematic chemistry
Arsenic and antimony sulphur compounds precipitating around edge of pool
Champagne Pool, Waiotapu, NZ

Geochemistry can determine if any nasty chemical constituents are going to be a problem for the development of the power plant

Chemical impacts

Disposal of drilling mud
Pipe scale
Other drilling products

Social Impacts of development

Loss of tourist features

Social impacts

Many features have cultural significance

Noise pollution

ap of surface activity

ENTIAL

which features change

Ongoing monitori

Enables early detec


Next talk….
Optimising National Geothermal Use…
How to classify, regulate and monitor