British Geological Survey
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Gateway to the Earth

BURIED VALLEYS

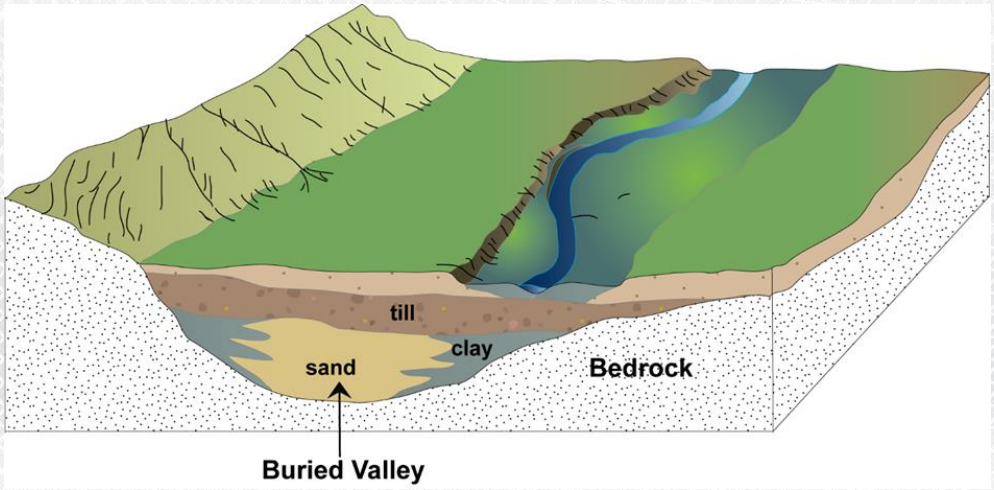
AND WHERE TO FIND THEM

TIM KEARSEY

JONATHAN LEE, ANDREW FINLAYSON, TONY IRVING, MARIETA GARCIA-BAJO

What is a Buried valley?

Palaeo valleys (or buried valleys) are valley systems that have become filled with sediment and are no longer active



They are typically formed by:

i. Subaerial fluvial incision

ii. Glacial over-deepening

iii. Tunnel valleys (or tunnel channels)

iv. polygenetic palaeo-valleys

Why are they important?

They are significant for:

- Groundwater
- Foundation conditions
- Geothermal resources

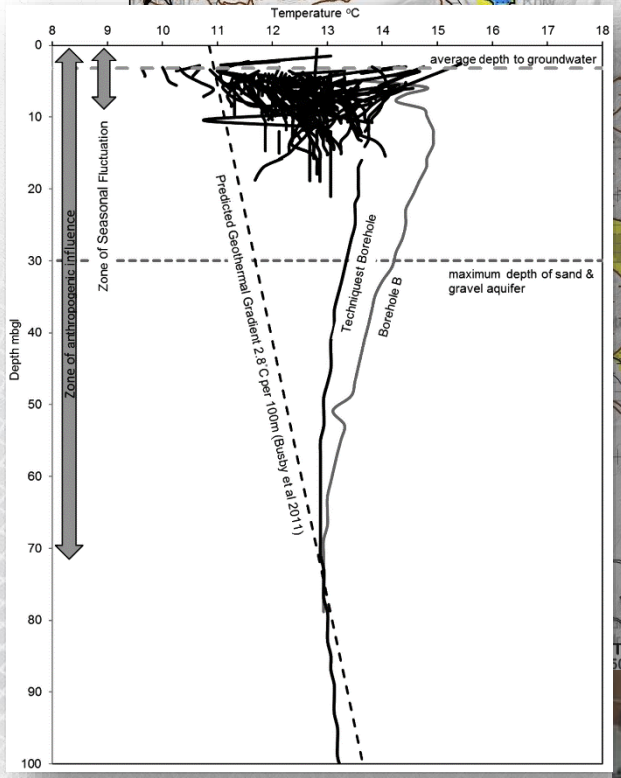
Engineering significance

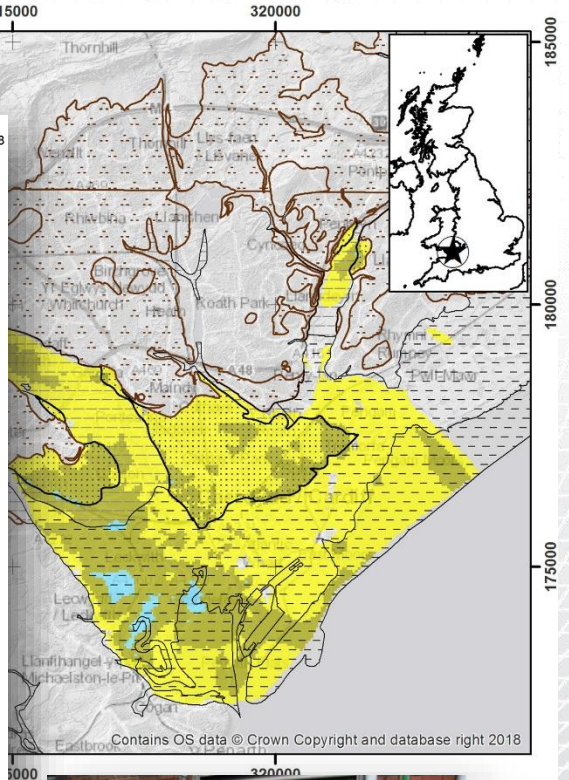
- Voids
- Variable particle sizes
- Compressible soils
- Perched water tables

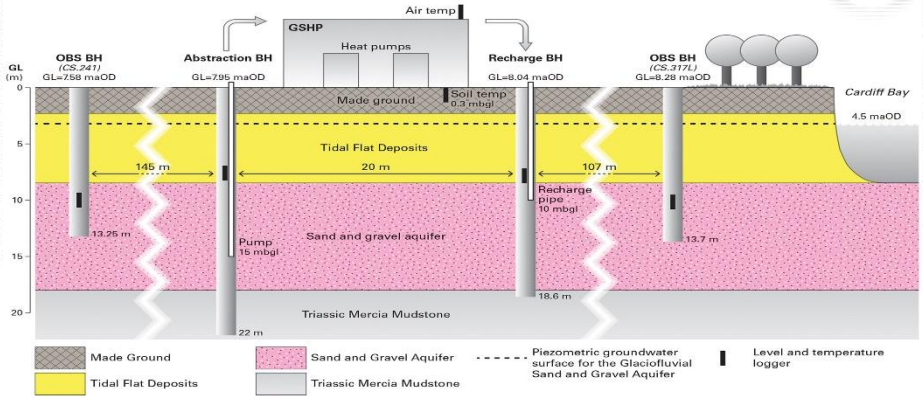
Shallow Geothermal

Cardiff Shallow Geothermal Project

- Targeting shallow sand and gravel aquifer in a buried valley under Cardiff
- Shallow groundwater temperatures under the city were found to be 2°C warmer
- ‘Sub-urban heat island effect’
- Now being used for Open-loop geothermal heating

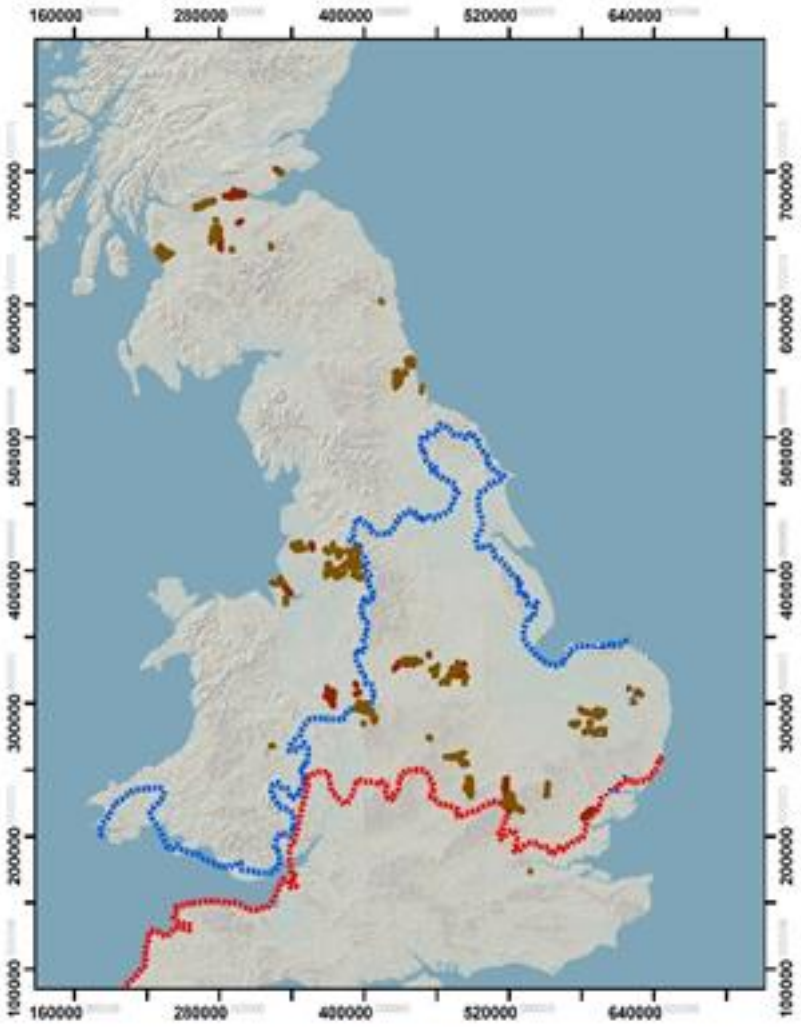




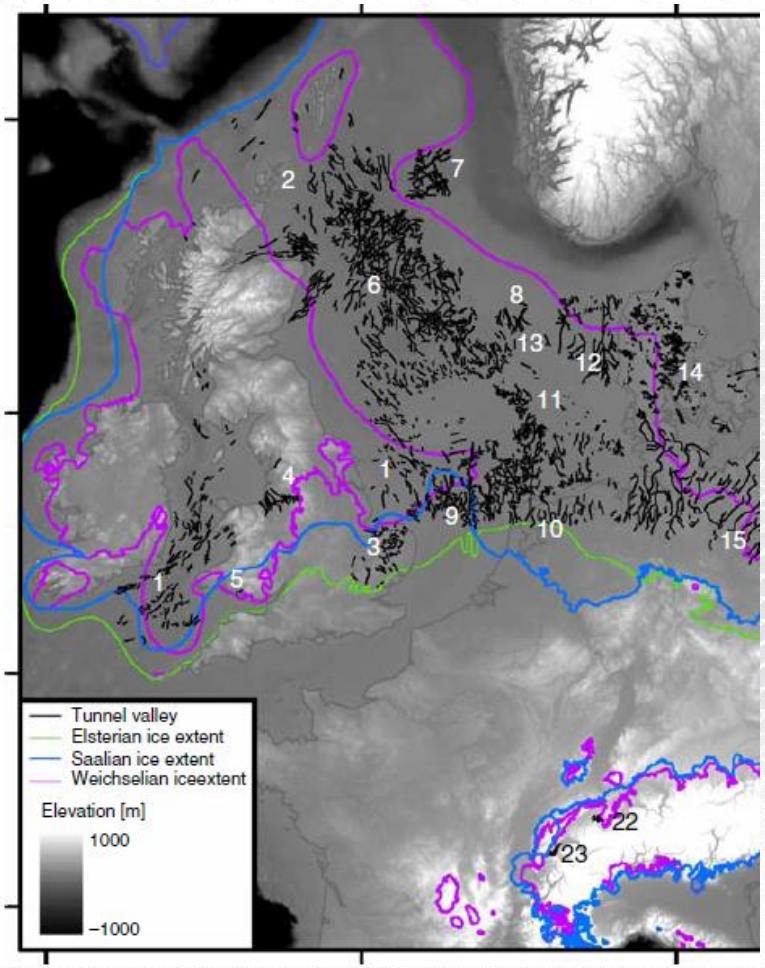


Boon, D.P., Farr, G.J., Abesser, C., Patton, A.M., James, D.R., Schofield, D.I. and Tucker, D.G., 2019. Groundwater heat pump feasibility in shallow urban aquifers: Experience from Cardiff, UK. *Science of The Total Environment*, p.133847.

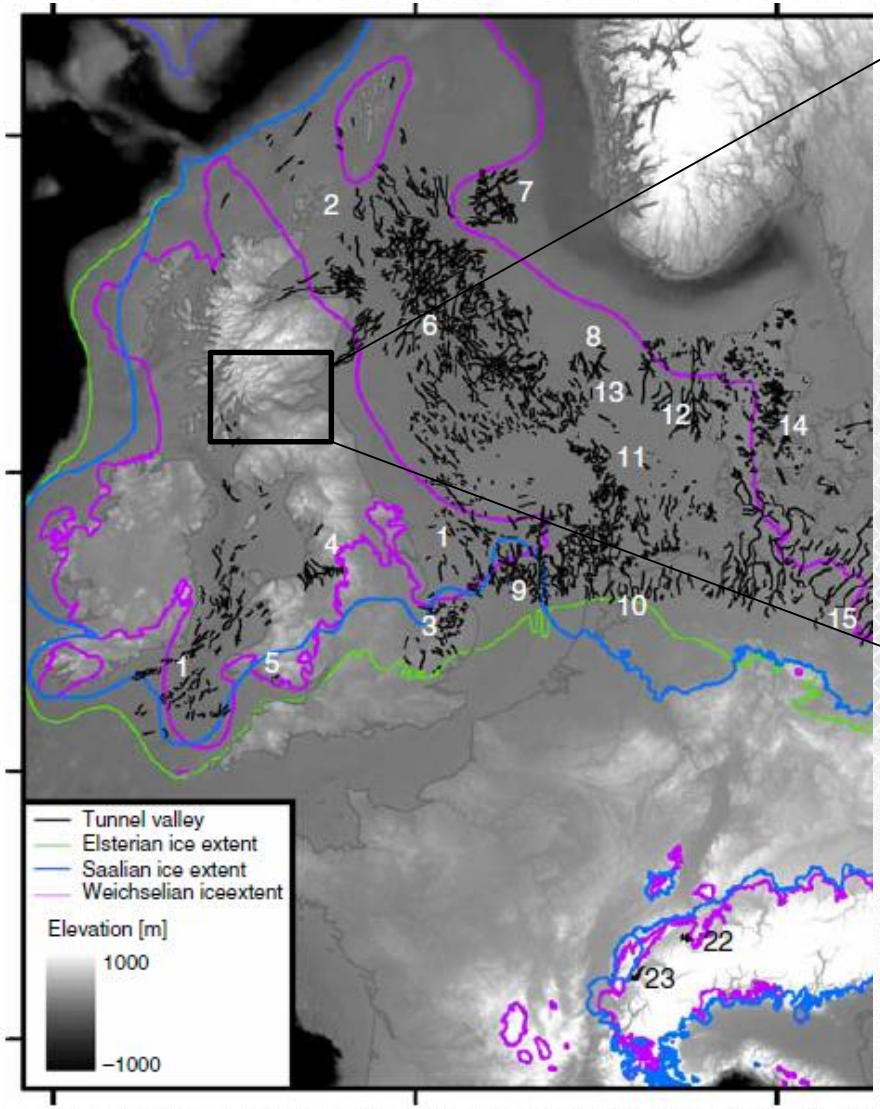
What do we know about the distribution of Buried Valleys onshore UK?



Buried Valleys on BGS digital maps



Distribution of Tunnel valleys in Europe
(Van Der Vegt et al. 2012)



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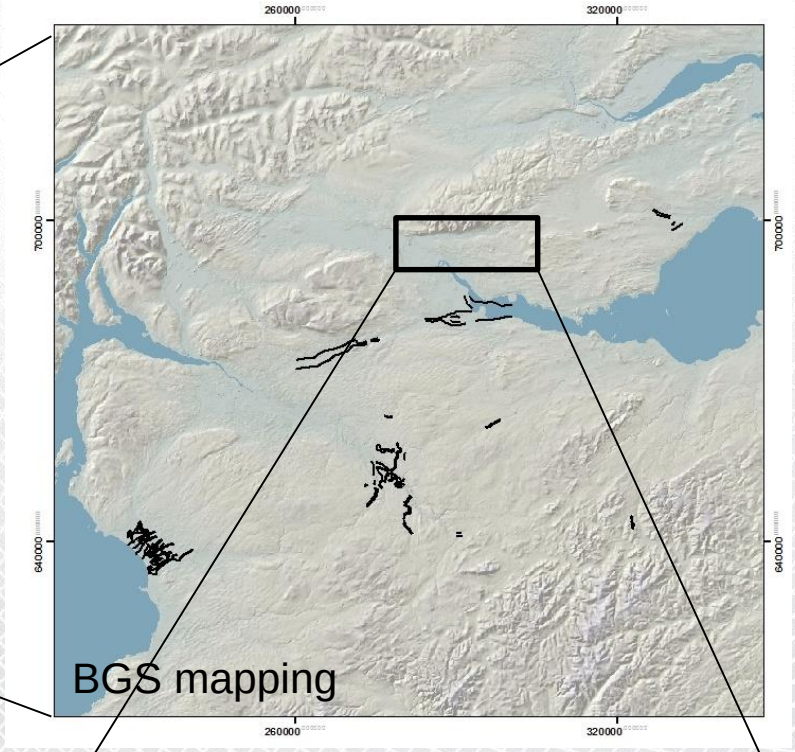


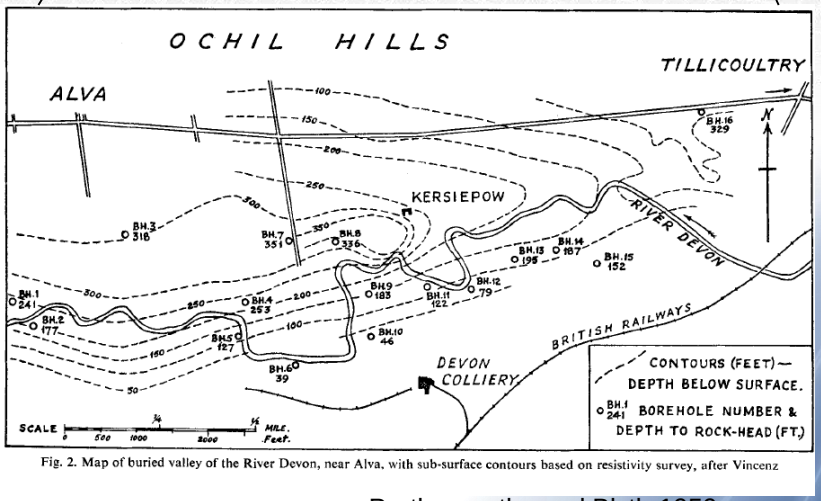
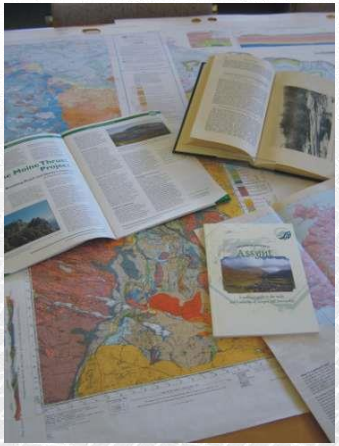


Fig. 2. Map of buried valley of the River Devon, near Alva, with sub-surface contours based on resistivity survey, after Vincenz

Parthasarathy and Blyth 1959

Historical References to Buried Valleys



120 BGS publications
25 technical reports
8 open reports

contained the phrases “buried valley”, “tunnel valley”, “sub-drift topography” and “drift filled channel

Location of buried valleys from 96 different publications

Buried channels have been recorded near Northampton, by Mr. Beeby Thompson; and “at Furtho an old valley of the Ouse has in its midst boulder-clay to a thickness of 100 ft. or more.” (7). The drift at Henlow extends to a depth of over 200 ft. below sea-level and is thought to occupy a channel which has been traced past Hitchin.

IN THE

COUNTIES OF ENGLAND AND WALES

EXCLUSIVE OF RC

A. STRAHAN, Sc.
H. DEWEY,
SIMMONS, B.
D. A. WRAY,

PUBLISHED BY ORDER OF TH

PRINTED FOR HIS
By JAS. TRUSCOT

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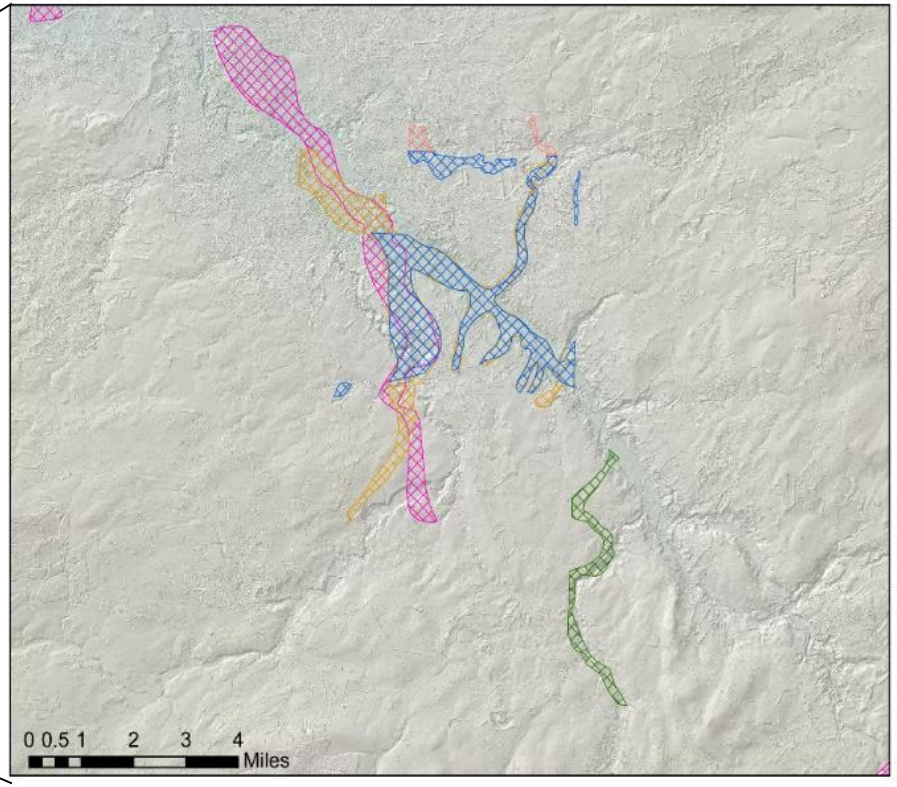
E. STANFORD, Lt
W. & A. K. JOHNSTON
HODGES, FIGGIS

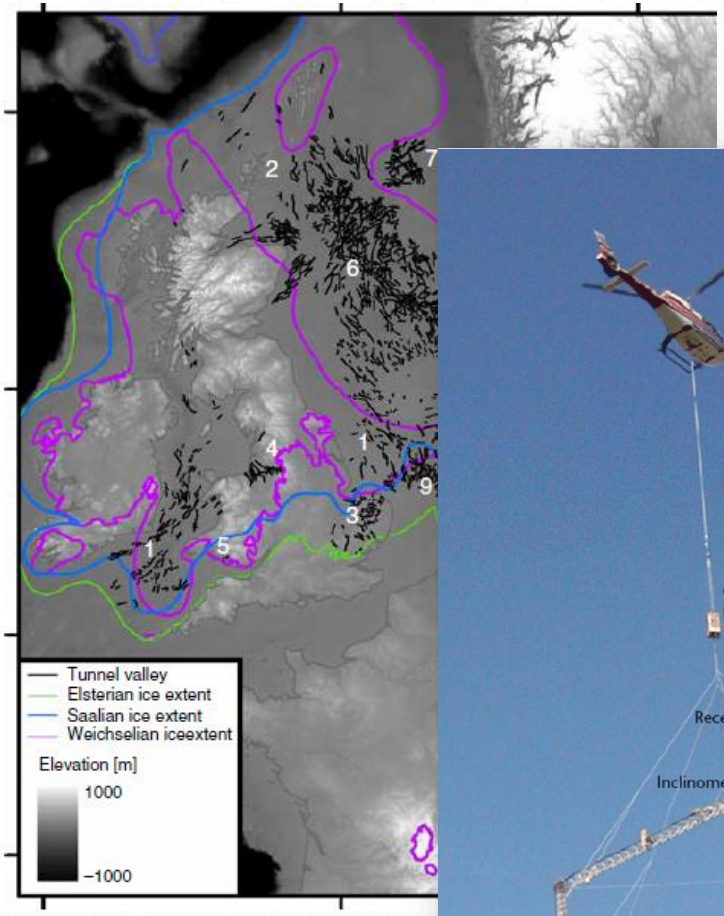
Historical References to Buried Valleys

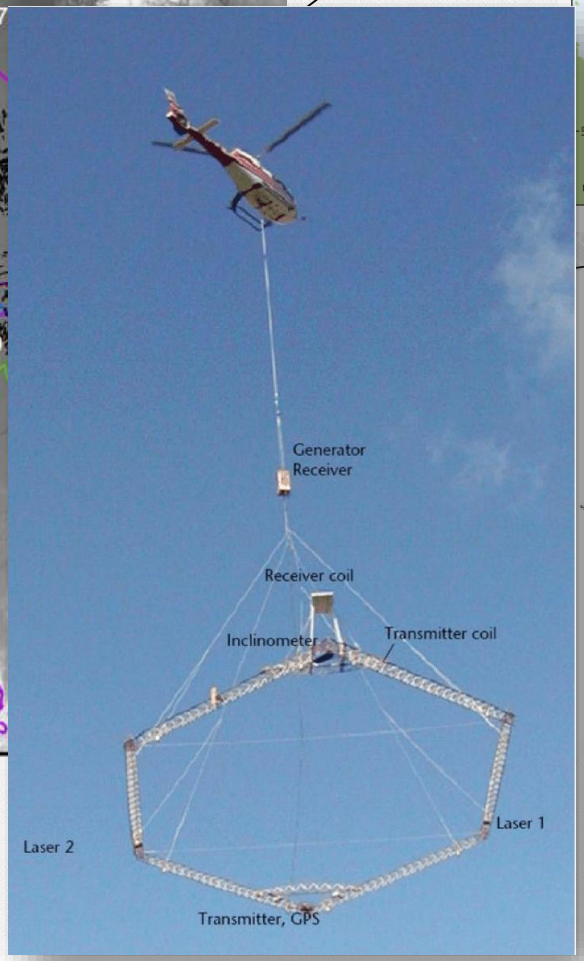


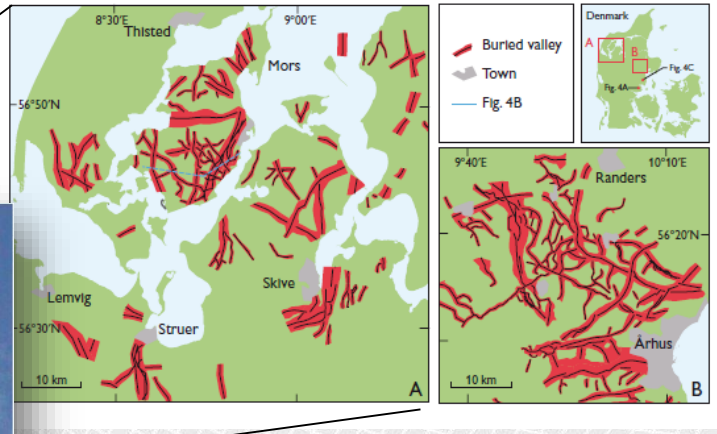
Legend

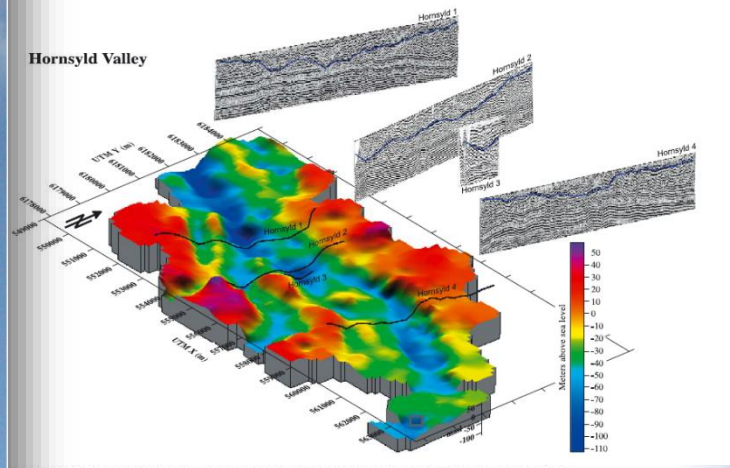
- BGS, 1926, Hamilton, sheet 23, Drift, Geological Survey of Scotland, 1:50,000 geological map series
- BGS, 1992, Airdrie, sheet 31W, Drift, Geological Survey of Scotland, 1:50,000 geological map series
- BGS, 1993, Hamilton, sheet 23W, Drift, Geological Survey of Scotland, 1:50,000 geological map series
- Kearsey, T., Lee, J., Finlayson, A., Garcia-Bajo, M. Irving, A., 2018, Examining the geometry, age and genesis of buried Quaternary valley systems in the Midland Valley of Scotland, UK. Boreas,
- Paterson, I.B., McADAM, A.D. and MacPherson, K.A.T., 1998. Geology of the Hamilton district: memoir for 1: 50,000 geological sheet 23W (Scotland) (Vol. 23). Stationery Office Books (TSO).

How do others do it?









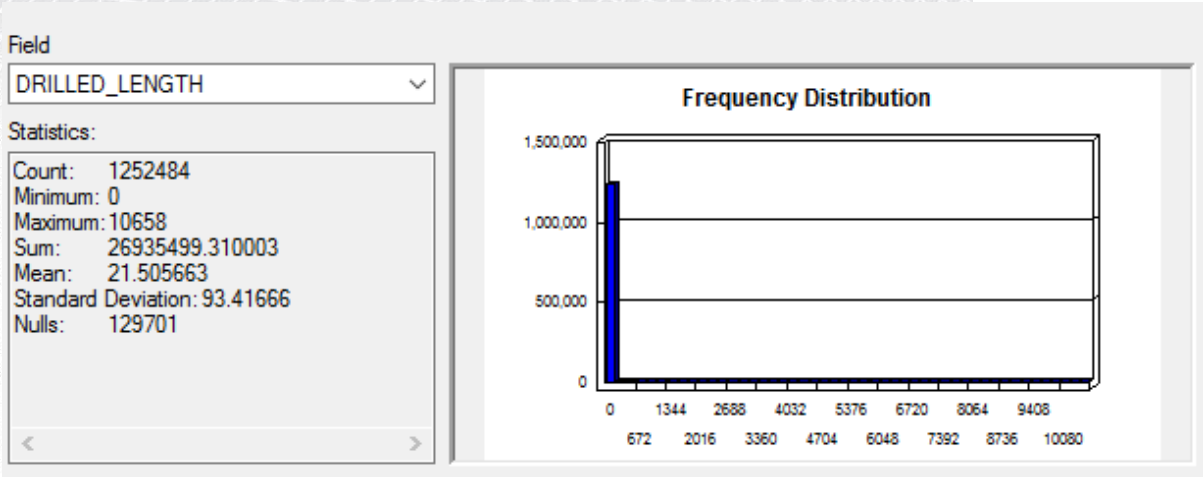
Jørgensen et al. 2002

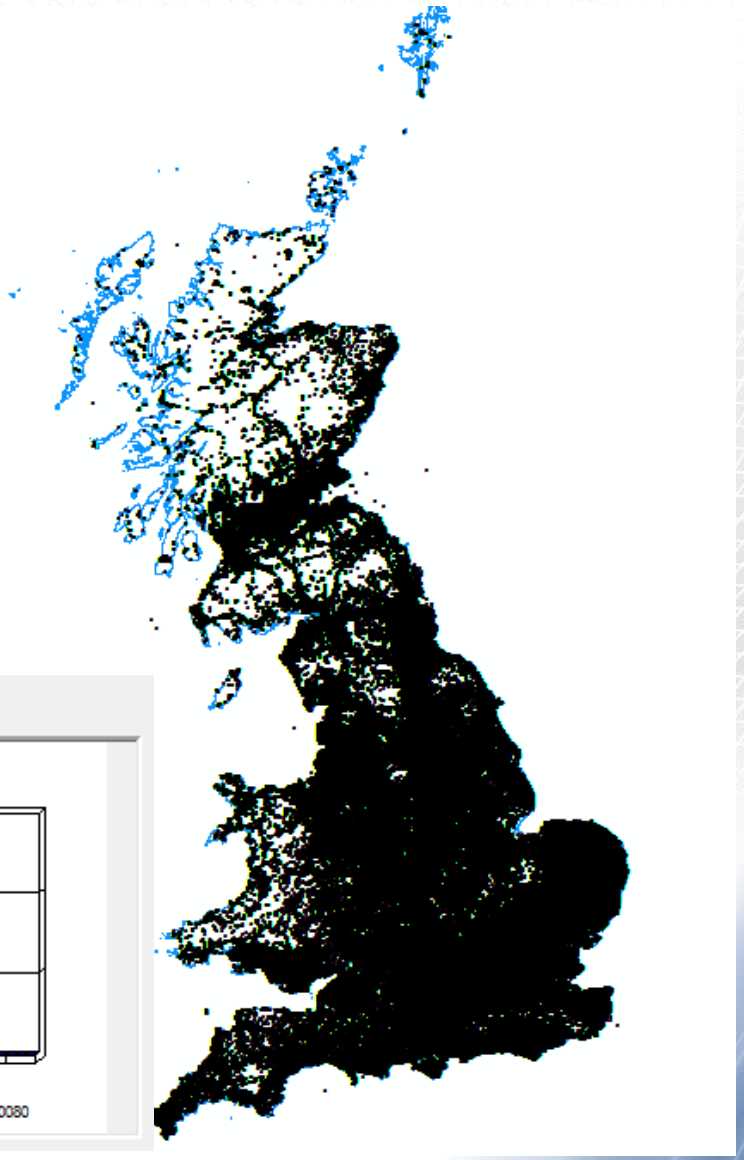
Using boreholes to hunt Buried Valleys

BGS has records of 1, 252,484 boreholes

Range in depth from
0.01m (test pit)
10km (deviated hydrocarbon well)

23% of these have has the top of bedrock manually identified and coded into a database over the last 20 years





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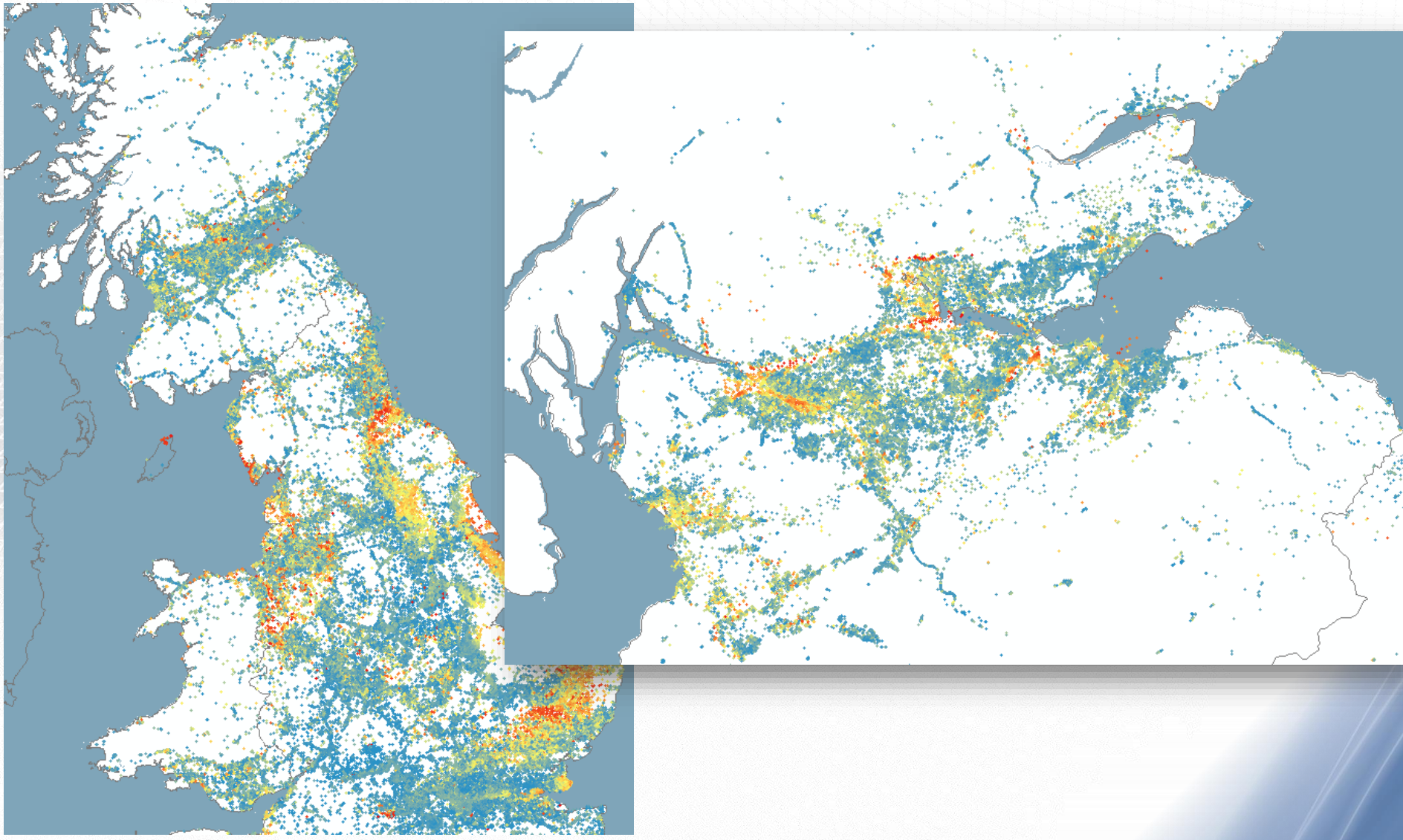
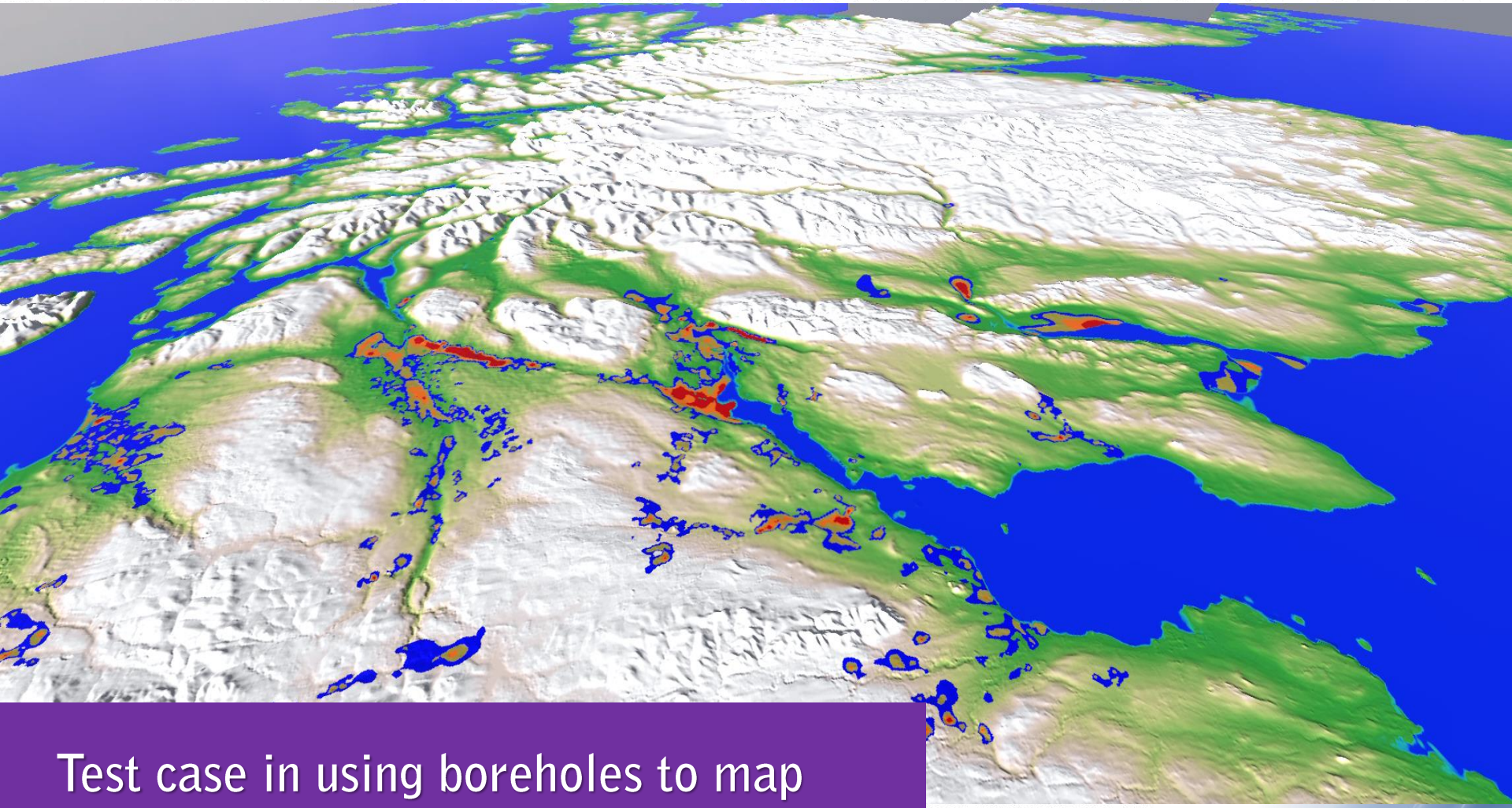
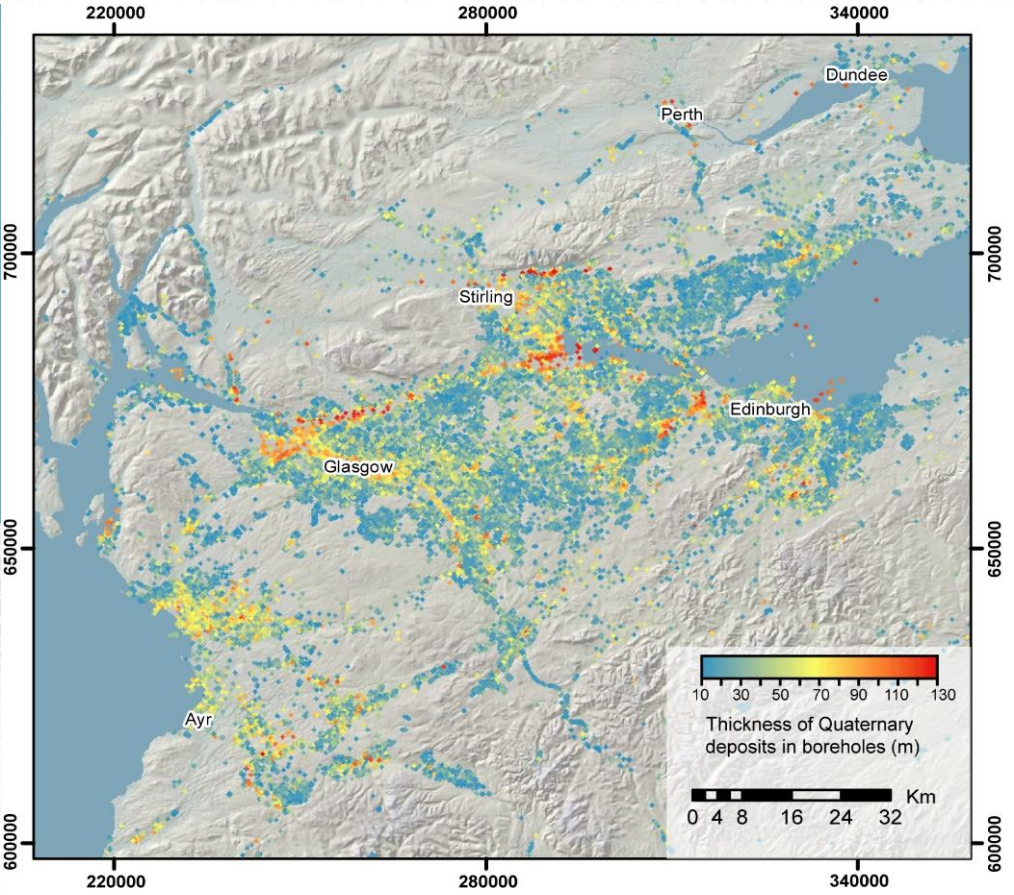


Midland Valley of Scotland



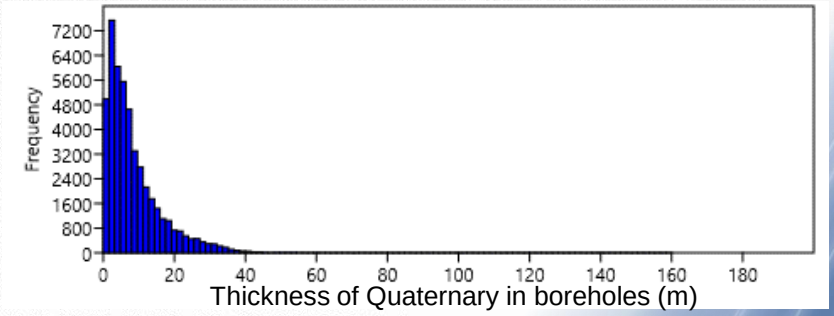
Test case in using boreholes to map Buried Valleys

Finding Buried Valleys in the Midland Valley of Scotland

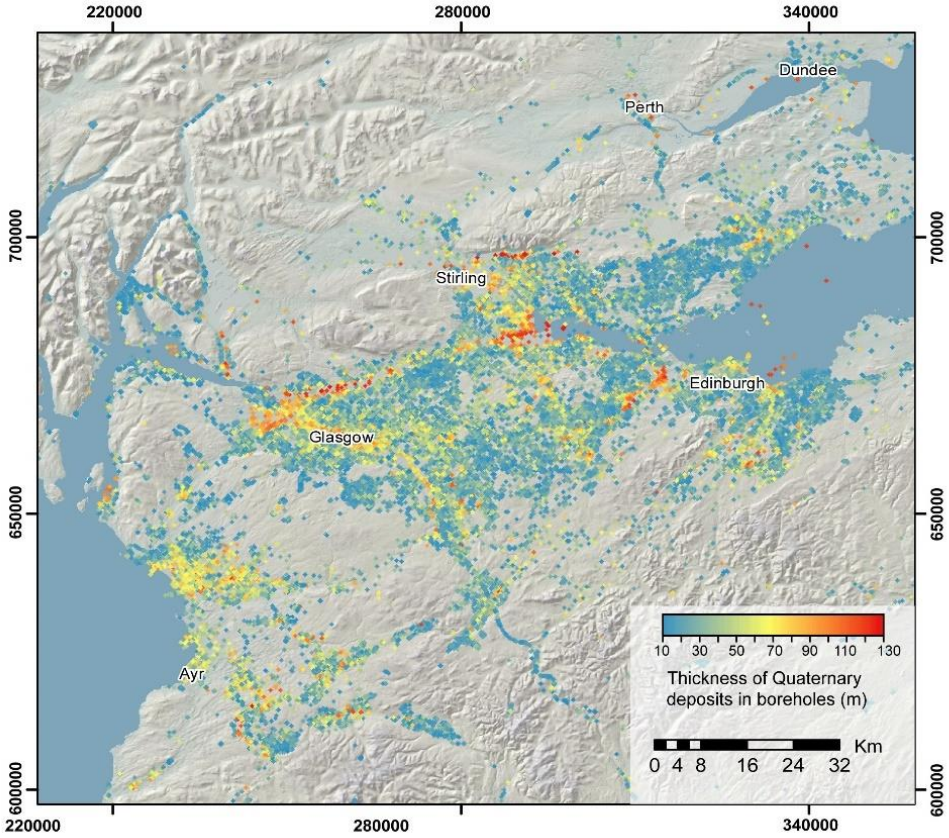


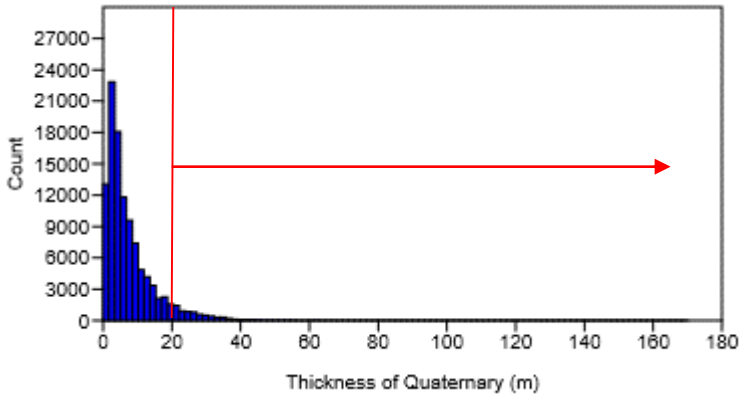
113 415 boreholes that intersect the top of bedrock

Thickness of Quaternary from boreholes
Average= 7.54 m
90% percentile = 19 m
95 % percentile = 25 m
Maximum = 161.54 m



A working definition of a Buried Valley

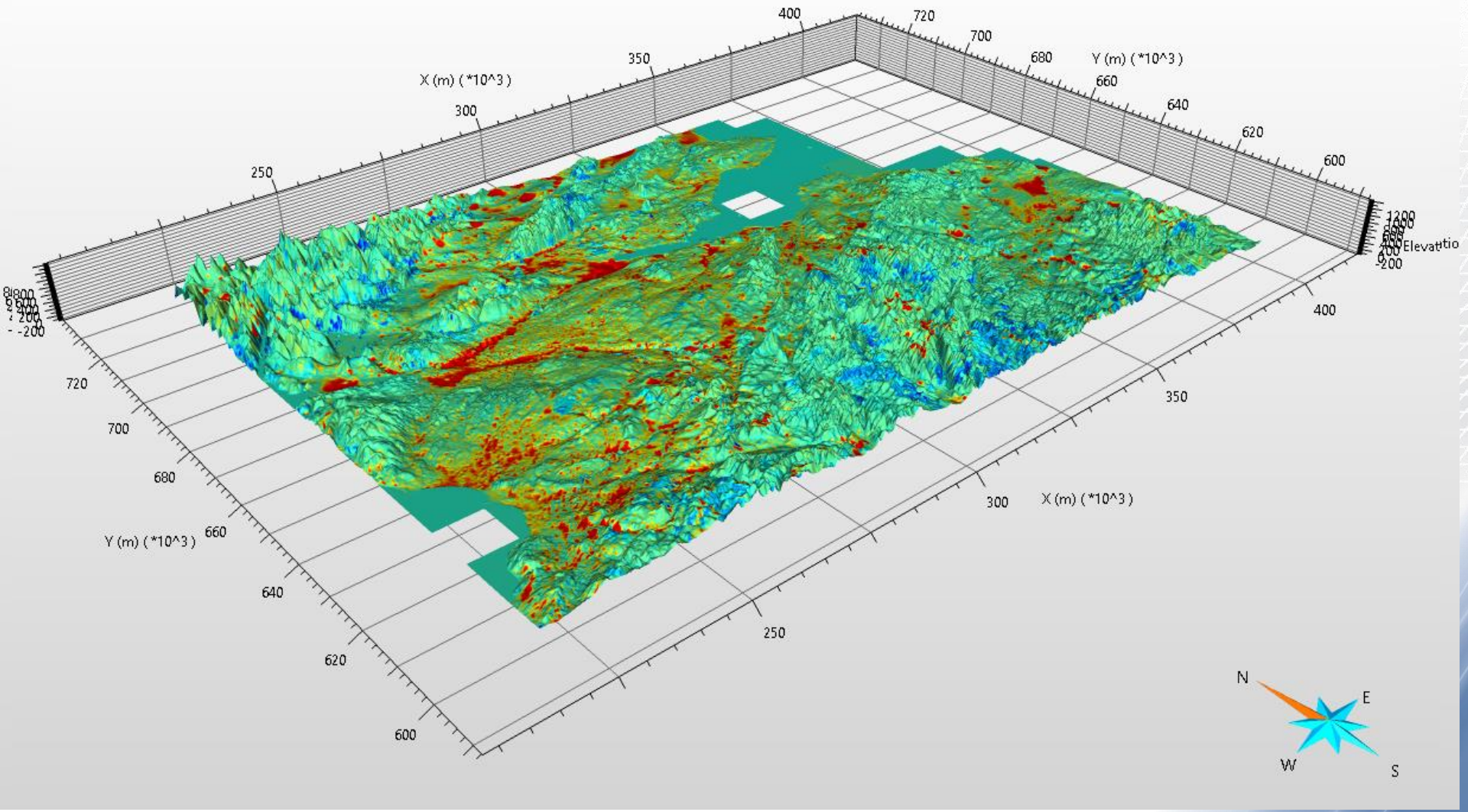




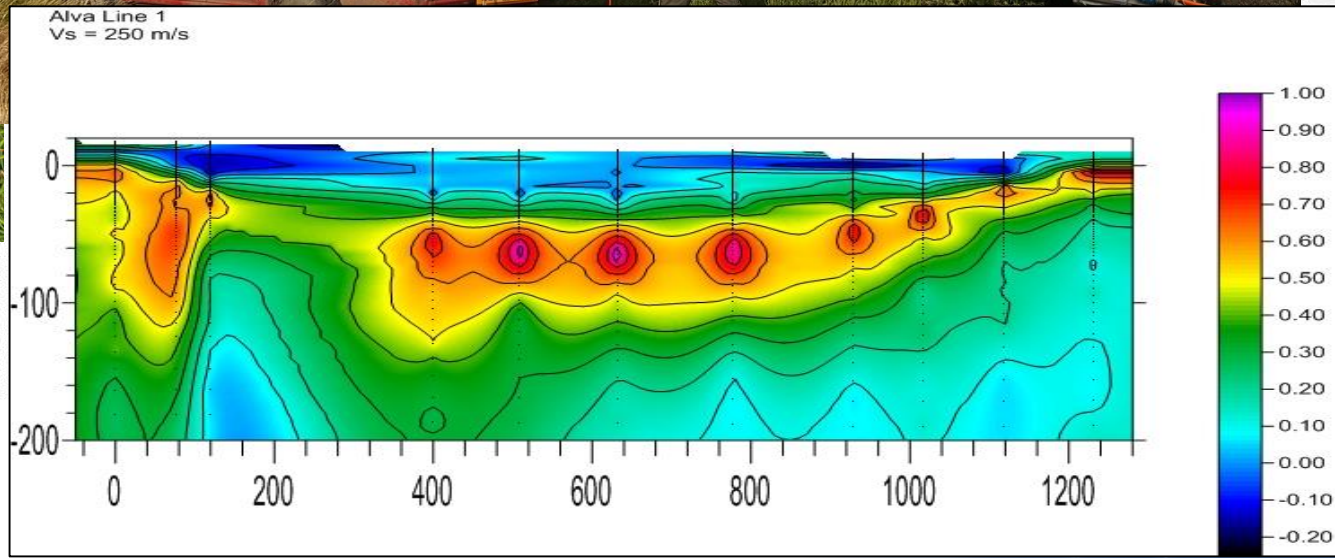
The definition of a ‘buried bedrock trough’ used:

1. Negative linear feature
2. Greater than 20m thick

Identifying Buried Valleys

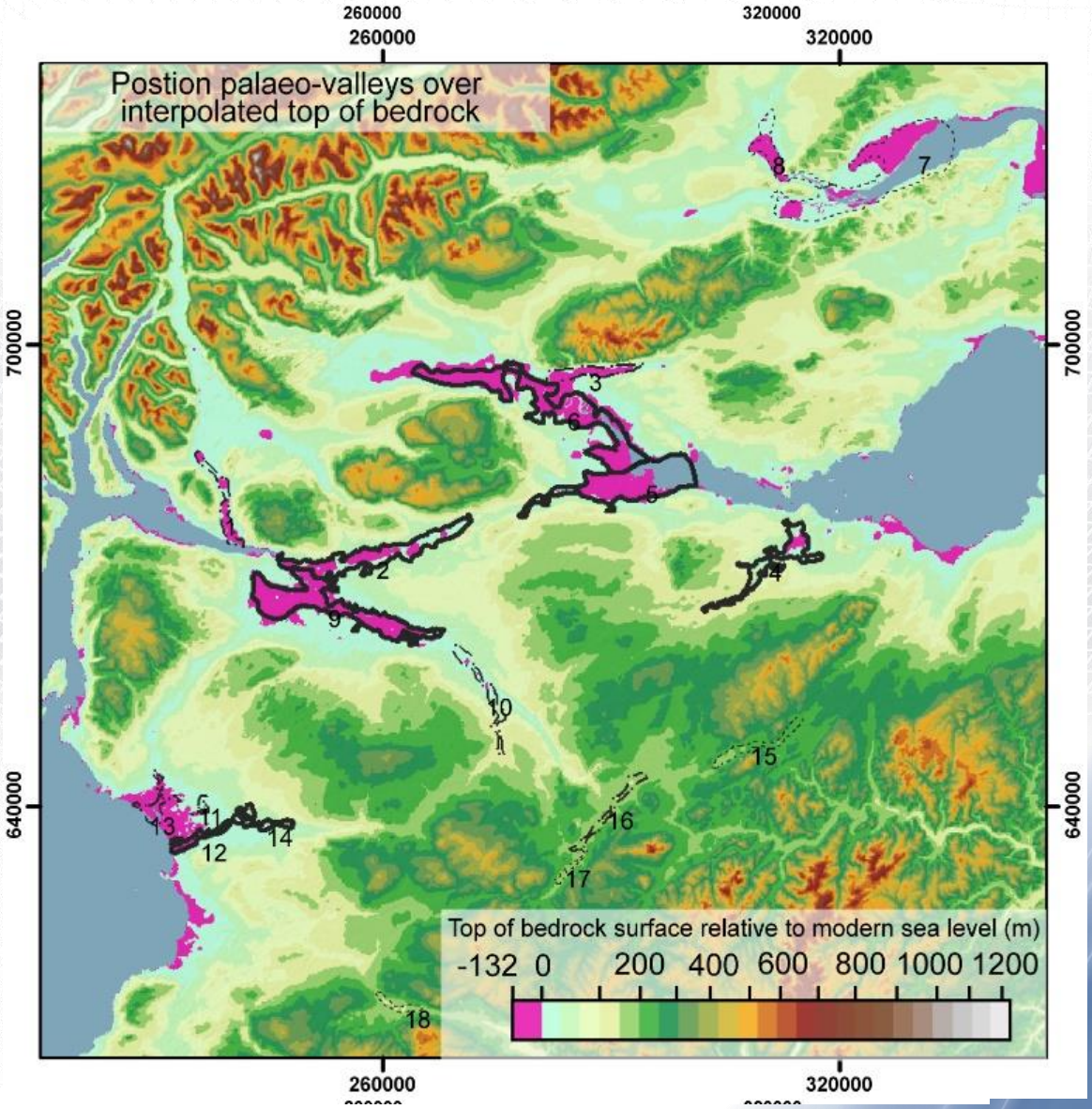


Shallow geophysics

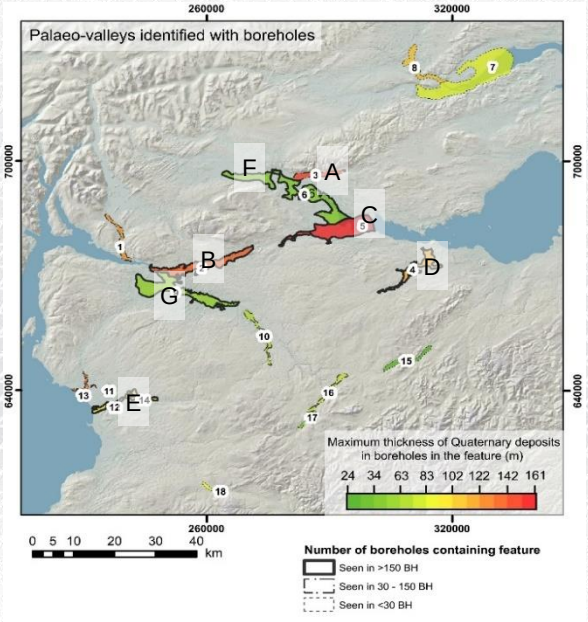


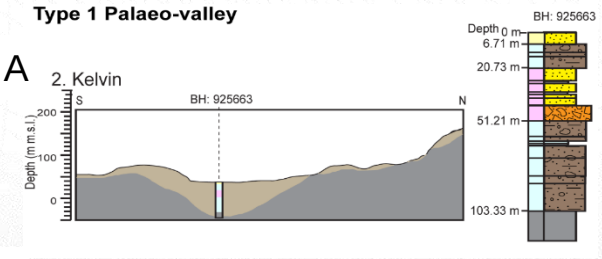
Identifying Buried Valleys

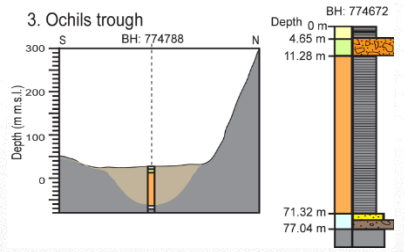
- 18 buried valleys were identified
- Length 4 -31km long
- Width 480 – 3778m
- Depth 24 – 161m
- 13 have bases below current sea level

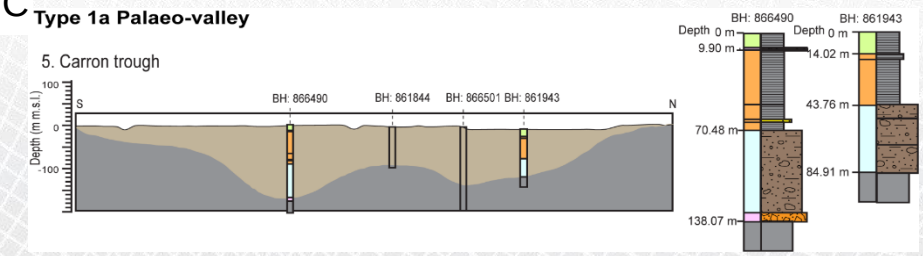


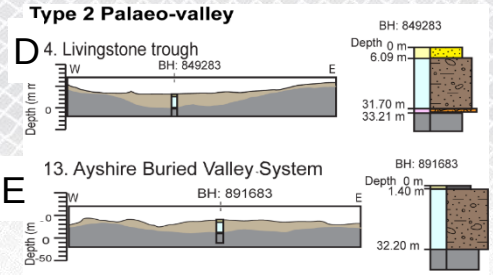
Variation in geometry and morphology

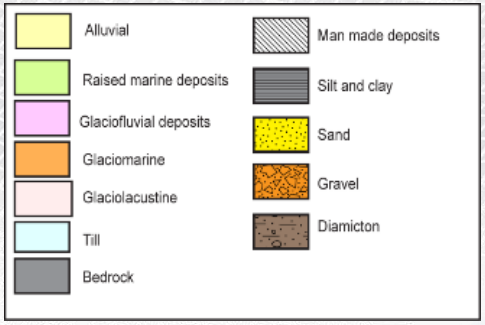


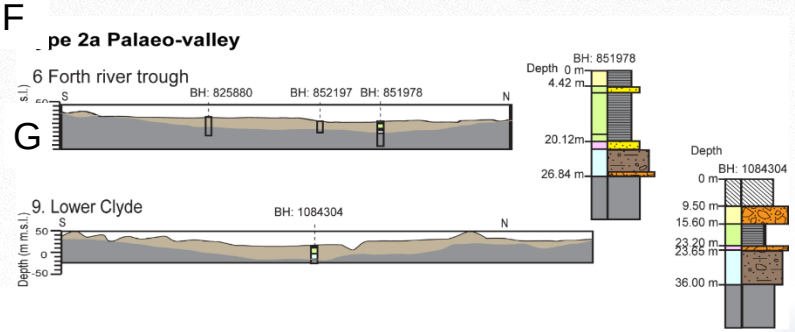






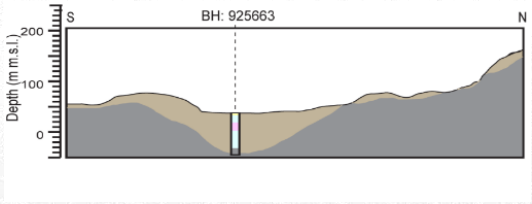


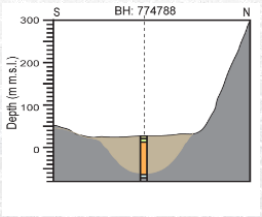


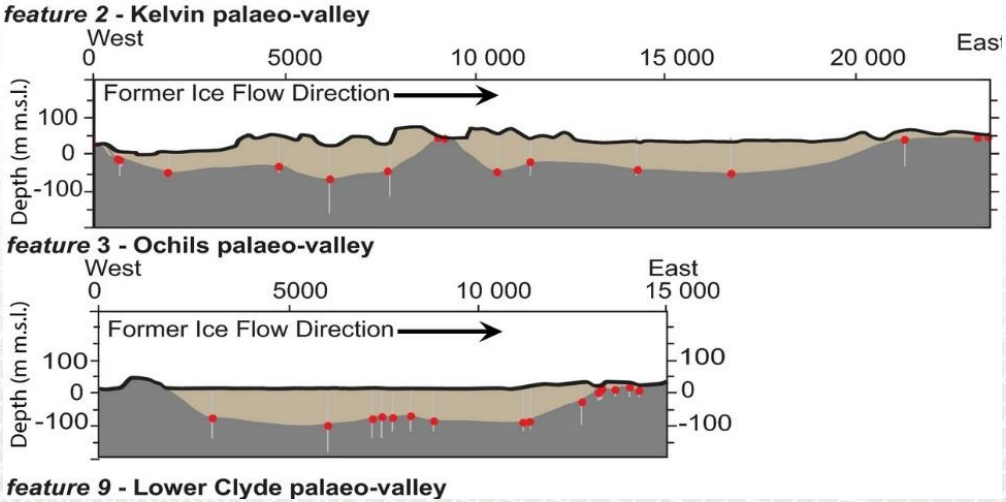


Variation in geometry and morphology

Type 1







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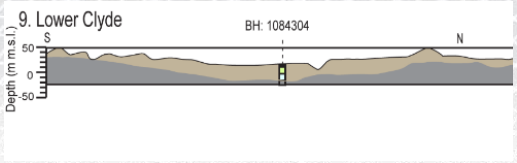

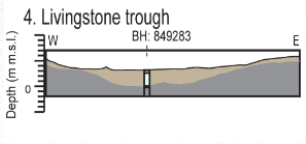

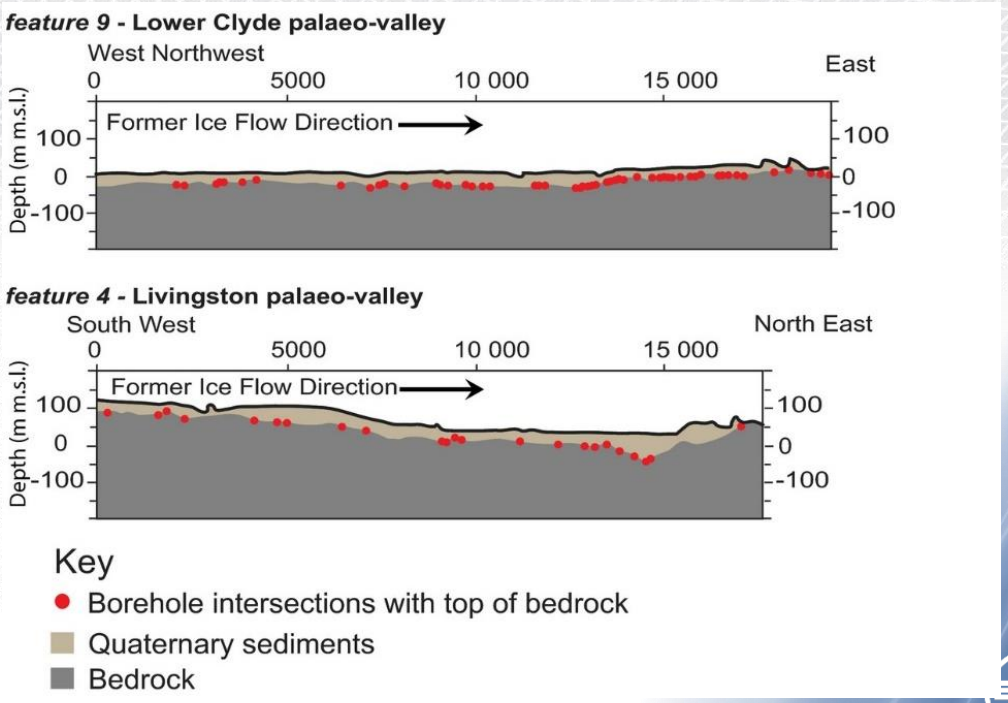

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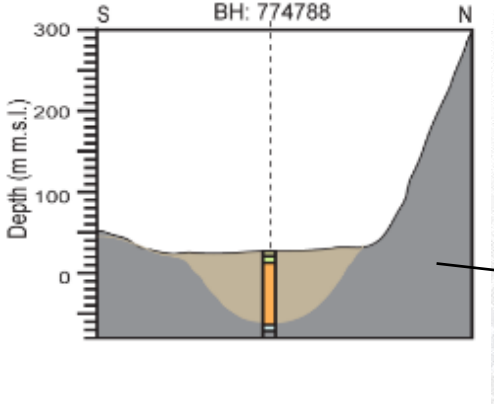
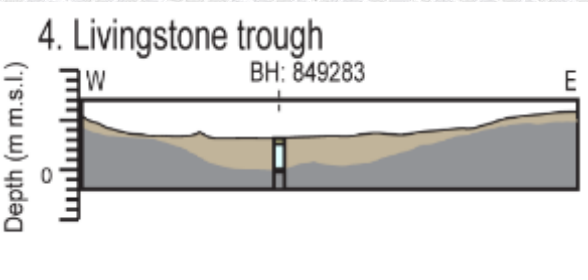
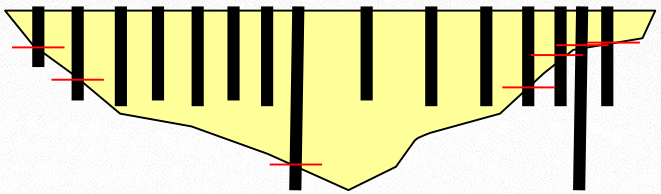
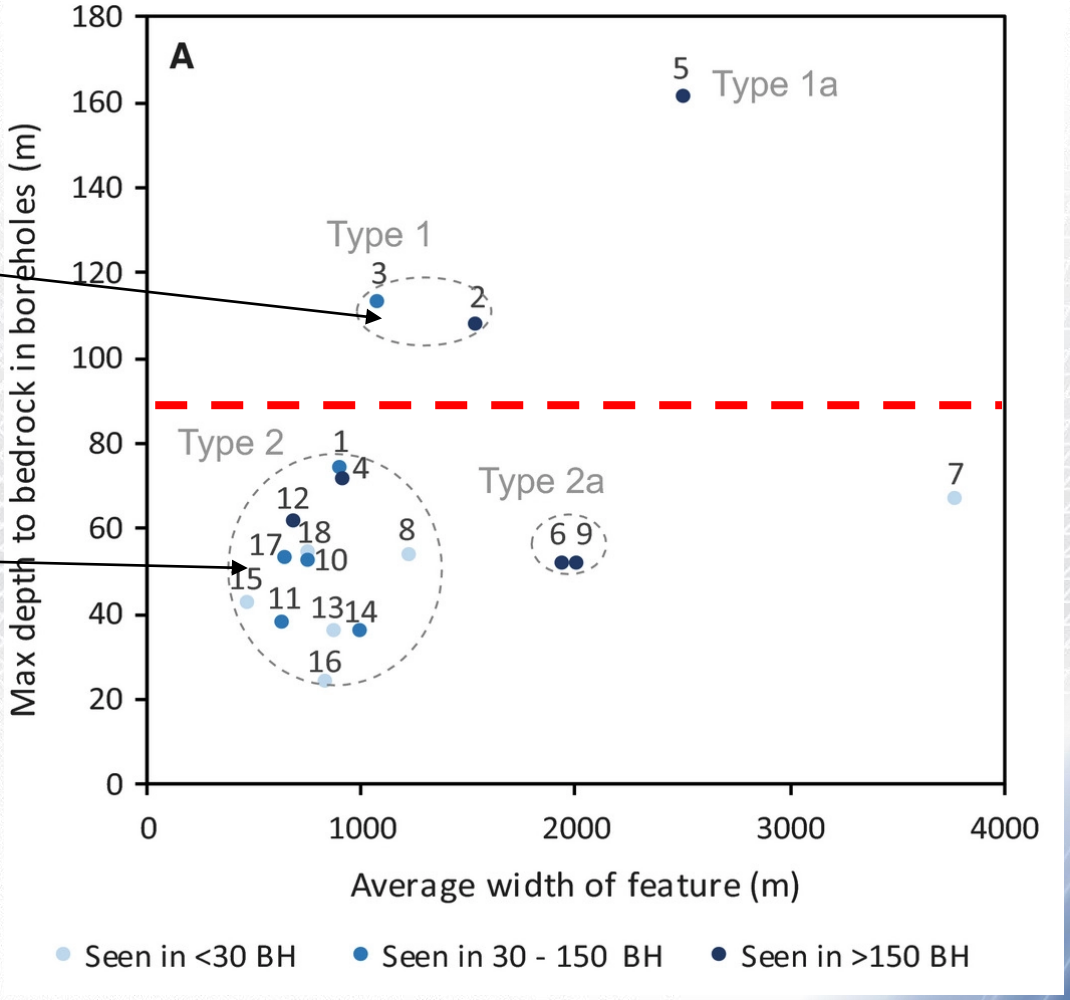
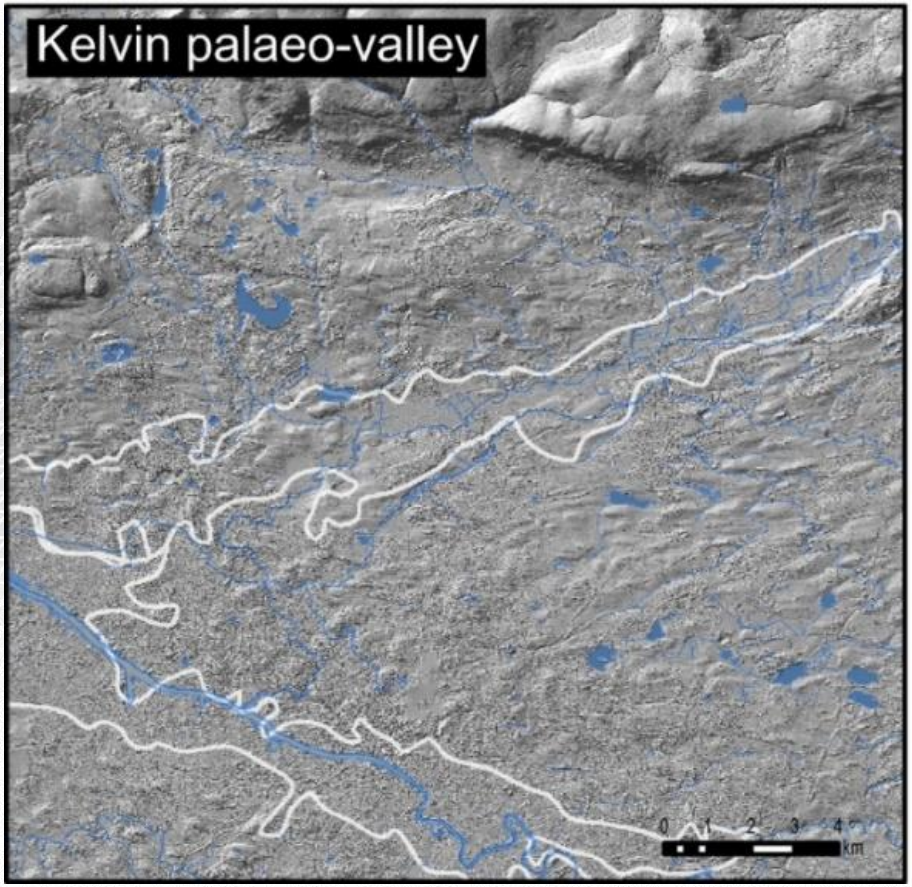


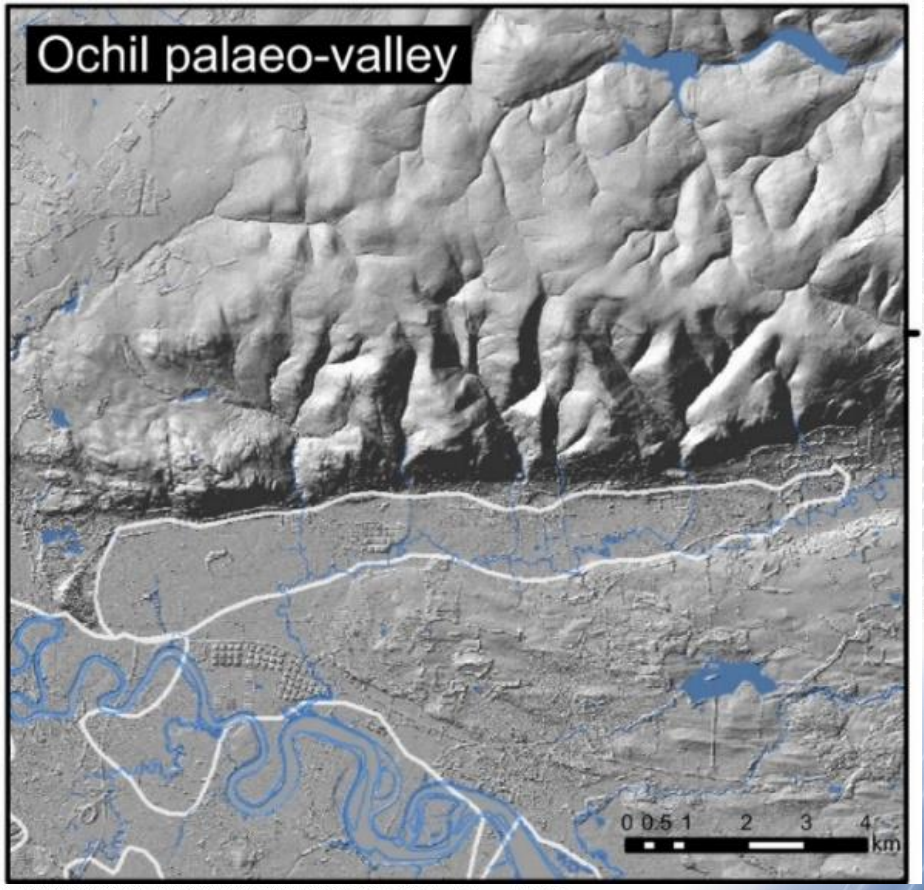




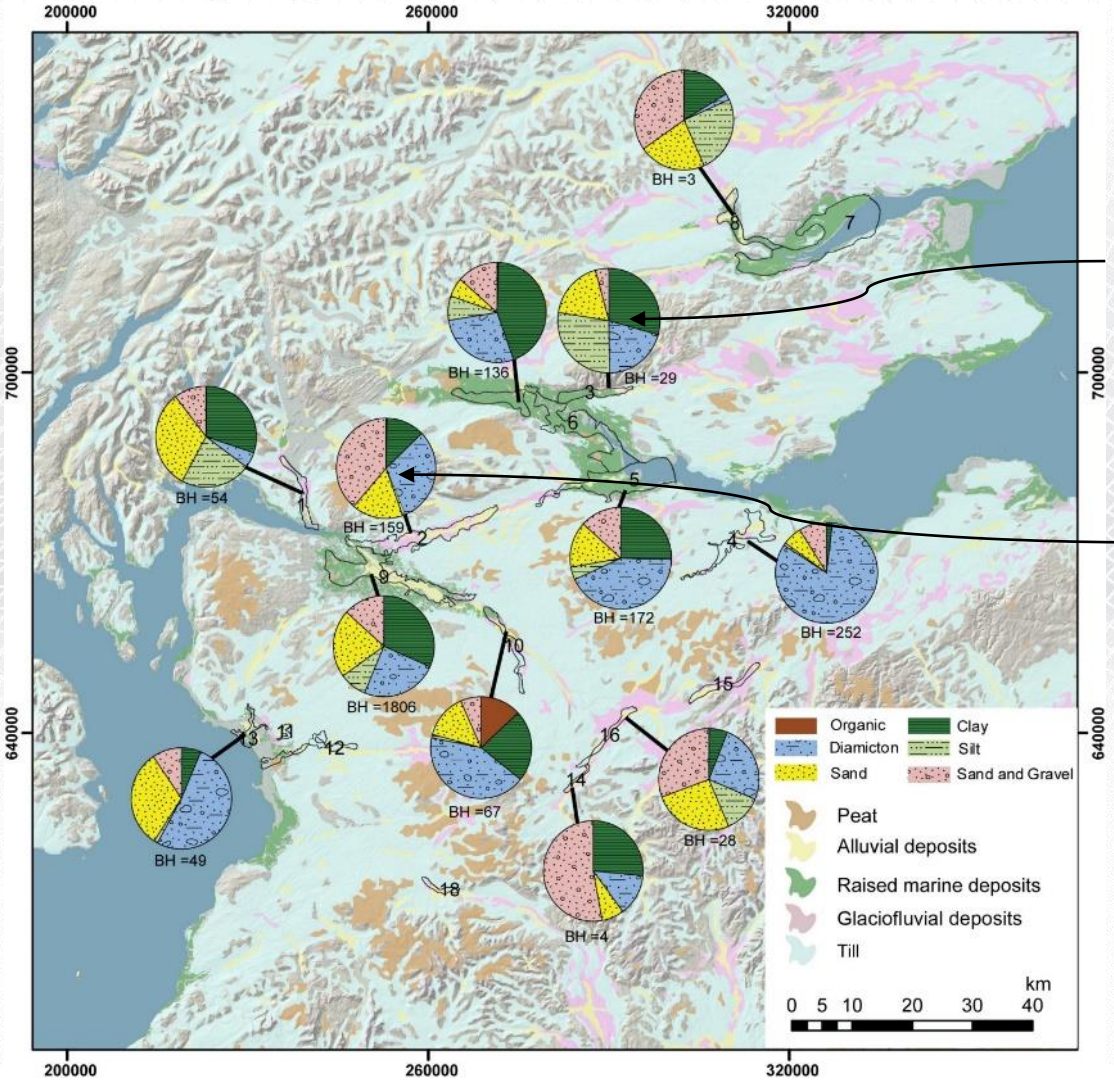


Surface geomorphology





Sedimentary fill



Fills are very variable

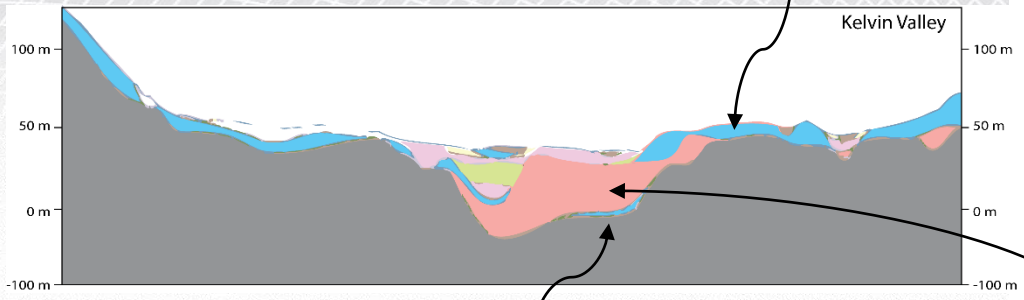
Some filled by dominantly clay and silt

Some filled by dominantly sand and gravel

Sedimentary fill

Most are filled with Devenisan Till and postglacial deposits

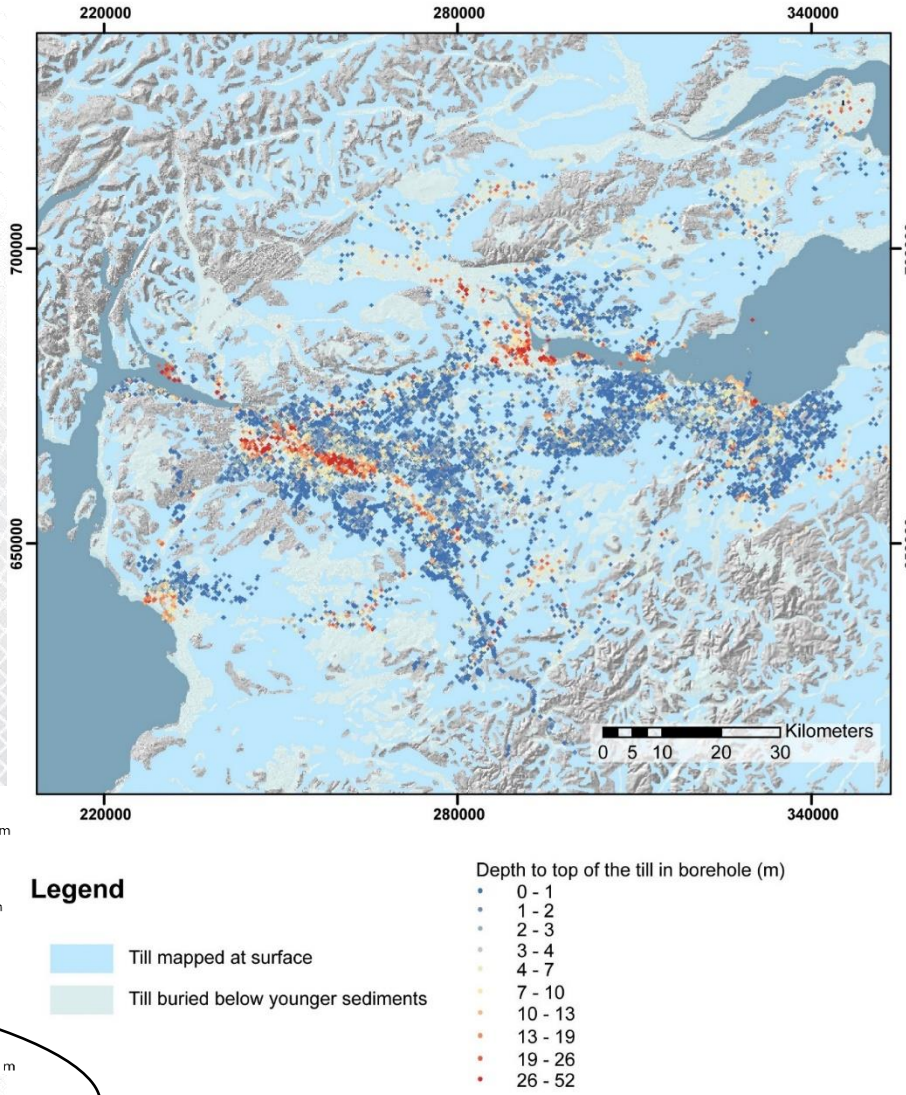
Some of the Type 1 Valleys contain fills that predate the LGM



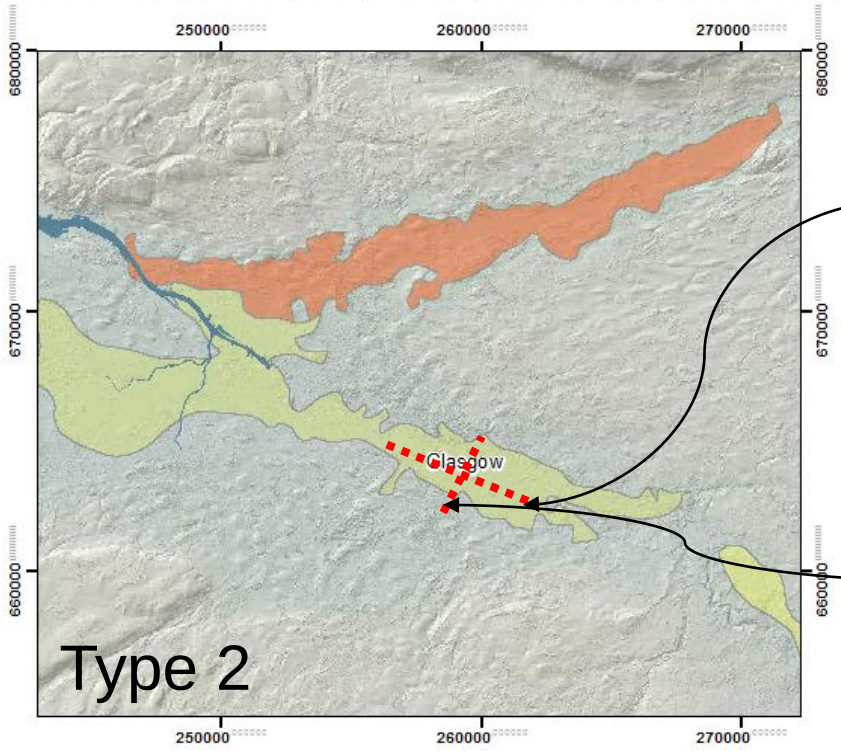
Devenisan Till

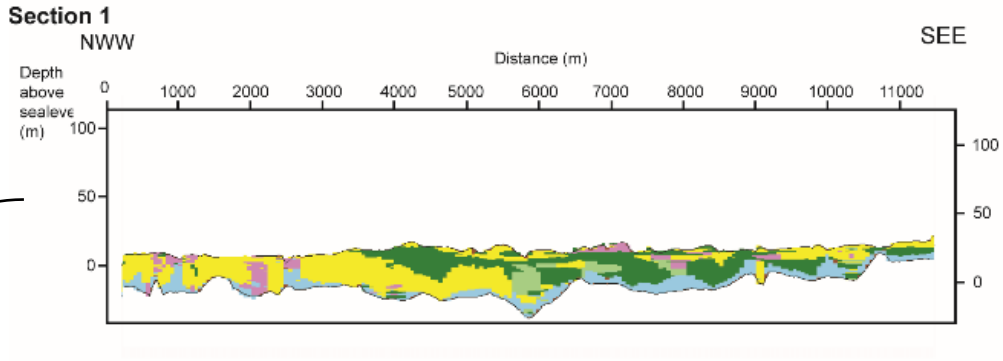
Pre-Devenisan Till

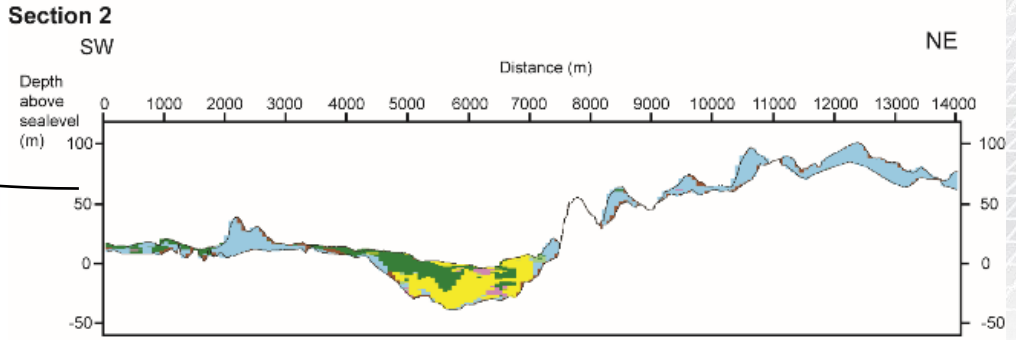
Cadder Formation
31,140 (± 170) cal. ^{14}C a BP



Nature of fill







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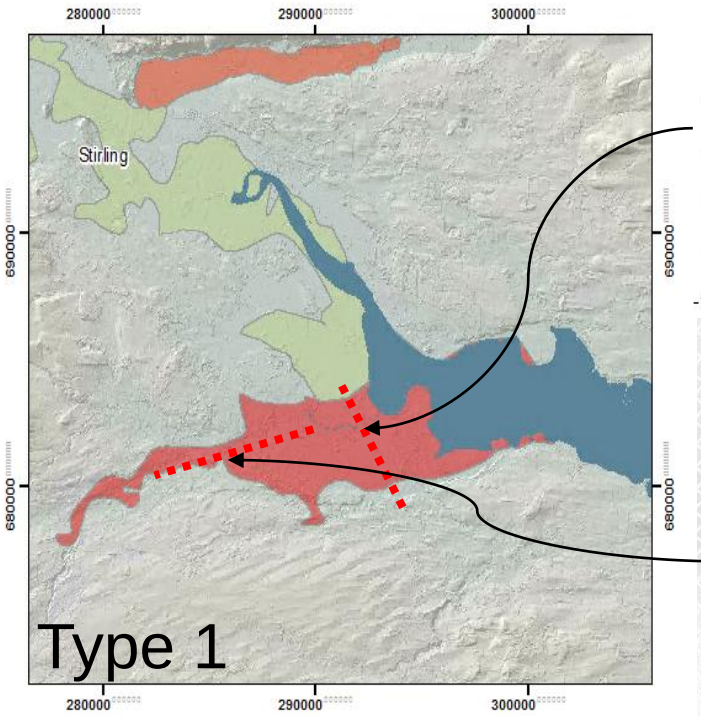
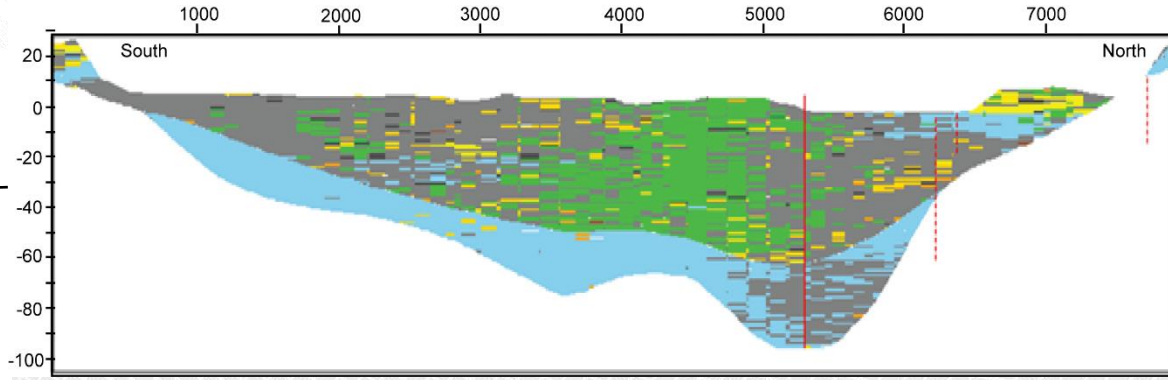
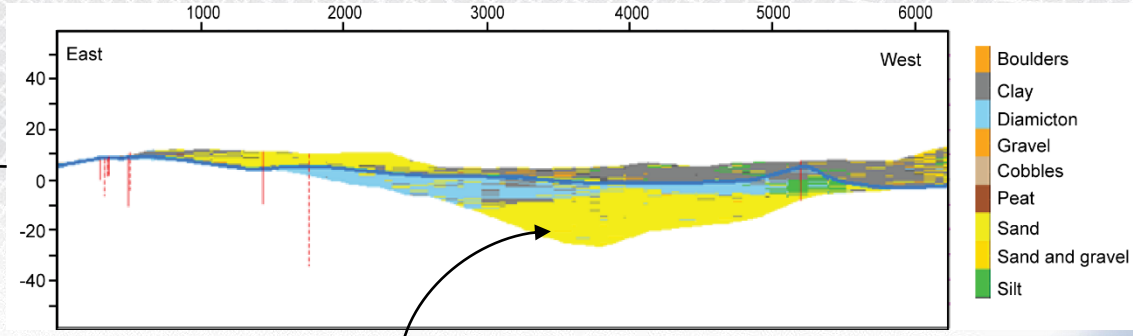
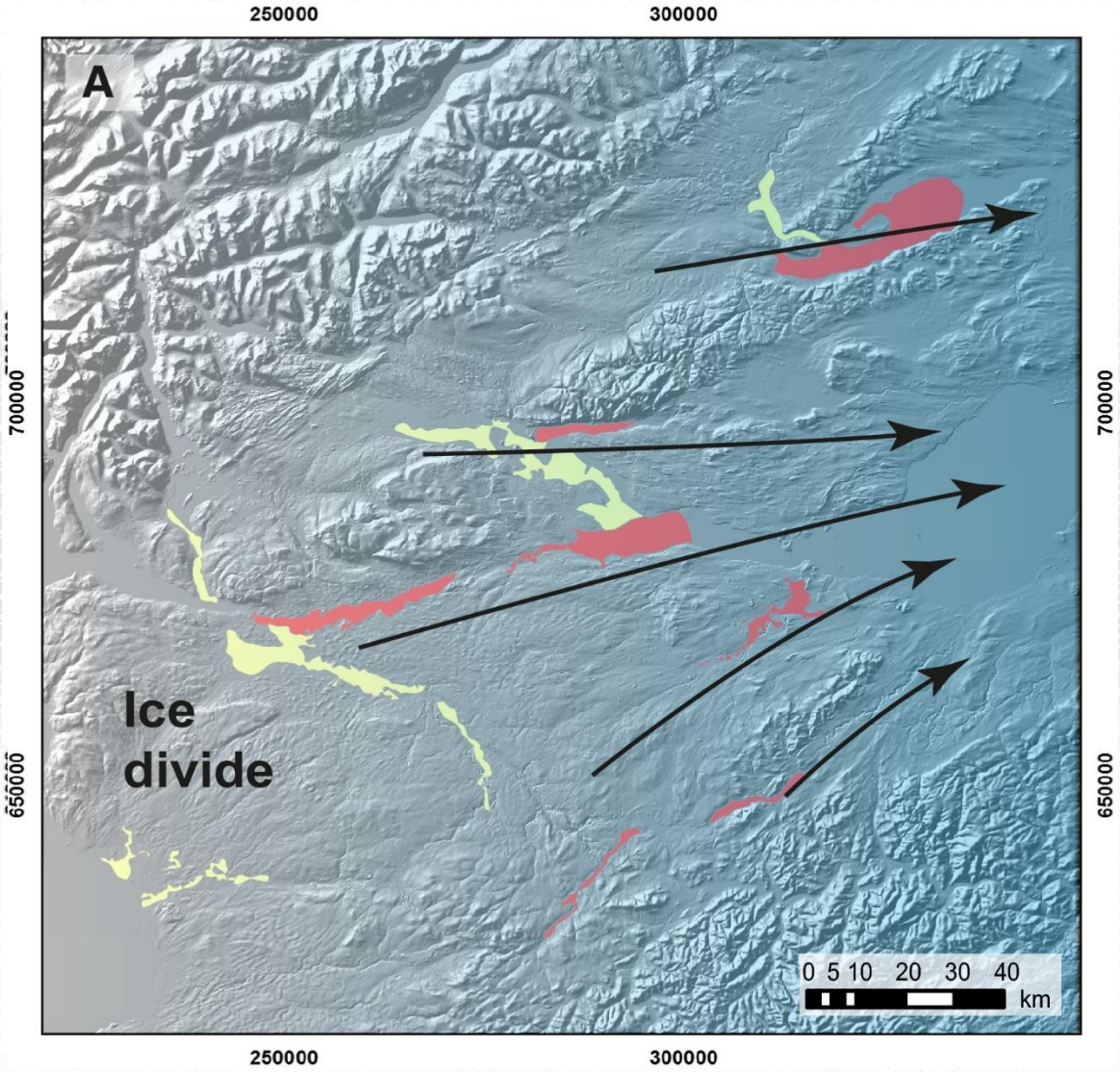






Sub till sand bodies

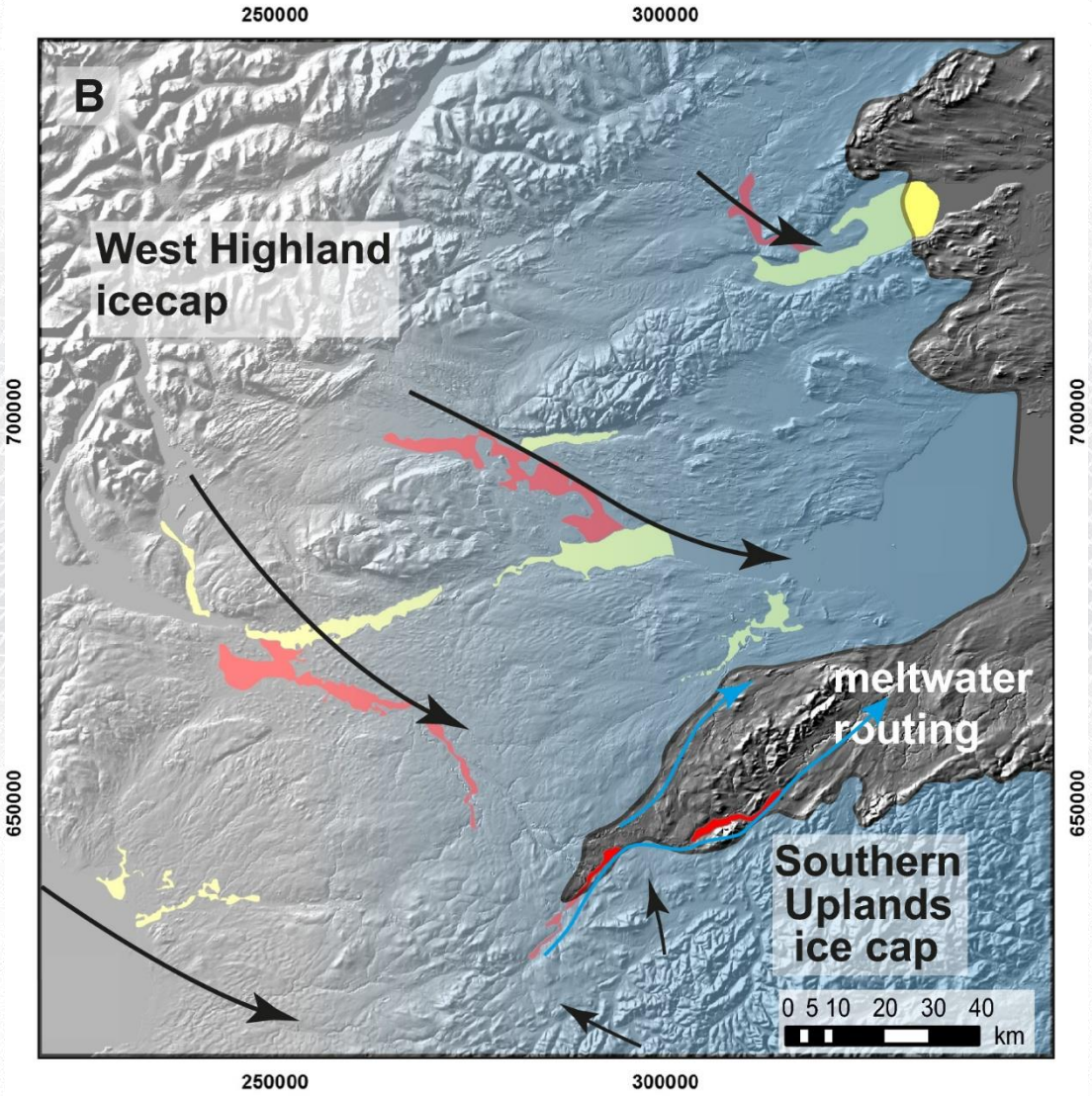
Ice-flow alignment and timing



Buried valleys show cross cutting alignments

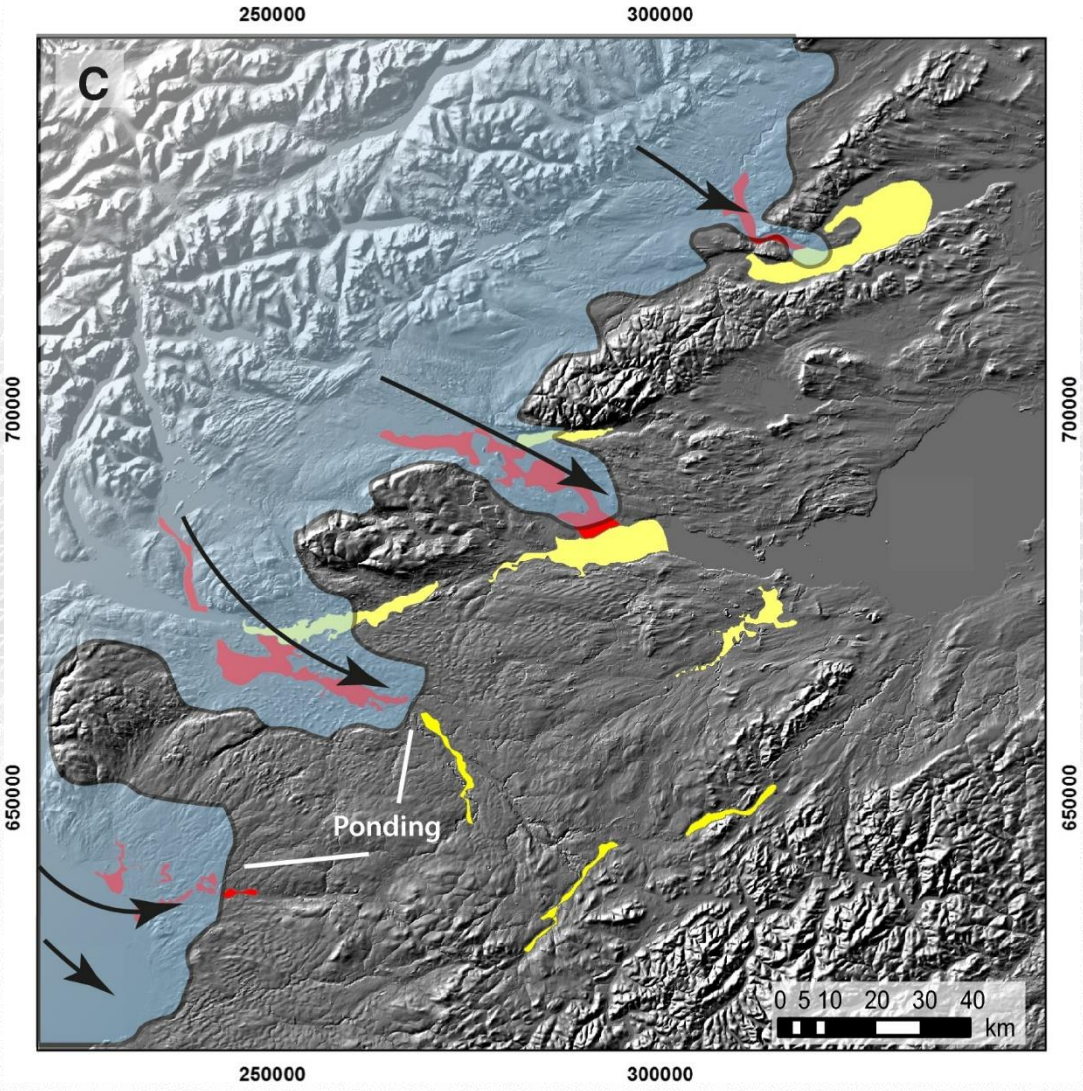
Main Late Devensian Ice flow

Ice-flow alignment and timing



Ice sheet starts to break into separate caps

Ice-flow alignment and timing

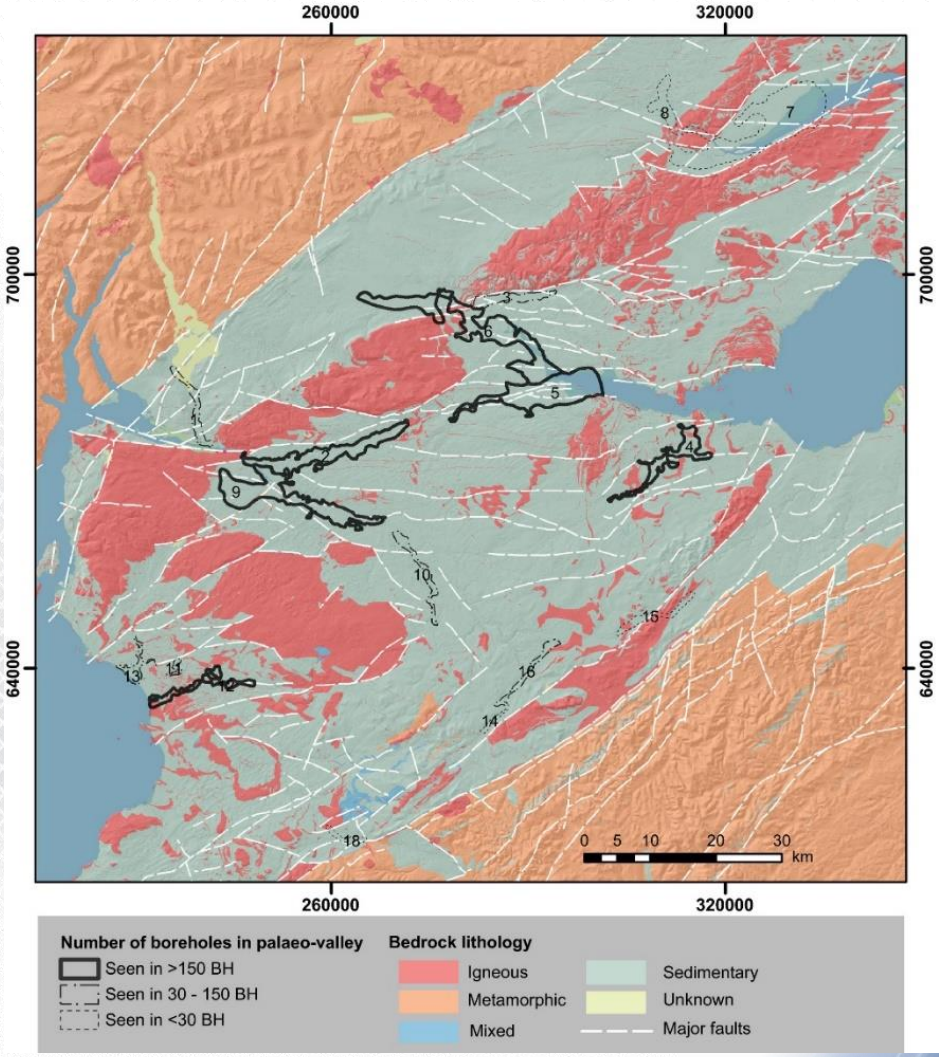


Ice sheet breaks into separate caps

Effect of the Substrate

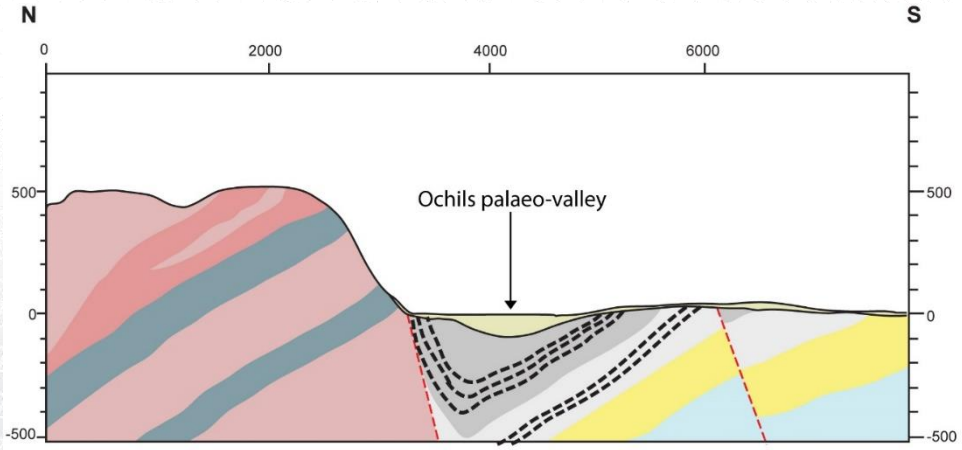
1. The juxtaposition of igneous and sedimentary rocks, influences their postion and depth

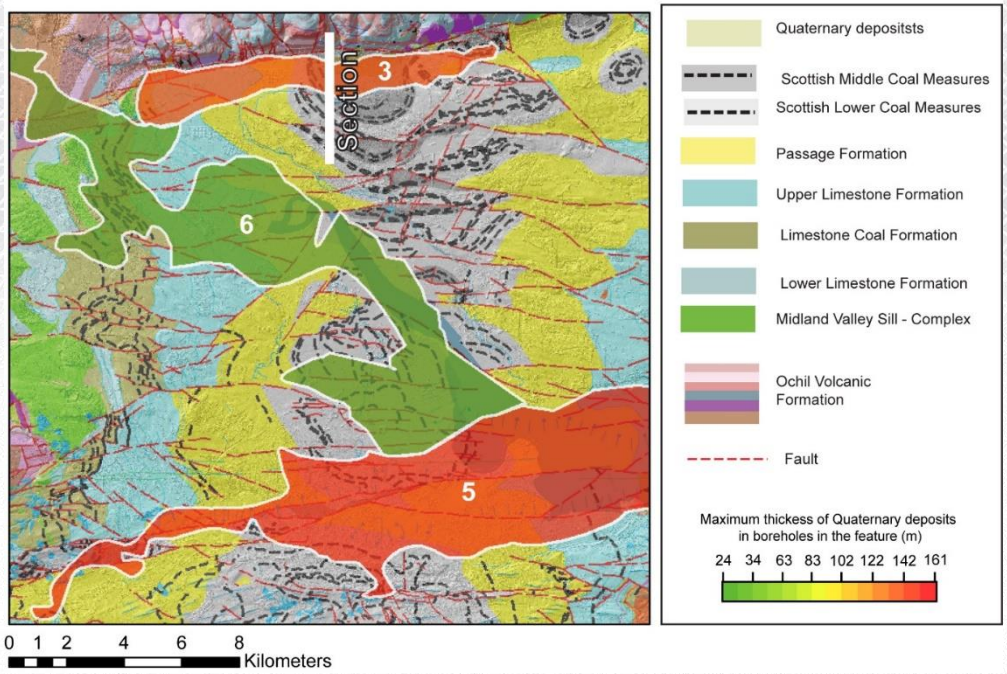
2. The deepest palaeo-valleys occur down-ice of ‘knick-points’ in the resistant Palaeozoic igneous bedrock.



Phillips, E., Everest, J. & Diaz-Doce, D. 2010: *Sedimentary Geology* 232, 98– 118.
Lee, J. R., Wakefield, O. J., Phillips, E. & Hughes, L. 2015: *Quaternary Science Reviews* 109, 88– 110.

Effect of the Substrate

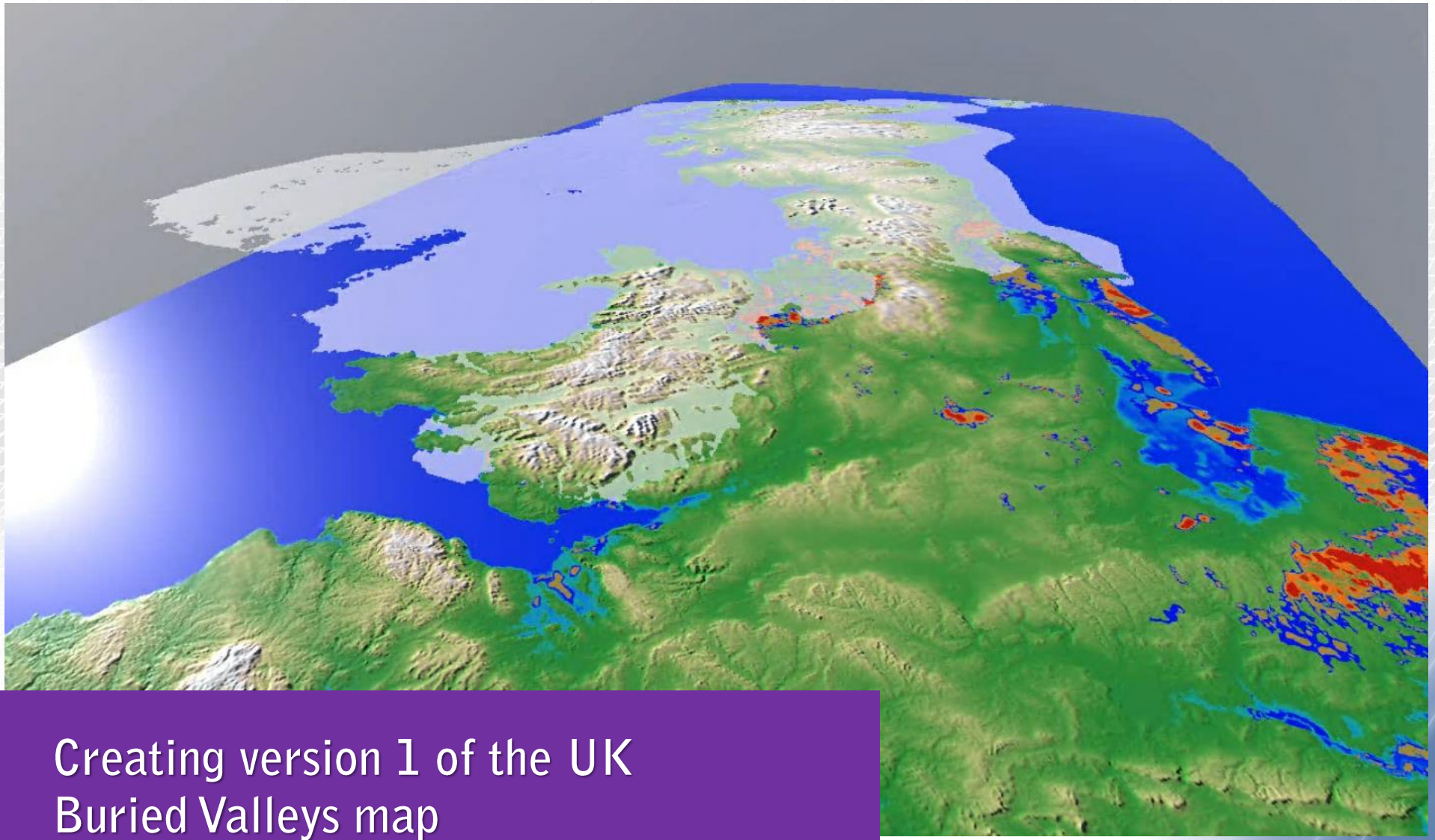




Appear to cross cut faulting and don't show asymmetry against faults

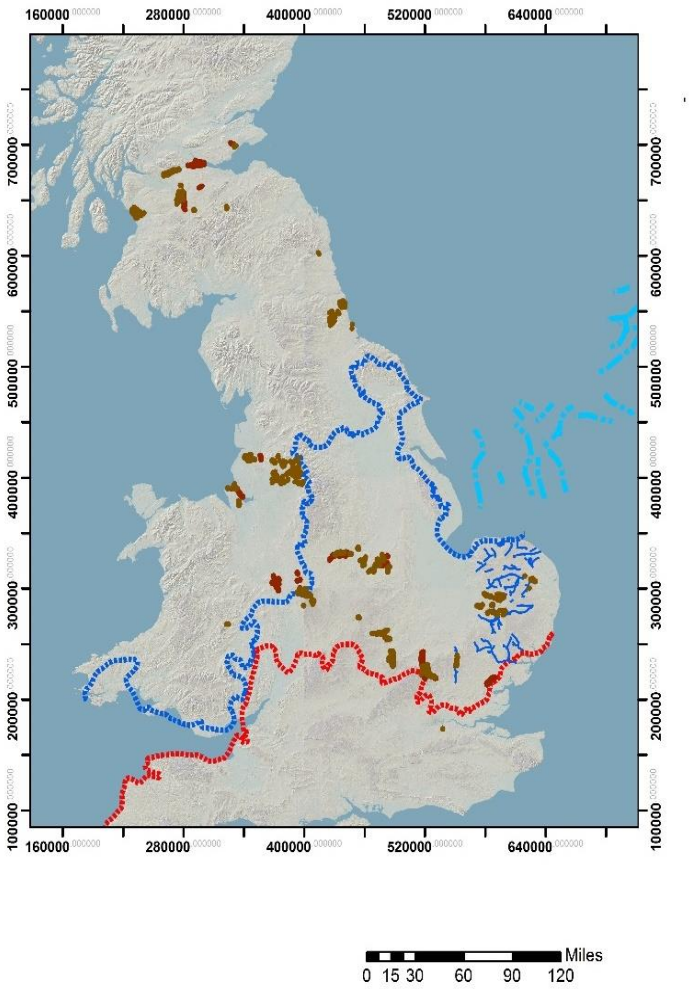
Are often contained within fault blocks suggesting that it is the juxtaposition of different lithologies and ice flow dynamics that forms these features

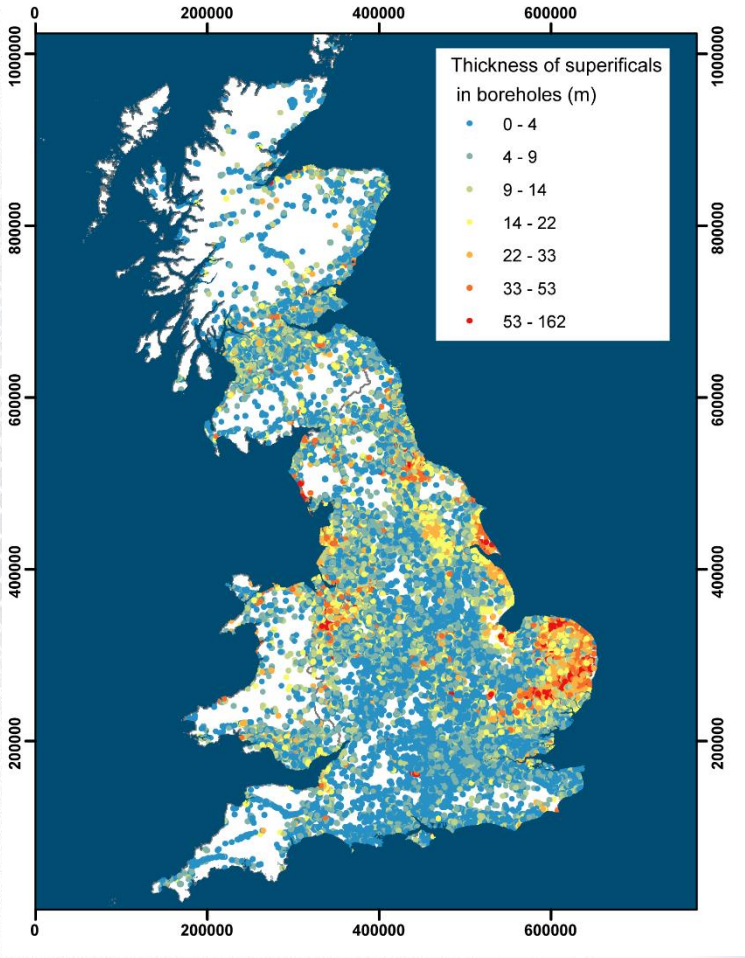
UK Buried Valleys



Creating version 1 of the UK Buried Valleys map

UK data before project

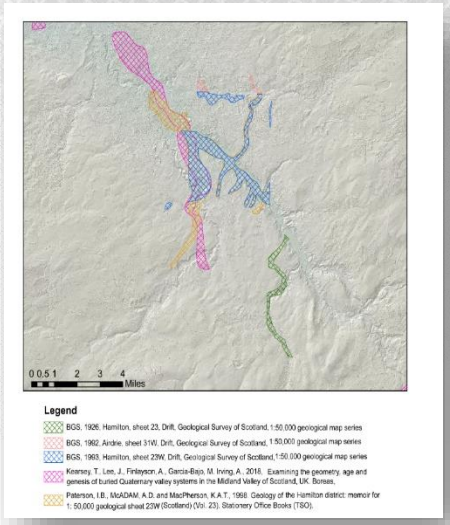




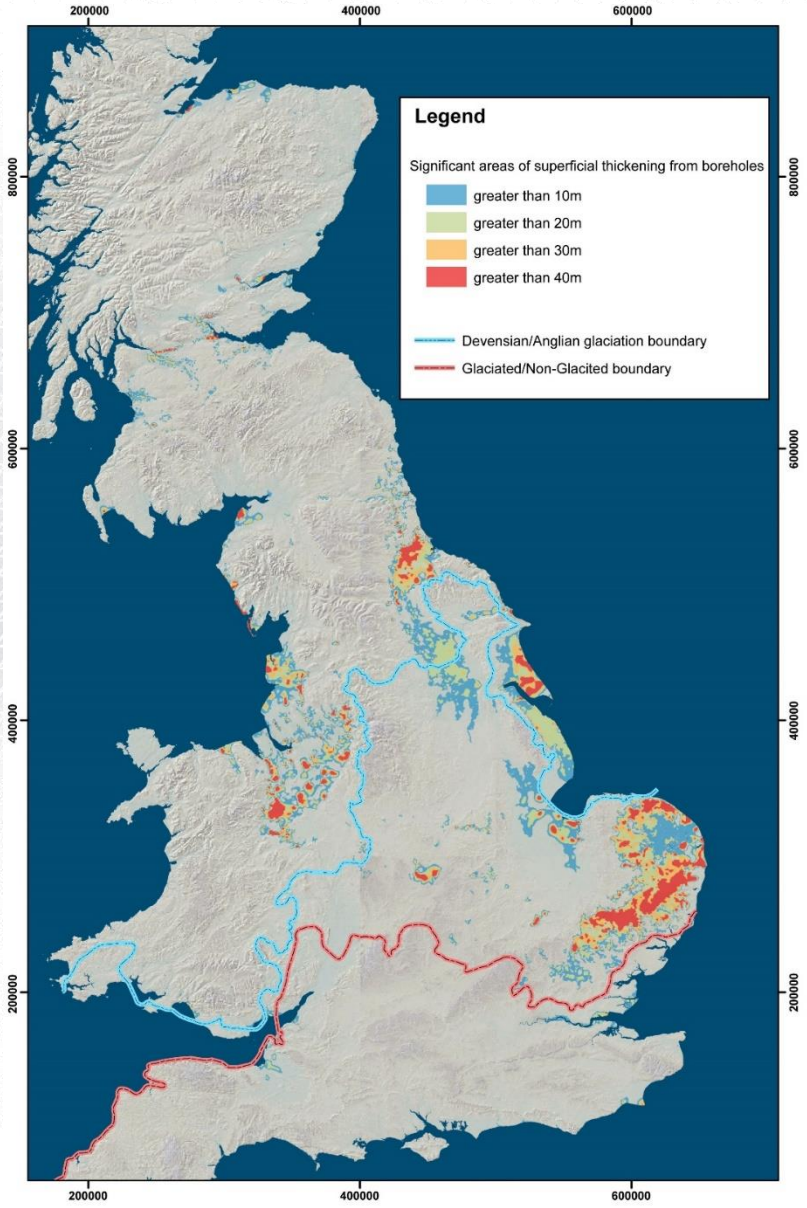
Historical dataset

Buried valleys are only found in those part of the UK which have been glaciated

Lots of conflicting interpretation



Modelled thickness of Buried Valleys



Interpolation of borehole data

- Only features that were centred on five or more boreholes containing 20 m or more of superficial deposits are show
- Only works in areas with lots of boreholes

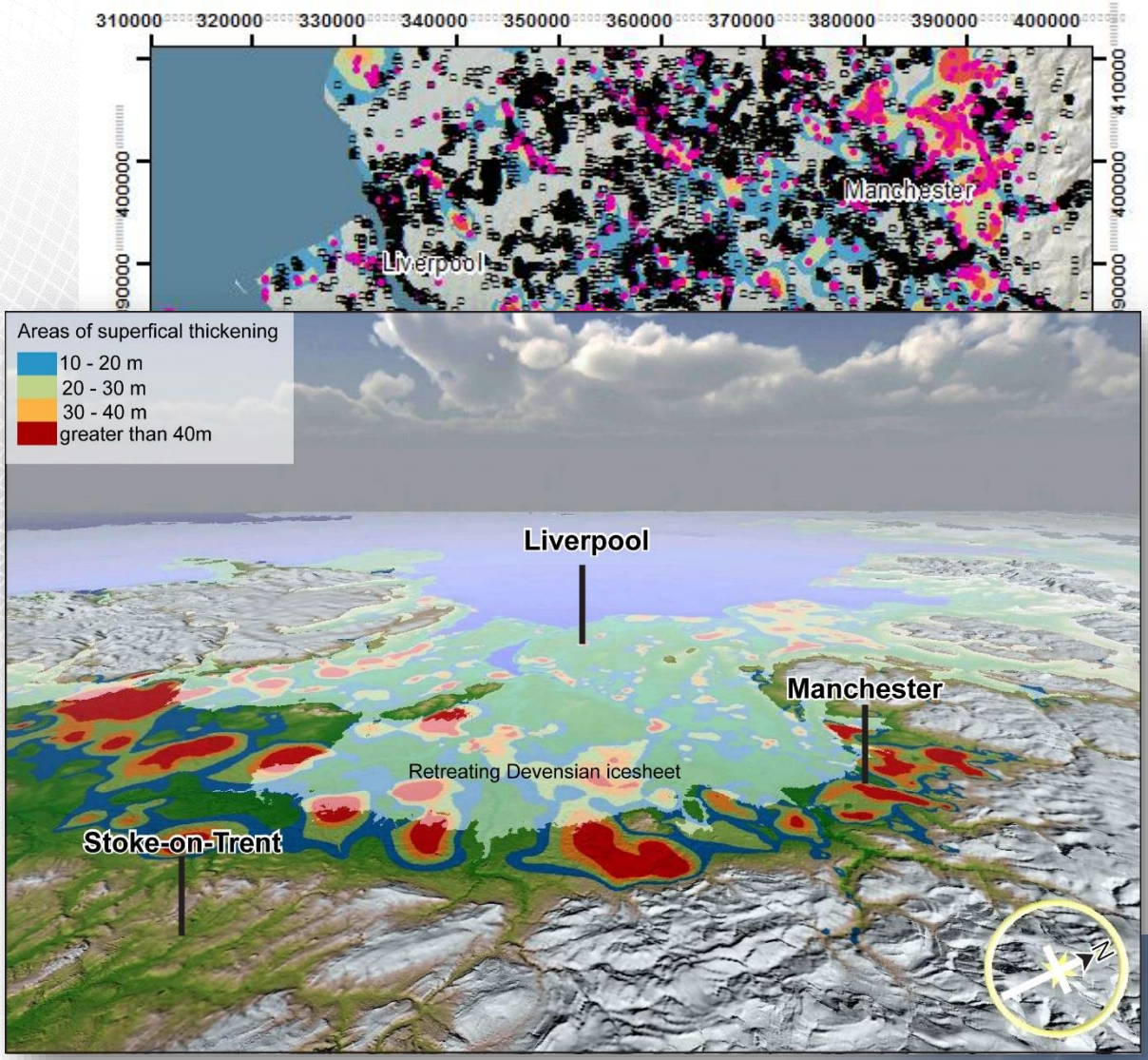
Modelled thickness of Buried Valleys

Reveals a lot of detail in the Cheshire Basin

Many previously unknown buried valleys and variations in thickness of superficial deposits

Constrained by large numbers of boreholes

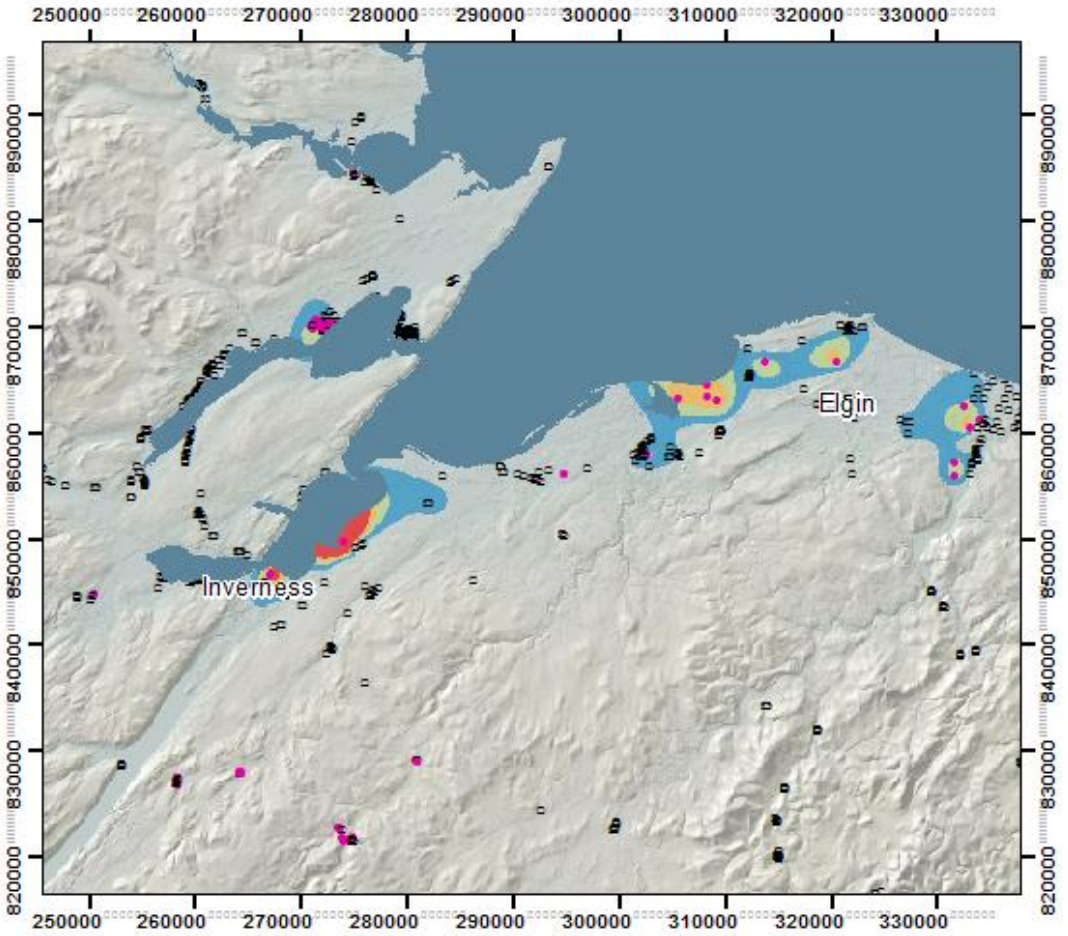
May be part of the Devensian sub glacial drainage system

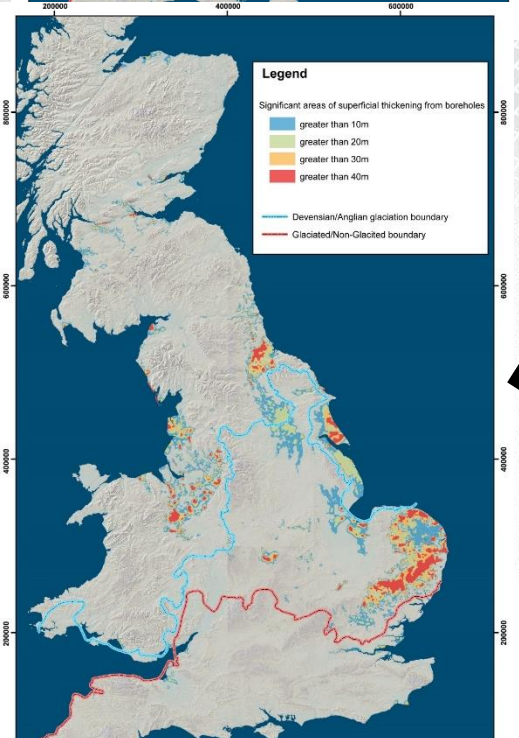


Modelled thickness of Buried Valleys

Identified some thick areas around Inverness and Elgin

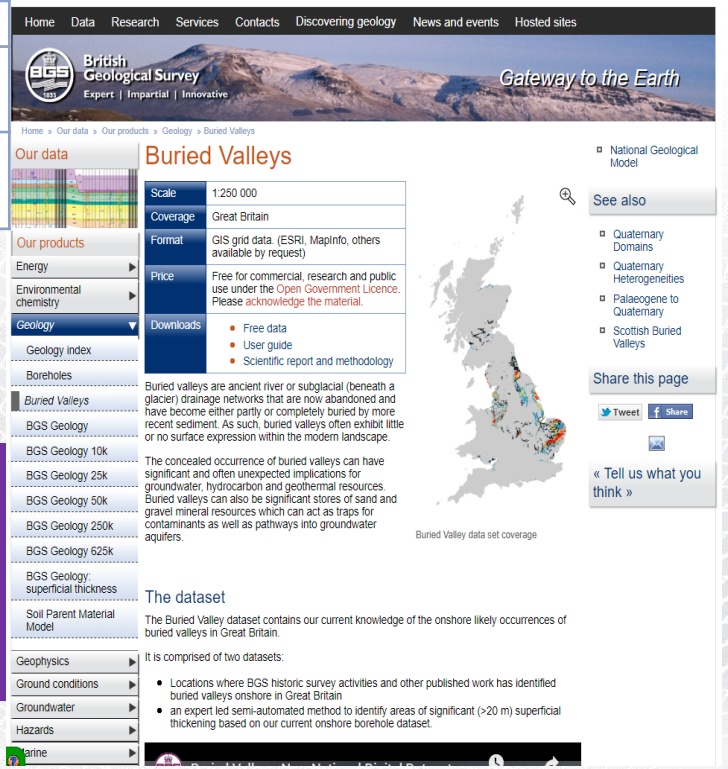
However, the interpolation struggles in these areas because there are very few boreholes





Scale	1:250 000
Coverage	Great Britain
Format	GIS grid data. (ESRI, MapInfo, others available by request)
Price	Free for commercial, research and public use under the Open Government Licence. Please acknowledge the material.

UK National Buried Valley Dataset



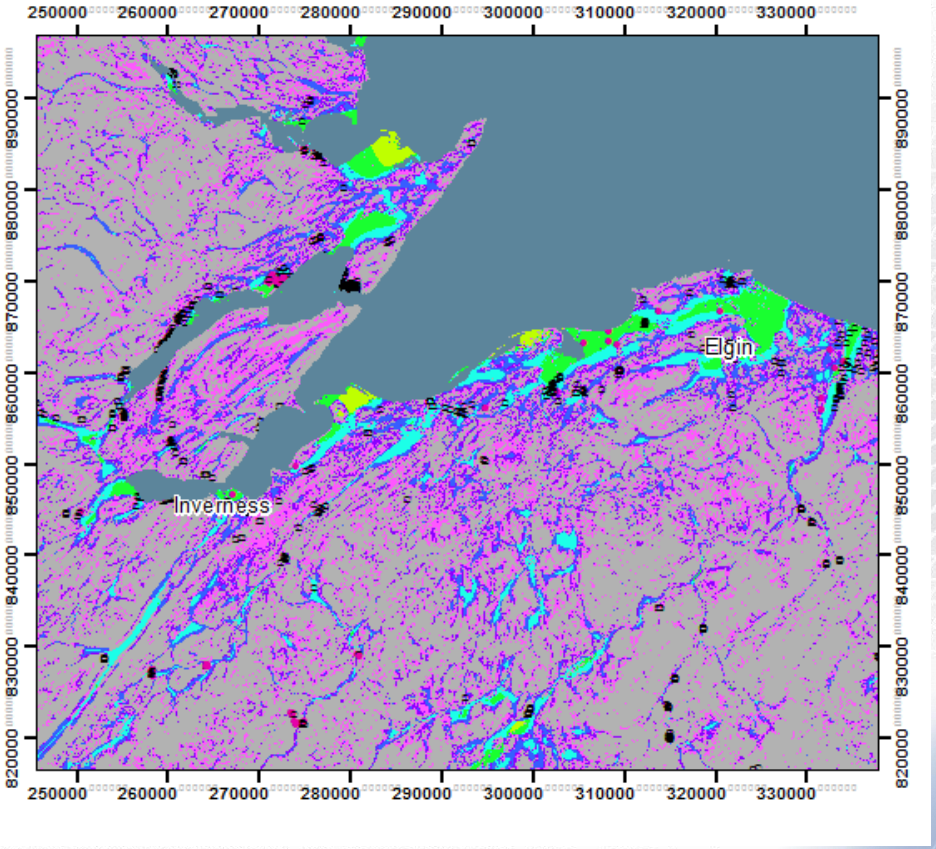
https://www.bgs.ac.uk/products/onshore/BuriedValleys.html

Where next?

Improve identification in areas of sparse borehole coverage

Better constrain the types an geometry of the infilling sediments

Link Onshore with offshore



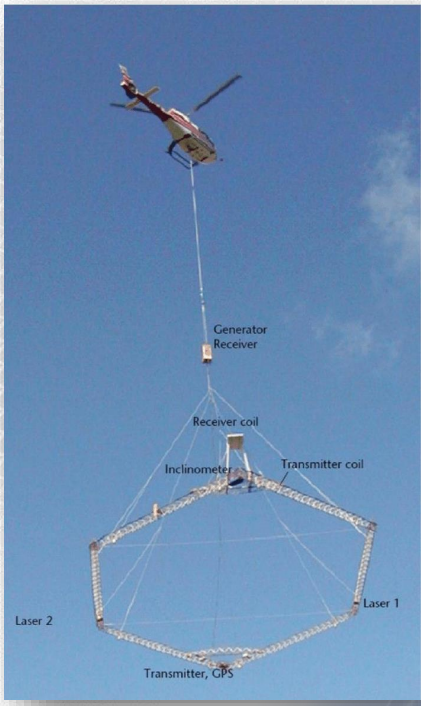
Summary

1. Buried valleys are poorly understood onshore, but are very relevant to Engineering geology and Groundwater communities.

2. Using large numbers of geotechnical boreholes it is possible to identify features.

3. They appear to be formed by different processes at different times. The deepest may have been re-used in multiple glaciations.

4. Working towards a National understanding of these features.



Acknowledgements

Jonathan Lee, Andrew Finlayson, Marieta Garcia-Bajo, Tony Irving, Hannah Gow, Russell Lawley, Jon Merritt

Further reading:

Kearsey, Timothy I.; Lee, Jonathan R.; Finlayson, Andrew; Garcia-Bajo, Marieta; Irving, Anthony A.M.. 2018 Examining the geometry, age and genesis of buried Quaternary valley systems in the Midland Valley of Scotland, UK. ***Boreas***. https://doi.org/10.1111/bor.12364 [OPEN ACCESS]

https://www.bgs.ac.uk/products/onshore/BuriedValleys.html