

Dirty Boots

The Geothermal Scientist in the Field



Geothermal Scientific Investigations
Gary Smith

Talk outline

1. Short version of OSH interaction

2. Identifying hazards in a range of geothermal environments

3. Ways to keep yourself safe when undertaking various data collection methods

NZ OSH compliance for Company staff

1) All staff have a legal responsibility to:

Identify hazards in their work environment

Create measures to eliminate, isolate or minimize potential hazards

Take action to control and minimize the extent of any injury

An employer is held legally responsible for creating a safe work environment

A photograph of a geothermal area. In the foreground, a large geyser is erupting, sending a thick plume of white steam high into the air. To the left, a waterfall cascades over rocks. The ground is rocky and covered with some sparse vegetation. In the background, a dense forest of tall, thin trees is visible. The overall scene is a natural, rugged landscape.

Geothermal areas are dangerous environments to work in

Geothermal data collection requires spatial awareness in many different ways

Personal safety

Group safety: Legal liability for OSH compliance

Discrete sampling: Legal and personal

Company rep in a commercial sense



A photograph of a geothermal vent. In the center, a geyser-like eruption of white steam or water is rising from a dark, rocky pool. The surrounding ground is dark and rocky, with some brownish mineral deposits. The background shows a rocky, hilly landscape under a clear sky.

As we examine some different geothermal settings.....


we will consider the physiological threat these pose to people.

What is the human bodies max temperature tolerance?

Brain fits and expires above 42°C

Let's start with obvious field hazards



A photograph of a rocky coastline. In the upper right, a large splash of white water is visible, cascading down. The rocks are dark and textured. The text "Splashing = burns" is overlaid on the splash area.

Splashing = burns

Discharge drain for the Wairakei Geothermal Power plant

Silica build up needed to be removed every 6 months





Field Craft

Essential to look and listen

Unpredictable

**Observation is
a
scientific skill**

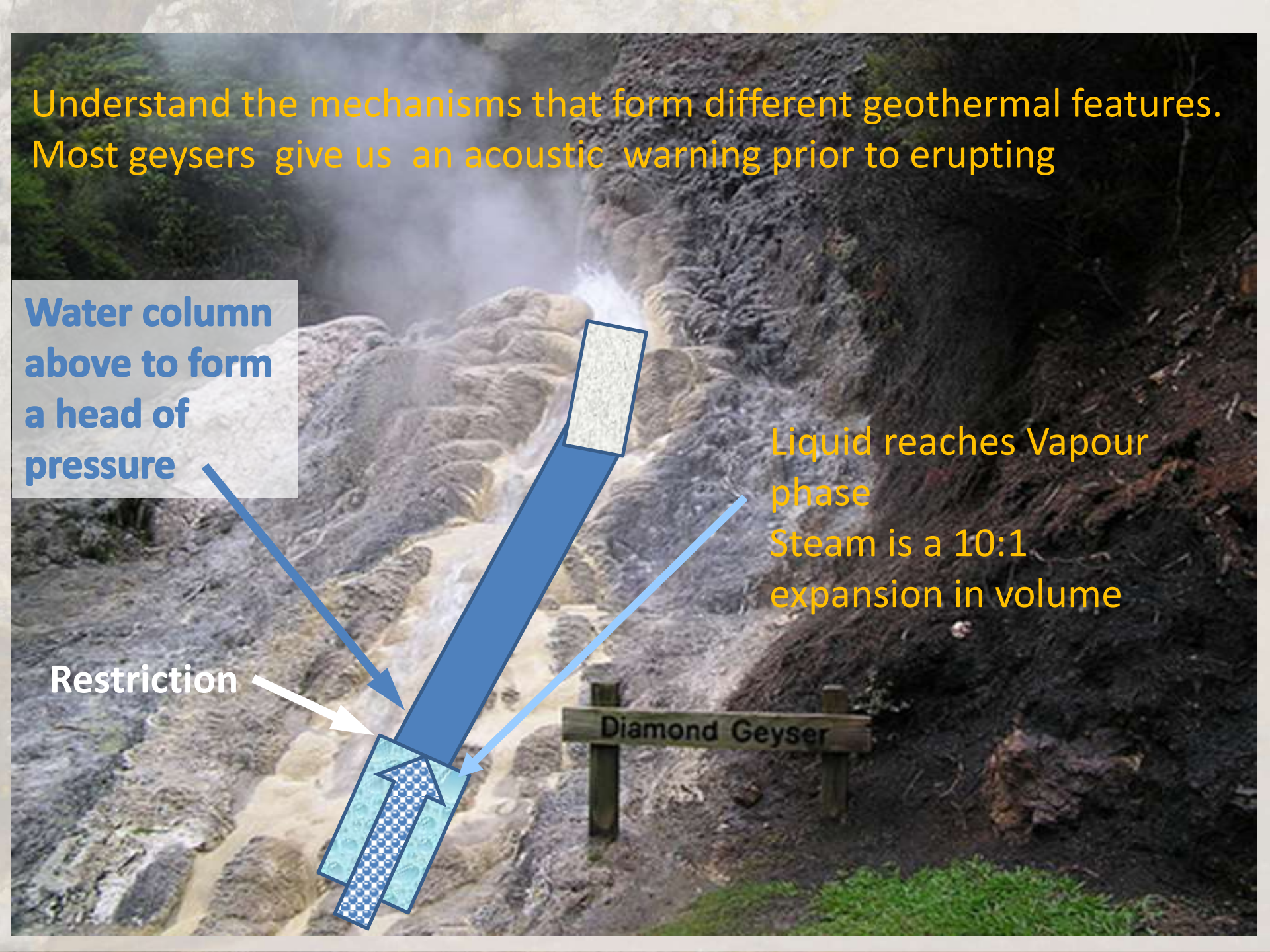
Understand the mechanisms that form different geothermal features.
Most geysers give us an acoustic warning prior to erupting

Water column
above to form
a head of
pressure

Restriction

Liquid reaches Vapour
phase
Steam is a 10:1
expansion in volume

Diamond Geyser



Waimangu geyser 1900 to 1904



150m -450m high



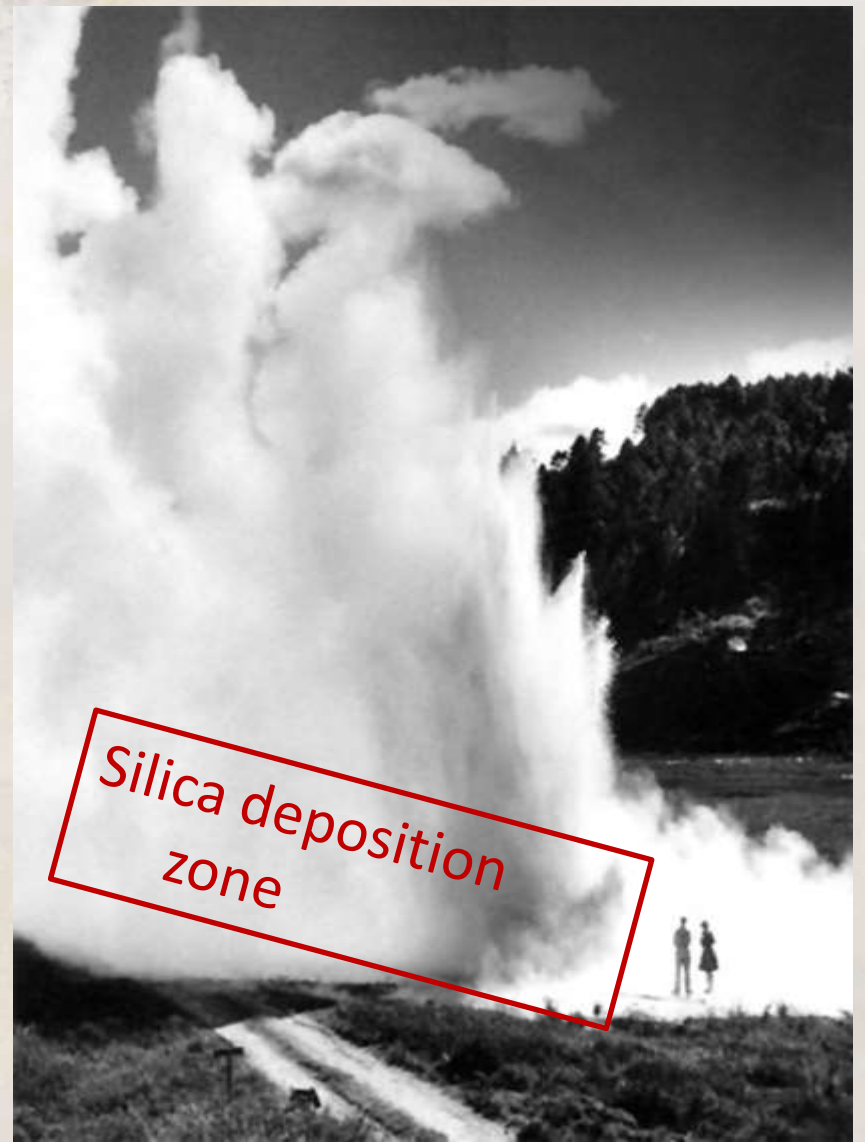
Sky tower 330m high

Initial assessment includes field observations



Silica deposits on vegetation





Potential traps around water features



These mats are floating
If you stood on them you would fall into the pool



Overhanging edges can collapse

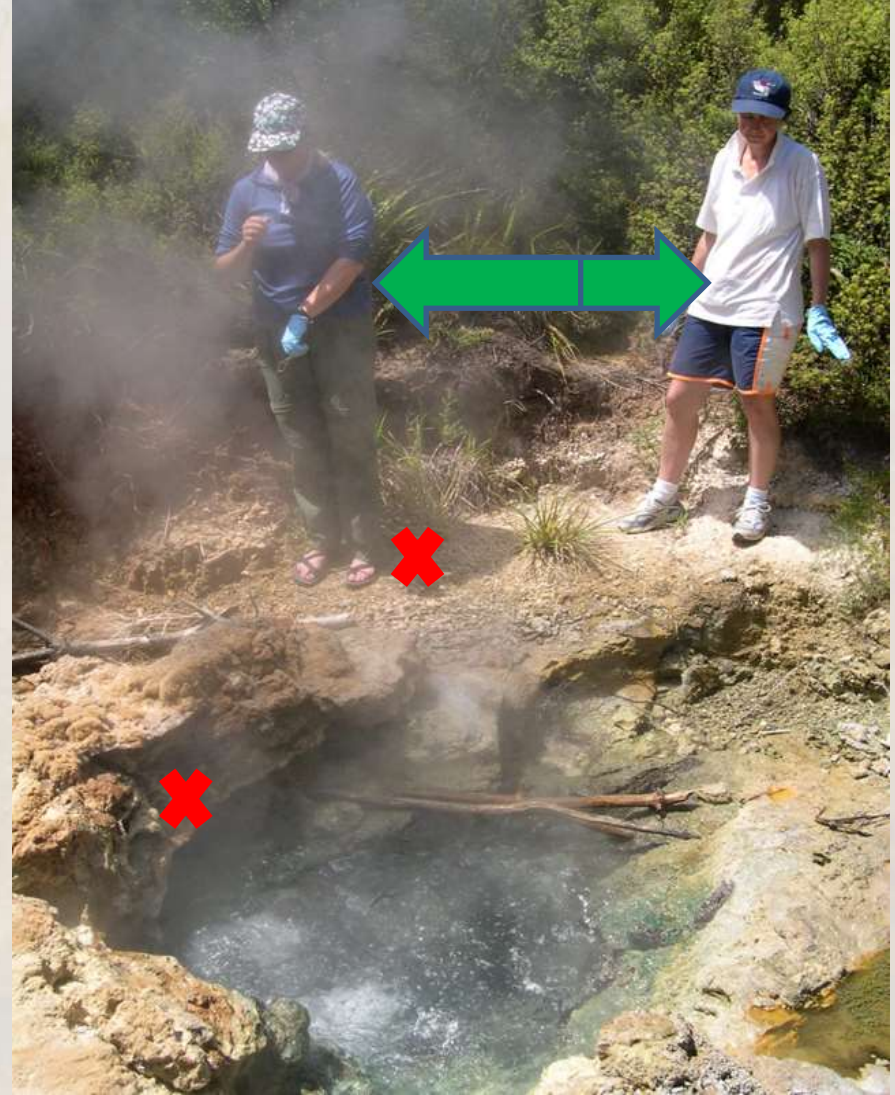
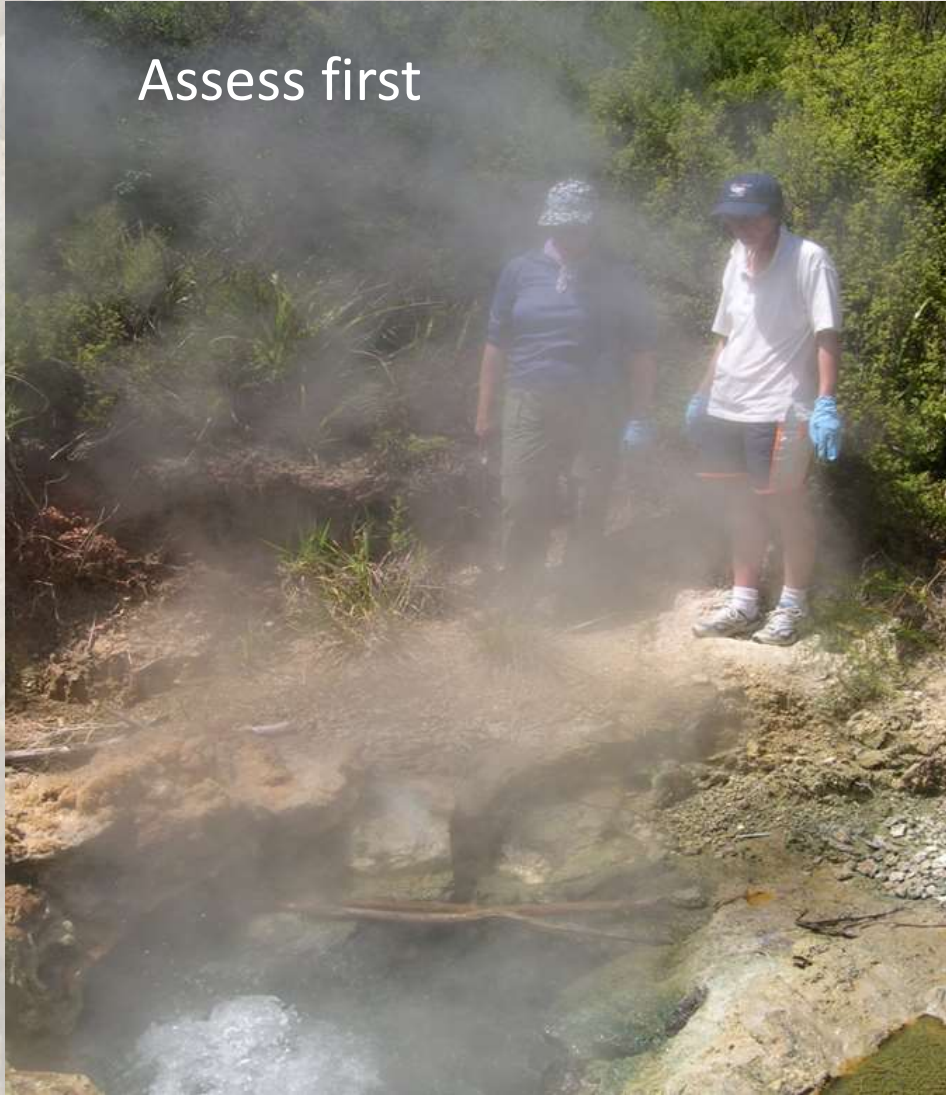




Overhanging edges can be very thin and protrude considerable distances

Tap the ground and listen for hollow sound

Assess first



The geologist always wants the rock that is in
a difficult place to get to

Safety first



Working in the mud



Some geothermal hazards are not so obvious and fall into the subtle zone of 50-60°C, where it looks perfectly safe to walk, swim



On reverse slope of mud bank

Not too close to edge

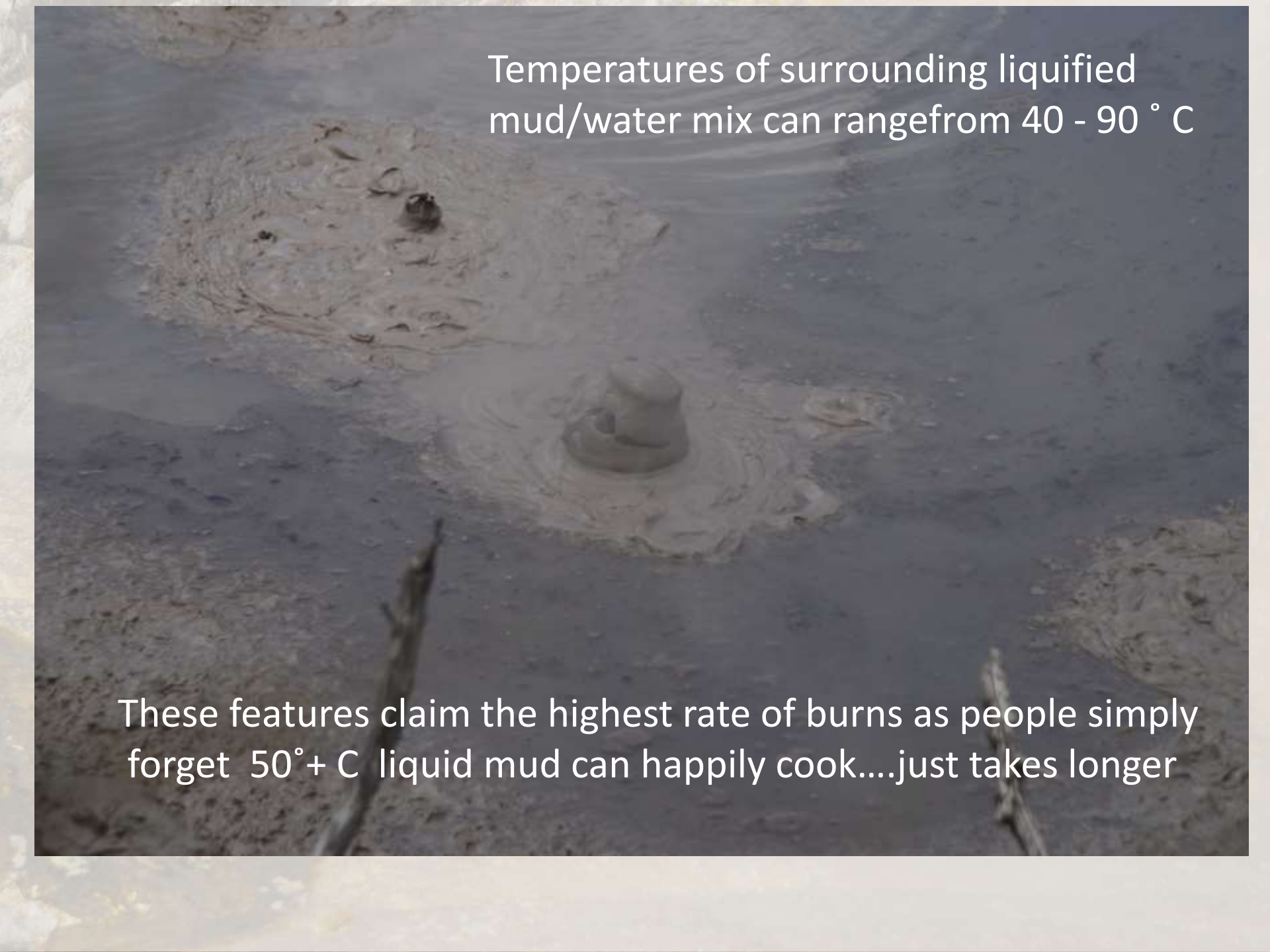
Using contactless IR temperature probe as the K-type cable
was too short to reach the pool

Less accurate
but safe



Recovering samples using extendable arm





Temperatures of surrounding liquified mud/water mix can range from 40 - 90 ° C

These features claim the highest rate of burns as people simply forget 50°+ C liquid mud can happily cook....just takes longer

The background image shows a rugged coastline with light-colored, layered rock formations. In the upper left, there are some dark, leafless branches. The sea is visible in the distance, with a prominent white sea stack rising from the water. The overall scene is somewhat hazy, suggesting a misty or overcast day.

Catastrophic events

Hydrothermal Eruptions

Common

Occur suddenly

Can be catastrophic

Always be aware of your surroundings

Look and Listen while working

If you observe a sudden change be aware these signs could be precursors to an event

Hydrothermal eruption, Ngatamariki 2005



Waiotapu

Lake Orutu

Lake Ngakoro

Champagne
Pool



Toxic gases

Sulphur provides evidence of H₂S



LEAVE THE AREA IMMEDIATELY





Dead birds – a sure sign of danger!



Typical environments we work in

Multiple Hazards

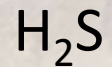
Gases

Hot, soft ground

Steam

Toxic Gases

The simple facts



At levels above 200 ppm, collapse, coma and death due to respiratory failure can occur within seconds after only a few inhalations

Hydrogen sulphide H₂S

Hydrogen sulphide has a very low odour threshold

rotten egg smell at concentrations of 1-30 ppm in air.

Above 100 ppm, H₂S gas causes rapid temporary paralysis of the olfactory nerves in the nose, leading to a ***loss of the sense of smell.***

This means that the gas can be present at dangerously high concentrations, with no perceivable odour.

Do not use your nose as a gas monitor



Hydrogen sulphide is approximately 20 percent heavier than air, so will collect in depressions in the ground and in confined spaces.

Use gas detection instrumentation before entering confined spaces

Dissolution or collapse features
commonly have steep under cut sides

Temp ranges 50-98
pH 1-7

Great multi- gas collection point



Carbon dioxide Gas

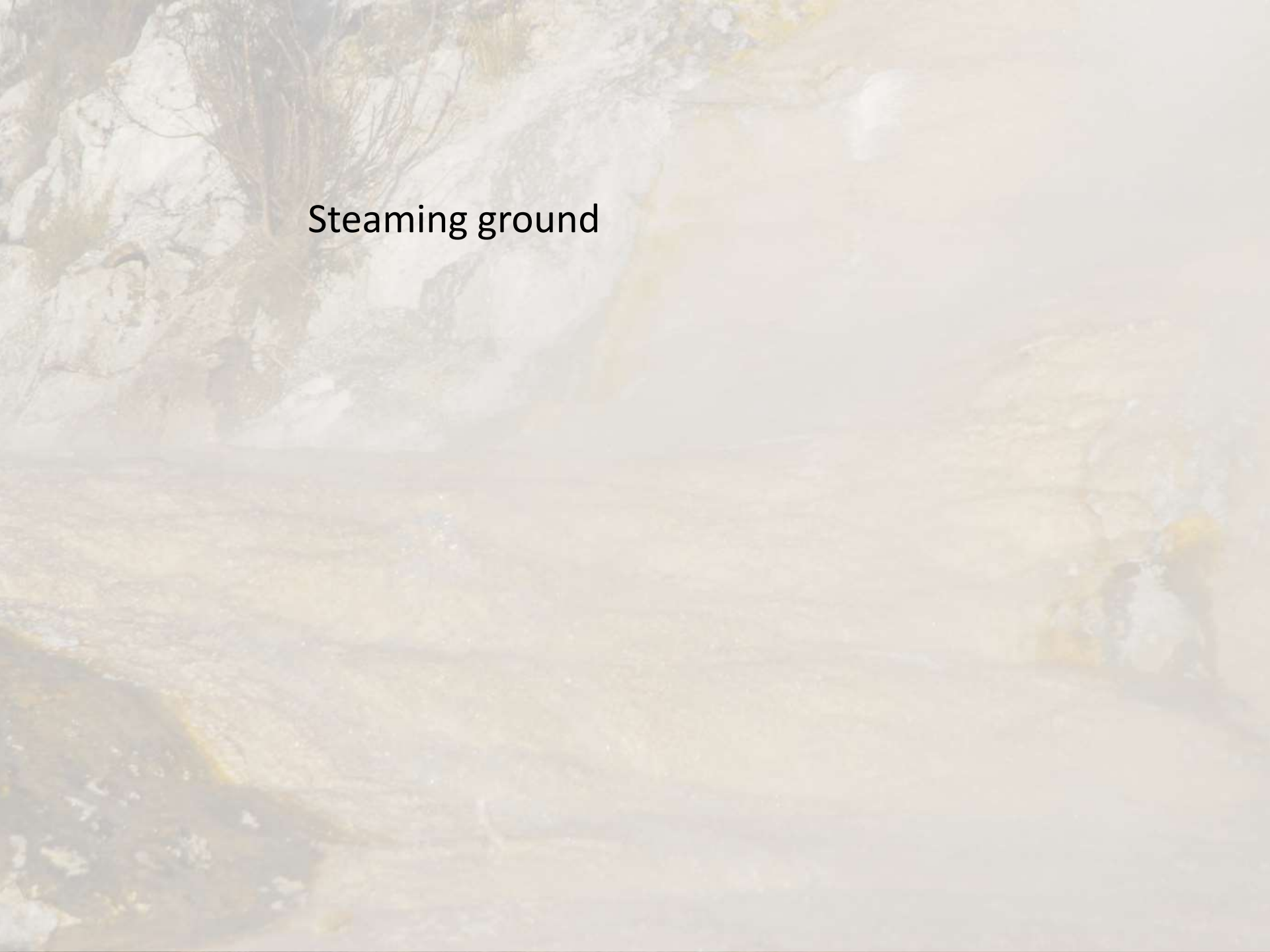
This is a common gas in geothermal systems.

Like H₂S, it is denser than air so readily accumulates in depressions and enclosed spaces. It is colourless, odourless and toxic in high concentrations.



Lake Nyos



A photograph of a geothermal landscape. The foreground and middle ground are dominated by light-colored, porous rocks and mineral deposits, likely sulfur or silica. A thick, white plume of steam or mist rises from the ground, partially obscuring the background. In the lower right, a person wearing a dark jacket and a bright yellow safety vest is visible, providing a sense of scale. The overall scene is hazy and atmospheric.

Steaming ground

How do you know where to walk?

Steaming ground is the most dangerous environment to work in as ground collapse is common

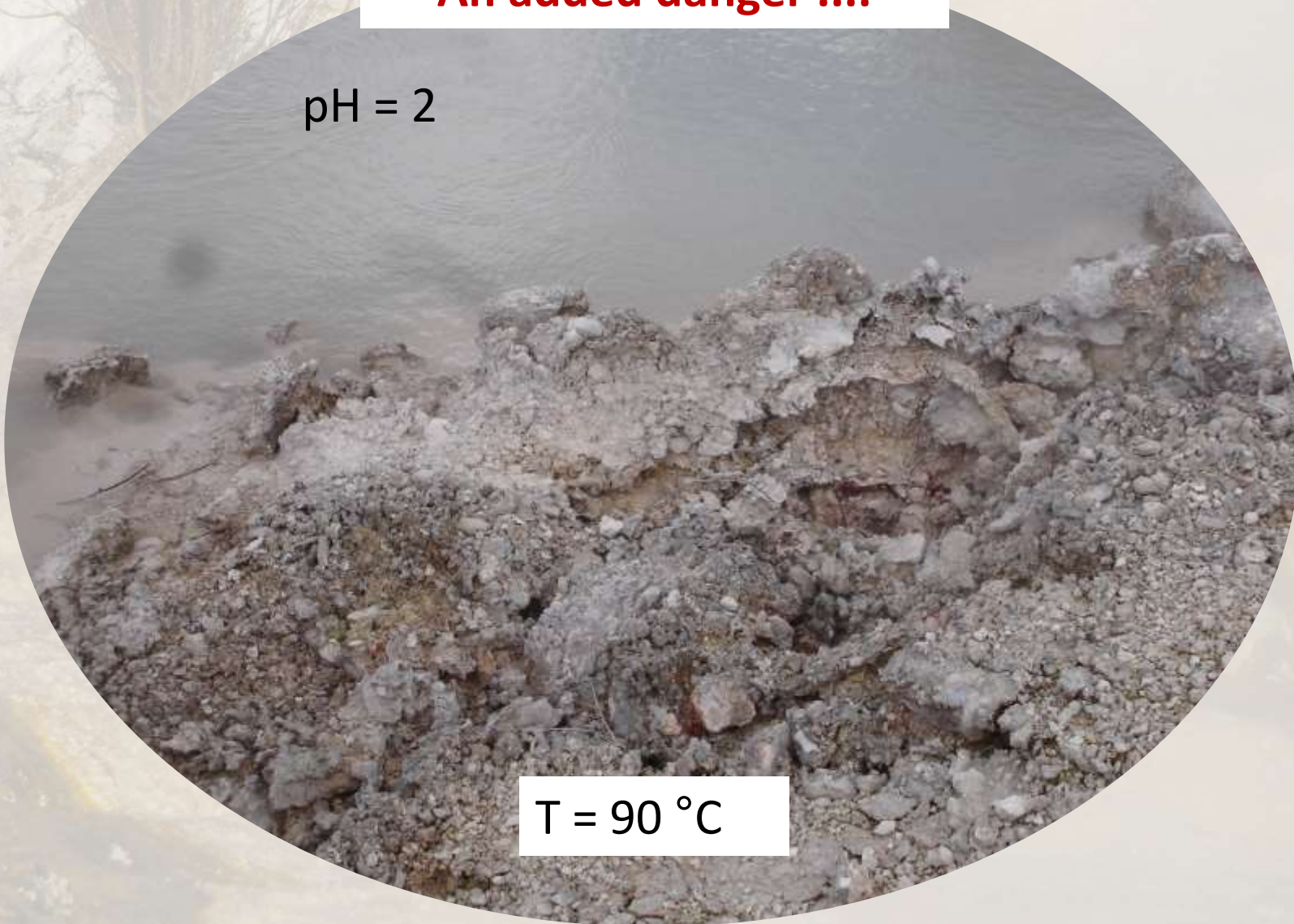


Associated with high temperatures, abundant gases

An added danger

pH = 2

T = 90 °C



Challenging environments

Extremely thin crust and hot water

How do I get
that sample?



Challenges in collecting heat flow data

An essential part of our geothermal work

Commercial exploration involves characterizing and
Prioritising sites to justify target zones before deploying more
expensive techniques , such as MT, CSAMT and TEM



Install weather station usually the easiest task



A convenient fence and road cone



... attached to the car



Team work can be challenging

Need spatial awareness

Need team co-operation

Need to look out for your team mate



Be clear about each persons role

Often difficult to go back to the same site, so must collect all data and make sure it is good data before you leave

Bush bashing to get to our site for the installation of a weir-box



Crowded working
space in a dangerous
setting



Measuring the thermal gradient is usually on warm or hot ground

Determining heat and mass flow from a fumarole

Usually located on dangerous ground



The process begins with careful evaluation of the site






14/02/2012



14/02/2012



The background image is a faded, low-contrast photograph of a rocky, mountainous landscape. In the upper left, there are jagged rock formations and some sparse, dry-looking vegetation. The middle ground shows a wide, flat expanse, possibly a valley or a plain, with some faint, indistinct shapes that could be buildings or structures. In the lower right, a small, dark silhouette of a person is visible, standing on a rocky outcrop. The overall scene is hazy and lacks sharp detail, suggesting a distant or obscured view.

Other field work problems ...

- Wind
- Lightning 5km radius





**Field hazards
Not in NZ**





Be a celebrity.....be seen

Where's Wallace?





Red and Orange fine in a controlled environment.
Fluorescent gear legitimizes off track work



Good colour choice for job in hand



RED vs Orange in bright sun and Bush background



Orange vs. Red in Winter



Distance in Bush
can render
Green/Yellow HI-VIZ
to become **camouflaged**



Accidental hunting shootings in NZ

NZ Accidental Shooting deaths

Yr av: 5 (58, 2005)

USA Accidental Shooting deaths

Yr av: 800 (29500, 2005)

Wear high visibility jackets

Good body position



Work in pairs



Safety can always be assessed by the simple question

Not CAN I do it

BUT **SHOULD I** do it

