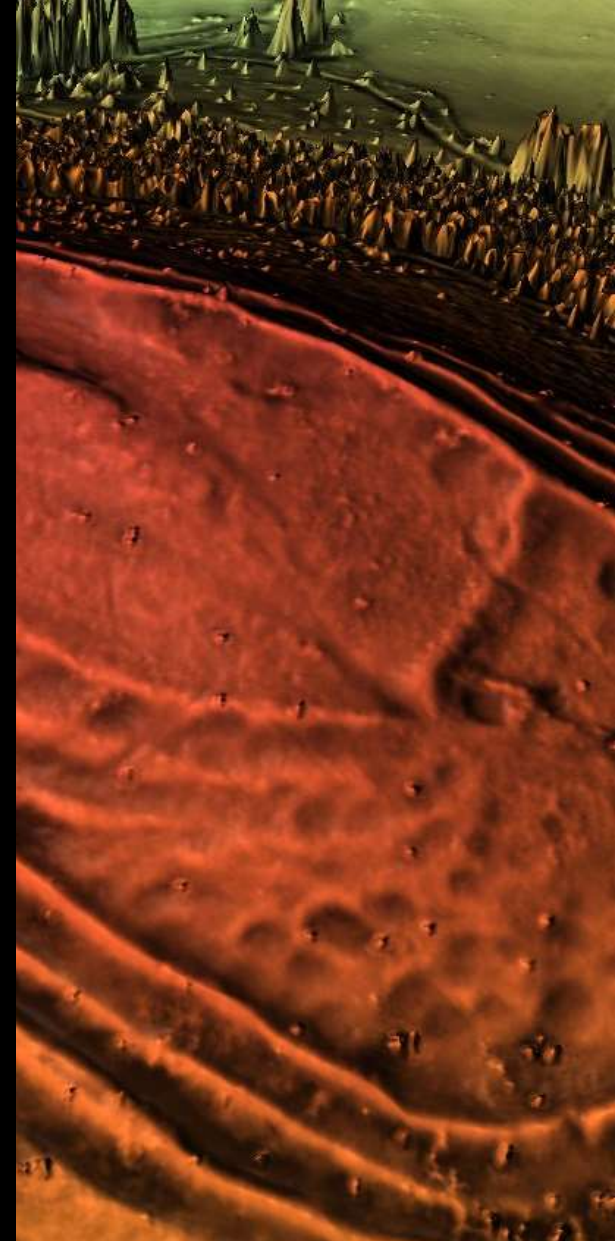




LiDAR Training Workshop

What it is, and how we use it for archaeological purposes

Giles Carey, Historic Environment Team, Shropshire Council





Light Information Detection and Ranging

We'll be looking at:

- Remote sensing in archaeology in general
- LiDAR – what it is
- LiDAR – how we use it for archaeological purposes

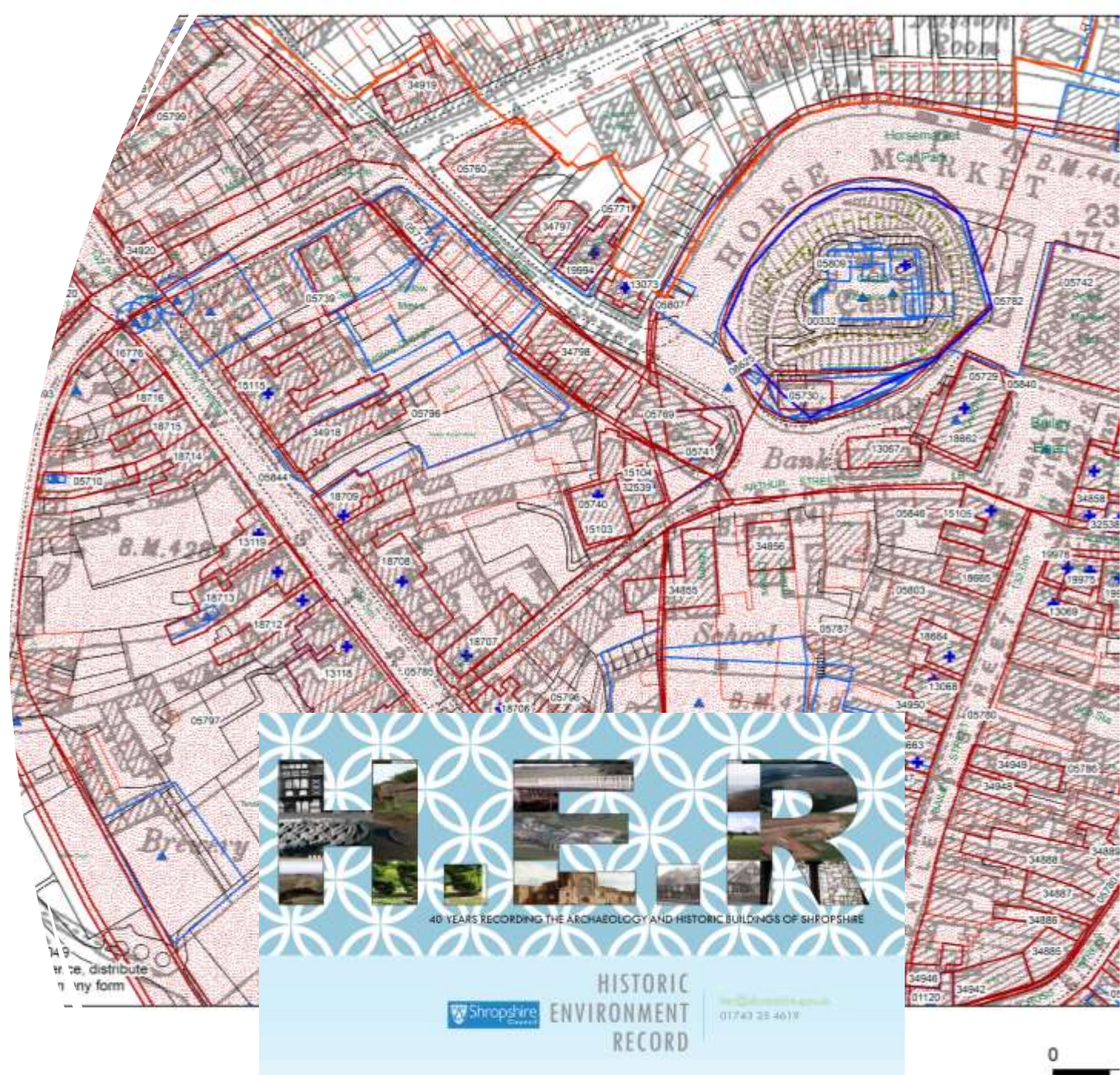
It's designed to be interactive, so feel free to get involved!

A vertical photograph of a landscape with rolling green hills and a forested ridge in the background, positioned on the right side of the slide.

Shropshire's Historic Environment Record

Our mission is to be the primary source of trusted information on Shropshire's historic environment – its:

- archaeological sites and monuments,
- archaeological finds
- historic buildings and
- landscape features



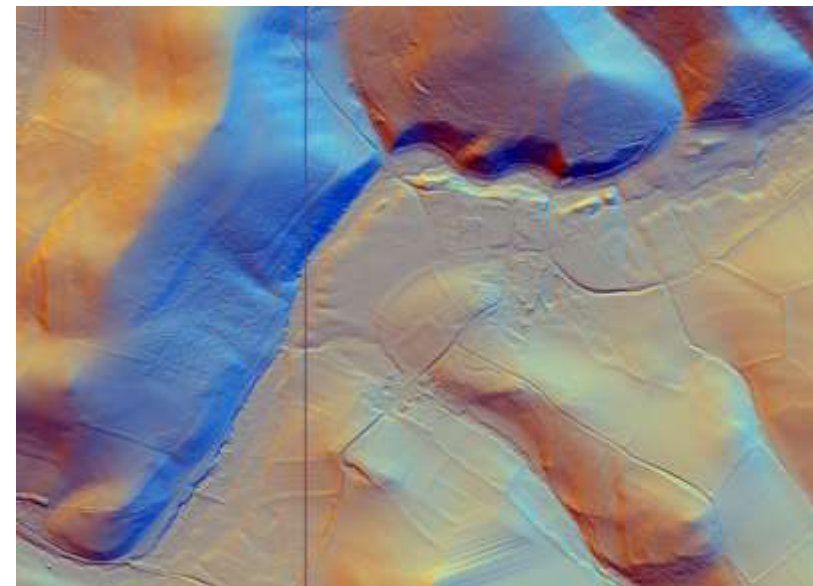
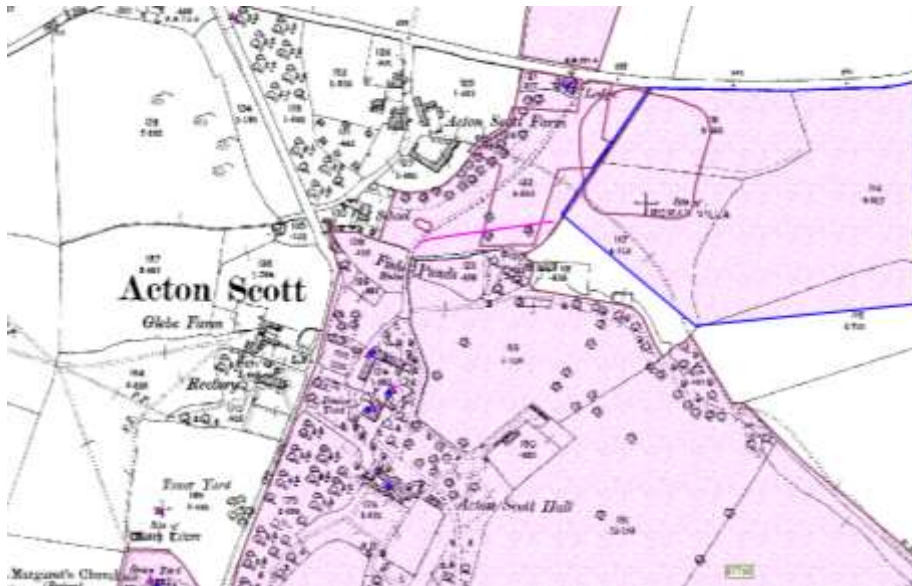


Archaeological sites

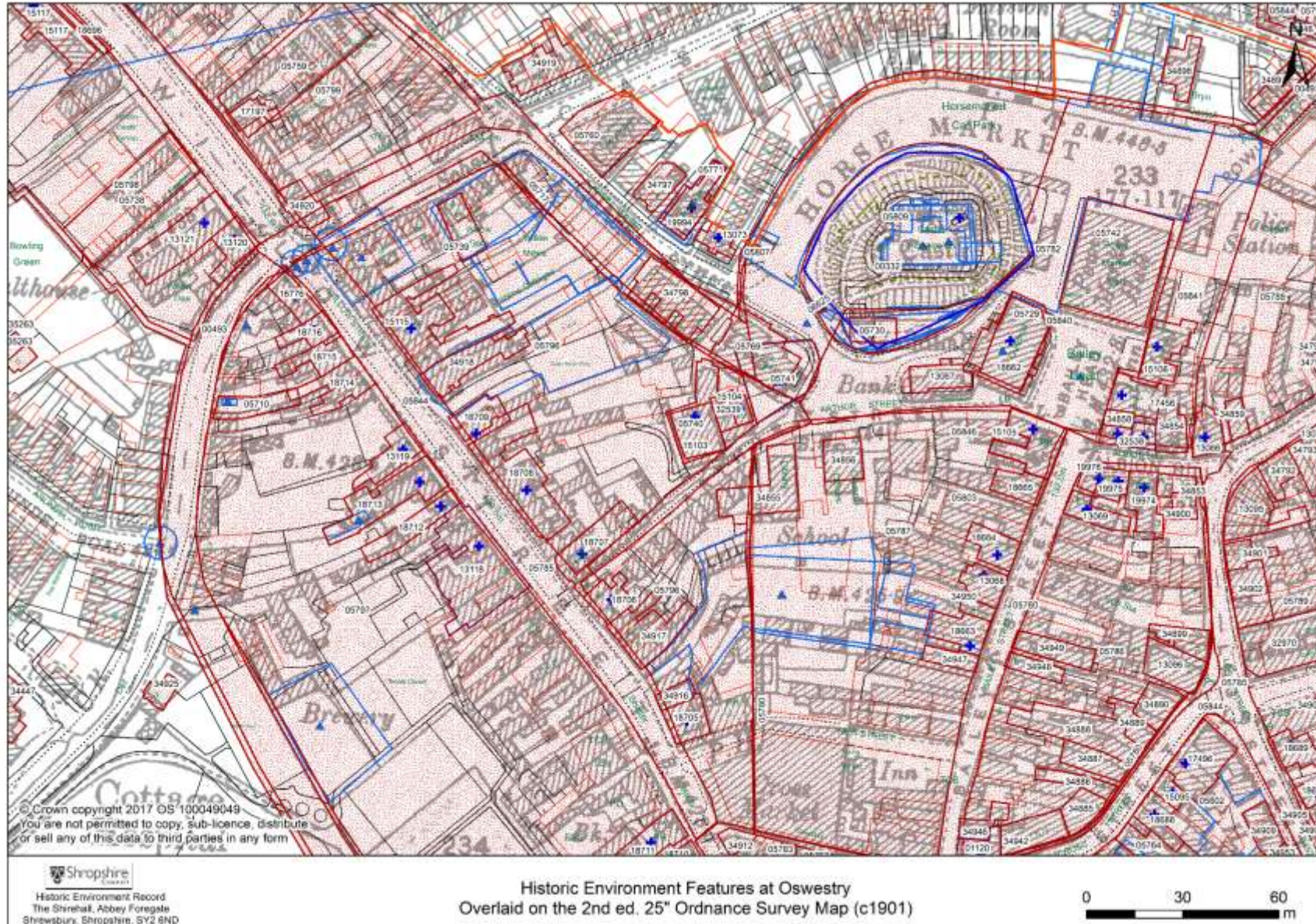
- From **castles** and **hillforts** to many other features spanning the last 10,000 years of the county's history...
- Surviving both above-ground as **earthworks** and below-ground – discovered through **excavation** or as **cropmarks** on aerial photographs

Historic landscapes

Tools to help 'read' the varied historic landscapes of Shropshire



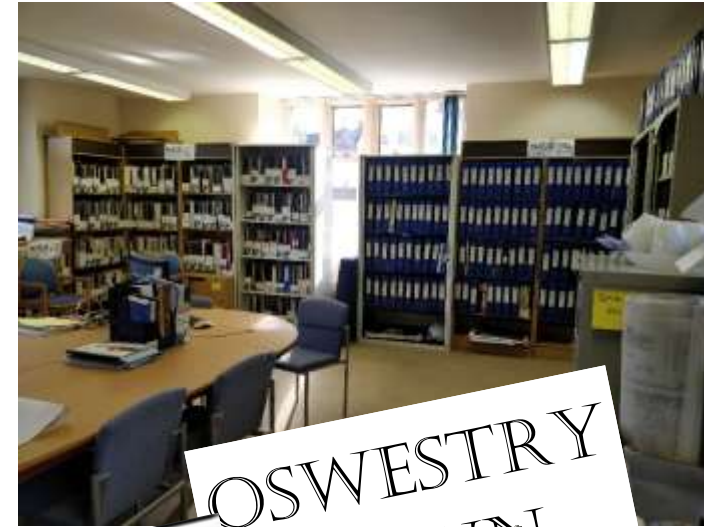
Putting heritage on the map




Where does the information come from?

The Historic Environment Record is supported by an extensive array of **source material** much of it held in a digital form

- Published sources – e.g. Victoria County History, local archaeological journals, national and local books and pamphlets
- Results of national and local thematic data gathering projects.
- Aerial photographs – both oblique and vertical imagery
- Extensive collections of ground photographs collected over 40+ years
- Site visit information
- Historic maps
- Increasingly, collections of digital survey resources
- Extensive collections of reports on particular sites made through the Planning Process, when historic features are investigated.





Aerial photography: earthworks and buildings

Aerial photography used to record
archaeological features above
ground - **earthworks**



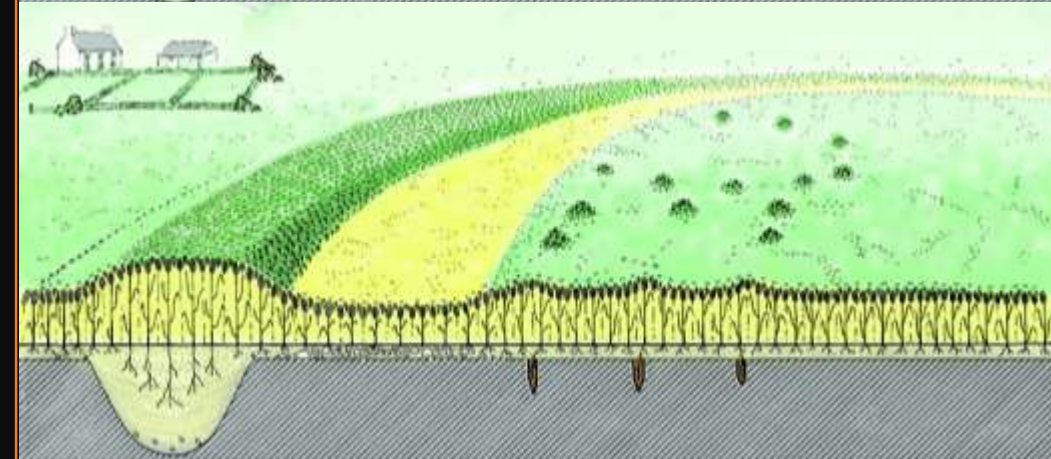
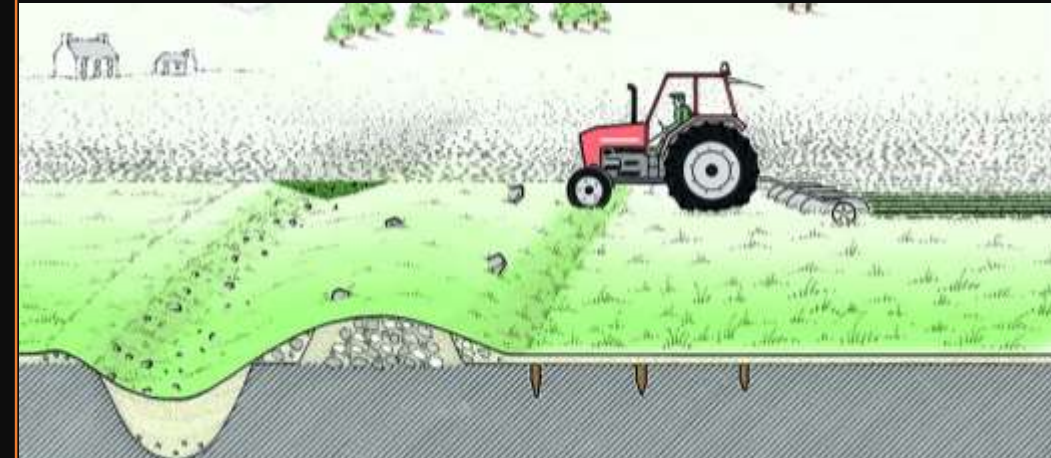


- Recording, managing and mapping upstanding elements of our historic environment – buildings and surviving earthworks

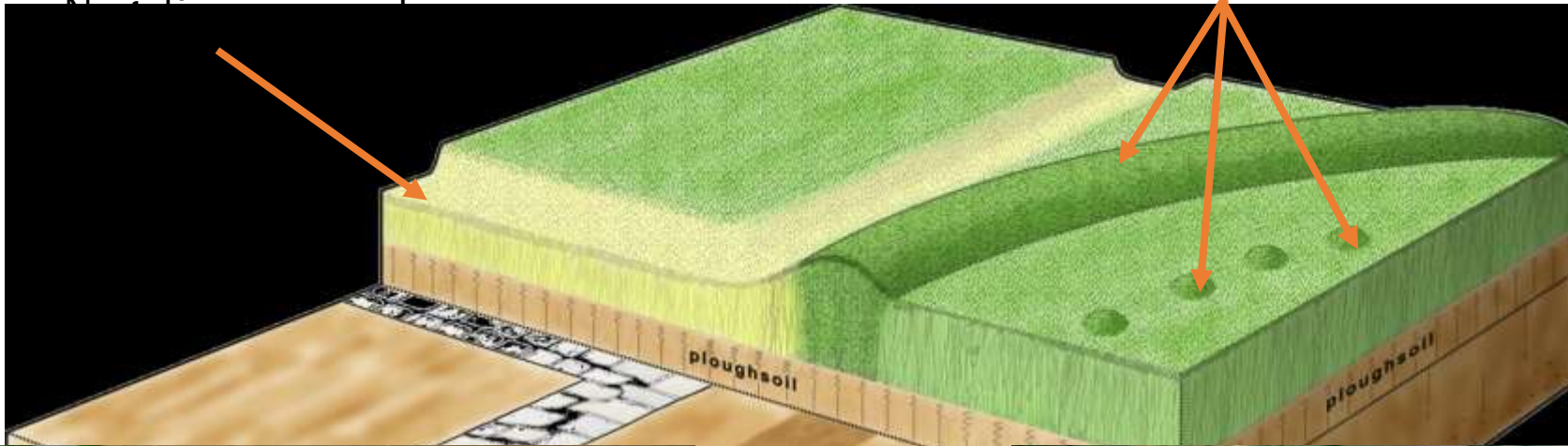


Aerial photography: cropmarks

Aerial photography used to record archaeological features leading to differential crop growth



Positive cropmarks



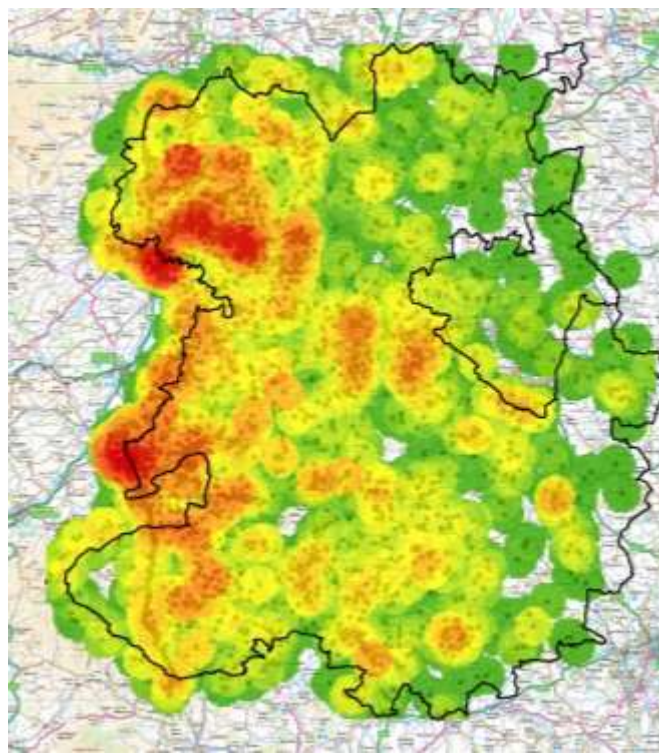


- Identifying many sites which are new to our records, particularly flying when crop is under stress (drought of 2018).
- Adding detail to known and previously recorded sites.
- Mapping this detail and adding it all to the **Historic Environment Record**

Collections of aerial photographs

Local

- Aerial survey carried out since c.1930s – mainly oblique for archaeological purposes.
- The HER holds c10,000 oblique aerial photographs, mainly taken between the 1970s and 1990s.
- We also hold runs of vertical aerial imagery – e.g. Ordnance Survey, RAF imagery (limited) and complete 1983 coverage
- 10,000+ digital oblique aerial photographs



Collections held elsewhere

- The Historic England Archive, in Swindon: oblique aerial imagery, from, for instance, Arnold Baker, Jim Pickering, as well as their own specialist flying:
<https://historicengland.org.uk/images-books/archive/collections/aerial-photos/>
- The Cambridge University Collection of Aerial Photography:
<https://cambridgeairphotos.com>
- Aerofilms:
<https://www.britainfromabove.org.uk/>
- Google Earth imagery – 2018 layers particularly useful for cropmark archaeology



LiDAR – the light fantastic

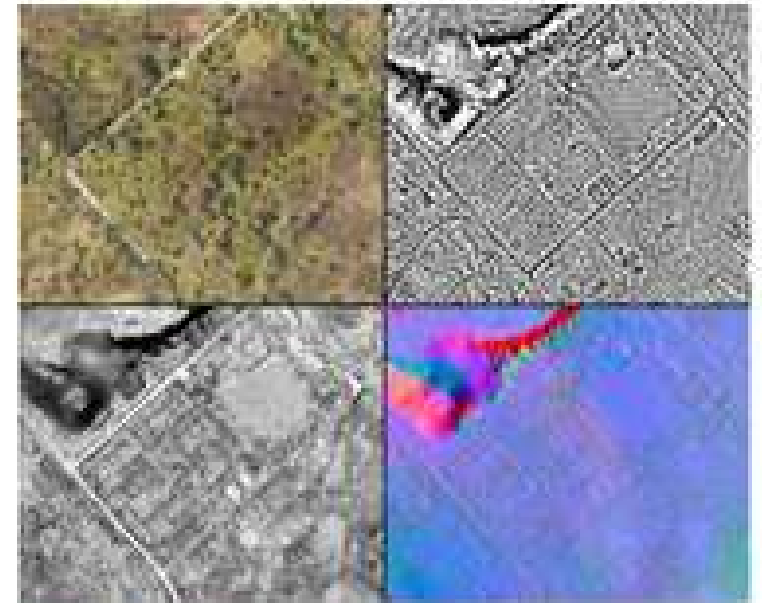
- Light Detection and Ranging – LiDAR– has brought another way of visualizing, interpreting and mapping the historic environment of the county.
- Building an accurate 3D digital elevation model of the earth’s surface – using an airborne laser scanner to produce a ‘microtopographic model’
- Also known as: ALS (Airborne laser scanning)
- used for a wide range of other purposes!



Historic England

Using Airborne Lidar in Archaeological Survey

The Light Fantastic

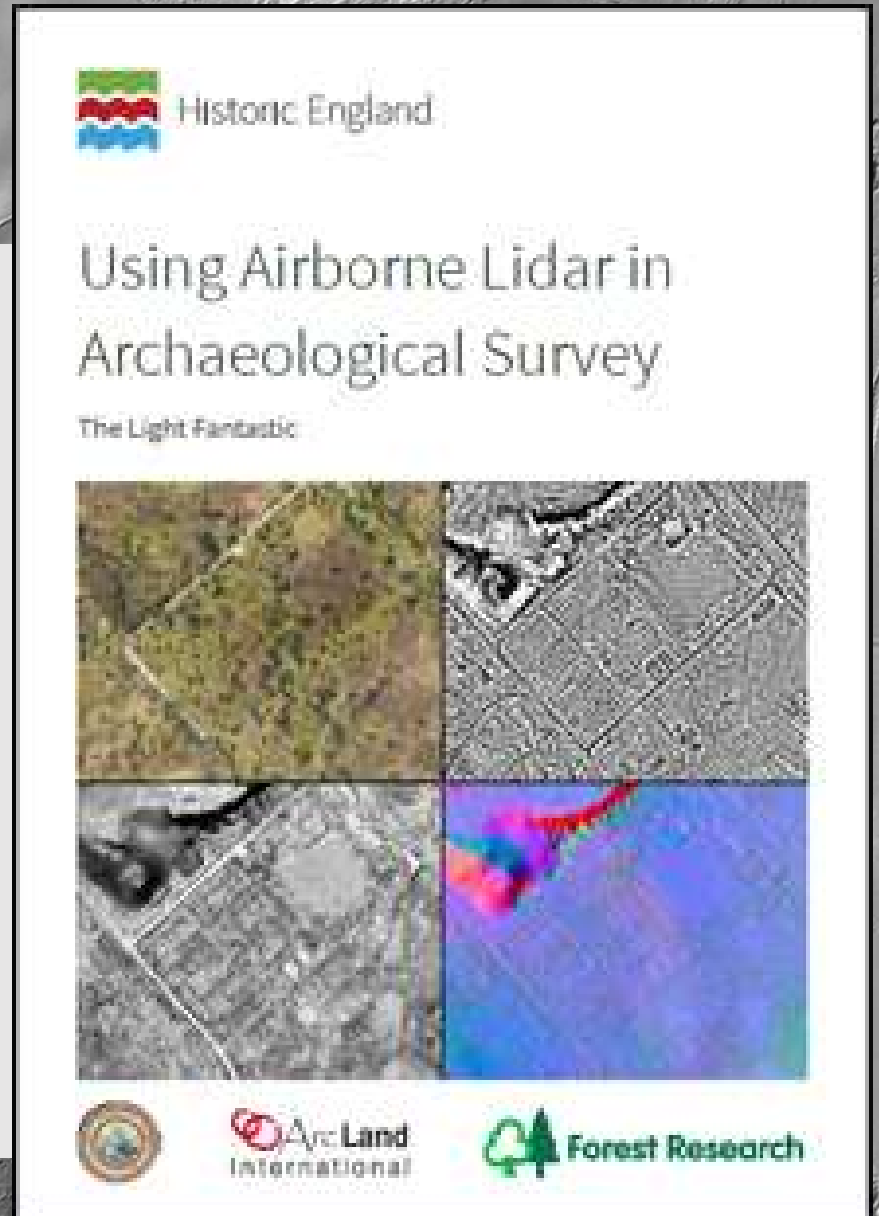


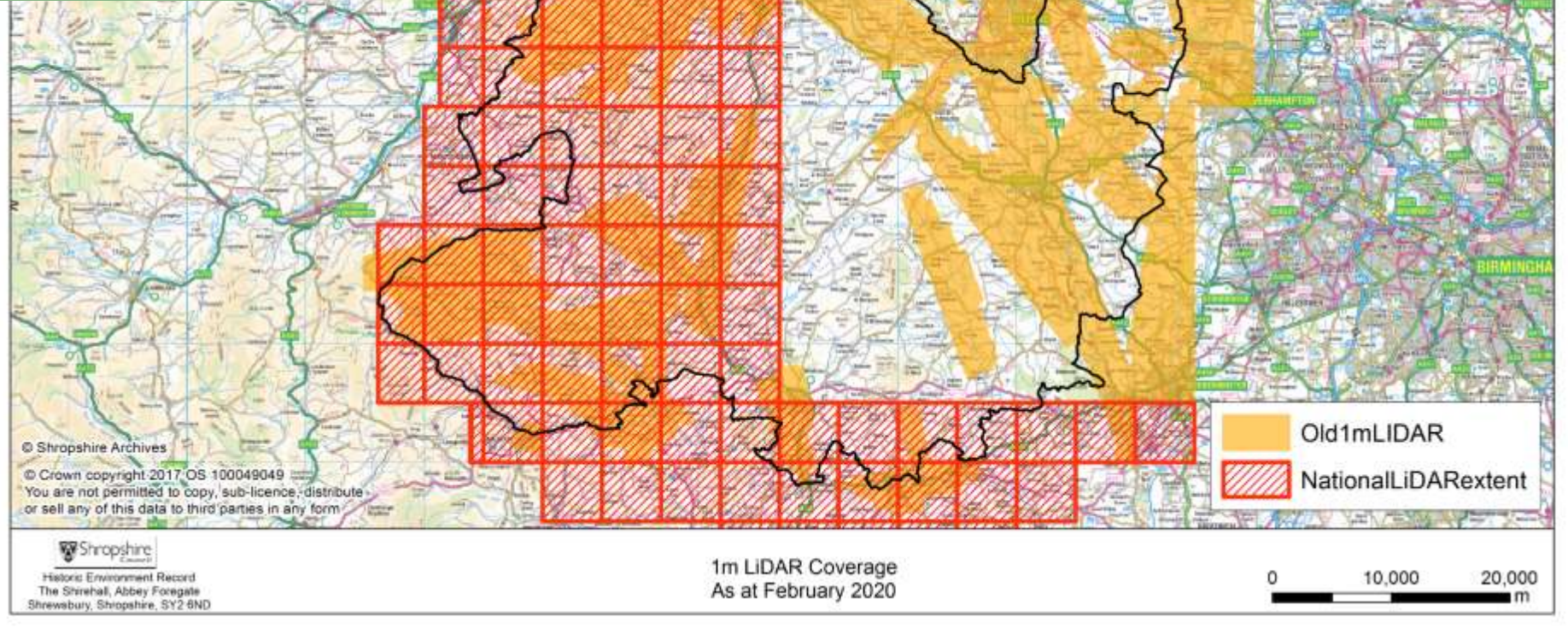
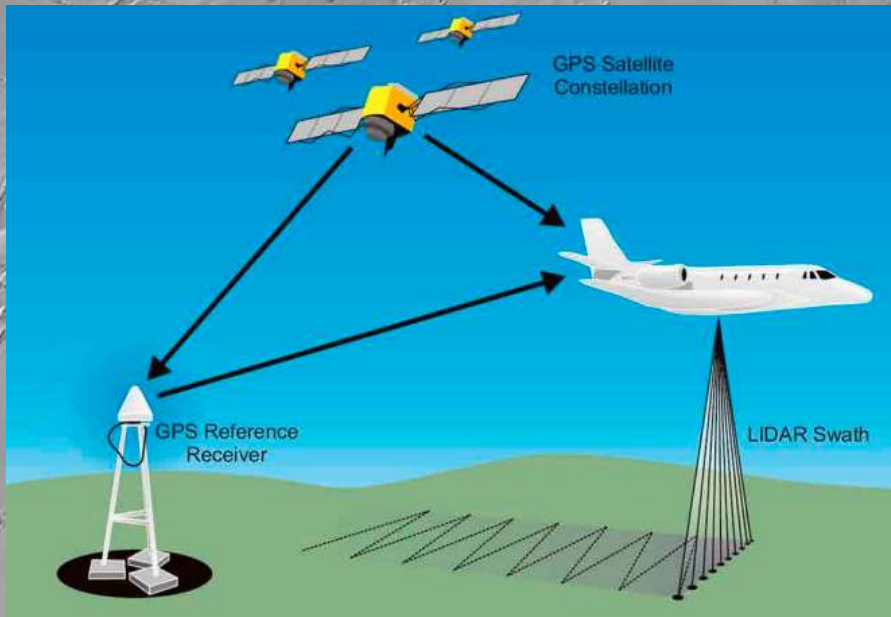
ArcLand
International

Forest Research

LiDAR – the light fantastic

- First used in the UK c.2003 for Coventry by the Environment Agency – originally focused on *flood risk mapping* – but now, extended through the National Programme into England-wide coverage by 2024 @1m resolution
- Smaller-scale, (and some larger-scale) surveys commissioned specifically for heritage projects e.g. Stiperstones and Corndon LPS, Wyre Forest and now, Our Common Cause
- But with 1m coverage being made widely available, there is huge potential in all the data that is already out there...





Different LiDAR 'products'



ASCII Data

Raw text file containing list of individual data points

'the point cloud'



Digital Surface Model (DSM)

The 'surface' features encountered by LiDAR – 'hard detail' of buildings, boundaries, and tree canopy/vegetation



Digital Terrain Model (DTM)

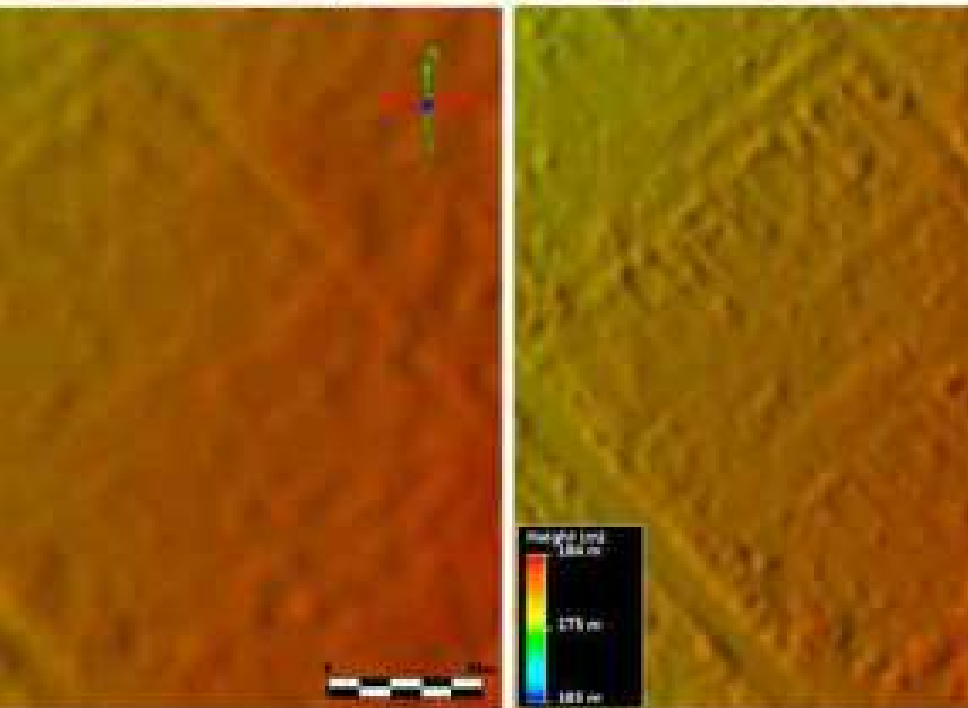
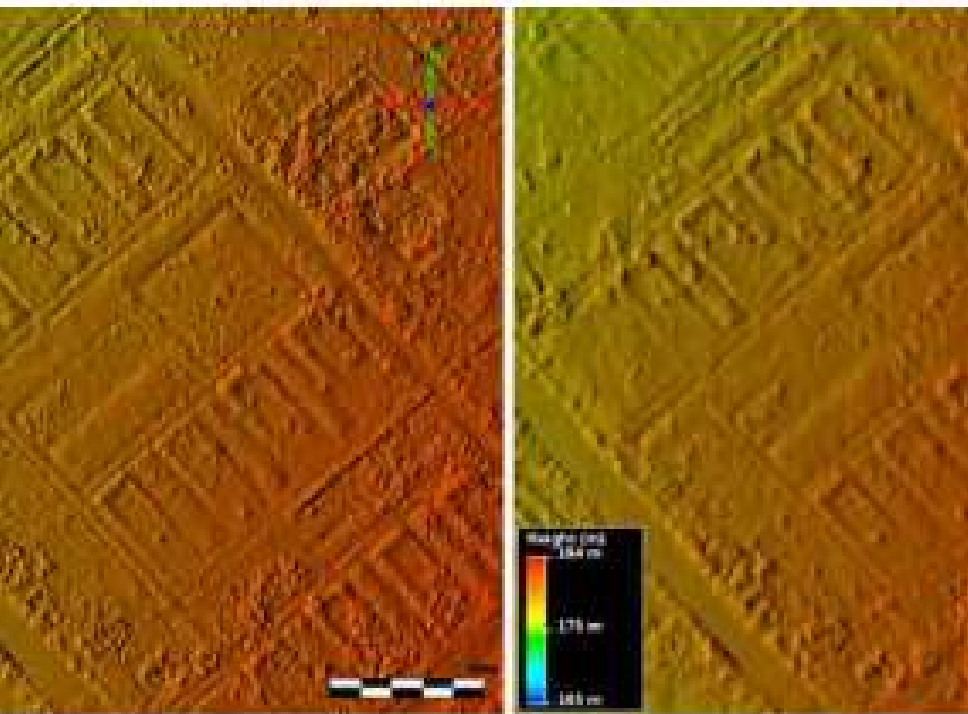
The 'bare earth' data – this represents the last pass of the LiDAR sensor.

Buildings and trees filtered out by computer algorithm – but beware limitations.

Hillshade – a way of visualising this data by artificially 'lighting' the landscape to reveal topographic variation – usually with 'raking' light.

Raw data – only way to ensure accurate **height data** is obtained e.g. looking at earthwork profiles.

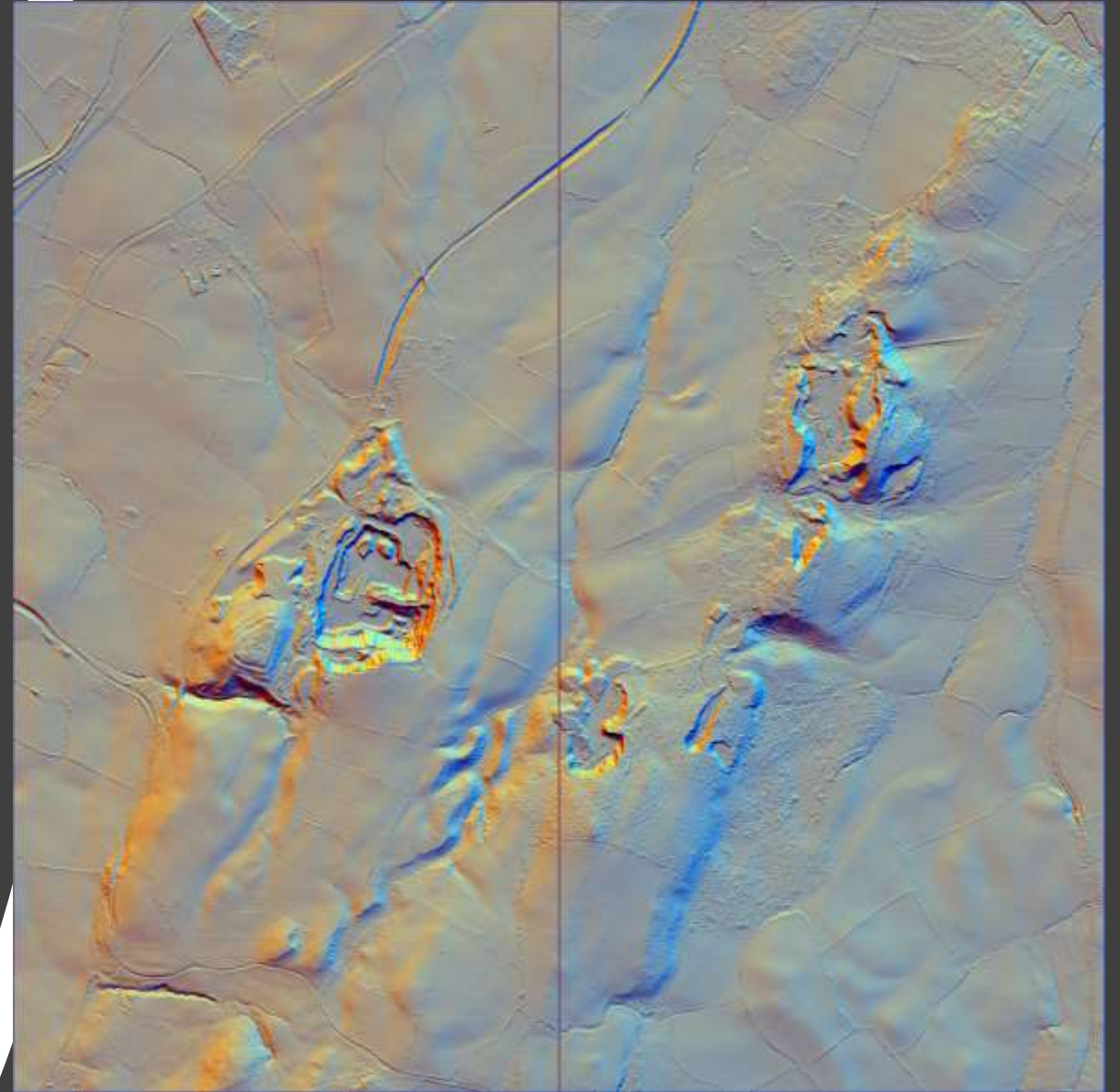
A matter of resolution



- Referring to resolution of gridding used, typically:
 - 2m: a landscape view; definition of larger-scale features e.g. ridge and furrow, general form of earthwork features; general topography.
 - 1m: generally adequate for detection of features in open countryside, or under 'regular' tree-cover such as plantation. Definition may be lost on smaller features.
 - 0.5m: the 'standard' for specially commissioned heritage projects. Provides high definition of features, particularly where they are small (e.g. under 2m in diameter), or where vegetation cover is variable and patchy e.g. under gorse, bracken etc.
- General rule of thumb for remote-sensing is that only features of a size 3× the resolution of the model in at least one dimension will be detectable.

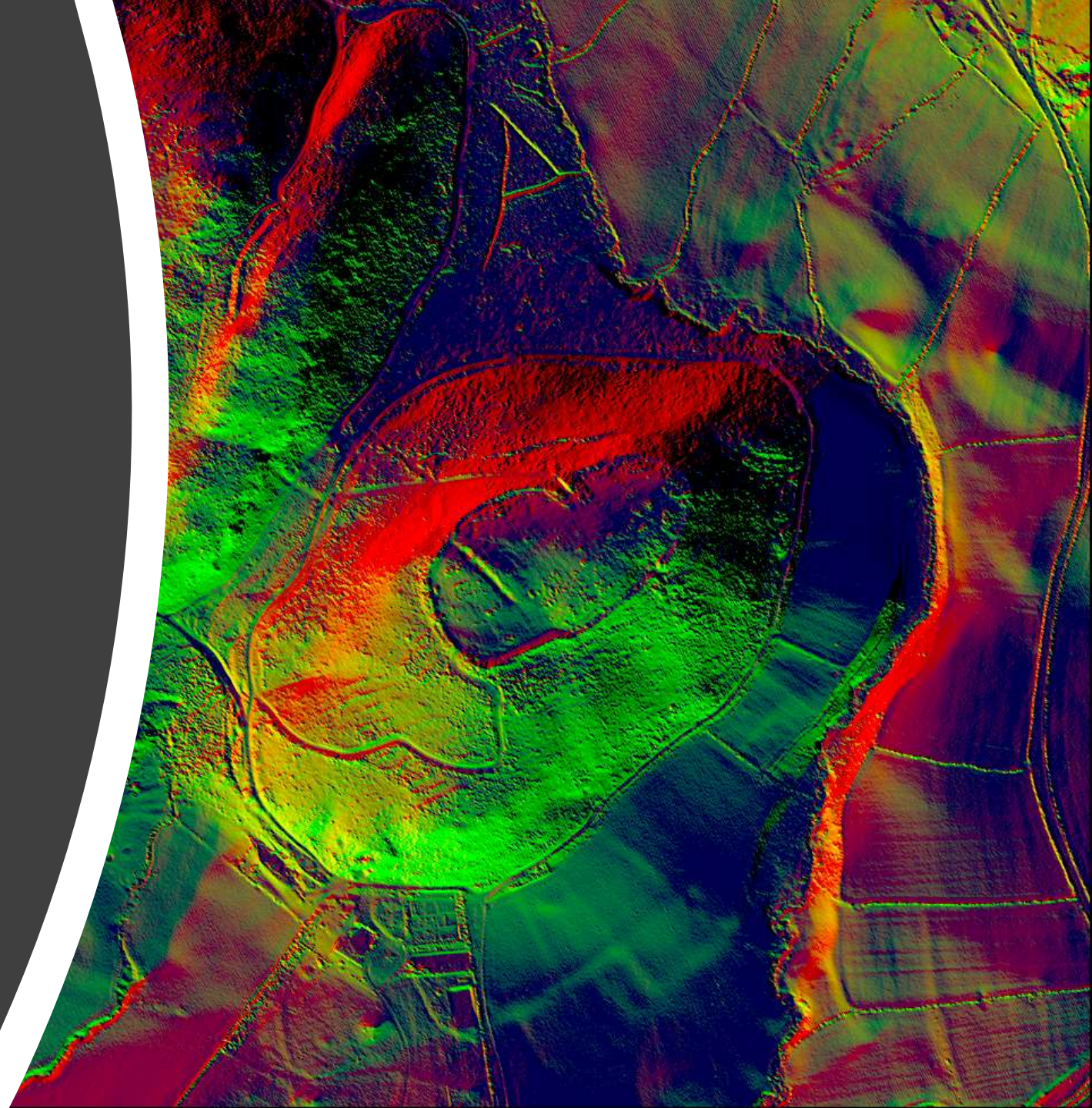
'Seeing through trees'

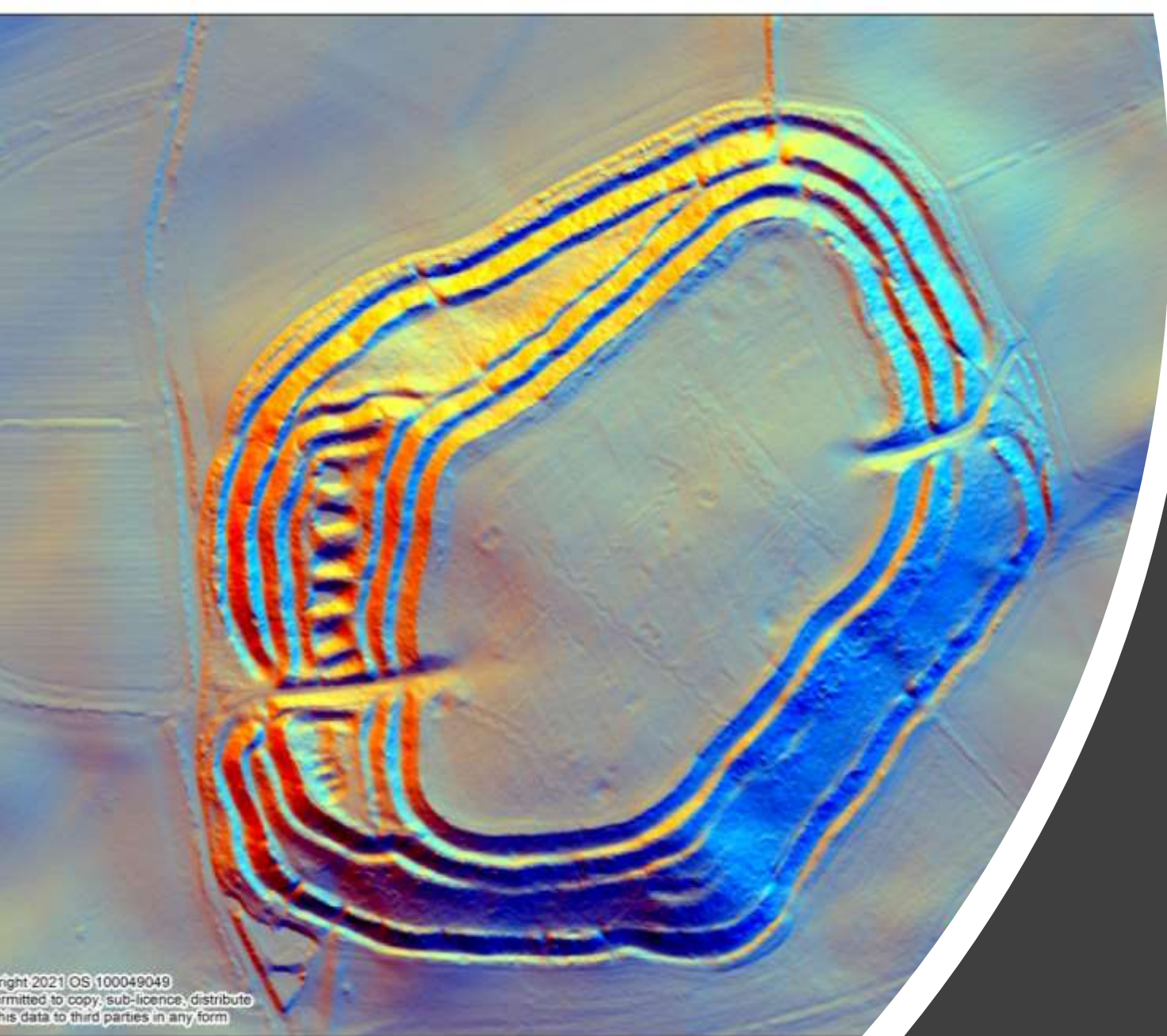
- Specially processed LiDAR reveals not only the ramparts of the hillfort on top of The Roveries, but also the remnants of a prehistoric field system to the South



Enhancing visibility

- Specially processed LiDAR reveals not only the ramparts of the hillfort on top of The Roveries, but also the remnants of a prehistoric field system to the South
- Many of these elements are very difficult to see on the ground – slight earthworks that can be made sense of at landscape scale!





A slice through time

Multiple different time periods visible
in a 'hillshade' of Old Oswestry
hillfort

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this data to third parties in any form

MERIDIES.

SALONICA.

Sabina flu.

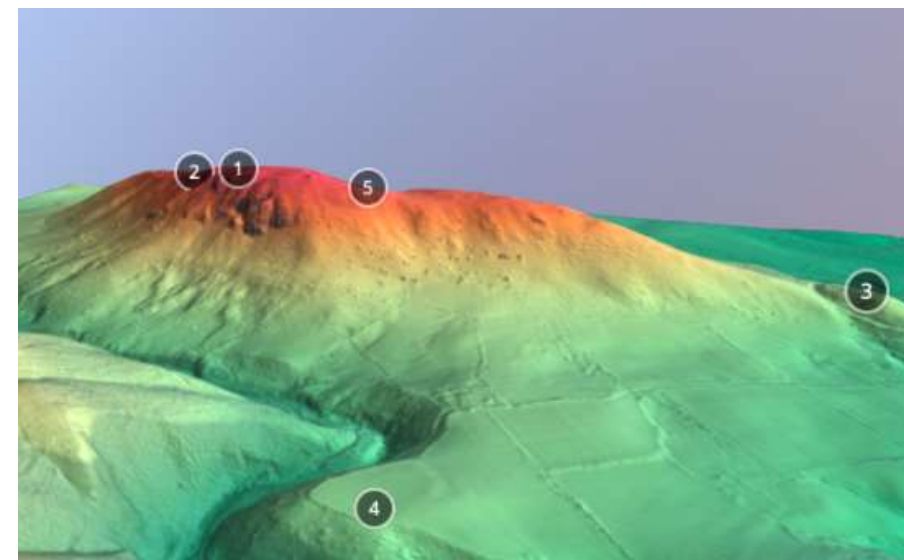
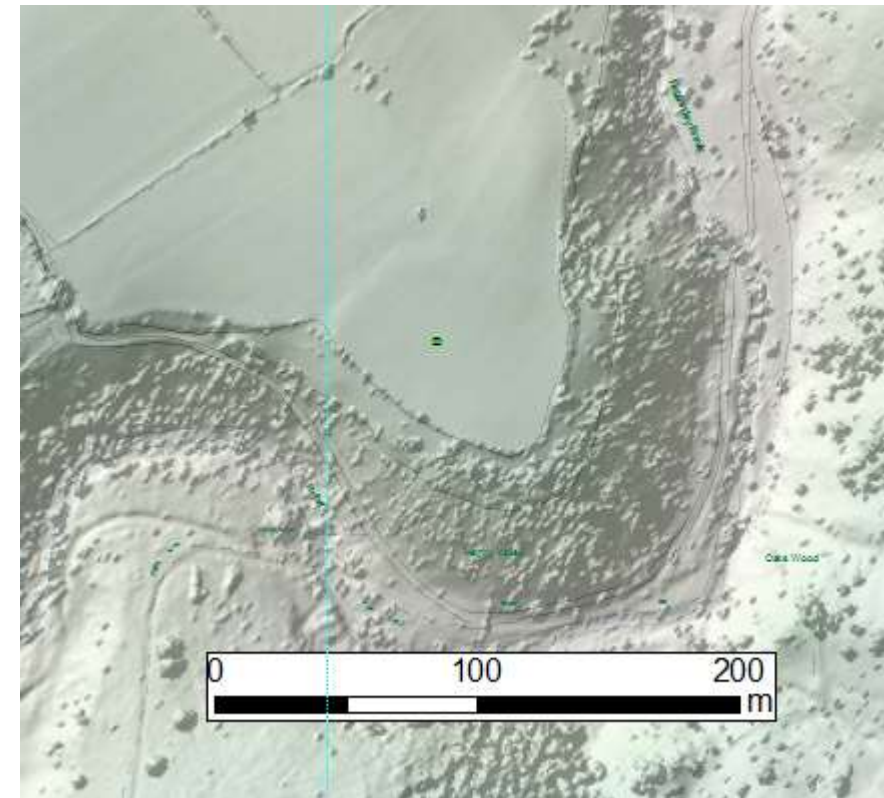
SEPTENTRIO

How do we use this archaeologically?



Discovery: Finding new sites

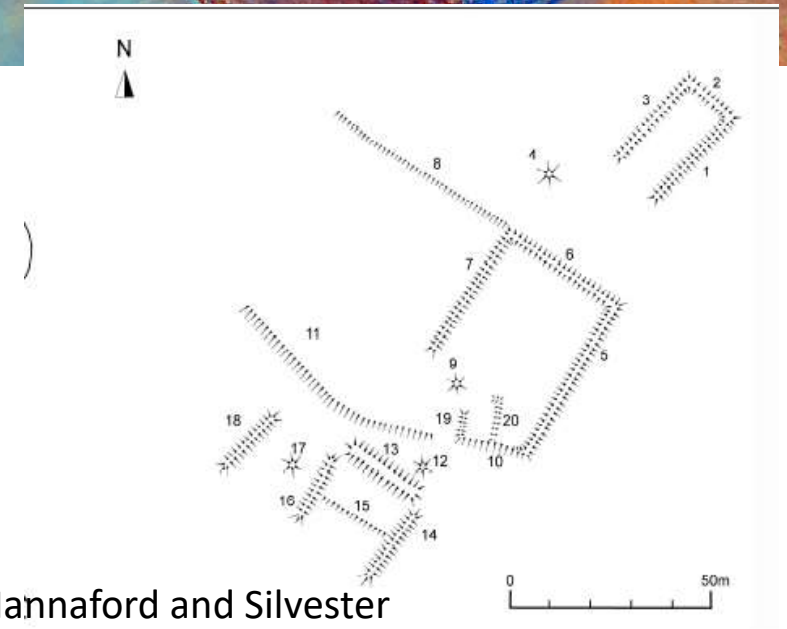
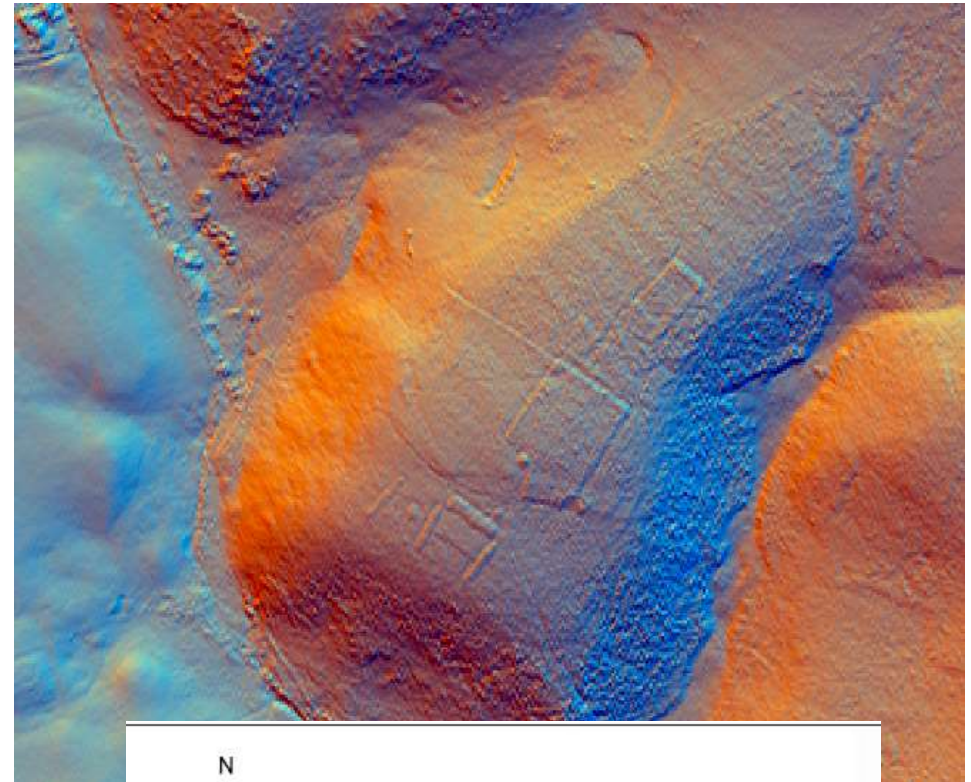
- Particularly relevant in the wooded areas of Shropshire - current woodland cover is Shropshire **9.3%**
- Even without woodland cover, high resolution LiDAR allows systematic landscape scale review of earthworks, particularly in the Upland Zone of the county
- Even where areas have been subject to systematic survey, LiDAR allows subtle earthworks to be enhanced – allowing new sites to be discovered

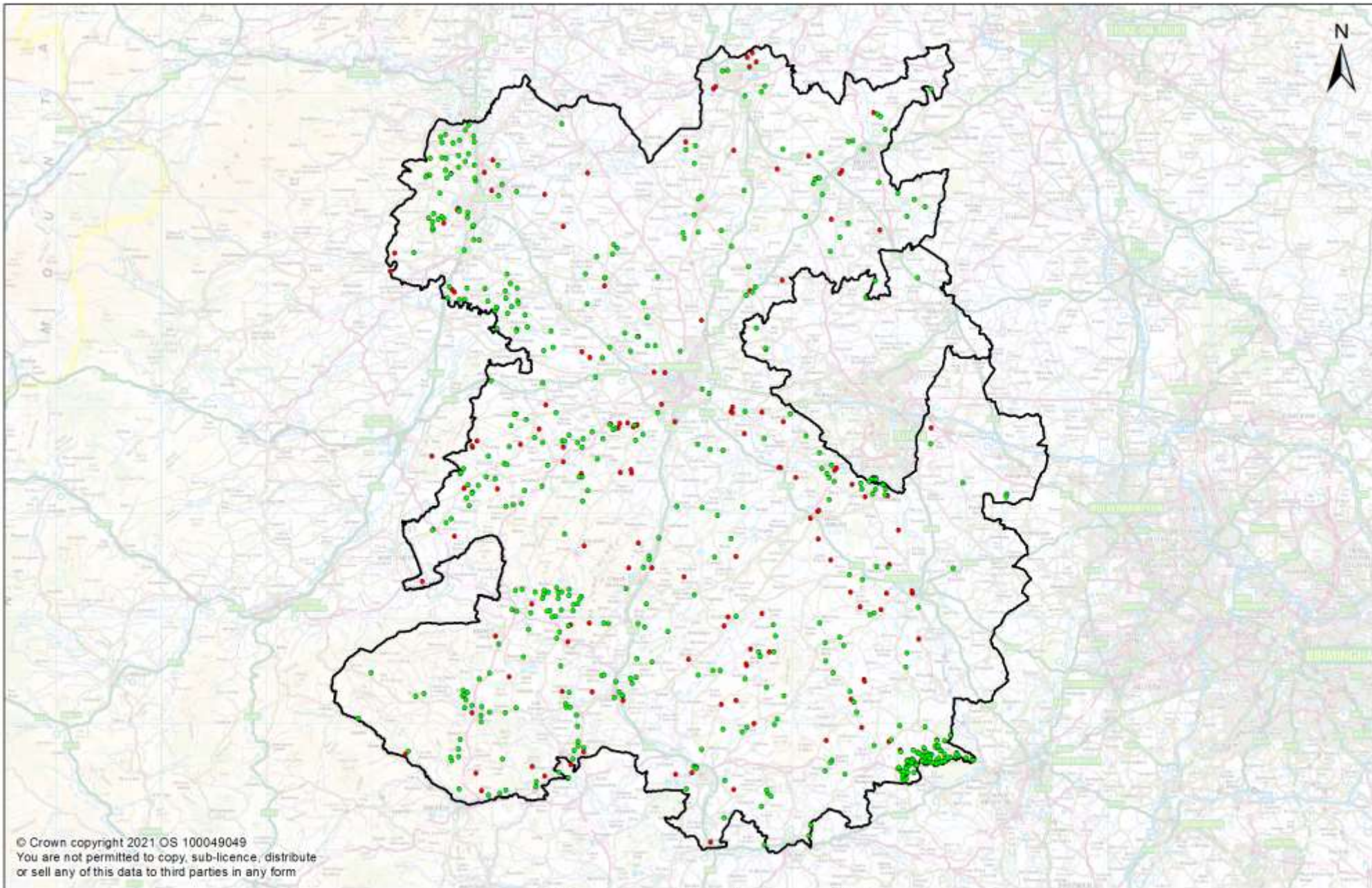


Possible promontory fort/enclosure recognised from LiDAR, Habberley Brook, E of Earl's Hill

Understanding: detail for known sites

- Where sites are in woodland, conventional survey is often limited – e.g. aerial survey due to tree canopy, trees interfering with measured survey, bracken cover with moorland/open hill survey
- LiDAR is fully **georeferenced** i.e. tied into a map with no adjustments required. This allows for accurate mapping of earthwork features which have previously been mapped from other sources.





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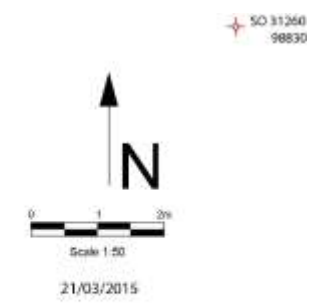
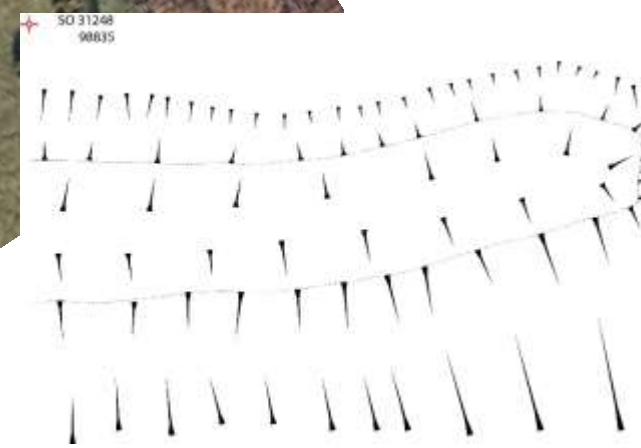
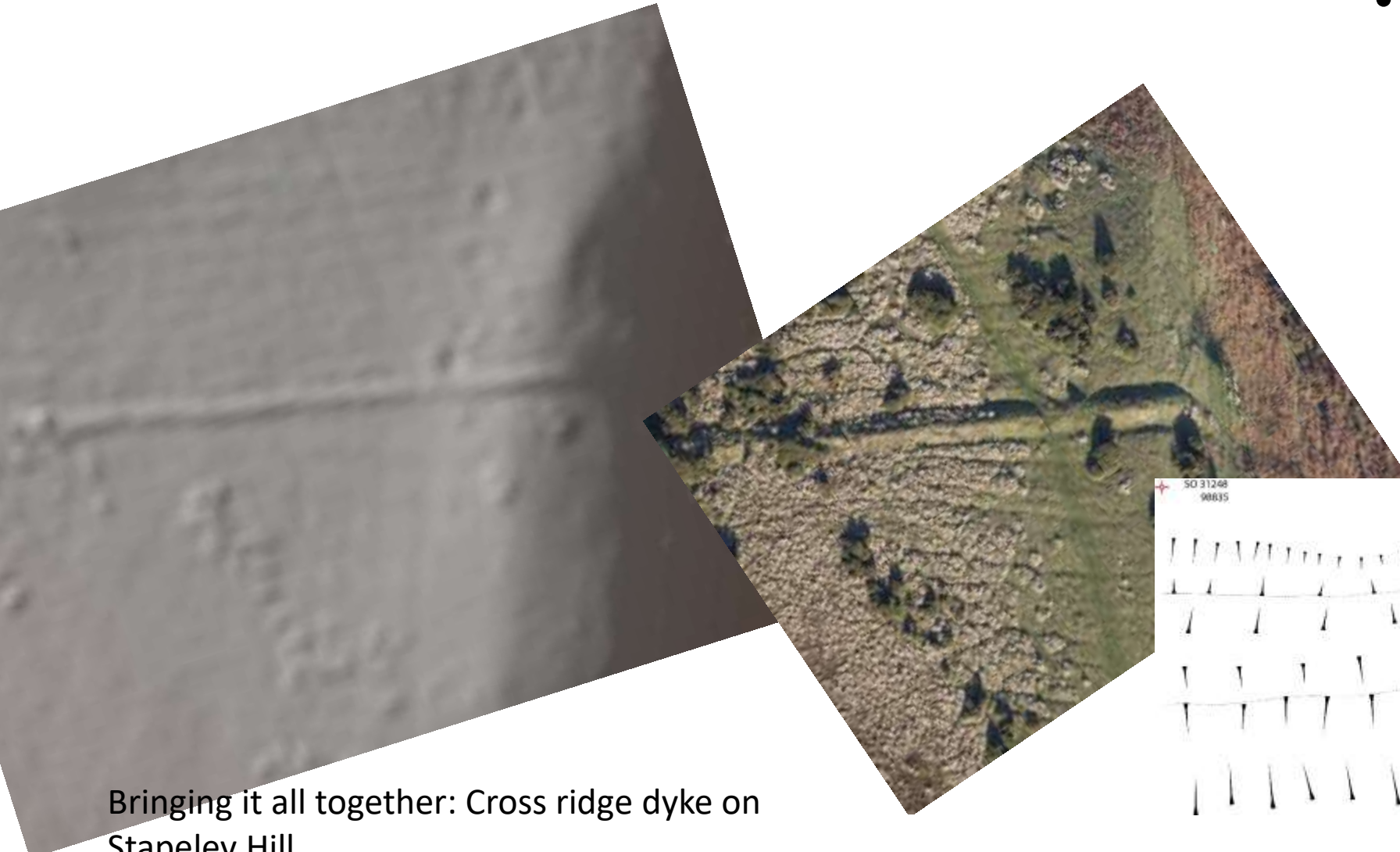
Historic Environment Record
The Shirehall, Abbey Foregate
Shrewsbury, Shropshire, SY2 6ND

HER records compiled primarily from LIDAR



Comparative data

- Interpretation of all remote sensed data is always more robust when compared with other sources...



Bringing it all together: Cross ridge dyke on Stapeley Hill

Historic mapping



- Earlier maps – estate maps, field maps, dispute maps – 15th to 19th centuries - particularly those held at Shropshire Archives.
 - Often 'schematic' with divergences in scale, perspective, representation etc.
- Tithe maps & apportionments – mid 19th century
 - Large scale, with much detail of field names, buildings depicted etc.
- Maps made for specific purposes – e.g. railway plans.
- Ordnance Survey 1880 town plans (1:500 scale). Selected Shropshire Towns
- 1st edition Ordnance Survey (1880s) – 1:2500 and 1:10560
- 2nd edition Ordnance Survey (1900s) – 1:2500 and 1:10560
- More recent editions of the Ordnance Survey

Explore from home: The National Library of Scotland

- 1880 town plans (1:500 scale). Selected Shropshire Towns
- 1st edition Ordnance Survey (1880s)
- 2nd edition Ordnance Survey (1900s)
- More recent editions of the Ordnance Survey
- <https://maps.nls.uk/>

Comparing historic mapping and LiDAR imagery – side-by-side viewer

National Library of Scotland
Leabharlann Nàiseanta na h-Alba

Map images

[Map Finder](#) | [Explore Georeferenced Maps](#) | Side by Side

Swipe OFF | [Swipe ON](#)

Keyword search

1. Select a category: Only show maps with more detail than the current zoom level - (16)

2. Select a map series: [Zoom to extent](#)

1. Select a category: Only show maps with more detail than the current zoom level - (16)

2. Select a map series: [Zoom to extent](#)

Show Search Panel



The image shows a side-by-side comparison of two maps of the same geographic area. The left map is a historic Ordnance Survey map from 1885-1900, showing a network of roads and a river. Labels include 'otts Road' and 'Calf R'. The right map is a modern LiDAR DTM (Digital Terrain Model) from 2019-2021, showing the same area with a color gradient representing elevation, where red indicates higher ground and blue indicates lower ground. Both maps have zoom controls (+ and -) on their left sides.

Help

200 m

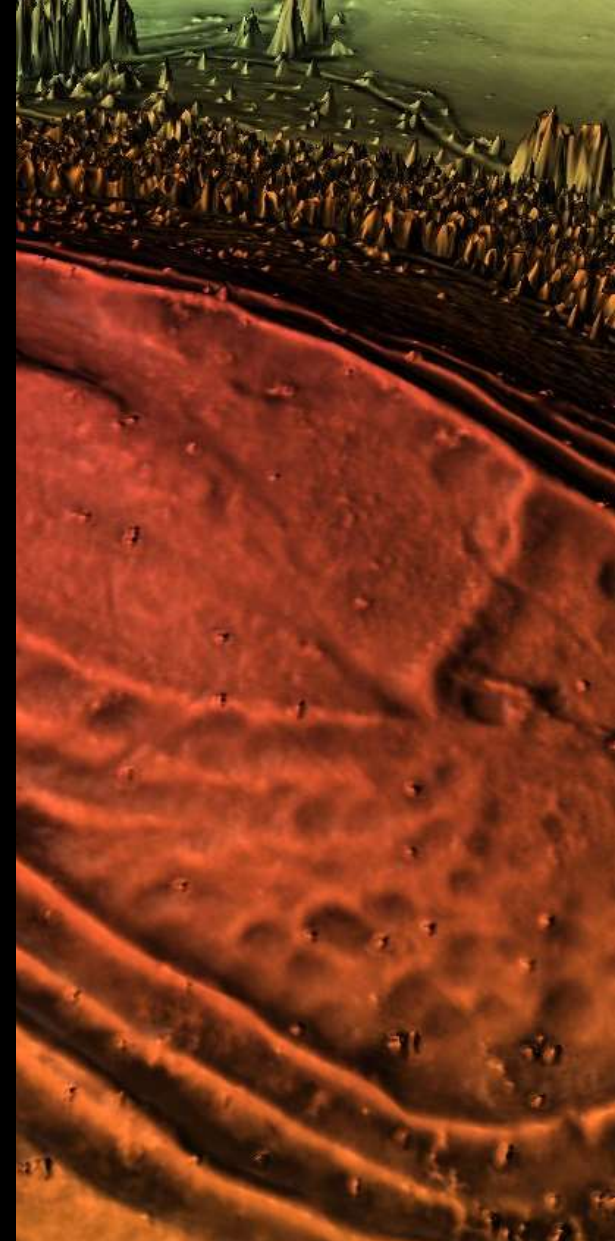
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LiDAR Training Workshop

Understanding different types of processing and visualization

Giles Carey, Historic Environment Team, Shropshire Council



Processing LiDAR

- Not something you will be necessarily doing but really important to understand how processing in different ways will affect what you can 'see' in the data.
- Some data e.g. from the *Environment Agency* is supplied in a 'raw' format and there are free tools available to process – the one we have used extensively is **RVT (Relief Visualization Toolbox) LiDAR** – developed by archaeologists for archaeologists.
- Data is then often viewed in GIS – and Open Source QGIS is particularly powerful in this regard.
- Important to remember that none of this software picks out archaeology – it shows you every earthwork, whatever it's origin!



Possible warrener's lodge?

High platforms/quarry scoops

Internal passage

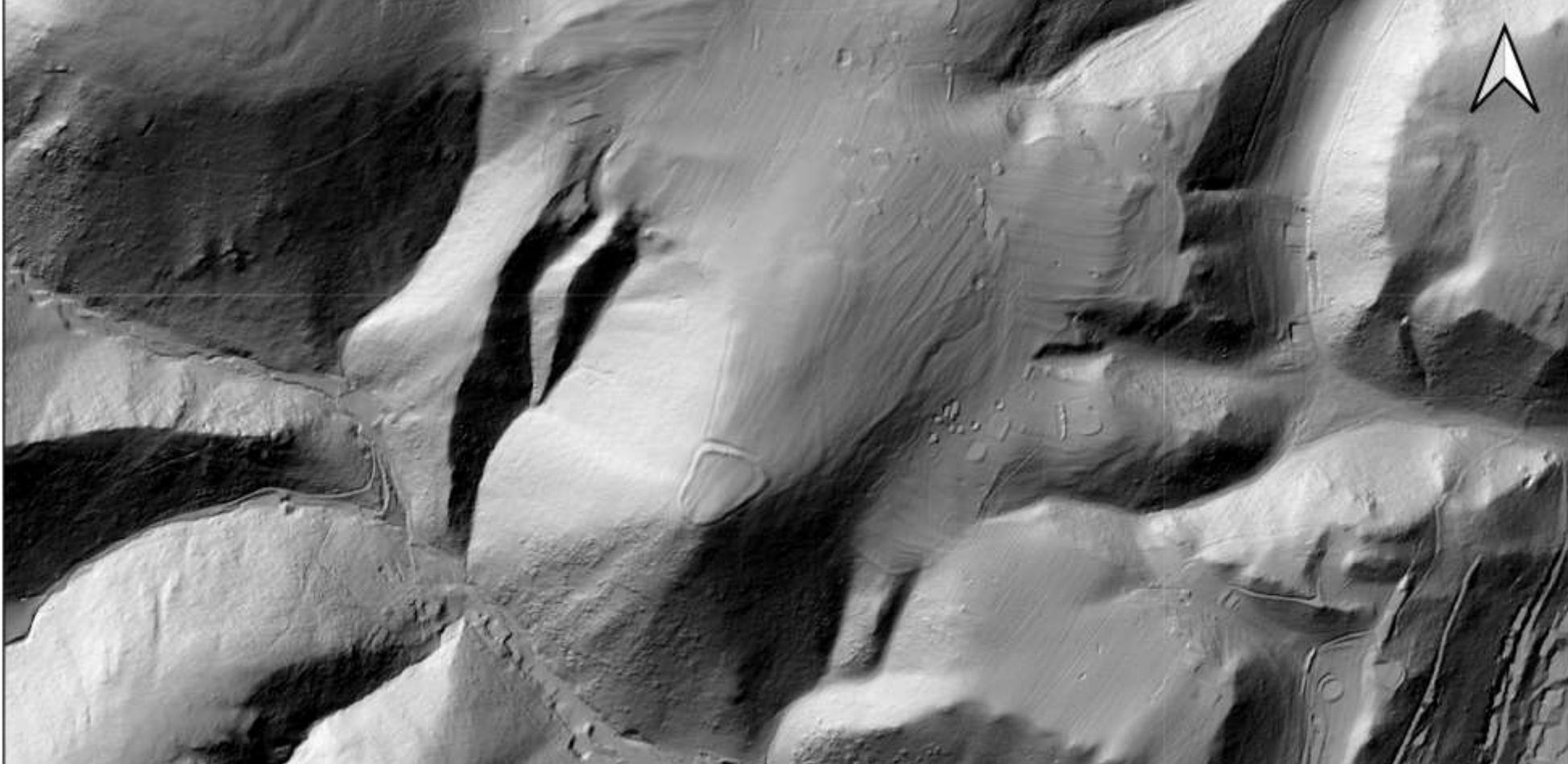
'Funnelled' western entrance



'Raw data' – Point Cloud

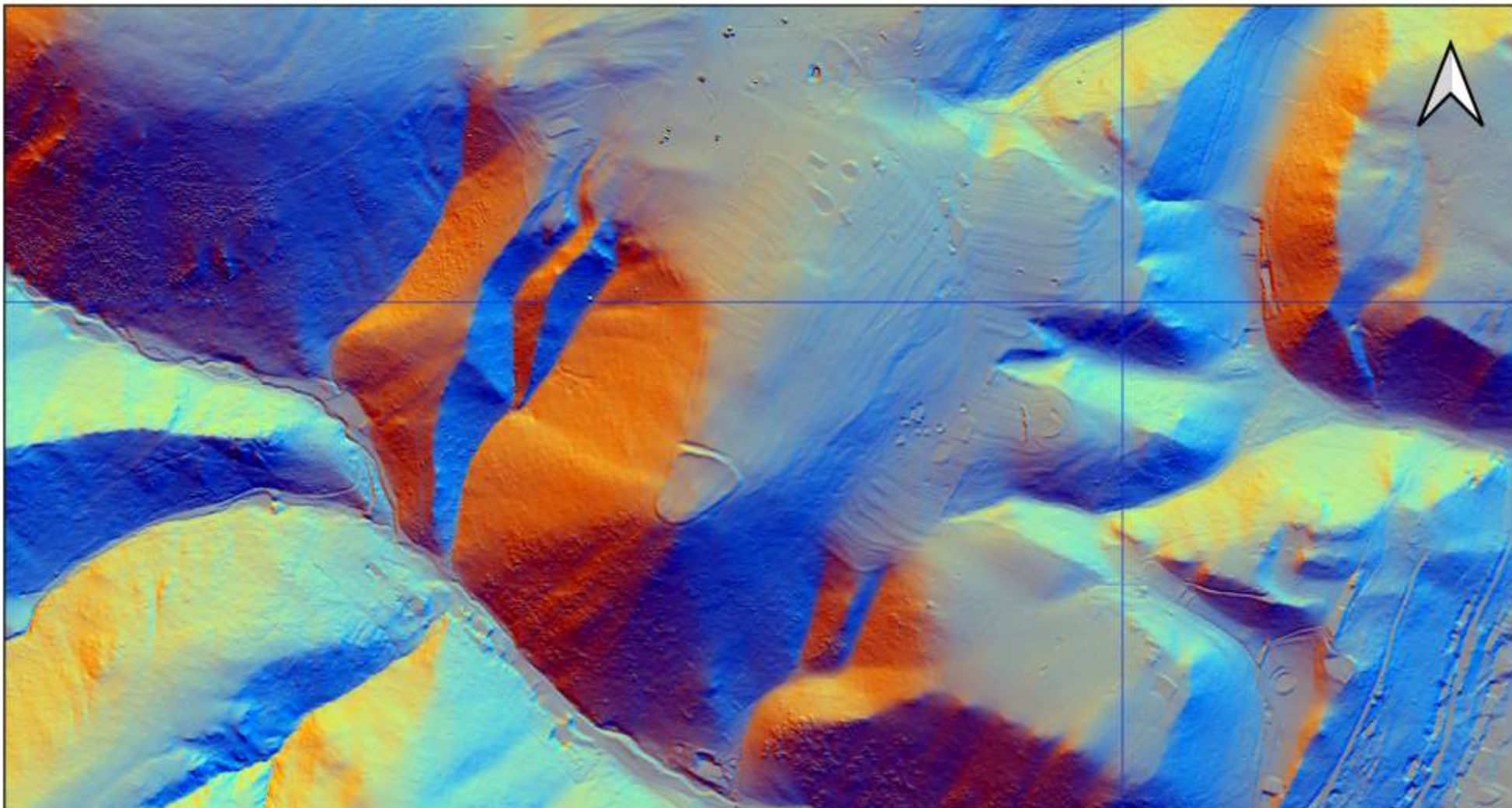
- A side-on view of a “point cloud.” Each point has an x, y, and z coordinate, giving its exact 3D location.
- Supplied as a text files (.asc) which doesn't look like much until you start processing it!





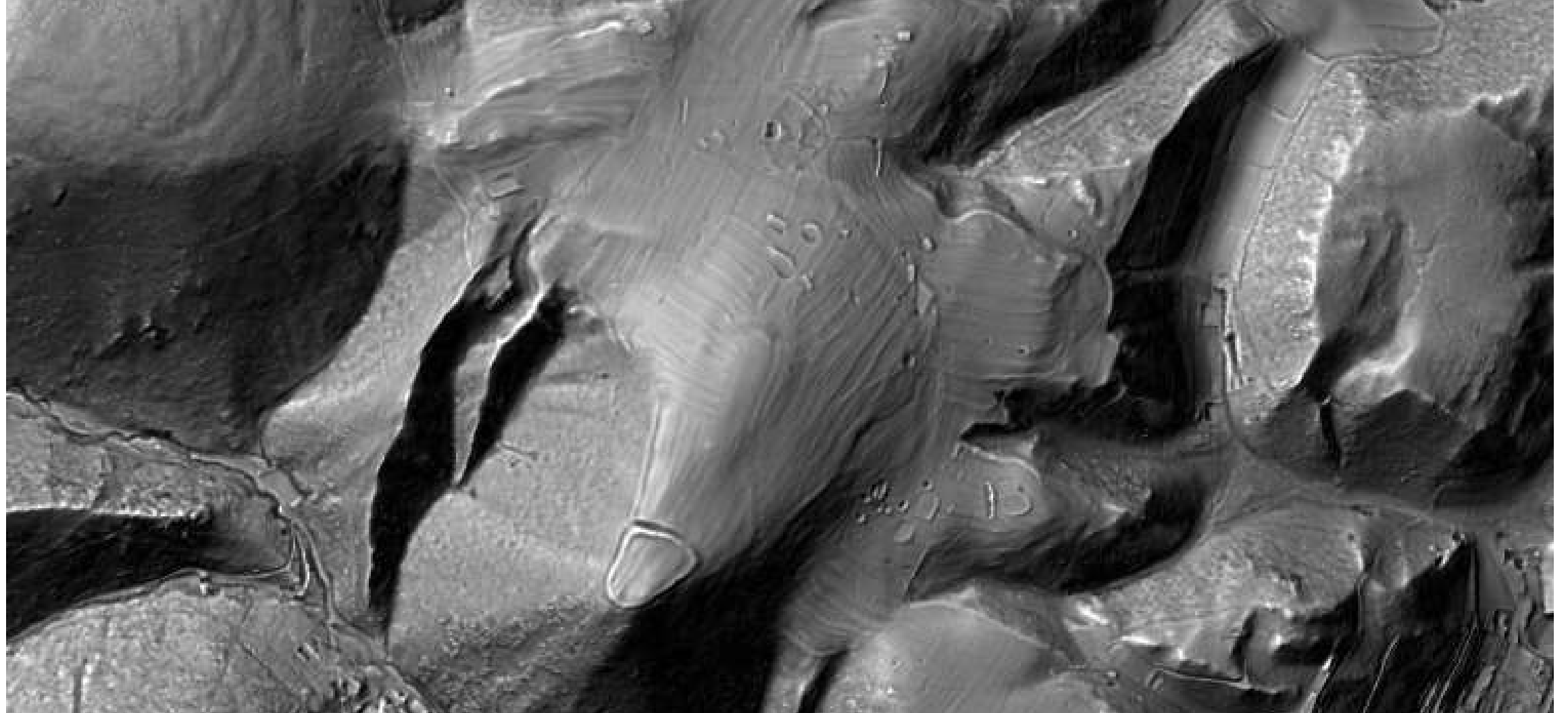
DTM 'hillshade'

- Creating an artificially lit visualization, a solid surface interpolated from all the point data – usually lit from NW (azimuth 315 degrees, elev 35)
- Can no longer take native measurements from the dataset



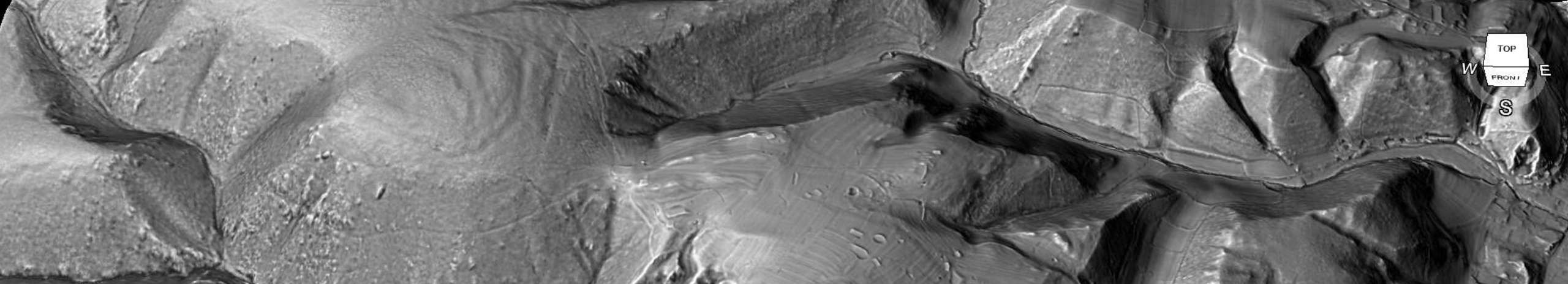
DTM 'multi-hillshade'

- Lit artificially from multiple cardinal points – in this case 16 different directions. Features are captured which are directional in nature.



Local relief model

- Large landscape scale variation removed from the data, to enhance local, small-scale variation
- Sharpens detail – positive features shown as white, negative as black



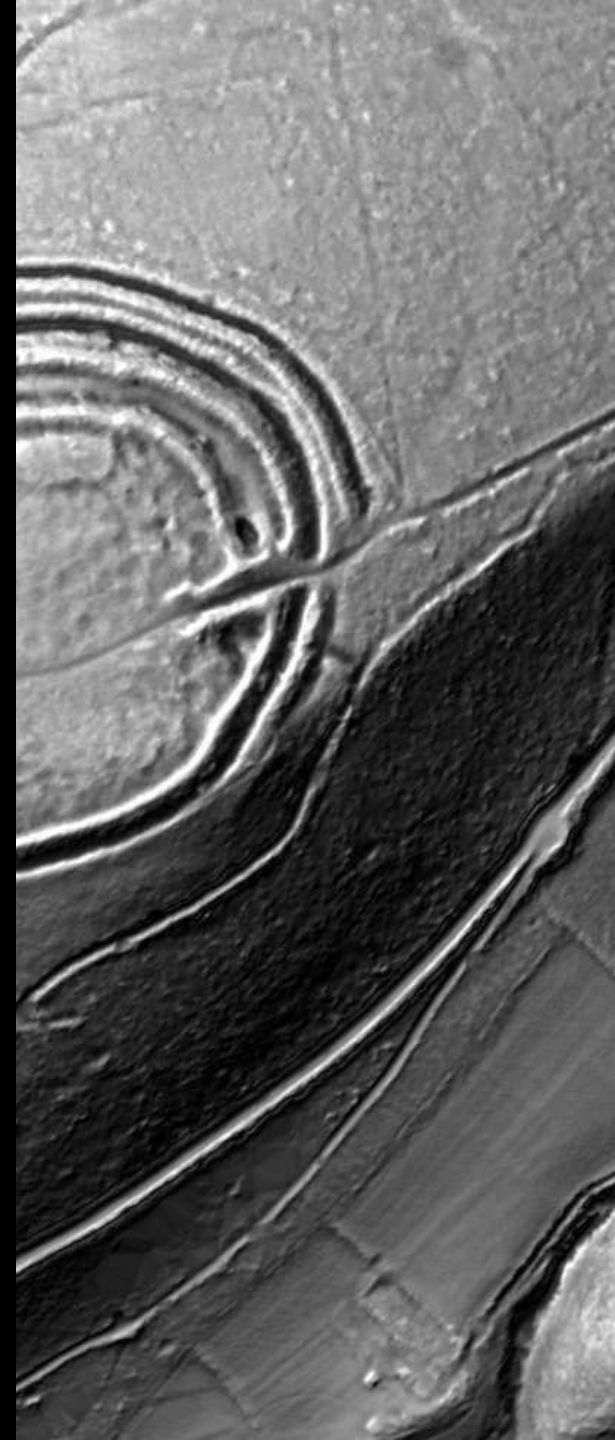
3D visualizations

Not just a 'pretty' picture but a way of interacting with the landscape



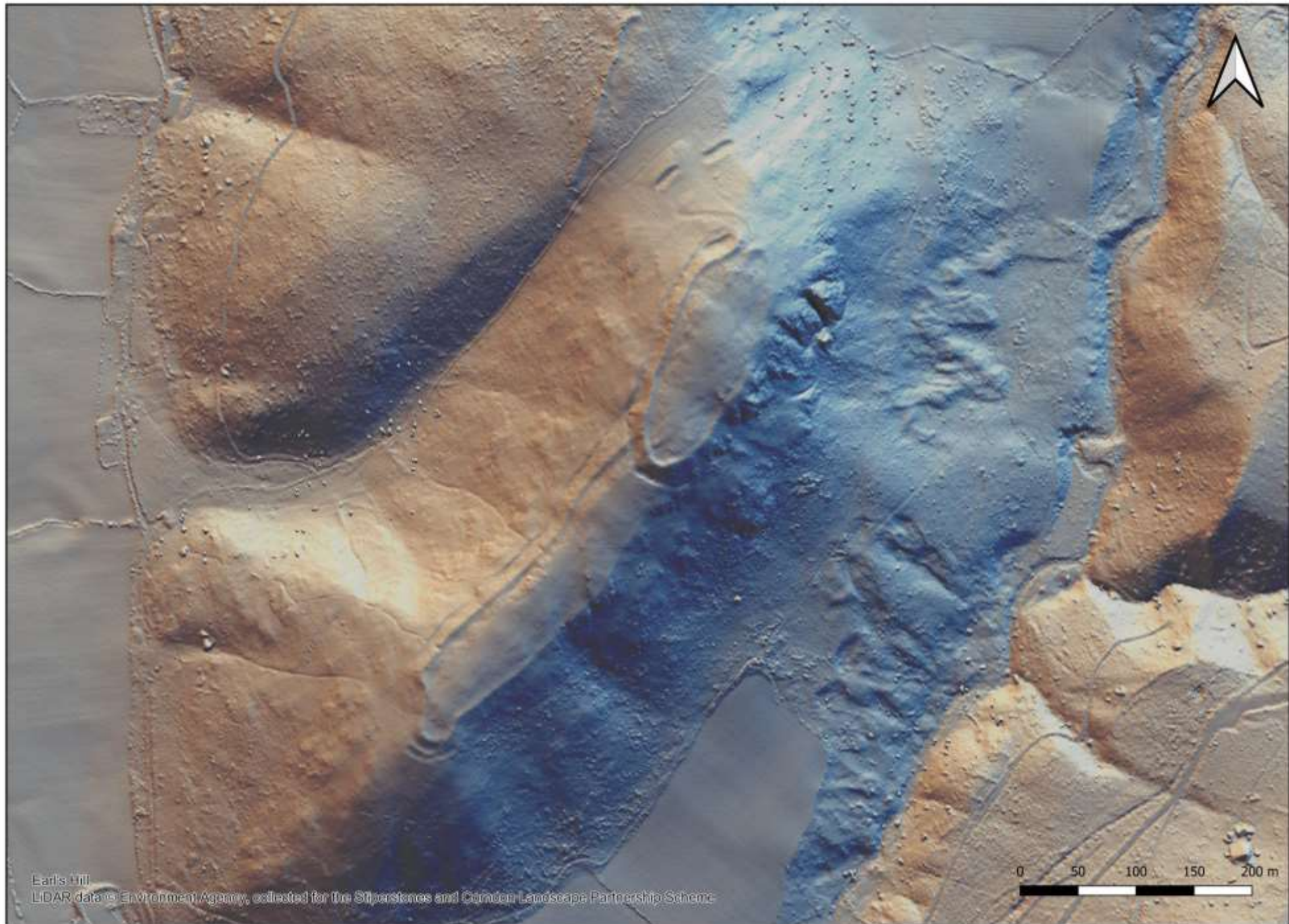
Some examples

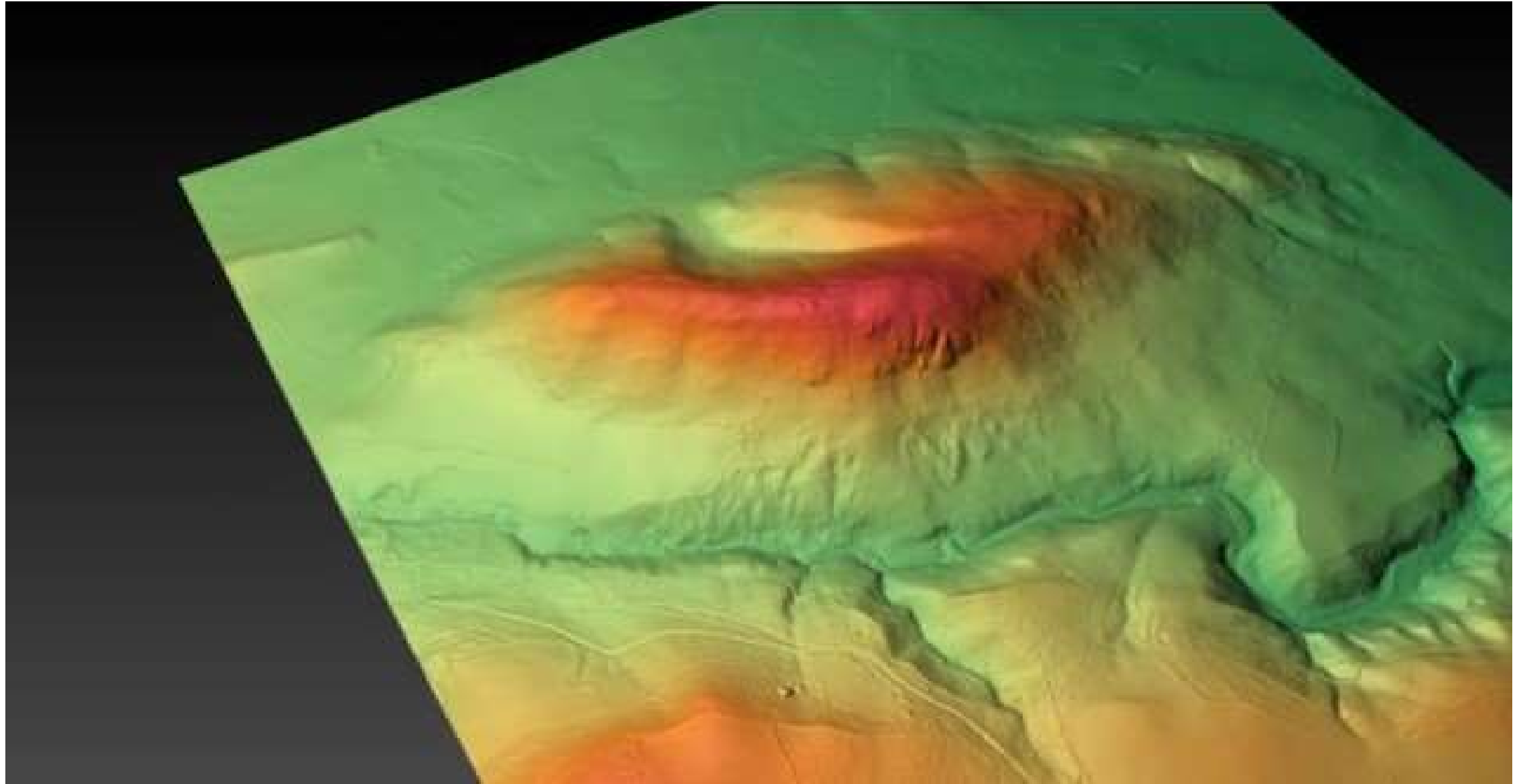
Using visualizations in a way to bring out archaeological features

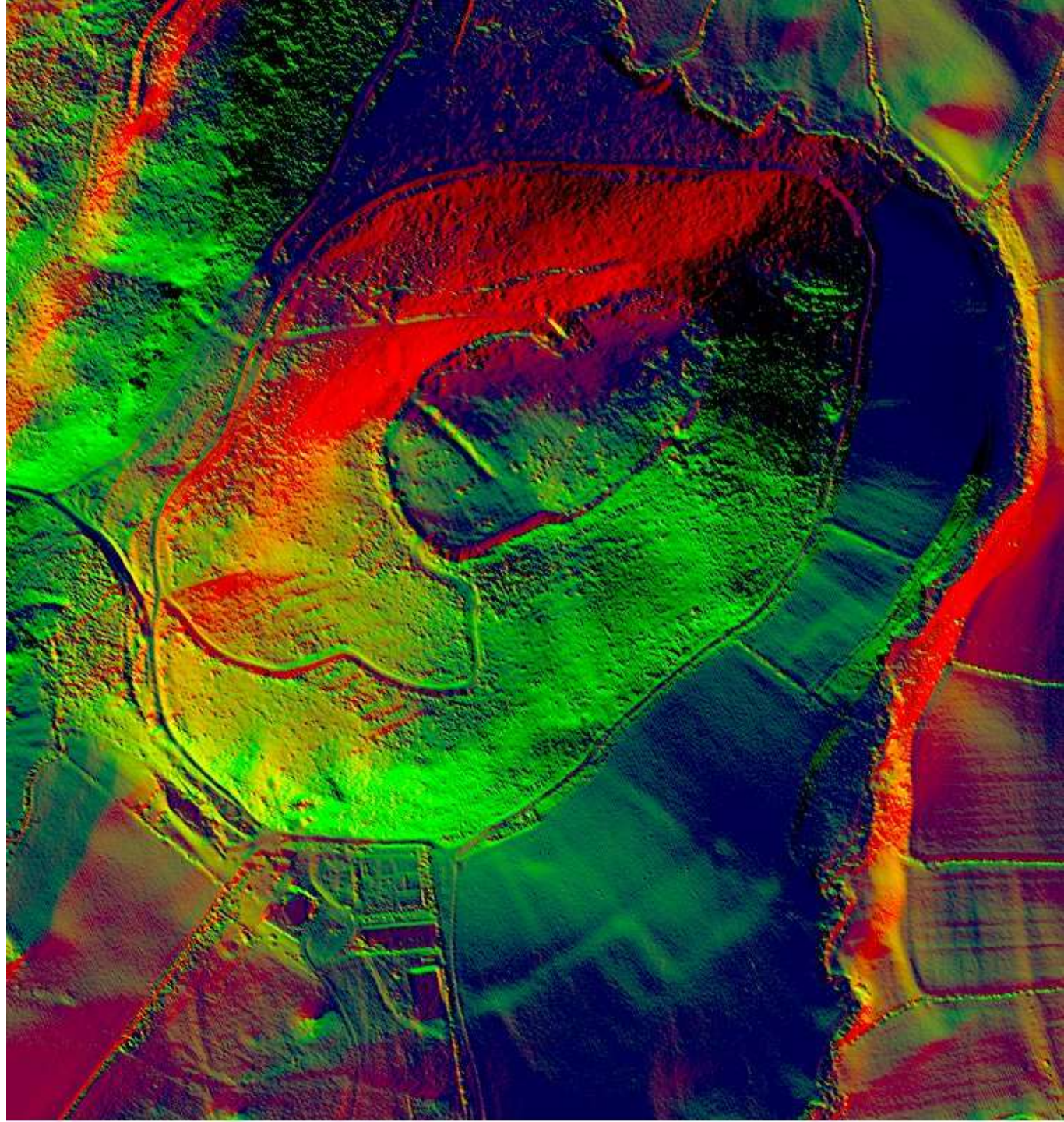


- Internal features at Burrow Hill, Hope









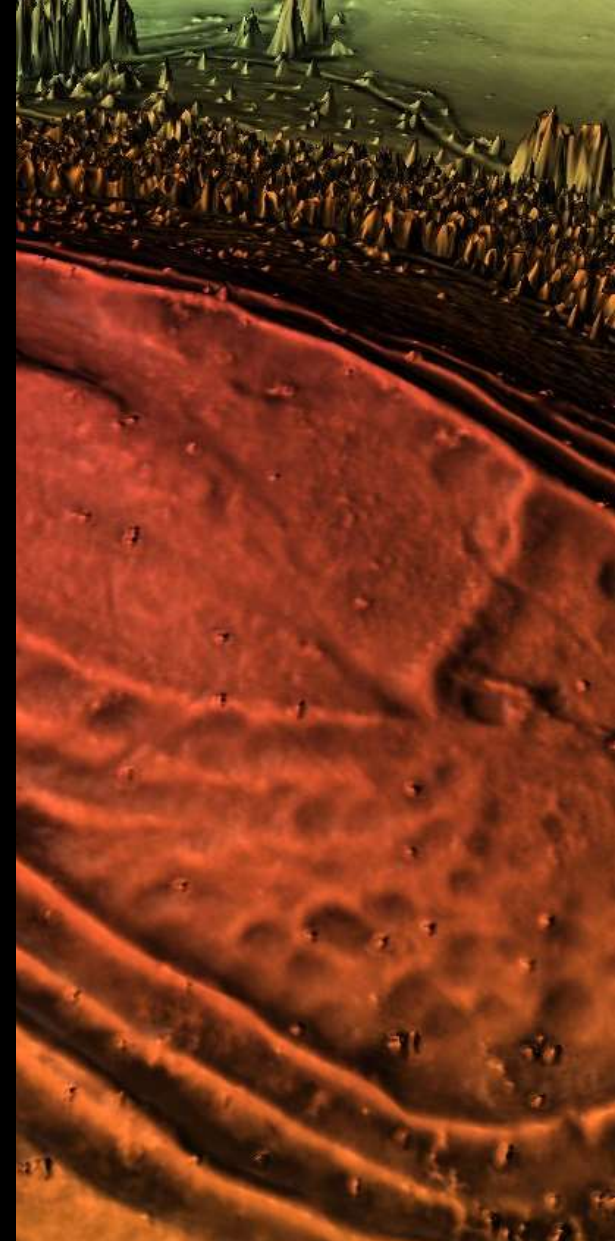




LiDAR Training Workshop

Interpreting LiDAR

Giles Carey, Historic Environment Team, Shropshire Council



The background is a color-coded LiDAR point cloud of a landscape. The colors represent elevation, with blue for lower elevations and yellow/red for higher elevations. A prominent circular feature, possibly a depression or a small pond, is visible in the center-right. The terrain is characterized by a network of linear features, likely roads or paths, and a grid-like pattern of fields or agricultural plots. A white horizontal line is positioned below the title.

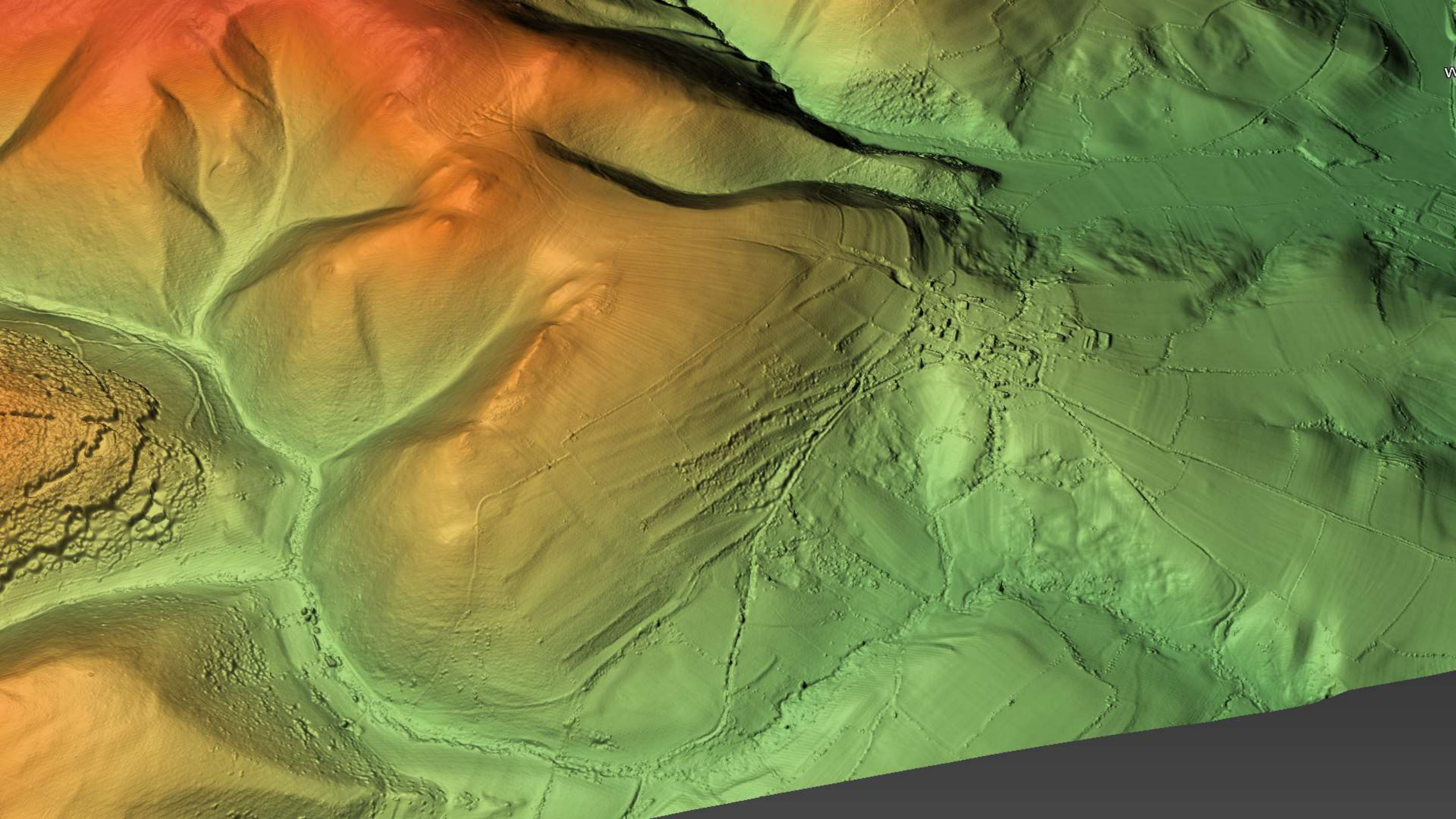
Interpreting: what is it?

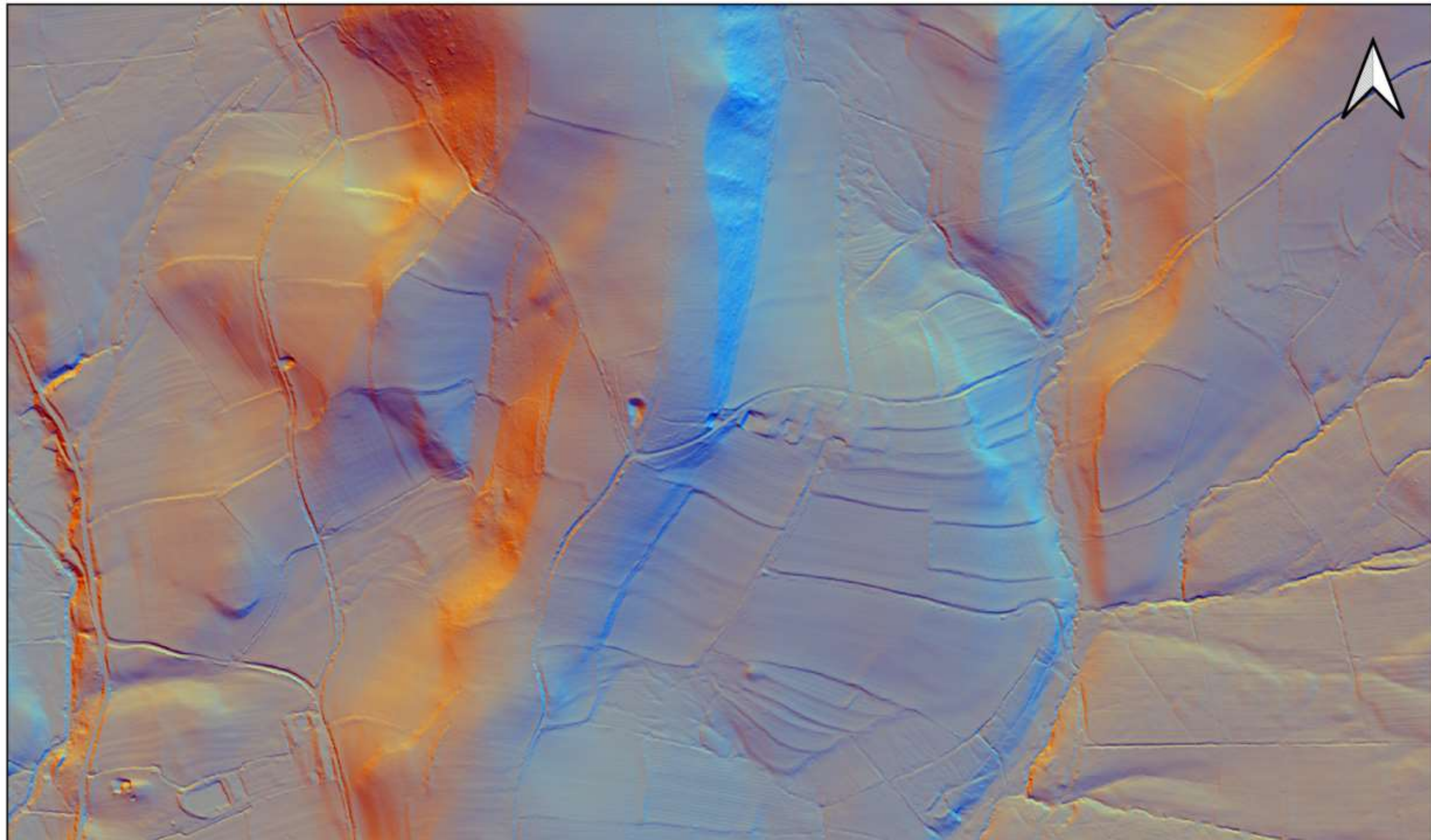
- Could it be related to a natural process/geological?
 - Checking it's not vegetation or buildings related – Google Earth
- What other **sources** do we have for the area?
- Does it appear to be a positive or negative feature?
- Thinking about **morphology** – size and shape
- No substitute for looking at it on the ground...but do remember, some features very apparent on LiDAR are very slight in reality.

Upland Earthworks: Field Systems

- Does it tally with post-medieval field system (tithe mapping, c.1840s, 1st and 2nd edition Ordnance Survey)?
- Earlier field systems might be **coaxial**
- **Lynchets** – terracing formed on steep slopes, often following the contour
- Ridge and furrow – characteristic S-curve through to steam ploughing



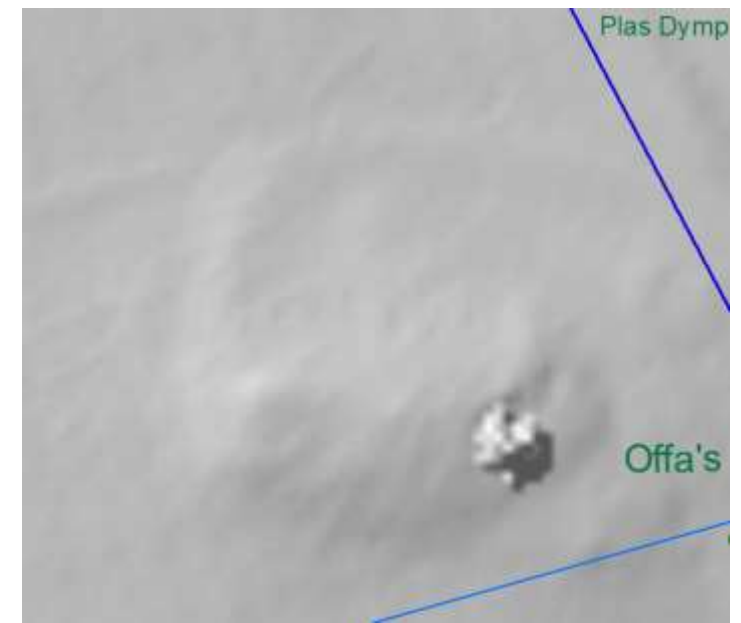






Upland Earthworks: Mounds

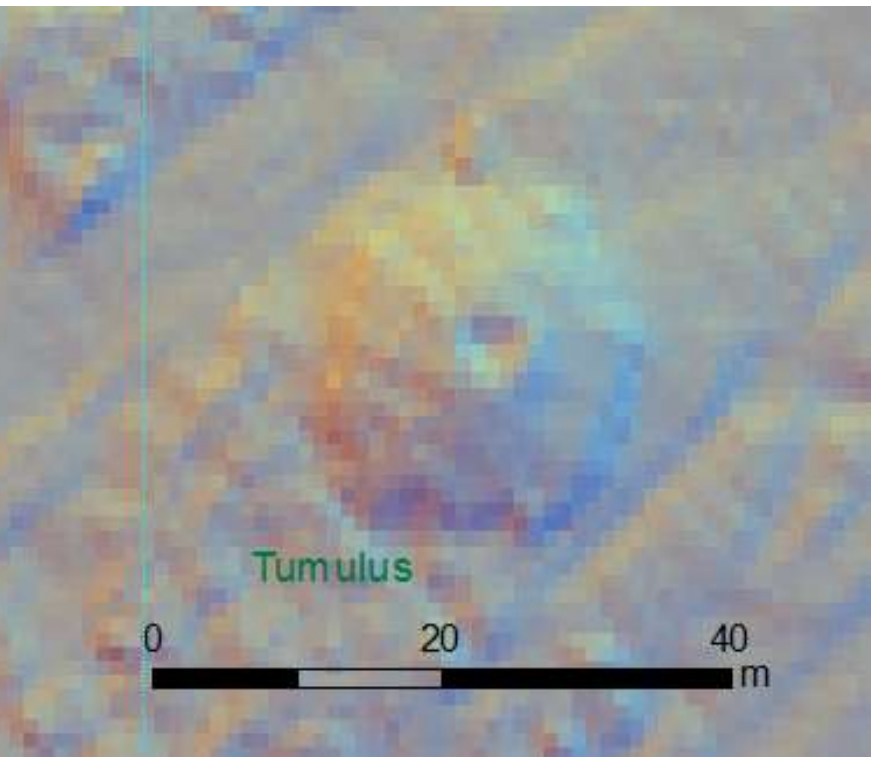
- Mottes: flat-topped (or often quite conical in Vale of Montgomery etc.), usually with attached bailey(s); 20-40m diameter
- Spoil heaps: in areas of mining remains, amorphous spreads, often with multiple 'summits' as representing informal development



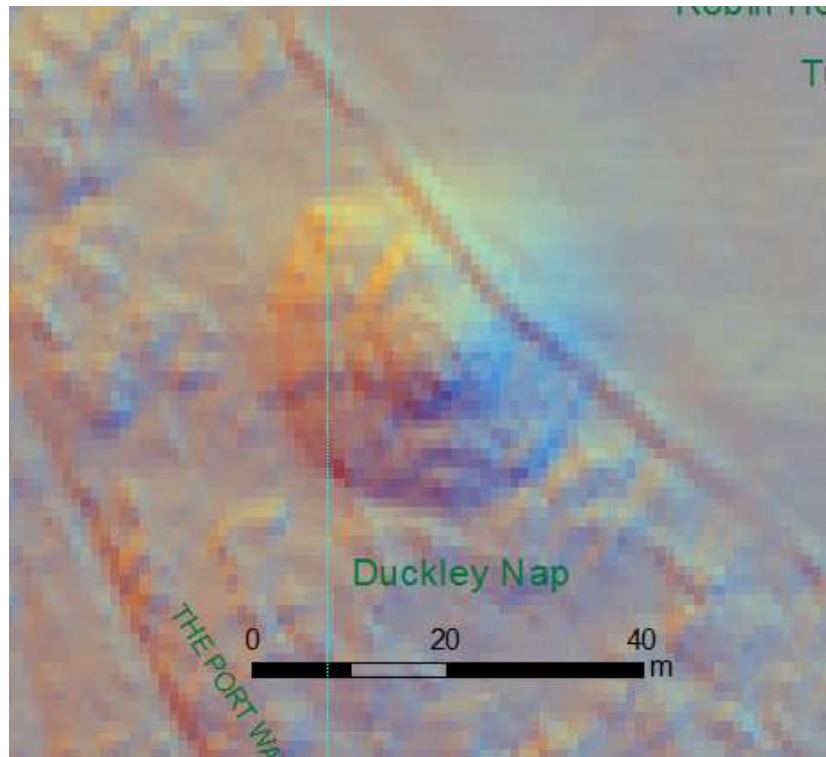


Upland Earthworks: Barrows

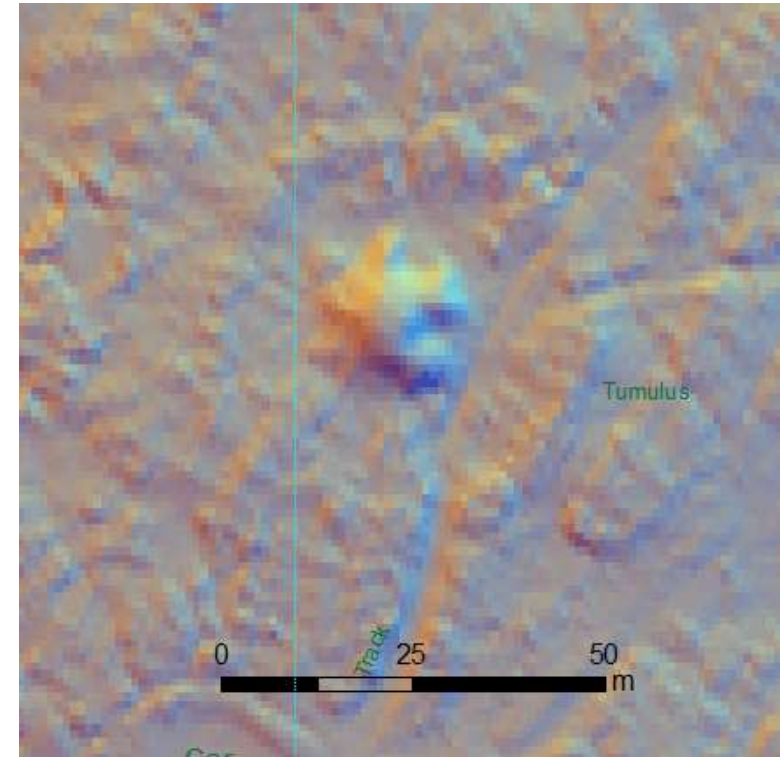
- *Tumuli* – mounds of earth/stone often on top of, and marking inhumations or cremation burials
- Bronze Age Round barrows (c.2000-1500 BC)
 - Bowl barrow: ‘pudding-bowl’ shaped mounds, with surrounding ditch (5m-c.25m) – often ‘spread’ by agricultural practice
 - Bell barrow: bowl-shaped mound separated from surrounding ditch by a berm (<30m)
 - Disc barrow: small ‘pudding-bowl’ mound, wide berm surrounded by circular bank and ditch (up to 40m across)



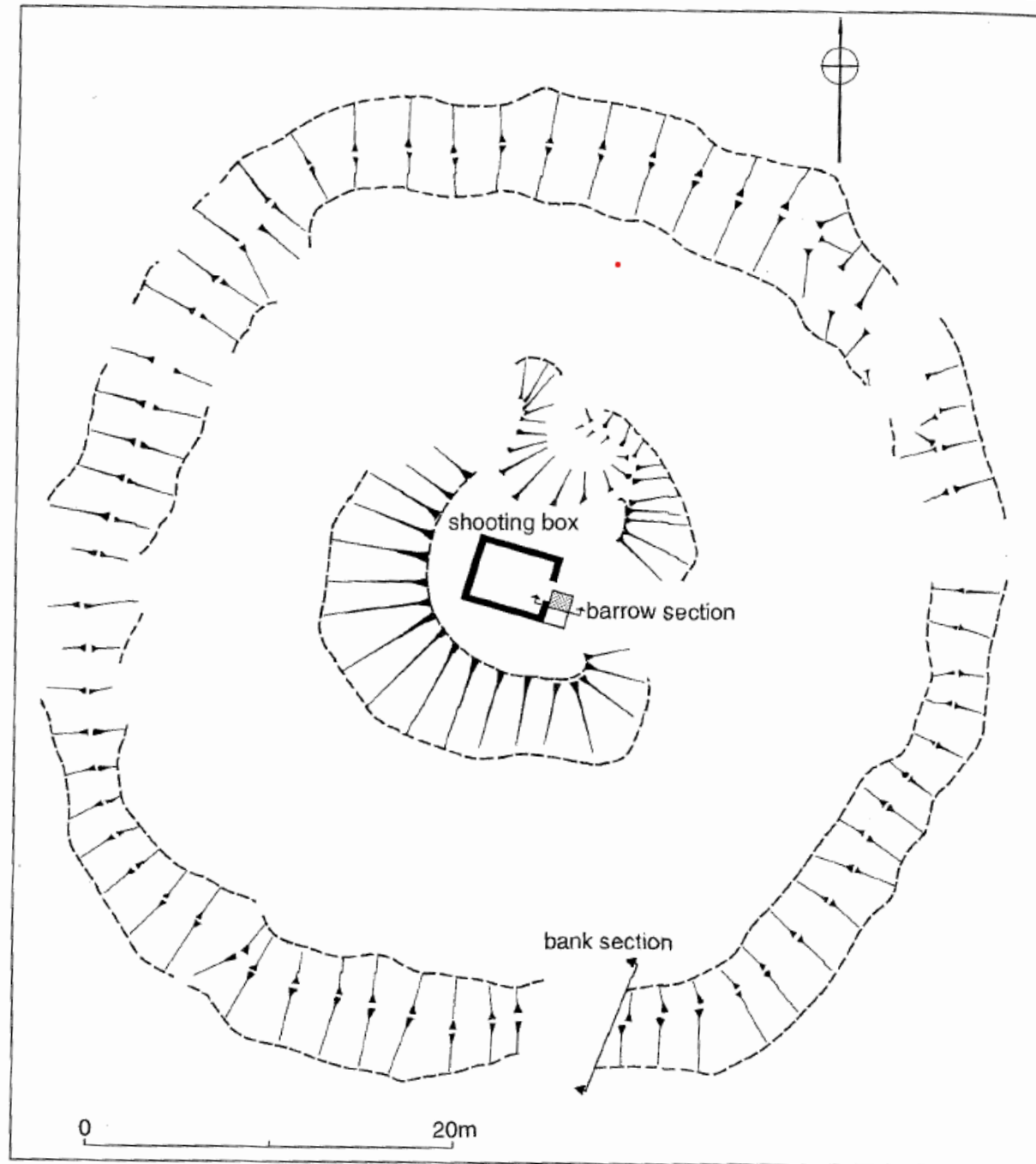
Bowl barrow, Wildmoor

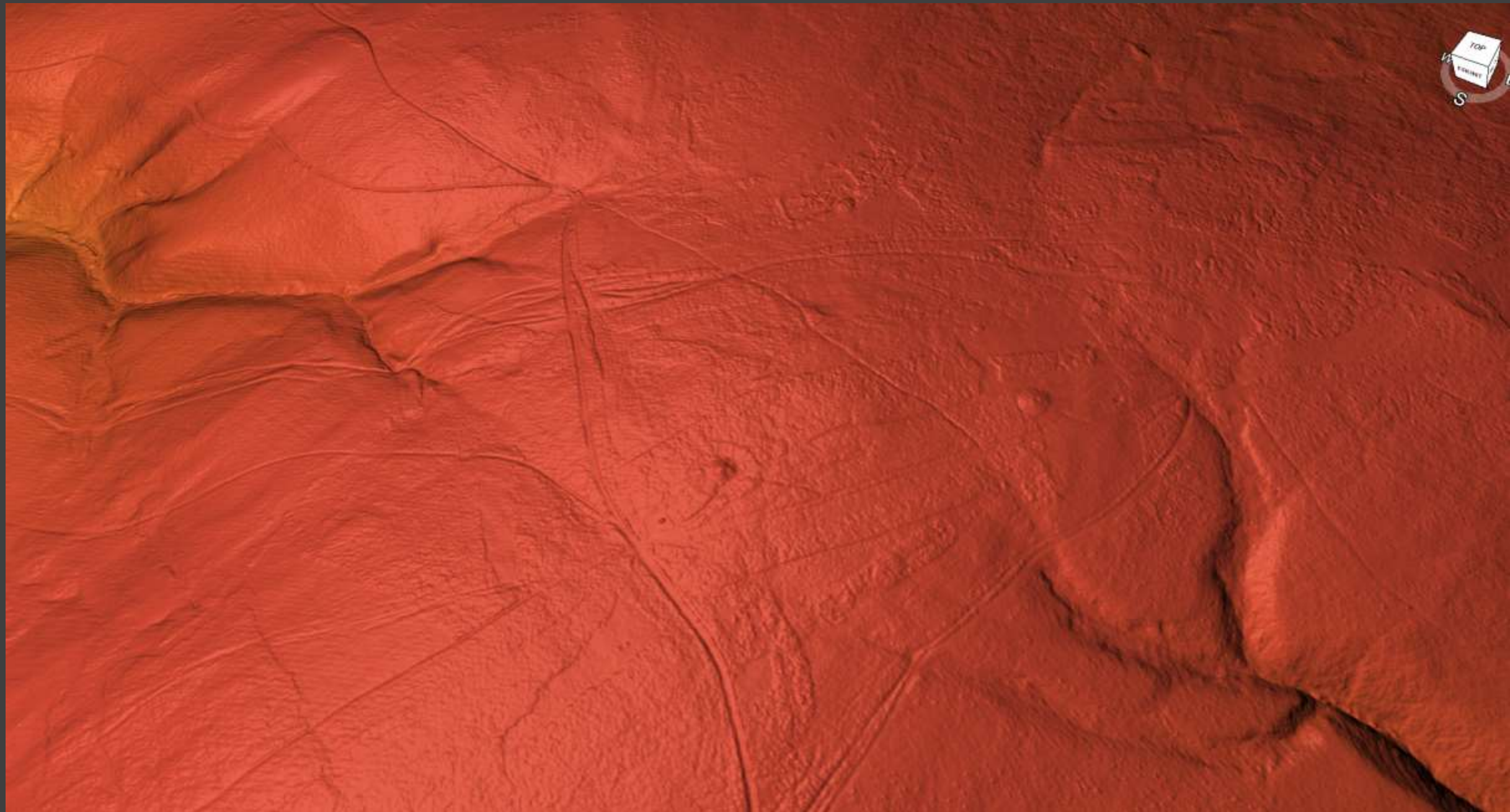


Bell barrow, Duckley Nap (Rob Hood's Butts)
(only example of this type on the Long Mynd)



Shooting Box Disc Barrow – only known example in Shropshire



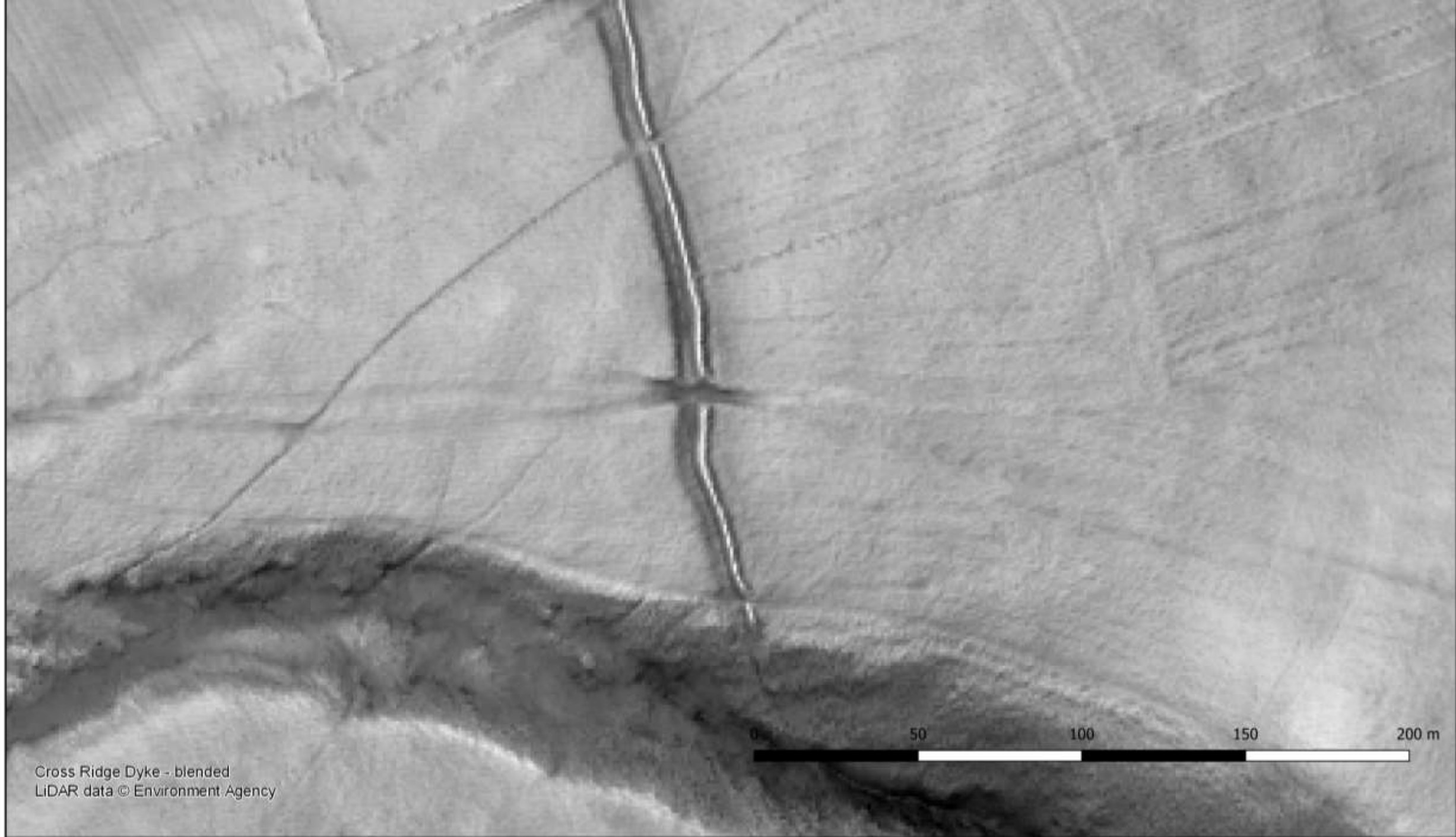


Upland Earthworks: Banks

- Cross Ridge Dykes: linear prehistoric land boundaries – sometimes multiple banks and ditches
- Wood Banks

Systems of banks:

- Rifle ranges
- Rabbit warrening
- Field systems (see below)



Cross Ridge Dyke - blended
LIDAR data © Environment Agency

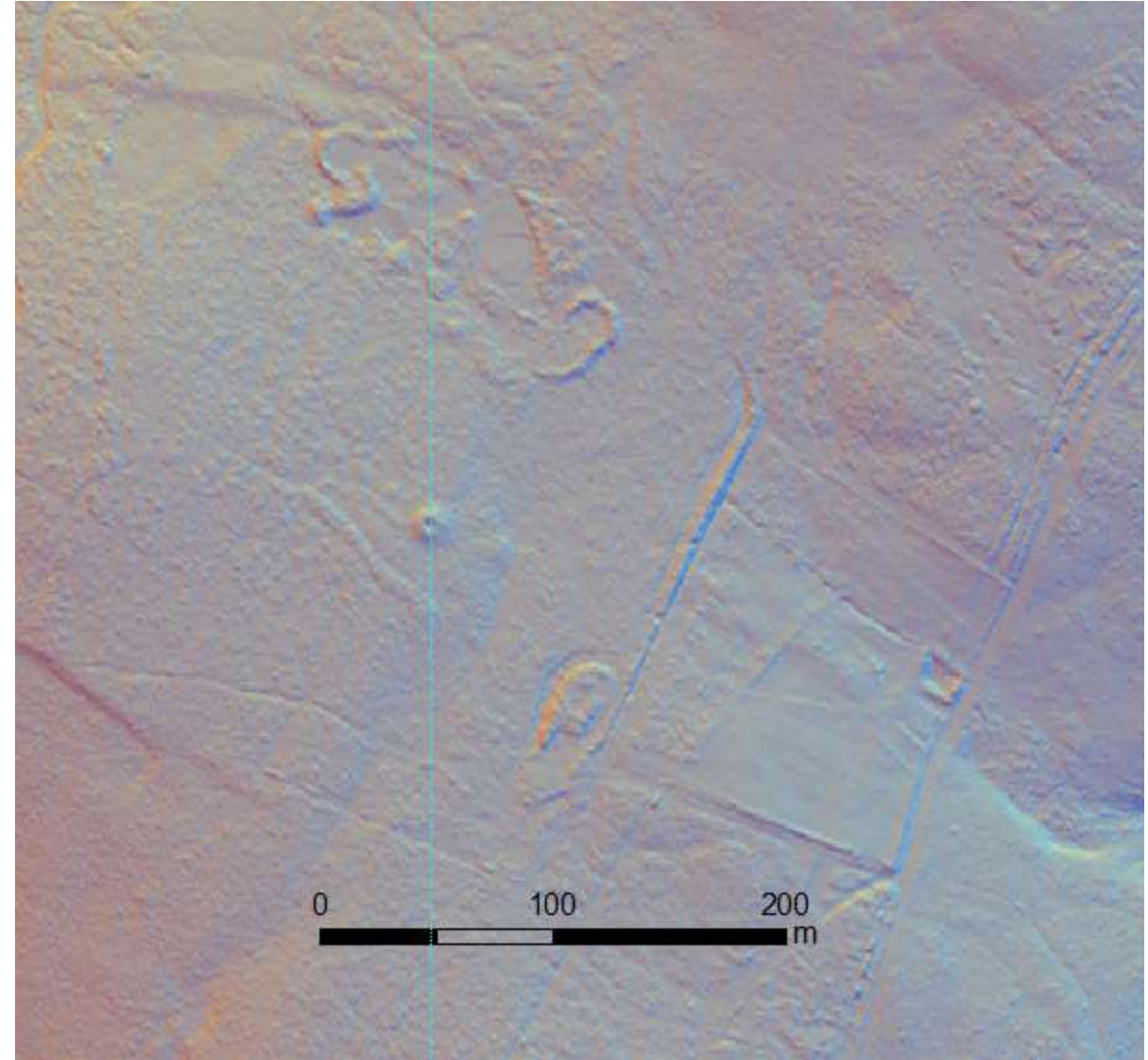
Cross ridge dykes

- Often cutting off spurs – 3 well-preserved examples on the Long Mynd
- Stretching up to 140m long (Devil's Mouth)
- Boundary markers – certainly not defensive as overlooked from both sides!
- Middle-Later Bronze Age Date from C14 of the Devil's Mouth cross dyke



Upland Earthworks: Pits/Hollows

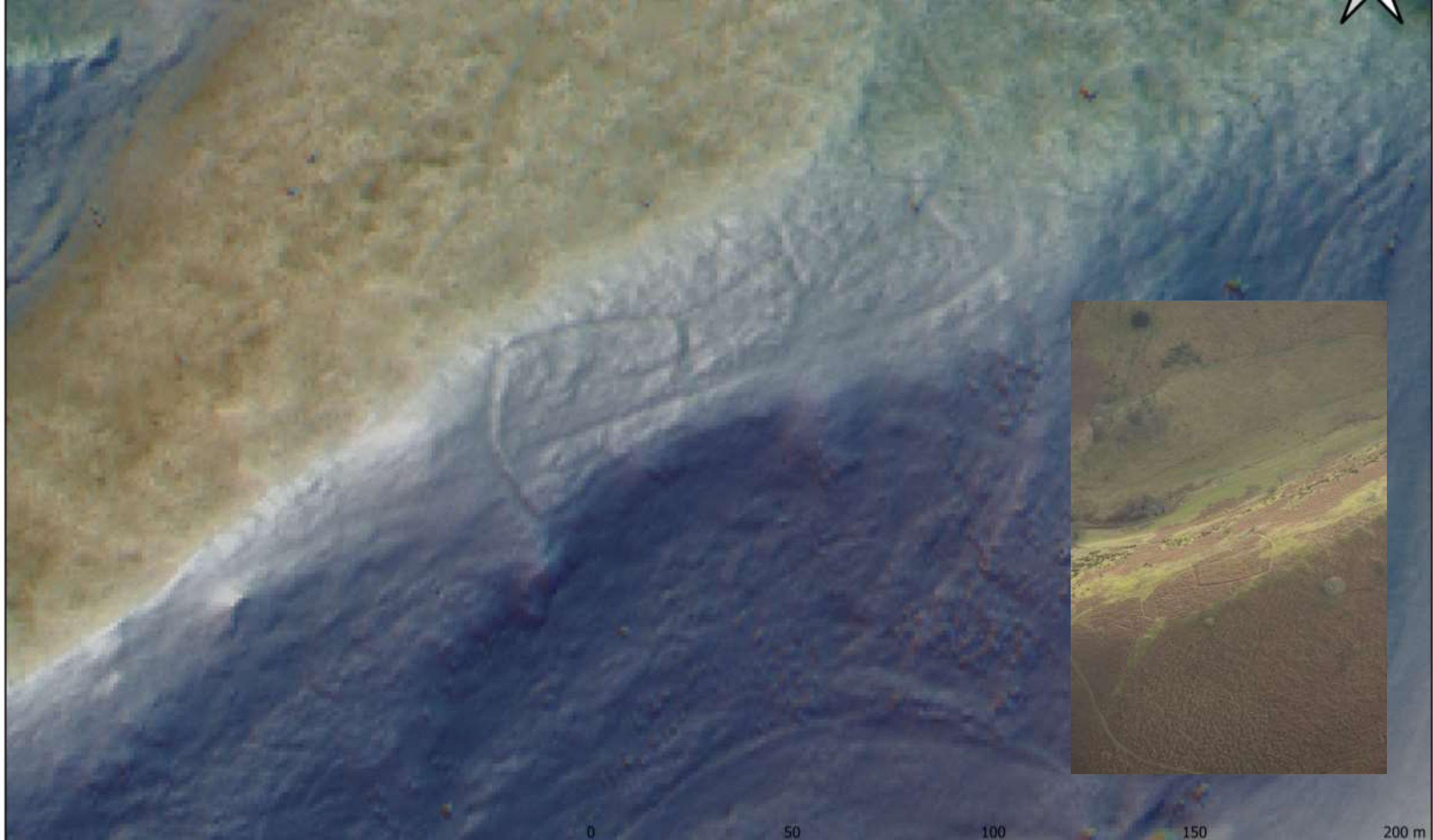
- Quarry pit/extraction pit
- Mining – including prospective mining
- Ponds
- Saw pits
- Tree throws



Upland Earthworks: Enclosures

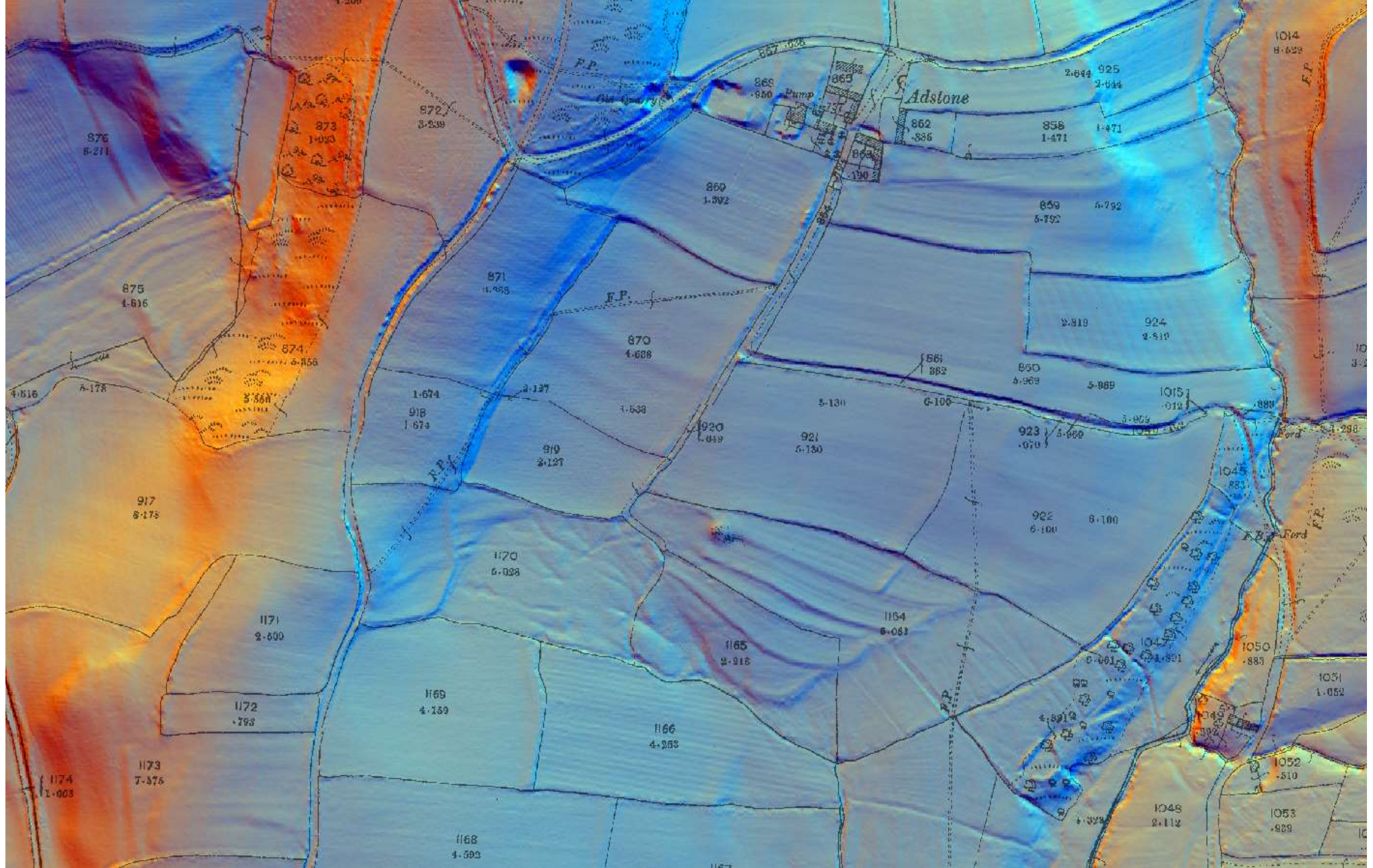
- Simple – morphology might suggest age e.g. D-shaped might be suggested as IA/Roman
- More complex – e.g. annexes, conjoined enclosures
- Most complex – multivallate hillforts!





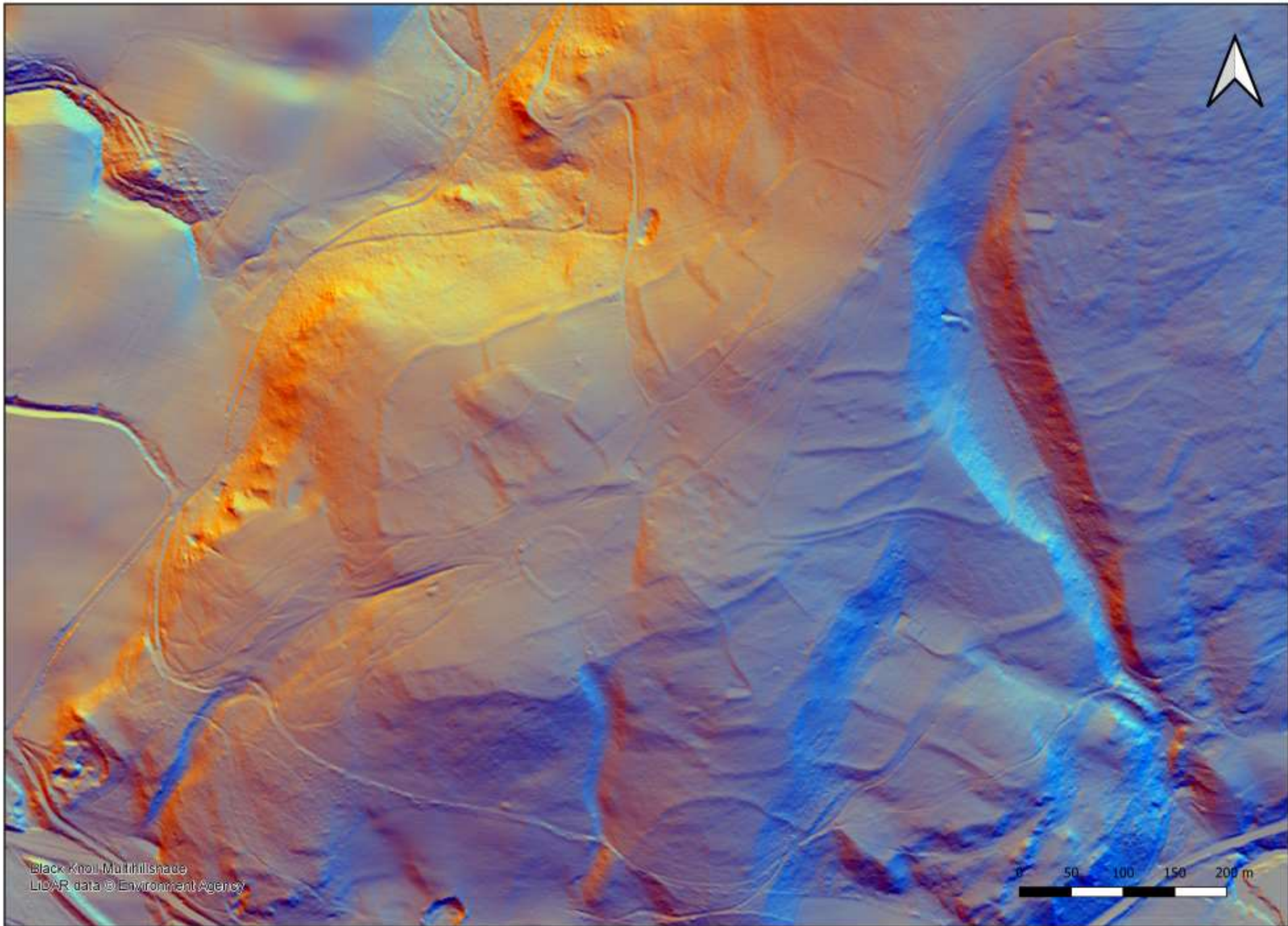
Upland Earthworks: Settlement Earthworks

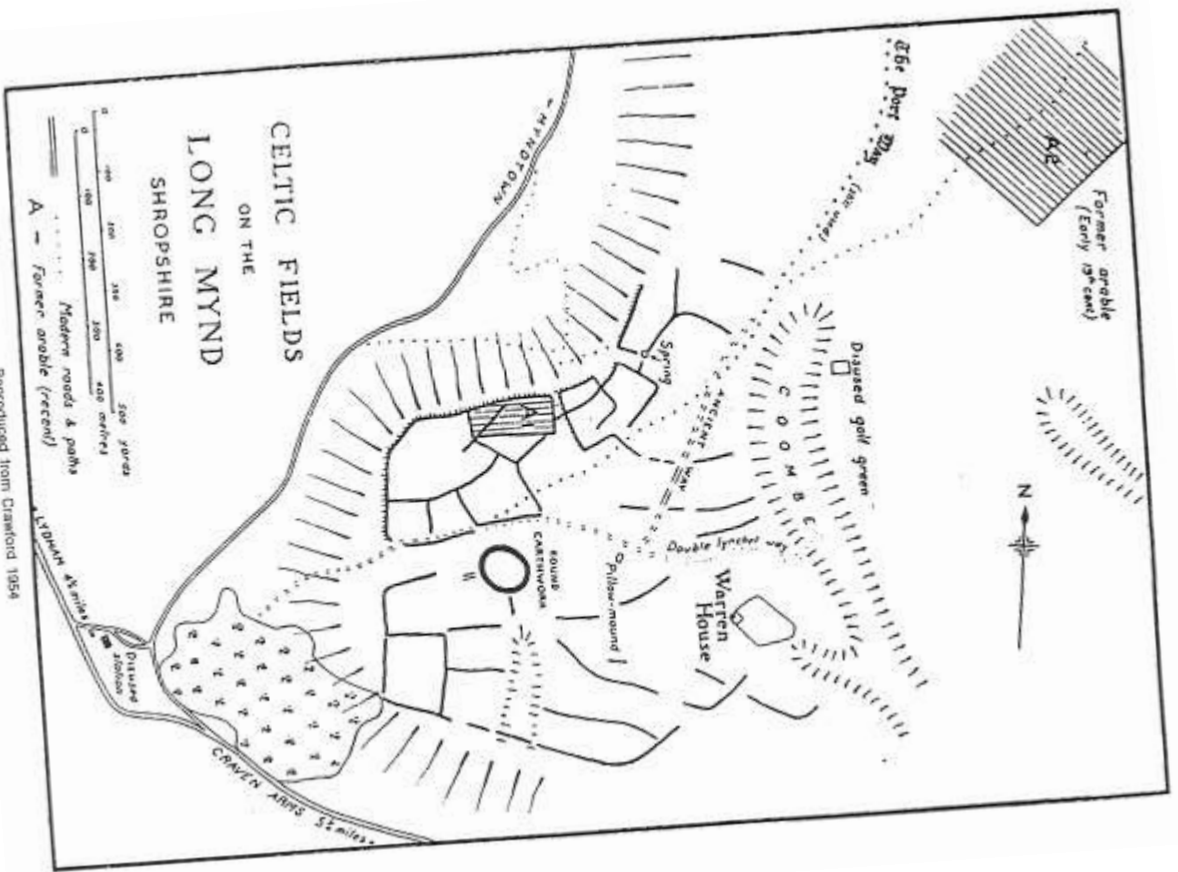
- **Deserted/Shifted villages:** banks & ditches, pits, mounds, platforms, routeways, enclosures (crofts and tofts) – often surrounded by extant ridge and furrow
- Moated sites
- Wartime occupation sites



Landscapes as palimpsests

- Long time-depth to features on The Long Mynd and its hinterland
- Complex inter-relationship of features – only sometimes is relative dating possible through the earthwork evidence alone.
- Shooting Box barrow as a good example of feature that has been used and reused, leaving differential earthwork traces.





Reproduced from Crawford 1954

