The Preservation of the 1980 Mount St Helens Tephra Layer

Nick Cutler[1], Richard Streeter[2], Andrew Dugmore[3], Polly Thompson[3], and Anthony Newton[3]

[1]Newcastle University
[2]University of St Andrews
[3]University of Edinburgh

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Abstract

Tephra layers are often used to reconstruct past eruptions. However, accurate interpretation of tephra layers depends on their degree of preservation. We asked: how much volcanological information do terrestrial tephra layers typically retain? We addressed this question with a study of the tephra layer produced by the May 1980 eruption of Mount St Helens, comparing historical records of deposit thickness and grain size distribution with measurements made four decades after the eruption. Using published isopach maps as a guide, we looked for the tephra layer in locations 15 – 600 km from Mount St Helens, selecting sample locations we judged to have high preservation potential. We found that preservation of the 1980 tephra deposit was often extremely good: observed thickness, mass loading and grain size distributions were similar to equivalent measurements made in 1980. However, we also observed high variability in preservation on small spatial scales, and our results indicate that landscape-scale volcanological reconstruction is sensitive to sample number and location, even when many sites display excellent preservation. Tephra preservation is clearly a complex and contingent process influenced by climate, biology, topography, parent material (i.e., grain size, morphology and geochemistry) and time. The relative importance of these factors will vary from place to place. We propose that the only way to tease apart these factors – and to fully understand the information content of tephra layers - is through direct observation of tephra deposits (whether natural or experimental) over extended time periods.

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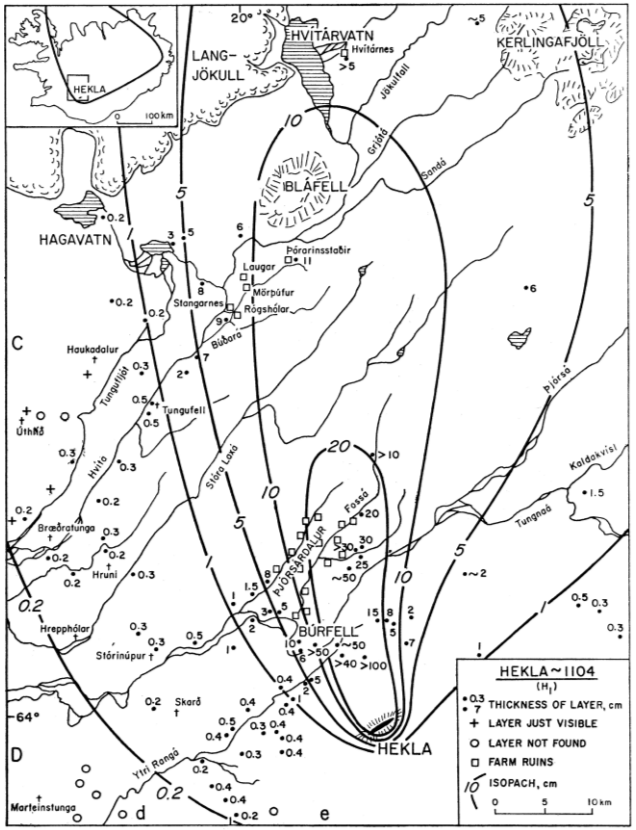
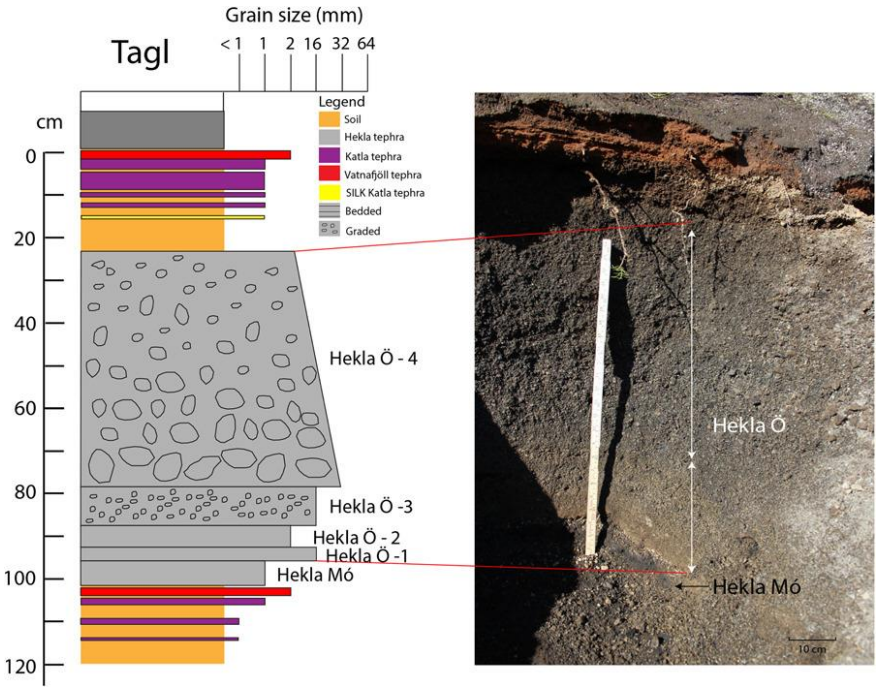
Nick Cutler (Newcastle University); Richard Streeter (University of St Andrews); Andy Dugmore, Anthony Newton & Polly Thompson (University of Edinburgh)

Context



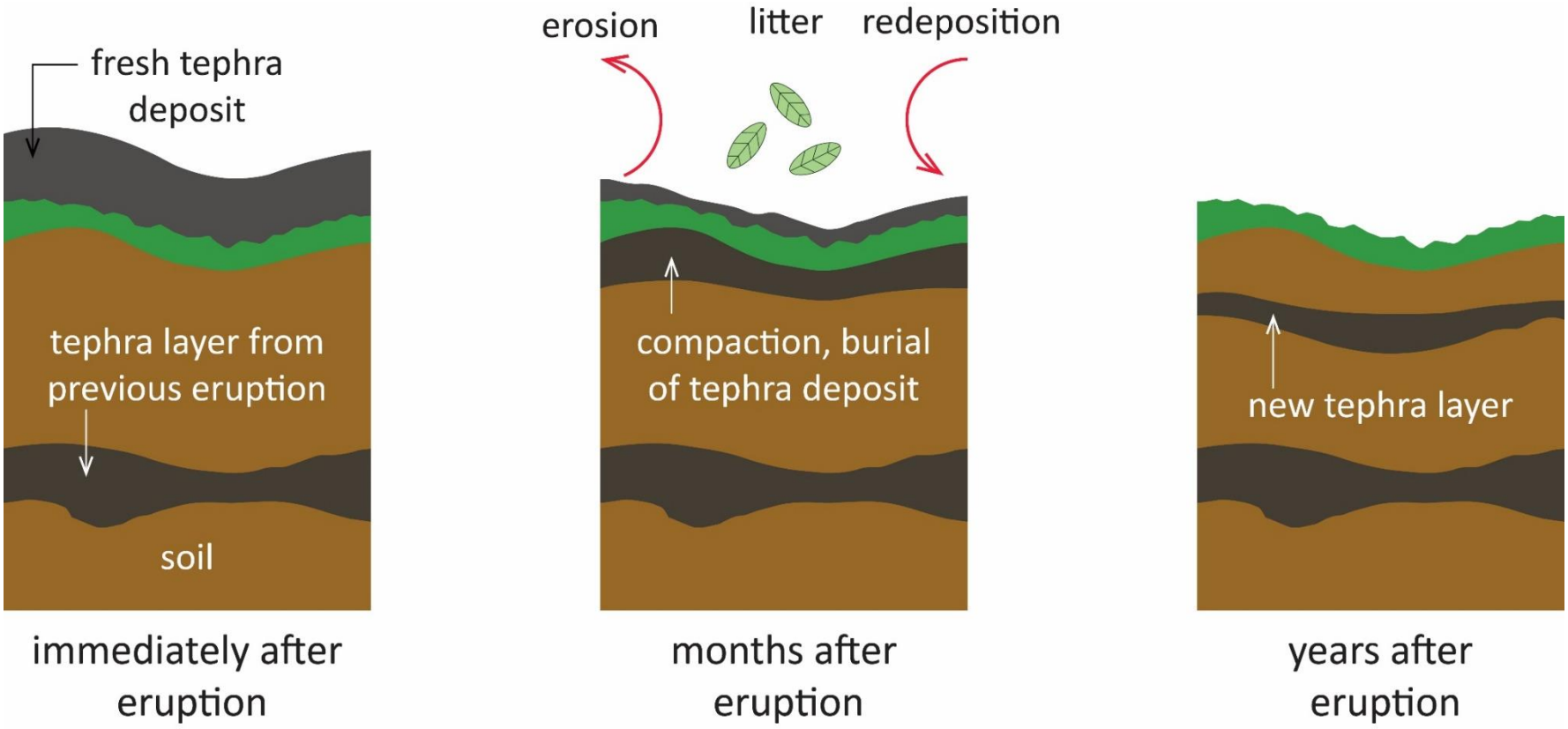
Hekla 1104 CE
Thorarinsson (1967)



Tephra stratigraphy
Jónsson et al. *(2020)*

Tephra and volcanological inference

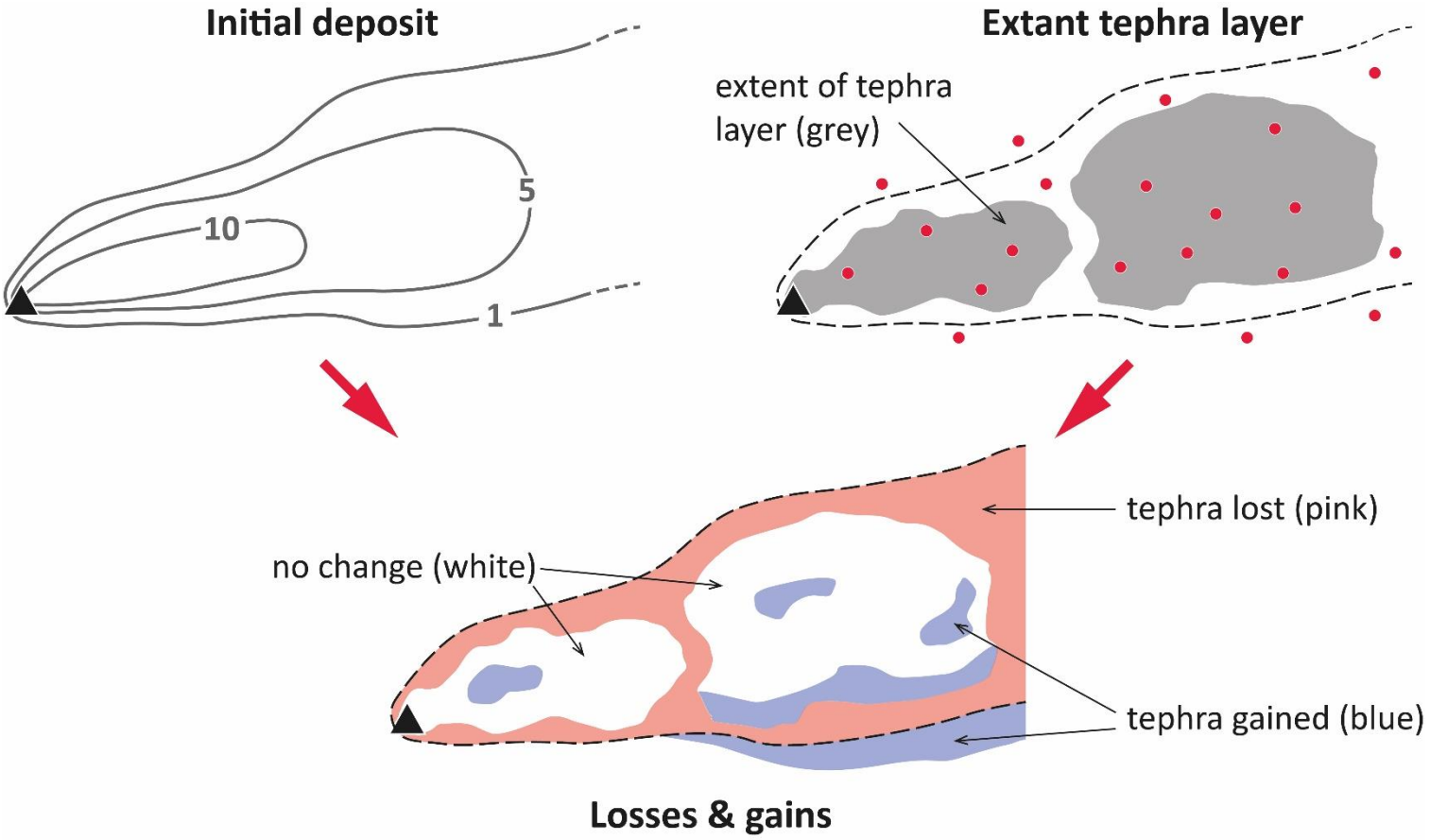
Context



Degree of preservation matters

- To what extent do terrestrial tephra layers resemble the deposit from which they are formed?

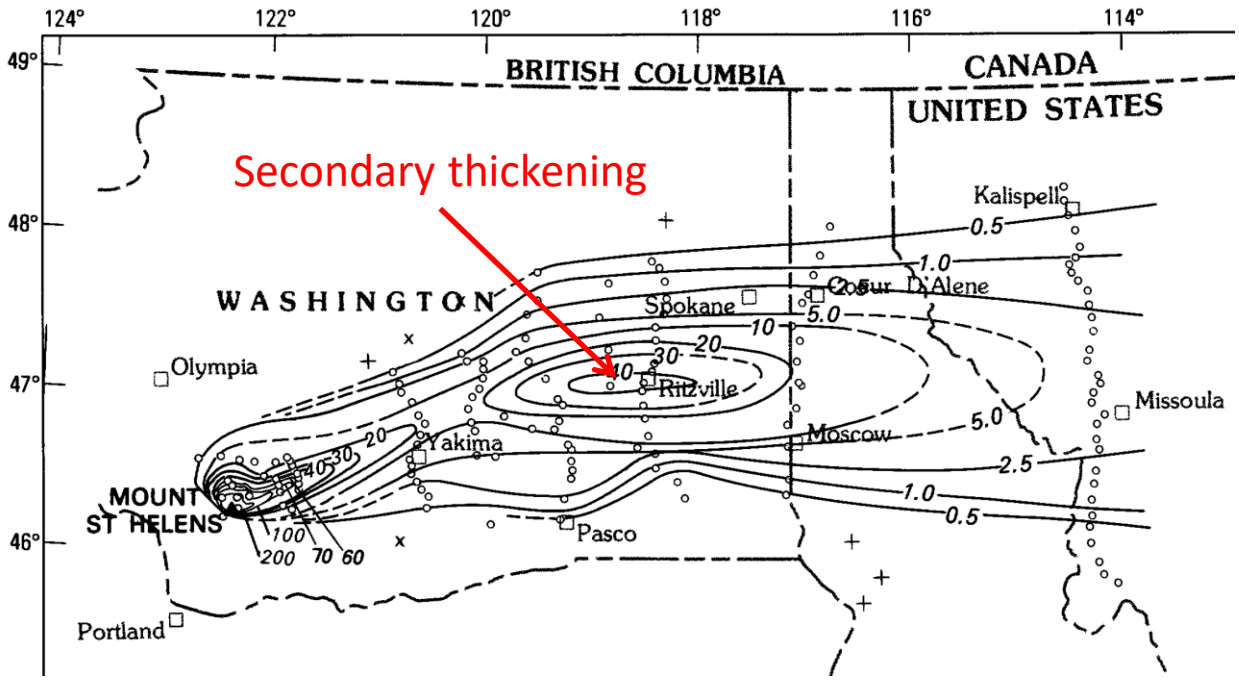
Methods



Research strategy

- Re-survey of well known, recent tephra layer

Methods

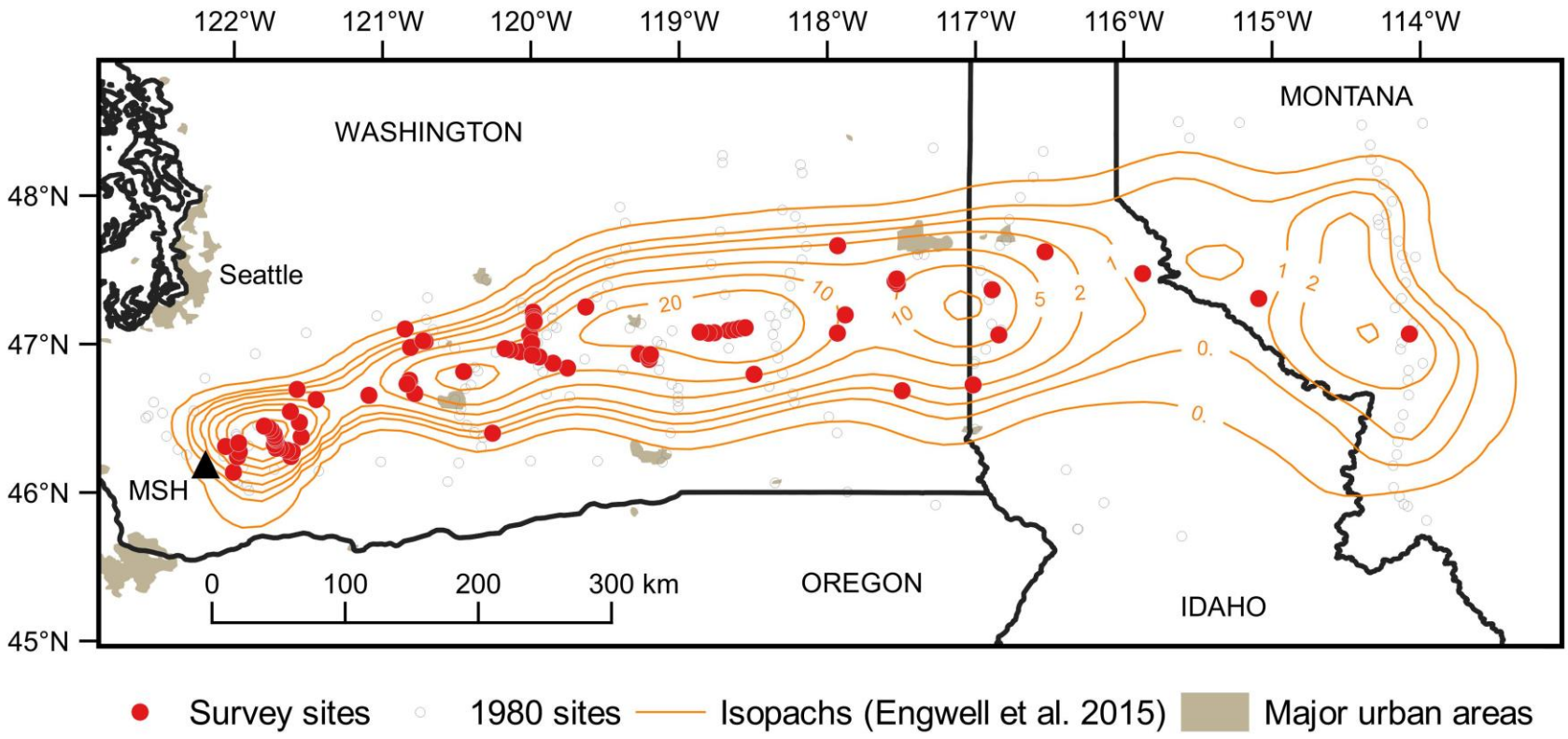


Sarna-Wojcicki et al. *(1981)*

Research location: Mount St Helens

- Study focussed on tephra from 1980 eruption

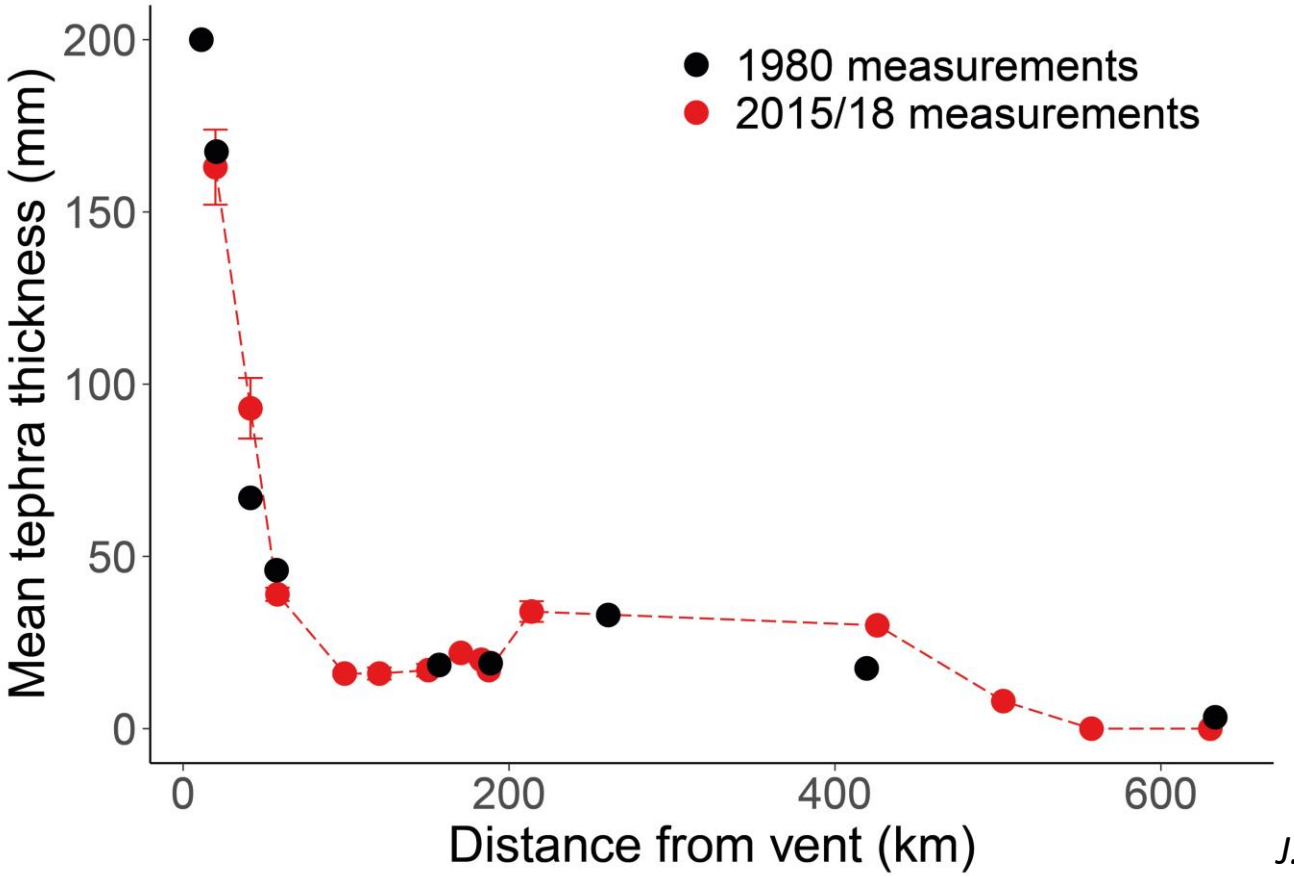
Methods



Fieldwork

- 86 Sampling locations, 13 to >600 km from volcano

Findings

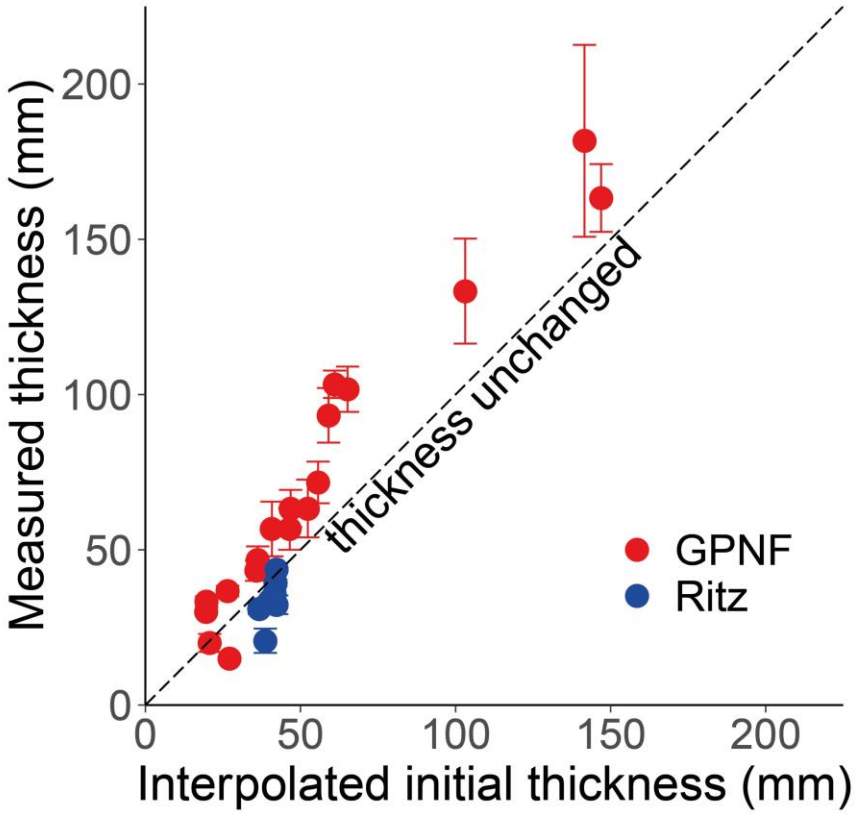


Tephra thickness along plume axis
Cutler et al. *(2020) J. Volcanol. Geotherm. Res.*

Tephra thickness

- Tephra layer thickness closely resembles initial deposit

Findings

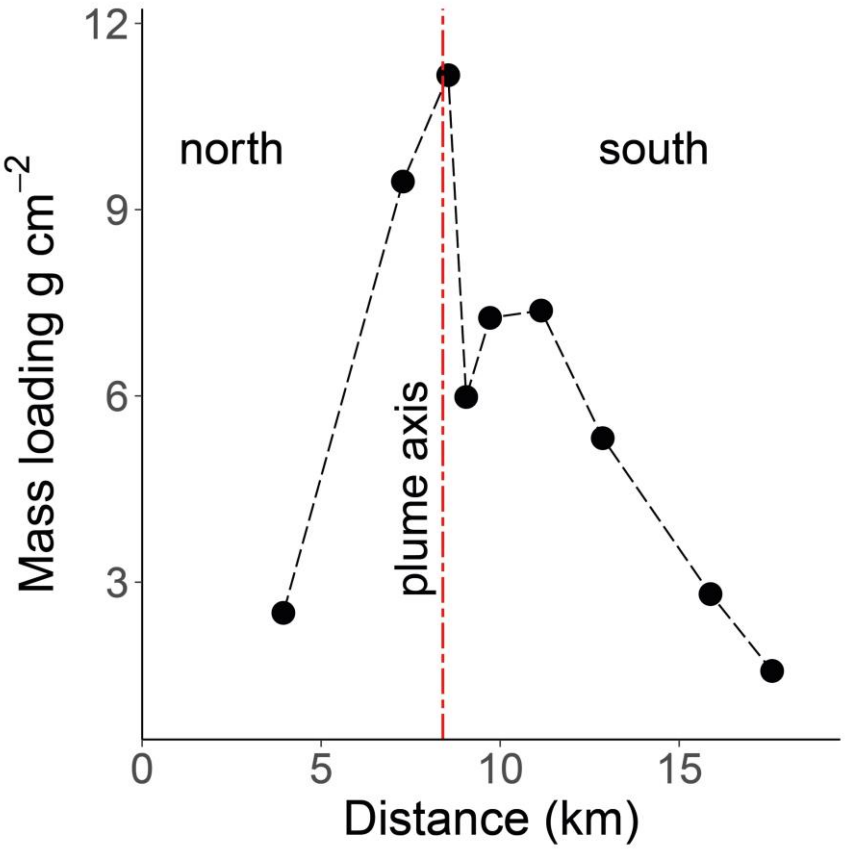


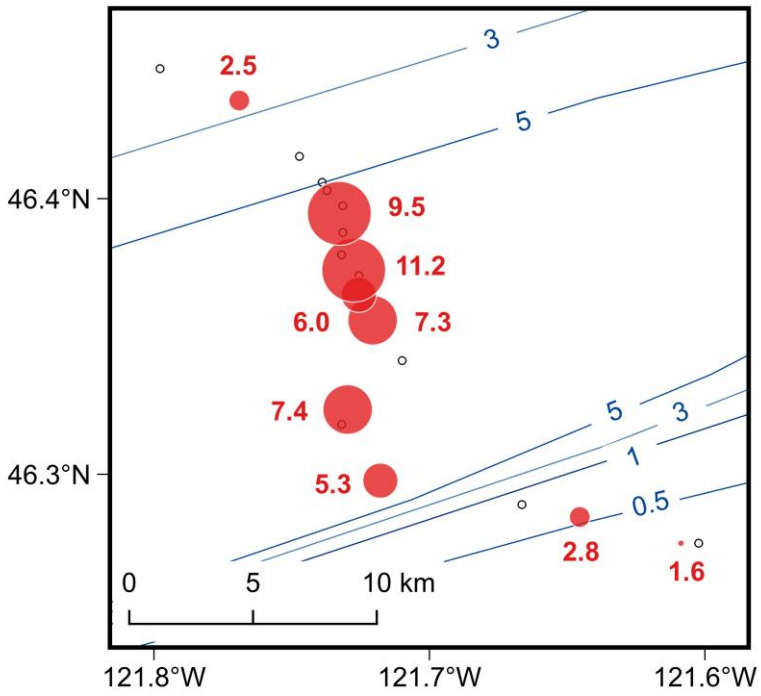
Comparison of a) interpolated deposit & b) tephra layer thickness
Cutler et al. *(2018) Bull. Volcanol.*

Tephra thickness

- Tephra layer thickness closely resembles initial deposit

Findings





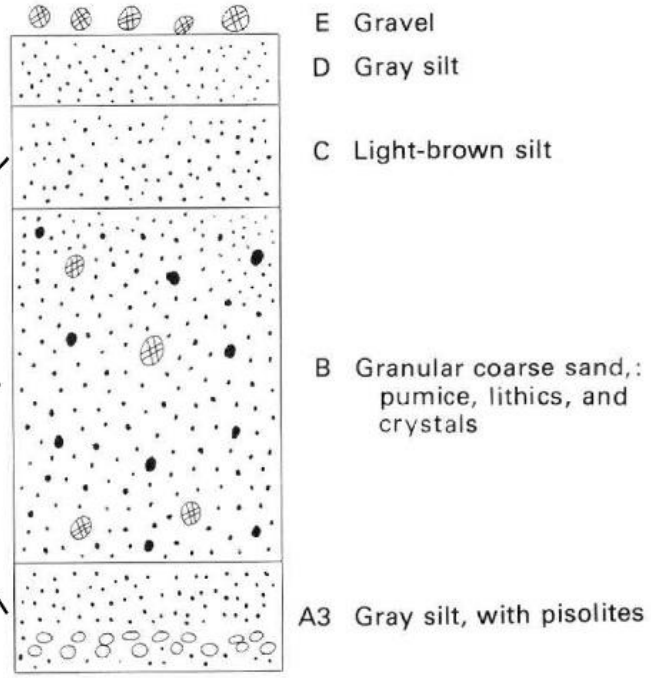
MSH1980 mass loading (g cm^{-2})
1980 in blue, 2015 in red
Cutler et al. *(2018) Bull. Volcanol.*

Tephra mass loading

- Follows thickness, i.e., close to 1980 values

Findings

A typical section from 2018

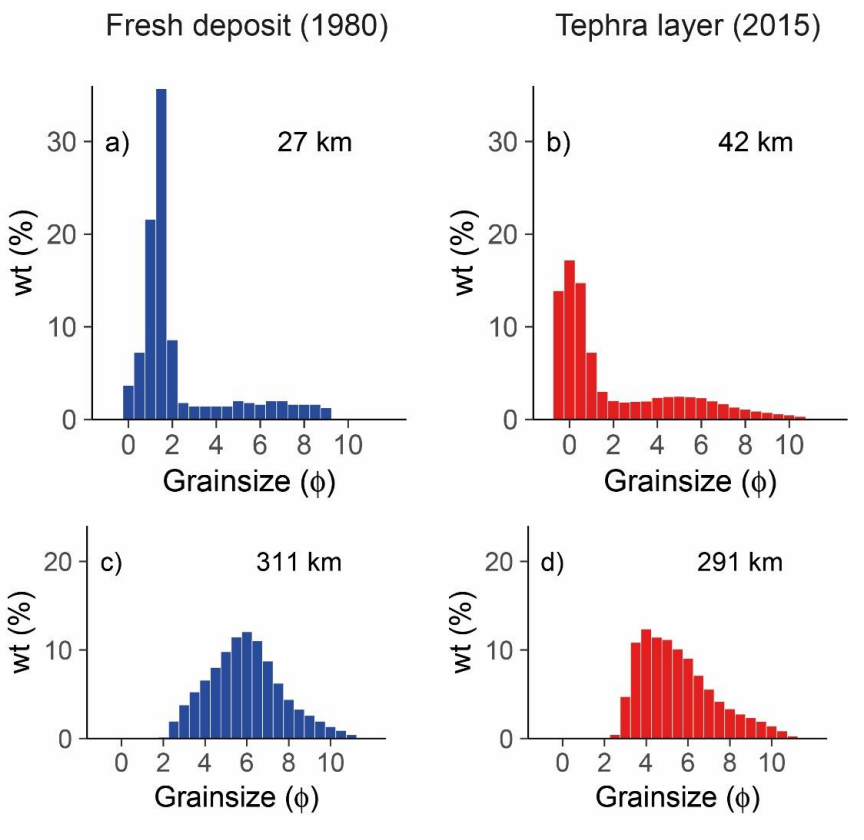


Waitt & Dzurisin (1981)

Stratigraphy

- Units observed by USGS in 1980 preserved

Findings



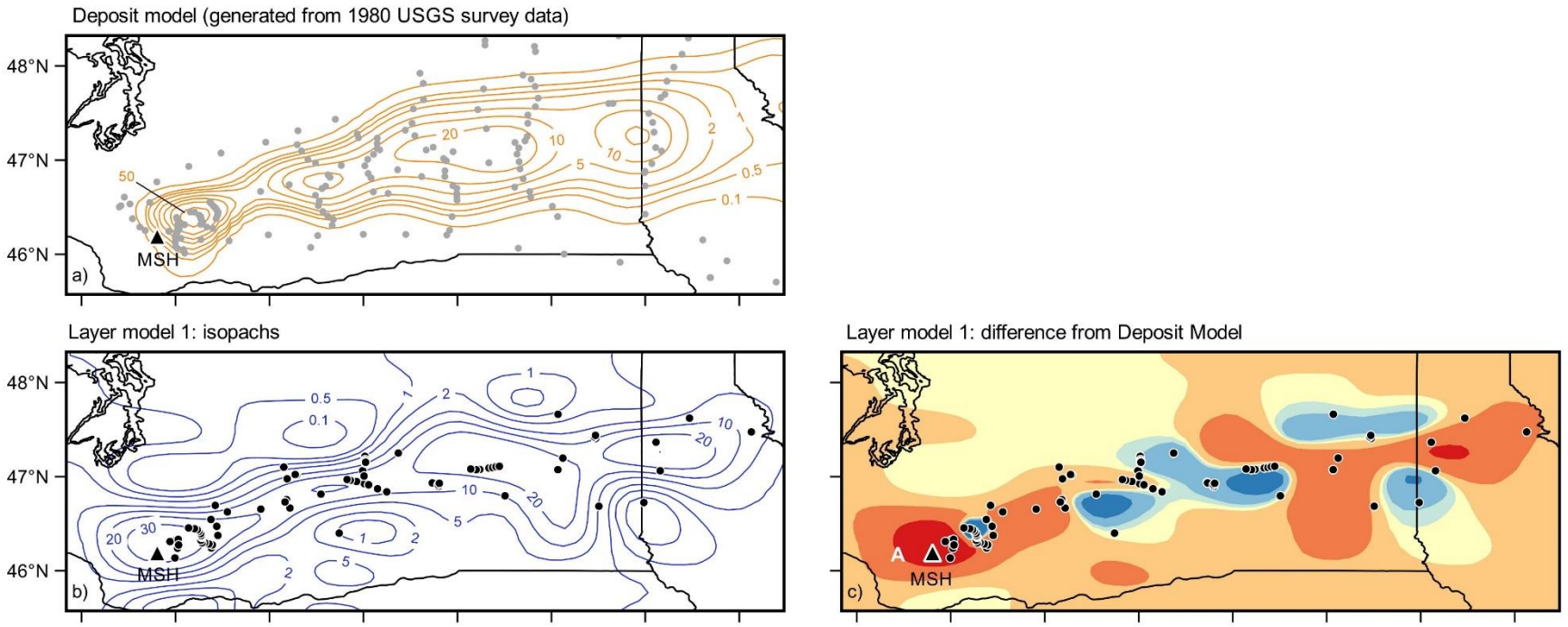
MSH1980 in Ritzville, with biocrust

MSH1980 grain size distributions
Cutler et al. *(2021) Bull. Volcanol.*

Grain size

- Distinctive patterns in grain size distributions preserved

Findings



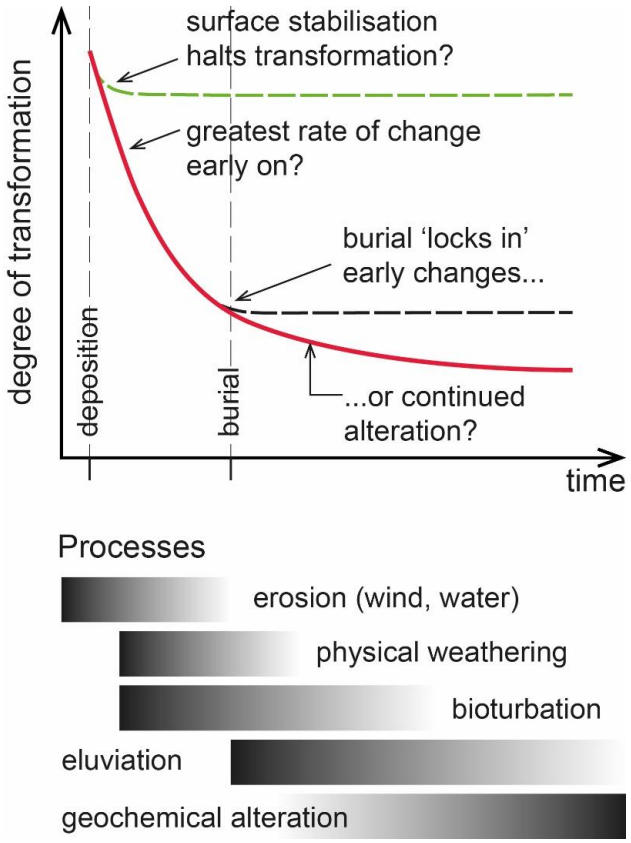
Modelled tephra layer thickness

Cutler et al. *(2020) J. Volcanol. Geotherm. Res.*

Reconstruction of fallout

- Our model <u>overestimated</u> fallout volume

Next steps



Conceptual model

$$s = f(cl, o, r, p, t)$$

Hans Jenny's soil forming factors (1941)

Somewhere in a warehouse…

The value of experimental applications

- We need long-term experiments

Thank you for listening!

Royal Geographical Society with IBG

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QRA
Quaternary Research Association