Organic matter from archeological tanning pits

First insights from combined micromorphology and lipid biomarkers

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Tanning processes are poorly documented before medieval period

Organic geochemistry and micromorphology are powerfull tools to investigate past human activities but were scarcely applied together to archeological studies

AIM

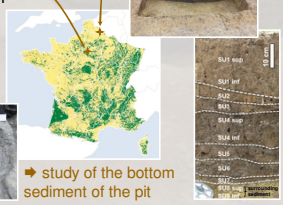
- ➡ Establish the signature of recent tanning activity from combined micromorphology and geochemistry (Saint-Denis medieval pit)
- ➡ Test the hypothesis of tanning activity for an older pit (Famars roman pit)
- ➡ Further precise tanning processes through human history

preliminary study

EXPERIMENTAL

Saint-Denis medieval town ➡ circular pit (16th cAD) ➡ ➡ proved tanning craft

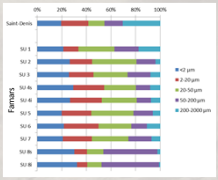
Famars roman town ➡ square pit (3rd cAD) river & butchery vicinity ➡ ➡ tanning craft ?



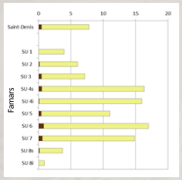
➡ study of the bottom sediment of the pit

➡ study of the eight stratigraphic units (SU)

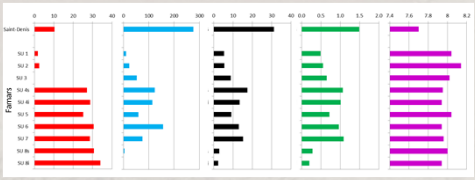
BULK SEDIMENT



granulometry



Organic (●) and inorganic ( ) phosphorus (g/kg)



Total iron (●), carbonate (●), organic carbon (■), nitrogen (●) content (g/kg) and pH (●)

➡ reference pit of Saint-Denis : high carbon, nitrogen (and phosphorus) content

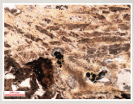
➡ Famars pit : SU4-7 ≠ colluviums (SU1-3) & surrounding sediment (SU8) ⇨¿ craft record ?

COMPARATIVE MICROMORPHOLOGY & LIPID BIOMARKERS

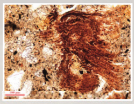
Sample	Matrix / pedo-features	Micromorphology: Inclusions: Type & Abundance: Mineral & manufactured	Plant origin	Animal origin	Phosphate pedo-features	Unidentified yellow isotropic aggregates	Human activities
Saint - Denis	Dusty alluvial silty sand, crack to massive microstructure	++ lime aggregate, some with hairs	+ bark ?, charcoal, phytoliths, wood	+ bones, fishbones, few dejections	+	0	Hair removal (= tanning ?)
SU 1 sup	Dusty brown clay silt, 20 % sub-angular sands, fine charcoals, spongy microstructure, channels	0 / + burnt rounded aggregates, scarce ceramic splinters	+ charcoals, silicified plant tissues	+ small bone fragments	+++ nodules / impregnations vivianite	0	ancient surface trampling
SU 1 inf							
SU 2 sup	Thin layer of mineral, few bones, fine charcoals, 1 ceramic splinter, P<O> feat. elongated void	0 / + calcareous gravels (wh P<O>coatings)	+ charcoals, yellow decaying plants with phytoliths	+ small bone fragments	++ / +++ nodules / impregnations, vivianite	0	ancient surface trampling
SU 2 inf	Dusty brown clay silt, fine charcoals, massive, channels, elongated vesicles (top)						few activity remains
SU 3	Dark brown clay silt, lime / ashes / phosphate aggregates, channels, cavities, vesicles, brown dusty silt clay coatings	0 / + burnt aggregates, massive agg. with P<O>	+ charcoals, mixed lime/ashes/P aggr.	+ small bone fragments	+ nodules / impregnations, vivianite	+	Decreases of activities remains production
SU 4 sup top	wh brown clay silt, lime / ashes / phosphate aggregates, yellow isotropic aggregates	0 / +	+	+	+	+++	Dense accumulation of disorganized activity remains
SU 4 sup middle	Massive washed off silt, some vesicles, clay aggr. from geological layers with P impregn.	Lime aggregates and lenses, scarce lime aggregates with hairs (?), very few rounded hearth fragments	Carbonated & siliceous ashes, lenses of phytoliths, yellow decayed plant, charcoals, burnt seeds, calcitic pseudomorph of wood	small bone fragments	nodules / impregnations, vivianite		Preparation of activity floor
SU 4 sup bottom	Mixing of anthropogenic aggregates & components						Dense accumulation of disorganized activity remains
SU 4 inf top	Brown clay silt, thin layer of anthropogenic components, some washed off silt lenses	0 / +	+	+	++	+++	Ancient surface with activity remains
SU 4 inf middle	Brown silt clay, layers and lenses of anthropogenic comp. & aggr., vesicles & cavities	Lime aggregates and lenses, scarce lime aggregates with hairs?	Carbonated & siliceous ashes, lenses of phytoliths, yellow decayed plant, charcoals, burnt seeds	Few bones & dejection fragments	nodules / impregnations, iron phosphate (vivianite)		Ancient surface :: dense accum. of activity remains
SU4 inf bottom	Massive washed off silt, some vesicles						Preparation of activity floor, water flows
SU 5 top	Brown silt to clay silt, thin layer of anthropogenic components	+	+	+	++	++	Ancient surface with activity remains
SU 5 middle	Brown silt to clay silt, layer of anthropogenic components & aggregates, vesicles & cavities	Lime aggregates and lenses, scarce lime aggregates with hairs (?)	Carbonated & siliceous ashes, lenses of phytoliths, yellow decayed plant, charcoals, burnt seeds fragments	Some diatoms, few bones & dejection fragments	nodules / impregnations, iron phosphate (vivianite)		Dense accumulation of activity remains
SU 5 bottom	Brown silt to clay silt, massive, washed off silt, some vesicles						Preparation of activity floor, water flows
SU6	Brown silt to clay silt, layered, cavities, abundant lenses of anthropogenic components	++ Lime aggregates and lenses, scarce lime aggregates with hairs ?	+ Carbonated & siliceous ashes, few charcoals, wood pseudomorph	+ Small bones & dejection fragments	++ nodules / impregnations, vivianite	+++	Dense accumulation of activity remains
SU7	Brown silt, massive, lenses of anthropogenic components (top & bottom)	++ Lime aggregates and lenses, scarce aggregates with hairs	+ Carbonated & siliceous ashes, few charcoals	+ Small bones and dejection fragments	+ nodules / impregnations, vivianite	+++	Dense accumulation of activity remains
SU 8 sup	Glauconiac sand clay, very few silt clay coating	0	0	0	0 / + at the top	0	none

Sample	compounds	n-alkanols	n-acids	n-alkanes	glycerol monos-, di-, tri-esters	cholesterol	ethyl-coprostanol	β-sitosterol	stigmasterol	stiostanol	friedelin
	formula	$C_nH_{2n+2}O$	$C_nH_{2n}O_2$	C_nH_{2n+2}		$C_{27}H_{46}O$	$C_{27}H_{48}O$	$C_{29}H_{50}O$	$C_{29}H_{48}O$	$C_{29}H_{52}O$	$C_{30}H_{50}O$
Saint - Denis	abundance	1,00	0,22	0,30	1,20	0,06	0,04	1,18	-	0,10	0,31
	distribution	(C17+C19)/C20+	(C16+C18)/C20,C22+	(C17+C19+C21)/C20+	(C16+C18)/C20+						
SU 1 sup	abundance	0,93	0,35	0,15	0,57	0,06		0,05	0,1	-	-
	distribution	(C17+C19)/C20+	(C16+C18)/C20+	(C17+C19)/C20+	(C16+C18)/C20+						
SU 1 inf	abundance	0,2	1,00	0,05	0,09	0,01	-	0,1	0,1	-	-
	distribution	(C17+C19)/C20+	(C16+C18)/C20+	(C17+C19)/C20+	(C16+C18)/C20+						
SU 2 sup	abundance	1,00	0,09	0,14	0,32	0,03	0,04	0,1	0,06	0,07	
	distribution	(C17+C19)/C20+	(C16+C18)/C20+	(C17+C19)/C20+	(C16+C18)/C20+						
SU 2 inf	abundance	0,3	0,24	0,31		0,09	0,04	0,07	0,03	0,02	
	distribution	$(C_{17}+C_{19})/C_{20}$	$(C_{16}+C_{18})/C_{22}$	$(C_{17}+C_{19})/C_{21}$	$(C_{16}+C_{18})/C_{20}$						
SU 3	abundance	1,00	0,5	0,15	0,14	0,1	0,03	0,1	0,03	0,06	-
	distribution	$(C_{17}+C_{19})/C_{20}$	$(C_{16}+C_{18})/C_{22}$	$(C_{17}+C_{19})/C_{21}$	$(C_{16}+C_{18})/C_{20}$						
SU 8 sup	abundance	0,15	1,00	0,02	0,22	0,02		0,15	0,04	-	
	distribution	$(C_{17}+C_{19})/C_{20}$	$(C_{16}+C_{18})/C_{18}$	$(C_{17}+C_{19})/C_{21}$	$(C_{16}+C_{18})/C_{20}$						

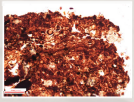
REFERENCE TANNING PIT : MEDIEVAL TOWN OF SAINT-DENIS

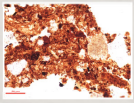


➡ Lime aggregate with hair



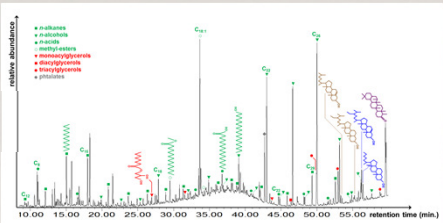
➡ Burnt plant remain





➡ Decaying (plant ?) organic matter

Microphotographs of the bottom sediment of the tanning pit



Chromatogram of the total lipids extracted from the bottom sediment of the tanning pit

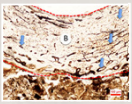
➡ micromorphological & geochemichal signature of tanning activity :

Micromorphology		Lipid biomarkers	Source	Potential step in tanning process	
Lime agregates			➡ Lime	➡➡ Hair removal (liming)	
Burnt plant remains Charcoals Phytoliths		Long chain lipids Phytosterols Friedelin	➡ Plants	➡➡ Rinsing (deliming) with aqueous solutions containing plants & dejections	➡➡ Tanning
Hairs (Fish)Bones Dejections	P	Organo-P molecules Cholesterol Ethylcoprostanol	➡ Animals		➡➡ Skin refuses

➡ main process achieved in the pit : hair removal (liming)

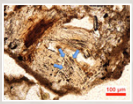
ROMAN TOWN OF FAMARS : ¿ TANNING PIT ?

Microphotograph of the stratigraphic column of Famars Pit



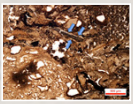
Microphotograph of SU 2

➡ Bone fragment (B) with bacterian weathering (➡)



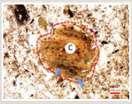
Microphotograph of SU 3inf

➡ Possible hairs bulbs (➡) in a yellow phosphate matrix



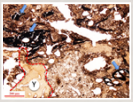
Microphotograph of SU 4sup

➡ Complex lime, phosphate & ashy matrix with silicified plant tissues (➡)



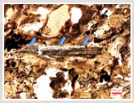
Microphotograph of SU 5/6

➡ Coprolith with vivianite at the bottom of the aggregate (➡)



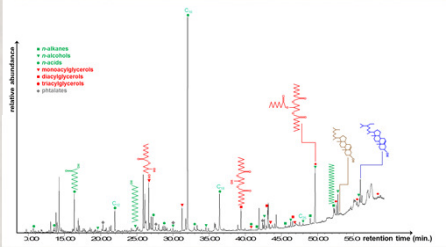
Microphotograph of SU 7

➡ Yellow isotropic aggregate (Y) and charcoals (black, ➡)

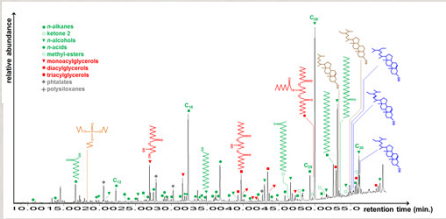


Microphotograph of SU 6

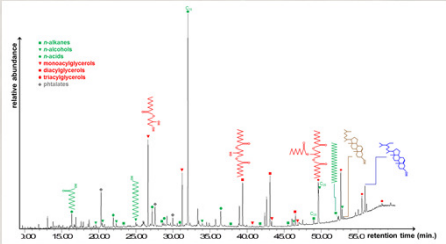
➡ Poaceae phytoliths in anatomical connexion (➡)



Chromatogram of the total lipids extracted from sediment of stratigraphic unit 1inf



Chromatogram of the total lipids extracted from sediment of stratigraphic unit 6



Chromatogram of the total lipids extracted from sediment of stratigraphic unit 8 sup

➡ SU 1 -3 : second phase of the pit infilling : colluvium (scarce & unspecific organic remains)

➡ SU 4 - 7 : first phase of the pit infilling

- micromorphologic & molecular components in agreement with hide preparation
- similar content for the 4 layers ⇔ successive episodes of the same activity
- organic content more diversified than in Saint-Denis ⇔ several/different stages of craft process
- absence of triterpenoids ⇔ different tanning agent ?

➡ SU 8 : sediment + scarce/no anthropogenic components ⇔ no in situ anthropogenic activity

Combined micromorphology & geochemistry :

➡ Identification of tanning activity in archaeological sediments

➡ Complementary tools to precise craft processes for poorly documented periods