Appendix A – Rotorua Business Questionnaire

A.1. Information Sheet

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

To Whom It May Concern,

I am a student at the University of Canterbury, undertaking a Master of Science thesis in Geology. I am writing to ask if you would please answer a questionnaire related to my research project.

My research involves assessing the vulnerability of modern laptop and desktop computers to volcanic ash and gas. Computers are an essential part of modern society for a wide range of personal and business uses. It is important to understand how such equipment performs in volcanic environments, so that before and during volcanic eruptions appropriate mitigation advice can be distributed.

I will be conducting both laboratory and field experiments where laptop and desktop computers will be subject to different ash and gas environments over various timeframes. The aim will be to determine which components are the most vulnerable and how to best protect them from volcanic ash and gas, while still maintaining functionality.

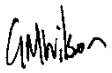
The purpose of this questionnaire is to gather data from businesses about computer performance within areas affected and unaffected by geothermal gases in Rotorua. You are invited to answer an online questionnaire (website link below), which will take approximately 20 minutes to complete. Please complete the questionnaire by 1 October 2010.

Please note that this questionnaire has been approved by the Department of Geological Sciences, University of Canterbury, and the answers you provide will be included in my thesis which is a public document available through the University of Canterbury library database. The results of this questionnaire will be returned to you after they have been collated. You may withdrawal your participation at any time.

If you have any concerns about the questionnaire please do not hesitate to contact me by email at grant.wilson@pg.canterbury.ac.nz or one of my supervisors: Dr. Thomas Wilson (Hazard and Disaster Management lecturer at the University of Canterbury) at thomas.wilson@canterbury.ac.nz; Professor Jim Cole (Professor of Geology at the University of Canterbury) at jim.cole@canterbury.ac.nz; Brad Scott (Volcano Surveillance Coordinator at GNS Science) at b.scott@gns.cri.nz.

Please type the following website address into your internet browser to take the questionnaire:
http://tinyurl.com/rotorua-survey-1

Yours sincerely,



Grant Wilson
MSc Candidate
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Private Bag 4800
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A.2. Questionnaire

The purpose of this questionnaire is to gather data from businesses about computer performance within areas affected and unaffected by geothermal gases in Rotorua. Please note that this questionnaire has been approved by the Department of Geological Sciences, University of Canterbury, and the answers you provide will be included in my thesis which is a public document available through the University of Canterbury library database. The questionnaire will take approximately 20 minutes to complete. Please complete the questionnaire by **1 October 2010**.

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Space is provided at the end for additional comments

1. What is your job title?

_____

2. What is the name of the company you work for?

_____

3. Which classification best describes your company? *(Please tick one)*			
☐	Accommodation and food services	☐	Computer repair
☐	Computer retail	☐	Construction
☐	Education	☐	Entertainment/recreation
☐	Financial and insurance services	☐	Healthcare
☐	Local government	☐	Manufacturing
☐	Professional scientific and technical services	☐	Real estate
☐	Retail trade	☐	Telecommunication services
☐	Transportation	☐	Wholesale trade
☐	Other services *(please specify)*		

4. How many staff members are employed within your company?					
1 – 10	11 – 20	21 – 30	31 – 40	41 – 50	51+
☐	☐	☐	☐	☐	☐

5. Which suburb is your company located in? *(Please tick one)*			
☐	Fairy Springs	☐	Fenton
☐	Fordlands	☐	Glenholme East
☐	Glenholme West	☐	Hillcrest
☐	Kawaha Point	☐	Koutu
☐	Kuirau	☐	Lynmore
☐	Mangakakahi	☐	Ngapuna
☐	Ohinemutu	☐	Pomare
☐	Springfield	☐	Utuhina
☐	Victoria	☐	Whaka
☐	Other *(please specify)*		

For question 6 geothermal features are defined as: hot barren ground; hot springs; mudpools; fumaroles (steam vents); and geysers.

6. Approximately how close is your company's building to any geothermal features? *(Please tick one)*	
☐	There is a geothermal feature within our property
☐	250 m – 500 m
☐	500 m – 1000 m
☐	1 km – 2 km
☐	2 km+
☐	Do not know

7. Have any of your company's buildings/offices been tested for gas levels?	
☐	Yes
☐	No *(go to question 11)*
☐	Do not know

8. What type of gas(es) were present? *(Please tick all that apply)*	
☐	Carbon Dioxide *(please answer question 9)*
☐	Hydrogen Sulfide*(please answer question 10)*
☐	Do not know *(go to question 11)*
☐	Other *(please specify)*

9. What was the level of **Carbon Dioxide** present?	
☐	None
☐	0 – 2,500 parts per million (ppm)
☐	2,501 – 5,000 ppm
☐	5,001 ppm+
☐	Do not know

10. What was the level of **Hydrogen Sulfide** present?	
☐	None
☐	0 – 10 parts per million (ppm)
☐	11 – 20 ppm
☐	21 ppm+
☐	Do not know

The following two sections contain specific questions regarding damages to your company's desktop and laptop computers

Desktop Computers

11. Approximately how many **desktop computers** does your company have?					
None	1 – 5	6 – 10	11 – 15	16 – 20	21+
☐ *(Go to question 22)*	☐	☐	☐	☐	☐

12. What are your **desktop computers** used for? *(Please tick all that apply)*			
☐	General use *(e.g. word processing, email, etc.)*	☐	Network servers
☐	Point of sale (POS) facilities	☐	Machinery control
☐	Data collection	☐	Do not know
☐	Other *(please specify)*		

13. How often does your company replace its **desktop computers**?			
Every _____ months			
And why does your company replace its **desktop computers**?			
☐	Accidents	☐	Damage
☐	End of lease	☐	Poor performance
☐	Other *(please specify)*		
And is the replacement planned or unplanned?			
☐	Planned		
☐	Unplanned		
☐	Do not know		

14. Have any of your **desktop computers** sustained damage from geothermal gas?	
☐	Yes
☐	No *(go to question 22)*
☐	Do not know *(go to question 22)*

15. Approximately how many of your **desktop computers** have suffered damage?					
1 – 2	3 – 4	5 – 6	7 – 8	9 – 10	11+
☐	☐	☐	☐	☐	☐

16. What type of damage has occurred to **desktop computers**? *(Please tick all that apply)*			
☐	Corrosion of components on the circuit board reducing life expectancy	☐	Corrosion of other internal components *(e.g. CD Drive, Hard Drive, etc.)* reducing life expectancy
☐	Corrosion of external connectors reducing performance	☐	Corrosion of external case
☐	Corrosion inside power supply reducing life expectancy	☐	Corrosion of cooling fans reducing performance
☐	Keys on keyboard not responding	☐	Mouse not responding
☐	Discolouration of screen	☐	Acid etching of screen
☐	Short circuits	☐	Do not know
☐	Other *(please specify)*		

17. What affect did the above damage have on **desktop computers**? *(Please tick all that apply)*			
☐	Computer would not turn on	☐	Computer would turn on sometimes
☐	Computer would turn off periodically without warning	☐	Screen would not turn on
☐	Screen would turn on sometimes	☐	Screen would turn off periodically
☐	Keyboard would not work	☐	Keyboard would work sometimes
☐	Mouse would not work	☐	Mouse would work sometimes
☐	Loss of data	☐	Do not know
☐	Other *(please specify)*		

18. On average, how long after your company purchases **desktop computers** does the above mentioned damage occur? *(Please write a number next to the appropriate unit of time)*	
	Weeks
	Months
	Years

19. Generally where are **desktop computers** located when they sustained damage? *(Please tick all that apply)*			
☐	Room with air conditioning	☐	Room without air conditioning
☐	Room with opening windows and/or doors	☐	Room without air conditioning and opening windows and/or doors
☐	Basements	☐	Attics
☐	Other *(please specify)*	☐	Do not know

20. Generally where are **undamaged desktop computers** located? *(Please tick all that apply)*			
☐	Room with air conditioning	☐	Room without air conditioning
☐	Room with opening windows and/or doors	☐	Room without air conditioning and opening windows and/or doors
☐	Basements	☐	Attics
☐	Other *(please specify)*	☐	Do not know

21. Do more or less **desktop computers** fail in an air conditioned room compared to a non-air conditioned room?	
☐	More
☐	Less
☐	Do not know
☐	Not applicable

Please use the space below for any additional comments regarding desktop computers.

Laptop computers

22. Approximately how many **laptop computers** does your company have?					
None	1 – 5	6 – 10	11 – 15	16 – 20	21+
☐ *(Go to question 34)*	☐	☐	☐	☐	☐

23. What are you **laptop computers** used for? *(Please tick all that apply)*			
☐	General use *(e.g. word processing, email, etc.)*	☐	Network servers
☐	Point of sale (POS) facilities	☐	Machinery control
☐	Data collection	☐	General use off site
☐	Field work	☐	Do not know
☐	Other *(please specify)*		

24. If any of your laptop computers are taken off site, where are they usually taken? *(Please include the geographic area of where they are taken)*

25. How often does your company replace its **laptop computers**?			
Every _____ months			
And why does your company replace its **laptop computers**?			
☐	Accidents	☐	Damage
☐	End of lease	☐	Poor performance
☐	Other *(please specify)*		

And is the replacement planned or unplanned?	
☐	Planned
☐	Unplanned
☐	Do not know

26. Have any of your **laptop computers** suffered damage from geothermal gas?	
☐	Yes
☐	No *(go to question 34)*
☐	Do not know *(go to question 34)*

27. Approximately how many of your **laptop computers** have suffered damage?					
1 – 2	3 – 4	5 – 6	7 – 8	9 – 10	11+
☐	☐	☐	☐	☐	☐

28. What type of damage has occurred to **laptop computers**? *(Please tick all that apply)*			
☐	Corrosion of components on the circuit board reducing life expectancy	☐	Corrosion of other internal components *(e.g. CD Drive, Hard Drive, etc.)* reducing life expectancy
☐	Corrosion of external connectors reducing performance	☐	Corrosion of external case
☐	Corrosion inside power supply reducing life expectancy	☐	Corrosion of cooling fans reducing performance
☐	Keys on keyboard not responding	☐	Mouse pad not responding
☐	Discolouration of screen	☐	Acid etching of screen
☐	Short circuits	☐	Do not know
☐	Other *(please specify)*		

29. What affect did the above damage have on **laptop computers**? *(Please tick all that apply)*			
☐	Computer would not turn on	☐	Computer would turn on sometimes
☐	Computer would turn off periodically without warning	☐	Screen would not turn on
☐	Screen would turn on sometimes	☐	Screen would turn off periodically
☐	Keyboard would not work	☐	Keyboard would work sometimes
☐	Mouse pad would not work	☐	Mouse pad would work sometimes
☐	Data loss	☐	Do not know
☐	Other *(please specify)*		

30. On average, how long after your company purchases **laptop computers** does the above mentioned damage occur? *(Please write a number next to the appropriate unit of time)*	
	Weeks
	Months
	Years

31. Generally where are **laptop computers** located when they sustained damage? *(Please tick all that apply)*			
☐	Room with air conditioning	☐	Room without air conditioning
☐	Room with opening windows and/or doors	☐	Room without air conditioning or opening windows and/or doors
☐	Basements	☐	Attics
☐	Other *(please specify)*	☐	Do not know

32. Generally where are **undamaged laptop computers** located? *(Please tick all that apply)*			
☐	Room with air conditioning	☐	Room without air conditioning
☐	Room with opening windows and/or doors	☐	Room without air conditioning or opening windows and/or doors
☐	Basements	☐	Attics
☐	Other *(please specify)*	☐	Do not know

33. Do more or less **laptop computers** fail in an air conditioned office compared to a non-air conditioned office?	
☐	More
☐	Less
☐	Do not know
☐	Not applicable

Please use the space below for any additional comments regarding laptop computers.

34. On average, how much money does your company spend **each year** on **planned servicing** of **desktop computers**?							
None	$1 – $5,000	$5,001 – $10,000	$10,001 – $15,000	$15,001 – $20,000	$20,001+	Do not know	Not applicable
☐	☐	☐	☐	☐	☐	☐	☐

35. What percentage of the **planned servicing** costs for **desktop computers** is a result of geothermal gases?								
None	1 – 10%	11 – 20%	21 – 30%	31 – 40%	41 – 50%	51+%	Do not know	Not applicable
☐	☐	☐	☐	☐	☐	☐	☐	☐

36. On average, how much money does your company spend **each year** on **planned servicing** of **laptop computers**?							
None	$1 – $5,000	$5,001 – $10,000	$10,001 – $15,000	$15,001 – $20,000	$20,001+	Do not know	Not applicable
☐	☐	☐	☐	☐	☐	☐	☐

37. What percentage of the **planned servicing** costs for **laptop computers** is a result of geothermal gases?								
None	1 – 10%	11 – 20%	21 – 30%	31 – 40%	41 – 50%	51+%	Do not know	Not applicable
☐	☐	☐	☐	☐	☐	☐	☐	☐

38. On average, how much money does your company spend **each year** on **unplanned servicing** of **desktop computers**?							
None	$1 – $5,000	$5,001 – $10,000	$10,001 – $15,000	$15,001 – $20,000	$20,001+	Do not know	Not applicable
☐	☐	☐	☐	☐	☐	☐	☐

39. What percentage of the **unplanned servicing** costs for **desktop computers** is a result of geothermal gases?								
None	1 – 10%	11 – 20%	21 – 30%	31 – 40%	41 – 50%	51+%	Do not know	Not applicable
☐	☐	☐	☐	☐	☐	☐	☐	☐

40. On average, how much money does your company spend **each year** on **unplanned servicing** of **laptop computers**?							
None	$1 – $5,000	$5,001 – $10,000	$10,001 – $15,000	$15,001 – $20,000	$20,001+	Do not know	Not applicable
☐	☐	☐	☐	☐	☐	☐	☐

41. What percentage of the **unplanned servicing** costs for **laptop computers** is a result of geothermal gases?								
None	1 – 10%	11 – 20%	21 – 30%	31 – 40%	41 – 50%	51+%	Do not know	Not applicable
☐	☐	☐	☐	☐	☐	☐	☐	☐

42. Is the cost of unplanned servicing of your company's computers, as a result of damage from geothermal gases, covered by insurance?	
☐	Yes
☐	No
☐	Do not know

43. Other than the financial cost, how have damaged computers affected your company? *(Please tick all that apply)*			
☐	Loss of productivity	☐	Loss of communication with staff and clients
☐	Loss of time	☐	Loss of data
☐	Other *(please specify)*	☐	Do not know

44. Which of the following does your company use to keep the air inside your buildings free from geothermal gases? *(Please tick all that apply)*			
☐	Filtration of air coming into the building	☐	Positive pressure within the building
☐	Air filters on computer fans	☐	None
☐	Other *(please specify)*	☐	Do not know

45. Have any items other than computers *(e.g. electrical fittings, metal pipes, metal products, air conditioning units, etc.)* in your company's building sustained damage from geothermal gas?	
☐	Yes *(please explain below which items have been damaged and the damage caused)*
☐	No
☐	Do not know

For any additional comments please use the space below.

Thank you very much for your time and cooperation in completing this questionnaire.

Can you please provide your details for your preferred method of contact so I can send the questionnaire results to you.

Postal Address	Email Address

If you have any concerns about the questionnaire please do not hesitate to contact me by email at grant.wilson@pg.canterbury.ac.nz or one of my supervisors: Dr. Thomas Wilson (Hazard and Disaster Management lecturer at the University of Canterbury) at thomas.wilson@canterbury.ac.nz; Professor Jim Cole (Professor of Geology at the University of Canterbury) at jim.cole@canterbury.ac.nz; and Brad Scott (Volcano Surveillance Coordinator at GNS Science) at b.scott@gns.cri.nz.

A.3. Questionnaire Results

Questions 1 and 2 have been excluded to preserve respondent's anonymity.

Table A.1: Question 3 – Which classification best describes your business?

	Count	**Percentage**
Accommodation and food services	5	18
Computer repair	3	11
Computers retail	1	4
Construction	0	0
Education	0	0
Entertainment/recreation	1	4
Financial and insurance services	3	11
Healthcare	0	0
Local government	0	0
Manufacturing	0	0
Professional scientific and technical services	0	0
Real estate	0	0
Retail trade	7	25
Telecommunications services	0	0
Transportation	0	0
Wholesale trade	2	7
Other	6	21
TOTAL	**28**	**100**

Other responses:

- Consultants
- Information and advice
- Chartered accountants
- Veterinary care
- Electrical repairs and installations

- Legal

Table A.2: Question 4 – How many staff members are employed within your company?

	Count	**Percentage**
1 – 10	19	66
11 – 20	3	10
21 – 30	4	14
31 – 40	0	0
41 – 50	0	0
51+	3	10
TOTAL	**29**	**100**

Table A.3: Question 5 – Which suburb in your company located in?

	Count	**Percentage**
Fairy Springs	0	0
Fenton	12	41
Fordlands	0	0
Glenholme East	2	7
Glenholme West	0	0
Hillcrest	0	0
Kawaha Point	0	0
Koutu	0	0
Kuirau	1	3
Lynmore	0	0
Mangakakahi	0	0
Ngapuna	0	0
Ohinemutu	0	0
Pomare	0	0
Springfield	0	0
Utuhina	1	3
Victoria	0	0

Whaka	1	3
Other	12	41
TOTAL	**29**	**100**

Other responses:

- CBD (11 responses)
- Te Ngae

Table A.4: Question 6 – Approximately how close is your company's buildings to any geothermal features?

	Count	**Percentage**
There is a geothermal feature within our property	3	10
250 – 500 m	10	34
500 – 1000 m	8	28
1 – 2 km	8	28
2 km+	0	0
Do not know	0	0
TOTAL	**29**	**100**

Table A.5: Question 7 – Have any of your company's buildings/offices been tested for gas levels?

	Count	**Percentage**
Yes	3	10
No	12	41
Do not know	14	48
TOTAL	**29**	**100**

Table A.6: Question 7 – What type of gas(es) were present?

	Count	Percentage
Carbon Dioxide	0	0
Hydrogen Sulfide	1	50
Do not know	1	50
Other	0	0
TOTAL	**2**	**100**

Table A.7: Question 9 – What was the level of Carbon Dioxide present?

	Count	Percentage
None	0	0
0 – 2,500 parts per million (ppm)	0	0
2,501 – 5,000 ppm	0	0
5,001 ppm+	0	0
Do not know	0	0
TOTAL	**0**	**0**

Table A.8: Question 10 – What was the level of Hydrogen Sulfide present?

	Count	Percentage
None	0	0
0 – 10 parts per million (ppm)	0	0
11 – 20 ppm	0	0
21 ppm+	0	0
Do not know	1	100
TOTAL	**1**	**100**

Desktop computers

Table A.9: Question 11 – Approximately how many desktop computers does your company have?

	Count	Percentage
None	0	0
1 – 5	14	50
6 – 10	8	29
11 – 15	1	4
16 – 20	1	4
21+	4	14
TOTAL	**28**	**100**

Table A.10: Question 12 – What are you desktop computers used for?

	Count
General use	25
Network servers	12
Point of sale facilities	10
Machinery control	0
Data collection	6
Do not know	0
Other	4
TOTAL	**57**

Other responses:

- Stock/order
- Bookings (via email)
- Placing client investment orders
- Internet searching

Table A.11: Question 13A – How often does your company replace its desktop computers?

	Average
Months	42

Table A.12: Question 13B – Why does your company replace its desktop computers?

	Count
Accidents	1
Damage	5
End of lease	2
Poor performance	11
Do not know	5
Other	9
TOTAL	**33**

Other responses:

- Kaput
- If there is a fault that our IT department cannot fix over the phone, they just send us a new one
- To keep them high spec
- Faults
- Wear and tear and malfunction
- Corrosion of circuit boards
- Rust due to thermal air
- End of business life

Table A.13: Question 13C – Is the replacement planned or unplanned?

	Count	**Percentage**
Planned	8	30
Unplanned	15	56
Do not know	4	15
TOTAL	**27**	**100**

Table A.14: Question 14 – Have any of your desktop computers sustained damage from geothermal gas?

	Count	Percentage
Yes	5	19
No	7	26
Do not know	15	56
TOTAL	**27**	**100**

Table A.15: Question 15 – Approximately how many of your desktop computers have suffered damage?

	Count	Percentage
1 – 2	1	20
3 – 4	3	60
5 – 6	0	0
7 – 8	0	0
9 – 10	0	0
11+	1	20
TOTAL	**5**	**100**

Table A.16: Question 16 – What type of damage has occurred to desktop computers?

	Count
Corrosion of components on the circuit board reducing life expectancy	4
Corrosion of other internal components reducing life expectancy	3
Corrosion of external connectors reducing performance	3
Corrosion of external case	0
Corrosion inside power supply reducing life expectancy	0
Corrosion of cooling fans reducing performance	2
Key on keyboard not responding	1
Mouse not responding	2
Decolouration of screen	1
Acid etching of screen	0
Short circuits	1

Do not know	0
Other	0
TOTAL	**17**

Table A.17: Question 17 – What affect did the above damage have on desktop computers?

	Count
Computer would not turn on	1
Computer would turn on sometimes	4
Computer would turn off periodically without warning	0
Screen would not turn on	1
Screen would turn on sometimes	2
Screen would turn off periodically	0
Keyboard would not work	1
Keyboard would work sometimes	0
Mouse would not work	1
Mouse would work sometimes	1
Loss of data	0
Do not know	0
Other	0
TOTAL	**11**

Table A.18: Question 18 – On average, how long after your company purchases desktop computers does the above mentioned damage occur?

	Average
Weeks	-
Months	6
Years	4

Table A.19: Question 19 – Generally where are desktop computers located when they sustain damage?

	Count
Room with air conditioning	2
Room without air conditioning	2
Room with opening windows and/or doors	2
Room without air conditioning and opening windows and/or doors	1
Basements	0
Attics	0
Do not know	0
Other	1
TOTAL	**8**

Other responses:

- Everywhere

Table A.20: Question 20 – Generally where are un-damaged desktop computers located?

	Count
Room with air conditioning	1
Room without air conditioning	0
Room with opening windows and/or doors	0
Room without air conditioning and opening windows and/or doors	1
Basements	0
Attics	0
Do not know	1
Other	2
TOTAL	**5**

Other responses:

- We have none
- None

Table A.21: Question 21 – Do more or less desktop computers fail in an air conditioned room compared to a non-air conditioned room?

	Count	Percentage
More	1	50
Less	0	0
Do not know	1	50
TOTAL	**2**	**100**

Respondent's comments regarding desktop computers.

- All our computers, faxes, printers, alarm system etc., have sulfur damage and they all get replaced when they die - always caused by sulfur.
- I have only been here two years, but my understanding is that anything with a printed circuit board suffers "quickly".
- Mostly problems have occurred with the wiring and connections. Have rewired the whole building and new server, 15 months ago.

Laptop computers

Table A.22: Question 22 – Approximately how many laptop computers does your company have?

	Count	Percentage
None	10	37
1 – 5	16	59
6 – 10	0	0
11 – 15	0	0
16 – 20	0	0
21+	1	4
TOTAL	**27**	**100**

Table A.23: Question 23 – What are you laptop computers used for?

	Count
General use	15
Network servers	4
Point of sale facilities	3
Machinery control	0
Data collection	4
General use off site	10
Field work	5
Do not know	0
Other	1
TOTAL	**42**

Other responses:

- Internet searches

Question 24 – If any of your laptop computers are taken off site, where are they usually taken?

- Lynmore
- Within Rotorua
- We cover the Rotorua State Highway network and often travel all over the country
- Tauranga, Hamilton
- Lynmore – residence
- Poets corner, Pomare and Ngongataha
- Rotorua District
- To rural properties on the outskirts of Rotorua
- All over the country, branch managers and sales reps have them
- Anywhere

Table A.24: Question 25A – How often does your company replace its laptop computers?

	Average
Months	36

Table A.25: Question 25B – Why does your company replace its laptop computers?

	Count
Accidents	0
Damage	1
End of lease	1
Poor performance	8
Do not know	5
Other	2
TOTAL	**17**

Other responses:

- Laptop is fairly new
- End of business life

Table A.26: Question 25C – Is the replacement planned or unplanned?

	Count	Percentage
Planned	4	24
Unplanned	7	41
Do not know	6	35
TOTAL	**17**	**100**

Table A.27: Question 26 – Have any of your laptop computers sustained damage from geothermal gas?

	Count	Percentage
Yes	0	0
No	7	41
Do not know	10	59
TOTAL	**17**	**100**

Table A.28: Question 27 – Approximately how many of your laptop computers have suffered damage?

	Count	Percentage
1 – 2	0	0
3 – 4	0	0
5 – 6	0	0
7 – 8	0	0
9 – 10	0	0
11+	0	0
TOTAL	**0**	**0**

Table A.29: Question 28 – What type of damage has occurred to laptop computers?

	Count
Corrosion of components on the circuit board reducing life expectancy	0
Corrosion of other internal components reducing life expectancy	0
Corrosion of external connectors reducing performance	0
Corrosion of external case	0
Corrosion inside power supply reducing life expectancy	0
Corrosion of cooling fans reducing performance	0
Key on keyboard not responding	0
Mouse not responding	0
Decolouration of screen	0
Acid etching of screen	0
Short circuits	0
Do not know	0
Other	0
TOTAL	**0**

Table A.30: Question 29 – What affect did the above damage have on laptop computers?

	Count
Computer would not turn on	0
Computer would turn on sometimes	0
Computer would turn off periodically without warning	0
Screen would not turn on	0
Screen would turn on sometimes	0
Screen would turn off periodically	0
Keyboard would not work	0
Keyboard would work sometimes	0
Mouse would not work	0
Mouse would work sometimes	0
Loss of data	0
Do not know	0
Other	0
TOTAL	**0**

Table A.31: Question 30 – On average, how long after your company purchases laptop computers does the above mentioned damage occur?

	Average
Weeks	-
Months	-
Years	-

Table A.32: Question 31 – Generally where are laptop computers located when they sustain damage?

	Count
Room with air conditioning	0
Room without air conditioning	0
Room with opening windows and/or doors	0
Room without air conditioning and opening windows and/or doors	0
Basements	0
Attics	0

Do not know	0
Other	0
TOTAL	**0**

Table A.33: Question 32 – Generally where are un-damaged laptop computers located?

	Count
Room with air conditioning	0
Room without air conditioning	0
Room with opening windows and/or doors	0
Room without air conditioning and opening windows and/or doors	0
Basements	0
Attics	0
Do not know	0
Other	0
TOTAL	**0**

Table A.34: Question 33 – Do more or less laptop computers fail in an air conditioned room compared to a non-air conditioned room?

	Count	**Percentage**
More	0	0
Less	0	0
Do not know	0	0
TOTAL	**0**	**0**

There were no comments from respondent's regarding laptop computers.

General Questions

Table A.35: Question 34 – On average, how much money does your company spend each year on planned servicing of desktop computers?

	Count	Percentage
None	11	48
$1 – $5,000	5	22
$5,001 – $10,000	2	9
$10,001 – $15,000	0	0
$15,001 – $20,000	0	0
$20,001+	0	0
Do not know	5	22
TOTAL	**23**	**100**

Table A.36: Question 35 – What percentage of the planned servicing cost for desktop computers is a result of geothermal gas?

	Count	Percentage
None	10	43
1 – 10%	0	0
11 – 20%	0	0
21 – 30%	0	0
31 – 40%	0	0
41 – 50%	1	4
51%+	1	4
Do not know	11	48
TOTAL	**23**	**100**

Table A.37: Question 36 – On average, how much money does your company spend each year on planned servicing of laptop computers?

	Count	Percentage
None	9	60
$1 – $5,000	3	20
$5,001 – $10,000	0	0

$10,001 – $15,000	0	0
$15,001 – $20,000	0	0
$20,001+	0	0
Do not know	3	20
TOTAL	**15**	**100**

Table A.38: Question 37 – What percentage of the planned servicing cost for laptop computers is a result of geothermal gas?

	Count	**Percentage**
None	10	67
1 – 10%	0	0
11 – 20%	0	0
21 – 30%	0	0
31 – 40%	0	0
41 – 50%	0	0
51%+	0	0
Do not know	5	33
TOTAL	**15**	**100**

Table A.39: Question 38 – On average, how much money does your company spend each year on unplanned servicing of desktop computers?

	Count	**Percentage**
None	1	4
$1 – $5,000	14	61
$5,001 – $10,000	3	13
$10,001 – $15,000	0	0
$15,001 – $20,000	0	0
$20,001+	0	0
Do not know	5	22
TOTAL	**23**	**100**

Table A.40: Question 39 – What percentage of the unplanned servicing cost for desktop computers is a result of geothermal gas?

	Count	Percentage
None	4	18
1 – 10%	0	0
11 – 20%	1	5
21 – 30%	0	0
31 – 40%	2	9
41 – 50%	1	5
51%+	2	9
Do not know	12	55
TOTAL	**22**	**100**

Table A.41: Question 40 – On average, how much money does your company spend each year on unplanned servicing of laptop computers?

	Count	Percentage
None	6	46
$1 – $5,000	4	31
$5,001 – $10,000	0	0
$10,001 – $15,000	0	0
$15,001 – $20,000	0	0
$20,001+	0	0
Do not know	3	23
TOTAL	**13**	**100**

Table A.42: Question 41 – What percentage of the unplanned servicing cost for laptop computers is a result of geothermal gas?

	Count	Percentage
None	6	40
1 – 10%	0	0
11 – 20%	0	0
21 – 30%	0	0
31 – 40%	0	0

41 – 50%	0	0
51%+	0	0
Do not know	9	60
TOTAL	**15**	**100**

Table A.43: Question 42 – Is the cost of unplanned servicing of your company's computers, as a result of damage from geothermal gases, covered by insurance?

	Count	**Percentage**
Yes	1	4
No	9	39
Do not know	13	57
TOTAL	**23**	**100**

Table A.44: Question 43 – Other than financial cost, how have damaged computers affected your company?

	Count
Loss of productivity	11
Loss of communication with staff and clients	6
Loss of time	12
Loss of data	5
Do not know	3
Other	3
TOTAL	**40**

Other responses:

- We plan for it so it does not affect us
- Inconvenience
- Loss of money from client email 'hire'

Table A.45: Question 44 – Which of the following does your company use to keep the air inside your buildings free from geothermal gases?

	Count
Filtration of air coming into building	5
Positive pressure within building	1
Air filters on computer fans	2
None	14
Do not know	1
Other	2
TOTAL	**25**

Other responses:

- A door!
- Exhaust fan

Table A.46: Question 45 – Have any other items other than computers in your company's building sustained damage from geothermal gas?

	Count	**Percentage**
Yes	12	52
No	5	22
Do not know	6	26
TOTAL	**23**	**100**

Respondent's comments regarding other items that have sustained damage:

- Televisions, refrigerators, stereos, clocks, cars.
- Everything else.
- We suffer some corrosion of wires, electrical cords and most often power sockets.
- Power points and light fittings, door locks and padlocks, galvanised fencing and gates, vehicles (panels).
- FireFinder Fire Alarm - zoned, addressable alarm system. Extensive circuit board corrosion, needing replacement within three years. On-going replacement of individual smoke detector and manual call points.

- Refrigeration Coils.
- Printed circuit boards last two years, photocopier boards start needing replacement from two years, by three years the lease contract is effectively voided. Drink chillers in every lounge need replacement coolant every month because of corrosion to the pipes causing leaks, and their compressors require replacement by about 3-4 years. All water pipes are treated gingerly because of corrosion (we do not clean the flaky black stuff off them in case we break through them). Wiring on light fittings corrodes. We have (horse) racing about monthly here, and before each race the plumber and electrician go through the complex and test everything works. Taps all need replacing because of corrosion. Once a year the electrician cleans all the contacts on all the switchboards. Any electrical appliance that has not been used for e.g. a year, I clean the pins of the plug before inserting into the power socket.
- Air conditioners, fridges and heaps of computer mice sustain damage due to corrosion.
- Any metal fittings corroded and discoloured, prongs on three pin plugs discoloured, taps and handles corroded.
- Air conditioning units seem to require high maintenance and performance is poor. Our server also crashed totally back in 2005 however it is not known if geothermal gas had any bearing on the crash.
- Air-conditioning units.

Respondent's overall comments:

- Really do not know how you can accurately quantify damage to PCs as a result of geothermal gas vs. use/age and wear and tear. We just figured that the one PC that has been replaced in three years was due to be replaced because it 'blew up' i.e. end of its life, kaput!
- Like I said before, our main expense when it comes to geothermal gas is having to replace 20 pairs of headphones every six months. Usually costing $600-$800 a time.
- The only main part at risk from geothermal gas is CRT screens.
- We are yet to experience a serious hydrogen sulphide related problem with our computers, I guess we are lucky in that regard. More obvious damages have been to our TV sets which we replace on a regular basis.

- Because we lease our computers any malfunction that they sustain is done under warranty. We have the highest fail rate for our company in this region but the cause has never been fully identified as the volcanic gas surrounding the building. Our computers are sent to the main computer department in Hamilton to be repaired or replaced. The main causes of malfunction are either the power supply inside the computer or something on the mother board. I do know of other companies who do not seem to suffer as much of a problem and our lab which is off site does not seem to get the same failure rate. This may mean that most of our problems are only power supply related. Rental companies in Rotorua that have people living at Hells Gate were it is a very strong geothermal area replace their rental equipment every year as the sulphur there cause great problems. We have little failure of hard disk drives including portable ones and our screens hardly ever have problems either. The phones do not seem to have too many issues but we upgraded most of them when we moved the office around (same building, different layout). The main visible effect of our location is simply the discolouring of wires and blackening of contacts in plugs, etc.
- Basically PCs and laptops are replaced when they become too slow. Whether they have been affected by geothermal activity is unknown as we do not get them autopsied as that would incur another cost.
- Untraceable USB errors - could be sulphur damage - I will look on the motherboard for damage, when I replace it next week.
- Thank goodness for backups! Only had one laptop here for six months, it is often elsewhere, so less exposure, one hopes.
- When desktops or laptops are scrapped we remove the hard drives and open the outer casings to totally destroy them by scrapping the disks or putting a hole through them. To date not one of the actual hard drives opened have ever appeared tarnished or corroded in anyway (i.e. there is no blackening of the metal). The rest of the internal components also appear normal.
- We have in the past had trouble with the phone lines and this could have been affected by the geothermal underground.

Appendix B – Volcanic Observatories Questionnaire

B.1. Information Sheet

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

To Whom It May Concern,

I am a student at the University of Canterbury, New Zealand, undertaking a Master of Science thesis in Geology. I am writing to ask if someone from your organisation who has experience with surveillance equipment development, deployment and maintenance could please answer a questionnaire related to my research project.

My research is in two parts:

- Determining the vulnerability of modern laptop computers to the effects of volcanic eruptions, in particular volcanic ash and gas.
- Determining the vulnerability of materials commonly used to protect volcanic surveillance equipment, from volcanic ash and gas.

Both laboratory and field experiments and subsequent analysis will be undertaken to determine the vulnerabilities. The aim of this project is to provide useful data to volcanic observatories and the public, which live and work in close proximity to volcanoes, and to determine the most suitable way to protect equipment like sensitive electronic items from volcanic ash and gas, while still maintaining functionality.

In order the make more suitable recommendations I would like to know what experience volcanic observatories worldwide have had with protecting surveillance equipment, solar panels and laptop computers. I invite you (or someone who has experience with surveillance equipment deployment and maintenance) to answer an online questionnaire (website link below), which will take approximately 30 minutes to complete. Please submit the questionnaire before 1 October 2010.

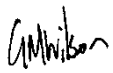
Please note that this questionnaire has been approved by the Department of Geological Sciences, University of Canterbury, and the answers you provide will be included in my thesis which is a public document available through the University of Canterbury library database.

The results of this survey will be returned to your organisation after they have been collated. You may withdrawal your participation at any time.

If you have any concerns about the questionnaire please do not hesitate to contact me by email at grant.wilson@pg.canterbury.ac.nz or one of my supervisors: Dr. Thomas Wilson (Hazard and Disaster Management lecturer at the University of Canterbury) at thomas.wilson@canterbury.ac.nz; Professor Jim Cole (Professor of Geology at the University of Canterbury) at jim.cole@canterbury.ac.nz; and Brad Scott (Volcano Surveillance Coordinator at GNS Science) at b.scott@gns.cri.nz.

Please click here or copy and paste the following URL into your internet browser http://canterbury.qualtrics.com/SE/?SID=SV_etv6aEbFXoipdB2 to take the questionnaire in English.

Yours sincerely,



Grant Wilson
MSc Candidate
Geological Sciences
University of Canterbury
Christchurch
New Zealand

B.2. Questionnaire Reminder

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

To Whom It May Concern,

On 16 June 2010 you received an email from a student completing a Master of Science thesis in Geology at the University of Canterbury, New Zealand, inviting you to complete a questionnaire about the experiences volcanic observatories have had with protecting volcanic surveillance equipment from volcanic ash and gas.

If you have not already completed the questionnaire, it would be much appreciated if you did, the website link is provided below. Please complete the questionnaire by 1 October 2010.

If you have any concerns about the questionnaire please do not hesitate to contact me by email at grant.wilson@pg.canterbury.ac.nz.

Please click here or copy and paste the following URL into your internet browser http://canterbury.qualtrics.com/WRQualtricsSurveyEngine?SID=SV_3eNmBev6hjNibpq&RID=MLRP_d69GFllK5wvFS04&_=1 to take the questionnaire in English.

Yours sincerely,

Grant Wilson
MSc Candidate
Geological Sciences
University of Canterbury
Christchurch
New Zealand

B.3. Questionnaire

The aim of this questionnaire is to gather information from volcanic observatories worldwide about their experiences with protecting volcanic surveillance equipment, solar panels and laptop computers. Please note that this questionnaire has been approved by the Department of Geological Sciences, University of Canterbury, and the answers you provide will be included in my thesis which is a public document available through the University of Canterbury library database. The questionnaire will take approximately 30 minutes to complete.

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Space is provided at the end for additional comments

1. What is your job title?

_____

2. What is the name of the organisation you work for?

_____

3. How many staff members are employed at your organisation?					
<10	11 – 20	21 – 30	31 – 40	41 – 50	51+
☐	☐	☐	☐	☐	☐

4. How long have you worked at your organisation?					
<1 year	1 – 5 years	6 – 10 years	11 – 15 years	16 – 20 years	21+ years
☐	☐	☐	☐	☐	☐

5. How many volcanoes are under surveillance by your organisation?					
None	<5	6 – 10	11 – 15	16 – 20	21+
☐	☐	☐	☐	☐	☐

6. What types of volcanoes are under surveillance by your organisation? *(Please tick all that apply)*			
☐	Fissure Vents	☐	Lava Domes
☐	Cinder Cones	☐	Shield Volcanoes
☐	Subglacial Volcanoes	☐	Stratovolcanoes
☐	Volcanic Fields	☐	Calderas
☐	Other *(please specify)*		

7. Which of the following surveillance equipment does your organisation have deployed at volcanoes? *(Please tick all that apply)*			
☐	Seismic Stations	☐	GPS Stations
☐	Gravity Stations	☐	Ground Based Gas Monitoring Stations
☐	Tiltmeters	☐	Electronic Distance Measurement Stations
☐	Remote Cameras	☐	Communication Equipment *(e.g. radio transmitters, etc.)*
☐	Temporary Equipment	☐	Data Storage Centres
☐	Other *(please specify)*		

8. Approximately how many of the following surveillance equipment does your organisation currently have deployed at volcanoes? *(Please write the name(s) of other equipment not on the list in the last two rows)*

	1 – 5	6 – 10	11 – 15	16 – 20	21+	Not Applicable
Seismic Stations	☐	☐	☐	☐	☐	☐
GPS Stations	☐	☐	☐	☐	☐	☐
Gravity Stations	☐	☐	☐	☐	☐	☐
Ground Based Gas Monitoring Stations	☐	☐	☐	☐	☐	☐
Tiltmeters	☐	☐	☐	☐	☐	☐
Electronic Distance Measurement Stations	☐	☐	☐	☐	☐	☐
Remote Cameras	☐	☐	☐	☐	☐	☐
Communications Equipment	☐	☐	☐	☐	☐	☐
Temporary Equipment	☐	☐	☐	☐	☐	☐

Data Storage Centres	☐	☐	☐	☐	☐	☐
Other:	☐	☐	☐	☐	☐	☐
Other:	☐	☐	☐	☐	☐	☐

9. From your experience what is the most damaging volcanic hazard to **your organisation's** surveillance equipment? *(Please tick one)*			
☐	Gas	☐	Ash
☐	Ballistics	☐	Acid Rain
☐	Earthquakes	☐	Other *(please specify)*

Surveillance Equipment Questions

This section contains a number of questions related to how your organisation protects its volcanic surveillance equipment and any failures.

10. Does your organisation take extra effort to protect some or all of the volcanic surveillance equipment it operates?	
☐	Yes
☐	No *(go to question 170)*

11. Which of the following surveillance equipment does your organisation protect from the volcanic environment? *(Please tick all that apply and write the name(s) of other equipment not on the list in the last row)*			
☐	Seismic Stations	☐	GPS Stations
☐	Gravity Stations	☐	Ground Based Gas Monitoring Stations
☐	Tiltmeters	☐	Electronic Distance Measurement Stations
☐	Remote Cameras	☐	Communication Equipment *(e.g. radio transmitters, etc.)*
☐	Temporary Equipment	☐	Data Storage Centres
☐	*Other:*	☐	*Other:*

The following sets of questions are related to what materials are used to protect surveillance equipment and what damage has occurred to the equipment. The questions are under the headings of the volcanic surveillance equipment listed above. Only complete the questions related to the equipment that you selected in question 11.

Monitoring Equipment

12. What materials are used to protect your organisation's **monitoring equipment**? *(Please tick all that apply)*			
☐	Wood	☐	Stainless Steel
☐	Steel	☐	Zinc
☐	Copper	☐	Roofing Iron
☐	Concrete	☐	Perspex/Plexiglas/Acrylic
☐	Glass	☐	Electrical Tape/Waterproof Tape
☐	Other *(please specify)*		

13. Please provide an explanation of how these materials are used to protect **monitoring equipment.**

14. Have any of your organisation's **monitoring equipment** sustained damage from volcanic hazards **while being protected**?	
☐	Yes
☐	No *(go to question 20)*

15. What type(s) of damaged has occurred to **monitoring equipment**? *(Please tick all that apply)*			
☐	Minor corrosion of outside of equipment not affecting functionality	☐	Major corrosion of outside of equipment reducing functionality and life expectancy
☐	Minor abrasion of outside of equipment not affecting functionality	☐	Major abrasion of outside of equipment reducing functionality and life expectancy

☐	Corrosion of components on circuit boards reducing functionality and life expectancy	☐	Short circuits
☐	Dents and/or holes from impacts	☐	Acid etching of equipment
☐	Clogged motors	☐	Clogged air intakes
☐	Totally destroyed	☐	Do not know
☐	Other *(please specify)*		

16. What volcanic hazard(s) caused the above damage to your organisation's **monitoring equipment**? *(Please tick all that apply)*			
☐	Ash	☐	Gas
☐	Acid rain	☐	Lava bomb
☐	Other *(please specify)*	☐	Do not know

17. Have any of your organisation's **monitoring equipment** stopped working due to the above damage?	
☐	Yes
☐	No

18. On average, how often does your organisation have to **repair monitoring equipment** because they stopped working due to the above damage? *(Please write a number next to the appropriate unit of time)*	
	Weeks
	Months
	Years

19. On average, how often does your organisation have to **replace monitoring equipment** because they stopped working due to the above damage? *(Please write a number next to the appropriate unit of time)*	
	Weeks
	Months
	Years

20. Have any of the **materials** your organisation used to protect **monitoring equipment** sustained damage from volcanic hazards?	
☐	Yes
☐	No *(go to question 24)*

21. What type of damaged occurred to these materials? *(Please tick all that apply)*			
☐	Corrosion of Metals Causing Structural Failures	☐	Corrosion of Metals Forming Holes
☐	Abrasion of Materials Causing Structural Failures	☐	Abrasion of Materials Forming Holes
☐	Dents and/or Holes From Impacts	☐	Acid Etching of Materials
☐	Totally Destroyed	☐	Do not know
☐	Other *(please specify)*		

22. What volcanic hazard(s) caused the above damage to the materials protecting **monitoring equipment**? *(Please tick all that apply)*			
☐	Ash	☐	Gas
☐	Acid rain	☐	Lava bomb
☐	Other *(please specify)*	☐	Do not know

23. On average, how often does your organisation have to **replace** the materials that protect **monitoring equipment** because they sustained damage from volcanic hazards? *(Please write a number next to the appropriate unit of time)*	
	Days
	Weeks
	Months
	Years

24. Does your organisation change its protection method(s) and/or protection materials for **monitoring equipment** at different locations/conditions around a volcano?	
☐	Yes *(please explain below how the protection methods change)*
☐	No

25. Please rate the overall effectiveness of the protection methods and materials used by your organisation to protect **monitoring equipment** from the following hazards:					
	Very Effective (equipment requires maintenance once or less per year)	**Effective** (equipment requires maintenance 2-3 times per year)	**Somewhat Effective** (equipment requires maintenance 4-6 times per year)	**Ineffective** (equipment requires maintenance more than 6 times per year)	Not Applicable
Ballistic impacts	☐	☐	☐	☐	☐
Loading from ashfall	☐	☐	☐	☐	☐
Abrasion from ash	☐	☐	☐	☐	☐
Gas infiltration	☐	☐	☐	☐	☐
Acid rain infiltration	☐	☐	☐	☐	☐

Please use the space below for any additional comments regarding the protection and failure of **monitoring equipment**.

168. On average, how much money does your organisation spend each year on **repairing** volcanic surveillance equipment?					
None	US$1 – US$10,000	US$10,001 – US$20,000	US$30,001 – US$40,000	US$40,001 – US$50,000	US$50,001+
☐	☐	☐	☐	☐	☐

169. On average, how much money does your organisation spend each year on **replacing** volcanic surveillance equipment?					
None	US$1 – US$10,000	US$10,001 – US$20,000	US$30,001 – US$40,000	US$40,001 – US$50,000	US$50,001+
☐	☐	☐	☐	☐	☐

Only answer question 170 and 171 if you answered 'No' to question 10

170. Has your organisation considered protecting surveillance equipment in the past?	
☐	Yes
☐	No

171. What are the main reasons why your organisation does not protect surveillance equipment? *(Please tick all that apply)*	
☐	Initial cost too high
☐	Ongoing maintenance cost too high
☐	Protection would not be effective
☐	Equipment would not last any longer
☐	Other *(please specify)*

Solar Panel Questions

This section contains a number of questions related to how your organisation protects its solar panels and any failures.

172. Does any of your organisation's surveillance equipment require solar panels for their power supply?	
☐	Yes
☐	No *(go to question 194)*

173. Approximately how many solar panels does your organisation have deployed in the field to provide power to surveillance equipment?					
1 – 10	11 – 20	21 – 30	31 – 40	41 – 50	51+
☐	☐	☐	☐	☐	☐

174. Does your organisation protect solar panels from volcanic hazards?	
☐	Yes
☐	No *(go to question 183)*

175. What materials are used to protect your organisation's **solar panels**? *(Please tick all that apply)*			
☐	Wood	☐	Stainless Steel
☐	Steel	☐	Zinc
☐	Copper	☐	Roofing Iron
☐	Concrete	☐	Perspex/Plexiglas/Acrylic
☐	Glass	☐	Electrical Tape/Waterproof Tape
☐	Other *(please specify)*		

176. Please provide an explanation of how these materials are used to protect solar panels.

177. Have any of your organisation's solar panels sustained damage from volcanic hazards **while protected**?	
☐	Yes
☐	No *(go to question 183)*

178. What type of damaged occurred to solar panels **while protected**? *(Please tick all that apply)*			
☐	Corrosion of metal frame causing structural failure	☐	Corrosion of metal frame forming holes
☐	Abrasion of metal frame causing structural failure	☐	Abrasion of metal frame forming Holes
☐	Dents and/or holes from impacts	☐	Acid etching of glass
☐	Abrasion of glass	☐	Corrosion of electrical connections
☐	Short circuits	☐	Totally destroyed
☐	Other *(please specify)*	☐	Do not know

179. What volcanic hazard(s) caused the above damage to solar panels **while protected**? *(Please tick all that apply)*			
☐	Ash	☐	Gas
☐	Acid rain	☐	Lava bomb
☐	Other *(please specify)*	☐	Do not know

180. Did the damage cause the solar panel to work less efficiently or stop working?	
☐	Less efficiently
☐	Stop working
☐	Do not know *(go to question 182)*

181. Did the fact the solar panel was working less efficiently or stopped working cause the surveillance equipment the solar panel was powering to stop working?	
☐	Yes
☐	No
☐	Do not know

182. On average, how often does your organisation have to **replace** solar panels because they stopped working due to damage **while protected**? *(Please write a number next to the appropriate unit of time)*	
	Weeks
	Months
	Years

183. Have any of your organisation's solar panels sustained damage from volcanic hazards **while unprotected**?	
☐	Yes
☐	No *(go to question 189)*

184. What type of damaged occurred to solar panels **while unprotected**? *(Please tick all that apply)*			
☐	Corrosion of metal frame causing structural failure	☐	Corrosion of metal frame forming holes
☐	Abrasion of metal frame causing structural failure	☐	Abrasion of metal frame forming Holes

☐	Dents and/or holes from impacts	☐	Acid etching of glass
☐	Abrasion of glass	☐	Corrosion of electrical connections
☐	Short circuits	☐	Totally destroyed
☐	Other *(please specify)*	☐	Do not know

185. What volcanic hazard(s) caused the above damage to solar panels **while unprotected**? *(Please tick all that apply)*			
☐	Ash	☐	Gas
☐	Acid rain	☐	Lava bomb
☐	Other *(please specify)*	☐	Do not know

186. Did the damage cause the solar panel to work less efficiently?	
☐	Less efficiently
☐	Stop working
☐	Do not know *(go to question 188)*

187. Did the damage cause the solar panel to stop working?	
☐	Yes
☐	No
☐	Do not know

188. On average, how often does your organisation have to **replace** solar panels because they stopped working due to damage **while unprotected**? *(Please write a number next to the appropriate unit of time)*	
	Weeks
	Months
	Years

189. Please rate the overall effectiveness of the protection methods and materials used by your organisation to protect solar panels from the following hazards:					
	Very Effective (solar panels require maintenance once or less per year)	**Effective** (solar panels require maintenance 2-3 times per year)	**Somewhat Effective** (solar panels require maintenance 4-6 times per year)	**Ineffective** (solar panels require maintenance more than 6 times per year)	Not Applicable
Ballistic impacts	☐	☐	☐	☐	☐
Loading from ashfall	☐	☐	☐	☐	☐
Abrasion from ash	☐	☐	☐	☐	☐
Gas infiltration	☐	☐	☐	☐	☐
Acid rain infiltration	☐	☐	☐	☐	☐

190. On average, how much money does your organisation spend each year on **replacing** solar panels?						
None	US$1 – US$10,000	US$10,001 – US$20,000	US$20,001 – US$30,000	US$30,001 – US$40,000	US$40,001 – US$50,000	US$50,001+
☐	☐	☐	☐	☐	☐	☐

191. During sustained eruptive activity ashfall can cover solar panels. Please explain your organisation's approach to cleaning ash off solar panels or your reasons why you do not clean ash off.

192. Please rate the effectiveness of the above cleaning method(s) for removing ash from a solar panel?				
Very Effective (>91% of ash removed)	**Effective** (90-51% of ash removed)	**Somewhat Effective** (50-11% of ash removed)	**Ineffective** (<10% of ash removed)	Not Applicable
☐	☐	☐	☐	☐

193. Does the above cleaning method(s) cause any abrasion of the glass on the solar panel?	
☐	Yes
☐	No

Please use the space below for any additional comments regarding the protection and failure of solar panels.

Laptop Computer Questions

This section contains a number of questions related to how your organisation protects its laptop computers and any failures.

194. Does your organisation use laptop computers in the field for any reason?	
☐	Yes
☐	No *(go to question 220)*

195. What are these laptop computers used for in the field? *(Please tick all that apply)*	
☐	Downloading data from surveillance equipment in the field *(laptop does not remain in the field)*
☐	Configuring surveillance equipment while in the field *(laptop does not remain in the field)*
☐	Running surveillance equipment from a laptop computer *(laptop remains in the field)*
☐	Other *(please specify)*

196. Are these laptop computers designed for outdoor use?	
☐	Yes *(please explain below what makes them useful for outdoor use)*
☐	No

197. How long do these laptop computers remain in the field per deployment? *(Please write a number next to the appropriate unit of time)*	
	Weeks
	Months
	Years

198. Approximately how many times per year are laptop computers taken into the field?				
<5	5 – 10	11 – 15	16 – 20	21+
☐	☐	☐	☐	☐

199. If laptop computers are in the field for more than one day, are they protected from the environment?	
☐	Yes
☐	No *(go to question 209)*

200. Is the laptop computer protected from meteorological factors or volcanic hazards or both?	
☐	Meteorological factors *(e.g. rain, snow, etc.)*
☐	Volcanic hazards *(e.g. ash, gas, etc.)*
☐	Both

201. If the laptop computer is designed for outdoor use, does your organisation increase the laptop computers protection?	
☐	Yes
☐	No

202. What materials are used to protect your organisation's laptop computers while in the field? *(Please tick all that apply)*			
☐	Wood	☐	Stainless Steel
☐	Steel	☐	Zinc
☐	Copper	☐	Roofing Iron

☐	Concrete	☐	Perspex/Plexiglas/Acrylic
☐	Glass	☐	Electrical Tape/Waterproof Tape
☐	Other *(please specify)*		

203. Please provide an explanation of how these materials are used to protect laptop computers.

204. Have any of your organisation's laptop computers sustained damage from volcanic hazards **while protected** in the field?	
☐	Yes
☐	No *(go to question 209)*

205. What type of damaged occurred to laptop computers **while protected**? *(Please tick all that apply)*			
☐	Corrosion of components on the circuit board reducing life expectancy	☐	Corrosion of other internal components reducing life expectancy *(e.g. CD Drive, Hard Drive, etc.)*
☐	Corrosion of external connectors reducing performance	☐	Abrasion of components on the circuit board reducing life expectancy
☐	Abrasion of other internal components reducing life expectancy *(e.g. CD Drive, Hard Drive, etc.)*	☐	Abrasion of external case
☐	Abrasion of screen reducing life expectancy	☐	Acid etching of screen reducing life expectancy
☐	Dents and/or holes from impacts	☐	Ash stuck under keyboard keys
☐	Clogged air intakes	☐	Clogged cooling fans
☐	Short circuits	☐	Totally destroyed
☐	Other *(please specify)*	☐	Do not know

206. What volcanic hazard(s) caused the above damage to laptop computers **while protected**? *(Please tick all that apply)*			
☐	Ash	☐	Gas
☐	Acid rain	☐	Lava bomb
☐	Other *(please specify)*	☐	Do not know

207. On average, how often does your organisation have to **repair** laptop computers because they stopped working due to damage **while protected**? *(Please write a number next to the appropriate unit of time)*	
	Weeks
	Months
	Years

208. On average, how often does your organisation have to **replace** laptop computers because they stopped working due to damage **while protected**? *(Please write a number next to the appropriate unit of time)*	
	Weeks
	Months
	Years

209. Have any of your organisation's laptop computers sustained damage from volcanic hazards **while unprotected** in the field?	
☐	Yes
☐	No *(go to question 214)*

210. What type of damaged occurred to laptop computers **while unprotected**? *(Please tick all that apply)*			
☐	Corrosion of components on the circuit board reducing life expectancy	☐	Corrosion of other internal components reducing life expectancy *(e.g. CD Drive, Hard Drive, etc.)*
☐	Corrosion of external connectors reducing performance	☐	Abrasion of components on the circuit board reducing life expectancy
☐	Abrasion of other internal components reducing life expectancy *(e.g. CD Drive, Hard Drive, etc.)*	☐	Abrasion of external case
☐	Abrasion of screen reducing life expectancy	☐	Acid etching of screen reducing life expectancy

☐	Dents and/or holes from impacts	☐	Ash stuck under keyboard keys
☐	Clogged air intakes	☐	Clogged cooling fans
☐	Short circuits	☐	Totally destroyed
☐	Other *(please specify)*	☐	Do not know

211. What volcanic hazard(s) caused the above damage to laptop computers **while unprotected**? *(Please tick all that apply)*

☐	Ash	☐	Gas
☐	Acid rain	☐	Lava bomb
☐	Other *(please specify)*	☐	Do not know

212. On average, how often does your organisation have to **repair** laptop computers because they stopped working due to damage **while unprotected**? *(Please write a number next to the appropriate unit of time)*

	Weeks
	Months
	Years

213. On average, how often does your organisation have to **replace** laptop computers because they stopped working due to damage **while unprotected**? *(Please write a number next to the appropriate unit of time)*

	Weeks
	Months
	Years

214. Please rate the overall effectiveness of the protection methods and materials used by your organisation to protect laptop computers from the following hazards:

	Very Effective (laptops require maintenance once or less per year)	**Effective** (laptops require maintenance 2-3 times per year)	**Somewhat Effective** (laptops require maintenance 4-6 times per year)	**Ineffective** (laptops require maintenance more than 6 times per year)	Not Applicable
Ballistic impacts	☐	☐	☐	☐	☐

Loading from ashfall	☐	☐	☐	☐	☐
Abrasion from ash	☐	☐	☐	☐	☐
Gas infiltration	☐	☐	☐	☐	☐
Acid rain infiltration	☐	☐	☐	☐	☐

215. After a laptop computer has come back from being in the field, is it cleaned?	
☐	Yes
☐	No *(go to question 217)*

216. Please explain how this cleaning is undertaken.

_____

_____

_____

_____

217. From your experience, does exposure of laptop computers to volcanic hazards reduce the laptops life expectancy?	
☐	Yes
☐	No

218. On average, how much money does your organisation spend each year on **repairing** laptop computers due to damage sustained while protected?					
None	US$1 – US$5,000	US$5,001 – US$10,000	US$10,001 – US$15,000	US$15,001 – US$20,000	US$20,001+
☐	☐	☐	☐	☐	☐

219. On average, how much money does your organisation spend each year on **replacing** laptop computers due to damage sustained while protected?					
None	US$1 – US$5,000	US$5,001 – US$10,000	US$10,001 – US$15,000	US$15,001 – US$20,000	US$20,001+
☐	☐	☐	☐	☐	☐

220. On average, how much money does your organisation spend each year on **replacing** laptop computers due to damage sustained while unprotected?					
None	US$1 – US$5,000	US$5,001 – US$10,000	US$10,001 – US$15,000	US$15,001 – US$20,000	US$20,001+
☐	☐	☐	☐	☐	☐

221. On average, how much money does your organisation spend each year on **replacing** laptop computers due to damage sustained while unprotected?					
None	US$1 – US$5,000	US$5,001 – US$10,000	US$10,001 – US$15,000	US$15,001 – US$20,000	US$20,001+
☐	☐	☐	☐	☐	☐

Please use the space below for any additional comments regarding the protection and failure of laptop computers.

Closing Questions

222. Has your organisation ever conducted experiments to determine the most effective method(s) for protecting surveillance equipment?	
☐	Yes
☐	No *(go to question 222)*

223. Please explain what these experiments entailed, and how they were carried out or references to any published details/results.

224. Has your organisation's method(s) of protecting surveillance equipment changed or been modified over time to provide better protection?	
☐	Yes
☐	No *(go to question 224)*
☐	Not Applicable *(please go to the last page)*

225. Please explain what prompted your organisation to change its protection methods.

226. Approximately what percentage of your organisation's volcanic surveillance budget is used for protecting surveillance equipment?						
0%	1 – 5%	6 – 10%	11 – 20%	21 – 30%	31 – 50%	51+%
☐	☐	☐	☐	☐	☐	☐

227. Approximately what percentage is used for ongoing maintenance costs?						
0%	1 – 5%	6 – 10%	11 – 20%	21 – 30%	31 – 50%	51+%
☐	☐	☐	☐	☐	☐	☐

For any additional comments regarding surveillance equipment protection, equipment failure and ideas for experiments please use the space below.

Thank you very much for your time and cooperation in completing this questionnaire.

Please provide your email address so that I can send you the questionnaire results.

Email Address

If you have any concerns about the questionnaire please do not hesitate to contact me by email at grant.wilson@pg.canterbury.ac.nz or one of my supervisors: Dr. Thomas Wilson (Hazard and Disaster Management lecturer at the University of Canterbury) at thomas.wilson@canterbury.ac.nz; Professor Jim Cole (Professor of Geology at the University of Canterbury) at jim.cole@canterbury.ac.nz; and Brad Scott (Volcano Surveillance Coordinator at GNS Science) at b.scott@gns.cri.nz.

B.4. Questionnaire Results

Questions 1 and 2 have been excluded to preserve respondent's anonymity.

Table B.1: Question 3 – How many staff members are employed at your organisation?

	Count	**Percentage**
<10	4	25
11 – 20	2	13
21 – 30	3	19
31 – 40	1	6
41 – 50	1	6
51+	5	31
TOTAL	**16**	**100**

Table B.2: Question 4 – How long have you worked at your organisation?

	Count	**Percentage**
<1 year	0	0
1 – 5 years	4	25
6 – 10 years	6	38
11 – 15 years	1	6
16 – 20 years	0	0
21+	5	31
TOTAL	**16**	**100**

Table B.3: Question 5 – How many volcanoes are under surveillance by your organisation?

	Count	**Percentage**
None	0	0
<5	4	29
6 – 10	9	64
11 – 15	1	7
16 – 20	0	0
21+	0	0

TOTAL	**14**	**100**

Table B.4: Question 6 – What types of volcanoes are under surveillance by your organisation?

	Count
Fissure vents	6
Lava domes	6
Cinder cones	9
Shield volcanoes	5
Subglacial volcanoes	0
Stratovolcanoes	12
Volcanic fields	7
Calderas	10
Other	0
TOTAL	**55**

Table B.5: Question 7 – Which of the following surveillance equipment does your organisation have deployed at volcanoes?

	Count
Seismic stations	13
GPS stations	11
Gravity stations	4
Ground based gas monitoring stations	9
Tiltmeters	9
Electronic distance measurement stations	5
Remote cameras	10
Communications equipment	10
Temporary equipment	9
Data storage centres	6
Other	14
TOTAL	**114**

Other responses:

- Magnetometers (2 responses)
- Thermometers (3 responses)
- Self-potential meters
- Gas collectors
- Short level line
- DOAS (mobile, scan)
- Magnetic equipment
- Electromagnetic equipment
- Infra-red camera
- Portable gas monitoring stations

Table B.6: Question 8 – Approximately how many of the following surveillance equipment does your organisation currently have deployed at volcanoes?

	Percentage				
	1 – 5	**6 – 10**	**11 – 15**	**16 – 20**	**21+**
Seismic stations	17	8	17	33	25
GPS stations	40	30	0	0	30
Gravity stations	100	0	0	0	0
Ground based gas monitoring stations	63	25	0	0	13
Tiltmeters	63	13	0	13	13
Electronic distance measurement stations	25	50	0	25	0
Remote cameras	75	25	0	0	0
Communications equipment	25	13	0	38	25
Temporary equipment	43	29	0	29	0
Data storage centres	60	0	0	40	0
Other equipment	86	14	0	0	0

Table B.7: Question 9 – From your experience what is the most damaging volcanic hazard to your organisation's surveillance equipment?

	Count	Percentage
Gas	3	23
Ash	5	38
Ballistics	4	31
Acid Rain	0	0
Earthquakes	0	0
Other	1	8
TOTAL	**13**	**100**

Other responses:

No comment provided.

Table B.8: Question 10 – Does your organisation take extra effort to protect some or all of the volcanic surveillance equipment it operates?

	Count	Percentage
Yes	10	77
No	3	23
TOTAL	**13**	**100**

Table B.9: Question 11 – Which of the following surveillance equipment does your organisation protect from the volcanic environment?

	Count
Seismic stations	9
GPS stations	4
Gravity stations	2
Ground based gas monitoring stations	5
Tiltmeters	4
Electronic distance measurement stations	1
Remote cameras	6
Communications equipment	5
Temporary equipment	6

Data storage centres	0
Other equipment	4
TOTAL	**46**

Seismic stations

Table B.10: Question 12 – What materials are used to protect your organisation's seismic stations?

	Count
Wood	2
Stainless steel	3
Steel	2
Zinc	1
Copper	0
Roofing iron	2
Concrete	7
Perspex/Plexiglas/Acrylic	3
Glass	1
Electrical tape/Waterproof tape	4
Do not know	0
Other	2
TOTAL	**27**

Question 13 – Please provide and explanation of how there materials are used to protect seismic stations.

- A mesh cage with steel bars is built around the equipment (*translated from Spanish*).
- Electronics are placed in a sealed environment with desiccant (for water and SO_2); outer hardware is plastic or stainless steel to prevent corrosion.
- These materials are used for protection as boxes made of resistant materials to hard weather conditions (very low temperatures, constant rain, rapid changes of temperature, volcanic ash).
- We keep the seismic stations (seismometers) covered in the ground in a bin with a lid. We cover the batteries and the regulator etc., with tarpaulin, especially the portable or temporary stations.

- Extreme waterproofing slows down corrosive effects of acid gases.
- Electronic equipment for telemetrics is placed inside boxes.

Table B.11: Question 14 – Have any of your organisation's seismic stations sustained damage from volcanic hazards while protected?

	Count	**Percentage**
Yes	4	50
No	3	38
Do not know	1	13
TOTAL	**8**	**100**

Table B.12: Question 15 – What type(s) of damage has occurred to seismic stations?

	Count
Minor corrosion of outside of equipment not affecting functionality	2
Major corrosion of outside of equipment reducing functionality and life expectancy	2
Minor abrasion of outside of equipment not affecting functionality	1
Major abrasion of outside of equipment reducing functionality and life expectancy	1
Corrosion of components on circuit boards reducing functionality and life expectancy	3
Short circuits	2
Dents and/or holes from impacts	0
Acid etching of equipment	2
Clogged motors	1
Clogged air intakes	1
Totally destroyed	0
Do not know	0
Other	3
TOTAL	**18**

Other responses:

- Chopped cables by animals, stolen equipment, electric and sun overcharging
- Ash blocks the solar panels and thus no power is supplied to the sensors to operate
- Solar panels buried by ash

Table B.13: Question 16 – Which volcanic hazard(s) caused the damage to your organisation's seismic stations?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Minor corrosion of outside of equipment not affecting functionality	2	2	1	0	0	0
Major corrosion of outside of equipment reducing functionality and life expectancy	1	2	2	0	0	1 (*pyroclastic flow*)
Minor abrasion of outside of equipment not affecting functionality	1	0	0	0	0	0
Major abrasion of outside of equipment reducing functionality and life expectancy	1	1	0	0	0	0
Corrosion of components on circuit boards reducing functionality and life expectancy	1	1	2	0	1	0
Short circuits	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	1	2	2	0	0	0

Clogged motors	1	0	0	0	0	0
Clogged air intakes	0	1	1	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	2	0	0	0	0	0

Table B.14: Question 17 – Have any of your organisation's seismic stations stopped working due to the above damage?

	Count	**Percentage**
Yes	3	75
No	0	0
Do not know	1	25
TOTAL	**4**	**100**

Table B.15: Question 18 – On average, how often does your organisation have to repair seismic stations because they stopped working due to the above damage?

	Average
Weeks	1
Months	3
Years	5

Table B.16: Question 19 – On average, how often does your organisation have to replace seismic stations because they stopped working due to the above damage?

	Average
Weeks	-
Months	3
Years	4

Table B.17: Question 20 – Have any of the materials your organisation uses to protect seismic stations sustained damage from volcanic hazards?

	Count	**Percentage**
Yes	3	50
No	2	33

Do not know	1	17
TOTAL	**6**	**100**

Table B.18: Question 21 – What type(s) of damage occurred to these materials?

	Count
Corrosion of metals causing structural failure	1
Corrosion of metals forming holes	2
Abrasion of metals causing structural failure	1
Abrasion of metals forming holes	1
Dents and/or holes from impacts	0
Acid etching of equipment	2
Totally destroyed	1
Do not know	1
Other	1
TOTAL	**10**

Other responses:

- Corrosion from gases

Table B.19: Question 22 – Which volcanic hazard(s) caused the damage to the materials protecting your organisation's seismic stations?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Corrosion of metals causing structural failure	1	1	1	0	0	0
Corrosion of metals forming holes	0	2	2	0	0	0
Abrasion of metals causing structural failure	1	0	0	0	0	1 (*pyroclastic flow)*
Abrasion of metals	1	1	0	0	0	1

forming holes						(*pyroclastic flow)*
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	2	1	0	0	0
Totally destroyed	0	0	0	0	0	1 (*pyroclastic flow)*
Other damage	0	1	1	0	0	0

Table B.20: Question 23 – On average, how often does your organisation have to replace the materials that protect seismic stations because they sustained damage from volcanic hazards?

	Average
Weeks	-
Months	3
Years	3

Table B.21: Question 24 – Does your organisation change its protection method(s) and/or protection materials for seismic stations at different locations/conditions around a volcano?

	Count	**Percentage**
Yes	5	83
No	0	0
Do not know	1	17
TOTAL	**6**	**100**

Comments regarding changing protections methods:

- We have not changed.
- There have been several changes in the materials mentioned before due to specific conditions of station and the volcano. E.g. aluminium boxes changed for concrete structures, iron boxes changed for aluminium boxes.
- The technicians regularly go around the volcanoes to check the stations and because there is shortage of staff the volcanoes cannot be checked every month but at least all of them

are checked once each year, especially in the remote areas. So different volcanoes have different seismic stations, some are permanent stations and some are temporary. So the permanent ones would be more protected as they have a roof over them while the temporary ones have tarpaulin over them. The tarpaulin must be checked if it's ok, or needs to be changed.

- More protection for stations close to gas emission sources.
- It depends basically on available budget and materials.

Table B.22: Question 25 – Please rate the overall effectiveness of the protection methods and materials used by your organisation to protect seismic stations from the following hazards.

	Percentage				
	Very effective	**Effective**	**Somewhat effective**	**Ineffective**	**Not Applicable**
Ballistic impacts	20	0	20	0	60
Loading from ashfall	20	40	20	0	20
Abrasion from ash	25	25	25	0	25
Gas infiltration	60	20	20	0	0
Acid rain infiltration	17	50	17	0	17

Comments regarding seismic stations:

- Use materials resistant to corrosive gases, such as paints and materials that will not rust. Place equipment in safe with easy access (*translated from Spanish*).

GPS Stations

Table B.23: Question 26 – What materials are used to protect your organisation's GPS stations?

	Count
Wood	0
Stainless steel	2
Steel	0
Zinc	0
Copper	0

Roofing iron	0
Concrete	2
Perspex/Plexiglas/Acrylic	2
Glass	1
Electrical tape/Waterproof tape	0
Do not know	0
Other	0
TOTAL	**7**

Question 27 – Please provide and explanation of how there materials are used to protect GPS stations.

- Electronics are placed in a sealed environment with desiccant (for water and SO2), outer hardware is plastic or stainless steel to prevent corrosion.
- Same as seismic.

Table B.24: Question 28 – Have any of your organisation's GPS stations sustained damage from volcanic hazards while protected?

	Count	**Percentage**
Yes	1	50
No	1	50
Do not know	0	0
TOTAL	**2**	**100**

Table B.25: Question 29 – What type(s) of damage has occurred to GPS stations?

	Count
Minor corrosion of outside of equipment not affecting functionality	1
Major corrosion of outside of equipment reducing functionality and life expectancy	0
Minor abrasion of outside of equipment not affecting functionality	0
Major abrasion of outside of equipment reducing functionality and life expectancy	0
Corrosion of components on circuit boards reducing functionality	0

and life expectancy	
Short circuits	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Clogged motors	0
Clogged air intakes	0
Totally destroyed	0
Do not know	0
Other	0
TOTAL	**1**

Table B.26: Question 30 – Which volcanic hazard(s) caused the damage to your organisation's GPS stations?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Minor corrosion of outside of equipment not affecting functionality	0	0	1	0	0	0
Major corrosion of outside of equipment reducing functionality and life expectancy	0	0	0	0	0	0
Minor abrasion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major abrasion of outside of equipment reducing functionality and life expectancy	0	0	0	0	0	0
Corrosion of components on circuit boards reducing functionality	0	0	0	0	0	0

and life expectancy						
Short circuits	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	0	0	0	0	0
Clogged motors	0	0	0	0	0	0
Clogged air intakes	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.27: Question 31 – Have any of your organisation's GPS stations stopped working due to the above damage?

	Count	**Percentage**
Yes	0	0
No	1	100
Do not know	0	0
TOTAL	**1**	**100**

Table B.28: Question 32 – On average, how often does your organisation have to repair GPS stations because they stopped working due to the above damage?

	Average
Weeks	-
Months	-
Years	10

Table B.29: Question 33 – On average, how often does your organisation have to replace GPS stations because they stopped working due to the above damage?

	Average
Weeks	-
Months	-
Years	10

Table B.30: Question 34 – Have any of the materials your organisation uses to protect GPS stations sustained damage from volcanic hazards?

	Count	Percentage
Yes	1	50
No	1	50
Do not know	0	0
TOTAL	**2**	**100**

Table B.31: Question 35 – What type(s) of damage occurred to these materials?

	Count
Corrosion of metals causing structural failure	0
Corrosion of metals forming holes	1
Abrasion of metals causing structural failure	0
Abrasion of metals forming holes	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Totally destroyed	0
Do not know	0
Other	0
TOTAL	**1**

Table B.32: Question 36 – Which volcanic hazard(s) caused the damage to the materials protecting your organisation's GPS stations?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Corrosion of metals causing structural failure	0	0	0	0	0	0
Corrosion of metals forming holes	0	1	0	0	0	0
Abrasion of metals causing structural failure	0	0	0	0	0	

Abrasion of metals forming holes	0	0	0	0	0	
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.33: Question 37 – On average, how often does your organisation have to replace the materials that protect GPS stations because they sustained damage from volcanic hazards?

	Average
Weeks	-
Months	-
Years	1

Table B.34: Question 38 – Does your organisation change its protection method(s) and/or protection materials for GPS stations at different locations/conditions around a volcano?

	Count	**Percentage**
Yes	1	50
No	1	50
Do not know	0	0
TOTAL	**2**	**100**

Comments regarding changing protections methods:

- Seal all electronics in double-boxes (i.e. pelican case within a pelican case) in areas especially prone to gas emissions.

Table B.35: Question 39 – Please rate the overall effectiveness of the protection methods and materials used by your organisation to protect GPS stations from the following hazards.

	Percentage				
	Very effective	**Effective**	**Somewhat effective**	**Ineffective**	**Not Applicable**
Ballistic impacts	0	0	0	0	100
Loading from ashfall	0	0	0	0	100
Abrasion from ash	0	0	0	0	100
Gas infiltration	50	50	0	0	0
Acid rain infiltration	50	50	0	0	0

Comments regarding GPS stations:

- Damage has only been as issue at one station of the 60 we operate, since that one stations is often in a gas plume.

Gravity Stations

Table B.36: Question 40 – What materials are used to protect your organisation's gravity stations?

	Count
Wood	1
Stainless steel	2
Steel	0
Zinc	0
Copper	0
Roofing iron	0
Concrete	1
Perspex/Plexiglas/Acrylic	1
Glass	0
Electrical tape/Waterproof tape	0
Do not know	0
Other	0
TOTAL	**5**

Question 41 – Please provide and explanation of how there materials are used to protect gravity stations.

- Meter is sealed in a Styrofoam box and protected from the weather by an A-frame 'doghouse' built over the top of the system.
- Same as seismic.

Table B.37: Question 42 – Have any of your organisation's gravity stations sustained damage from volcanic hazards while protected?

	Count	**Percentage**
Yes	0	0
No	2	100
Do not know	0	0
TOTAL	**2**	**100**

Table B.38: Question 43 – What type(s) of damage has occurred to gravity stations?

	Count
Minor corrosion of outside of equipment not affecting functionality	0
Major corrosion of outside of equipment reducing functionality and life expectancy	0
Minor abrasion of outside of equipment not affecting functionality	0
Major abrasion of outside of equipment reducing functionality and life expectancy	0
Corrosion of components on circuit boards reducing functionality and life expectancy	0
Short circuits	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Clogged motors	0
Clogged air intakes	0
Totally destroyed	0
Do not know	0

Other	0
TOTAL	**0**

Table B.39: Question 44 – Which volcanic hazard(s) caused the damage to your organisation's gravity stations?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Minor corrosion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major corrosion of outside of equipment reducing functionality and life expectancy	0	0	0	0	0	0
Minor abrasion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major abrasion of outside of equipment reducing functionality and life expectancy	0	0	0	0	0	0
Corrosion of components on circuit boards reducing functionality and life expectancy	0	0	0	0	0	0
Short circuits	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	0	0	0	0	0
Clogged motors	0	0	0	0	0	0
Clogged air intakes	0	0	0	0	0	0

Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.40: Question 45 – Have any of your organisation's gravity stations stopped working due to the above damage?

	Count	**Percentage**
Yes	0	0
No	0	0
Do not know	0	0
TOTAL	**0**	**0**

Table B.41: Question 46 – On average, how often does your organisation have to repair gravity stations because they stopped working due to the above damage?

	Average
Weeks	-
Months	-
Years	-

Table B.42: Question 47 – On average, how often does your organisation have to replace gravity stations because they stopped working due to the above damage?

	Average
Weeks	-
Months	-
Years	-

Table B.43: Question 48 – Have any of the materials your organisation uses to protect gravity stations sustained damage from volcanic hazards?

	Count	**Percentage**
Yes	0	0
No	2	100
Do not know	0	0
TOTAL	**2**	**100**

Table B.44: Question 49 – What type(s) of damage occurred to these materials?

	Count
Corrosion of metals causing structural failure	0
Corrosion of metals forming holes	0
Abrasion of metals causing structural failure	0
Abrasion of metals forming holes	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Totally destroyed	0
Do not know	0
Other	0
TOTAL	**0**

Table B.45: Question 50 – Which volcanic hazard(s) caused the damage to the materials protecting your organisation's gravity stations?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Corrosion of metals causing structural failure	0	0	0	0	0	0
Corrosion of metals forming holes	0	0	0	0	0	0
Abrasion of metals causing structural failure	0	0	0	0	0	0
Abrasion of metals forming holes	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.46: Question 51 – On average, how often does your organisation have to replace the materials that protect gravity stations because they sustained damage from volcanic hazards?

	Average
Weeks	-
Months	-
Years	-

Table B.47: Question 52 – Does your organisation change its protection method(s) and/or protection materials for gravity stations at different locations/conditions around a volcano?

	Count	**Percentage**
Yes	0	0
No	2	100
Do not know	0	0
TOTAL	**2**	**100**

Table B.48: Question 53 – Please rate the overall effectiveness of the protection methods and materials used by your organisation to protect gravity stations from the following hazards.

	Percentage				
	Very effective	**Effective**	**Somewhat effective**	**Ineffective**	**Not Applicable**
Ballistic impacts	100	0	0	0	0
Loading from ashfall	0	0	0	0	100
Abrasion from ash	0	0	0	0	100
Gas infiltration	50	50	0	0	0
Acid rain infiltration	50	50	0	0	0

Ground Based Gas Monitoring Stations

Table B.49: Question 54 – What materials are used to protect your organisation's ground based gas monitoring stations?

	Count
Wood	0
Stainless steel	2
Steel	0
Zinc	0
Copper	0
Roofing iron	1
Concrete	1
Perspex/Plexiglas/Acrylic	2
Glass	1
Electrical tape/Waterproof tape	1
Do not know	0
Other	0
TOTAL	**8**

Question 55 – Please provide and explanation of how there materials are used to protect ground based gas monitoring stations.

- The same was as with seismic.

Table B.50: Question 56 – Have any of your organisation's ground based gas monitoring stations sustained damage from volcanic hazards while protected?

	Count	**Percentage**
Yes	0	0
No	2	67
Do not know	1	33
TOTAL	**3**	**100**

Table B.51: Question 57 – What type(s) of damage has occurred to ground based gas monitoring stations?

	Count
Minor corrosion of outside of equipment not affecting functionality	0
Major corrosion of outside of equipment reducing functionality and life expectancy	0
Minor abrasion of outside of equipment not affecting functionality	0
Major abrasion of outside of equipment reducing functionality and life expectancy	0
Corrosion of components on circuit boards reducing functionality and life expectancy	0
Short circuits	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Clogged motors	0
Clogged air intakes	0
Totally destroyed	0
Do not know	0
Other	0
TOTAL	**0**

Table B.52: Question 58 – Which volcanic hazard(s) caused the damage to your organisation's ground based gas monitoring stations?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Minor corrosion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major corrosion of outside of equipment reducing functionality and life expectancy	0	0	0	0	0	0

Minor abrasion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major abrasion of outside of equipment reducing functionality and life expectancy	0	0	0	0	0	0
Corrosion of components on circuit boards reducing functionality and life expectancy	0	0	0	0	0	0
Short circuits	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	0	0	0	0	0
Clogged motors	0	0	0	0	0	0
Clogged air intakes	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.53: Question 59 – Have any of your organisation's ground based gas monitoring stations stopped working due to the above damage?

	Count	**Percentage**
Yes	0	0
No	0	0
Do not know	0	0
TOTAL	**0**	**0**

Table B.54: Question 60 – On average, how often does your organisation have to repair ground based gas monitoring stations because they stopped working due to the above damage?

	Average
Weeks	-
Months	-
Years	-

Table B.55: Question 61 – On average, how often does your organisation have to replace ground based gas monitoring stations because they stopped working due to the above damage?

	Average
Weeks	-
Months	-
Years	-

Table B.56: Question 62 – Have any of the materials your organisation uses to protect ground based gas monitoring stations sustained damage from volcanic hazards?

	Count	**Percentage**
Yes	0	0
No	2	67
Do not know	1	33
TOTAL	**3**	**100**

Table B.57: Question 63 – What type(s) of damage occurred to these materials?

	Count
Corrosion of metals causing structural failure	0
Corrosion of metals forming holes	0
Abrasion of metals causing structural failure	0
Abrasion of metals forming holes	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Totally destroyed	0
Do not know	0

Other	0
TOTAL	**0**

Table B.58: Question 64 – Which volcanic hazard(s) caused the damage to the materials protecting your organisation's ground based gas monitoring stations?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Corrosion of metals causing structural failure	0	0	0	0	0	0
Corrosion of metals forming holes	0	0	0	0	0	0
Abrasion of metals causing structural failure	0	0	0	0	0	0
Abrasion of metals forming holes	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.59: Question 65 – On average, how often does your organisation have to replace the materials that protect ground based gas monitoring stations because they sustained damage from volcanic hazards?

	Average
Weeks	-
Months	-
Years	-

Table B.60: Question 66 – Does your organisation change its protection method(s) and/or protection materials for ground based gas monitoring stations at different locations/conditions around a volcano?

	Count	Percentage
Yes	0	0
No	2	67
Do not know	1	33
TOTAL	**3**	**100**

Table B.61: Question 67 – Please rate the overall effectiveness of the protection methods and materials used by your organisation to protect ground based gas monitoring stations from the following hazards.

	Percentage				
	Very effective	**Effective**	**Somewhat effective**	**Ineffective**	**Not Applicable**
Ballistic impacts	0	0	0	0	100
Loading from ashfall	0	0	0	0	100
Abrasion from ash	0	0	0	0	100
Gas infiltration	0	67	0	0	33
Acid rain infiltration	0	67	0	0	33

Tiltmeters

Table B.62: Question 68 – What materials are used to protect your organisation's tiltmeters?

	Count
Wood	0
Stainless steel	2
Steel	0
Zinc	0
Copper	0
Roofing iron	1
Concrete	2
Perspex/Plexiglas/Acrylic	2
Glass	1

Electrical tape/Waterproof tape	1
Do not know	0
Other	0
TOTAL	**9**

Question 69 – Please provide and explanation of how there materials are used to protect tiltmeters.

- The same way as seismic stations and tiltmeters.
- Same.

Table B.63: Question 70 – Have any of your organisation's tiltmeters sustained damage from volcanic hazards while protected?

	Count	**Percentage**
Yes	0	0
No	3	100
Do not know	0	0
TOTAL	**3**	**100**

Table B.64: Question 71 – What type(s) of damage has occurred to tiltmeters?

	Count
Minor corrosion of outside of equipment not affecting functionality	0
Major corrosion of outside of equipment reducing functionality and life expectancy	0
Minor abrasion of outside of equipment not affecting functionality	0
Major abrasion of outside of equipment reducing functionality and life expectancy	0
Corrosion of components on circuit boards reducing functionality and life expectancy	0
Short circuits	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Clogged motors	0

Clogged air intakes	0
Totally destroyed	0
Do not know	0
Other	0
TOTAL	**0**

Table B.65: Question 72 – Which volcanic hazard(s) caused the damage to your organisation's tiltmeters?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Minor corrosion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major corrosion of outside of equipment reducing functionality and life expectancy	0	0	0	0	0	0
Minor abrasion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major abrasion of outside of equipment reducing functionality and life expectancy	0	0	0	0	0	0
Corrosion of components on circuit boards reducing functionality and life expectancy	0	0	0	0	0	0
Short circuits	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of	0	0	0	0	0	0

equipment						
Clogged motors	0	0	0	0	0	0
Clogged air intakes	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.66: Question 73 – Have any of your organisation's tiltmeters stopped working due to the above damage?

	Count	**Percentage**
Yes	0	0
No	0	0
Do not know	0	0
TOTAL	**0**	**0**

Table B.67: Question 74 – On average, how often does your organisation have to repair tiltmeters because they stopped working due to the above damage?

	Average
Weeks	-
Months	-
Years	-

Table B.68: Question 75 – On average, how often does your organisation have to replace tiltmeters because they stopped working due to the above damage?

	Average
Weeks	-
Months	-
Years	-

Table B.69: Question 76 – Have any of the materials your organisation uses to protect tiltmeters sustained damage from volcanic hazards?

	Count	**Percentage**
Yes	0	0
No	3	100

Do not know	0	0
TOTAL	**3**	**100**

Table B.70: Question 77 – What type(s) of damage occurred to these materials?

•

	Count
Corrosion of metals causing structural failure	0
Corrosion of metals forming holes	0
Abrasion of metals causing structural failure	0
Abrasion of metals forming holes	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Totally destroyed	0
Do not know	0
Other	0
TOTAL	**0**

Table B.71: Question 78 – Which volcanic hazard(s) caused the damage to the materials protecting your organisation's tiltmeters?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Corrosion of metals causing structural failure	0	0	0	0	0	0
Corrosion of metals forming holes	0	0	0	0	0	0
Abrasion of metals causing structural failure	0	0	0	0	0	0
Abrasion of metals forming holes	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0

Acid etching of equipment	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.72: Question 79 – On average, how often does your organisation have to replace the materials that protect tiltmeters because they sustained damage from volcanic hazards?

	Average
Weeks	-
Months	-
Years	-

Table B.73: Question 80 – Does your organisation change its protection method(s) and/or protection materials for tiltmeters at different locations/conditions around a volcano?

	Count	**Percentage**
Yes	0	0
No	3	100
Do not know	0	0
TOTAL	**3**	**100**

Table B.74: Question 81 – Please rate the overall effectiveness of the protection methods and materials used by your organisation to protect tiltmeters from the following hazards.

	Percentage				
	Very effective	**Effective**	**Somewhat effective**	**Ineffective**	**Not Applicable**
Ballistic impacts	0	0	0	0	100
Loading from ashfall	0	0	0	0	100
Abrasion from ash	0	0	0	0	100
Gas infiltration	67	33	0	0	0
Acid rain infiltration	33	33	0	0	33

Electronic Distance Measurement Stations

Table B.75: Question 82 – What materials are used to protect your organisation's electronic distance measurement stations?

	Count
Wood	0
Stainless steel	0
Steel	0
Zinc	0
Copper	0
Roofing iron	0
Concrete	0
Perspex/Plexiglas/Acrylic	0
Glass	0
Electrical tape/Waterproof tape	0
Do not know	0
Other	0
TOTAL	**0**

Question 83 – Please provide and explanation of how there materials are used to protect electronic distance measurement stations.

There were no responses for this question.

Table B.76: Question 84 – Have any of your organisation's electronic distance measurement stations sustained damage from volcanic hazards while protected?

	Count	Percentage
Yes	0	0
No	0	0
Do not know	0	0
TOTAL	**0**	**0**

Table B.77: Question 85 – What type(s) of damage has occurred to electronic distance measurement stations?

	Count
Minor corrosion of outside of equipment not affecting functionality	0
Major corrosion of outside of equipment reducing functionality and life expectancy	0
Minor abrasion of outside of equipment not affecting functionality	0
Major abrasion of outside of equipment reducing functionality and life expectancy	0
Corrosion of components on circuit boards reducing functionality and life expectancy	0
Short circuits	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Clogged motors	0
Clogged air intakes	0
Totally destroyed	0
Do not know	0
Other	0
TOTAL	**0**

Table B.78: Question 86 – Which volcanic hazard(s) caused the damage to your organisation's electronic distance measurement stations?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Minor corrosion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major corrosion of outside of equipment reducing functionality and life expectancy	0	0	0	0	0	0

Minor abrasion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major abrasion of outside of equipment reducing functionality and life expectancy	0	0	0	0	0	0
Corrosion of components on circuit boards reducing functionality and life expectancy	0	0	0	0	0	0
Short circuits	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	0	0	0	0	0
Clogged motors	0	0	0	0	0	0
Clogged air intakes	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.79: Question 87 – Have any of your organisation's electronic distance measurement stations stopped working due to the above damage?

	Count	**Percentage**
Yes	0	0
No	0	0
Do not know	0	0
TOTAL	**0**	**0**

Table B.80: Question 88 – On average, how often does your organisation have to repair electronic distance measurement stations because they stopped working due to the above damage?

	Average
Weeks	-
Months	-
Years	-

Table B.81: Question 89 – On average, how often does your organisation have to replace electronic distance measurement stations because they stopped working due to the above damage?

	Average
Weeks	-
Months	-
Years	-

Table B.82: Question 90 – Have any of the materials your organisation uses to protect electronic distance measurement stations sustained damage from volcanic hazards?

	Count	Percentage
Yes	0	0
No	0	0
Do not know	0	0
TOTAL	**0**	**0**

Table B.83: Question 91 – What type(s) of damage occurred to these materials?

	Count
Corrosion of metals causing structural failure	0
Corrosion of metals forming holes	0
Abrasion of metals causing structural failure	0
Abrasion of metals forming holes	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Totally destroyed	0
Do not know	0

Other	0
TOTAL	**0**

Table B.84: Question 92 –Which volcanic hazard(s) caused the damage to the materials protecting your organisation's electronic distance measurement stations?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Corrosion of metals causing structural failure	0	0	0	0	0	0
Corrosion of metals forming holes	0	0	0	0	0	0
Abrasion of metals causing structural failure	0	0	0	0	0	0
Abrasion of metals forming holes	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.85: Question 93 – On average, how often does your organisation have to replace the materials that protect electronic distance measurement stations because they sustained damage from volcanic hazards?

	Average
Weeks	-
Months	-
Years	-

Table B.86: Question 94 – Does your organisation change its protection method(s) and/or protection materials for electronic distance measurement stations at different locations/conditions around a volcano?

	Count	Percentage
Yes	0	0
No	0	0
Do not know	0	0
TOTAL	**0**	**0**

Table B.87: Question 95 – Please rate the overall effectiveness of the protection methods and materials used by your organisation to protect electronic distance measurement stations from the following hazards.

	Percentage				
	Very effective	**Effective**	**Somewhat effective**	**Ineffective**	**Not Applicable**
Ballistic impacts	0	0	0	0	0
Loading from ashfall	0	0	0	0	0
Abrasion from ash	0	0	0	0	0
Gas infiltration	0	0	0	0	0
Acid rain infiltration	0	0	0	0	0

Remote Cameras

Table B.88: Question 96 – What materials are used to protect your organisation's remote cameras?

	Count
Wood	1
Stainless steel	1
Steel	0
Zinc	0
Copper	0
Roofing iron	0
Concrete	0
Perspex/Plexiglas/Acrylic	2
Glass	2

Electrical tape/Waterproof tape	1
Do not know	0
Other	3
TOTAL	**10**

Other responses:

- The cameras have factory protection (*translated from Spanish*).
- Installed inside the observatory.
- Aluminium.

Question 97 – Please provide and explanation of how there materials are used to protect remote cameras.

- Attached to the cover.
- Metallic parts are provided by the equipment manufacture, glass and acrylic are used for housing window.
- Same.

Table B.89: Question 98 – Have any of your organisation's remote cameras sustained damage from volcanic hazards while protected?

	Count	**Percentage**
Yes	1	20
No	3	60
Do not know	1	20
TOTAL	**5**	**100**

Table B.90: Question 99 – What type(s) of damage has occurred to remote cameras?

	Count
Minor corrosion of outside of equipment not affecting functionality	0
Major corrosion of outside of equipment reducing functionality and life expectancy	0
Minor abrasion of outside of equipment not affecting functionality	0
Major abrasion of outside of equipment reducing functionality and	0

life expectancy	
Corrosion of components on circuit boards reducing functionality and life expectancy	0
Short circuits	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Clogged motors	0
Clogged air intakes	0
Totally destroyed	0
Do not know	0
Other	1
TOTAL	**1**

Other responses:

- Water leaks.

Table B.91: Question 100 – Which volcanic hazard(s) caused the damage to your organisation's remote cameras?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Minor corrosion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major corrosion of outside of equipment reducing functionality and life expectancy	0	0	0	0	0	0
Minor abrasion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major abrasion of outside	0	0	0	0	0	0

of equipment reducing functionality and life expectancy						
Corrosion of components on circuit boards reducing functionality and life expectancy	0	0	0	0	0	0
Short circuits	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	0	0	0	0	0
Clogged motors	0	0	0	0	0	0
Clogged air intakes	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	1	1	0	0	0

Table B.92: Question 101 – Have any of your organisation's remote cameras stopped working due to the above damage?

	Count	**Percentage**
Yes	1	100
No	0	0
Do not know	0	0
TOTAL	**1**	**100**

Table B.93: Question 102 – On average, how often does your organisation have to repair remote cameras because they stopped working due to the above damage?

	Average
Weeks	-
Months	-
Years	1

Table B.94: Question 103 – On average, how often does your organisation have to replace remote cameras because they stopped working due to the above damage?

	Average
Weeks	-
Months	-
Years	1

Table B.95: Question 104 – Have any of the materials your organisation uses to protect remote cameras sustained damage from volcanic hazards?

	Count	**Percentage**
Yes	0	0
No	4	80
Do not know	1	20
TOTAL	**5**	**100**

Table B.96: Question 105 – What type(s) of damage occurred to these materials?

	Count
Corrosion of metals causing structural failure	0
Corrosion of metals forming holes	0
Abrasion of metals causing structural failure	0
Abrasion of metals forming holes	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Totally destroyed	0
Do not know	0
Other	0
TOTAL	**0**

Table B.97: Question 106 – Which volcanic hazard(s) caused the damage to the materials protecting your organisation's remote cameras?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Corrosion of metals causing structural failure	0	0	0	0	0	0
Corrosion of metals forming holes	0	0	0	0	0	0
Abrasion of metals causing structural failure	0	0	0	0	0	0
Abrasion of metals forming holes	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.98: Question 107 – On average, how often does your organisation have to replace the materials that protect remote cameras because they sustained damage from volcanic hazards?

	Average
Weeks	-
Months	-
Years	-

Table B.99: Question 108 – Does your organisation change its protection method(s) and/or protection materials for remote cameras at different locations/conditions around a volcano?

	Count	**Percentage**
Yes	1	20
No	3	60
Do not know	1	20

TOTAL	**5**	**100**

Comments regarding changing protections methods:

- Cameras that are likely to be in gas plume at least once in a while are better sealed against gas infiltration.

Table B.100: Question 109 – Please rate the overall effectiveness of the protection methods and materials used by your organisation to protect remote cameras from the following hazards.

	Percentage				
	Very effective	**Effective**	**Somewhat effective**	**Ineffective**	**Not Applicable**
Ballistic impacts	0	0	0	0	100
Loading from ashfall	0	0	0	0	100
Abrasion from ash	0	0	0	0	100
Gas infiltration	25	25	0	0	50
Acid rain infiltration	25	25	0	0	50

Comments regarding remote cameras:

- The cameras are protected from storms and have had no problems (*translated from Spanish*).
- We are not using remote cameras to permanently monitor volcanoes; instead we take regular shots and video footage of volcanic activity.

Communication Equipment

Question 110 – Please list all the communication equipment that your organisation uses for volcanic surveillance.

- Radios and antennas (2 responses).
- WiFi, 450 MHz, 900 MHz and 2.4GHz radios, serial and ethernet bridges.
- Yagui antennas (400 and 900 MHz), analog radios monitron, eentec radio, freewave radio, neulink radio, mhx 910 radio.
- Seismic sensors, telemetry, VSAT.

- WiFi, ethernet bridge, transitioning from analog FM

Table B.101: Question 111 – What materials are used to protect your organisation's communication equipment?

	Count
Wood	1
Stainless steel	1
Steel	0
Zinc	0
Copper	0
Roofing iron	1
Concrete	0
Perspex/Plexiglas/Acrylic	1
Glass	0
Electrical tape/Waterproof tape	0
Do not know	0
Other	1
TOTAL	**5**

Other responses:

- Aluminium.

Question 112 – Please provide and explanation of how there materials are used to protect communication equipment.

- The same ways in seismic stations and others.
- Radios are protected with instrument electronics is same or similar enclosures.

Table B.102: Question 113 – Have any of your organisation's communication equipment sustained damage from volcanic hazards while protected?

	Count	**Percentage**
Yes	0	0
No	2	67

Do not know	1	33
TOTAL	**3**	**100**

Table B.103: Question 114 – What type(s) of damage has occurred to communication equipment?

	Count
Minor corrosion of outside of equipment not affecting functionality	0
Major corrosion of outside of equipment reducing functionality and life expectancy	0
Minor abrasion of outside of equipment not affecting functionality	0
Major abrasion of outside of equipment reducing functionality and life expectancy	0
Corrosion of components on circuit boards reducing functionality and life expectancy	0
Short circuits	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Clogged motors	0
Clogged air intakes	0
Totally destroyed	0
Do not know	0
Other	0
TOTAL	**0**

Table B.104: Question 115 – Which volcanic hazard(s) caused the damage to your organisation's communication equipment?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Minor corrosion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major corrosion of	0	0	0	0	0	0

outside of equipment reducing functionality and life expectancy						
Minor abrasion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major abrasion of outside of equipment reducing functionality and life expectancy	0	0	0	0	0	0
Corrosion of components on circuit boards reducing functionality and life expectancy	0	0	0	0	0	0
Short circuits	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	0	0	0	0	0
Clogged motors	0	0	0	0	0	0
Clogged air intakes	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.105: Question 116 – Have any of your organisation's communication equipment stopped working due to the above damage?

	Count	**Percentage**
Yes	0	0
No	0	0
Do not know	0	0
TOTAL	**0**	**0**

Table B.106: Question 117 – On average, how often does your organisation have to repair communication equipment because they stopped working due to the above damage?

	Average
Weeks	-
Months	-
Years	-

Table B.107: Question 118 – On average, how often does your organisation have to replace communication equipment because they stopped working due to the above damage?

	Average
Weeks	-
Months	-
Years	-

Table B.108: Question 119 – Have any of the materials your organisation uses to protect communication equipment sustained damage from volcanic hazards?

	Count	Percentage
Yes	0	0
No	2	67
Do not know	1	33
TOTAL	**3**	**100**

Table B.109: Question 120 – What type(s) of damage occurred to these materials?

	Count
Corrosion of metals causing structural failure	0
Corrosion of metals forming holes	0
Abrasion of metals causing structural failure	0
Abrasion of metals forming holes	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Totally destroyed	0
Do not know	0

Other	0
TOTAL	**0**

Table B.110: Question 121 – Which volcanic hazard(s) caused the damage to the materials protecting your organisation's communication equipment?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Corrosion of metals causing structural failure	0	0	0	0	0	0
Corrosion of metals forming holes	0	0	0	0	0	0
Abrasion of metals causing structural failure	0	0	0	0	0	0
Abrasion of metals forming holes	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.111: Question 122 – On average, how often does your organisation have to replace the materials that protect communication equipment because they sustained damage from volcanic hazards?

	Average
Weeks	-
Months	-
Years	-

Table B.112: Question 123 – Does your organisation change its protection method(s) and/or protection materials for communication equipment at different locations/conditions around a volcano?

	Count	Percentage
Yes	0	0
No	2	67
Do not know	1	33
TOTAL	**3**	**100**

Table B.113: Question 124 – Please rate the overall effectiveness of the protection methods and materials used by your organisation to protect communication equipment from the following hazards.

	Percentage				
	Very effective	**Effective**	**Somewhat effective**	**Ineffective**	**Not Applicable**
Ballistic impacts	0	0	0	0	100
Loading from ashfall	0	0	0	0	100
Abrasion from ash	0	0	0	0	100
Gas infiltration	33	33	0	0	33
Acid rain infiltration	33	33	0	0	33

Temporary Equipment

Question 125 – please list all the temporary equipment that your organisation uses for volcanic surveillance.

- Seismometers, GPS receivers, thermometers, pH meters, gas collectors, CO2/SO2 flux meters.
- Portable seismic stations, thermocouple, mobile DOAS, thermal imager camera (*translated from Spanish*).
- Portable seismometers, GPS receivers.
- Seismic stations.
- Portable seismometers.
- Time lapse cameras, GPS receivers.
- Seismic, gas measurement.

Table B.114: Question 126 – What materials are used to protect your organisation's temporary equipment?

	Count
Wood	2
Stainless steel	0
Steel	1
Zinc	0
Copper	0
Roofing iron	1
Concrete	0
Perspex/Plexiglas/Acrylic	0
Glass	0
Electrical tape/Waterproof tape	1
Do not know	0
Other	2
TOTAL	**7**

Other responses:

- Aluminium.

Question 127 – Please provide and explanation of how there materials are used to protect temporary equipment.

- Transport equipment (*translated from Spanish*).
- The same way as in seismic stations and others.
- If we need to build a stand for the batteries so that they do not get wet on the ground, we use wood. We cover the stations and batteries with tarpaulin.

Table B.115: Question 128 – Have any of your organisation's temporary equipment sustained damage from volcanic hazards while protected?

	Count	Percentage
Yes	1	25
No	3	75

Do not know	0	0
TOTAL	**4**	**100**

Table B.116: Question 129 – What type(s) of damage has occurred to temporary equipment?

	Count
Minor corrosion of outside of equipment not affecting functionality	0
Major corrosion of outside of equipment reducing functionality and life expectancy	0
Minor abrasion of outside of equipment not affecting functionality	0
Major abrasion of outside of equipment reducing functionality and life expectancy	0
Corrosion of components on circuit boards reducing functionality and life expectancy	0
Short circuits	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Clogged motors	0
Clogged air intakes	0
Totally destroyed	0
Do not know	1
Other	0
TOTAL	**1**

Table B.117: Question 130 – Which volcanic hazard(s) caused the damage to your organisation's temporary equipment?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Minor corrosion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major corrosion of	0	0	0	0	0	0

outside of equipment reducing functionality and life expectancy						
Minor abrasion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major abrasion of outside of equipment reducing functionality and life expectancy	0	0	0	0	0	0
Corrosion of components on circuit boards reducing functionality and life expectancy	0	0	0	0	0	0
Short circuits	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	0	0	0	0	0
Clogged motors	0	0	0	0	0	0
Clogged air intakes	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.118: Question 131 – Have any of your organisation's temporary equipment stopped working due to the above damage?

	Count	**Percentage**
Yes	0	0
No	0	0
Do not know	1	100
TOTAL	**1**	**100**

Table B.119: Question 132 – On average, how often does your organisation have to repair temporary equipment because they stopped working due to the above damage?

	Average
Weeks	-
Months	5
Years	-

Table B.120: Question 133 – On average, how often does your organisation have to replace temporary equipment because they stopped working due to the above damage?

	Average
Weeks	-
Months	5
Years	-

Table B.121: Question 134 – Have any of the materials your organisation uses to protect temporary equipment sustained damage from volcanic hazards?

	Count	Percentage
Yes	1	25
No	3	75
Do not know	0	0
TOTAL	**4**	**100**

Table B.122: Question 135 – What type(s) of damage occurred to these materials?

	Count
Corrosion of metals causing structural failure	0
Corrosion of metals forming holes	0
Abrasion of metals causing structural failure	0
Abrasion of metals forming holes	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Totally destroyed	0
Do not know	1

Other	0
TOTAL	**1**

Table B.123: Question 136 – Which volcanic hazard(s) caused the damage to the materials protecting your organisation's temporary equipment?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Corrosion of metals causing structural failure	0	0	0	0	0	0
Corrosion of metals forming holes	0	0	0	0	0	0
Abrasion of metals causing structural failure	0	0	0	0	0	0
Abrasion of metals forming holes	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.124: Question 137 – On average, how often does your organisation have to replace the materials that protect temporary equipment because they sustained damage from volcanic hazards?

	Average
Weeks	-
Months	5
Years	-

Table B.125: Question 138 – Does your organisation change its protection method(s) and/or protection materials for temporary equipment at different locations/conditions around a volcano?

	Count	Percentage
Yes	1	25
No	3	75
Do not know	0	0
TOTAL	**4**	**100**

Comments regarding changing protections methods:

- Please refer to similar previous question.

Table B.126: Question 139 – Please rate the overall effectiveness of the protection methods and materials used by your organisation to protect temporary equipment from the following hazards.

	Percentage				
	Very effective	**Effective**	**Somewhat effective**	**Ineffective**	**Not Applicable**
Ballistic impacts	0	50	0	0	50
Loading from ashfall	0	0	50	0	50
Abrasion from ash	0	50	0	0	50
Gas infiltration	0	75	0	0	25
Acid rain infiltration	0	75	0	0	25

Comments regarding temporary equipment:

- It is important to protect your computer to extend the life (*translated from Spanish*).

Data Storage Centres

Table B.127: Question 140 – What materials are used to protect your organisation's data storage centres?

	Count
Wood	0
Stainless steel	0
Steel	0

Zinc	0
Copper	0
Roofing iron	0
Concrete	0
Perspex/Plexiglas/Acrylic	0
Glass	0
Electrical tape/Waterproof tape	0
Do not know	0
Other	0
TOTAL	**0**

Question 141 – Please provide and explanation of how there materials are used to protect data storage centres.

Table B.128: Question 142 – Have any of your organisation's data storage centres sustained damage from volcanic hazards while protected?

	Count	**Percentage**
Yes	0	0
No	0	0
Do not know	0	0
TOTAL	**0**	**0**

Table B.129: Question 143 – What type(s) of damage has occurred to data storage centres?

	Count
Minor corrosion of outside of equipment not affecting functionality	0
Major corrosion of outside of equipment reducing functionality and life expectancy	0
Minor abrasion of outside of equipment not affecting functionality	0
Major abrasion of outside of equipment reducing functionality and life expectancy	0
Corrosion of components on circuit boards reducing functionality and life expectancy	0

Short circuits	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Clogged motors	0
Clogged air intakes	0
Totally destroyed	0
Do not know	0
Other	0
TOTAL	**0**

Table B.130: Question 144 – Which volcanic hazard(s) caused the damage to your organisation's data storage centres?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Minor corrosion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major corrosion of outside of equipment reducing functionality and life expectancy	0	0	0	0	0	0
Minor abrasion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major abrasion of outside of equipment reducing functionality and life expectancy	0	0	0	0	0	0
Corrosion of components on circuit boards reducing functionality	0	0	0	0	0	0

and life expectancy						
Short circuits	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	0	0	0	0	0
Clogged motors	0	0	0	0	0	0
Clogged air intakes	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.131: Question 145 – Have any of your organisation's data storage centres stopped working due to the above damage?

	Count	**Percentage**
Yes	0	0
No	0	0
Do not know	0	0
TOTAL	**0**	**0**

Table B.132: Question 146 – On average, how often does your organisation have to repair data storage centres because they stopped working due to the above damage?

	Average
Weeks	-
Months	-
Years	-

Table B.133: Question 147 – On average, how often does your organisation have to replace data storage centres because they stopped working due to the above damage?

	Average
Weeks	-
Months	-
Years	-

Table B.134: Question 148 – Have any of the materials your organisation uses to protect data storage centres sustained damage from volcanic hazards?

	Count	Percentage
Yes	0	0
No	0	0
Do not know	0	0
TOTAL	**0**	**0**

Table B.135: Question 149 – What type(s) of damage occurred to these materials?

	Count
Corrosion of metals causing structural failure	0
Corrosion of metals forming holes	0
Abrasion of metals causing structural failure	0
Abrasion of metals forming holes	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Totally destroyed	0
Do not know	0
Other	0
TOTAL	**0**

Table B.136: Question 150 – Which volcanic hazard(s) caused the damage to the materials protecting your organisation's data storage centres?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Corrosion of metals causing structural failure	0	0	0	0	0	0
Corrosion of metals forming holes	0	0	0	0	0	0
Abrasion of metals causing structural failure	0	0	0	0	0	0

Abrasion of metals forming holes	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.137: Question 151 – On average, how often does your organisation have to replace the materials that protect data storage centres because they sustained damage from volcanic hazards?

	Average
Weeks	-
Months	-
Years	-

Table B.138: Question 152 – Does your organisation change its protection method(s) and/or protection materials for data storage centres at different locations/conditions around a volcano?

	Count	**Percentage**
Yes	0	0
No	0	0
Do not know	0	0
TOTAL	**0**	**0**

Table B.139: Question 153 – Please rate the overall effectiveness of the protection methods and materials used by your organisation to protect data storage centres from the following hazards.

	Percentage				
	Very effective	**Effective**	**Somewhat effective**	**Ineffective**	**Not Applicable**
Ballistic impacts	0	0	0	0	0
Loading from ashfall	0	0	0	0	0
Abrasion from ash	0	0	0	0	0

Gas infiltration	0	0	0	0	0
Acid rain infiltration	0	0	0	0	0

Other Equipment

Table B.140: Question 154 – What materials are used to protect your organisation's other equipment?

	Count
Wood	0
Stainless steel	0
Steel	0
Zinc	0
Copper	0
Roofing iron	1
Concrete	0
Perspex/Plexiglas/Acrylic	0
Glass	0
Electrical tape/Waterproof tape	1
Do not know	0
Other	2
TOTAL	**4**

Other responses:

- Textile fibres.
- Aluminium.

Question 155 – Please provide and explanation of how there materials are used to protect other equipment.

- Cases for protection from weather.
- In aluminium boxes provided by manufacturer and iron boxes for general protection.

Table B.141: Question 156 – Have any of your organisation's other equipment sustained damage from volcanic hazards while protected?

	Count	Percentage
Yes	0	0
No	3	100
Do not know	0	0
TOTAL	**3**	**100**

Table B.142: Question 157 – What type(s) of damage has occurred to other equipment?

	Count
Minor corrosion of outside of equipment not affecting functionality	0
Major corrosion of outside of equipment reducing functionality and life expectancy	0
Minor abrasion of outside of equipment not affecting functionality	0
Major abrasion of outside of equipment reducing functionality and life expectancy	0
Corrosion of components on circuit boards reducing functionality and life expectancy	0
Short circuits	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Clogged motors	0
Clogged air intakes	0
Totally destroyed	0
Do not know	0
Other	0
TOTAL	**0**

Table B.143: Question 158 – Which volcanic hazard(s) caused the damage to your organisation's other equipment?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Minor corrosion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major corrosion of outside of equipment reducing functionality and life expectancy	0	0	0	0	0	0
Minor abrasion of outside of equipment not affecting functionality	0	0	0	0	0	0
Major abrasion of outside of equipment reducing functionality and life expectancy	0	0	0	0	0	0
Corrosion of components on circuit boards reducing functionality and life expectancy	0	0	0	0	0	0
Short circuits	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	0	0	0	0	0
Clogged motors	0	0	0	0	0	0
Clogged air intakes	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.144: Question 159 – Have any of your organisation's other equipment stopped working due to the above damage?

	Count	Percentage
Yes	0	0
No	0	0
Do not know	0	0
TOTAL	**0**	**0**

Table B.145: Question 160 – On average, how often does your organisation have to repair other equipment because they stopped working due to the above damage?

	Average
Weeks	-
Months	-
Years	-

Table B.146: Question 161 – On average, how often does your organisation have to replace other equipment because they stopped working due to the above damage?

	Average
Weeks	-
Months	-
Years	-

Table B.147: Question 162 – Have any of the materials your organisation uses to protect other equipment sustained damage from volcanic hazards?

	Count	Percentage
Yes	0	0
No	3	100
Do not know	0	0
TOTAL	**3**	**100**

Table B.148: Question 163 – What type(s) of damage occurred to these materials?

	Count
Corrosion of metals causing structural failure	0
Corrosion of metals forming holes	0
Abrasion of metals causing structural failure	0
Abrasion of metals forming holes	0
Dents and/or holes from impacts	0
Acid etching of equipment	0
Totally destroyed	0
Do not know	0
Other	0
TOTAL	**0**

Table B.149: Question 164 – Which volcanic hazard(s) caused the damage to the materials protecting your organisation's other equipment?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Corrosion of metals causing structural failure	0	0	0	0	0	0
Corrosion of metals forming holes	0	0	0	0	0	0
Abrasion of metals causing structural failure	0	0	0	0	0	0
Abrasion of metals forming holes	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of equipment	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.150: Question 165 – On average, how often does your organisation have to replace the materials that protect other equipment because they sustained damage from volcanic hazards?

	Average
Weeks	-
Months	-
Years	-

Table B.151: Question 166 – Does your organisation change its protection method(s) and/or protection materials for other equipment at different locations/conditions around a volcano?

	Count	Percentage
Yes	0	0
No	3	100
Do not know	0	0
TOTAL	**3**	**100**

Table B.152: Question 167 – Please rate the overall effectiveness of the protection methods and materials used by your organisation to protect other equipment from the following hazards.

	Percentage				
	Very effective	**Effective**	**Somewhat effective**	**Ineffective**	**Not Applicable**
Ballistic impacts	0	0	0	0	100
Loading from ashfall	0	0	0	0	100
Abrasion from ash	0	0	0	0	100
Gas infiltration	0	0	0	0	100
Acid rain infiltration	0	0	0	0	100

Table B.153: Question 168 – On average, how much money does your organisation spend each year on repairing volcanic surveillance equipment?

	Count	Percentage
None	0	0
US$1 – US$10,000	2	29
US$10,001 – US$20,000	1	14
US$20,001 – US$30,000	1	14

US$30,001 – US$40,000	0	0
US$40,001 – US$50,000	1	14
US$50,001+	0	0
Do not know	2	29
TOTAL	**7**	**100**

Table B.154: Question 169 – On average, how much money does your organisation spend each year on replacing volcanic surveillance equipment?

	Count	**Percentage**
None	0	0
US$1 – US$10,000	1	14
US$10,001 – US$20,000	2	29
US$20,001 – US$30,000	2	29
US$30,001 – US$40,000	0	0
US$40,001 – US$50,000	0	0
US$50,001+	0	0
Do not know	2	29
TOTAL	**7**	**100**

Table B.155: Question 170 – Has your organisation considered protecting surveillance equipment in the past?

	Count	**Percentage**
Yes	1	33
No	2	67
TOTAL	**3**	**100**

Table B.156: Question 171 – What are the main reasons why your organisation does not protect surveillance equipment?

	Count
Initial cost too high	1
On-going maintenance cost too high	0
Protection would not be effective	3

Equipment would not last any longer	3
Other	2
TOTAL	**9**

Other responses:

- Equipment is considered expendable. Data is more important (2 responses).

Solar Panels

Table B.157: Question 172 – Does any of your organisation's surveillance equipment require solar panels for their power supply?

	Count	Percentage
Yes	11	100
No	0	0
TOTAL	**11**	**100**

Table B.158: Question 173 – Approximately how many solar panels does your organisation have deployed in the field to provide power to surveillance equipment?

	Count	Percentage
1 – 10	1	10
11 – 20	1	10
21 – 30	3	30
31 – 40	0	0
41 – 50	1	10
51+	4	40
TOTAL	**10**	**100**

Table B.159: Question 174 – Does your organisation protect solar panels from volcanic hazards?

	Count	Percentage
Yes	1	10
No	9	90
TOTAL	**10**	**100**

Table B.160: Question 175 – What materials are used to protect your organisation's solar panels?

	Count
Wood	0
Stainless steel	0
Steel	0
Zinc	0
Copper	0
Roofing iron	0
Concrete	1
Perspex/Plexiglas/Acrylic	0
Glass	0
Electrical tape/Waterproof tape	0
Do not know	0
Other	0
TOTAL	**1**

Question 176 – Please provide and explanation of how there materials are used to protect solar panels.

- For permanent mounting.

Table B.161: Question 177 – Have any of your organisation's solar panels sustained damage from volcanic hazards while protected?

	Count	Percentage
Yes	1	100
No	0	0
TOTAL	**1**	**100**

Table B.162: Question 178 – What type(s) of damage has occurred to solar panels while protected?

	Count
Corrosion of metal frame causing structural failure	0
Corrosion of metal frame forming holes	0
Abrasion of metal frame causing structural failure	0

Abrasion of metal frame forming holes	0
Dents and/or holes from impacts	0
Acid etching of glass	1
Abrasion of glass	1
Corrosion of electrical connectors	0
Short circuits	0
Totally destroyed	0
Do not know	0
Other	0
TOTAL	**2**

Table B.163: Question 179 – Which volcanic hazard(s) caused the damage to your organisation's solar panels while protected?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Corrosion of metal frame causing structural failure	0	0	0	0	0	0
Corrosion of metal frame forming holes	0	0	0	0	0	0
Abrasion of metal frame causing structural failure	0	0	0	0	0	0
Abrasion of metal frame forming holes	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Acid etching of glass	0	1	0	0	0	0
Abrasion of glass	0	1	0	0	0	0
Corrosion of electrical connectors	0	0	0	0	0	0
Short circuits	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0

Other damage	0	0	0	0	0	0

Table B.164: Question 180 – Did the damage cause the solar panel to work less efficiently or stop working?

	Count	Percentage
Less efficiently	1	100
Stop working	0	0
Do not know	0	0
TOTAL	**1**	**100**

Table B.165: Question 181 – Did the fact the solar panels was working less efficiently or stopped working cause the surveillance equipment the solar panel was powering to stop working?

	Count	Percentage
Yes	1	100
No	0	0
Do not know	0	0
TOTAL	**1**	**100**

Table B.166: Question 182 – On average, how often does your organisation have to replace solar panels because they stopped working due to damage while protected?

	Average
Weeks	-
Months	-
Years	2

Table B.167: Question 183 – Have any of your organisation's solar panels sustained damage from volcanic hazards while unprotected?

	Count	Percentage
Yes	4	40
No	6	60
Do not know	0	0
TOTAL	**10**	**100**

Table B.168: Question 184 – What type(s) of damage has occurred to solar panels while unprotected?

	Count
Corrosion of metal frame causing structural failure	2
Corrosion of metal frame forming holes	2
Abrasion of metal frame causing structural failure	0
Abrasion of metal frame forming holes	0
Dents and/or holes from impacts	2
Acid etching of glass	1
Abrasion of glass	2
Corrosion of electrical connectors	2
Short circuits	0
Totally destroyed	1
Do not know	0
Other	1
TOTAL	**13**

Other responses:

- Ash weight.

Table B.169: Question 185 – Which volcanic hazard(s) caused the damage to your organisation's solar panels while unprotected?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Corrosion of metal frame causing structural failure	0	2	1	0	0	0
Corrosion of metal frame forming holes	0	2	1	0	0	0
Abrasion of metal frame causing structural failure	0	0	0	0	0	0
Abrasion of metal frame forming holes	0	0	0	0	0	0

Dents and/or holes from impacts	0	0	0	2	0	0
Acid etching of glass	0	1	1	0	0	0
Abrasion of glass	1	1	1	0	0	0
Corrosion of electrical connectors	0	1	1	0	0	0
Short circuits	0	0	0	0	0	0
Totally destroyed	0	0	0	1	0	1 (*pyroclastic flow*)
Other damage	1	0	0	0	0	0

Table B.170: Question 186 – Did the damage cause the solar panel to work less efficiently or stop working?

	Count	**Percentage**
Less efficiently	0	0
Stop working	2	67
Do not know	1	33
TOTAL	**2**	**100**

Table B.171: Question 187 – Did the fact the solar panels was working less efficiently or stopped working cause the surveillance equipment the solar panel was powering to stop working?

	Count	**Percentage**
Yes	2	67
No	0	0
Do not know	1	33
TOTAL	**3**	**100**

Table B.172: Question 188 – On average, how often does your organisation have to replace solar panels because they stopped working due to damage while unprotected?

	Average
Weeks	-
Months	5
Years	3

Table B.173: Question 189 – Please rate the overall effectiveness of the protection methods and materials used by your organisation to protect solar panels from the following hazards.

	Percentage				
	Very effective	Effective	Somewhat effective	Ineffective	Not Applicable
Ballistic impacts	0	0	0	0	100
Loading from ashfall	0	0	0	0	100
Abrasion from ash	0	0	0	0	100
Gas infiltration	0	0	0	0	100
Acid rain infiltration	0	0	0	0	100

Table B.174: Question 190 – On average, how much money does your organisation spend each year on replacing solar panels?

	Count	Percentage
None	0	0
US$1 – US$10,000	0	0
US$10,001 – US$20,000	0	0
US$20,001 – US$30,000	0	0
US$30,001 – US$40,000	0	0
US$40,001 – US$50,000	0	0
US$50,001+	0	0
Do not know	1	100
TOTAL	**1**	**100**

Question 191 – During sustained eruptive activity ashfall can cover solar panels. Please explain your organisation's approach to cleaning ash off solar panels or your reasons why you do not clean ash off.

- Depending on the proximity of the solar panel to the danger zone and the magnitude of the eruptive activity, we either wash it down with water and rags, or leave it as is until it is safe. As previously stated, the equipment is considered expendable.
- We have not had this experience (*translated from Spanish*).
- Ashfall is not a significant problem in Hawaii.
- We clean them with water, foam and detergent.
- If cleaning is necessary we usually do it after volcanic eruption.
- The solar panels are deployed in a 45º position; nevertheless sometimes they require to be cleaned directly.
- By brushing off the ash on the solar panel.
- Ash eruptions are extremely unusual so an occasional light ashfall is usually blown off by ambient winds.

Table B.175: Question 192 – Please rate the effectiveness of the above cleaning method(s) for removing ash from a solar panel.

	Count	**Percentage**
Very effective	3	38
Effective	3	38
Somewhat effective	0	0
Ineffective	0	0
Not applicable	2	25
TOTAL	**8**	**100**

Table B.176: Question 193 – Does the above cleaning method(s) cause and abrasion of the glass on the solar panel?

	Count	**Percentage**
Yes	0	0
No	4	50

Do not know	4	50
TOTAL	**8**	**100**

Comments regarding solar panels:

- For the electrical connection we minimise corrosion by applying sealant.
- No comments
- Our method is every effective.
- Use of soft materials to avoid corrosion and abrasion.

Laptops

Table B.177: Question 194 – Does your organisation use laptop computers in the field for any reason?

	Count	**Percentage**
Yes	8	100
No	0	0
TOTAL	**8**	**100**

Table B.178: Question 195 – What are these laptop computers used for in the field?

	Count
Downloading data from surveillance equipment in the field	8
Configuring surveillance equipment while in the field	6
Running surveillance equipment from a laptop computer	3
Other	0
Do not know	0
TOTAL	**17**

Table B.179: Question 196 – Are these laptop computers designed for outdoor use?

	Count	**Percentage**
Yes	5	71
No	2	29
TOTAL	**7**	**100**

Comments regarding what makes laptop computers suitable for outdoor use:

- Size and easy transport (*translated from Spanish*).
- Lightweight, waterproof screen, screen readable in bright sun, shock resistant.
- Robustness and adapted.
- For documenting and recording data in the field.
- Their design. We used Panasonic Toughbooks.
- Compact, self-contained.

Table B.180: Question 197 – How long do these laptop computers remain in the field per deployment?

	Average
Weeks	1
Months	-
Years	2

Table B.181: Question 198 – Approximately how many times per year are laptop computers taken into the field?

	Count	**Percentage**
<5	0	0
6 – 10	0	0
11 – 15	1	13
16 – 20	2	25
21+	5	63
TOTAL	**8**	**100**

Table B.182: Question 199 – If laptop computers are in the field for more than one day, are they protected from the environment?

	Count	**Percentage**
Yes	5	63
No	3	38
TOTAL	**8**	**100**

Table B.183: Question 200 – Is the laptop computer protected from meteorological factors or volcanic hazards or both?

	Count	Percentage
Meteorological factors	1	20
Volcanic factors	0	0
Both	4	80
TOTAL	**5**	**100**

Table B.184: Question 201 – If the laptop computer is designed for outdoor use, does your organisation increase the laptop computers protection?

	Count	Percentage
Yes	2	67
No	1	33
TOTAL	**3**	**100**

Table B.185: Question 202 – What materials are used to protect your organisation's laptop computers while in the field?

	Count
Wood	1
Stainless steel	1
Steel	0
Zinc	1
Copper	1
Roofing iron	1
Concrete	1
Perspex/Plexiglas/Acrylic	0
Glass	0
Electrical tape/Waterproof tape	1
Do not know	0
Other	5
TOTAL	**12**

Other responses:

- Plastic wrapper/bag.
- They are stored in the same huts as the seismometers and accessories.
- Durable cases/bags.
- Suitcase in polymer and leather.
- Plastic bag.

Question 203 – Please provide and explanation of how there materials are used to protect laptop computers.

- The computers and put in the same huts as the seismometers and accessories.
- Oftentimes laptop computers are being brought individually by our technical personnel conducting field investigations.
- Suitcase for protection from weather.
- Reduces rainfall.

Table B.186: Question 204 – Have any of your organisation's laptop computers sustained damage from volcanic hazards while protected in the field?

	Count	**Percentage**
Yes	0	0
No	5	100
Do not know	0	0
TOTAL	**5**	**100**

Table B.187: Question 205 – What type of damage occurred to laptop computer while protected?

	Count
Corrosion of components on the circuit board reducing life expectancy	0
Corrosion of other internal components reducing life expectancy	0
Corrosion of external connectors reducing performance	0
Abrasion of components on the circuit board reducing life expectancy	0
Abrasion of components on the circuit board reducing life	0

expectancy	
Abrasion of external case	0
Abrasion of screen reducing life expectancy	0
Acid etching of screen reducing life expectancy	0
Dents and/or holes from impacts	0
Ash stuck under keyboard keys	0
Clogged air intakes	0
Clogged cooling fans	0
Short circuits	0
Totally destroyed	0
Do not know	0
Other	0
TOTAL	**0**

Table B.188: Question 206 – Which volcanic hazard(s) caused the damage to your organisation's laptop computers while protected?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Corrosion of components on the circuit board reducing life expectancy	0	0	0	0	0	0
Corrosion of other internal components reducing life expectancy	0	0	0	0	0	0
Corrosion of external connectors reducing performance	0	0	0	0	0	0
Abrasion of components on the circuit board reducing life expectancy	0	0	0	0	0	0
Abrasion of components	0	0	0	0	0	0

on the circuit board reducing life expectancy						
Abrasion of external case	0	0	0	0	0	0
Abrasion of screen reducing life expectancy	0	0	0	0	0	0
Acid etching of screen reducing life expectancy	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Ash stuck under keyboard keys	0	0	0	0	0	0
Clogged air intakes	0	0	0	0	0	0
Clogged cooling fans	0	0	0	0	0	0
Short circuits	0	0	0	0	0	0
Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.189: Question 207 – On average, how often does your organisation have to repair laptop computers because they stopped working due to damage while protected?

	Average
Weeks	-
Months	-
Years	-

Table B.190: Question 208 – On average, how often does your organisation have to replace laptop computers because they stopped working due to damage while protected?

	Average
Weeks	-
Months	-
Years	-

Table B.191: Question 209 – Have any of your organisation's laptop computers sustained damage from volcanic hazards while unprotected?

	Count	Percentage
Yes	1	13
No	5	63
Do not know	2	25
TOTAL	**5**	**100**

Table B.192: Question 210 – What type(s) of damage occurred to laptop computers while unprotected?

	Count
Corrosion of components on the circuit board reducing life expectancy	1
Corrosion of other internal components reducing life expectancy	2
Corrosion of external connectors reducing performance	1
Abrasion of components on the circuit board reducing life expectancy	1
Abrasion of components on the circuit board reducing life expectancy	1
Abrasion of external case	1
Abrasion of screen reducing life expectancy	1
Acid etching of screen reducing life expectancy	0
Dents and/or holes from impacts	0
Ash stuck under keyboard keys	1
Clogged air intakes	1
Clogged cooling fans	1
Short circuits	1
Totally destroyed	0
Do not know	1
Other	0
TOTAL	**13**

Table B.193: Question 211 – Which volcanic hazard(s) caused the damage to your organisation's laptop computers while unprotected?

	Count					
	Ash	**Gas**	**Acid rain**	**Lava bomb**	**Do not know**	**Other hazard**
Corrosion of components on the circuit board reducing life expectancy	0	1	0	0	0	0
Corrosion of other internal components reducing life expectancy	1	1	0	0	0	0
Corrosion of external connectors reducing performance	0	1	0	0	0	0
Abrasion of components on the circuit board reducing life expectancy	1	0	0	0	0	0
Abrasion of components on the circuit board reducing life expectancy	1	0	0	0	0	0
Abrasion of external case	1	0	0	0	0	0
Abrasion of screen reducing life expectancy	1	0	0	0	0	0
Acid etching of screen reducing life expectancy	0	0	0	0	0	0
Dents and/or holes from impacts	0	0	0	0	0	0
Ash stuck under keyboard keys	1	0	0	0	0	0
Clogged air intakes	1	0	0	0	0	0
Clogged cooling fans	1	0	0	0	0	0
Short circuits	1	1	0	0	0	0

Totally destroyed	0	0	0	0	0	0
Other damage	0	0	0	0	0	0

Table B.194: Question 212 – On average, how often does your organisation have to repair laptop computers because they stopped working due to damage while unprotected?

	Average
Weeks	-
Months	-
Years	2

Table B.195: Question 213 – On average, how often does your organisation have to replace laptop computers because they stopped working due to damage while unprotected?

	Average
Weeks	-
Months	-
Years	2

Table B.196: Question 214 – Please rate the overall effectiveness of the protection methods and materials used by your organisation to protect laptop computers from the following hazards.

	Percentage				
	Very effective	**Effective**	**Somewhat effective**	**Ineffective**	**Not Applicable**
Ballistic impacts	0	0	0	0	0
Loading from ashfall	0	0	0	0	0
Abrasion from ash	0	0	0	0	0
Gas infiltration	0	0	0	0	0
Acid rain infiltration	0	0	0	0	0

Table B.197: Question 215 – After a laptop computers comes back from being in the field, is it cleaned?

	Count	**Percentage**
Yes	3	38
No	4	50

Do not know	1	13
TOTAL	**8**	**100**

Question 216 – Please explain how this cleaning is undertaken.

- Usually compressed air is blown into the unit, and contact cleaners are sprayed into the circuitry to remove any corrosion.
- With spray and a flannel (*translate from Spanish*).
- General cleaning with airgun and popular cleaning liquids for screens.

Table B.198: Question 217 – From your experience, does exposure of laptop computers to volcanic hazards reduce the laptops life expectancy?

	Count	**Percentage**
Yes	5	71
No	2	29
TOTAL	**7**	**100**

Table B.199: Question 218 – On average, how much money does your organisation spend each year on repairing laptop computers due to damage while protected?

	Count	**Percentage**
None	0	0
US$1 – US$5,000	0	0
US$5,001 – US$10,000	0	0
US$10,001 – US$15,000	0	0
US$15,001 – US$20,000	0	0
US$20,001+	0	0
Do not know	0	0
TOTAL	**0**	**0**

Table B.200: Question 219 – On average, how much money does your organisation spend each year on replacing laptop computers due to damage while protected?

	Count	**Percentage**
None	0	0
US$1 – US$5,000	0	0

US$5,001 – US$10,000	0	0
US$10,001 – US$15,000	0	0
US$15,001 – US$20,000	0	0
US$20,001+	0	0
Do not know	0	0
TOTAL	**0**	**0**

Table B.201: Question 220 – On average, how much money does your organisation spend each year on repairing laptop computers due to damage while unprotected?

	Count	**Percentage**
None	0	0
US$1 – US$5,000	0	0
US$5,001 – US$10,000	0	0
US$10,001 – US$15,000	0	0
US$15,001 – US$20,000	0	0
US$20,001+	0	0
Do not know	2	100
TOTAL	**2**	**100**

Table B.202: Question 221 – On average, how much money does your organisation spend each year on replacing laptop computers due to damage while unprotected?

	Count	**Percentage**
None	0	0
US$1 – US$5,000	0	0
US$5,001 – US$10,000	0	0
US$10,001 – US$15,000	0	0
US$15,001 – US$20,000	0	0
US$20,001+	0	0
Do not know	2	100
TOTAL	**2**	**100**

Comments regarding laptop computers:

- The laptop is susceptible to damage; you must protect the best way (*translated from Spanish*).
- We do not leave laptops in the field – only use them for configuration and data downloading where telemetry is not possible.
- Frequent problems of power (electricity) cuts in the central recording station. This affects laptops and other recording equipment.
- Shortening of battery life span and very moist environment causes damage to electronic devices.

Closing Questions

Table B.203: Question 222 – Has your organisation ever conducted experiments to determine the most effective method(s) for protecting surveillance equipment?

	Count	**Percentage**
Yes	0	0
No	7	88
Do not know	1	13
TOTAL	**8**	**100**

Question 223 – Please explain what these experiments entailed, and how they were carried out or references to any published details/results.

There were no responses for this question.

Table B.204: Question 224 – Has your organisation's method(s) of protecting surveillance equipment changed or been modified over time to provide better protection?

	Count	**Percentage**
Yes	3	50
No	3	50
Do not know	0	0
TOTAL	**6**	**100**

Question 225 – Please explain what prompted your organisation to change its protection methods.

- Periodic maintenance.
- Increased gas emissions led to different ways of protecting equipment against gas corrosion.
- Not fully aware.
- We have developed experience that has taught us to change in some cases from iron to aluminium and concrete.

Table B.205: Question 226 – Approximately what percentage of your organisation's volcanic surveillance budget is used for protecting surveillance equipment?

	Count	**Percentage**
None	0	0
1 – 5%	0	0
6 – 10%	2	33
11 – 20%	0	0
21 – 30%	0	0
31 – 40%	1	17
41 – 50%	0	0
51%+	0	0
Do not know	3	50
TOTAL	**6**	**100**

Table B.206: Question 227 – Approximately what percentage is used for on-going maintenance costs?

	Count	**Percentage**
None	0	0
1 – 5%	0	0
6 – 10%	2	33
11 – 20%	0	0
21 – 30%	1	17
31 – 40%	0	0
41 – 50%	0	0
51%+	0	0

Do not know	3	50
TOTAL	**6**	**100**

Respondent’s overall comments:

- Shelf life depends on the equipment to be protected from (*translated from Spanish*).