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# Fire management during Early Upper Palaeolithic : Archaeological and Experimental Results from the Régismont-le-Haut Aurignacian Campsite

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## Background and Aims

Discovered in 1961, the campsite of Régismont-le-Haut (Pradeau et al., 2014) has since provided a remarkable set of fireplaces dated to ca. 32-36 ky calBP. Regarding the Aurignacian context, this well-preserved open-air site provides a unique opportunity to investigate the daily-life of these ancient populations.

To date about thirty fire-related structures have been identified, all located within a single occupation that was adapted to the morphology of local topographic features, i.e. the intersection of two paleochannels. Current investigations are oriented towards the understanding of the organization, operation, and function of these combustion related structures. Our approach relies particularly on micromorphological and organic matter (OM) geochemical analysis. This multiscale approach was developed in conjunction with the constitution of an experimental reference set, both of which are necessary for refining our archaeological interpretations.

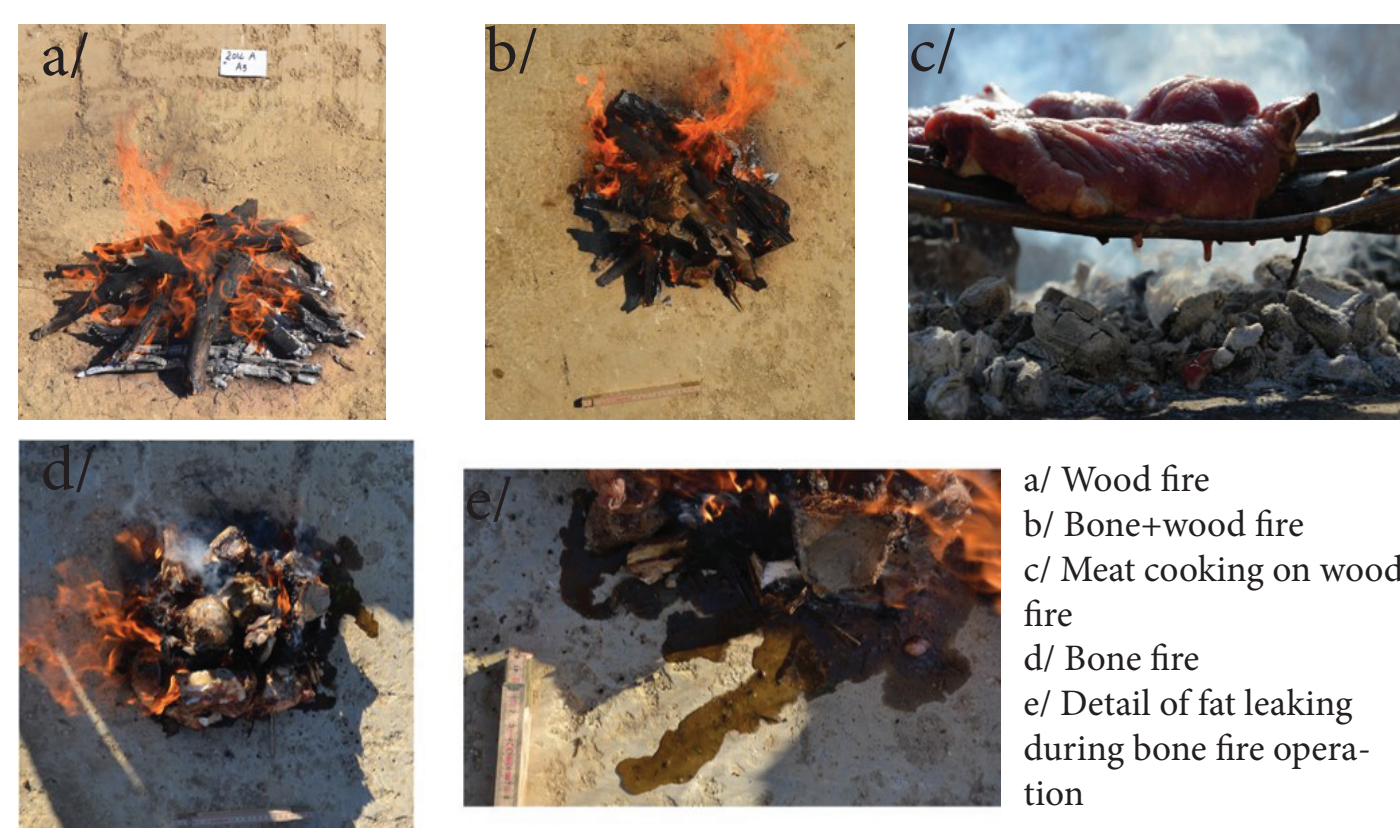
## Methods

- Micromorphological study of large soil thin sections following Stoops (2003) and Goldberg and MacPhail (2006)
- Organic carbon quantification by Elemental Analysis after acid fumigation (Harris et al. 2001)
- Lipid analysis by GC-MS after Accelerated Solvent Extraction (DCM/MeOH; 2:1, v/v; Quénéa et al., 2012)
- Bulk OM analysis by TMAH assisted pyrolysis-GC-MS (Quénéa et al., 2005)

## Experimental Reference Collection

### Experimental protocol

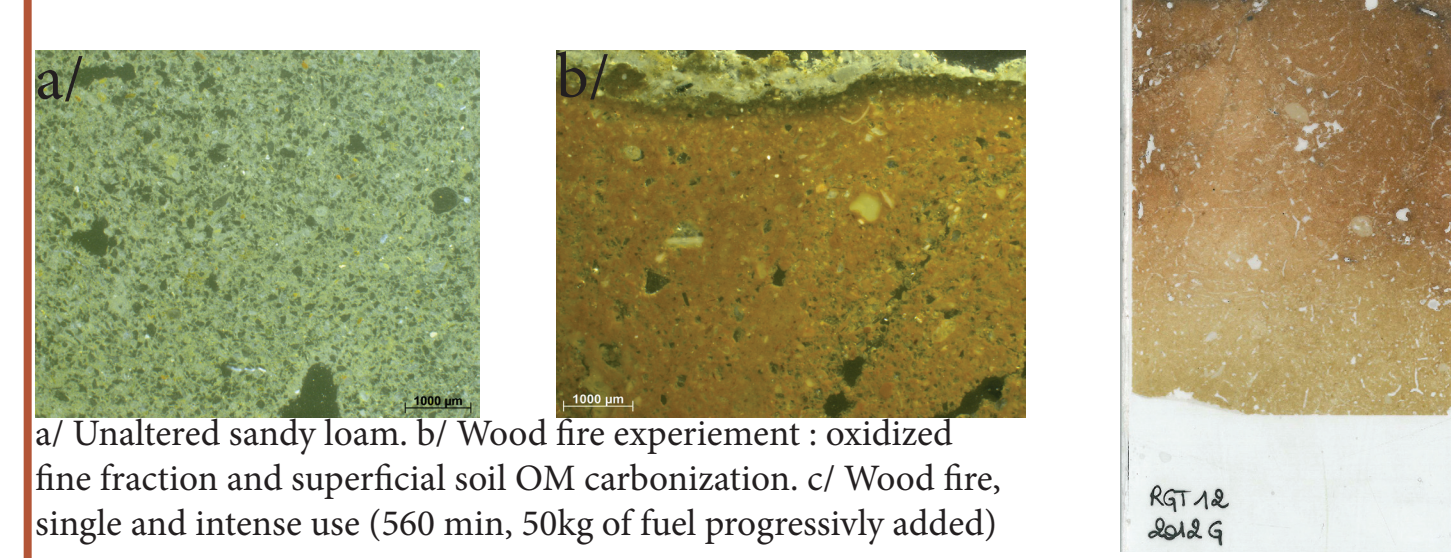
- Conducted between 2012 and 2014 in open-air conditions
  - Same sediment as archaeological layer : sandy loam
  - Control samples from natural/unaltered sediments
  - Wood used : *Pinus pinea* logs and twigs
  - Bone used : *Bos taurus* pelvic and long bones
  - Meat used : Beef and pork chops and fillets
- ### Objectives
- To test different types of fuel (wood, bone or both)
  - To test different durations of use and the influence of fireplace re-use
  - To test the impact of meat cooking



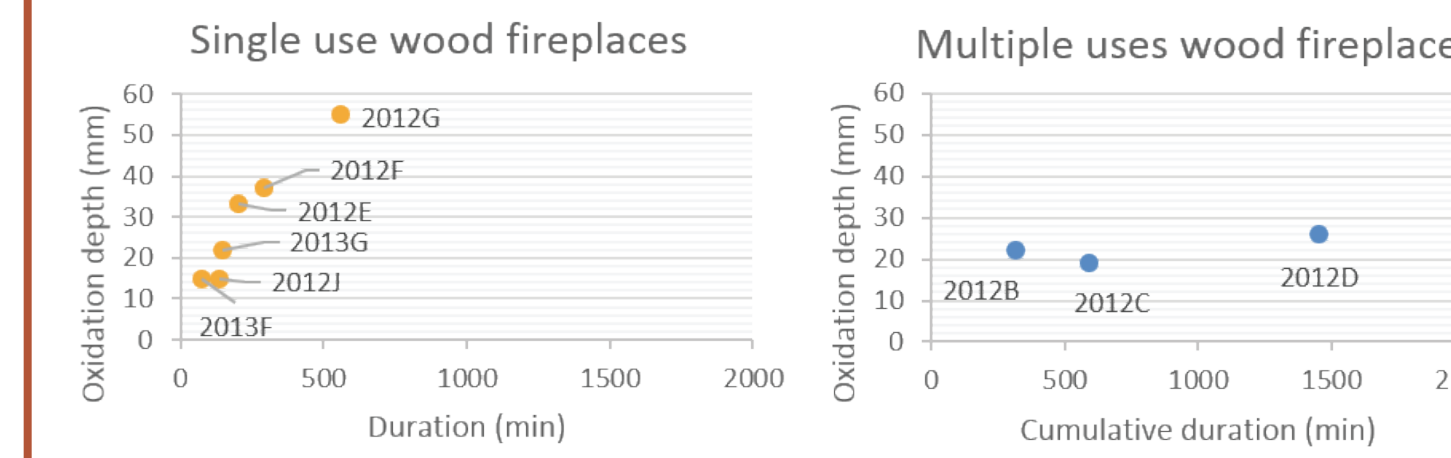
### Micromorphological results

#### Wood fire

- Thermal alteration (oxidation) of fine fraction and calcareous components
- No transformation of soil microstructure and superficial soil OM alteration

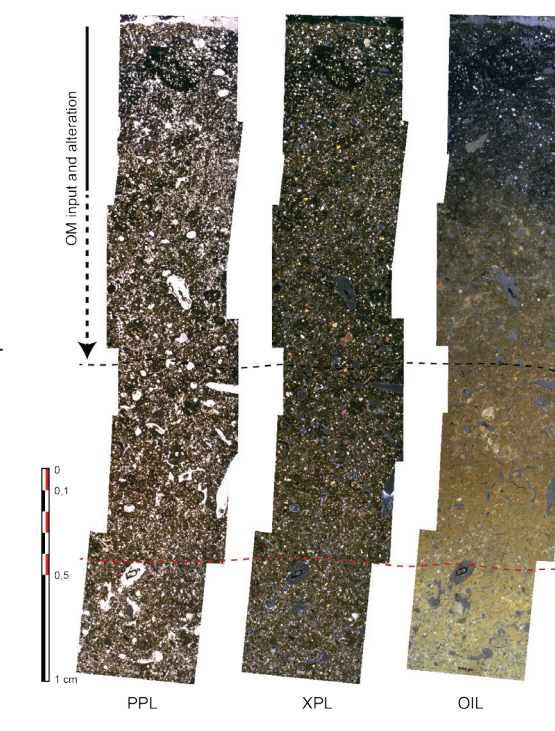


- Positive correlation between oxidation depth and duration/intensity of use ; no significant effect of re-use



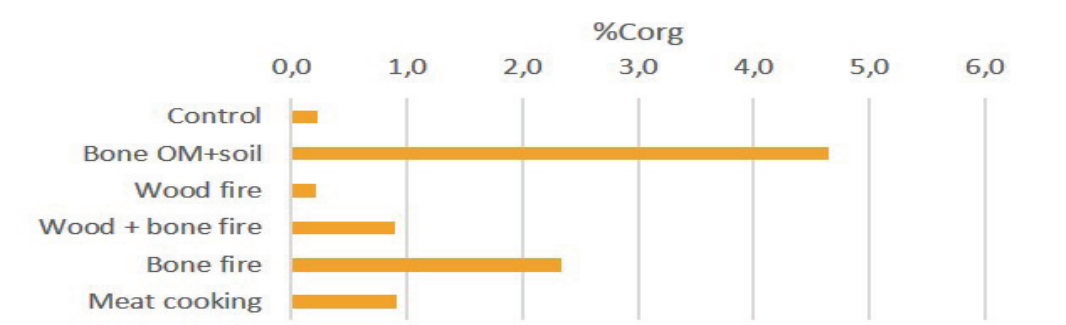
#### Bone fire

- Massive OM impregnation and coating features when bone is used; this OM is subsequently carbonized
- Weaker, but comparable, features with meat cooking on wood fire



### Geochemical results (Lejay et al., 2016)

- Organic content measurements (%Corg) consistent with OM input in experiments involving the use of bone or meat cooking
- No quantitative differences between control and wood fire



- Definition of organic signatures based on:

#### Lipid extract (GC-MS)

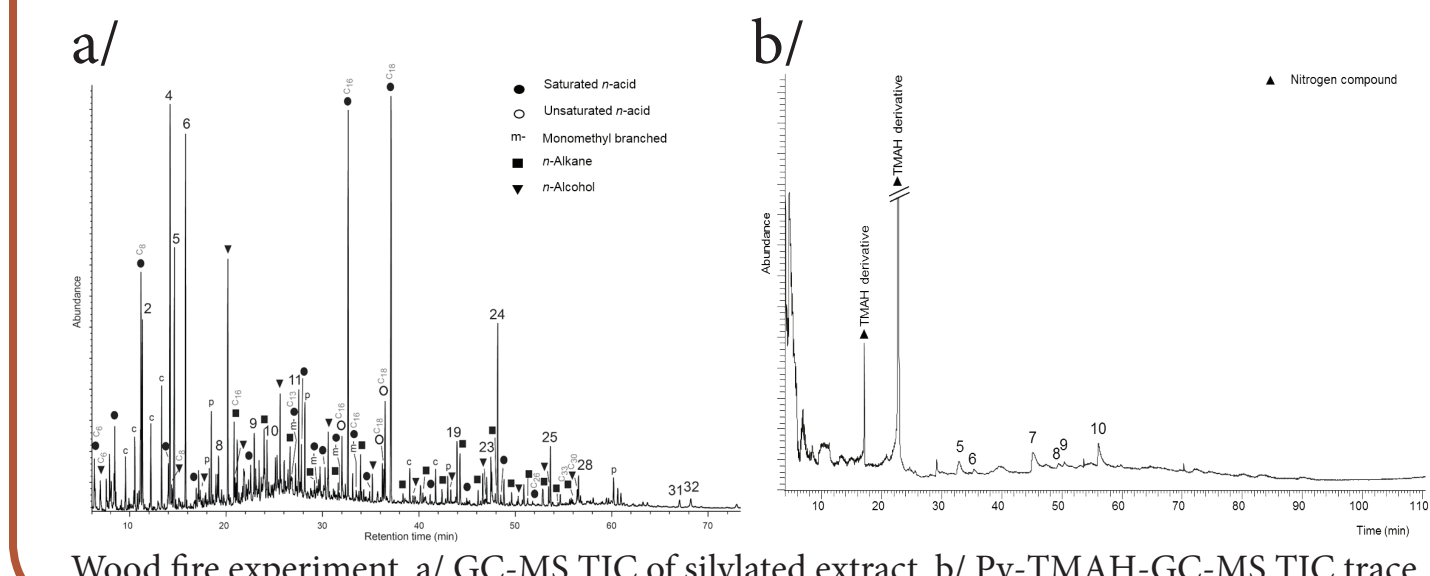
Compounds	Control	Soil with bone OM	Bone fire	Wood + Wood fire	Meat cooking	Possible origin
Saturated n-acids > C <sub>20</sub>	X	X	X	X	X	
n-Alcohols > C <sub>20</sub>	X	X	X	X	X	
n-Alkanes	X	X	X	X	X	
Hydrocarbons	X	X	X	X	X	Plant OM
Terpenes	X	X	X	X	X	
Benzoic acids			X	X	X	
Phenolic compounds			X	X	X	
Other aromatic compounds			X	X	X	Thermal alteration of plant OM
Benzols		X	X	X	X	Animal fat
Alkylphenols		X	X	X	X	Animal fat
Monomethyl branched diacids < C <sub>20</sub>			X	X	X	Slight thermal alteration of animal fat
Benzols		X	X	X	X	
Monomethyl branched acids < Me-C12		X	X	X	X	
n-Alcohols < C <sub>20</sub>		X	X	X	X	Thermal alteration of animal fat
Ketones		X	X	X	X	
Lactones		X	X	X	X	

#### Non-extractable OM (Py-TMAH-GC-MS)

Compounds	Control	Soil with bone OM	Bone fire	Wood + Wood fire	Meat cooking	Possible origin
Benzene derivatives			X	X	X	Thermal alteration of plant OM
Monomethyl branched unsaturated C <sub>20</sub> and C <sub>22</sub> acids, high C <sub>20</sub> and C <sub>22</sub> saturated acids		X	X	X	X	
Diols		X	X	X	X	Animal fat
α-Hydroxy-, epoxy saturated and unsaturated acids		X	X	X	X	
Glycerol derivatives		X	X	X	X	
n-Alkanes/n-alkene doublets		X	X	X	X	Thermal alteration of animal fat

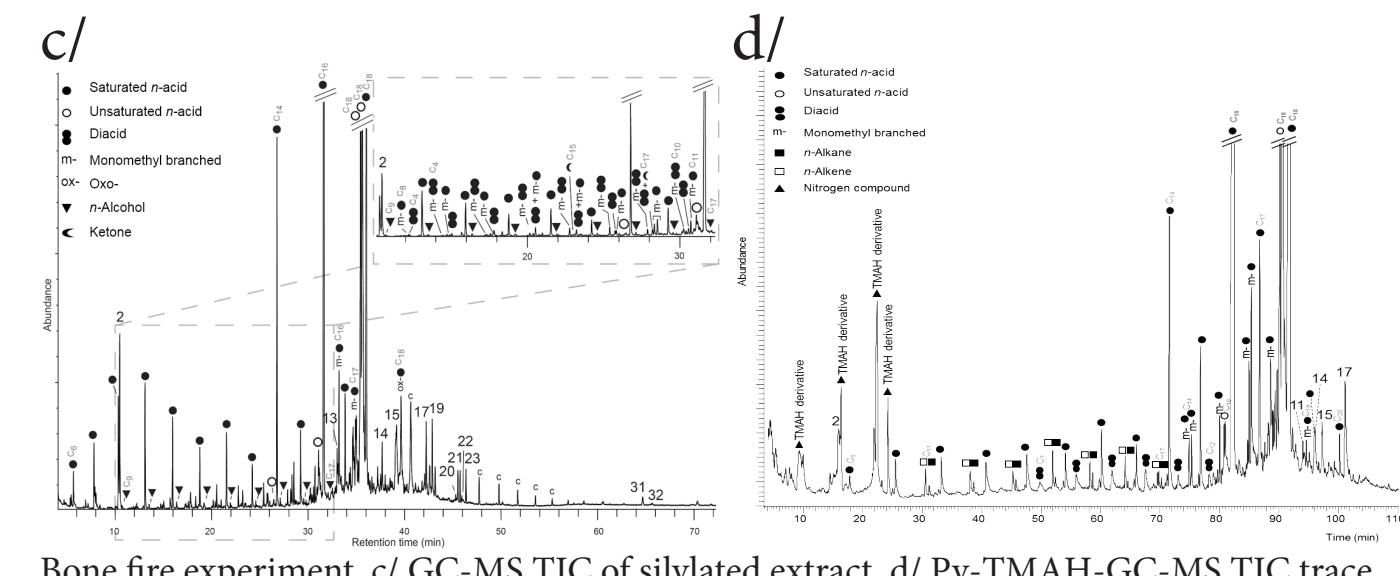
#### Wood fire

- Identification of fresh and thermally altered plant OM signature
- Phenolic and benzoic derivatives highlight byproducts of different wood degradation stages



#### Bone fire

- Identification of fresh and thermally altered animal OM signature
- Numerous compounds indicative of fat (and meat) degradation

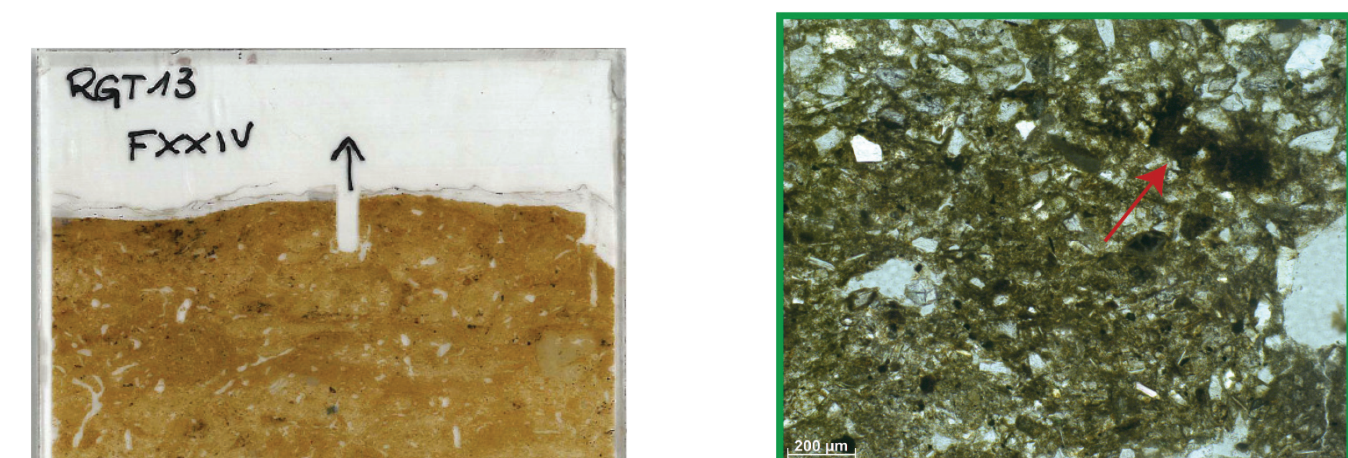


## Archaeological Results

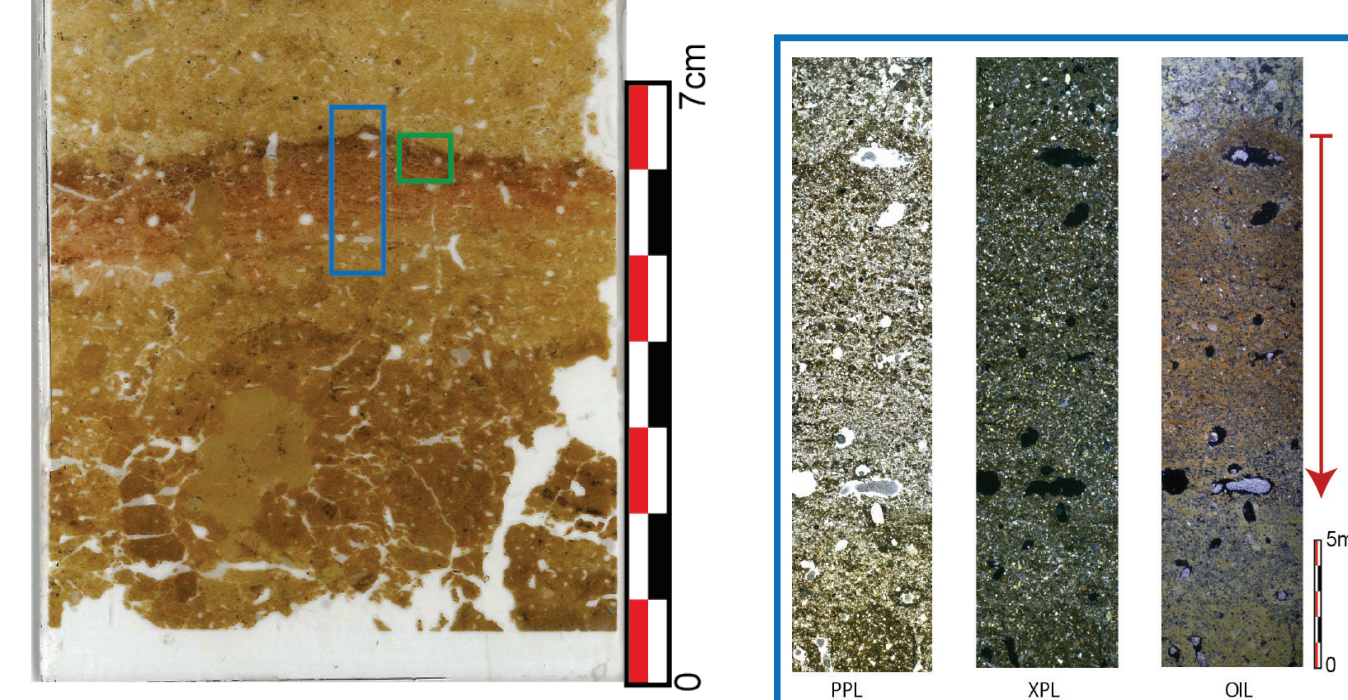
### Fireplace XXIV



In-situ reddened sediments overlaid by patches of brownish sediments with scarce wood charcoal.

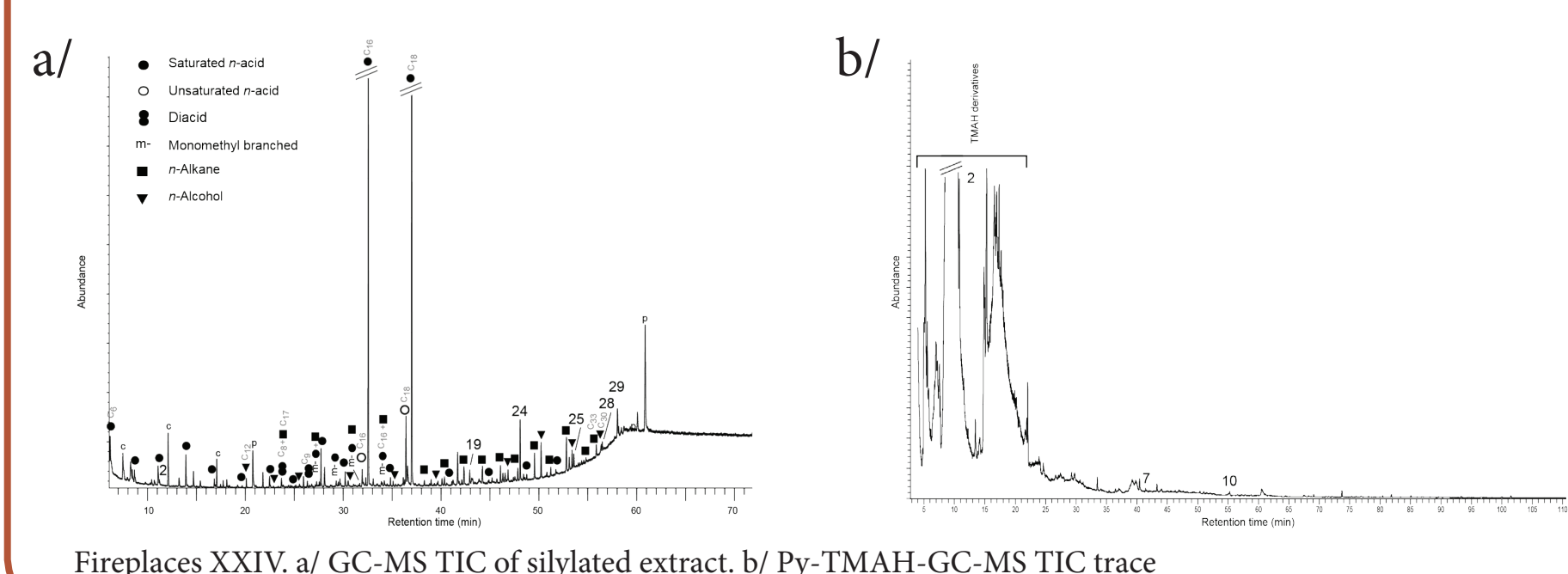


Rare brown amorphous materials (red arrow) on top of oxidised sediments, putatively corresponding to degraded soil OM (PPL)



Decreasing oxidation of the fine fraction. Rare mesofaunal and root channels.

- No %Corg variation (equal to control)
- Signature of fresh and thermally altered plant OM



Fireplaces XXIV. a/ GC-MS TIC of silylated extract. b/ Py-TMAH-GC-MS TIC trace

### Identification of two main fireplace types

#### Wood fueled, low intensity use and specialized fireplaces (F. XXIV type)

- Reddened sediments, few wood charcoal covering and rare bioturbation features.
- Surrounding artifacts reflect rather specific activities.
- Altered and unaltered plant OM

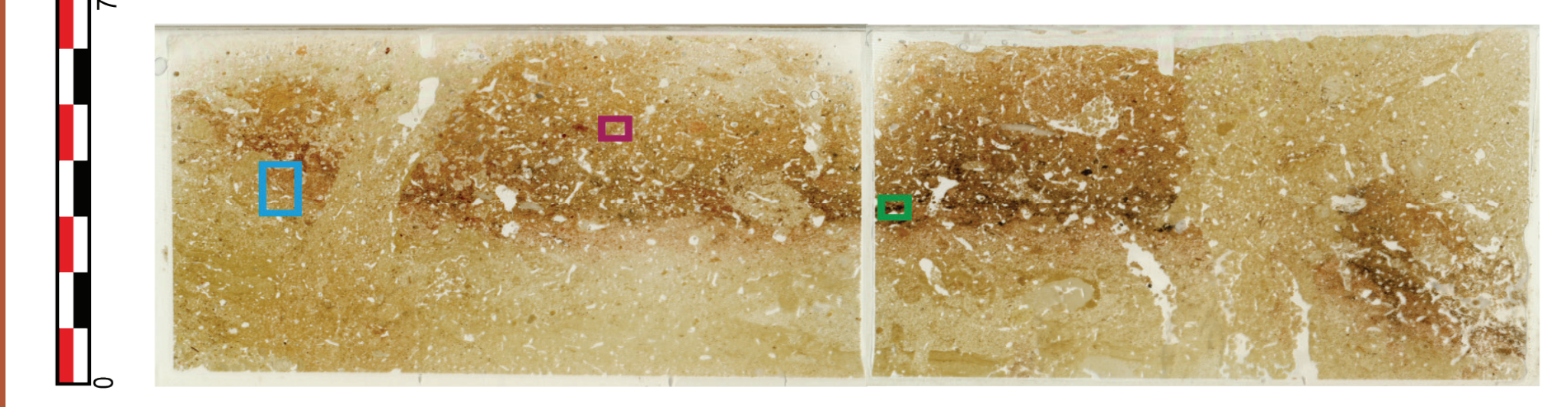
#### Bone +wood fueled, high intensity use and multipurpose fireplaces (F. XII type)

- Ash pseudomorphs, wood charcoal, burned bones
- OM impregnative features and highly bioturbated
- Central relative to numerous and diversified artifact concentrations
- Both altered and unaltered plant OM and rare markers of animal OM

### Fireplace XII

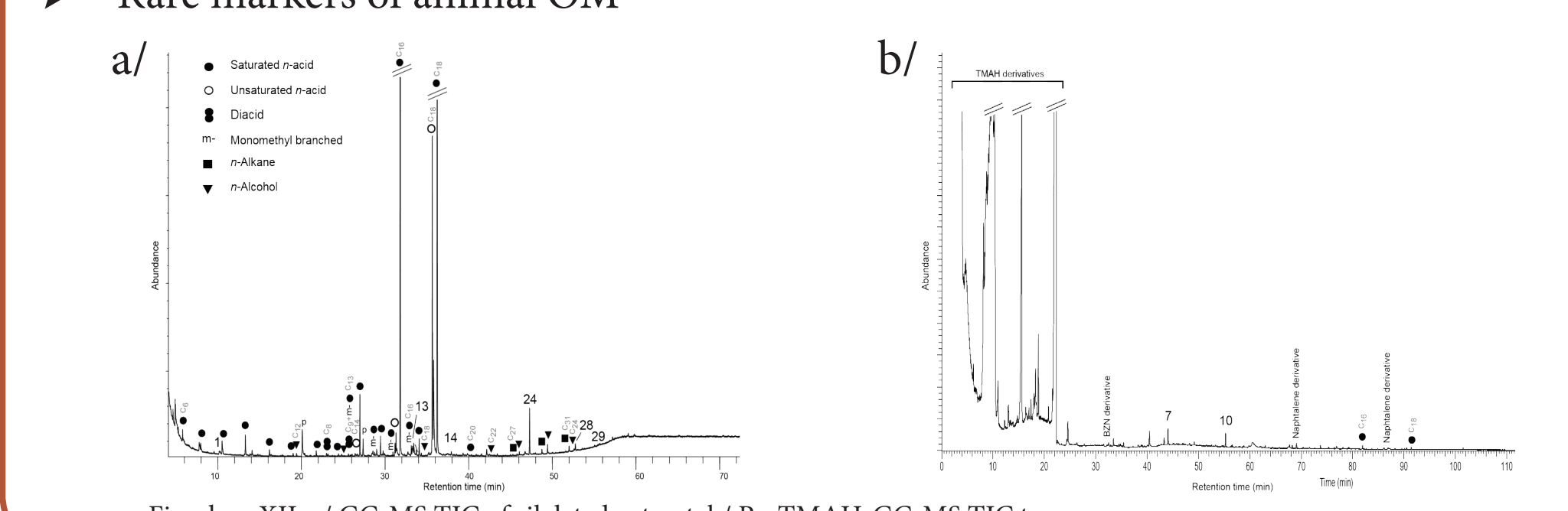


a : Unaltered sandy loam with calcite nodules  
b : Reddened sediments  
c : Combustion residues  
d : Reddened sediments mixed with combustion residues  
e : Burrow



Decreasing oxidation of lower sediments (OIL)  
Very altered and reworked wood charcoal within OM rich sediments (PPL)  
Dense network of mesofaunal and root channels. Mineral constituents are both oxidized and OM rich (PPL)

- Insignificant %Corg augmentation (+ 0.1-0.2% compared to control)
- Signature of fresh and thermally altered plant OM
- Rare markers of animal OM



Fireplace XII. a/ GC-MS TIC of silylated extract. b/ Py-TMAH-GC-MS TIC trace

## Conclusion

- Experimental reference sets improve archaeological interpretation
- Multiscale analysis provides detailed information regarding: operation, utilization and post-depositional processes
- Archaeological results highlight complex fire management from at least the Early Upper Palaeolithic and onward

## Future Research Axes

- Improvement of the experimental reference library
- Taphonomic research on aged structures / OM
- Exploration of fatty acid distributions and ratios
- Investigation of other organic compounds (N?)
- Application to other sites and periods