

Thunder Island - Teachers Guide

Thunder Island is a simulation activity where three student groups take on the role of different science groups that are providing information in almost-real-time to a fourth group that makes decisions about the possible eruption status and announces it to the group.

To prepare for this activity you need to cut up the data sheets so that you have three piles of data..one pile of SEISMIC data in order from hour 1 to 6, one pile of TEMPERATURE data in order from hour 1 to 6 and one pile of DISTANCE data in order from hour 1 to 6. Do not hand these out to students.

Divide your class into four equal groups. You then hand each group a sheet that contains background information, a sheet for their team (Seismic team, Deformation Team, Well Water Team, Eruption Center) and a map.

Have the students read their team sheet.

Divide your remaining class time into 6 time slots. I suggest 10 mins for the first hour, then 7 minutes, 5 mins then 3 mins, 3 min and 3 mins. This allows students at the start to understand what they are doing, then adds 'pressure' on them to use the data as they become better at looking and responding to the data.

Start the simulation by handing the teams their corresponding Hour 1 data slip. The Eruption Center does not receive a slip. When the teams draw a conclusion based on their data (how to do this is on their team sheet), they send one member to the Eruption Center team to explain their advice. The Eruption Center then has to issue an alert.

Once the first alert is issued, hand out Hour 2 data. and repeat the process.

Then Hours 3 - 6. Reducing the time means that they will have to be much faster as providing advice etc.

Be warned. This can be a lively, fun and LOUD activity.

Note: I developed this activity when I worked for the Australian Geological Survey Organization (now Geoscience Australia). In this version I have corrected some information and added these notes.



Thunder Island

Some Background

Thunder Island is a small volcanic island in the southwestern Pacific Ocean. It has a population of 3,500 located in five small townships. The island was discovered by the Dutch in 1720 and a small settlement grew up around Safe Bay, which was used as a safe anchorage by Dutch trading ships during the monsoon storm season. Within ten years of discovery, Shakey Harbor was established as a jail for convicts (mostly pirates) and a small township started to grow around a fresh water stream at Valleyside. Released convicts moved into Hermitside in 1750. In 1978, a tourist resort was built, known as The Resort. It caters for 200 people.

Township population (including estimated tourists)

Safe Bay 1300

Valleyside 100

Shakey Harbor 800

The Resort 250

Hermitside 50

The island has no roads and all transport is by foot or boat. A telephone system does operate to all townships except Hermitside, which is a 20-minute walk from Safe Bay or 35 minutes by boat.

Volcanic History

Two active volcanoes, Big Thunder and Little Thunder, occur on the island.

Big Thunder Volcano

Big Thunder erupts approximately once every nine years. It normally produces an amount of ash with the occasional andesitic lava flow. Eruptions are preceded by a rise in the temperature of water in the local wells and by increased seismic activity. During the last eruption eleven years ago, large amounts of ash covered Valleyside and a lava flow ran down a ridge between The Resort and Safe Bay. No one was injured but Valleyside residents were forced to evacuate.

Little Thunder Volcano

Little Thunder has an erratic eruption history. It is known to have erupted eight times since settlement, each time releasing vast amounts of basaltic lava and ash. Many buildings in Shakey Harbor were destroyed by a lava flow in 1823. The last eruption in 1916 was prior to the setting up of monitoring devices on the island.

In 1984, seismic stations and distance measuring equipment was set up on the island to monitor future eruptions.

Seismic Team - Shakey Harbor Headquarters

Your role is to monitor seismic activity as recorded by the five seismic stations located on Thunder Island (1-5). The seismic recorders only measure strong ground motions in the close vicinity of the recorder. The information is sent via telephone lines to your headquarters in Shakey Harbor.

Each recorder produces an average reading of seismic intensity every five minutes. These are sent to you each hour as a stream of 12 numbers from each center. The scale for these numbers is:

- 0 - no activity
- 1 - very minor activity 2 - minor activity
- 3 - substantial activity
- 4 - sub-major activity 5 - major activity
- 6 - dramatic activity 7 - extreme activity

Eruptions are normally preceded by intensities of 5 or more, recorded by stations surrounding the volcanic vent. The recorders are built to withstand intensity 7 for 10 minutes only, after which they may cease to operate.

Your job is to analyze the information and provide advice to the Eruption Control Center on your assessment of the eruption risk and location.

For example:

- Station 1 - 3,4,3,4,5,6,6,5,6,5,6,6
- Station 2 - 2,1,2,1,0,0,1,0,1,2,0,0
- Station 3 - 3,4,4,3,4,5,4,3,4,5,6,4
- Station 4 - 3,2,3,1,2,1,2,3,2,3,2,3
- Station 5 - 3,4,4,4,3,2,3,2,3,2,3,2

Activity is taking place on the western side of Little Thunder with maximum intensity being described as dramatic. The intensity has increased over time. This is confirmed by a station on the eastern side of Little Thunder. All other stations have had high but stable intensities.

Conclusion is that Little Thunder may erupt. **WARN ERUPTION CONTROL CENTER**
or

- Station 1) 1,2,2,3,2,3,1,2,3,2,2
- Station 2) 3,2,3,2,3,4,3,2,3,2,3,2
- Station 3) 1,2,2,3,2,2,1,2,2,1,2,2
- Station 4) 3,2,3,3,2,3,2,2,2,2,3,2
- Station 5) 2,1,2,1,2,2,3,3,2,1,2,1

Activity is stable. Fluctuations are within normal limits. **NO WARNINGS NEEDED.**

Deformation Monitoring Team - Valleyside Headquarters

Your role is to monitor deformation of the slopes of the volcano. Your information comes from accurate laser measurements between five distant measuring stations (a-e) on Thunder Island. The process of measuring the distances is automatic and is taken every 15 minutes, which are sent to you via telephone lines every hour (4 readings).

The normal readings are:

a-b 5110m	c-e 8590m
a-c 6450m	e-d 7475m
c-d 7190m	d-b 1155m

The instruments vary in their readings by + 1m. However, it is not unknown for some readings to change as much as 3 m during non-eruptive times. Any change larger than this and for more than one hour may indicate the rise of magma in the volcanic vent. The readings are fed into a computer that prints out the variation in meters from the normal measurements.

Your job is to analyze the information and provide advice to the Eruption Control Center on your assessment of the eruption risk and location.

For example

a-b 1,2,3,2
a-c 1,0,0,1
c-d 2,1,0,1
c-e 2,3,4,3
e-d 1,0,1,3
d-b 0,0,0,1

Distance measurements appear within limits. However the distance c-e may indicate activity on the northern slope of Big Thunder. ADVISE ERUPTION CENTER. or

a-b 0,1,2,1
a-c 3,2,1,2
c-d 2,3,3,4
c-e 3,3,3,4
e-d 2,3,4,5
d-b 3,2,3,2

Major deformation is occurring around Big Thunder. The southeastern slope is bulging up to 5m from normal measurements. WARN ERUPTION CENTER.

Well Water & Weather Team - Safe Bay Headquarters

Your role is to monitor the temperature changes in the five wells (V-Z) dotted around Thunder Island. Automatic thermometers are located in each well and information is sent via radio to headquarters where it is received by computer. The computer prints out the maximum temperature rise from the normal temperature of the well waters each hour. A fluctuation of 10°C is not uncommon, however, any rise beyond 10°C is a warning of moving magma.

Also, attached to a post at well W is a device that measures speed and direction of winds in the center of the island. Past eruption studies have shown that volcanic ash is blown 1 km X the wind speed.

Your job is to analyze the information and provide advice to the Eruption Control Center on your assessment of the eruption risk and location.

For example:

V: 6

W: 4

X: 8

Y: 4

Z: 3

Wind speed: 5 Wind direction (from) : S

Well temperatures are within limits. Well X is getting hot and further reading will need to be recorded. Ash falls could occur to the north of both volcanoes for 5 km. Safe Bay is in ash fall zone. ADVISE ERUPTION CENTER OF WELL X AND WEATHER.

Or :

V:2

W:12

X:3

Y:8

Z:16

Wind speed: 10 Wind direction : SE

Well temperatures indicate rise of magma under Big Thunder. Ash fall zone from Big Thunder will be 10km to the northwest. Safe Bay is under risk. WARN ERUPTION CENTER.



ERUPTION CENTER - The Resort Headquarters

Your role is to advise the local people of the eruption warning for each hour. You need to assess the information provided by the other three teams and release the following warnings if needed:

NO ALERT - TESTING WARNING SYSTEM

This is issued when there is no activity warnings from any team. It lets local people know that the warning system is working.

ERUPTION GREEN

This is issued if any two teams advise of unusual activity. Locals should keep listening to further warnings.

ERUPTION ORANGE BIG/LITITE

This is issued if any two teams give warning of activity at either of the volcanoes. Locals in ash fall areas are on notice of evacuation.

ERUPTION RED BIG/LITTLE

This is issued if all three teams give warnings of activity. Locals in ash fall areas are evacuated to safer townships.

ERUPTION - ERUPTION - ERUPTION

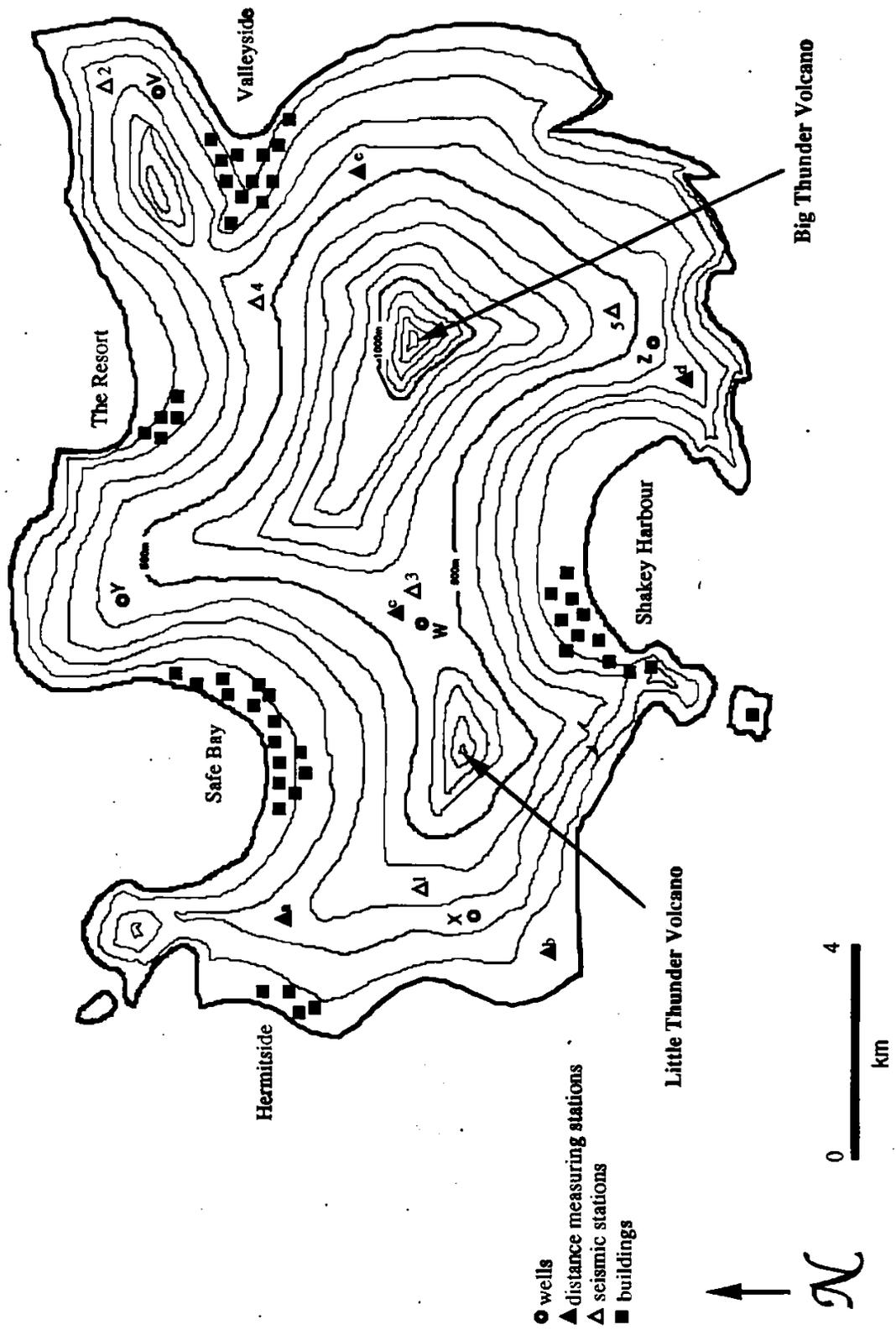
An eruption.

ERUPTION DOWNGRADE (ORANGE/GREEN/NO ALERT)

A decrease in risk.

While you wish to advise people of risk, you do not wish to cause panic in the local people, as it is important that they trust your judgements. (Remember the boy who cried, "Wolf"!)

Thunder Island



DISTANCES					<i>Hour 1</i>
a-b	1	2	1	2	
a-c	2	3	1	1	
c-d	2	2	1	1	
c-e	2	2	1	1	
e-d	1	2	1	1	
d-b	0	3	2	1	W

DISTANCES					<i>Hour 2</i>
a-b	2	2	1	2	
a-c	2	1	0	1	
c-d	3	3	2	3	
c-e	4	3	2	3	
e-d	4	1	1	3	
d-b	3	2	9	3	W

DISTANCES					<i>Hour 3</i>
a-b	1	1	1	2	
a-c	2	3	2	1	
c-d	4	5	4	5	
c-e	1	2	3	2	
e-d	6	5	4	5	
d-b	2	1	2	3	

DISTANCES					<i>Hour 4</i>
a-b	2	3	4	2	
a-c	1	2	2	2	
c-d	1	2	3	3	
c-e	3	3	3	3	
e-d	3	4	3	3	
d-b	4	5	3	2	

DISTANCES					<i>Hour 5</i>
a-b	2	2	3	2	
a-c	1	1	0	2	
c-d	5	6	4	5	
c-e	6	6	7	8	
e-d	9	6	7	5	
d-b	4	3	2	5	

DISTANCES					<i>Hour 6</i>
a-b	2	2	3	2	
a-c	2	3	2	1	
c-d	5	6	7	8	
c-e	10	9	8	8	
e-d	9	9	11	8	
d-b	5	5	5	6	

TEMPERATURES	<i>Hour 1</i>
V 2	
W 3	
X 2	
Y 4	
Z 5	
Wind Speed 15	Wind Direction W

TEMPERATURES	<i>Hour 2</i>
V 7	
W 7	
X 3	
Y 8	
Z 7	
Wind Speed 13	Wind Direction WSW

TEMPERATURES	<i>Hour 3</i>
V 8	
W 7	
X 5	
Y 6	
Z 7	
Wind Speed 10	Wind Direction SW

TEMPERATURES	<i>Hour 4</i>
V 9	
W 9	
X 8	
Y 10	
Z 11	
Wind Speed 14	Wind Direction SSW

TEMPERATURES	<i>Hour 5</i>
V 12	
W 19	
X 3	
Y 8	
Z 24	
Wind Speed 10	Wind Direction SW

TEMPERATURES	<i>Hour 6</i>
V 10	
W 12	
X 5	
Y 9	
Z 26	
Wind Speed 16	Wind Direction S

<i>Hour 1</i>												
SEISMIC												
Station 1	1	2	1	2	0	1	2	1	2	0	1	1
Station 2	2	3	2	3	2	2	3	3	2	1	2	3
Station 3	3	4	3	4	3	4	4	4	4	3	4	4
Station 4	4	4	4	3	4	4	3	4	3	3	2	2
Station 5	3	2	3	2	2	2	3	2	3	2	3	2

<i>Hour 2</i>												
SEISMIC												
Station 1	1	2	3	2	3	2	1	2	3	2	1	1
Station 2	2	3	3	2	3	3	3	2	3	2	3	2
Station 3	3	4	4	4	5	4	4	3	4	4	4	5
Station 4	2	3	3	3	4	4	4	3	4	4	4	3
Station 5	3	3	3	3	3	3	3	4	3	3	3	3

<i>Hour 3</i>												
SEISMIC												
Station 1	2	3	2	3	2	3	2	2	2	2	3	2
Station 2	3	4	3	3	2	3	2	3	4	4	3	4
Station 3	4	4	3	4	4	3	4	3	4	3	4	4
Station 4	4	4	4	4	3	4	4	4	4	3	4	4
Station 5	2	3	2	3	4	2	3	2	3	2	1	3

<i>Hour 4</i>												
SEISMIC												
Station 1	3	4	4	3	2	1	2	1	2	2	2	1
Station 2	3	2	2	3	2	1	1	2	3	2	3	2
Station 3	4	4	4	4	3	4	3	4	3	4	3	4
Station 4	3	3	3	4	3	4	4	3	3	3	4	5
Station 5	3	2	2	2	3	2	3	2	3	1	3	2

<i>Hour 5</i>												
SEISMIC												
Station 1	2	3	2	1	2	2	1	2	2	2	1	2
Station 2	3	4	3	4	3	2	3	4	3	2	3	2
Station 3	4	5	5	4	5	5	6	4	3	4	5	4
Station 4	4	4	4	5	5	5	6	6	5	6	4	5
Station 5	2	3	4	4	4	4	4	5	6	4	4	4

<i>Hour 6</i>												
SEISMIC												
Station 1	3	4	5	4	3	4	4	4	3	4	3	4
Station 2	4	4	4	3	4	4	4	3	4	5	4	3
Station 3	5	6	5	6	5	5	5	6	7	7	7	-
Station 4	4	5	6	7	7	7	-	-	7	7	7	-
Station 5	4	5	6	5	4	5	4	3	4	3	4	3