An update from the lab...

Volcanic Ash Testing Lab (VAT Lab)

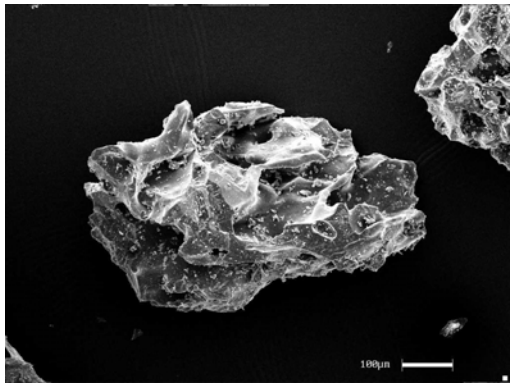
National Lifelines Forum – 23 September 2010

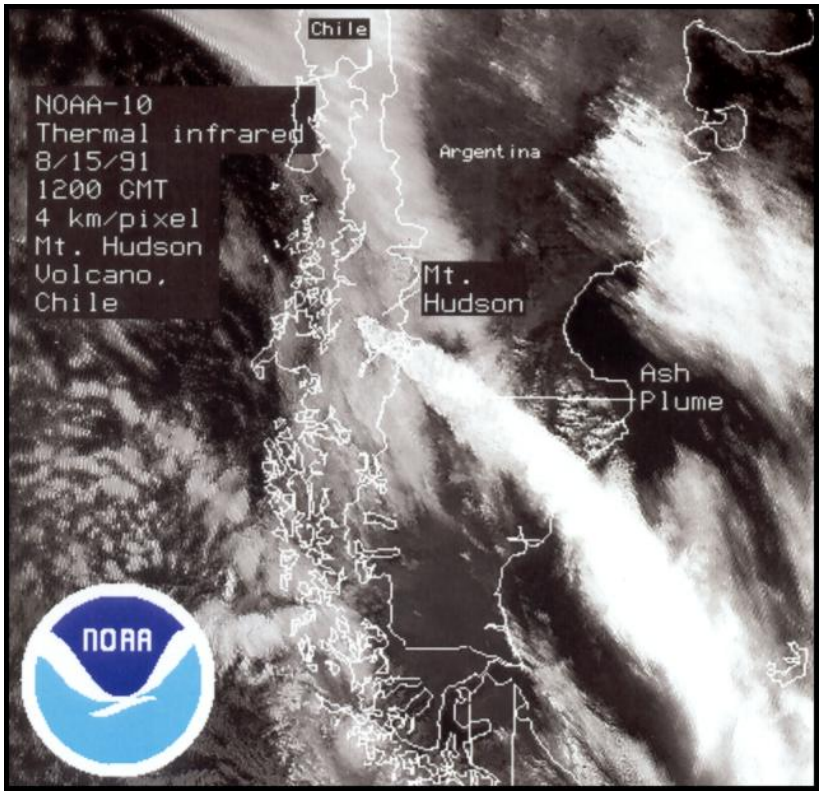
Tom Wilson, John Wardman, Carol Steward, David Johnston, Pat Bodger, et al.

University of Canterbury, GNS Science, Massey University, etc

What is volcanic ash?

- Abrasive
- Chemically corrosive
- Electrically conductive
- Variable grain size (<2μm)





- Eruption size, wind direction & speed affects distribution
- Most impacts tend to be disruptive rather than destructive
- Ashfall most frequently affects the most people

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Changing Risk Landscape

- Development is increasing risk in known hazards zone
- Potentially adding substantial risk where little or none existed before
  (true for all natural hazards)
- Smaller magnitude events at volcanoes will cause **more damage and disruption**

TABLE 5. SOCIETAL CHANGES OVER THE PAST 50 YEARS (1945–1995)

Measure	1945	1995
New Zealand population	1 702 330*	3 579 900§ (1995)
Hawkes Bay	49 796*	116 340# (1991)
Taupo District	4 248*	30 723# (1991)
Ruapehu District	15 320*	18 105# (1991)
Cars (number)	198 629†	1 647 134§ (1995)
Cars/head of population	0.12	0.46 (1995)
Speed limit (open road)	64 km/h (40 mph)	100 km/h
Domestic air travel — passenger no.	60 968†	4 502 000** (1993)
Domestic air flights/head of pop.	0.036	1.3 1993
Ski fields on Ruapehu	1	3
Number of ski lifts	0	36 (1995)
Number of skiers days	N/A	450 000†† (1994)

*1945 census.
†1945 Yearbook.
§1996 Yearbook.
#1991 census.
**Ministry of Transport.
††Ruapehu District Council.

Research Context – Volcanic Impact Research

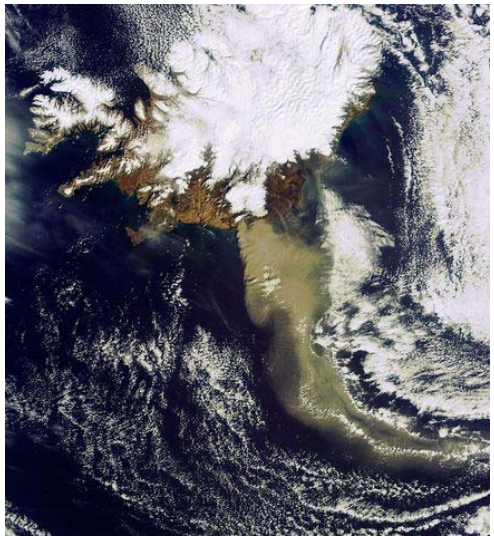
- Over the past 10-15 years the New Zealand research group (and collaborators) have aimed to undertake a sustained and systematic approach to volcanic impact assessment
  - critical infrastructure: electricity, water supplies, wastewater, land and air transport, telecommunications
  - ash cleanup and disposal
  - primary industries, including agriculture
  - social impacts
  - emergency management

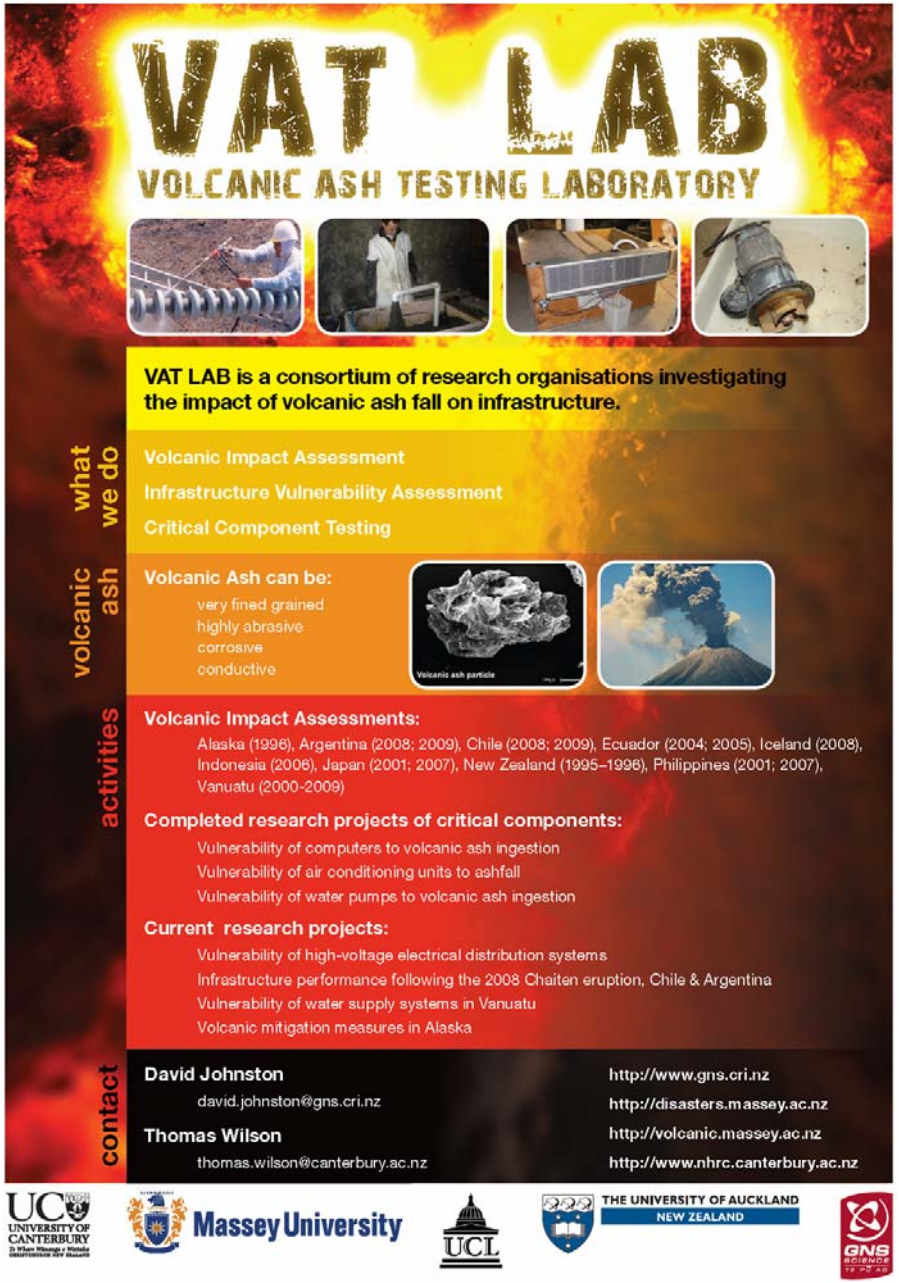
- Reconnaissance trips to impacted areas, e.g. Yakima, Spurr, Kagoshima x2, Catania, Ecuador, Merapi, Pinatubo, Hudson, Iceland agriculture, Heimaey, Chaiten, Redoubt

- Followed by laboratory testing of critical infrastructure components...VAT Lab

Eruption of Eyjafjallajokull, Iceland

- >300 million euro in direct economic loss (airlines), potentially billions of euro lost in service disruption, and a large social impact
- Scientists have been demanding ash concentrations thresholds be provided by the airline industry for **decades**
- Under the present CAA limits and according to high-resolution models the impact of the same event today would be considerably less
- Highlights the extreme lack of knowledge around ashfall impacts to critical infrastructure and communities





Consortium of research organisations investigating the impact of volcanic ashfall to infrastructure

Link between Geology, Engineering and Societal themes

Active collaboration with:

- University College London,
- University of Cambridge,
- Bonneville Power Administration,
- USGS

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Massey University

UNIVERSITY OF CAMBRIDGE

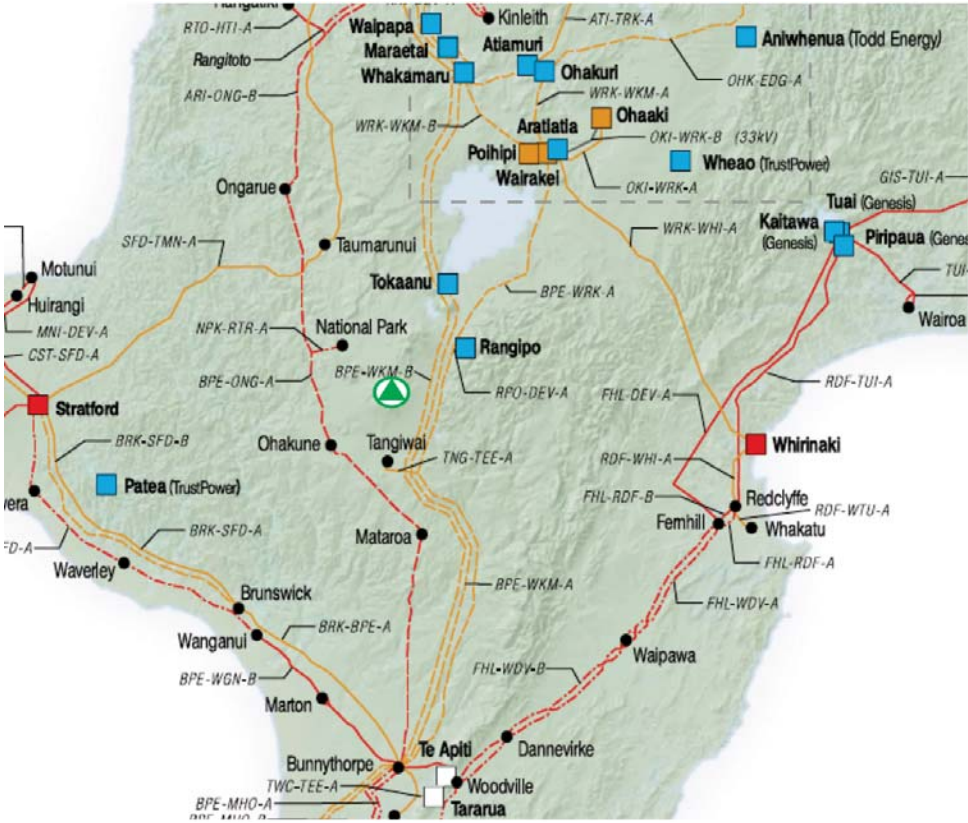
EQC EARTHQUAKE COMMISSION

GNS SCIENCE TE PŪ AO

UNIVERSIDAD NACIONAL DEL COMAHUE 1972

Ruapehu 1995

- Lines close to volcano contaminated by falls of volcanic ash and mud
  - Bunnythorpe – Tokaanu A/716
    - Towers 290-350 (320-330 critically affected)
  - Bunnythorpe – Tokaanu B/718
    - Towers 292-350 (320-330 critically affected)
  - Bunnythorpe – Wairakei A/721
    - Towers 310-370 (340-350 critically affected)
- Flashover and voltage fluctuation
- Exposed surfaces coated in 3mm of ash



Post Eruption

27th September, 1995

- 4 Crews of 4 men dispatched
- 18 towers

Cleaning methods:

- Water Blasting (1500 psi)
- Fire Hosing
- Dry wiping (mutton cloth)
- Knapsack sprayer & cloth

Estimated cleaning costs:

- De-energised cleaning of insulators (1 day, 1 crew): $2,040.2,
- Cleaning of structures (1 week, 1 crew): $10,470.6,
- Live-line Cleaning with hotstick (1 day, 1 crew): $3,125.2,

AELG – 19
Electricity, telecommunications & broadcasting

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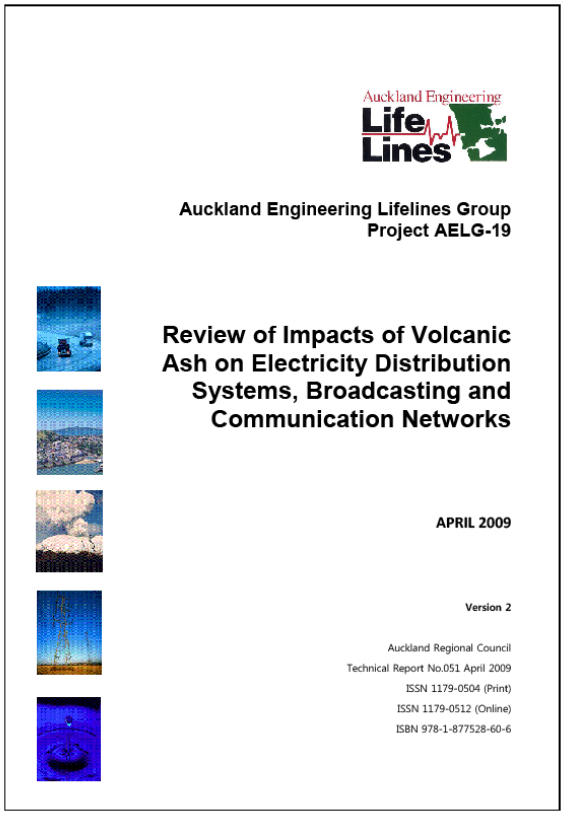
1. To summarise the information and research undertaken (nationally and internationally) on the impacts of volcanic ash on **electricity distribution systems, broadcasting** and **communication networks**.

2. To identify **vulnerable components** of electricity, broadcasting, radio transmission and communications networks to ash.

3. To identify **mitigation measures** to reduce vulnerability prior to a volcanic event, and measures to reduce damage during and post event.



FLASHOVER – high voltage network

FLASHOVER – low voltage network

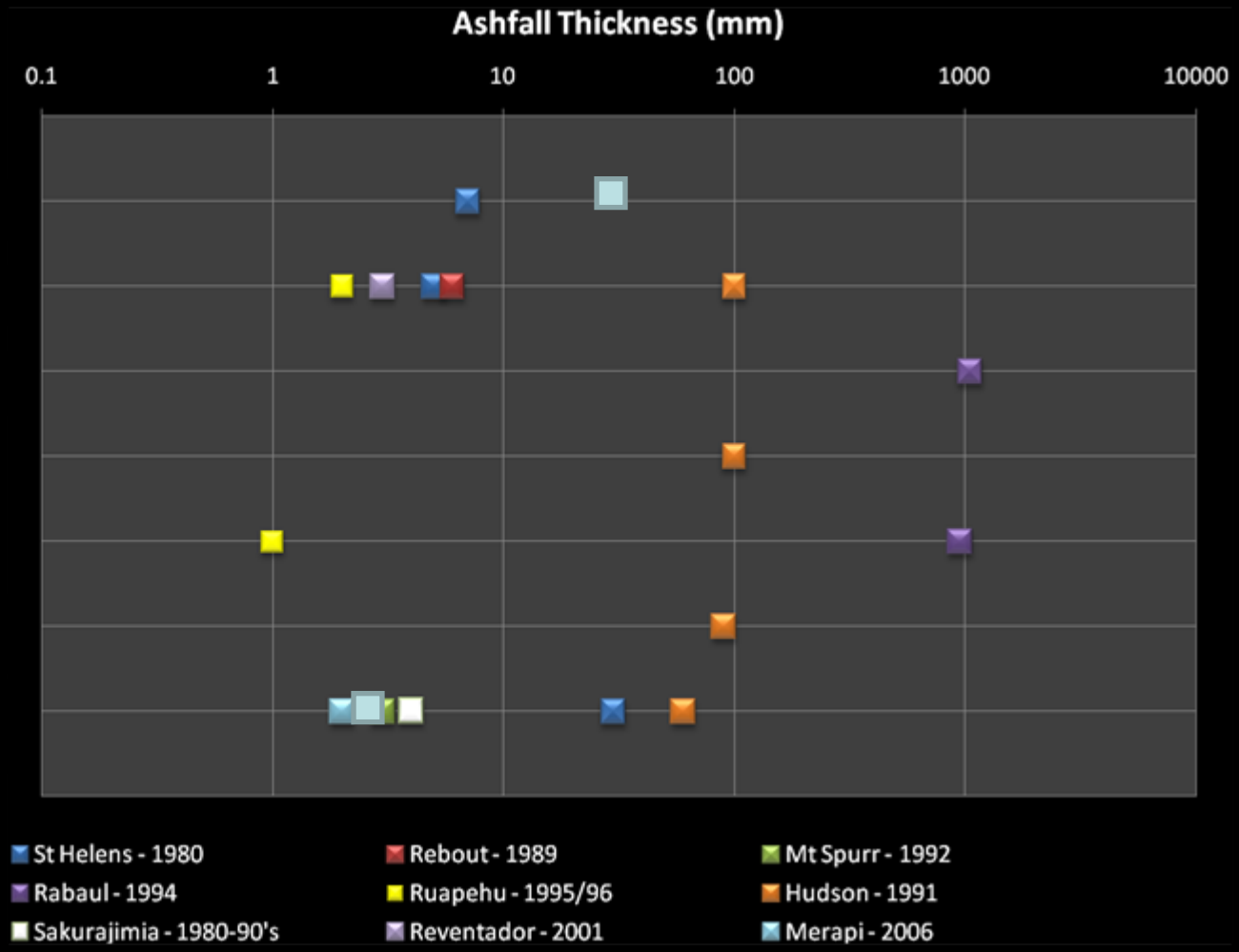
OBJECTS COLLAPSING ON LINES

TRANSFORMER DAMAGE

CONTROLLED OUTAGE

LINE COLLAPSE FROM ASH BUILD-UP

RESILIENCY TO ASH



Quantifying the Vulnerability of High Voltage Transmission Systems to Volcanic Ashfall Hazards

Wardman, J.B., Wilson, T.M., Bodger, P.S., Cole, J.W., Johnston, D.J.

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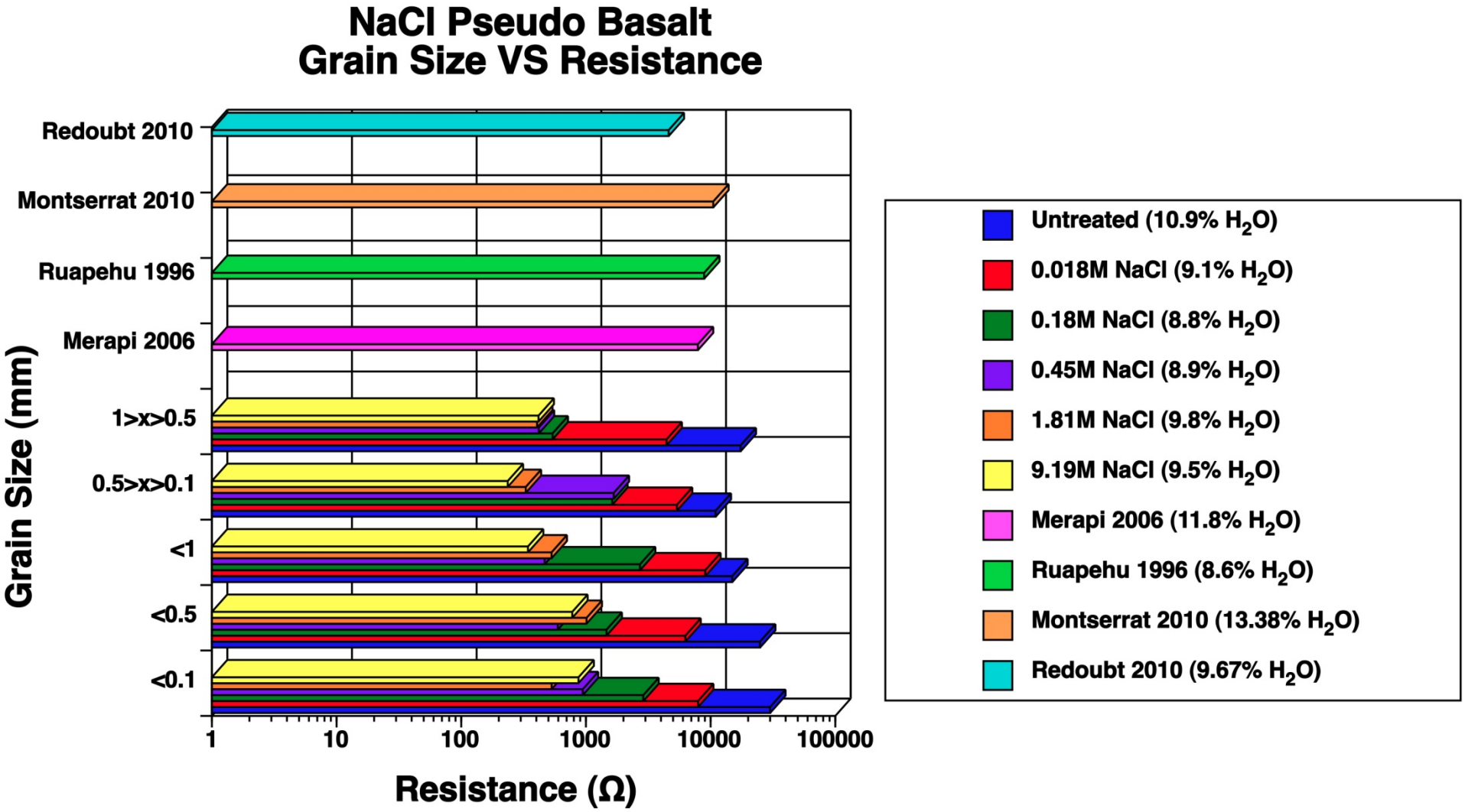
Electrical Resistance Testing

- Opportunity to implement a new practice
  - International interest
- Measure resistance of various ash types in ‘electrode dock’
- Cleaning when ESDD ≥0.03mg/cm2
- Nellis & Hendrix 1981: Ash 3-6mm thick=ESDD **0.3-0.6mg/cm2**
- Investigate controlling variables
- Compare & Identify suitable proxy

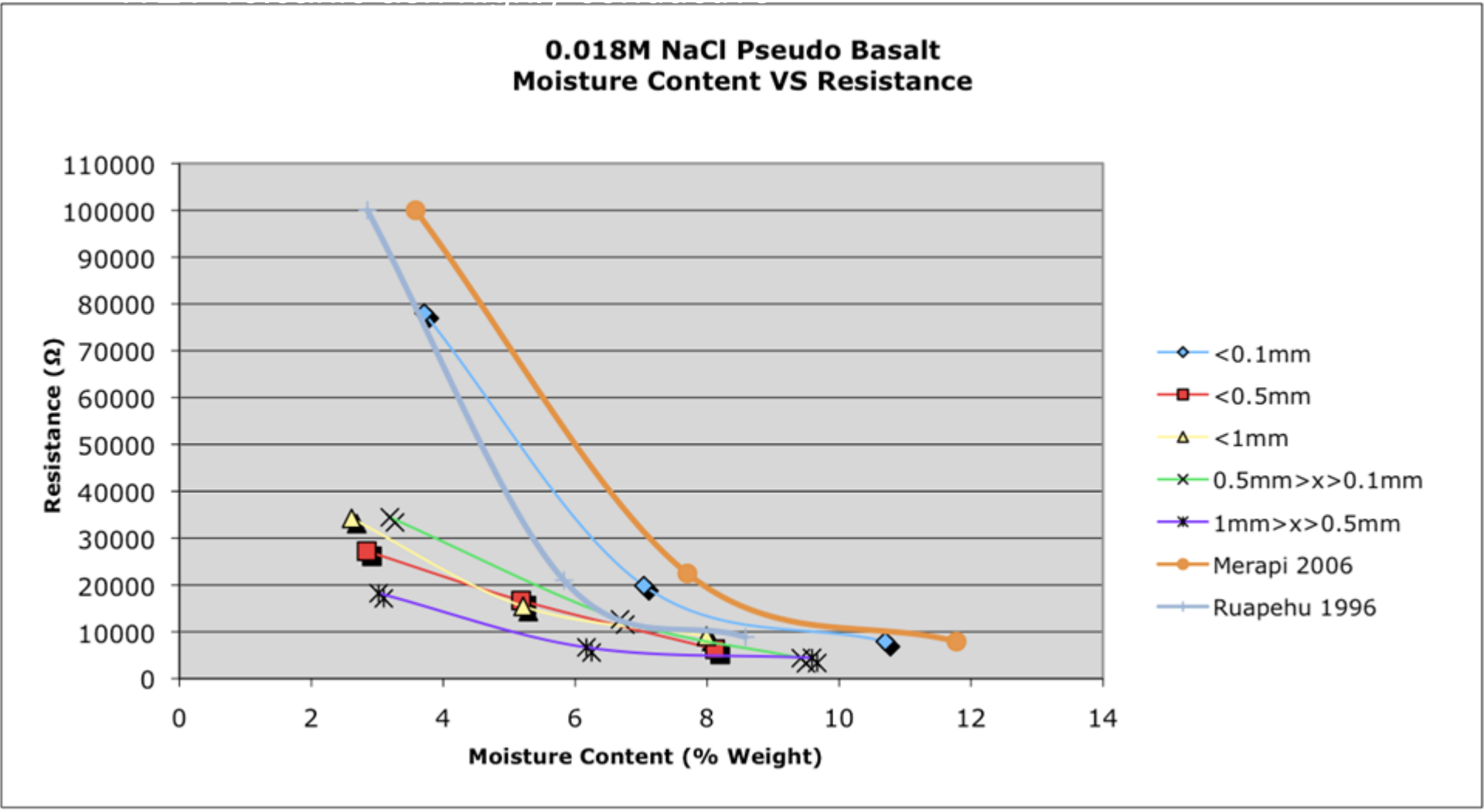
ESDD (mg/cm^2)	Site Severity
0 – 0.03	Very Light
0.03 – 0.06	Light
0.06 – 0.1	Moderate
>0.1	Heavy

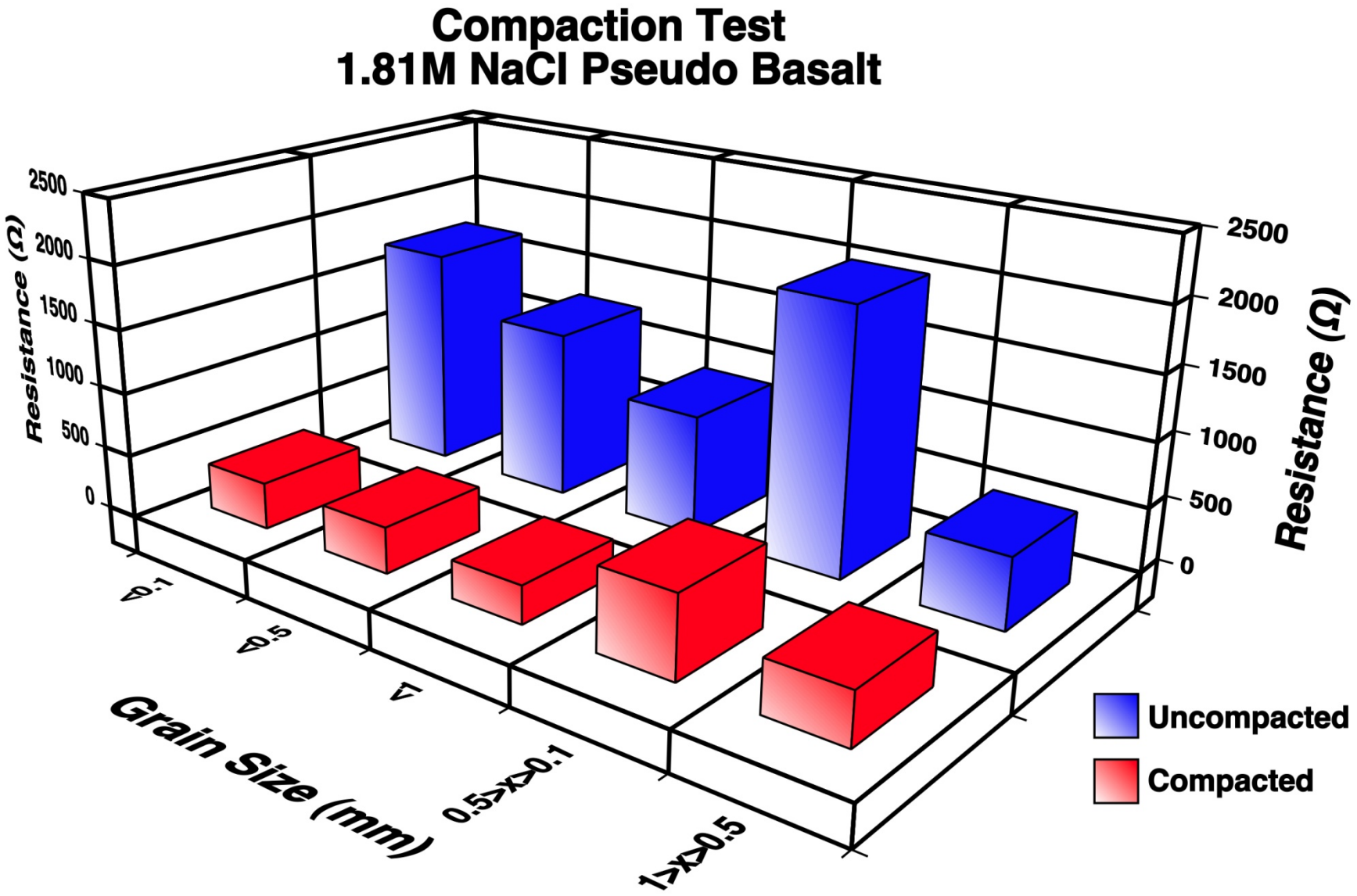
Characterizing the resistivity of volcanic ash



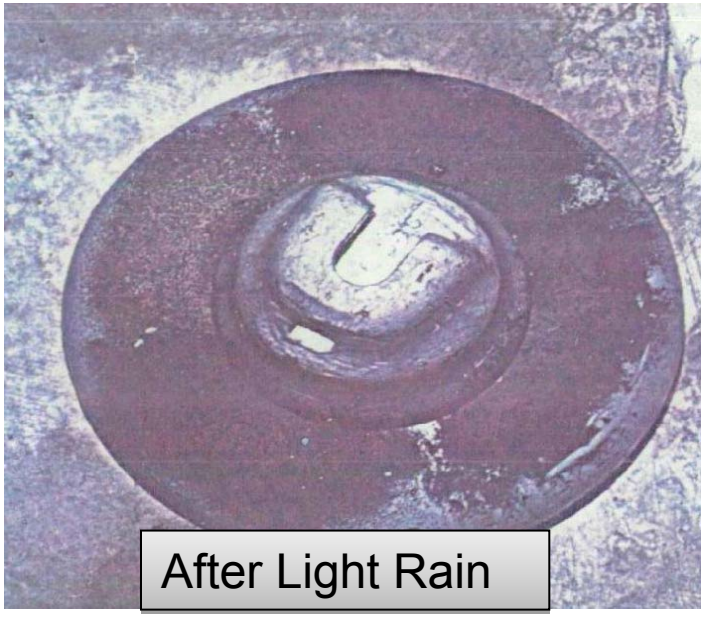
Water Content of the ash

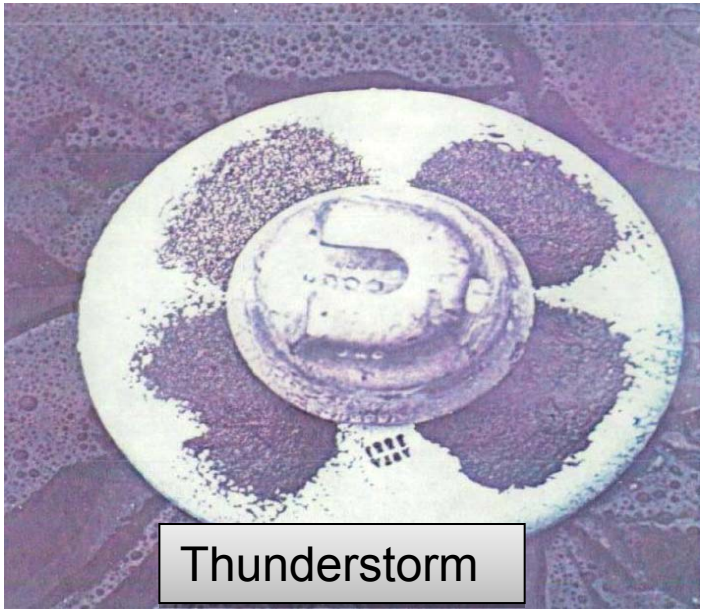
- ↑Water Content = ↓ Resistance

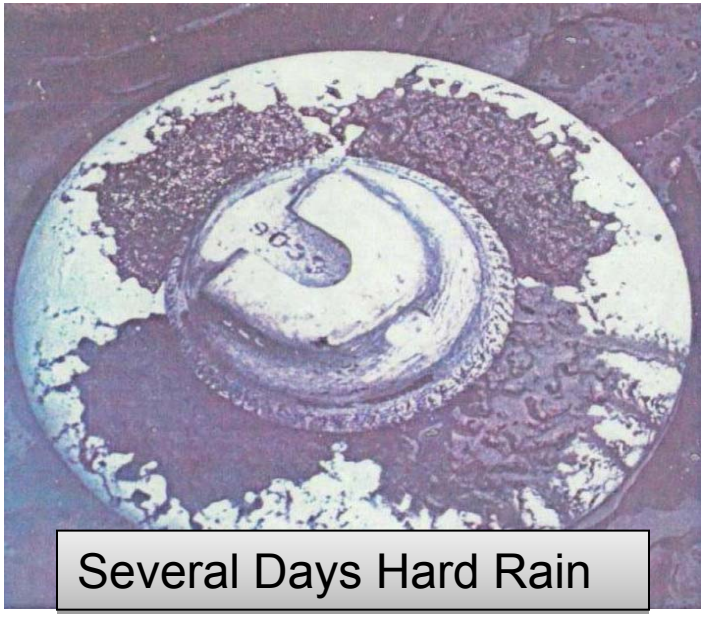


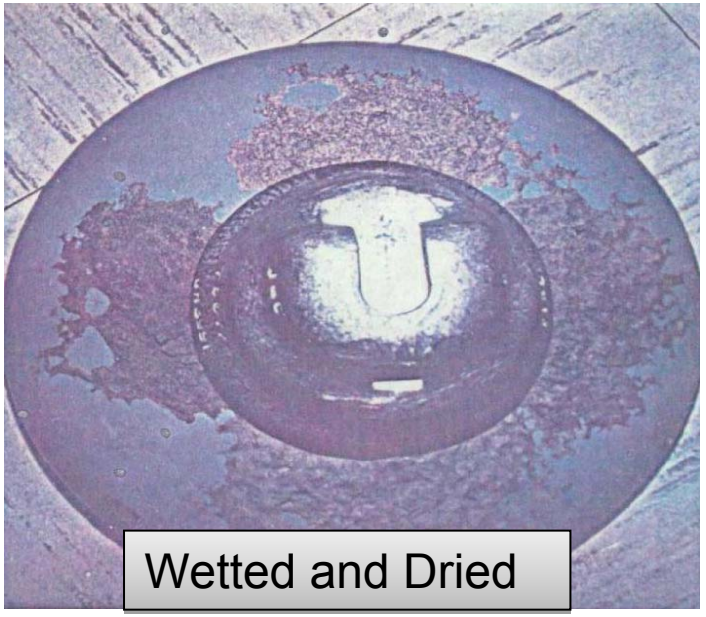

Compaction Test
1.81M NaCl Pseudo Basalt
Resistance (Ω)
2500
2000
1500
1000
500
0
Grain Size (mm)
<0.1
<0.5
<1
0.5>x>0.1
1>x>0.5
Uncompacted
Compacted

Adherence Properties









Contamination Testing

- Power-frequency testing of high voltage insulators contaminated with volcanic ash
    - 350 kW power capability, 50 Hz
- Test insulators of varying ratings, design and composition
    - Porcelain, glass, composite polymer
- Control and quantify major variables leading to flashover
    - i.e. moisture type/rate, ash volume, grain size, etc.
- Leakage current and geotechnical analysis of adherence properties


Clean String


Contaminated with 3mm ash

movie

Insulator Design

A central aim is to:

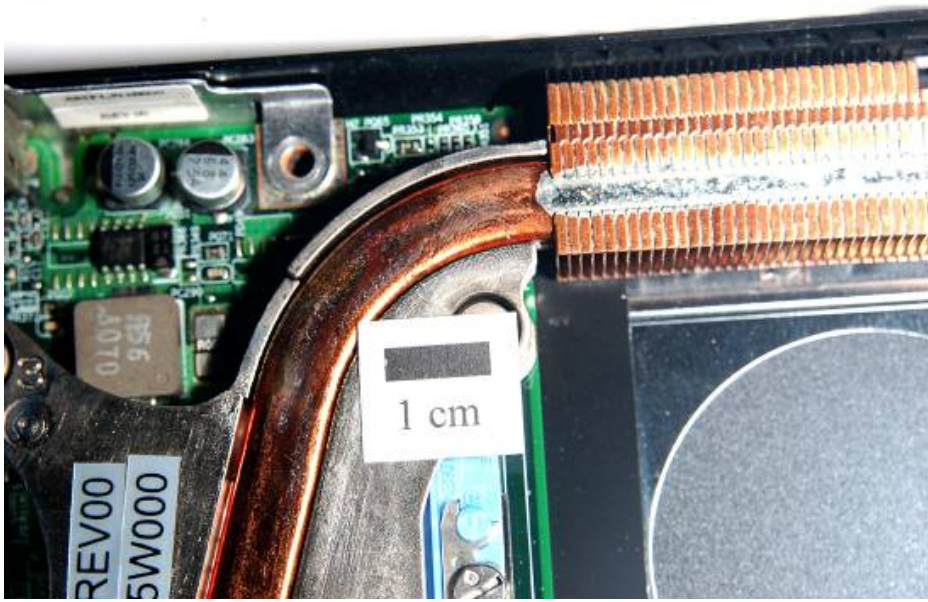
- Inform design criteria for volcano proximal or heavily polluted areas
- Self cleaning options?
  - Corona wind
  - TiO_2 (titanium dioxide) film (Yuzhen *et al*., 2009)
  - Effectiveness of RTV greases?

Grant Wilson – MSc @ UC

Early results

- All laptops kept working and are still working – tested on a 1 month cycle...
- Laptop 2 showed the most effects
  - Copper of heat sink and copper tape were discoloured
  - Some rust on internal stainless steel
  - Screen and keyboard were covered in H_2SO_4 residue
- Other laptops showed little effect
- USB cable plugs corroded

- Ash testing is next....



Ash fall impacts to roofing

Common misperception that ashfall will cause roof collapse due to structural collapse

•Reality is that only 0.01% of the exposed building stock will fail in a major ashfall

•Falls from roofs is one of the largest causes of injury and death following an ashfall in modern situations

Futaleufu, Chile received 200mm of ashfall followed by snowfall 10 days later.

•No structural collapse occurred

•>25% of the building stock exhibited heavy rust damage>20% suffered gutter collapse or damage.

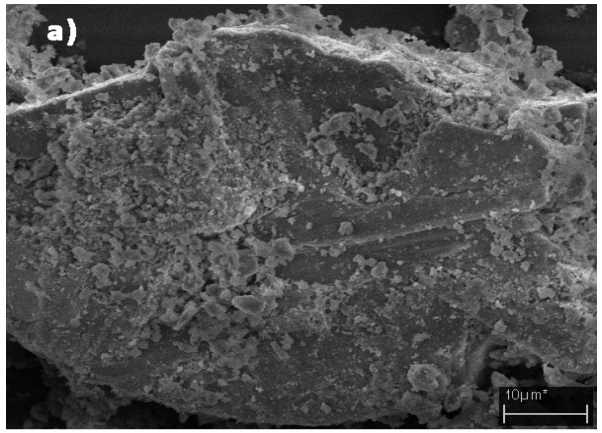
Ash fall impacts to roofing

1. The vulnerability of standard New Zealand metallic roofing and gutter materials to corrosion following volcanic ash exposure over time

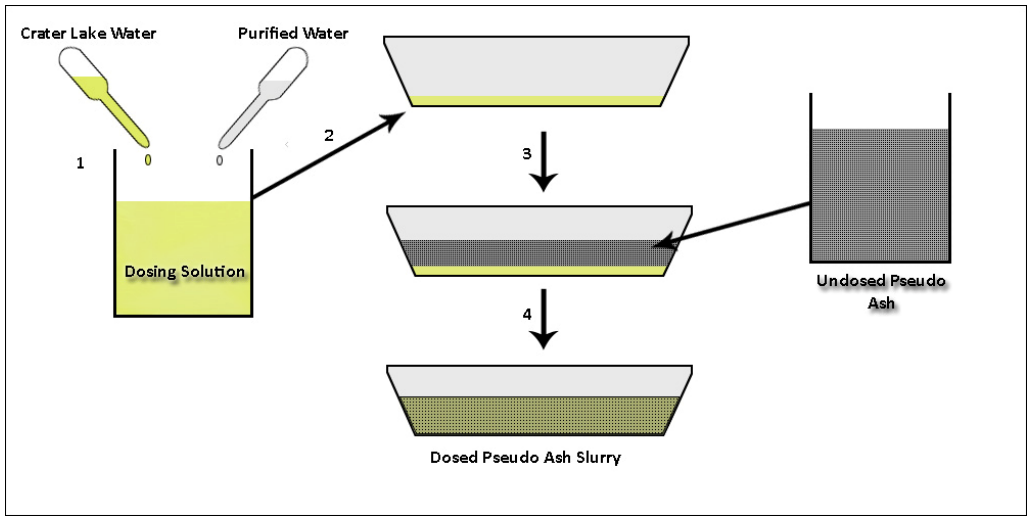
2. Deterioration rate of metallic roofing and gutter materials roof

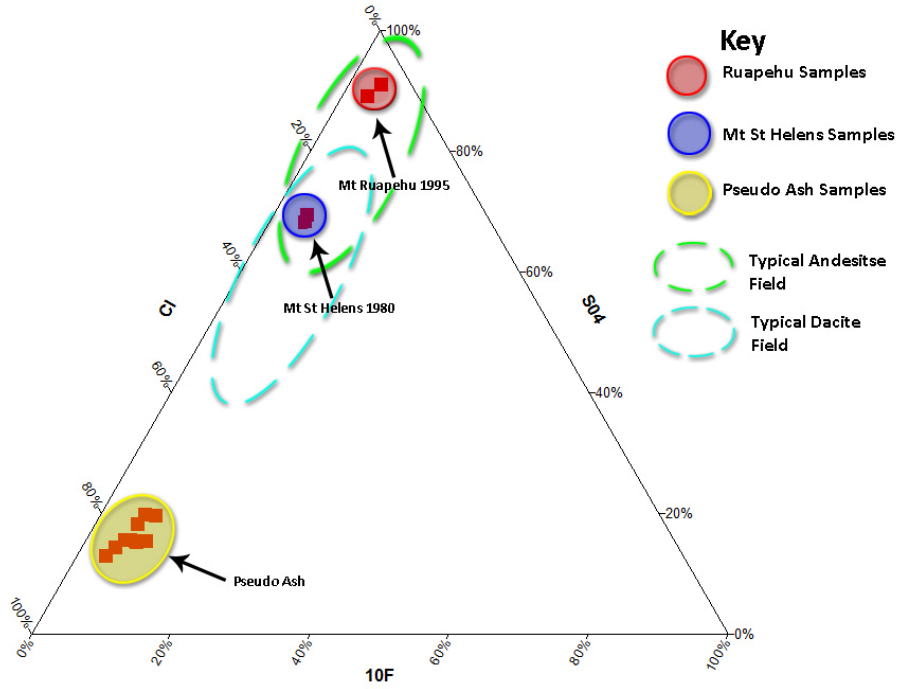
3. Performance of standard New Zealand gutters under ash loading

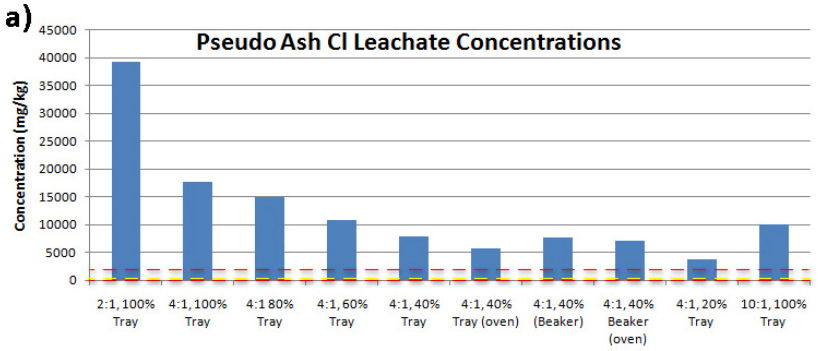
Sam Broom, Dean Podolsky, Jim Cole, Kerry Swanson, BRANZ, et al.

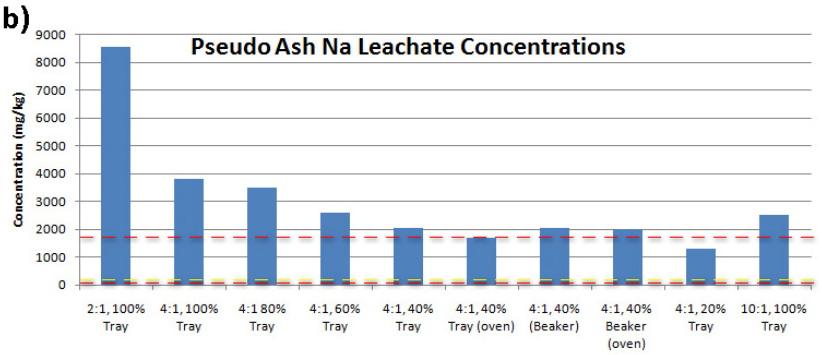


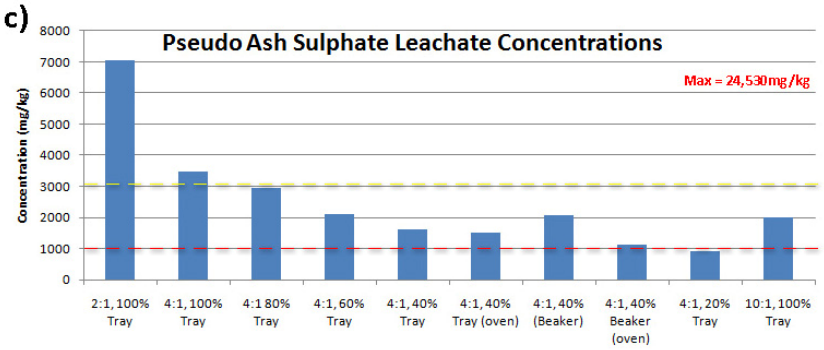
Wastewater analysis – effectiveness of flocculants



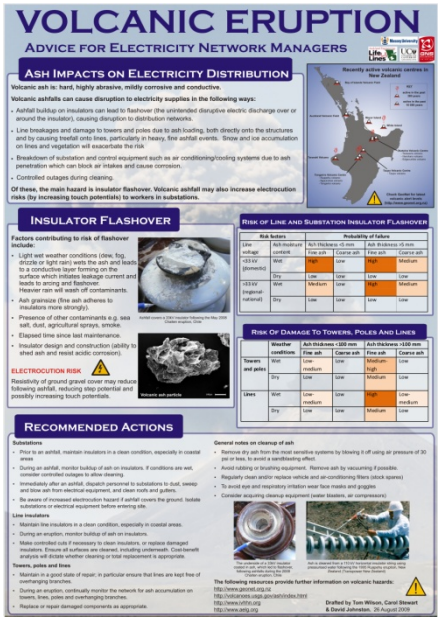


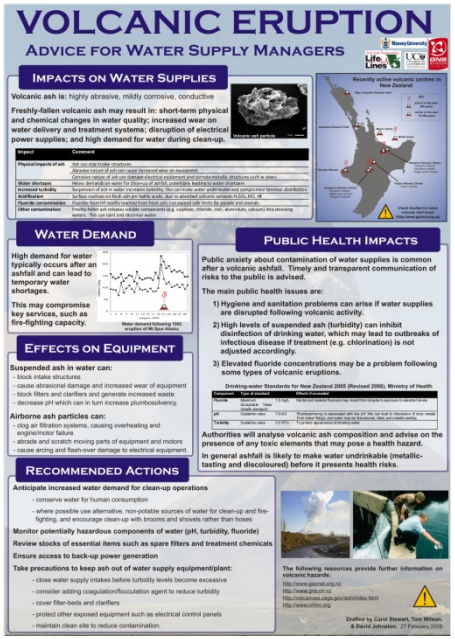


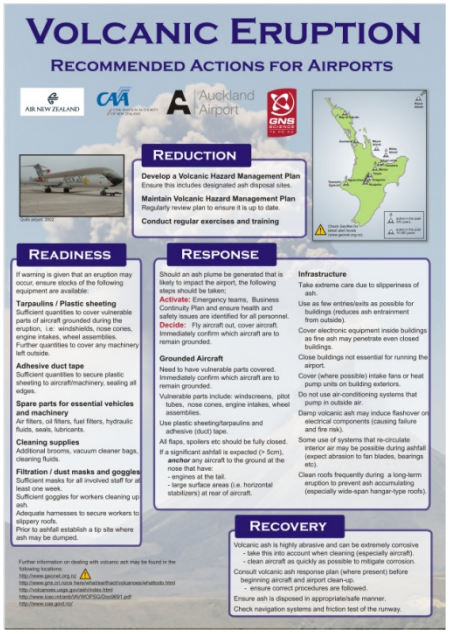




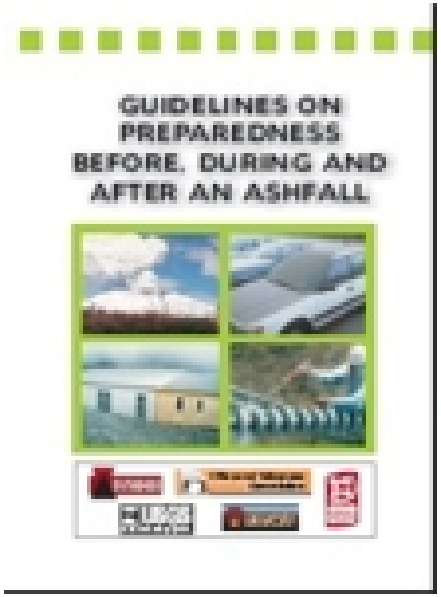
Ash Impacts Posters







Contributing to international resources



QUESTIONS?

Ashfall mitigation measures for livestock during the 2006 Ubinas eruption, Peru