



Inspecting the high mountain

Methodological renewal of the archaeological approach of the highland pastures

Calastrenc Carine^{1 et 2}, Rendu Christine², Baleux François¹, Poirier
Nicolas¹, Philippe Magali³
avec la collaboration de Sicre Claire^{4 et 5} et de Murielle Llubes⁶

1. CNRS - TRACES, UMR 5608, Toulouse
2. CNRS - FRAMESPA, UMR 5136, Toulouse
3. CNRS - GEODE, UMR 5602, Toulouse
4. Univ – IRIT, UMR 5505
5. CNRS – CESBIO, UMR 5126, Toulouse
6. Univ – GET, UMR 5563, Toulouse





- 1 **Specificities of archaeological prospecting in high mountains**
- 2 **A multi-source and multi-scale approach**
- 3 **Future research directions**





2

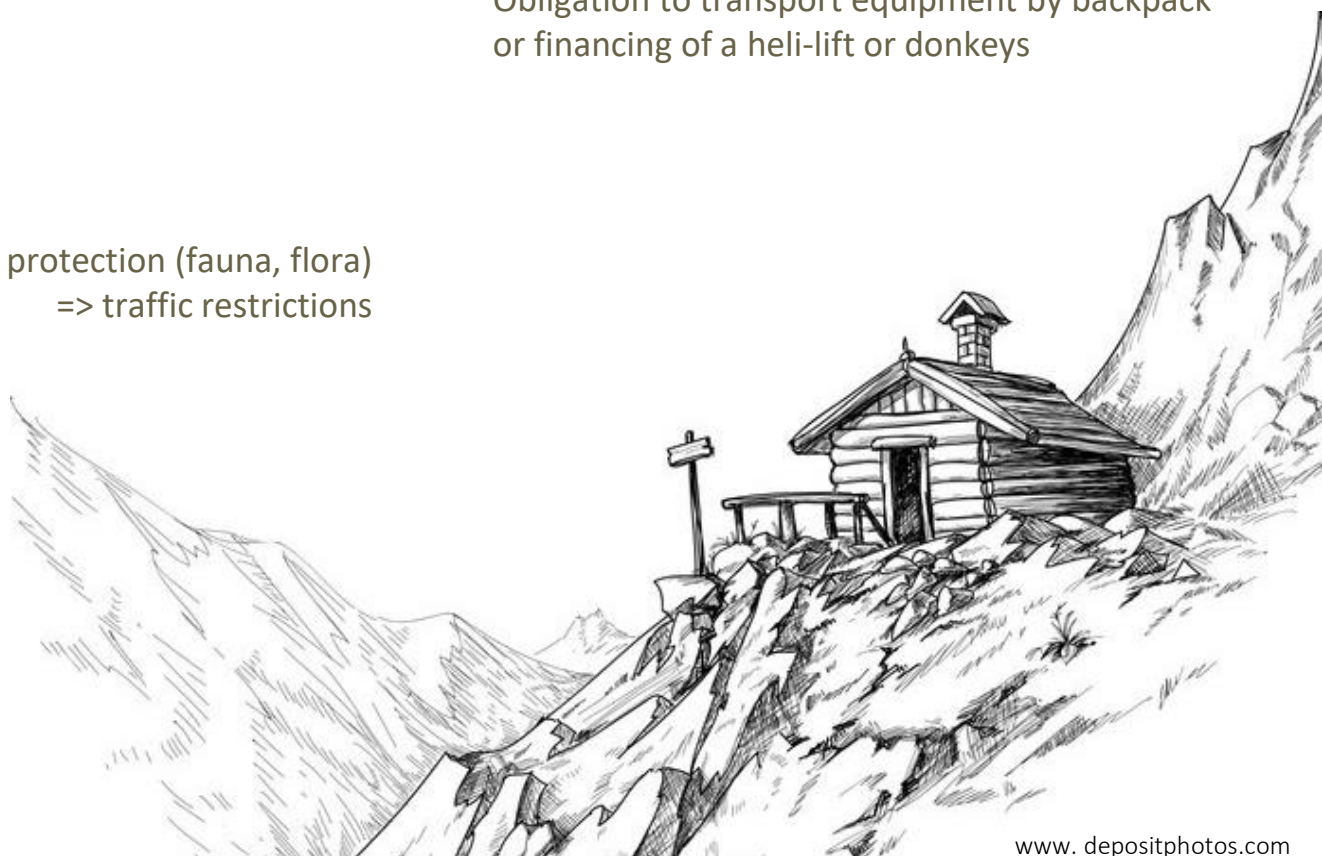
Areas subject to special protection (fauna, flora)
=> traffic restrictions

3

Obligation to transport equipment by backpack
or financing of a heli-lift or donkeys

1

Difficulty of access (approach
walk) and severe weather
constraints (6 months of
inaccessibility)





Buildings plans visible on surface



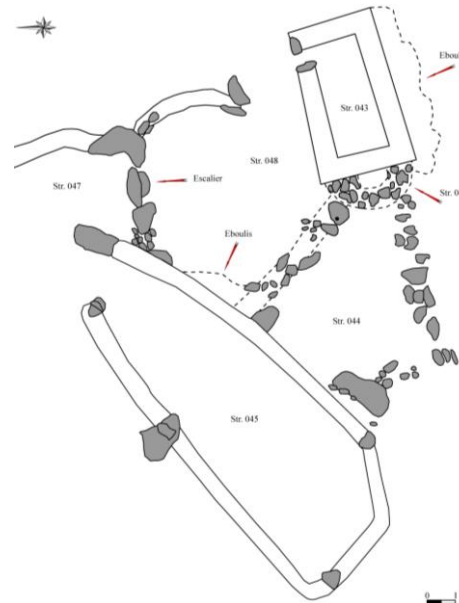
Anéou highland pasture – Str. 235



Anéou highland pasture – Str. 308



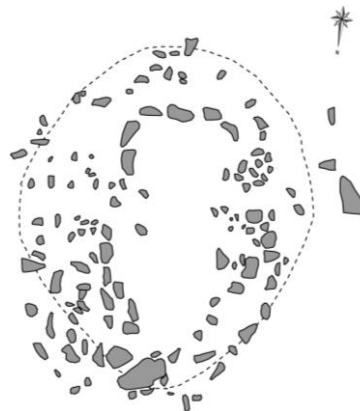
Str. 8 – Anéou highland pasture



Str. 43 à 48 – Anéou highland pasture



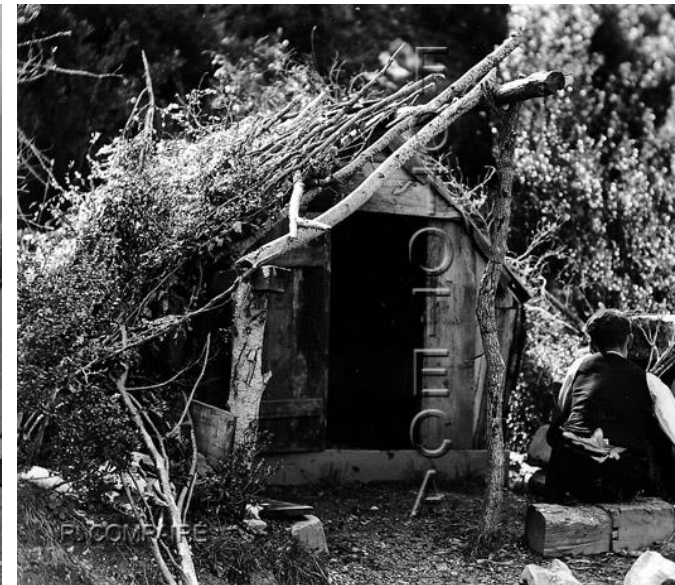
Str. 42 – Anéou highland pasture



Str. 10 – Anéou highland pasture



How identify pastoral infrastructures built, made totally or partially in perishable materials, covered by sediments or erased by human activities?



Hauts de Leud (Maramuresh, Roumania) 1992 - Photographer : C. Macherel © CNRS

Vallée de Guarrinza (Aragon Spain) – 1933 - Photographer : Compairé

Vallée de Ansó (Aragon - Spain) – 1920-1936 - Photographer : Ricardo Compairé Escartín



Anéou

Rendu, Calastrenc, Le Couédic

1300 hectares

272 structures

4 months à 2 peoples



Benasque

Calastrenc, Rivas, Ona Gonzalez

1400 hectares

324 structures

3 months à 2 peoples



Liantran

Calastrenc et al.

3 hectares

62 structures

1/2 months à 1 people





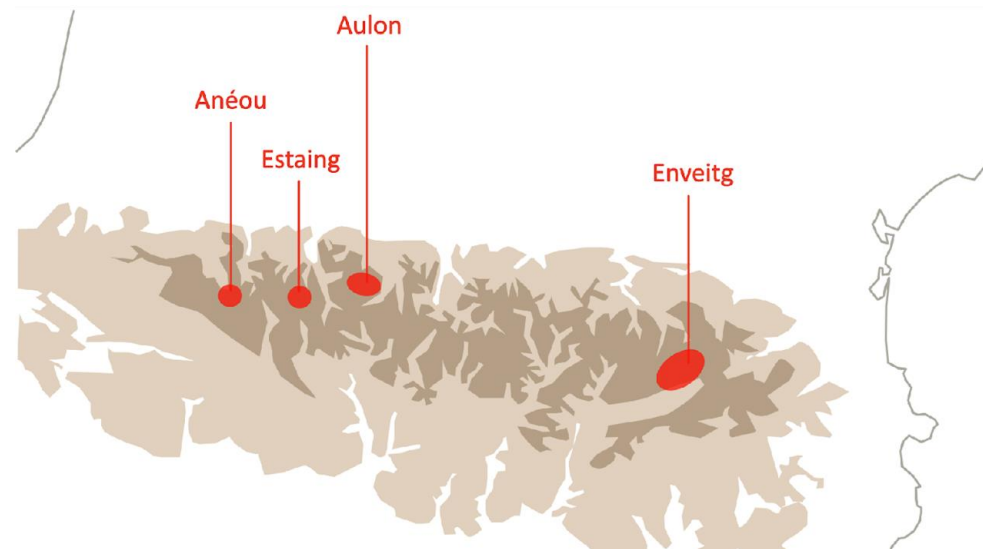
- ✓ Treat archaeologically more larger areas in shorter time?
- ✓ Obtain a statistically significant and robust inventory that includes dry stone structures, those invisible on the surface?





Tests and Calibration zones

- Liantran area, Estaing (Hautes-Pyrénées)
- Aulon Nature Reserve (Hautes-Pyrénées)
- Enveitg mountain (Pyrénées-Orientales)
- Anéou highland pasture (Pyrénées-Atlantiques)





Auloueilh area (Aulon Nature Reserve - 65)

⇒ 23 hectares



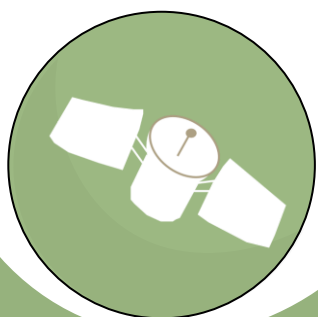


Auloueilh area (Aulon Nature Reserve - 65)

⇒ 23 hectares

- ✓ Surrounded by steep slopes
- ✓ Partly avalanchey slope
- ✓ Presence of a large rocky chaos from a moraine
- ✓ Presence of a fluctuating watercourse zone
- ✓ Very strong vegetation recovery (rhododendron + juniper + bilberry)





Satellite

Work scale : one mountain

Satellite remote sensing to locate large pastoral groups in good conservation status.

Multi-temporal Pleiades images acquisition made by de ISIS prog. Of the CNRS in 2019 and 2020.



U.A.V.

Work scale : one grassland

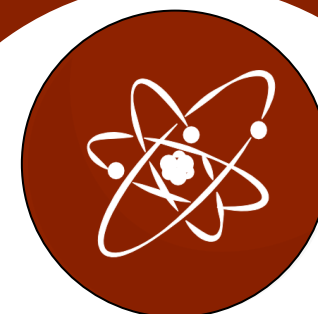
Photogrammetry, thermography, multispectral images and Lidar can be used to locate dry stone structures and identify architectural details.



Geophysical

Work scale : one structure

Georadar and **magnetometer** allow us to obtain an image of certain infrastructures that are invisible on the surface (enclosure, chimney, etc.).



Chimistry

Work scale : molecular level

Chemical analysis of soils (XRF) makes it possible to identify and locate archaeological remains that are invisible on the surface.

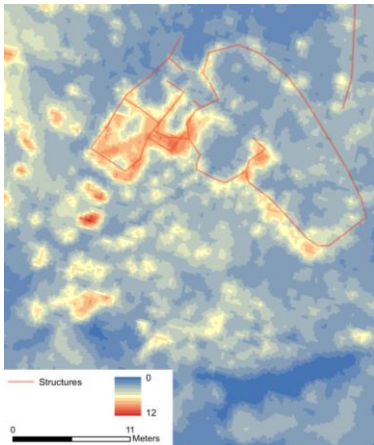


Auloueilh area (Aulon Nature Reserve - 65)

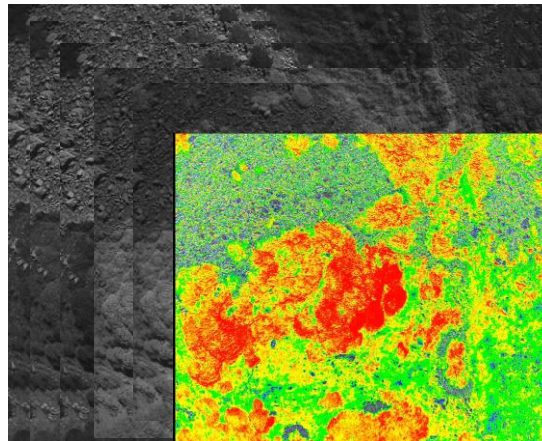
⇒ 23 hectares

✓ Data acquisition : 8 days in 3 years

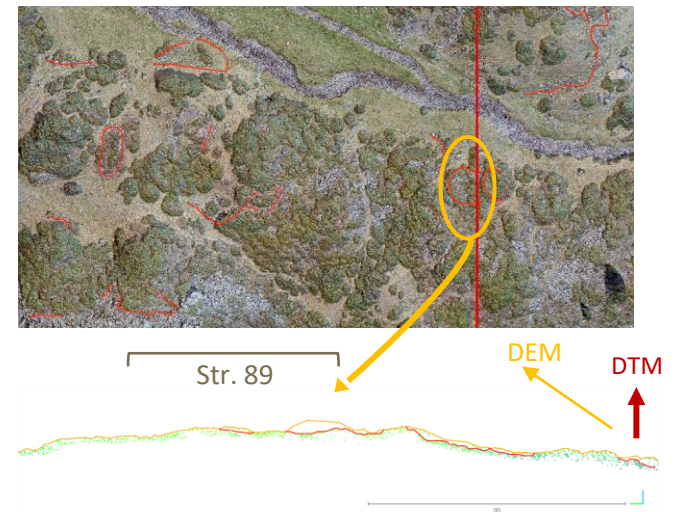
UAV thermography



Multispectral images



UAV Lidar

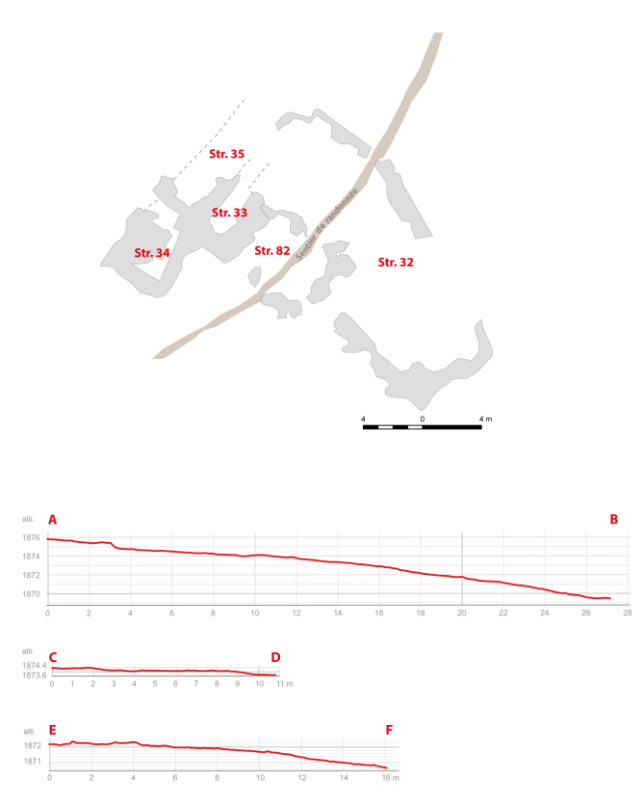
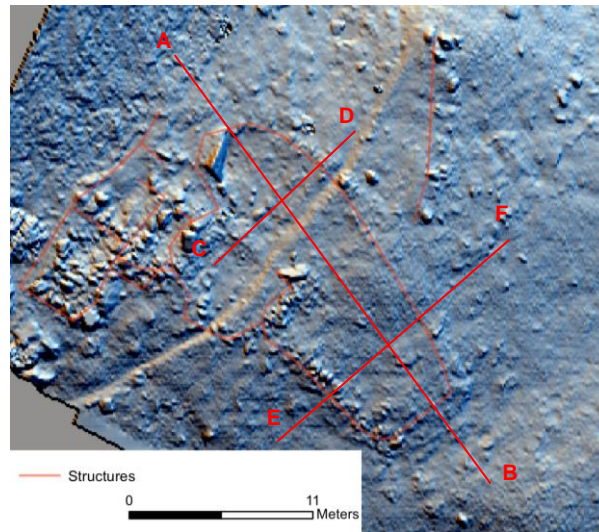




Auloueilh area (Aulon Nature Reserve - 65)

⇒ 23 hectares

✓ Data acquisition : 8 days in 3 years



Orthophotography made by photogrammetry

Digital terrain model made by photogrammetry

Profiles and measurements

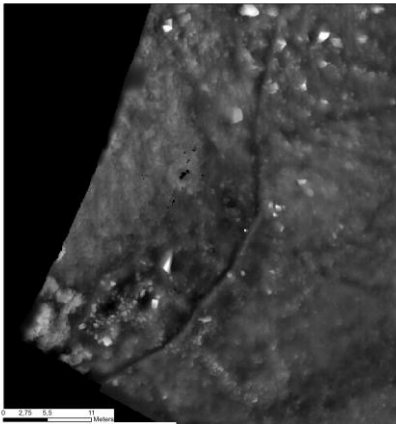


Auloueilh area (Aulon Nature Reserve - 65)

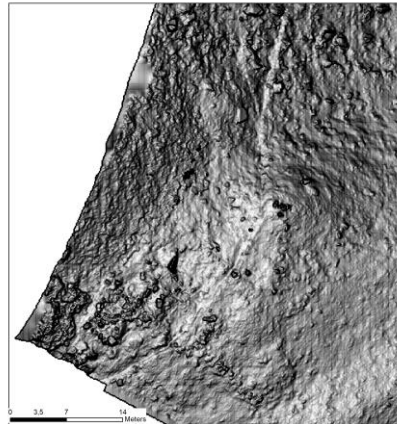
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✓ Data acquisition : 8 days in 3 years

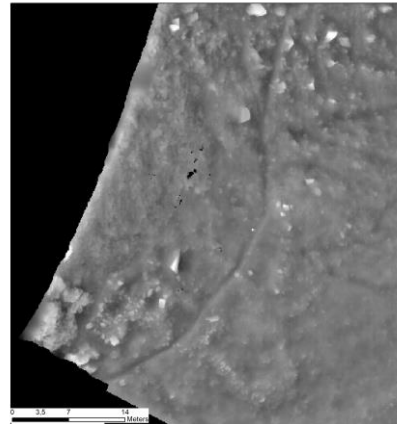
Local dominance
(Treatment RVT Software)



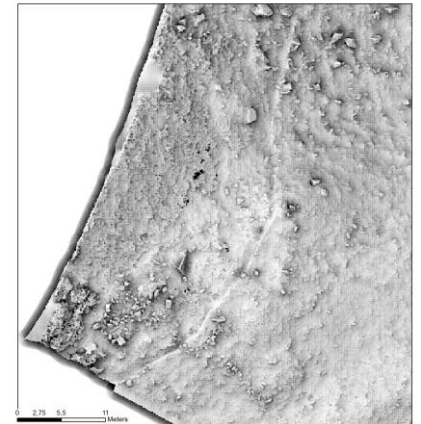
Slope
(Treatment RVT Software)



Simple Local Relief
(Treatment RVT Software)



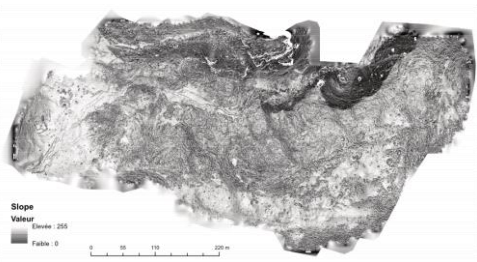
Sky View Factor
(Treatment RVT Software)



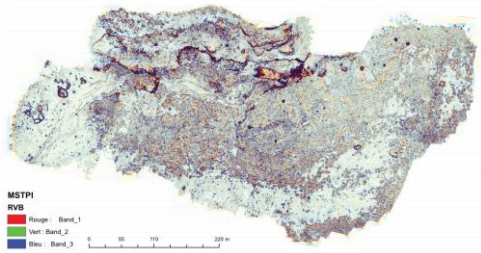
⇒ 31 vizualisation methods tested



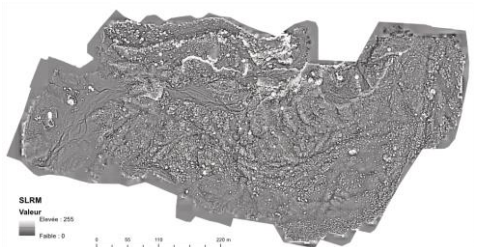
Analysis tools at the pasture level



Slope
(RVT Software)

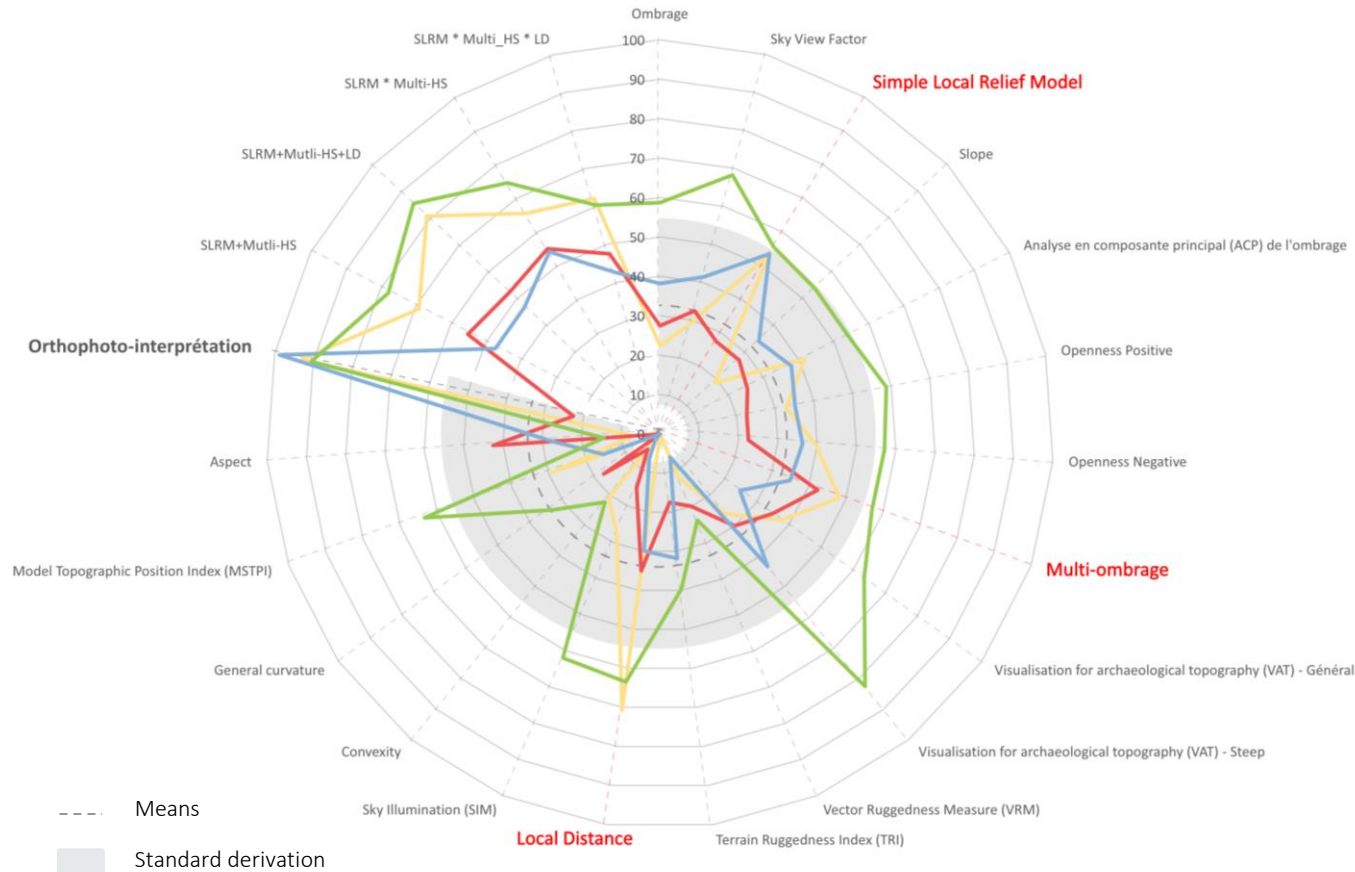


Multiscale Topographic Position Index
(SagaSig Software)



Simple Local Relief Model
(RVT Software)

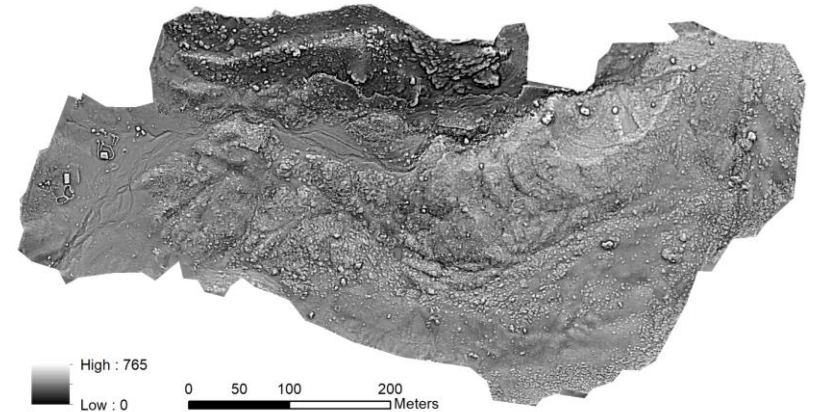
— Larruns (64) - Estive d'Aneou - La Glère — Enveitg (66) - Plaa de l'Orri — Aulon (65) - Auloueilh — Estaing (65) - Liantran



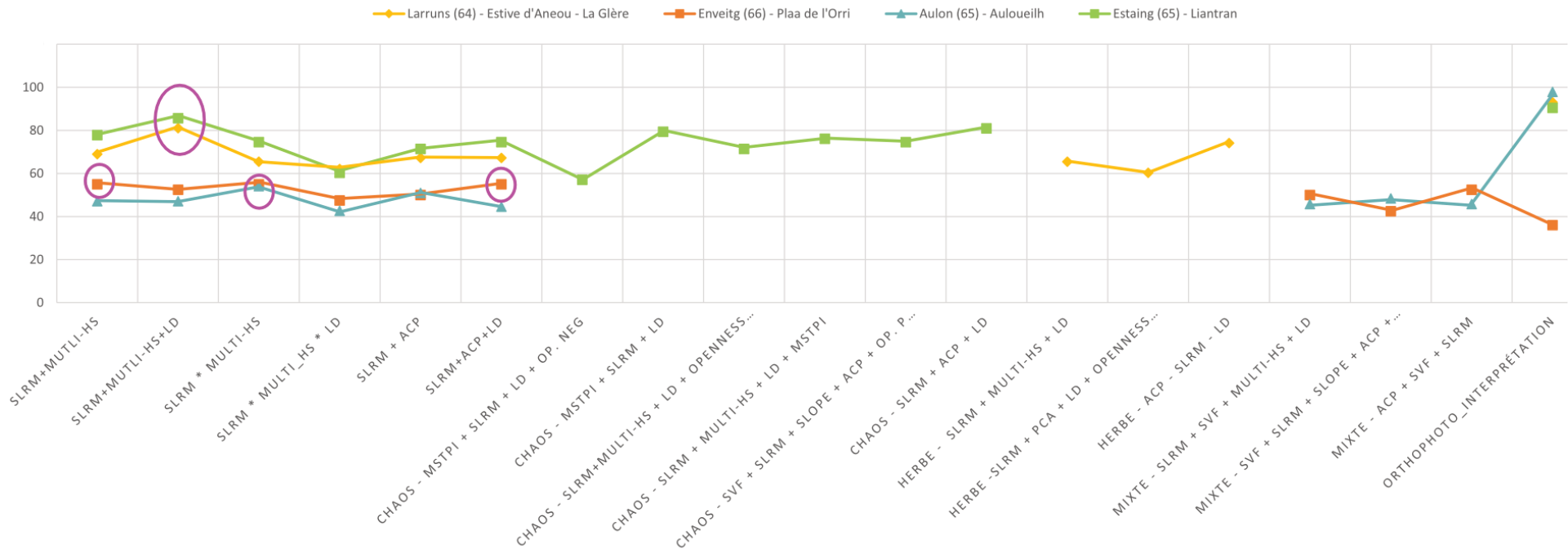


Analysis tools at the pasture level

- ✓ The most "efficient" rasters
- ✓ The methods identified as effective in areas of chaos



Addition of rasters : Simple Local Relief + Local dominance + Multi-Hilshade



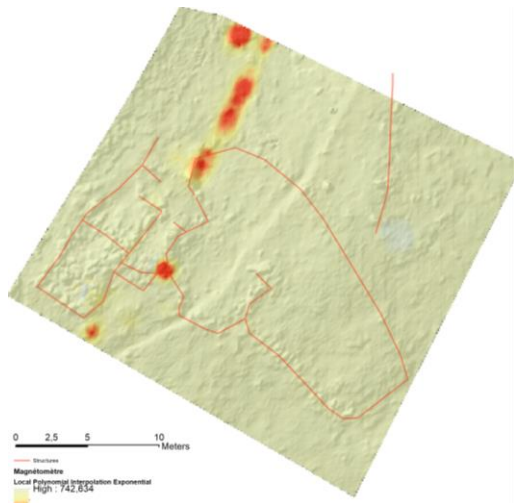


Auloueilh area (Aulon Nature Reserve - 65)

⇒ 23 hectares

✓ Data acquisition : 8 days in 3 years

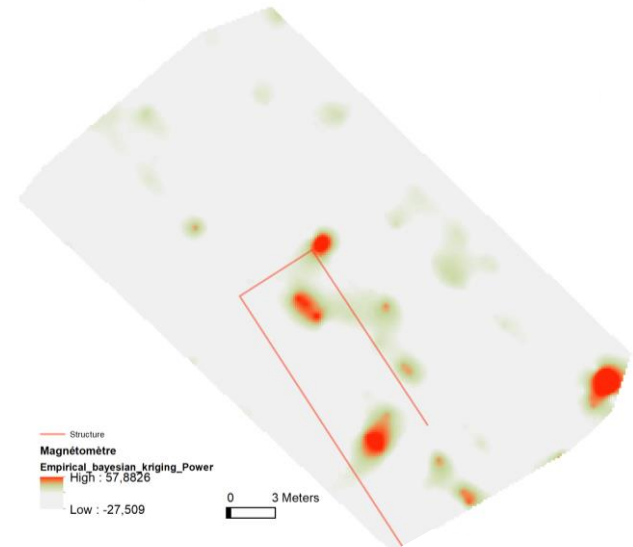
Magnetometer



Structure 31 to 35



Structure 13



Structure 39



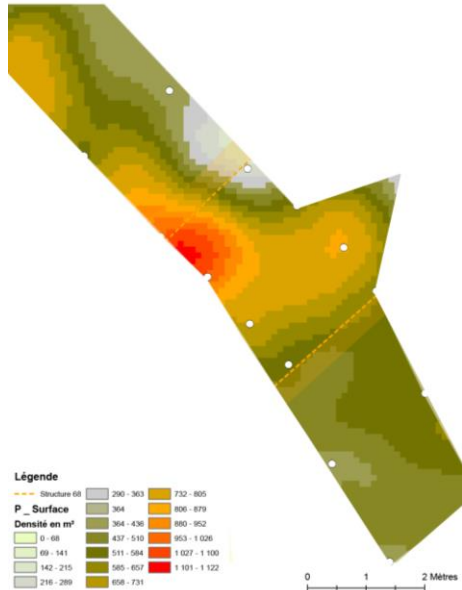
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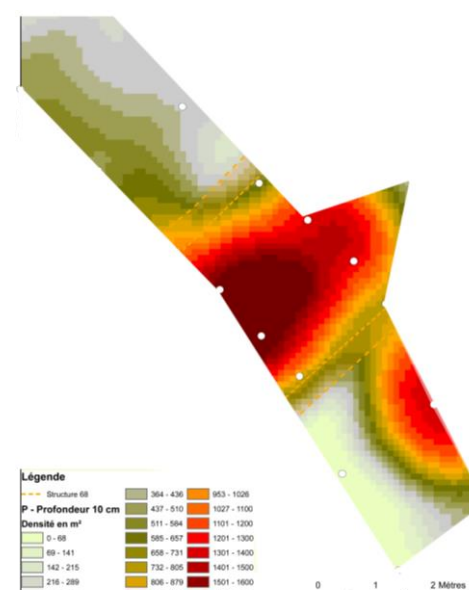
✓ Data acquisition : 8 days in 3 years

Phosphorus measurement (P)

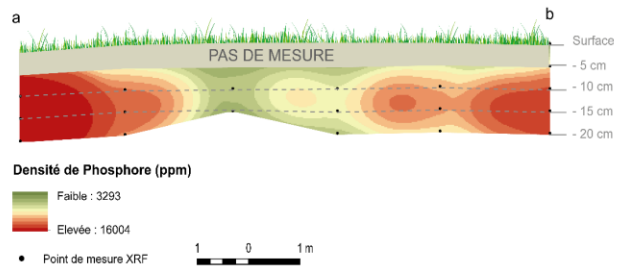
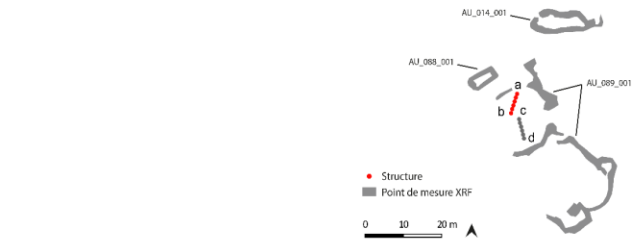
Surface



10 cm deep



X-ray fluorescence spectrometer measurement



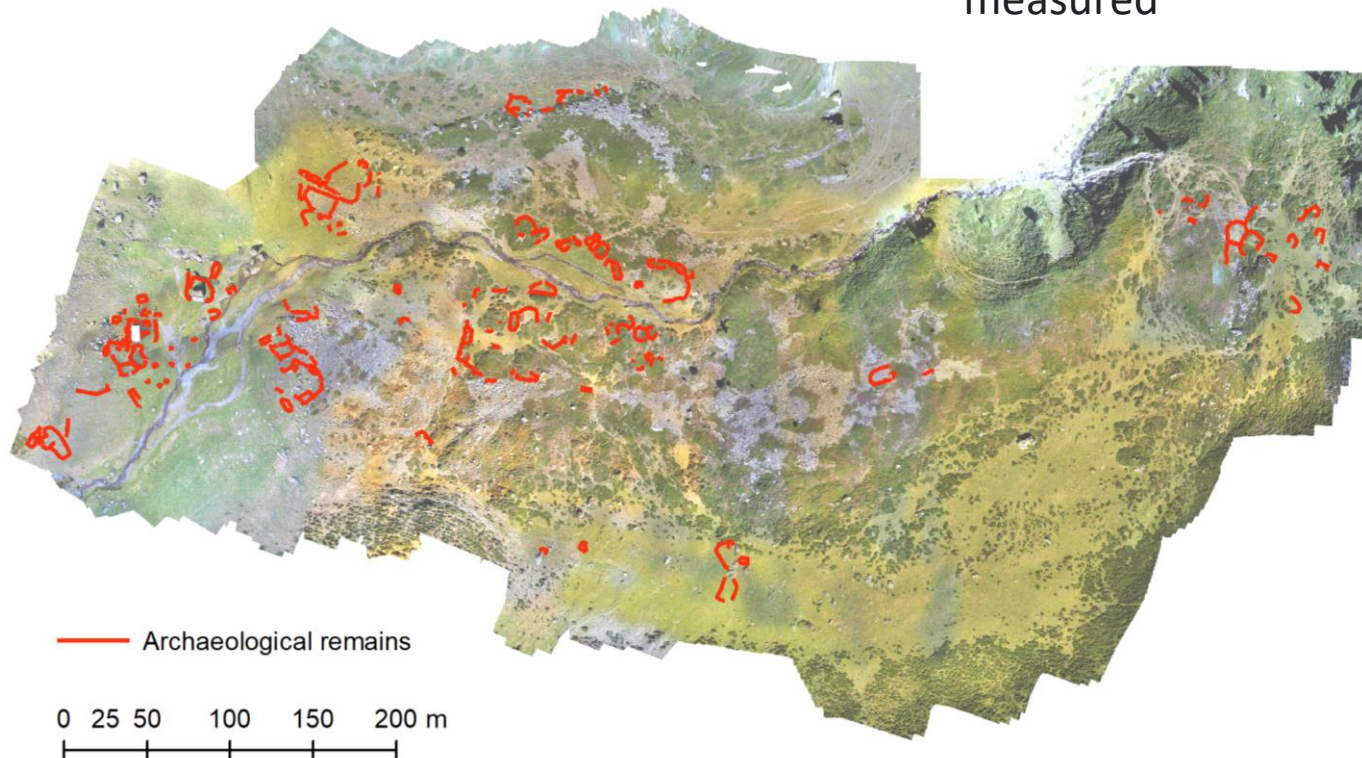


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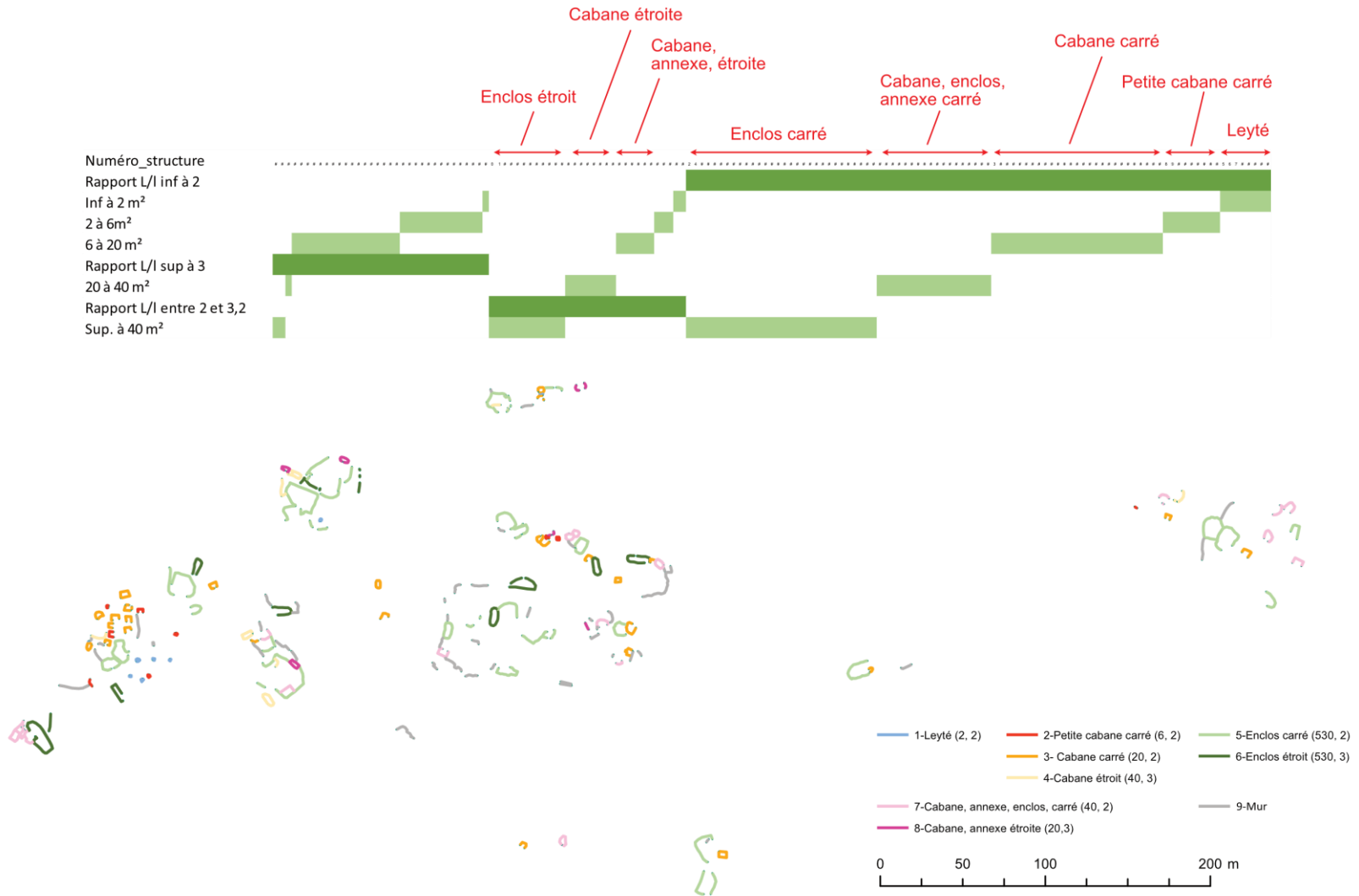
- ✓ Data acquisition : 8 days in 3 years
- ✓ Laboratory work : 8 weeks

⇒ 157 archaeological remains described, photographed and measured





Classification of archaeological remains



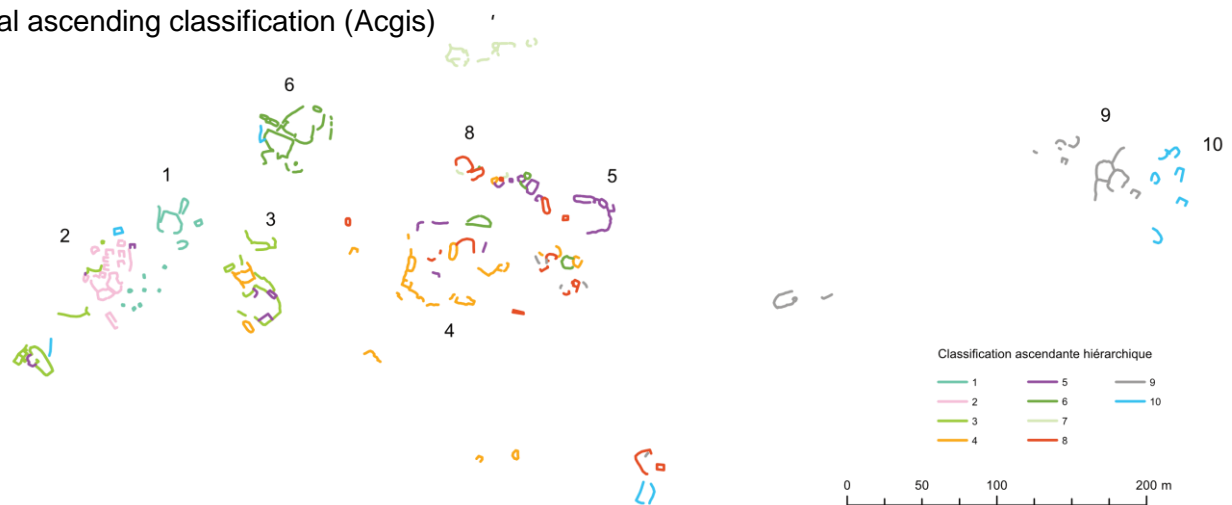


Grouping of archaeological remains into theoretical production units

Result of the clustering analysis (ArcGis software)



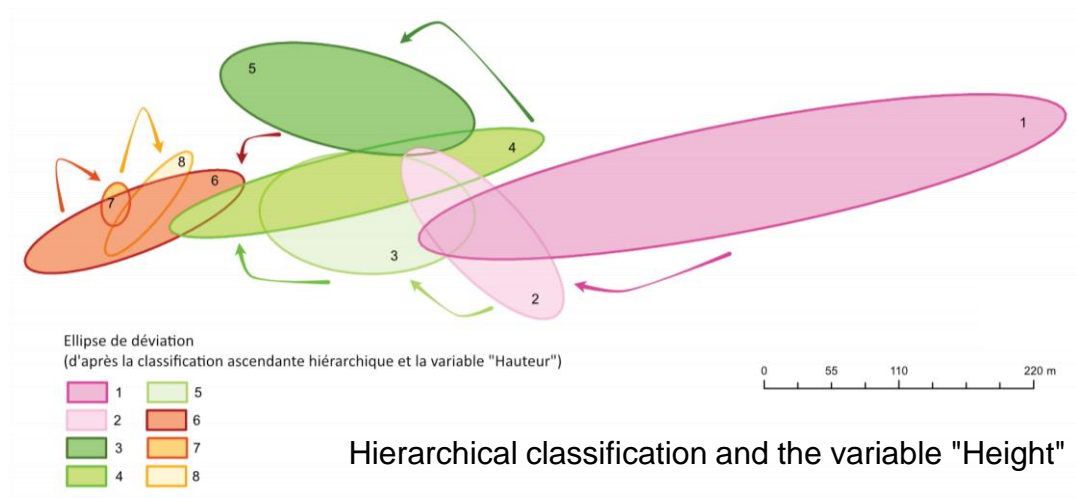
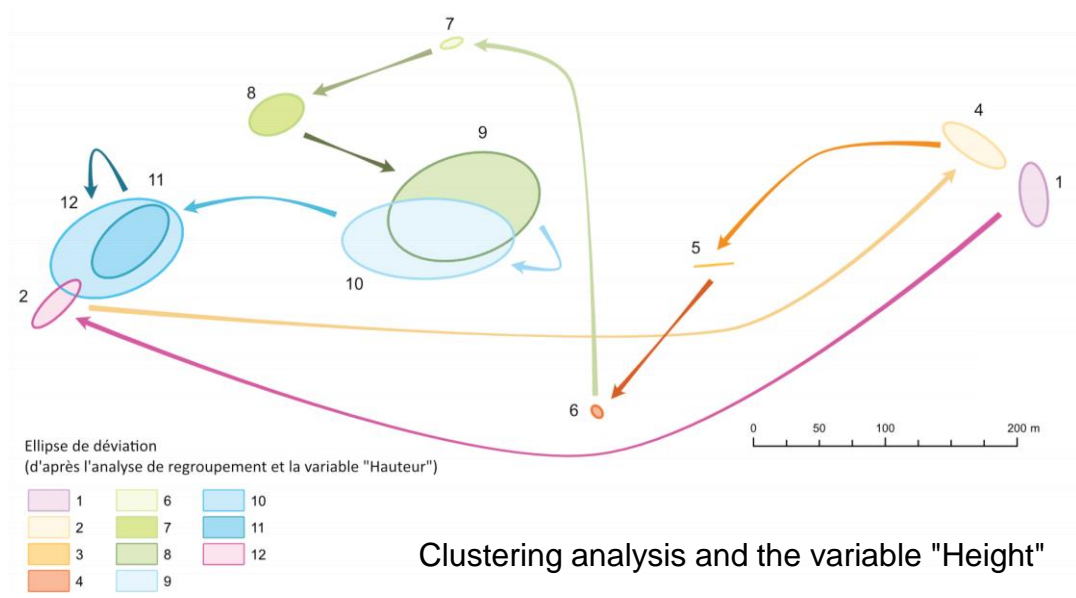
Spatialisation of the results of the hierarchical ascending classification (Acgis)





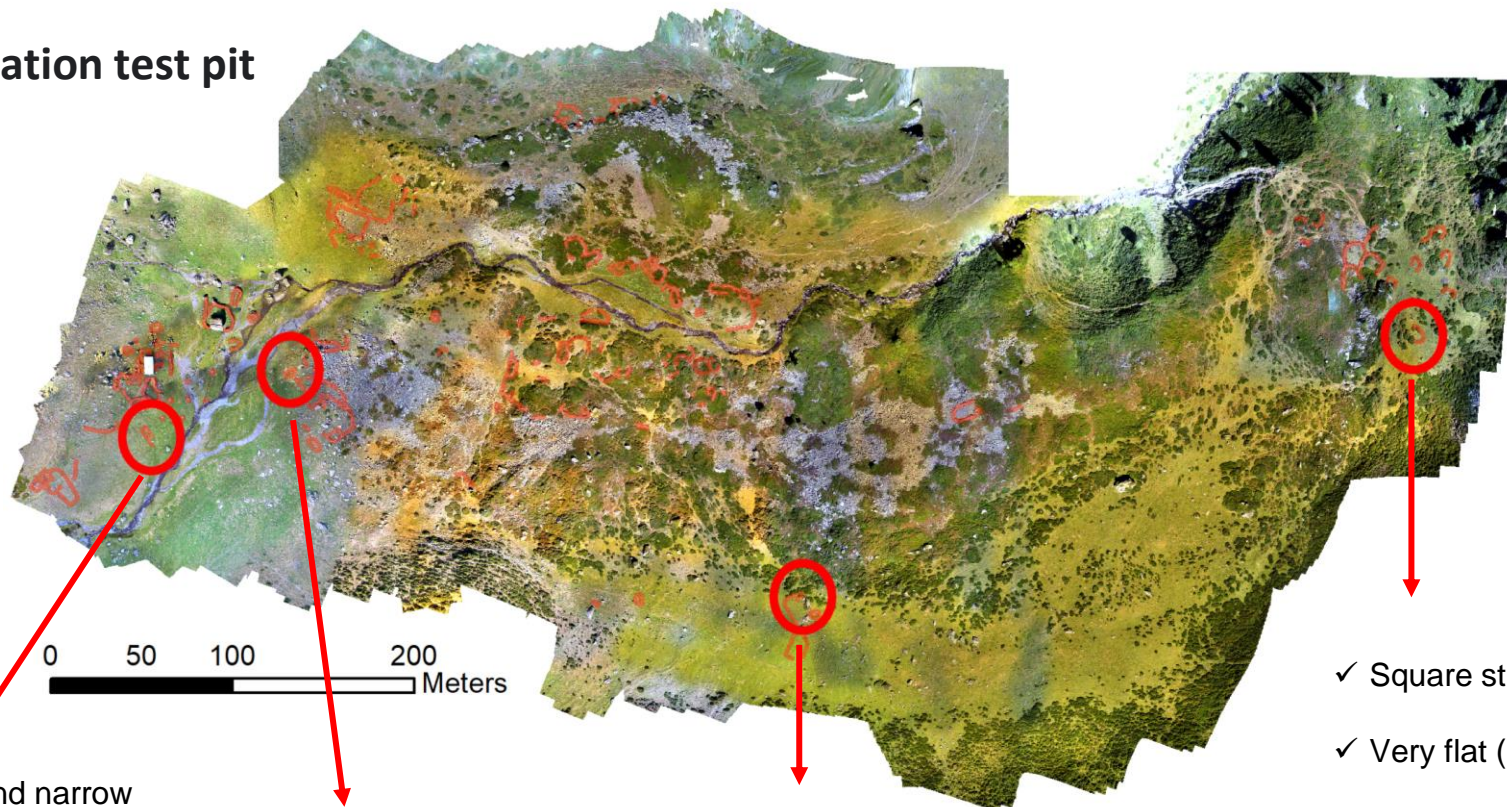
Inserting time

Map of standard deviation ellipses (ArcGis)





Validation test pit



- ✓ Long and narrow rectangular structure
- ✓ Isolated
- ✓ Possibly recent
- ✓ Remove rocks

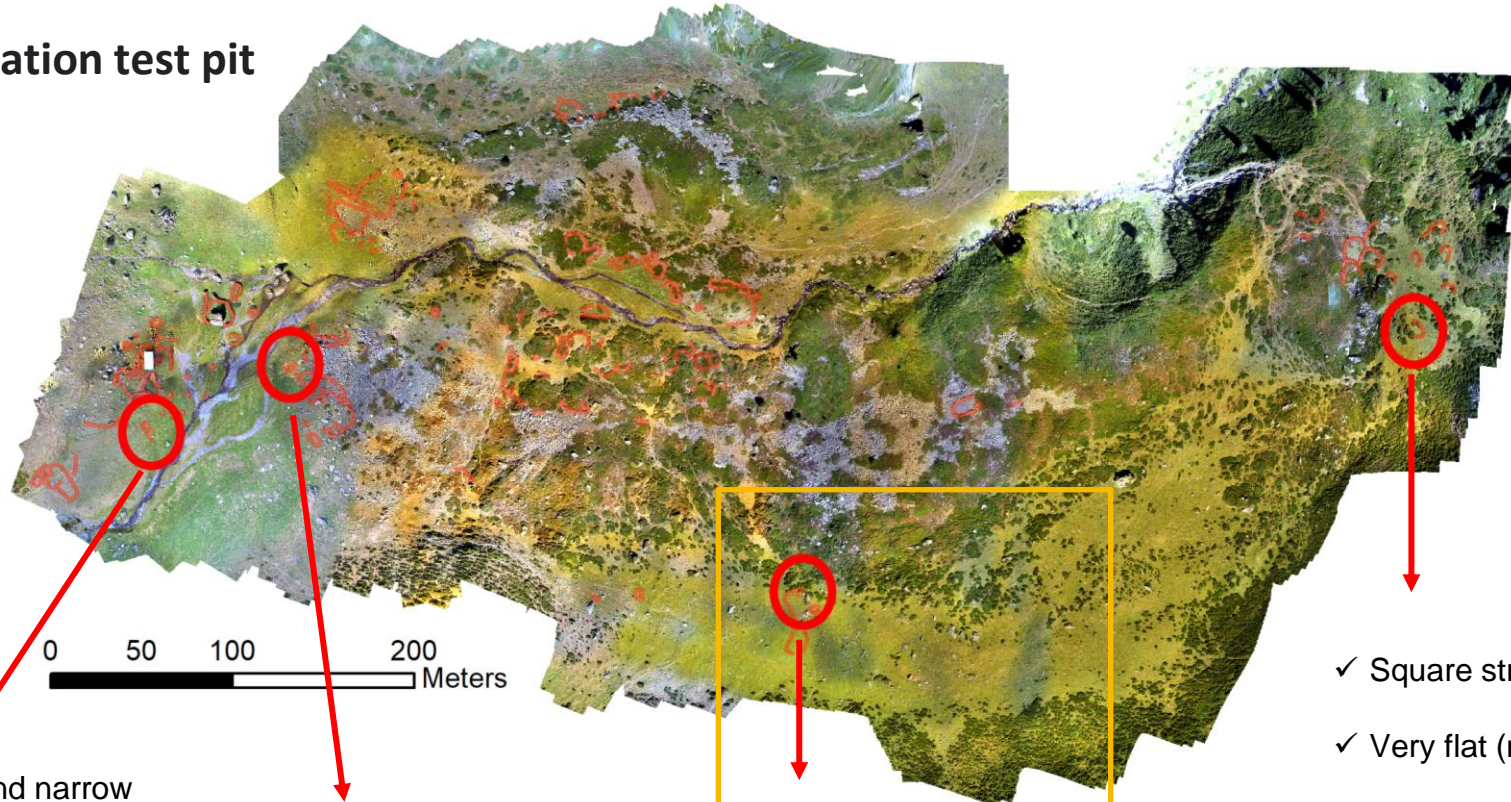
- ✓ Long and narrow rectangular structure
- ✓ Possible overlay of occupation
- ✓ Possibly recent but not so much

- ✓ Perceived only with the SLRM method

- ✓ Square structure
- ✓ Very flat (micro-relief)
- ✓ Possibly ancient



Validation test pit



- ✓ Long and narrow rectangular structure
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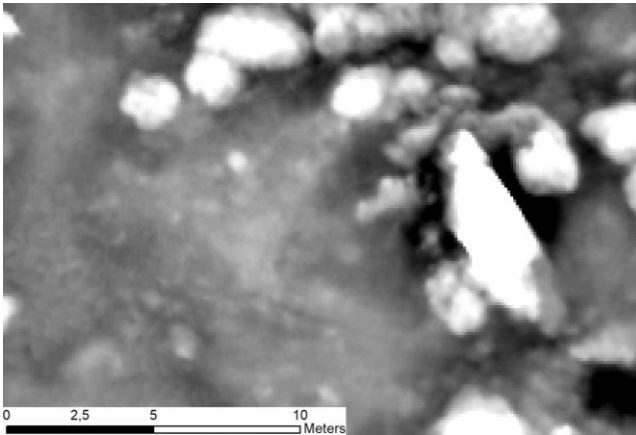
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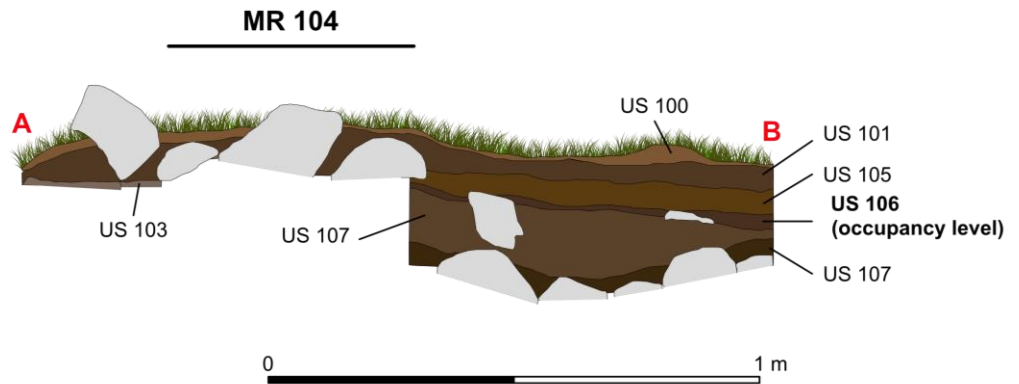
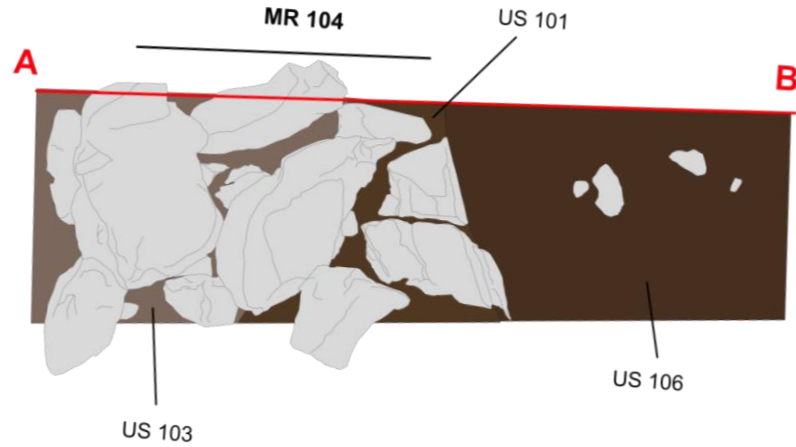
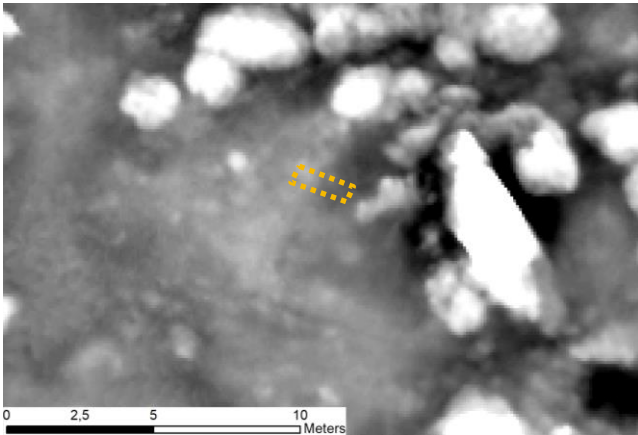
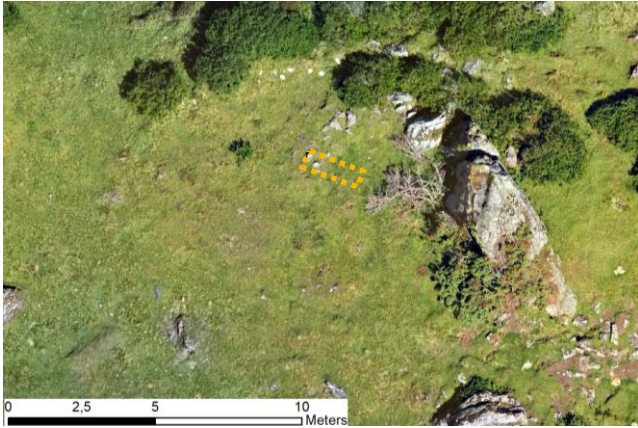
Validation test pit



Perceived only with the SLRM method



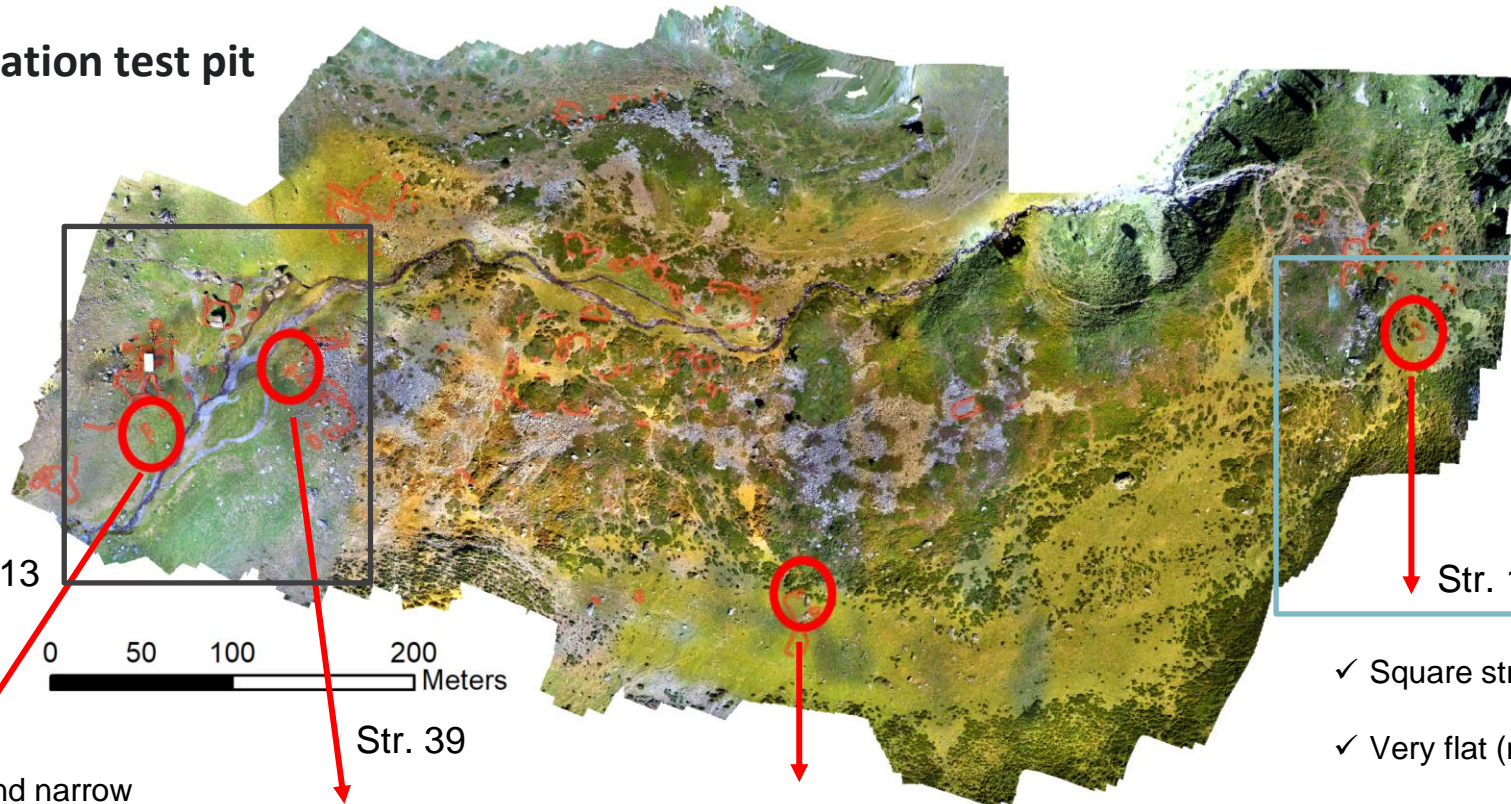
Validation test pit



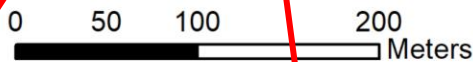
Perceived only with the SLRM method



Validation test pit



Str. 13



Str. 39

Str. 152

- ✓ Long and narrow rectangular structure
- ✓ Isolated
- ✓ Possibly recent
- ✓ Remove rocks

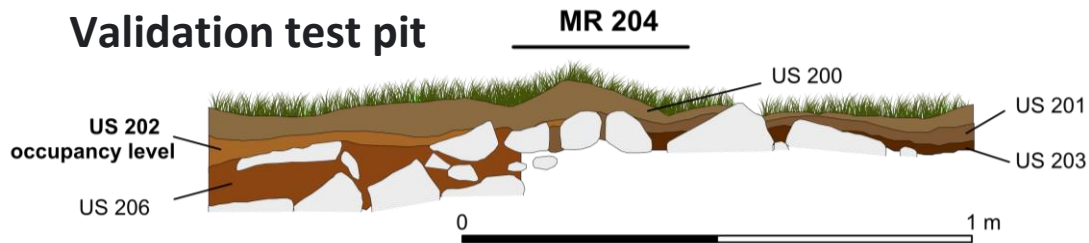
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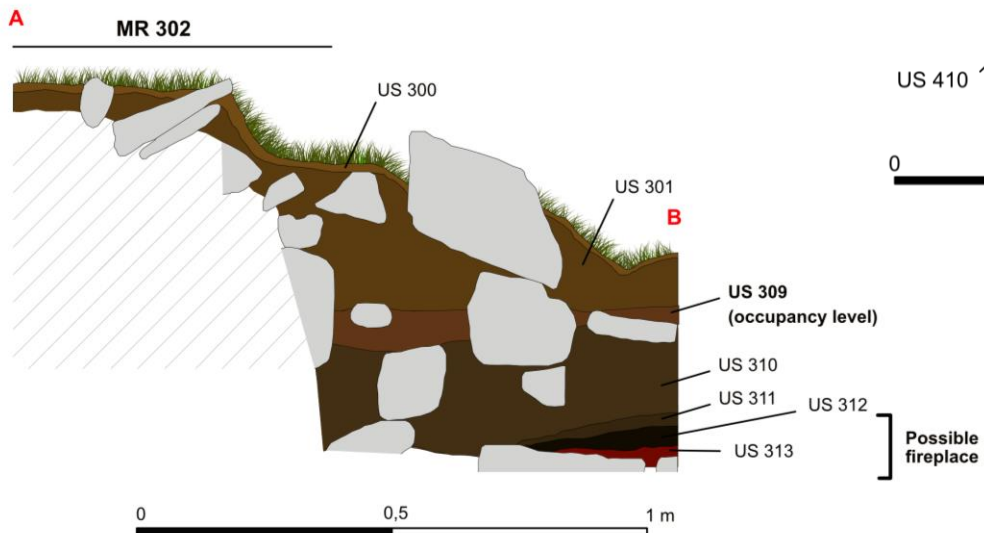


Validation test pit

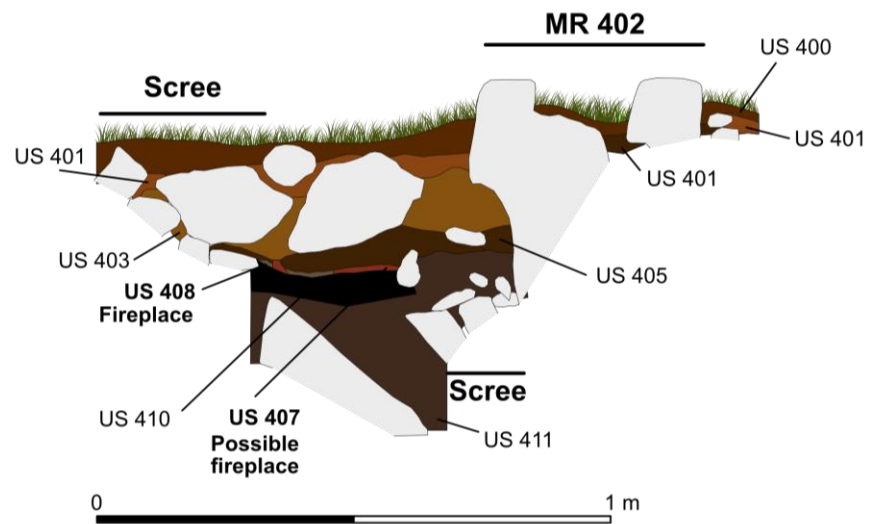


Profile - Structure 152

Profile - Structure 13



Profile - Structure 39

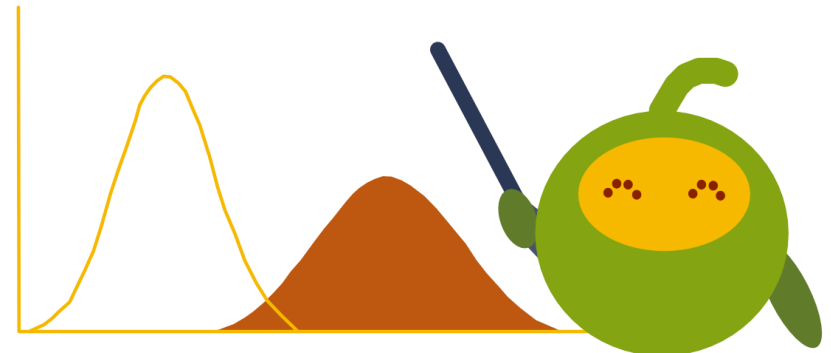




Future research directions

- ✓ Master funding for :
 - a) Remote sensing of archaeological structures on satellite images (TRACES et CNES)
 - b) Classification of Lidar point clouds to discriminate low vegetation (TRACES et CESBIO)

- ✓ Contact was made with the National Polytechnic Institute of Toulouse and the CESBIO to set up a collaboration for the insertion of AI procedure



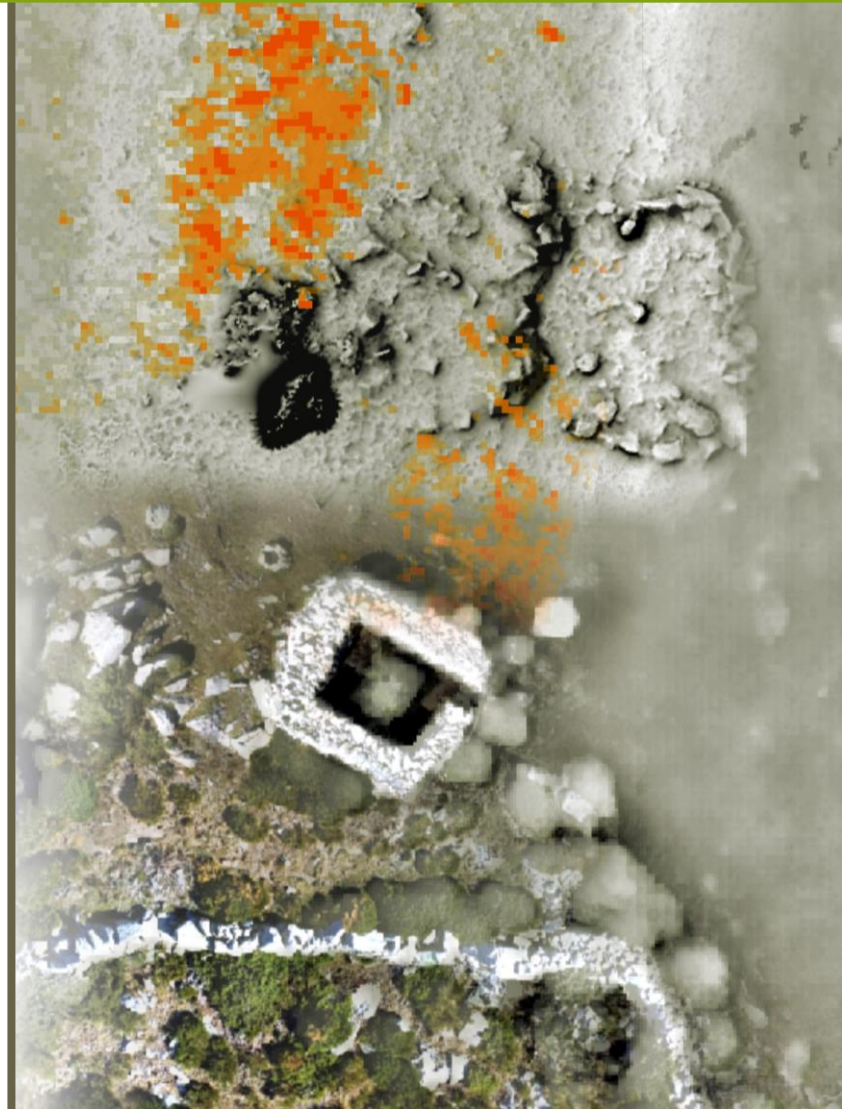


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6. Univ – GET, UMR 5563, Toulouse



Research institutes involved



Permanent and one-off funders

