Iron production management: a case study of bloomery iron production at Hlebine – Velike Hlebine and Dedanovice site

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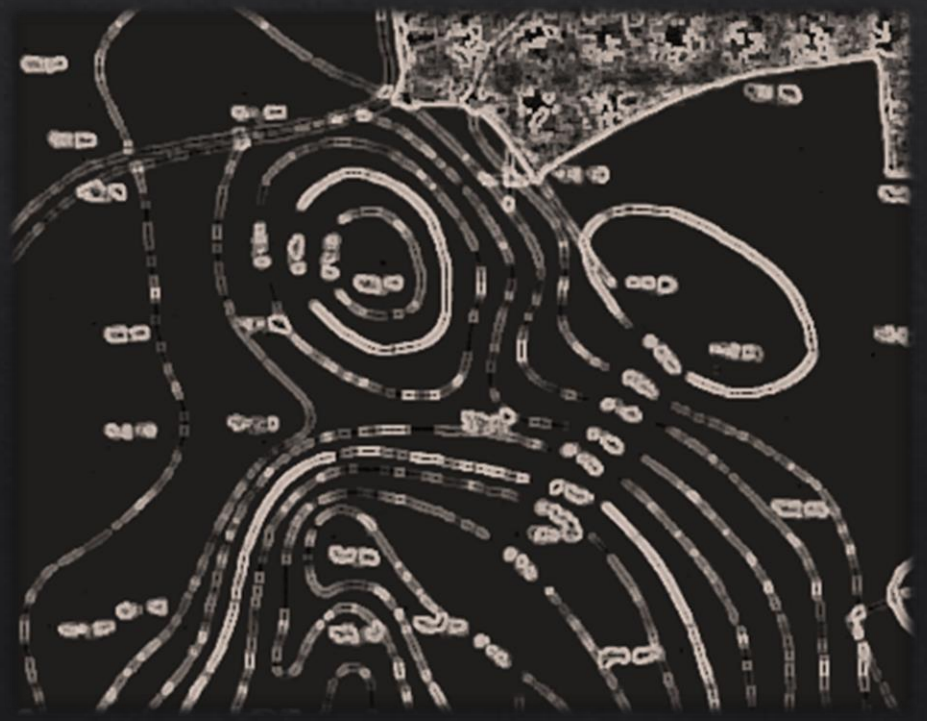


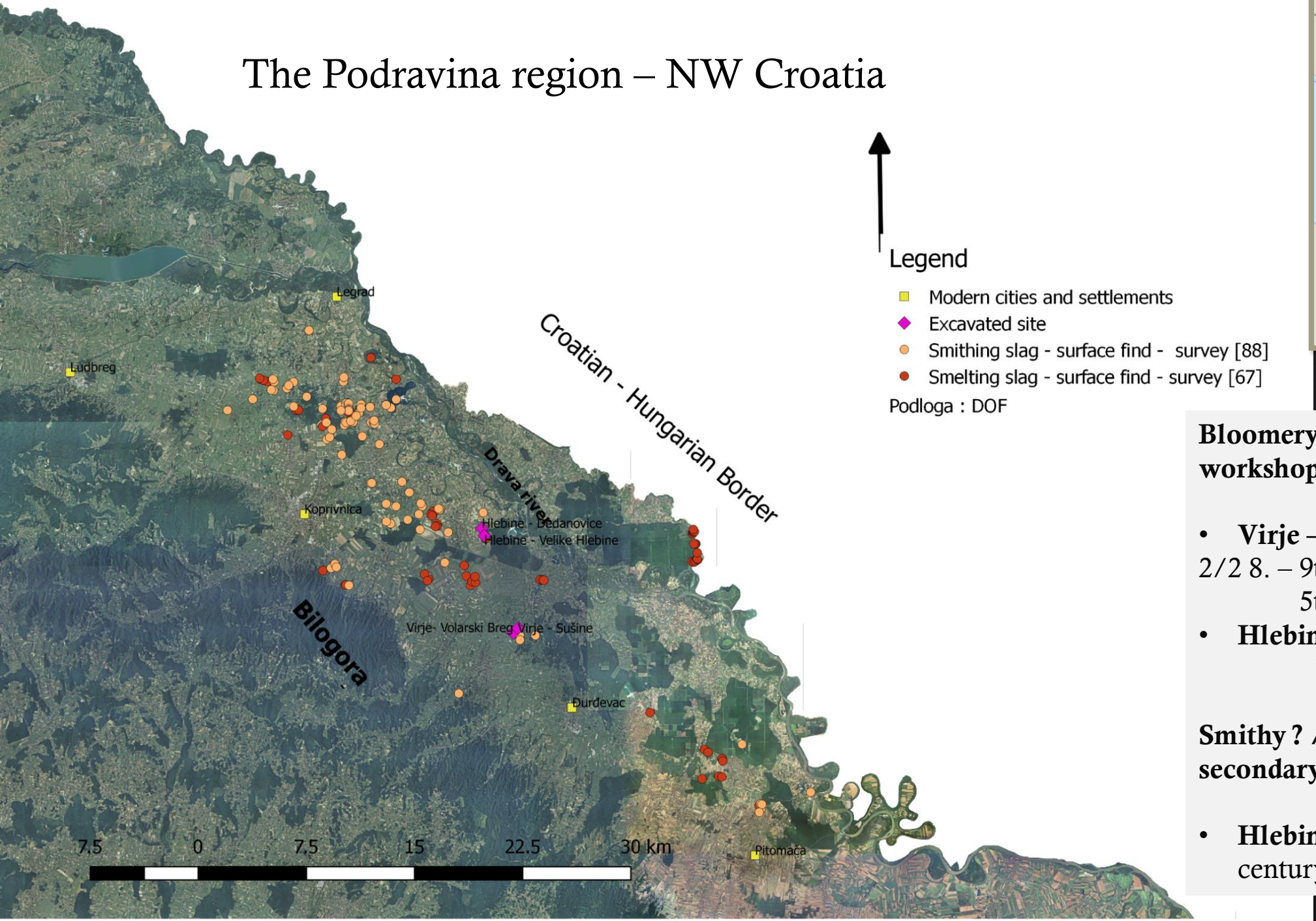
7th International Conference on Medieval archaeology
Secrets of iron – from raw material to an iron object

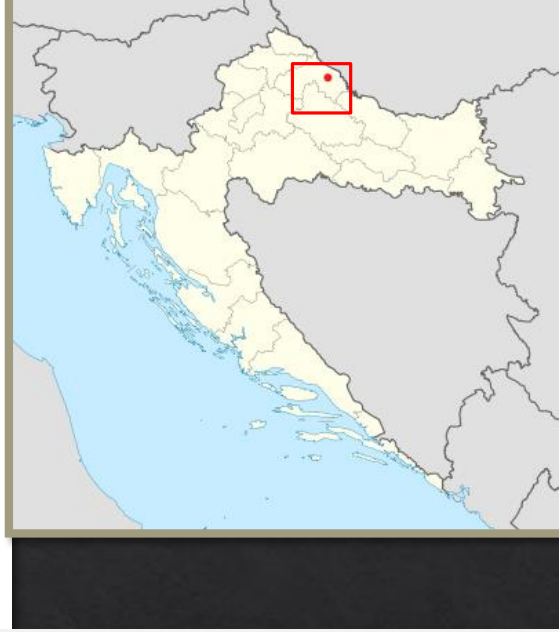
Zagreb, September 10 – 11th 2020.

HRZZ Hrvatska zaklada za znanost

TransFER

The Podravina region – NW Croatia



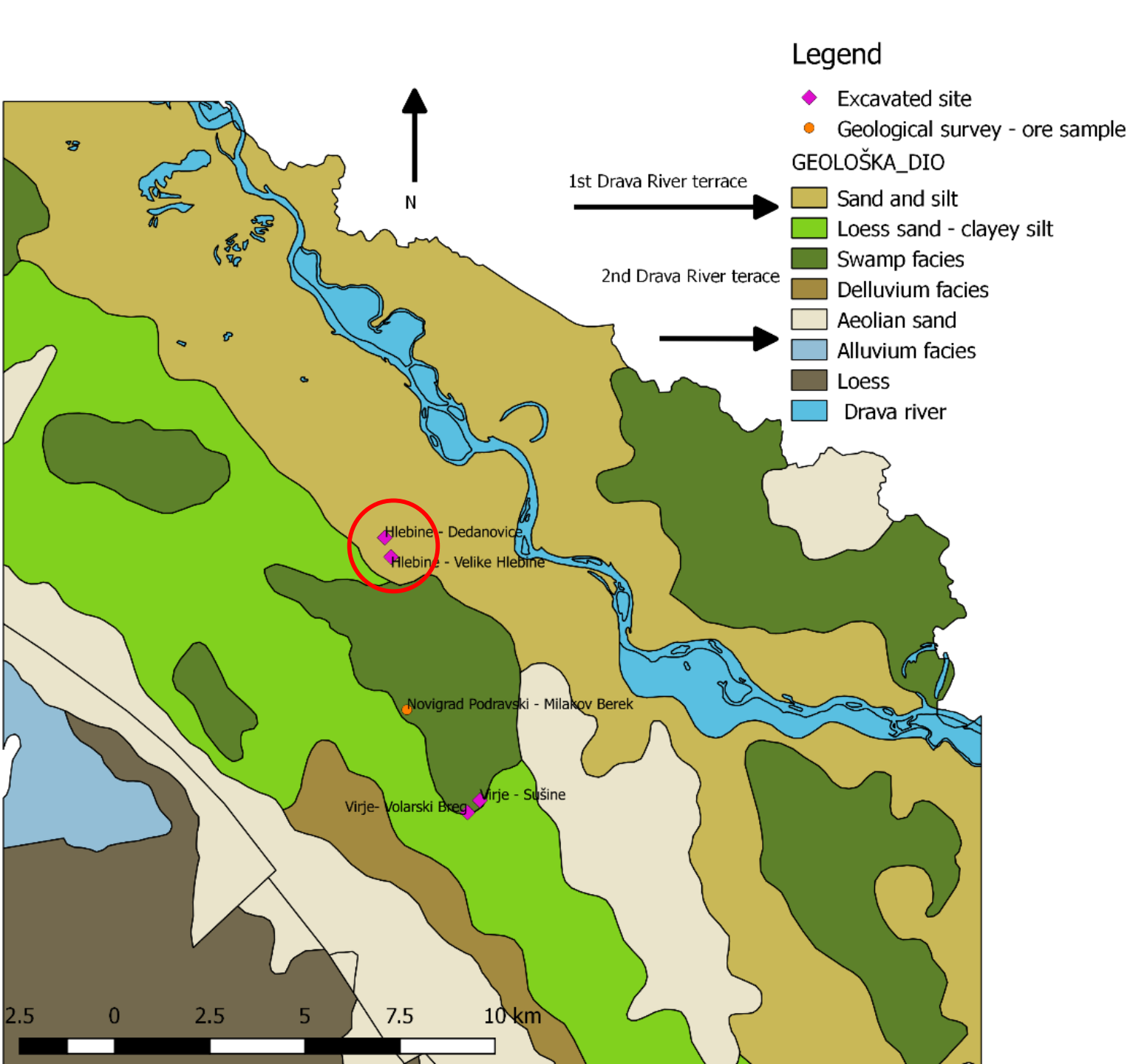


Bloomery // Iron production workshop

- **Virje – Volarski breg & Sušine**
  2/2 8. – 9th century
  5th century
- **Hlebine – Velike Hlebine**
  ½ 7.th century

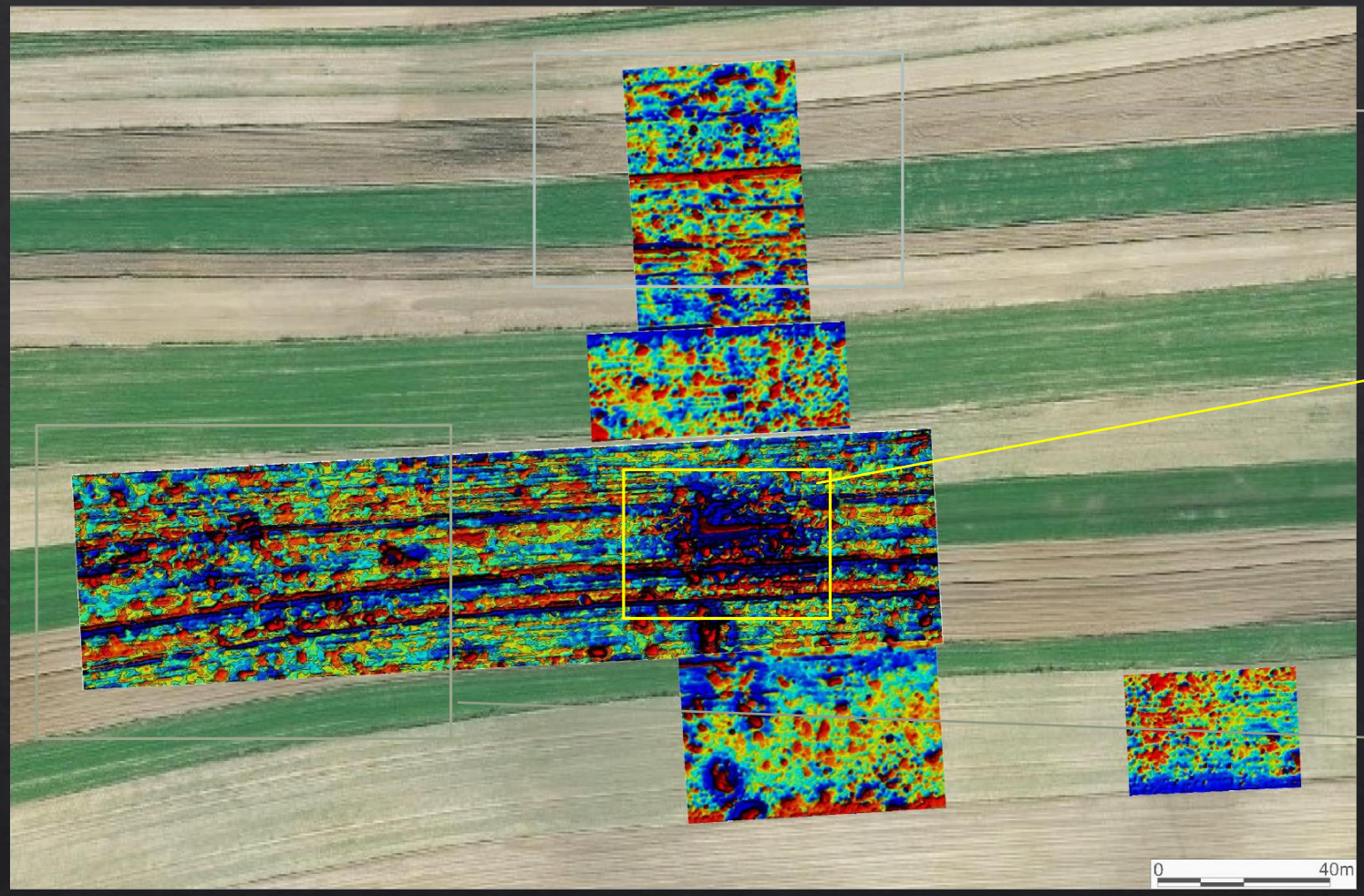
Smithy ? // primary and/or secondary smithing furnaces

- **Hlebine – Dedanovice** ½ 7th century



- edge of the flooding plain
- 2nd Drava river terrace – elevation change
- Boggy - marshy areas in vicinity – ore exploatation area?

Hlebine – Velike Hlebine site



Settlement, 8/9th century

Smelting workshop, 7th century

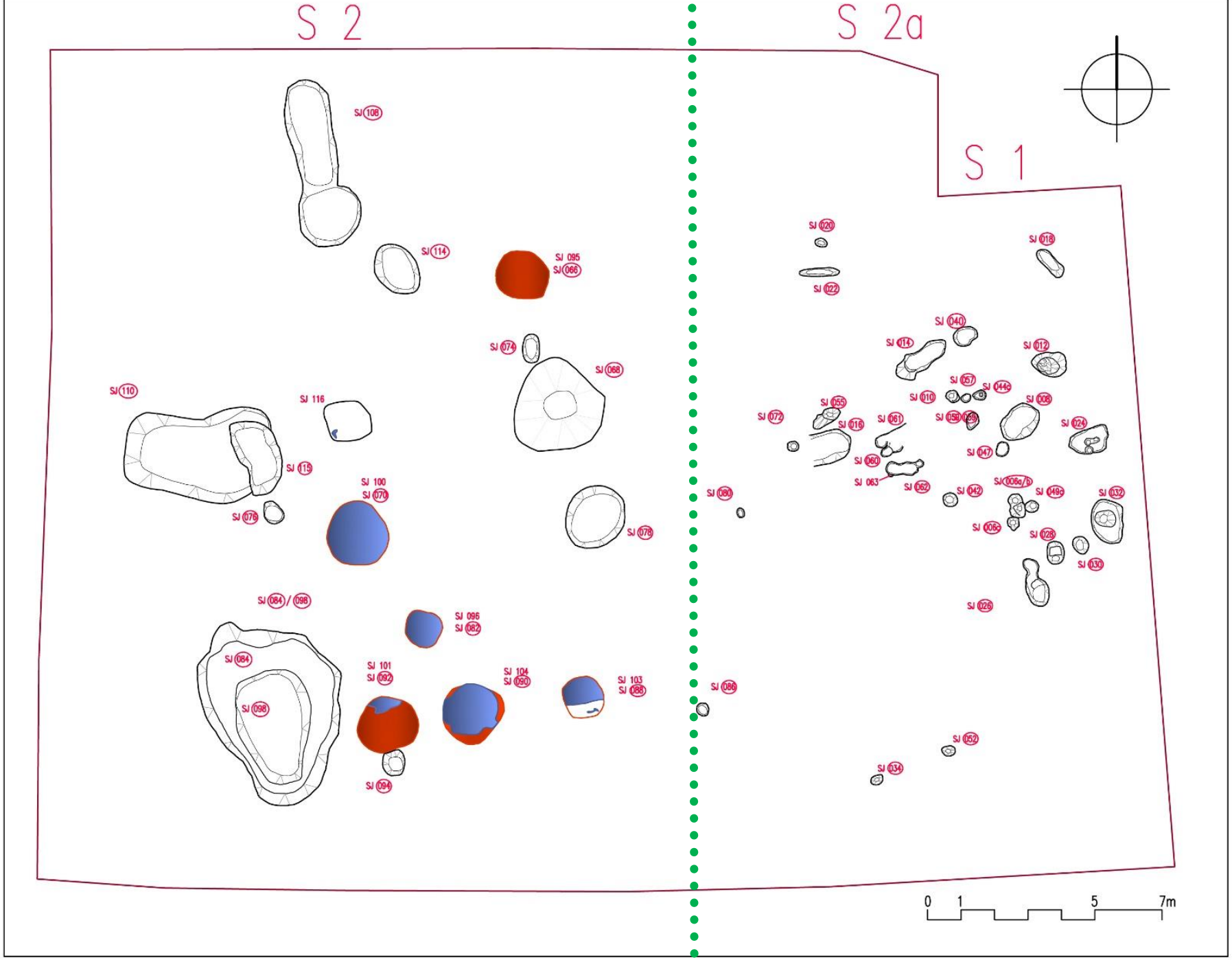
Settlement, unknown datation (prehistory?)

Results of magnetometry (Geometrics G-858), background : aerial photography (DOF).

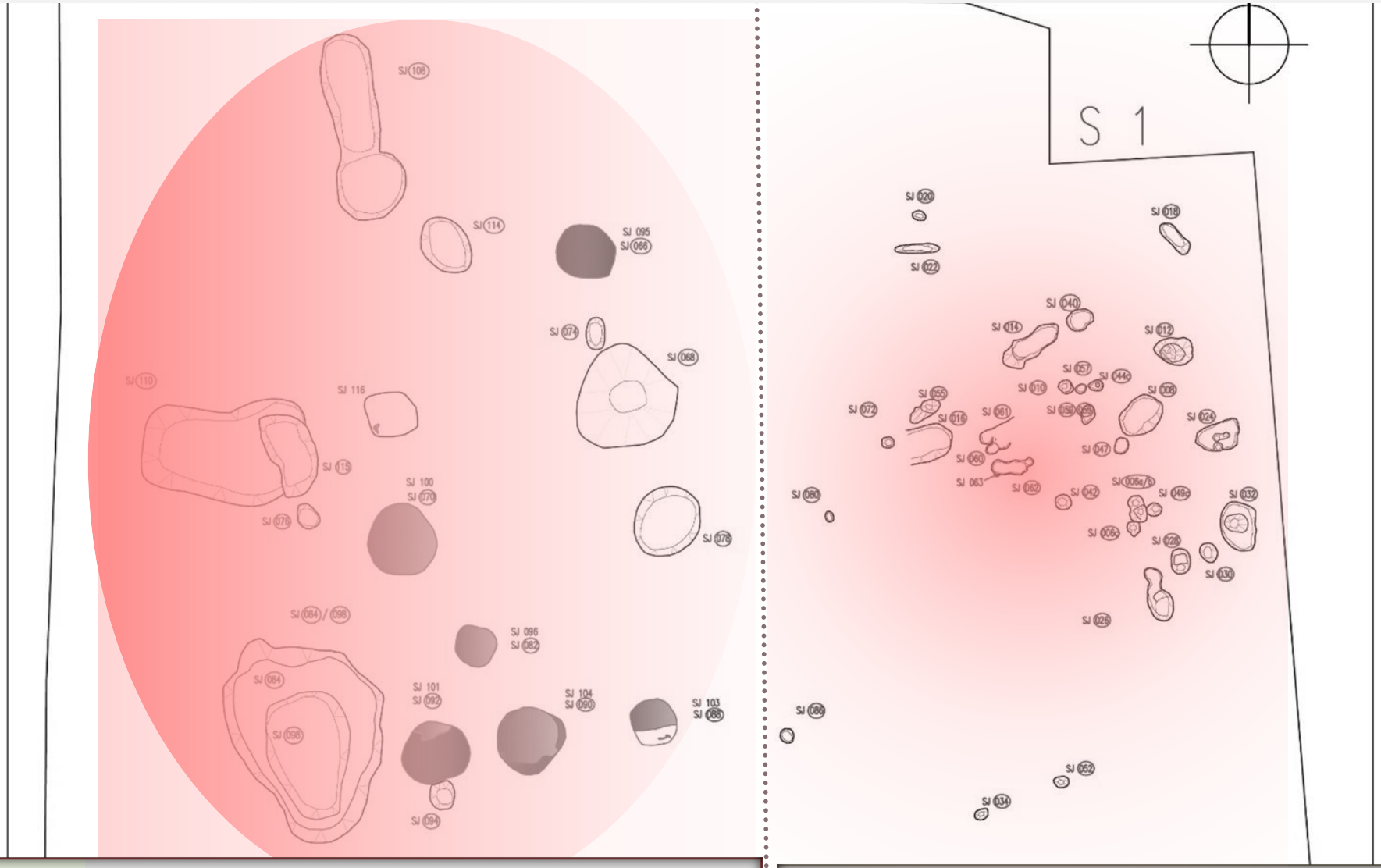
- Areas of extra high magnetic anomalies are concentrated on the place where a high concentration of surface slag was found.
- Cluster of low magnetic anomalies can be interpreted as pits without iron production debris. (Mušič, B., Medarič, I., Matijević, F., 2016 -2017.)

Ground plan, Hlebine - Velike Hlebine site, excavation 2016 – 2017

(made by: K.Turkalj)

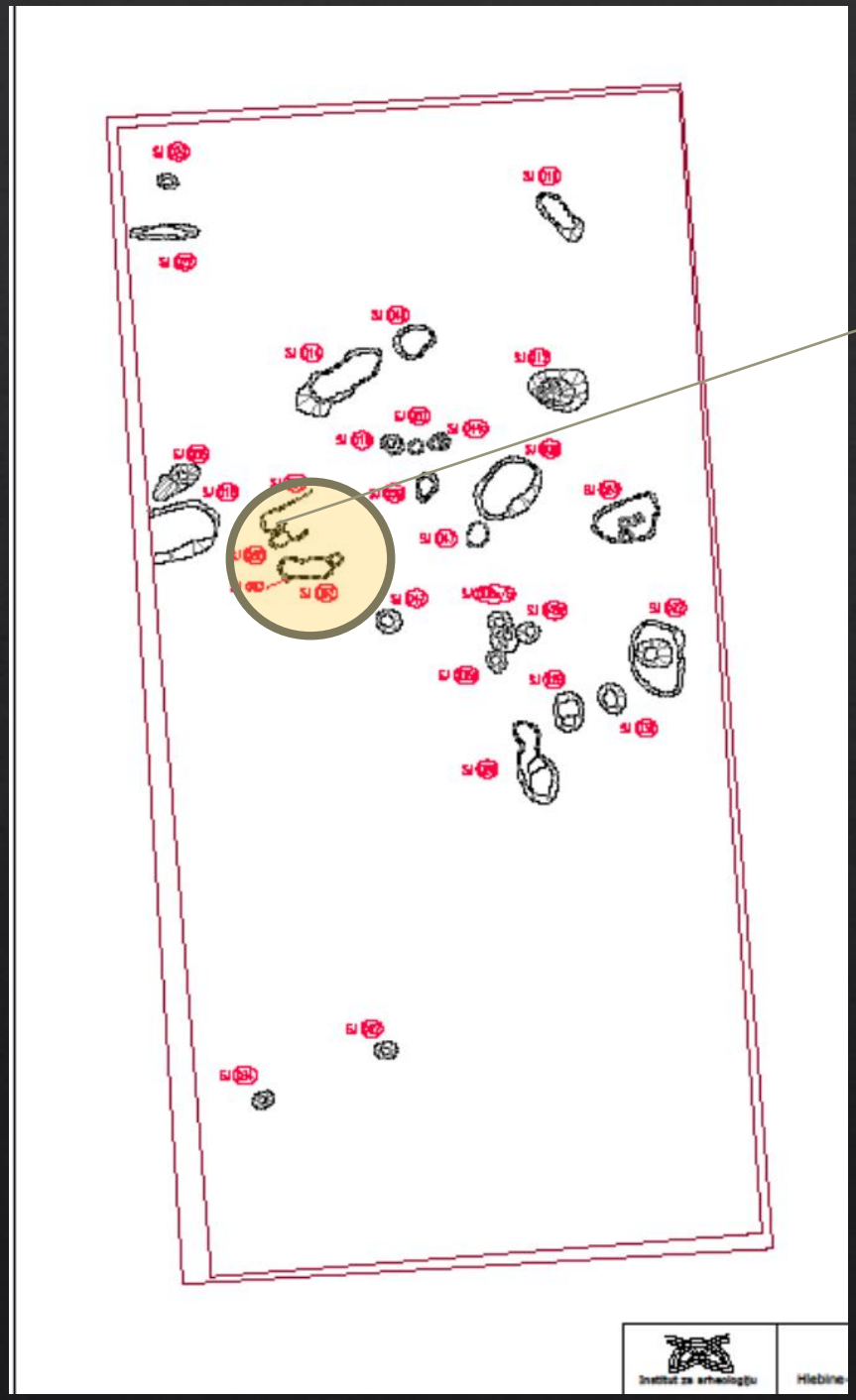


Spatial distribution of archaeological features and density of occurence of indicative finds



Type	Mass/ kg	Total waste %	density kg/m2
Slag/Fe/	382.98	81	0.61
Technical ceramics/furnace walls/tuyere	200.64	93	0.32

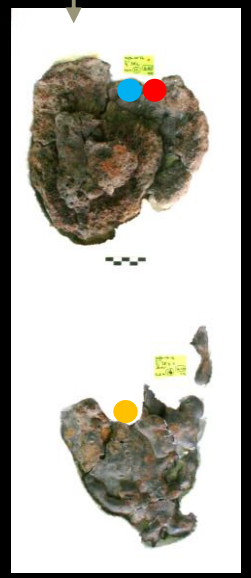
Mass/ kg	Total waste %	density kg/m2
90.90	19	0.44
15.08	7	0.07

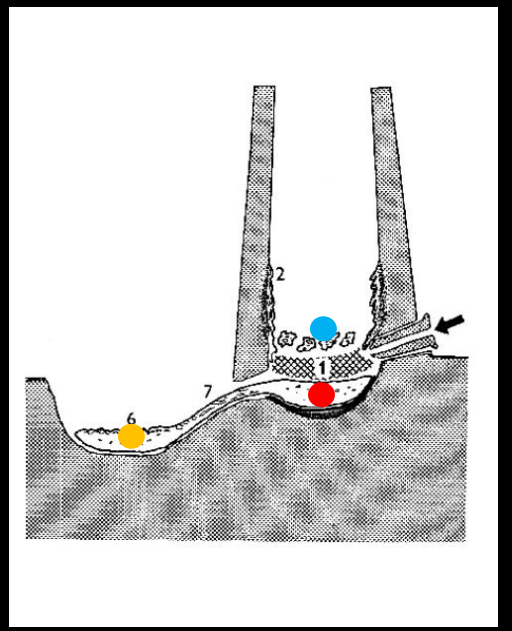


Remains of the funaces with slag *in situ*

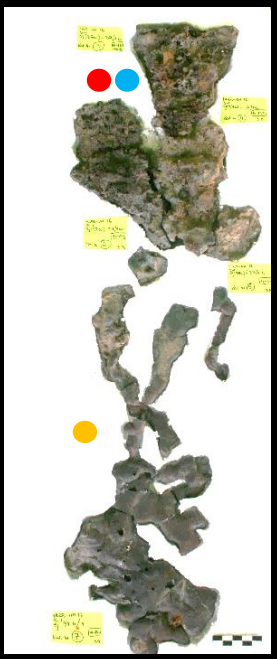
(SU 038/38-1

SU 037/ 37 -1)





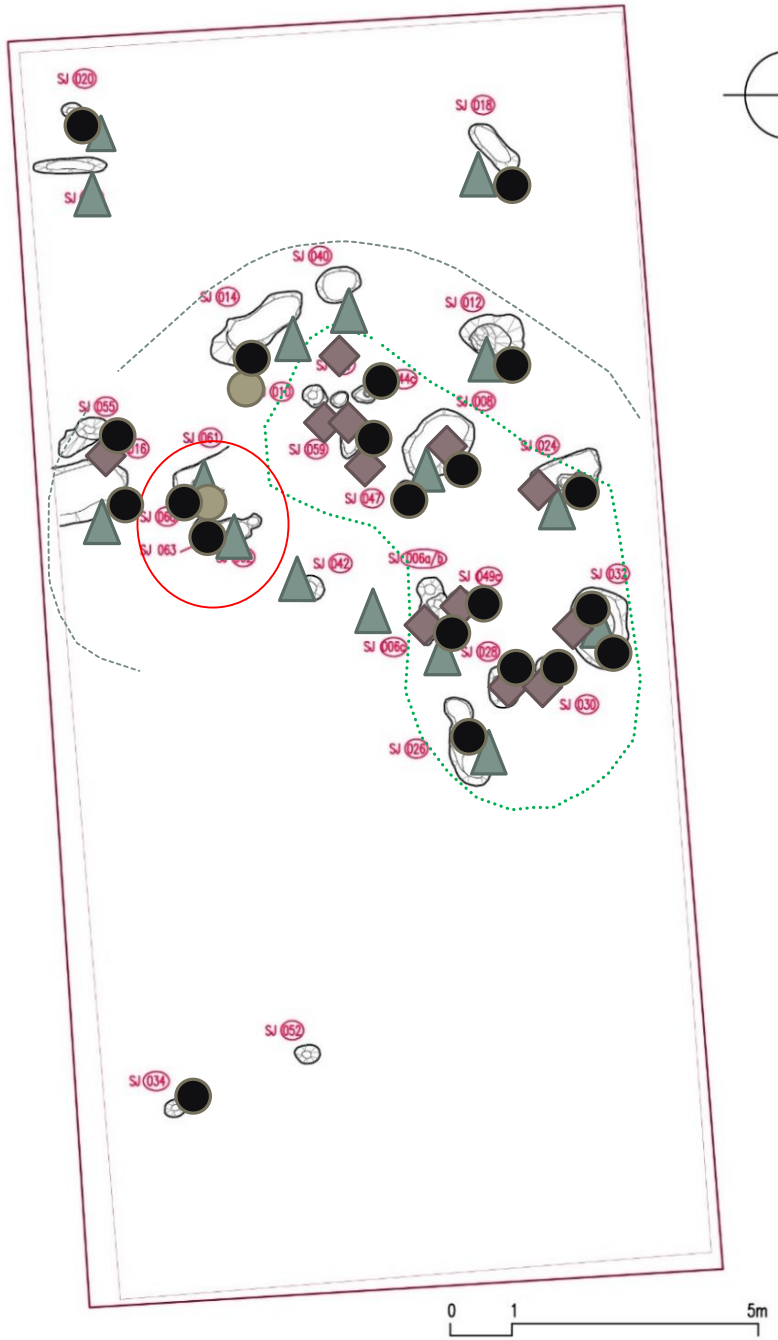
Free standing shaft, flat-hearth tapped furnace (Pleiner 2000: 258,fig.67)



SU 5a, N, 128, U 14

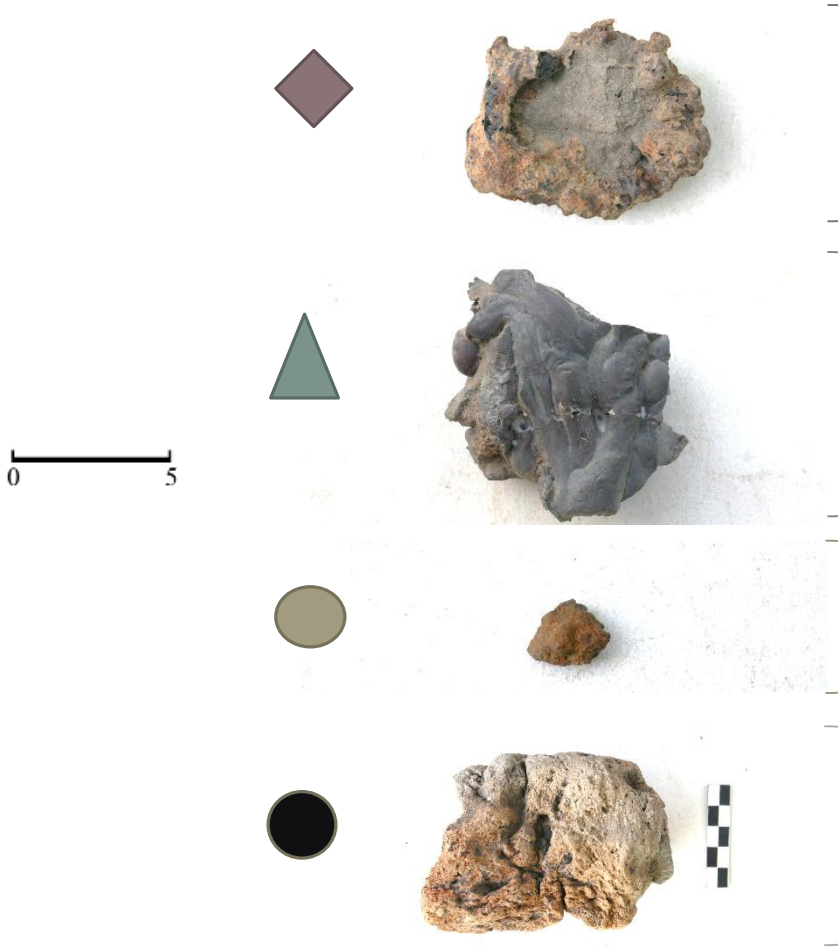
Incorporated:

Hammercale
Spheres of slag



Ground plan, Hlebine - Velike Hlebine site, excavation 2016 (made by: K.Turkalj)

Distribution of finds – eastern part



Post reduction slag – bloom refining/smithing?

Smelting slag
Tap slag
Furnace bottom slag
Furnace slag

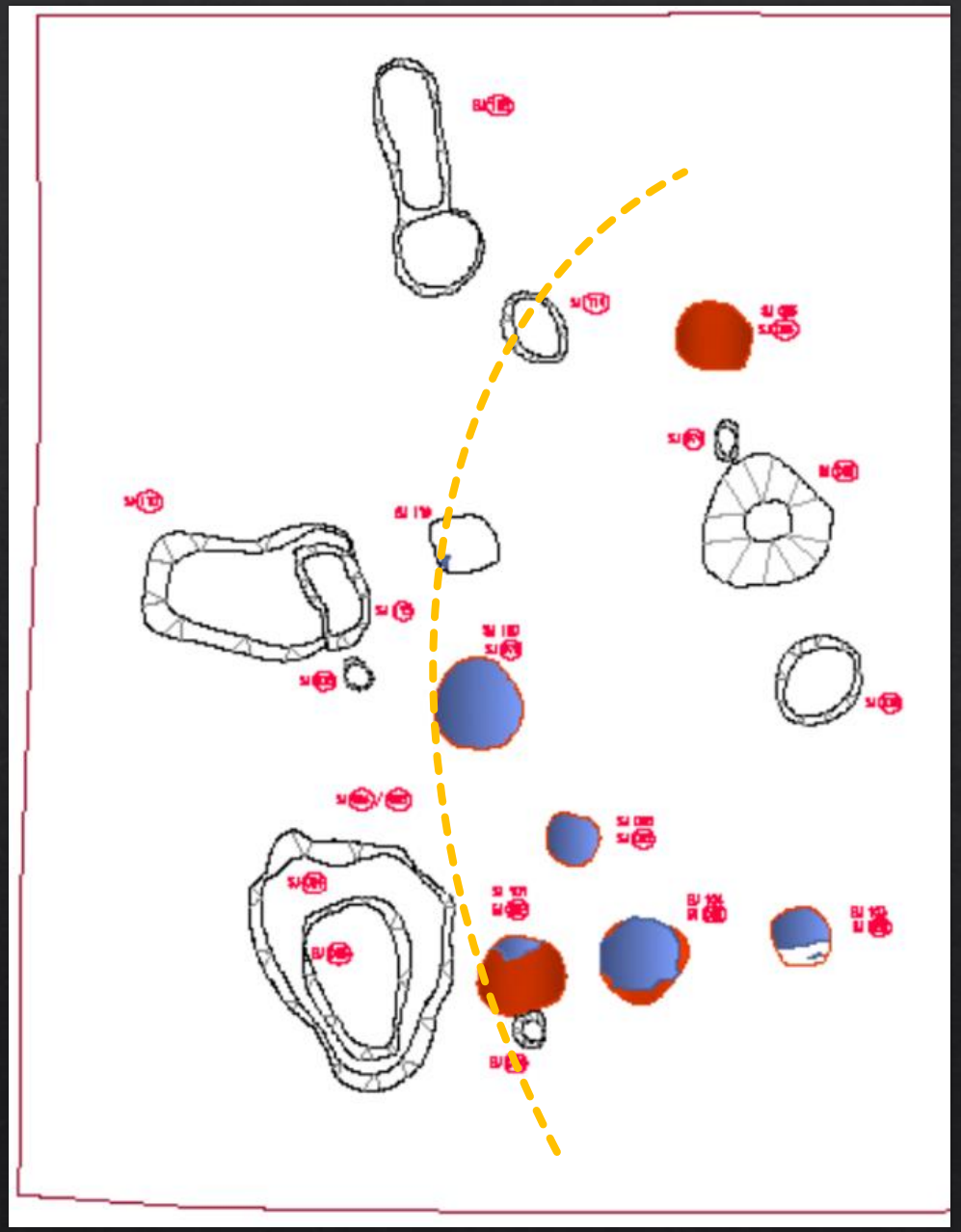
Roasted bog iron ore

Furnace walls/ tuyeres

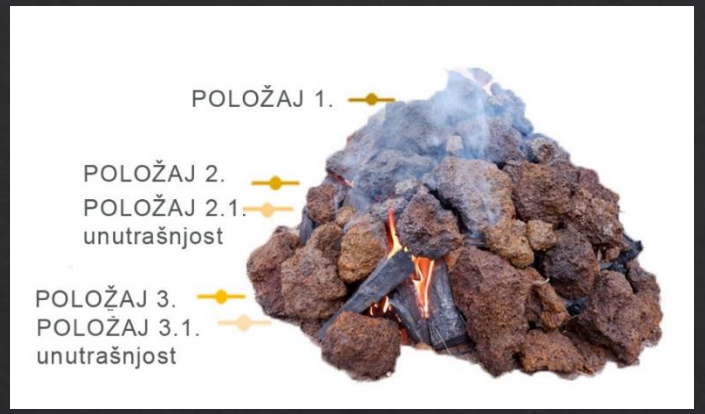
Distribution area – operating space

- Smelting
- Bloom refining – compacting and/or primary smithing
- Storage area (temporary) – ore & charcoal

Western part: archaeological record



Ground plan, Hlebine - Velike Hlebine site, excavation 2017 (made by: K.Turkalj)

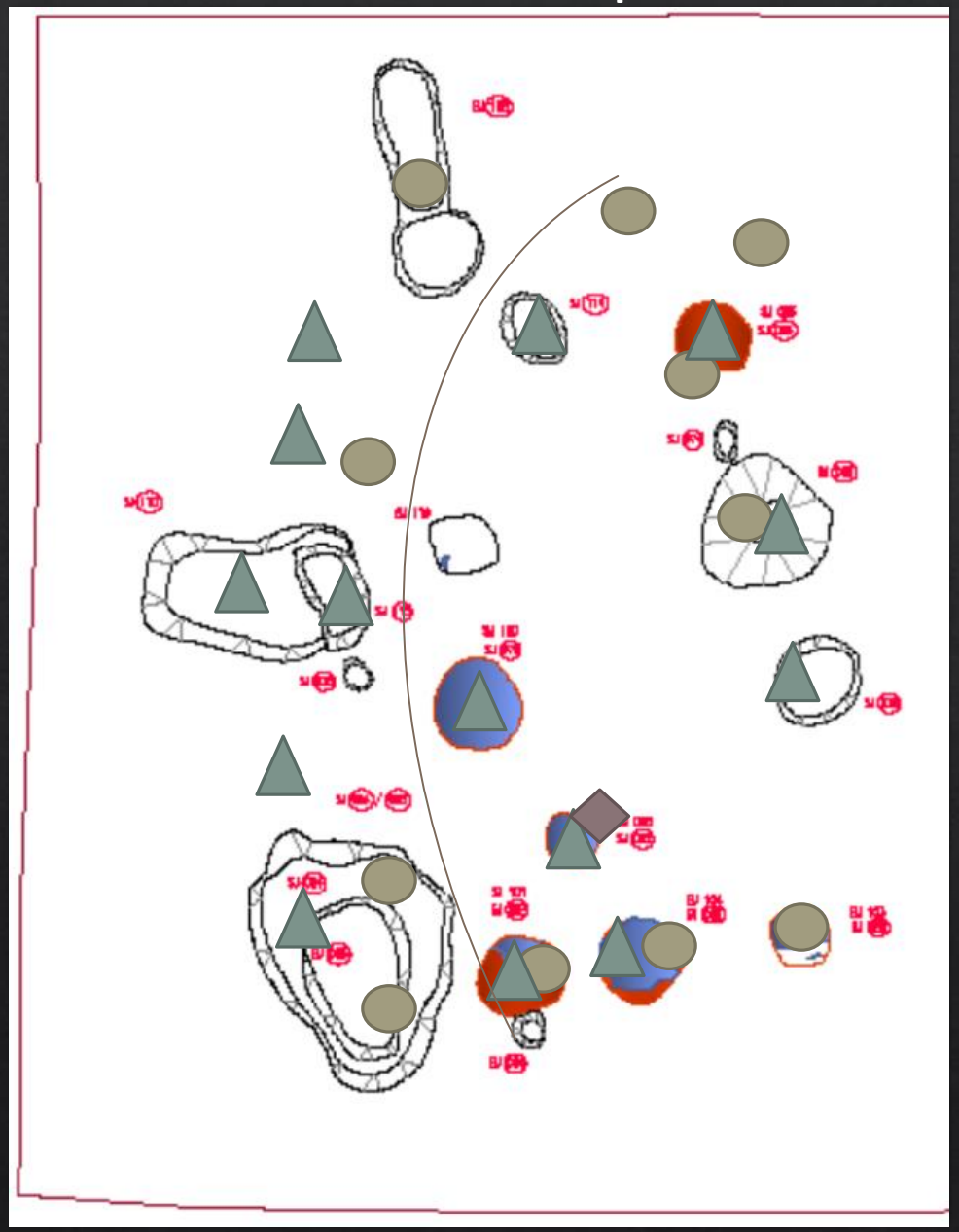


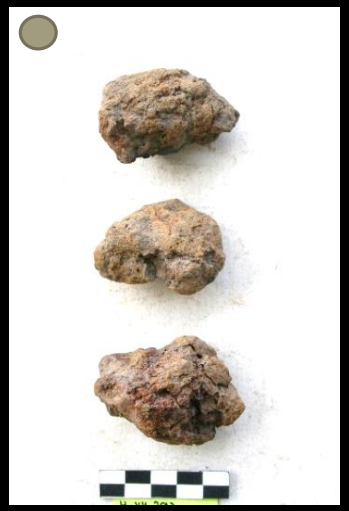
- 811 – 812 °C
(max range 701 – 891 °C)
- 2h

Traces of experimental roasting

11th IRON SMELTING WORKSHOP 2019: FROM THE SOIL TO THE IRON PRODUCT, Somogyfajsz, Hungary 2019.

Distribution of finds – western part





Bog iron ore (unroasted and roasted)

Smelting waste

- Tehnical ceramics
- Smelting slag

Bloom refining /primary smithing slag

Distribution – structured workspace

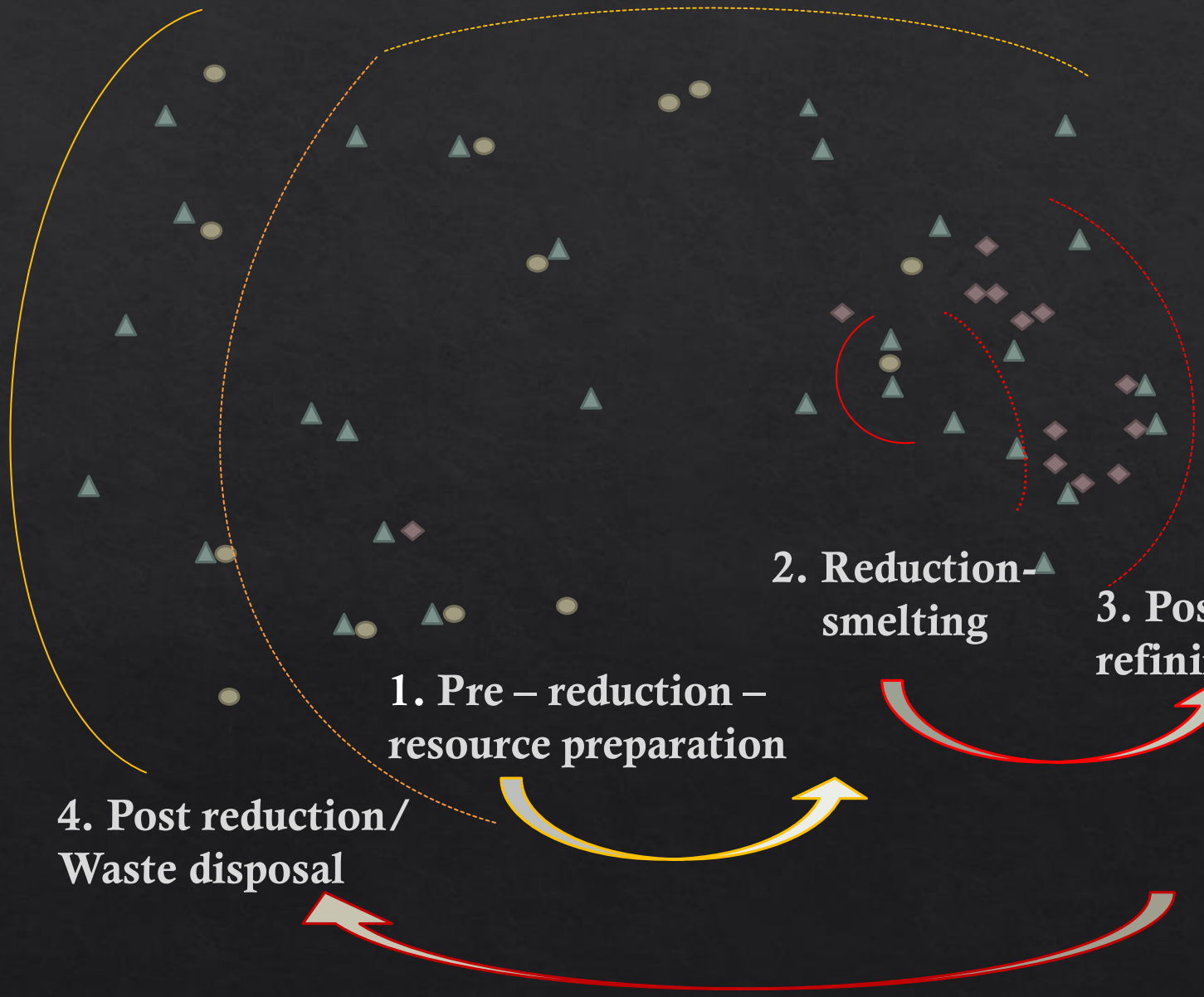
- Prereduction : Roasting of iron ore
- Postreduction: Waste discarding area (382 kg)

Spatially divided concentrations of waste – seasonal/campaign use of workspace

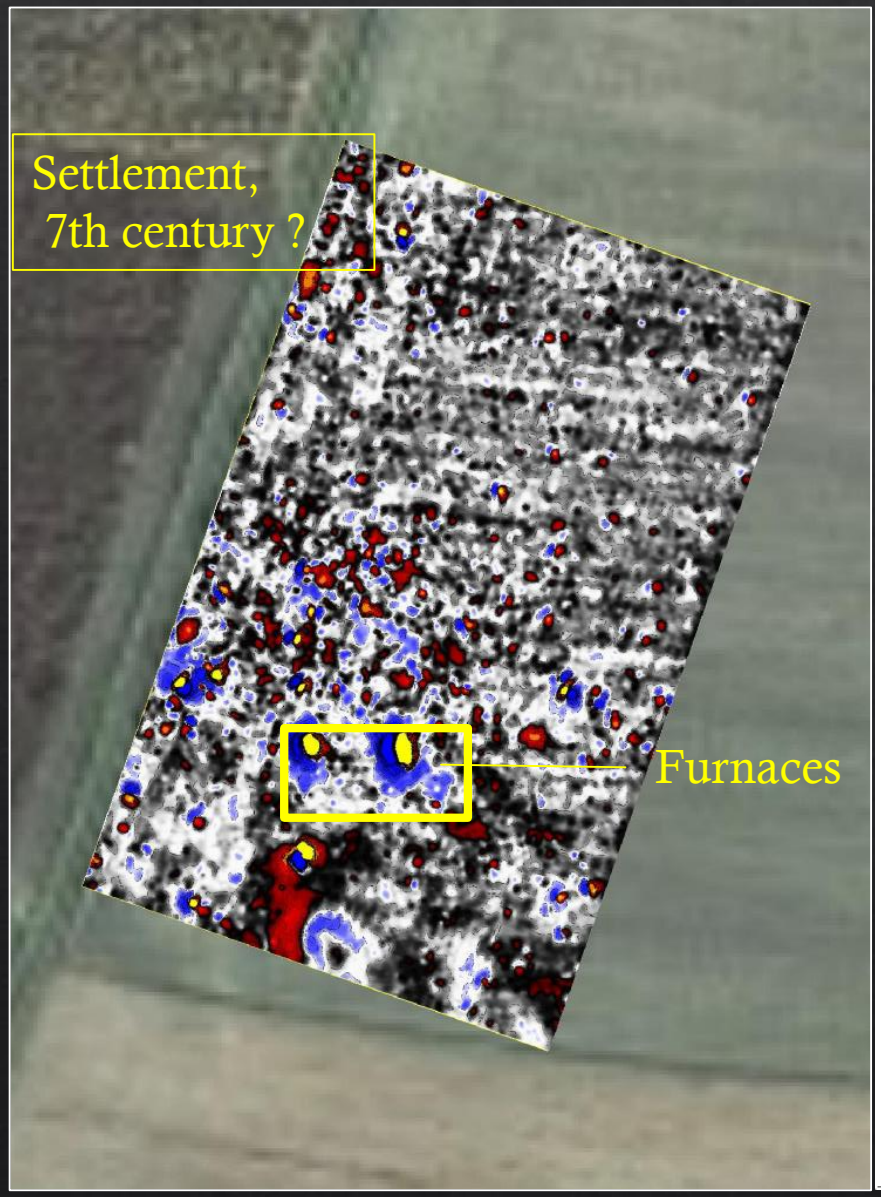
Spatial organisation of the workshop

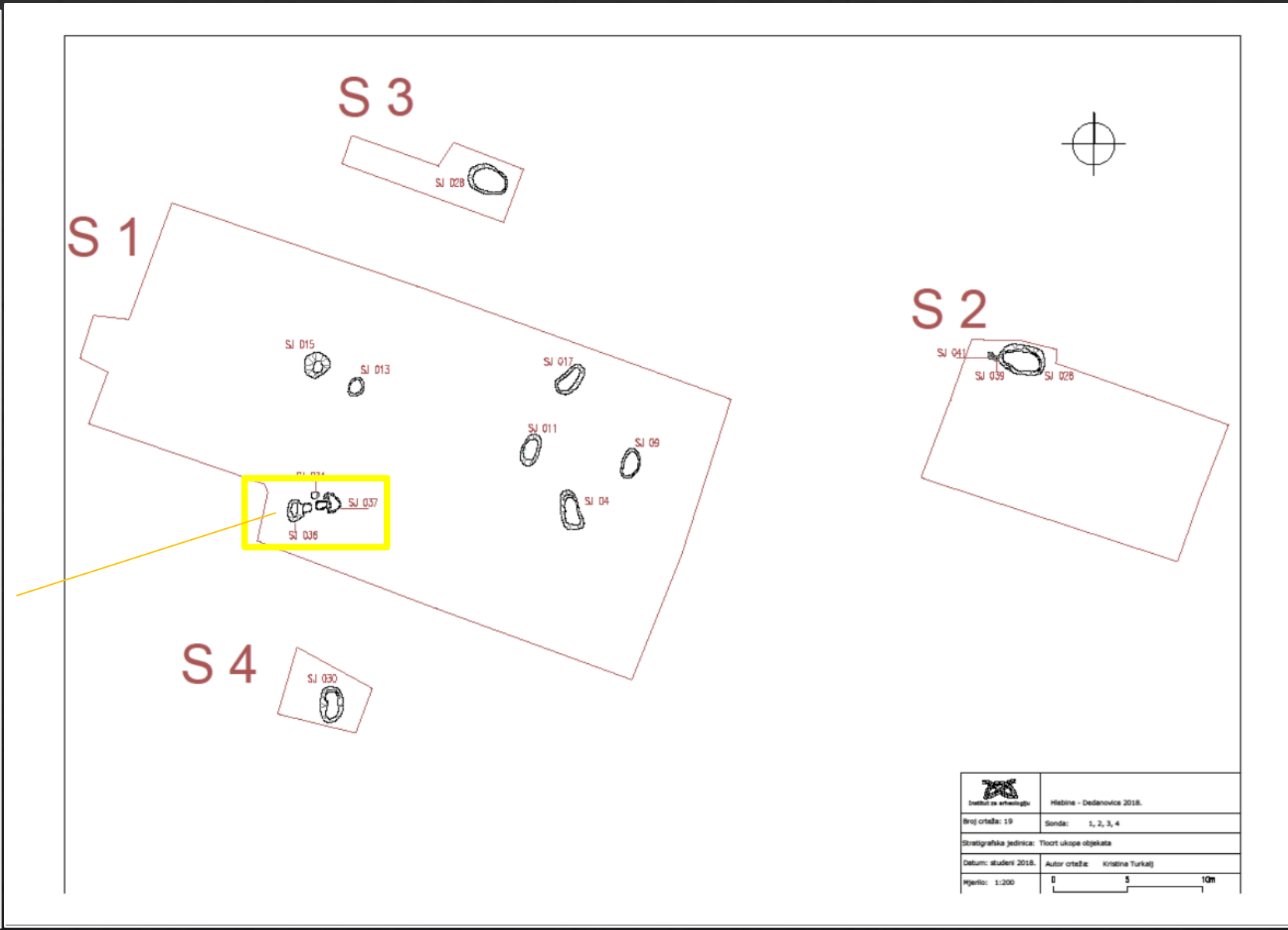
In situ slag= 1 smelt

Total smelting waste =
117 smelts/time span?



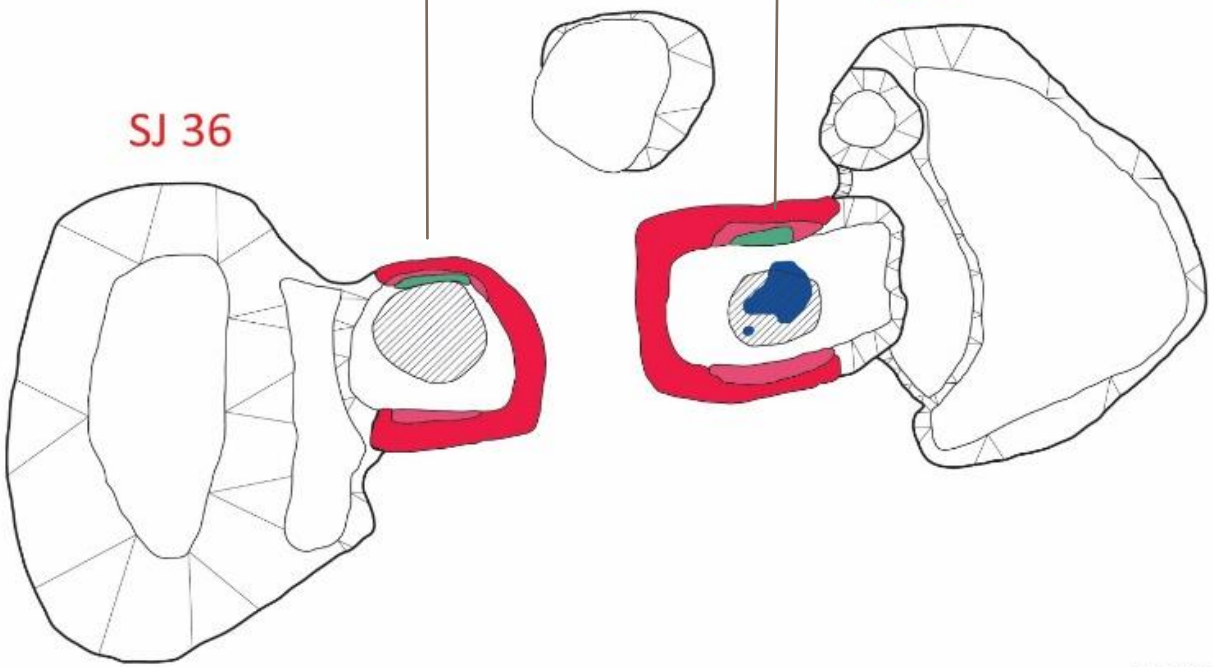
Hlebine – Dedanovice site

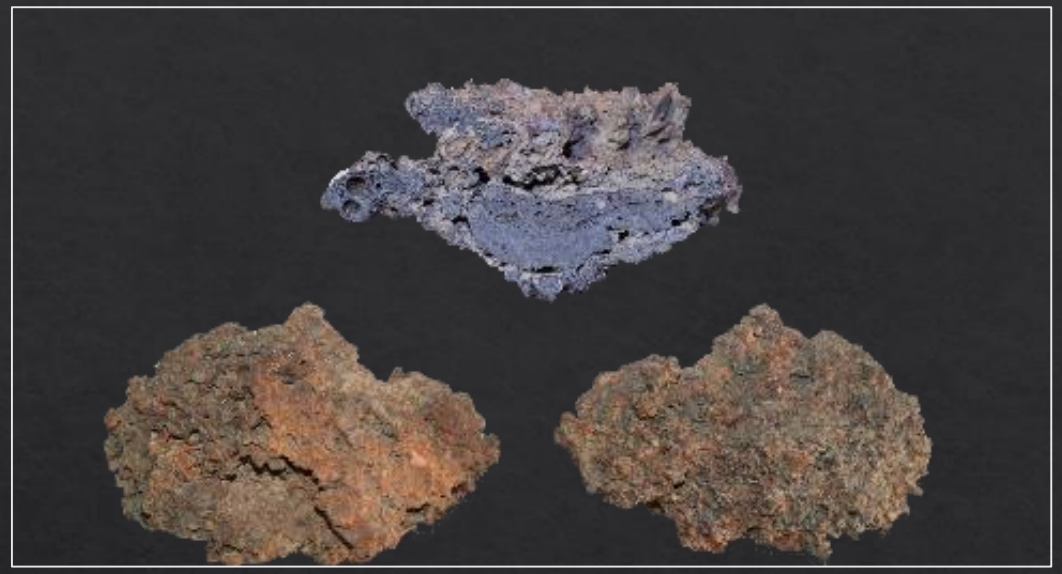




Resulsts of magnetometry (Geometrics G-858), background: DOF,
Mušič, B., Medarič, I., Matijević, F., 2016 -2017)

Hlebine – Dedanovice, furnaces (phase 1)
Trench 1, 2018., (foto: T. Sekelj Ivančan)



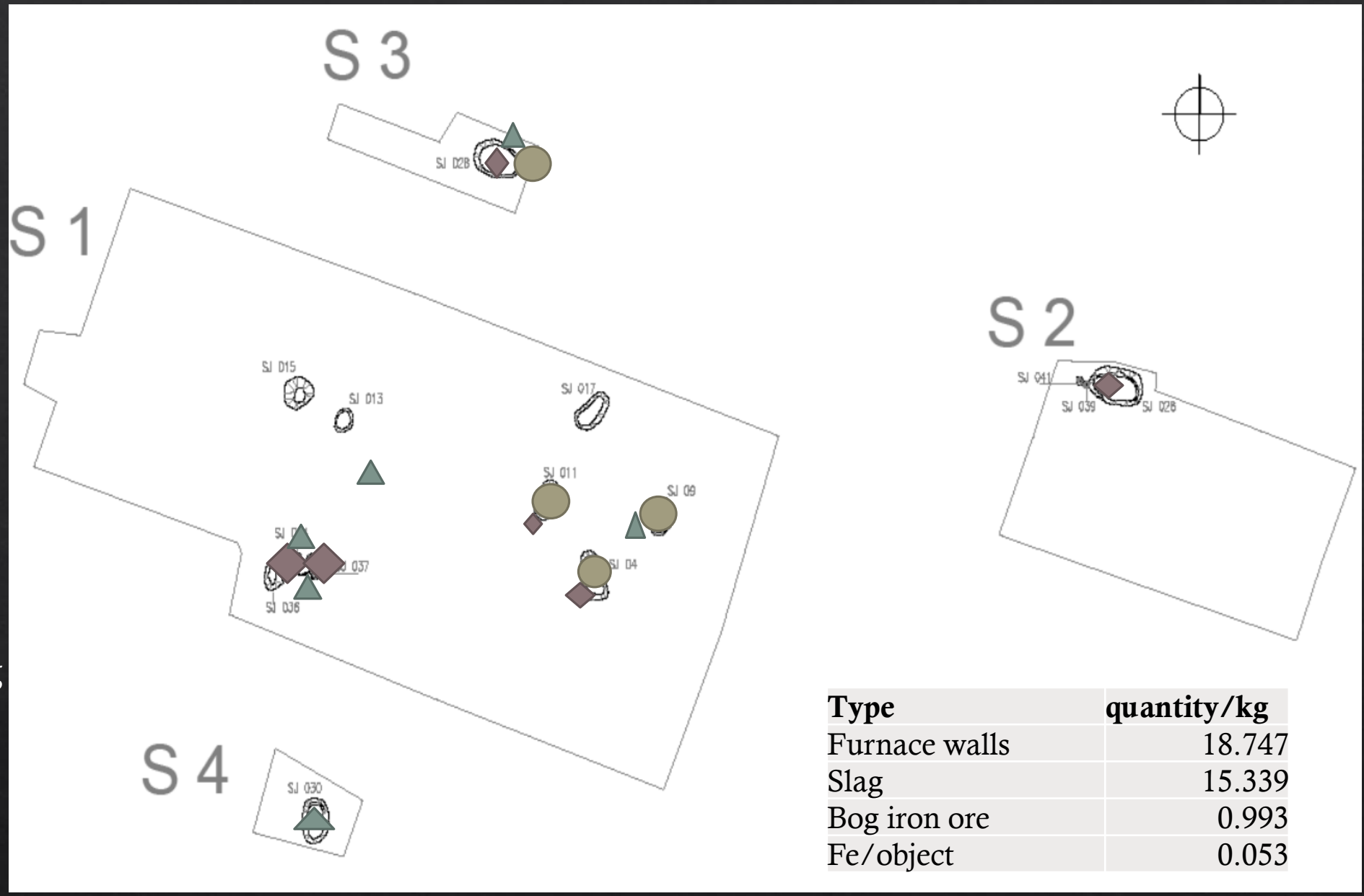



10 cm

Roasted bog iron ore

PCC – primary smithing slag

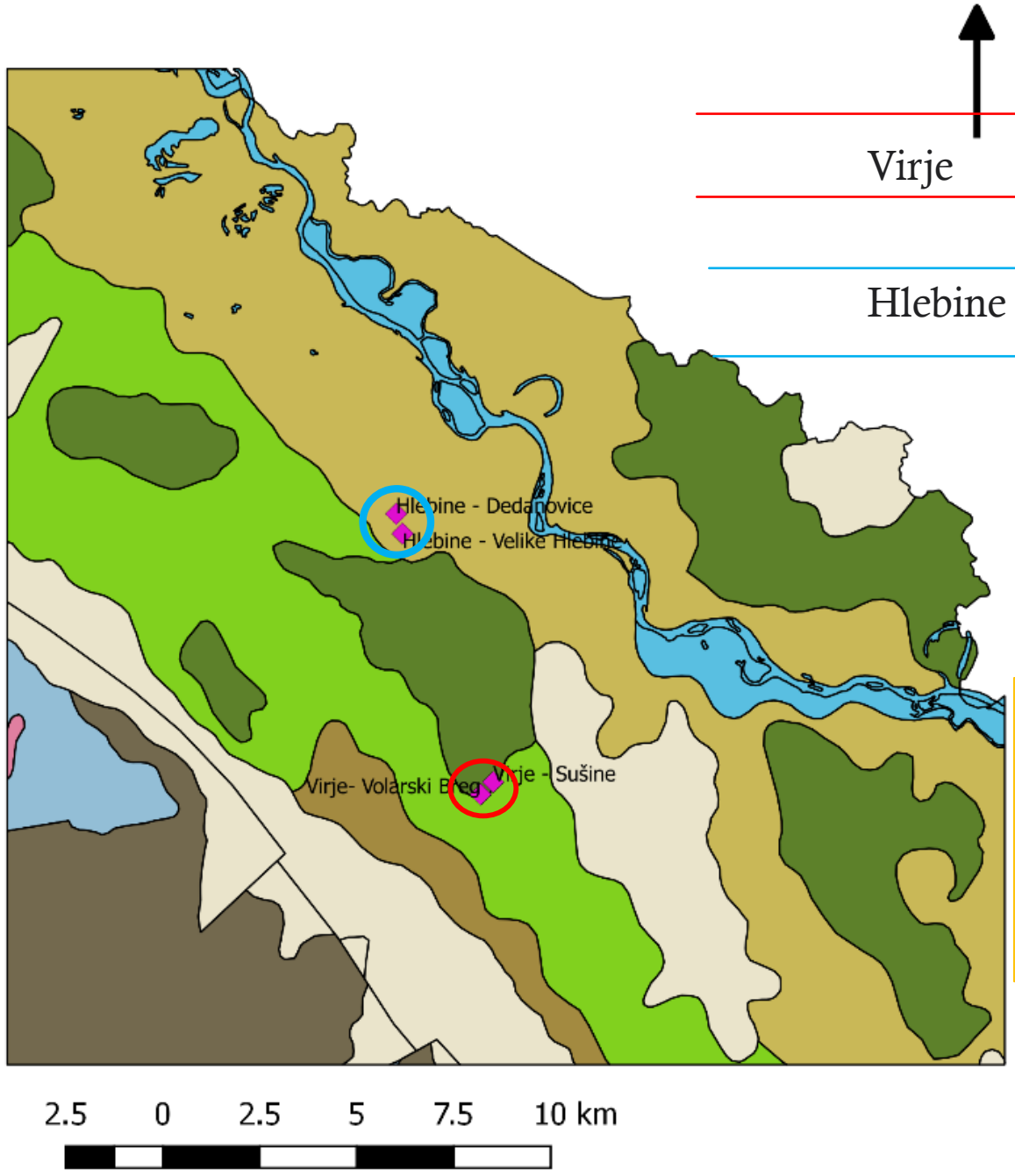
Furnace walls

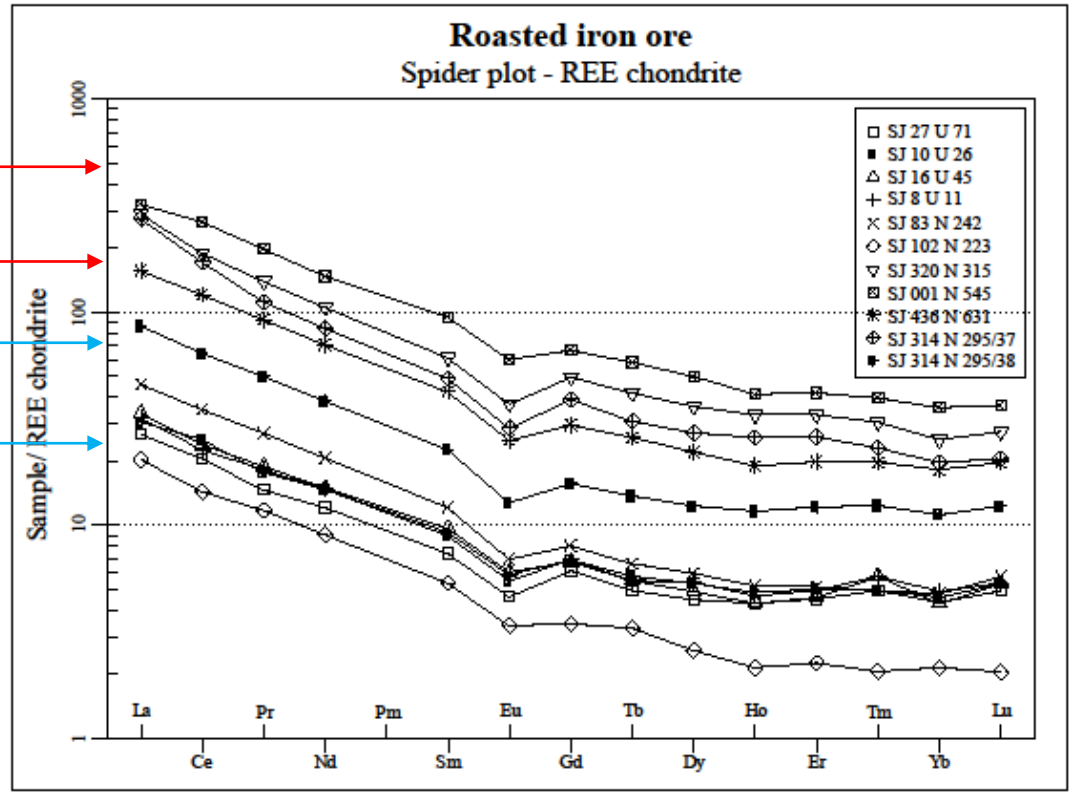


Type	quantity/kg
Furnace walls	18.747
Slag	15.339
Bog iron ore	0.993
Fe/object	0.053

Ground plan, Hlebine - Dedanovice 2018. (made by: K. Turkalj)

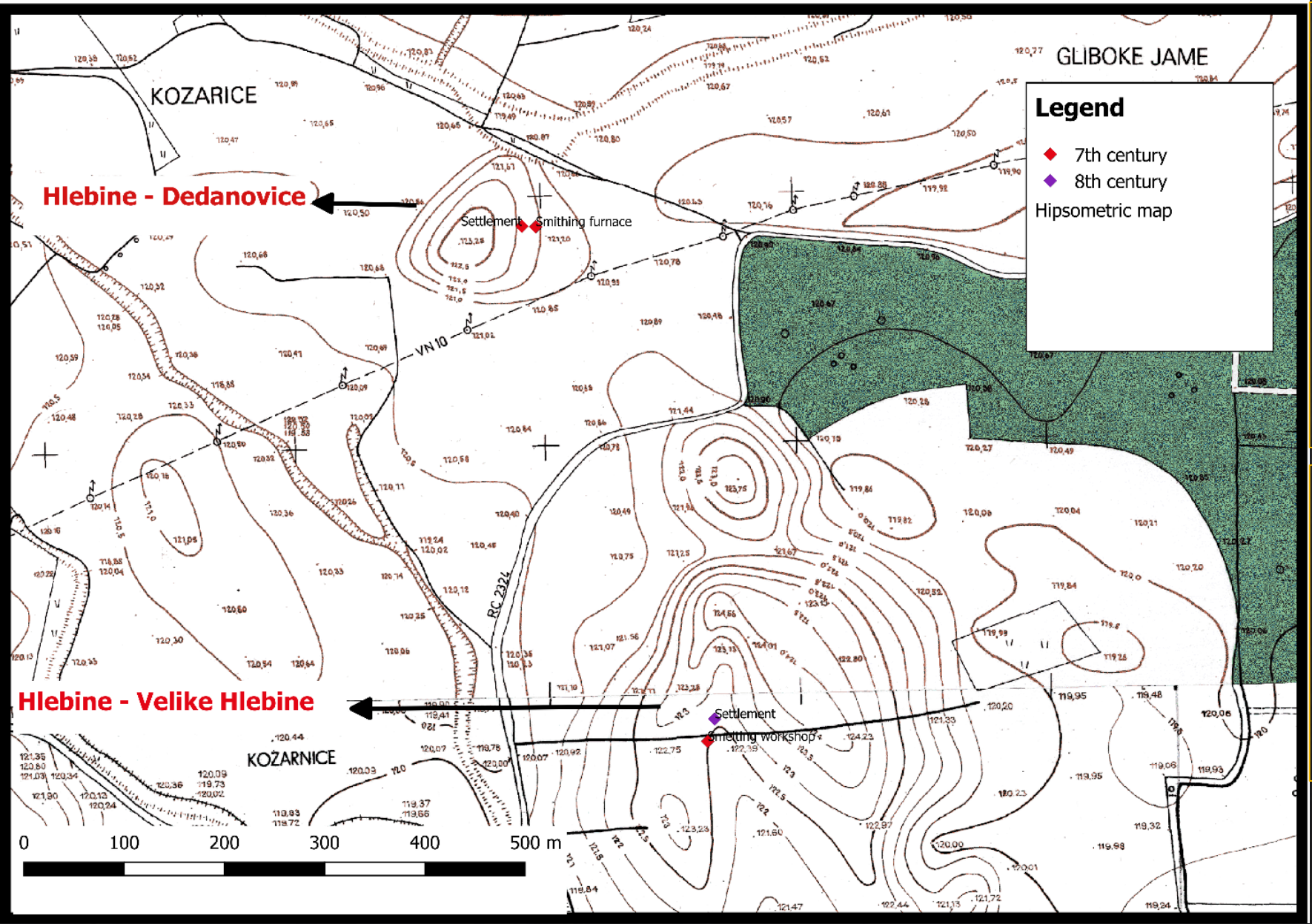

Seasonal storage
? – ore
Primary/secondary
smithing





Similar general trend of REE – similar origin of bog iron ores : similarity increases with spatial and temporal connection between sites

Similar microenviroment for bog iron ore formation = same exploatation ground - workshop location selection?



RESOURCE PREPARATION – SMELTING – BLOOM REFINING

- Seasonal / Campaign activities – temporary location

= Isolated ridge away from the setllement - close to the source of raw materials ?

PRIMARY SMITHING/BLOOM REFINING SECONDARY SMITHING / STORAGE

- continous labor, storage = edge of the settlement grounds

- structured organisation of labor and workspace on both sites

- Workspace location selection influenced by :
- type of activity (resource exploatation and preparation, smelting, primary smithing)
- dynamics of activities (seasonal or constant - continuous)
- natural landscape prerequisites (floods, wet-dry season, source of raw materials, bog iron ore deposits)

a high level of iron production management in the ½ 7th century

High level of demand for iron?
Levels of specialization ?
- same organised group of people – interrelated specialists ?

Thank you for attention !