



HAL
open science

Characterization, procurement and transformation of iron-rich raw material during Early Neolithic in Northwestern Europe

Aurélie Chassin de Kergommeaux, Vincent Blouet, Marie-Pierre Petitdidier, Emilie Chalmin, Goffioul Claire, Thomas Goovaerts, Ivan Jadin, Cécile Jungels, Thierry Leduc, Quentin Lemasson, et al.

► To cite this version:

Aurélie Chassin de Kergommeaux, Vincent Blouet, Marie-Pierre Petitdidier, Emilie Chalmin, Goffioul Claire, et al.. Characterization, procurement and transformation of iron-rich raw material during Early Neolithic in Northwestern Europe. 43rd International Symposium on Archaeometry (ISA 2022), May 2022, Lisbonne, Portugal. <hal-05003782>

HAL Id: hal-05003782

<https://hal.science/hal-05003782v1>

Submitted on 24 Mar 2025

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

Characterization, procurement and transformation of iron-rich raw material during Early Neolithic in Northwestern Europe

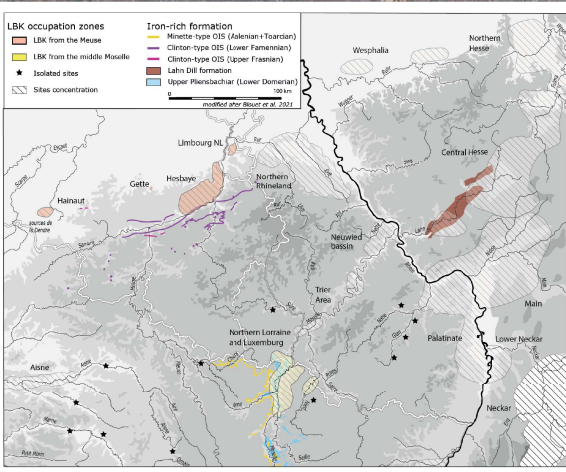
Aurélien Chassin de Kergommeaux¹, Vincent Blouet², Marie-Pierre Petitdidier³, Emilie Chalmier⁴, Claire Goffioul⁵, Thomas Goovaerts⁶, Ivan Jadin⁷, Céline Jungels⁸, Thierry Leduc⁹, Quentin Lemasson^{9,10}, Hélène Salomon¹¹, François Tromme¹⁰, Eric Goemaere¹²
¹EDSITEM (UMR 5204) Univ. Savoie, CNRS, France, ²INRAP, France, ³SRA Grand Est, France, ⁴Service de l'Archéologie de la Diffraction de Liège, AWAP, Belgium, ⁵Geological Survey of Belgium, RBINS, Belgium, ⁶Anthropology and Prehistory, Quaternary, OD Earth and History of Life, RBINS, Belgium, ⁷Préhistomuseum, Belgium, ⁸O2RMF, Ministère de la Culture, France, ⁹New AGLAE (FR 3506), France, ¹⁰CETREP, Les Chercheurs de la Wallonie, Belgium
 corresponding author: aurelien.chassin-de-kergommeaux@univ-smb.fr



Hematite crystals and (red to black) hematite-rich stones (sedimentary, metamorphic or weathered rocks) and ores, with high colouring strength have been intensively used throughout prehistoric times [1]. In Northwestern Europe, at the beginning of the Neolithic period, oolithic ironstones (OIS) were commonly used [2]. Despite red OIS being absent in most of the LBK (Linear Band Keramik) settlements of the French Lorraine (Moselle valley and tributaries), this early exploitation is documented especially in Belgium (Hesbaye and Dendre springs areas), the Netherlands (Maastricht area) and France (Normandy) [2]. But a (wide) variety of non-oolithic black-red stones are also found besides the OIS and/or including yellow to red iron-rich siltites and concretions, often in lower quantities. The « red » or black-red material frequently shows wear traces of abrasion (flattened surfaces and faceted pieces sometimes showing striations). In all sites, smaller angular fragments with no clear evidence of use are also found. In some places, grindstones, which are reused broken querns made out of various sandstones, show remnants or coating patches of red powder. Collections of iron-rich raw material from around eight sites in Hesbaye and thirteen in Lorraine were studied.

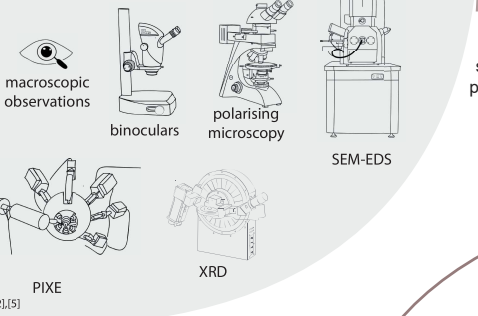
This research is focused on:

- the sourcing of the hematitic items through the identification of fingerprints;
- the methods of red powder production, especially with the possibility of heating iron-sulphides, goethite-rich siltites and iron-rich concretions,
- the common material between the Hesbaye and Lorraine areas.



Methods

All types of red artefacts found in Hesbaye and French Lorraine have been characterized through studies at macroscopic to elemental scales thanks to petrological and physico-chemical analyses.



Localisation of the geological formations identified as the plausible sources for the iron-rich raw material retrieved from Early Neolithic sites in Hesbaye (Belgium) and Lorraine (France) region (modified after the geological maps from the BRGM and GSB and Blouet et al. 2021 [3,4]).

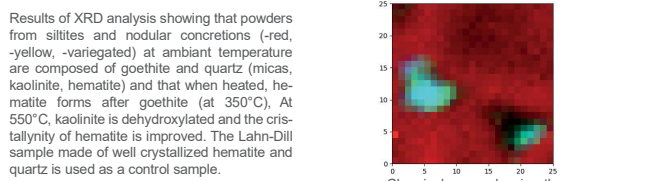
Results and discussions

The artefacts from the Hesbaye (Darion, Bierset, Horion-Hozémont, Alleur, Vaux-et-Borset, Hologne-Bonniers, Oleye Al Zèpe, Vieux-Waleffe) and Lorraine (Ay, Malling, Bouzonville, Ennery, Montenan Kirschgasse, Tremery, Metz nord site 43, Grandrange les Bréquettes site 10, Florange, Cattenom, Koenigsacker, Uckange, La Maye, Terville) settlements have been classified into 19 facies according to their petrography, chemistry and mineralogy. These 19 facies reflect the lithological variability of at least 7 geological formations.

	No heating							
	A-red	A-yellow	B-Lahn Dill	D-yellow	E	F-variegated	F-red	G-yellow
Goethite	29.9	79.9	-	90.8	40.8	31.1	-	73.8
Fe(OH)	-	-	-	9.4	-	-	-	-
Hematite	47.5	-	37.4	-	26.5	23.2	69.7	-
Quartz	3.2	0.9	62.8	-	22.5	16.8	8.2	9.2
Muscovite	19.3	19.2	-	-	10.2	19.4	22.2	9.6
Kaolinite	-	-	-	-	13.5	-	-	7.4

*Quartz peak overlaps with goethite peak

	After heating at 350 °C							
	A-red	A-yellow	B-Lahn Dill	D-yellow	E	F-variegated	F-red	G-yellow
Goethite	-	-	-	-	-	-	-	-
Hematite	83.68	69.5	97.1	93.4	69.7	51.8	80.7	34.4
Quartz	4.68	7.1	62.9	5.6	18.4	19.6	12.3	22.4
Muscovite	11.64	present	-	-	13.9	20.1	-	27.8
Kaolinite	-	3.4	-	-	-	8.5	7	15.4



Detrital

- siltite**
 - argillaceous: fine-grained rocks with grains < 63 µm, soft touch, ochre yellow to red colour, homogeneous, rare traces of pedogenesis.
 - micaceous: fine-grained rocks with grains < 63 µm, mica-rich, ochre red to red-violet colour, homogeneous, parallel stratification, polygonal fractures, rare dehydration crack.
 - fine to medium: grains > 63 µm, mica-rich, red violet, hematised cement, low apparent porosity, low apparent density.
 - coarse micaceous: grains > 125 µm, red-orange powder, subrounded to rounded quartz grains, medium apparent porosity, white micas, deep red-violet colour, low apparent density.
 - pink quartzite: quartzite by dissolution under pressure, hematite-rich interstitial cement, feldspar and banded micas.
 - cobble of red thin grained rocks: very fine grained rock, strong schistosity, red to variegated, debitage in thin flakes, quartz and mica possible.
- sandstone**
 - Permian - Trias - Jura: coarse micaceous, red and black, red and black, soft red.
- conglomerate**
 - angular elements: red-violet argillaceous matrix, shaly luster and schistosity, red-violet argillaceous matrix with subrounded black schistosed lithoclasts with a silvery luster, matrix lithoclasts, lithoclasts oriented along the schistosity plane, lithoclasts composed of tabular hematite crystals.
 - angular elements: red-violet argillaceous matrix with angular lithoclasts, black lithoclasts with a silvery luster composed of tabular hematite crystals, yellow finely grained lithoclasts, matrix - lithoclasts.

Diagenetic hematite

- Lahn Dill formation: massive hematite and goethite, high porosity - vacuoles (cm), low apparent density, composition of Si/Fe.
- Upper Pliensbachian (Upper Domesian): homogeneous, deep black, silvery luster, strong schistosity, red powder inbetween, high apparent density.
- Permian - Trias - Jura: flame-shaped siliceous matrix, red siliceous lithoclasts, red matrix - flame shaped, differential weathering black spots (tabulated hematite), red powder inbetween, oriented black spots (schistosity planes).
- Endovionien: red-violet siliceous, shaly luster and schistosity, moderate to poor very fine grained schistosity, porosity can be high with little black lithoclasts with a silvery luster, red powder, matrix >> lithoclasts.
- Devonian, Famenian ex-Amy: red-violet argillaceous matrix with subrounded black schistosed lithoclasts with a silvery luster, matrix lithoclasts, lithoclasts oriented along the schistosity plane, lithoclasts composed of tabular hematite crystals.
- Upper Pliensbachian (Upper Domesian): low apparent density and high apparent porosity, black with a tendency to purplish hues, sometimes botryoidal aspect, red pulverulent weathering.

Botryoidal hematite

- Fe-Pb-Zn mineralization: massive, porous.

Nodular concretion

- septarian nodule: massive rock with a high apparent density, homogeneous deep black with a tendency to purplish hues or red and black panaches, botryoidal structures visible with bare eyes, automorph (some bipyramidal), translucent, non colored or purple quartz in pores inbetween botryoids.
- concretion: depending of the heacons or complete, concentric colouring zonation, the core can be richer in silt, rare bioturbations and bright red (weathered) mesofossiles or red to trace.

OIS

- Clinton type: iron-rich OIS (hematite), dominated by black violet to red, other poster of this session: Chassin de Kergommeaux et al.
- Devonian, Famenian ex-Amy: iron-rich OIS (goethite), few ferruginised cement or translucent calcite, suggested almond shaped round ooids, black to brown ooids with a shiny patina.
- Permian - Trias - Jura: iron-rich OIS (hematite), dominated by black violet to red, other poster of this session: Chassin de Kergommeaux et al.

Chemical maps showing the higher Si content of the clasts in a red and black diagenetic hematite (PIXE 202-p3, Bierset; red = Fe, green = Si)

Geological description of the precise unit holding the iron-rich concretions and siltites in the Upper Pliensbachian stratigraphy.

Conclusions

The characterisation of the artifacts shows a common pattern - a double strategy of acquisition of the colouring raw material:

- a majority of local materials (Famenian OIS in Belgium vs nodules and siltites in Lorraine),
- Material from the Lahn-Dill are in Germany occur both in Belgian and Lorraine settlements area. Largest faceted pieces and raw blocks only occur in French Lorraine.

However, the use of OIS material should not be understated: it is common in the Belgian collection but rare in Lorraine while minette-type OIS is abundant in the landscape in Lorraine (goethite-rich OIS, yellow). Indeed, in Lorraine, just 2 artefacts in this material were found in the excavations against 7 artefacts in the Belgian Famenian OIS. This could be explained by the colour of the powder produced, brown yellow for the minette while dark red to red violet for the Famenian OIS. Furthermore, while the concretions and siltites were thought to be heated to get the red hues, experimentation and XRD analyses showed that the red hues are probably due to surface weathering plus a possible differential ageing of the iron-hydroxides in the geological formation. Thus, it is possible to say that these Early Neolithic societies used majoritarily 3 types of iron-rich raw material with different colours:

- deep intense red colours with the Lahn Dill hematites,
- red colours with Famenian OIS,
- yellow to light red colours thanks to the Upper Pliensbachian concretion and siltites.