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TransFER –

NEW RESEARCH PROJECT ON IRON PRODUCTION IN DRAVA RIVER VALLEY

International scientific conference

IRON IN ARCHAEOLOGY

Bloomery Smelters and Blacksmiths in Europe and Beyond

30th May – 1st June 2017
Prague, Czech Republic

TransFER

Iron production along the Drava River in the Roman period and the Middle Ages:
Creation and transfer of knowledge, technologies and goods

- Institute of Archaeology, Zagreb, Croatia
- 48 months (1st March 2017. – 28th February 2021.)
- PI: **Tajana Sekelj Ivančan**, PhD (IARH)
- Research group: **Tatjana Tkalčec,** PhD (IARH, Zagreb, Croatia)
  Siniša Krznar, PhD (IARH, Zagreb, Croatia)
  Ladislav Lazić, PhD (Sisak, Croatia)
  Ma **Robert Čimin** (Koprivnica, Croatia)
  Aleksandra Bugar, dipl. arh. (Zagreb, Croatia)
  Ivan Marija Hrovatin, dipl. arh. (Trieste, Italy)
  Branko Mušič, PhD, univ. dipl. ing. geol. (Ljubljana, Slovenia)
  Sibila Borojević Šoštarić, PhD (Zagreb, Croatia)
  Stanko Ružičić, (PhD (Zagreb, Croatia)
  Metka Culiberg, PhD (Ljubljana, Slovenia)
- Doctoral student: **Ivan Valent**, Ma (Koprivnica, Croatia)

The aim of the project

The aim of the project is to expand the scientific knowledge about the primary processing and manufacturing of iron in the lowland basin of the Drava River throughout the periods of the Antiquity and Middle Ages.

In order to define the meaning of iron production in the context of ancient and medieval societies in the study area, the following tasks were set:

(a) To specify the source of the iron ore and the other necessary resources (clay, water, wood);
(b) To define the technology of processing the iron ore throughout the historical periods and the intensity of production;
(c) To define the impact of iron production in the context of socio-cultural relations and interaction of people and goods.

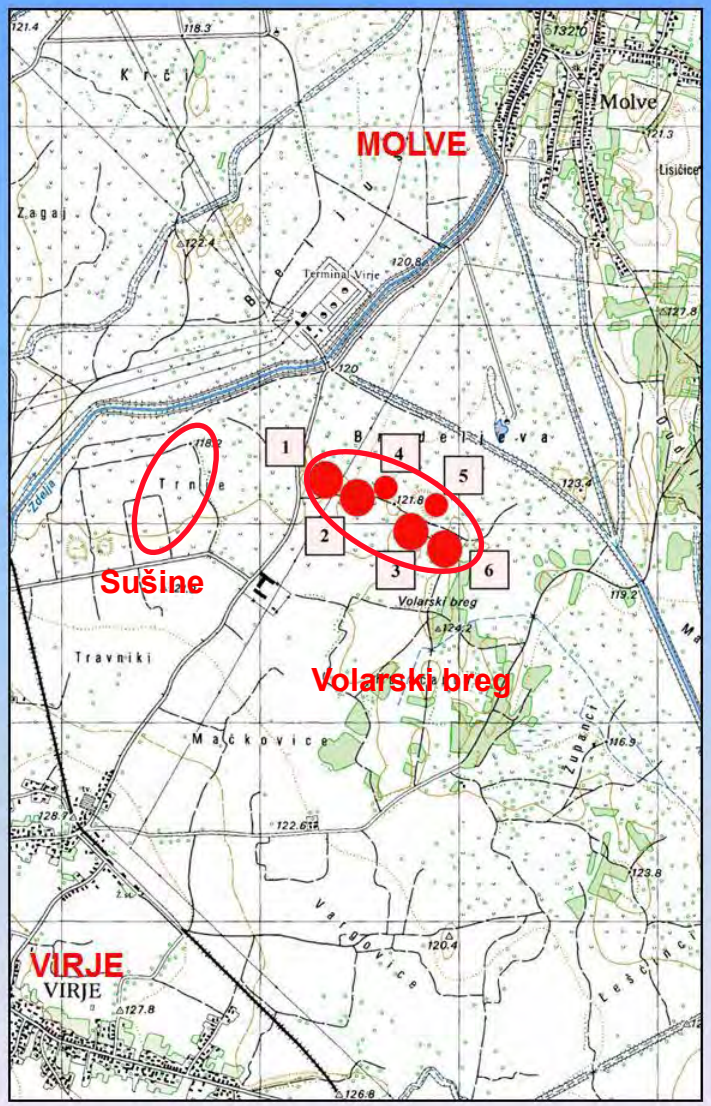
The archaeological site Virje-Volarski breg

The site is located in a large valley of the river Drava between villages Virje and Molve in Koprivnica-Križevci County, Croatia

The site is known in the literature as an archaeological site with settlement characteristics, since the 1980s

Surface archaeological finds:

1 - Late La Tène period, High Middle Ages
2 - Early Iron Age
3 - Late Middle Ages
4 - Late Bronze Age, Roman period
5 - Bronze age
6 - Late Middle Ages



Volarski breg – surface finds, 2007


2


4

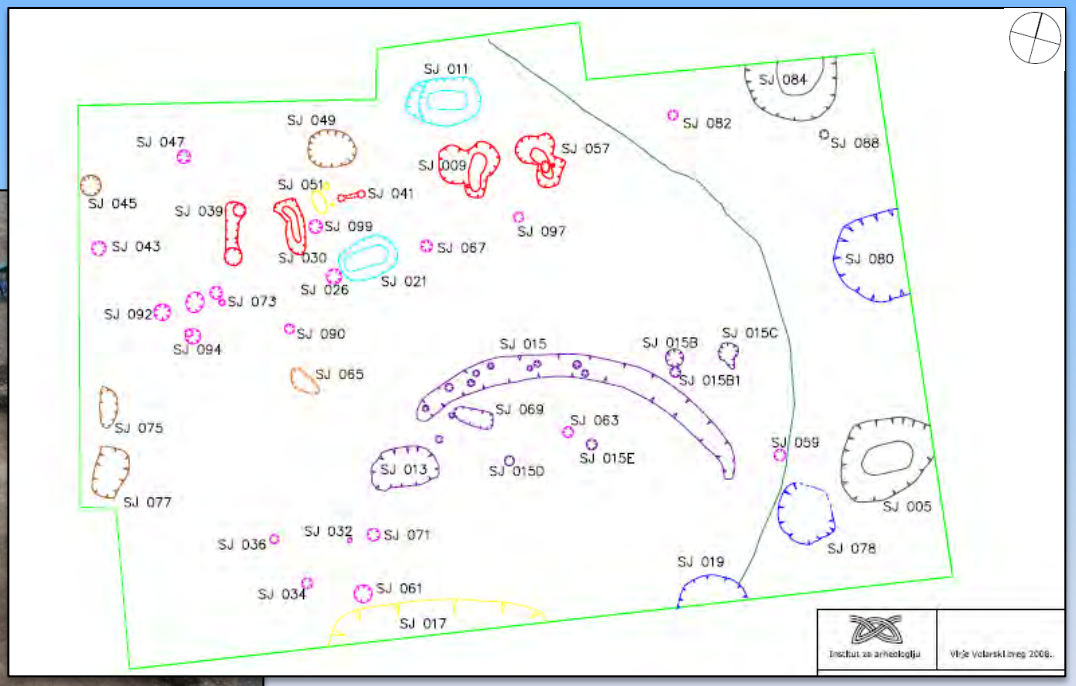

1


3

Archaeological research at the Virje-Volarski breg - 2008

Tranch 1 – 230 m2

- **5 smelting furnaces in situ (red),**
- **4 dislocated remains of destroyed furnaces (brown),**
- **5 burials with burnt earth at the bottom (blue),**
- **1 fence (?) and many burials of wooden posts (violet)**



Radiocarbon analysis

MIDDLE AGES

- FURNACE I. - *Radiocarbon Age - BP 1236±25*
  Two Sigma Range - **cal AD 760-874** (56.3%)
- PIT II. - *Radiocarbon Age - BP 1169±26*
  Two Sigma Range - **cal AD 777-900** (82%)

LATE ANTIQUITY

- PIT - *Radiocarbon Age - BP 1560±30*
  Two Sigma Range - **cal AD 420-570** (95%)

PREHISTORY

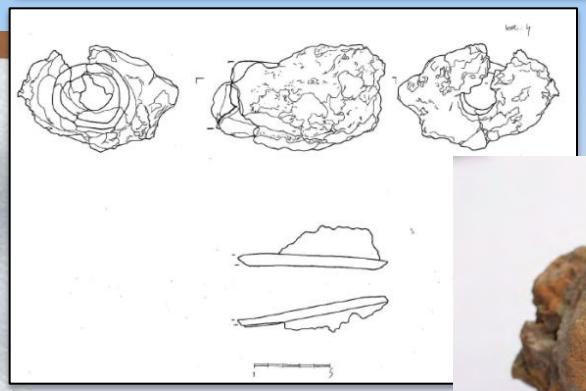
- OBJECT - *Radiocarbon Age - BP 2128±30*
  Two Sigma Range - **cal BC 208-52** (86.8%)

Analysis 14C:
Leibniz-Labor für
Altersbestimmung und
Isotopenforschung
Christian-Albrechts-Universität
Kiel, Germany

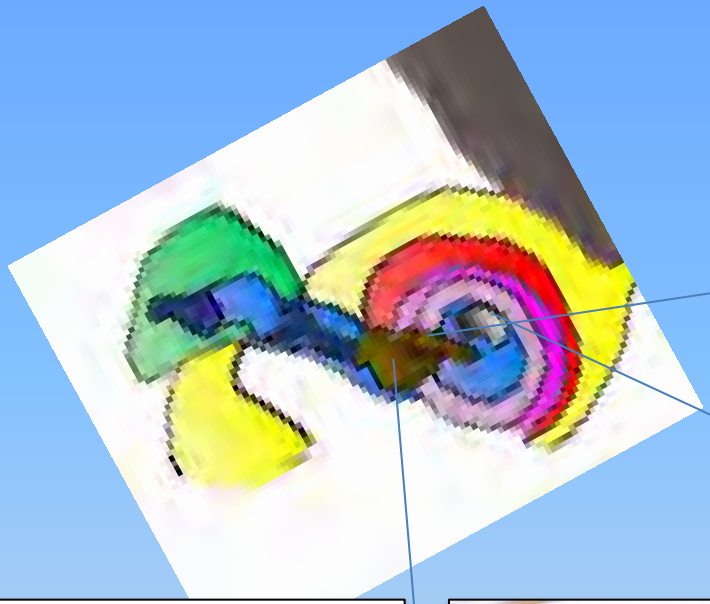
Two smelting furnaces visible after the removal of humus

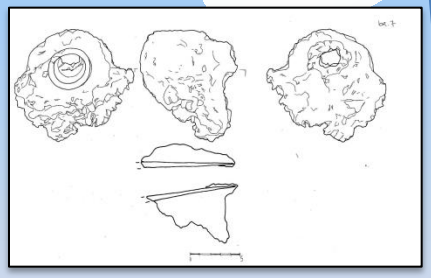
Smelting furnaces I and V

Smelting furnace I

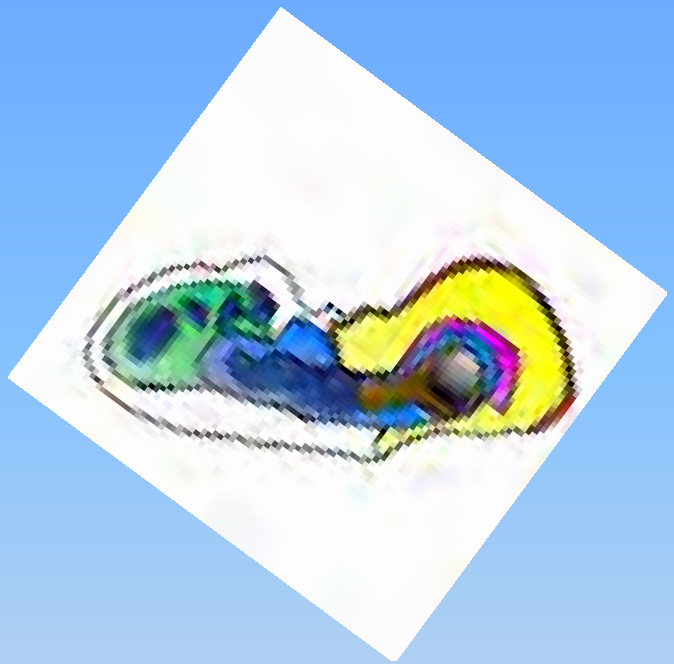


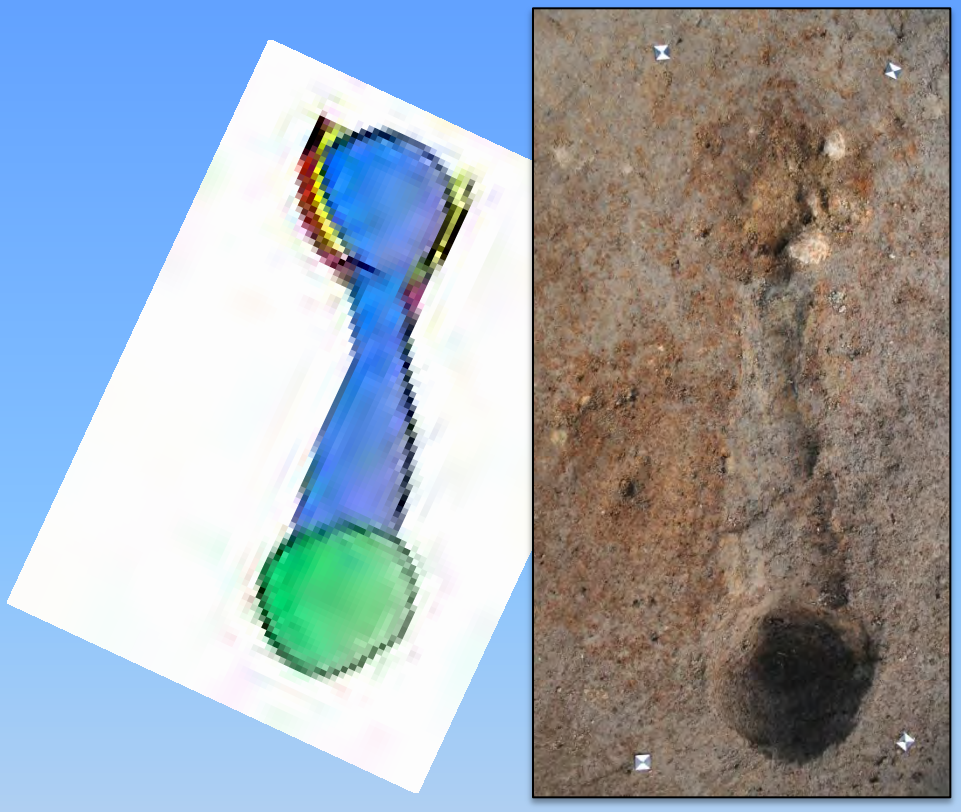
Smelting furnace V



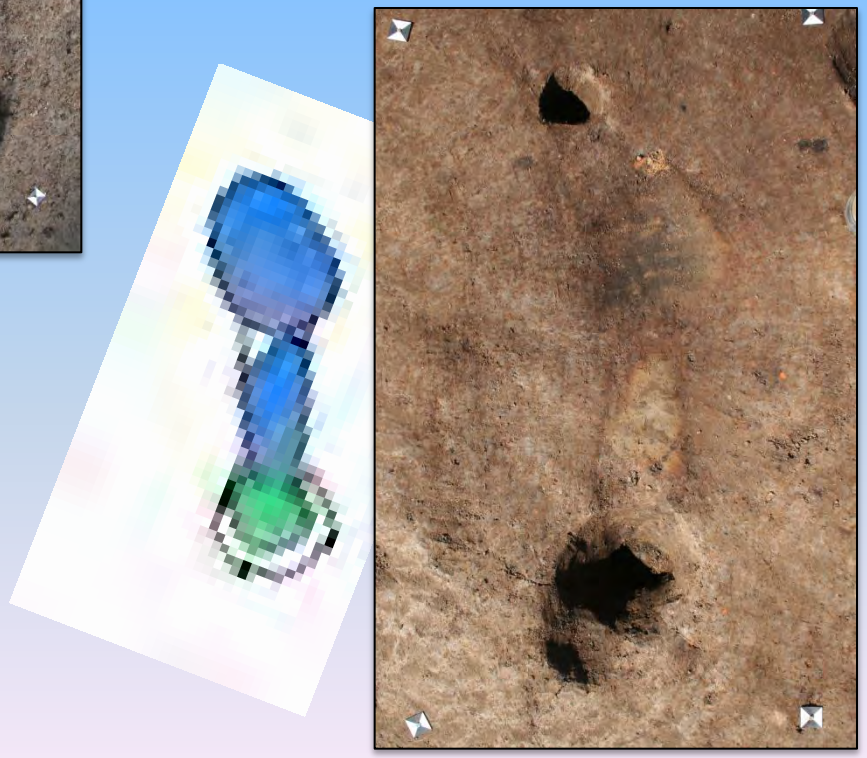


Smelting furnace II

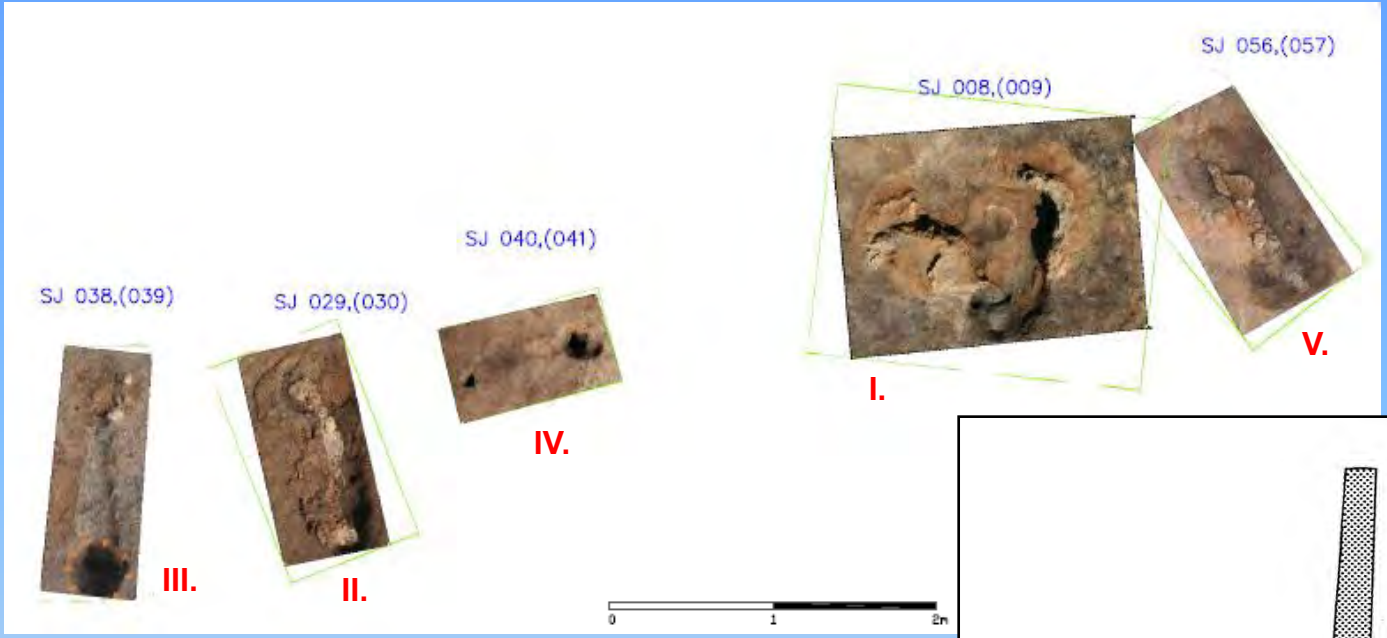




Smelting furnace III

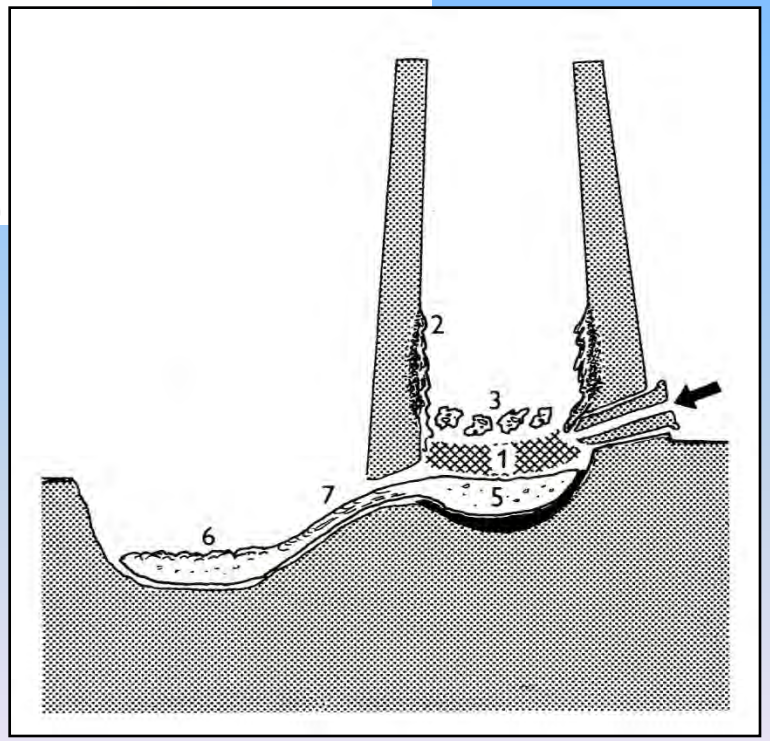


Smelting furnace IV



The flat-hearth tapped furnace type – the three parts

1. **Firebox – the interior of the funnel-shaped section of the furnace with a fired base where the iron ore mixed with charcoal was burned /1-5/;**
2. **The fired base of the small channel through which the slag ran /7/;**
3. **The pit where the slag collected /6/.**

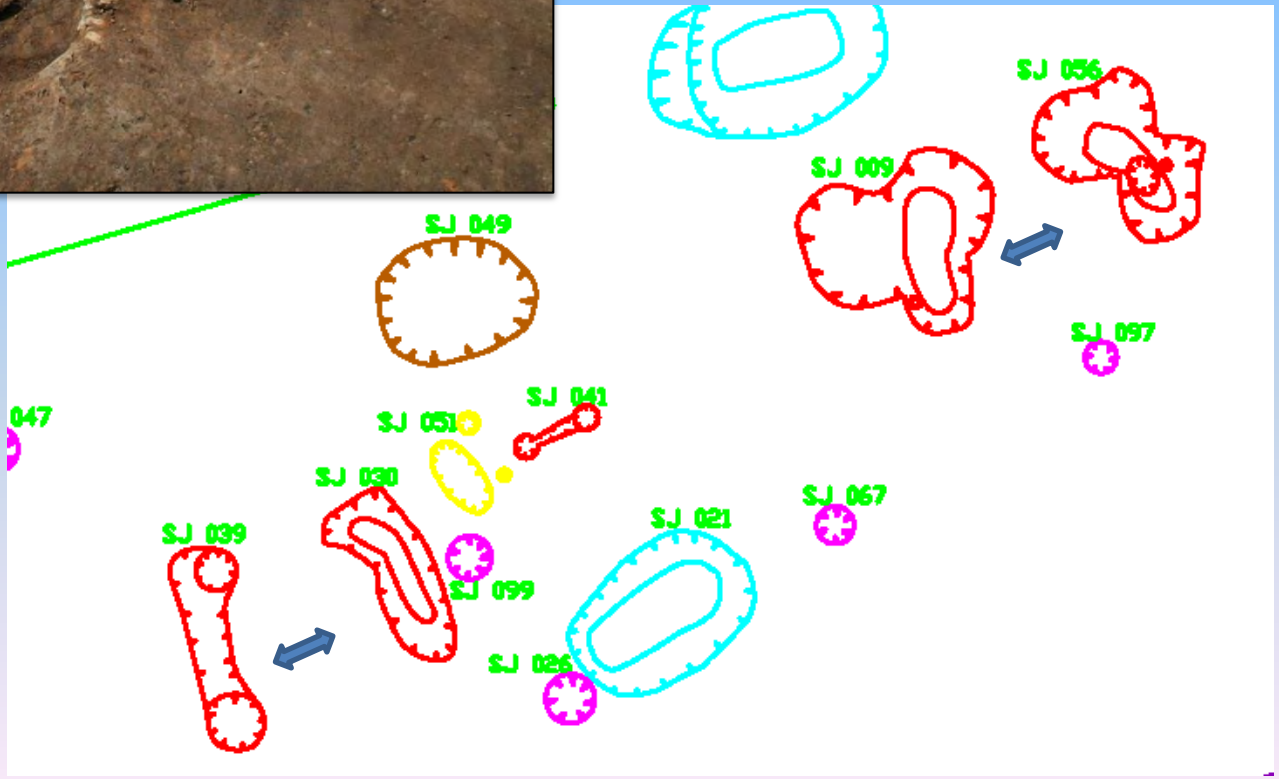


(Pleiner 2000: 258, Fig. 67)

Position and appearance of two opposite smelting furnace I. and V. during research

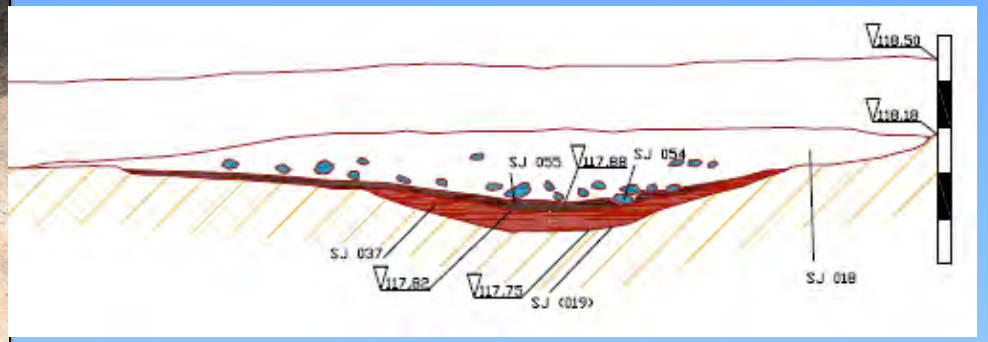
Furnace V.

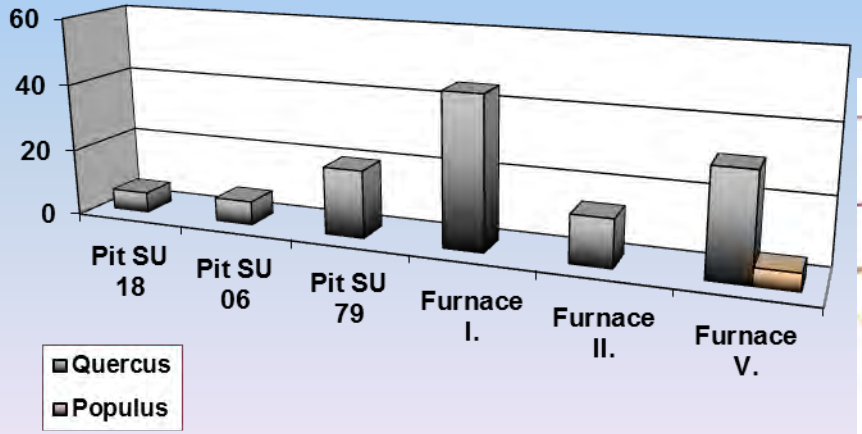
Furnace I.



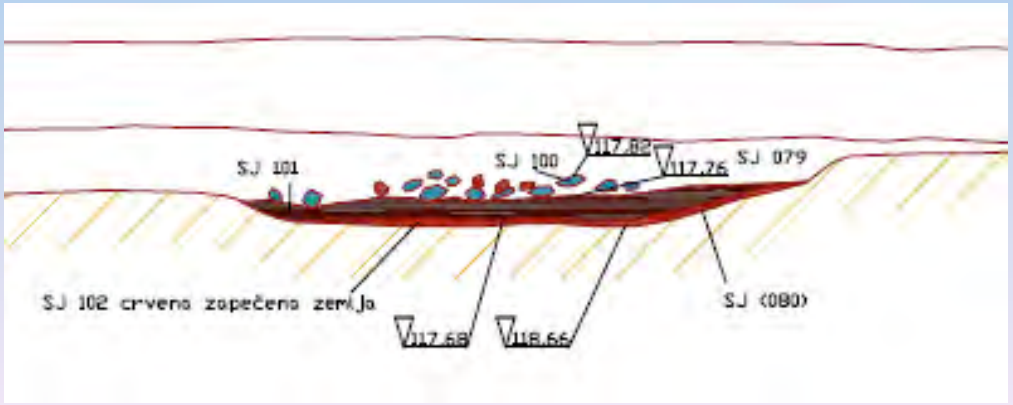
Pits for making charcoal

Pit SU 18

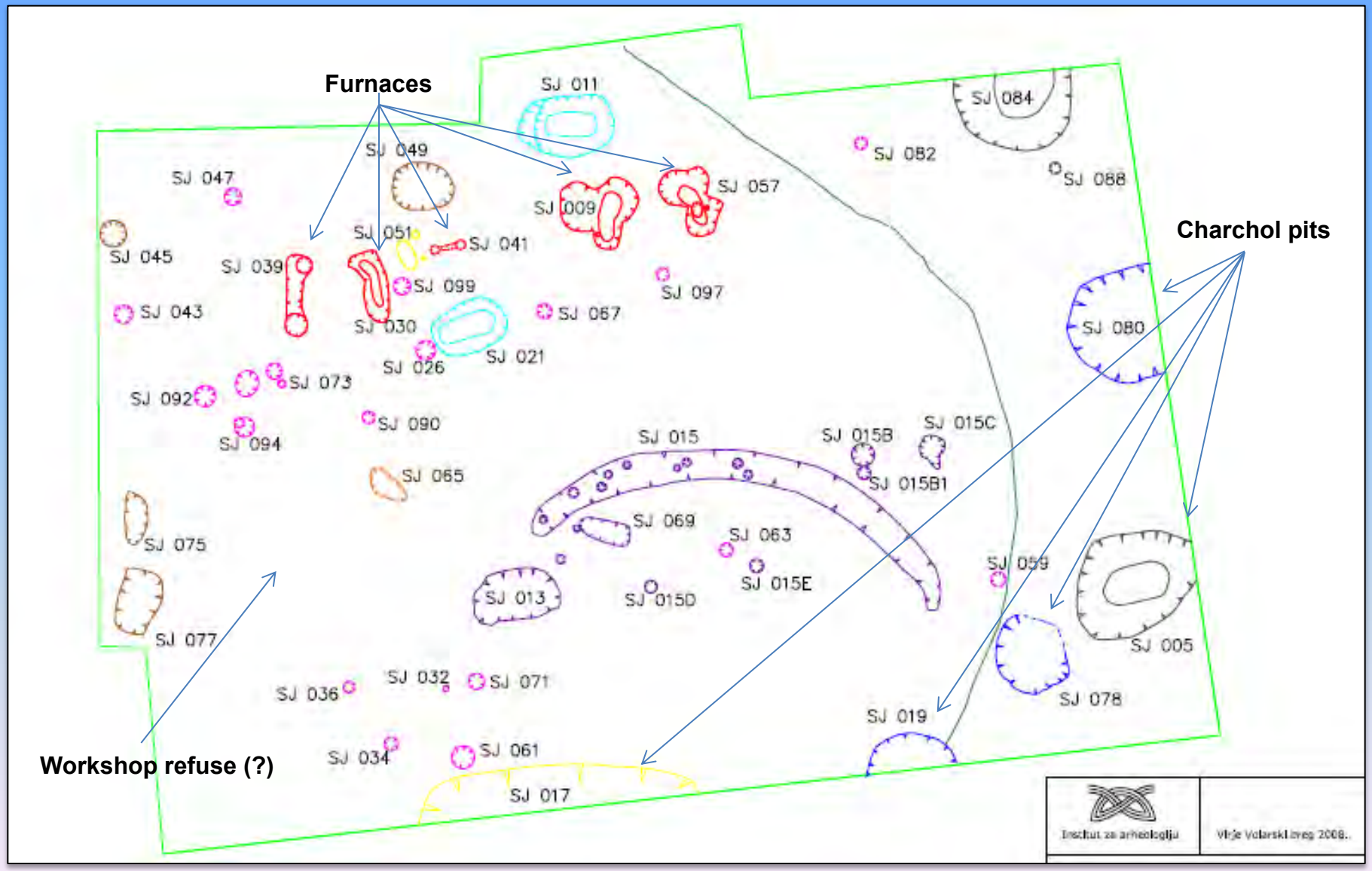




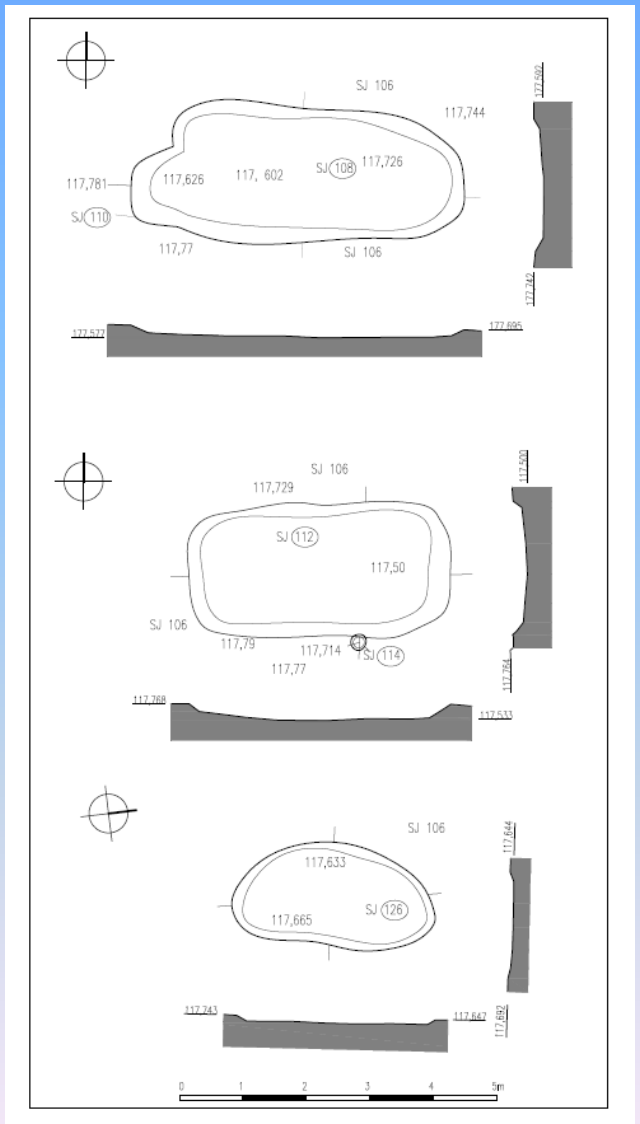
Pit SU 79



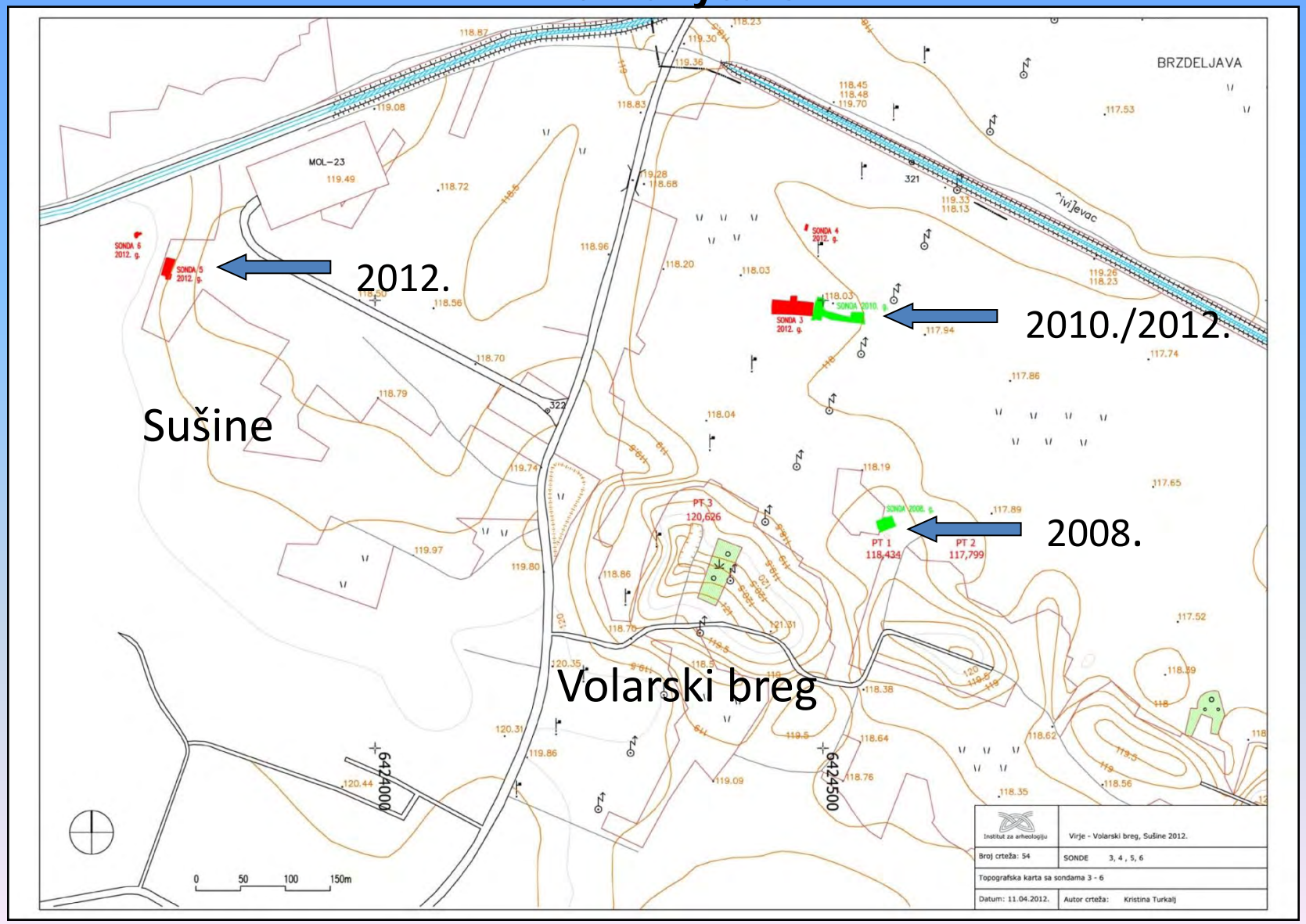
It seems the work in the smelting workshop was organized according to activities



Position Volarski breg - 2010

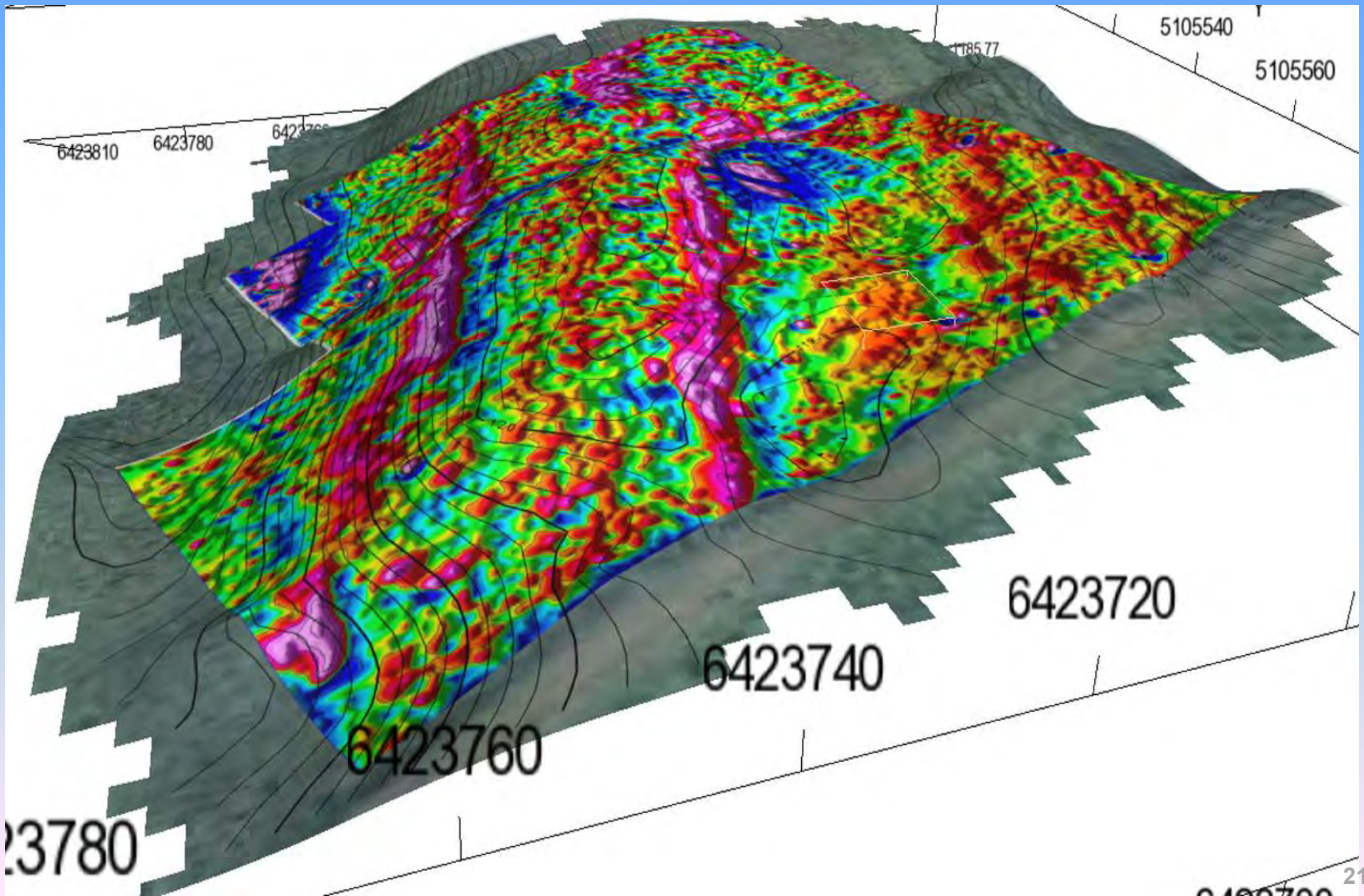


Virje – positions and investigation trenches - 2008th to 2012th years

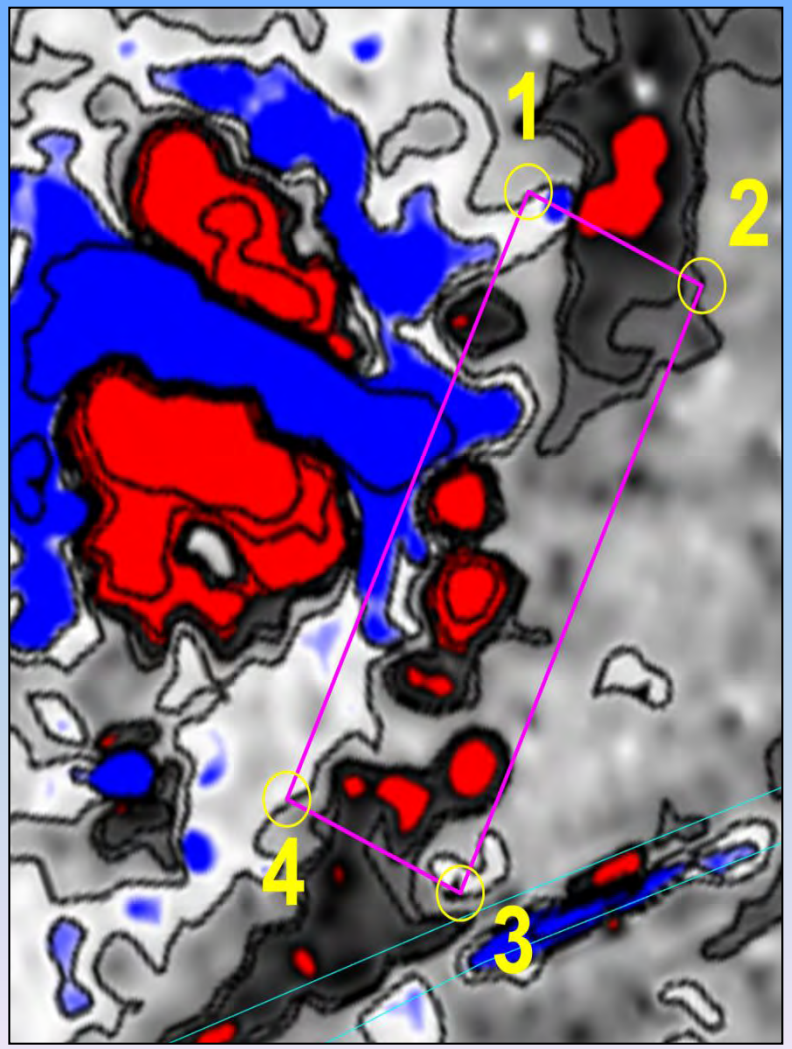


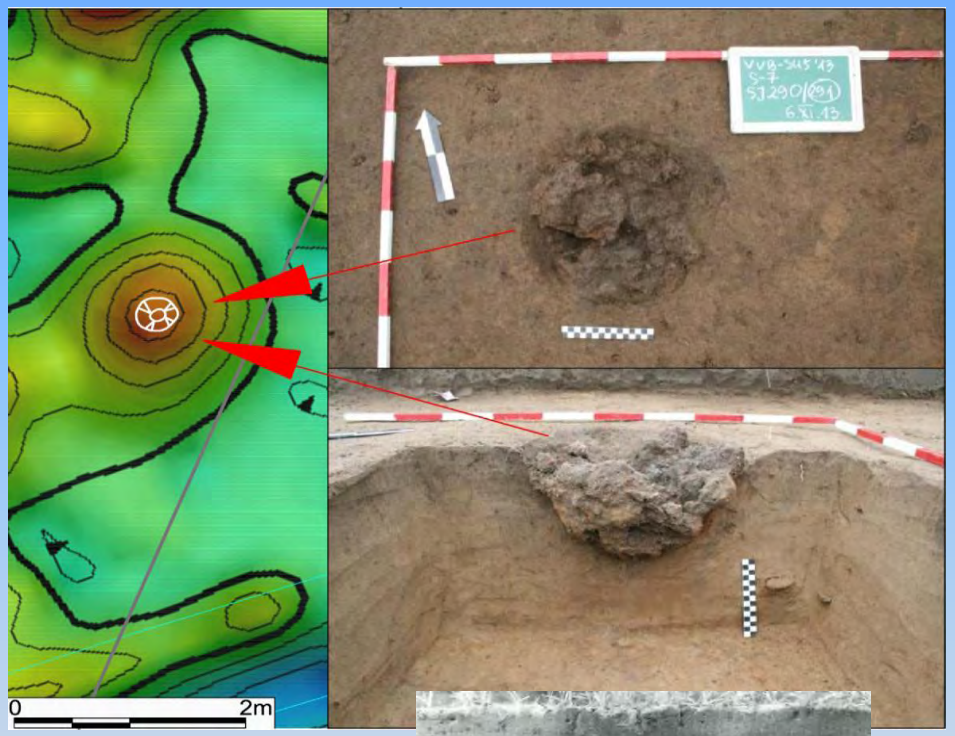
Sušine – surface finds, 2012

Results of the magnetic method on digital terrain model



Comparison of results of geophysical and archaeological research - furnace

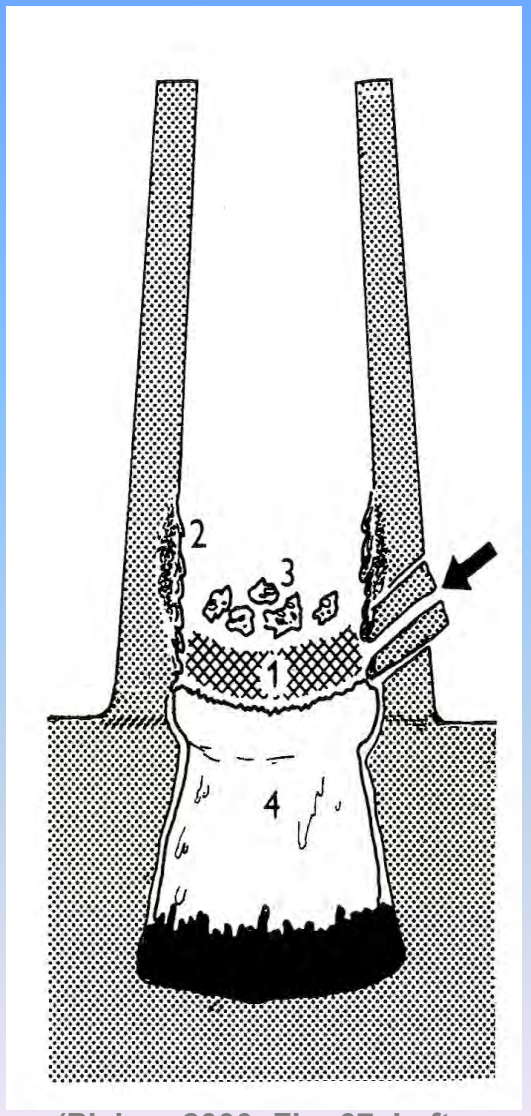




(Pleiner 2000: Pl. IX, Romano-Barbarian sleg pit furnaces in Jutland, Drengsted, Denmark)

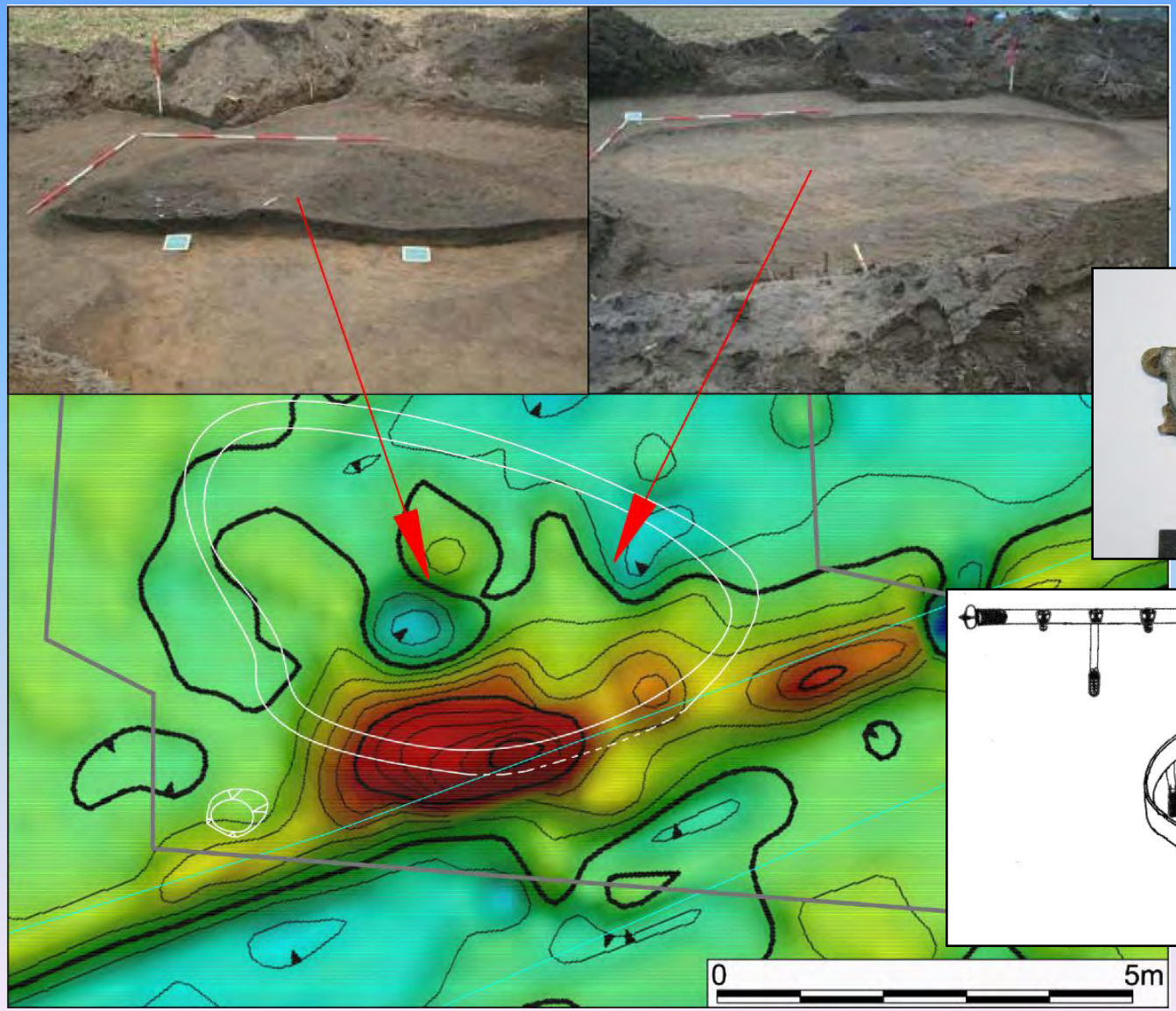
Position Sušine 2013 - smelting furnaces in situ

(Pleiner 2000: Pl. X, sleg pit furnaces in Jutland, Snorup, Denmark)

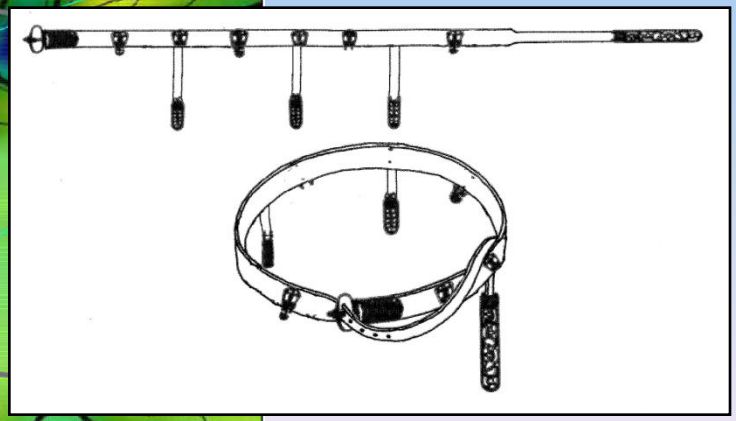


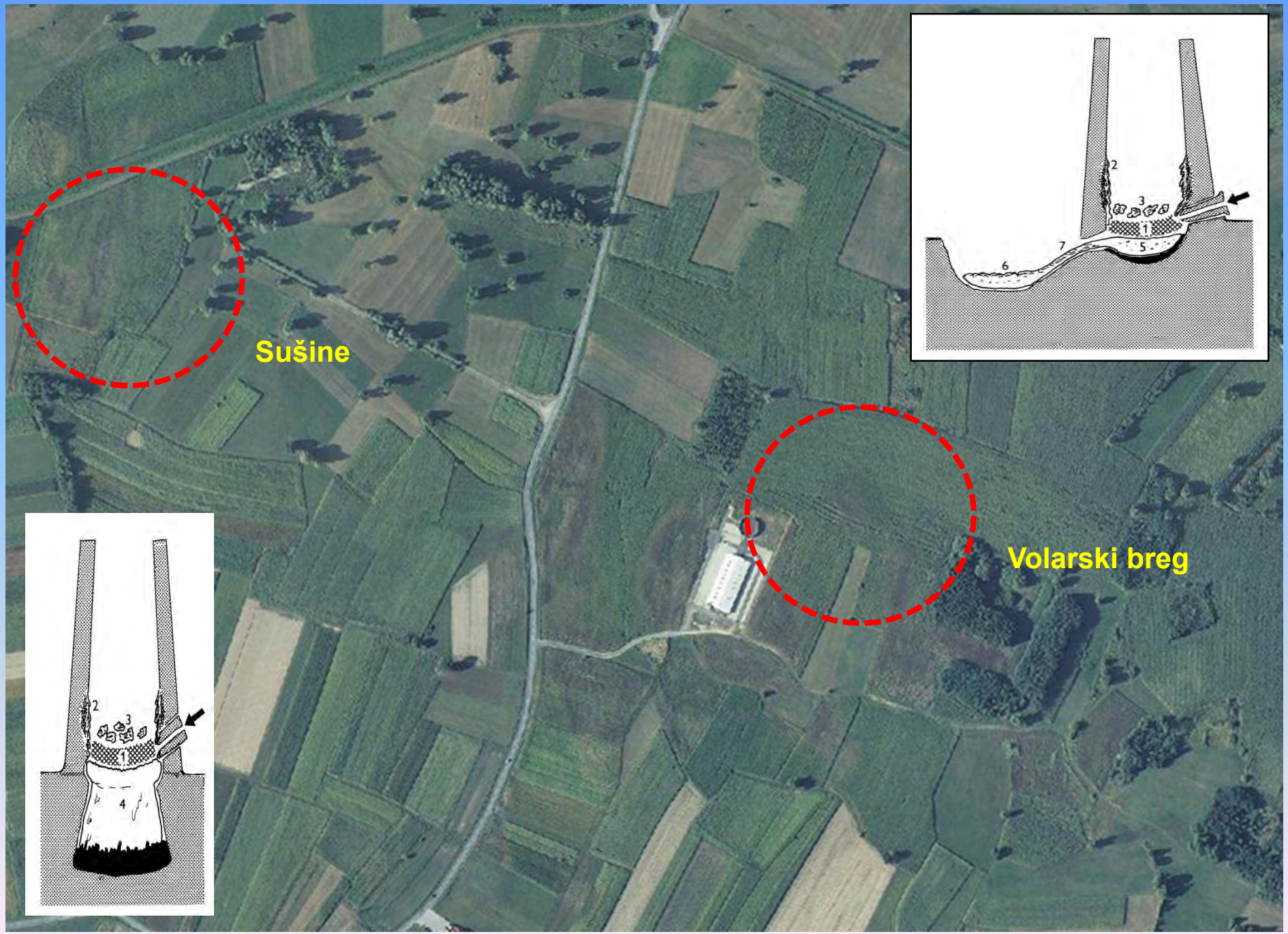
(Pleiner 2000: Fig. 67, Left sleg pit furnace)

Position Sušine, feature from the early Middle Ages – 2012



Part of the belt –
the second half of the 8th and beginning of the 9th century




Sušine
Volarski breg

Landscape along the Drava River. Source of raw materials?

Analysis of the concentration of iron in the soil :
Tamara Marković, PhD geol.

A total of iron,
dissolving the soil sample in aqua regia (HNO3:HCl):
12 samples= 0,4-5,1 (total Fe (%)

SU 173 = 19,3 (total Fe (%)
SU 197 = 23,4 (total Fe (%)

Bacteria *Leptothrix* in the ground - better deposition of iron

Archaeological sites with traces and / or findings smelting activities in northern Croatia

1. Archaeologically investigated :

- - prehistory – Topusko "Turska kosa" near Karlovac
- - Roman period - Imrijevci "Polačica" near Požega
  - Velika Gorica "Okuje I, II, III" near Zagreb
  - Sisak/Hrvatska Dubica (ingots)
  - Virje – Sušine
- - Early Middle Ages – Virje – Volarski breg

2. Several new potential sites in Podravina Region

Hungarian part of the Drava valley with marked places higher concentration of surface finds slag, nozzles and burned wall furnaces

Hlebine – geophysical exploration in 2015

Research: A – field investigations; B – Laboratory investigation; C – Analysis and interpretation

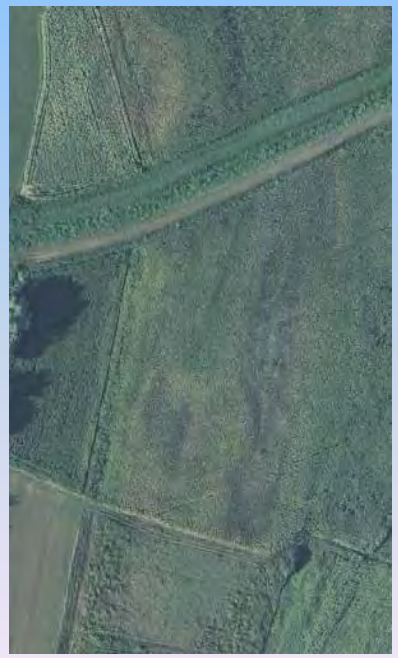
Tasks - 1st year:

1. field survey and reconnaissance of the region – central lowland section of the Drava River basin

2. gathering available archaeological material from museums and collections

3. remote investigation through satellite and aerial photographs

4. verifying toponomastic, cartographic, and historical sources



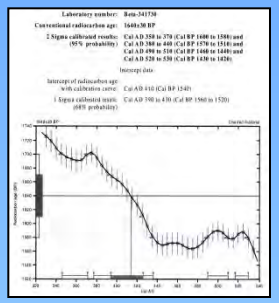
Virje-Sušine

5. confirming sites with a high content of iron oxy-hydroxides

Tasks - 2nd and 3rd year: Archaeological excavations

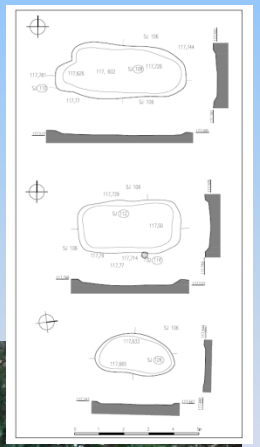
1. Two sites with smelting remains

- Workshop size
- Workshop elements - furnaces: appearance / type / data
  - pits for charcoal (wood type)
  - landfill (waste amount / production intensity)
- Date of the workshop
- Distance between concurrent workshops



2. Simultaneous settlements

- Defining the settlement elements and determining the function of the structures
- Settlement dana
- Selection of iron objects for analysis - their connection with the slag from the furnace and raw materials



Interdisciplinary research

- Geophysical investigation using the method of magnetic prospecting
- Establishing the extent of metallurgical activities by mapping magnetic susceptibilities

- Radiocarbon analysis of charcoal samples using the ^{14}C method

- Pedological sampling of the soil using standard samplers with a core length of 25 cm for chemical analysis to determine the iron content in the soil
- Determining the concentration of iron in the soil by the gravimetric method
- Soli samples with a concentration of iron >20% (potential raw material in the smelting process) will be sent for multielement geochemical analysis
- The multielement geochemical analysis of slag, furnace parts, and iron objects by X-ray fluorescence (XRF), ICP-AES, and ICP-MS

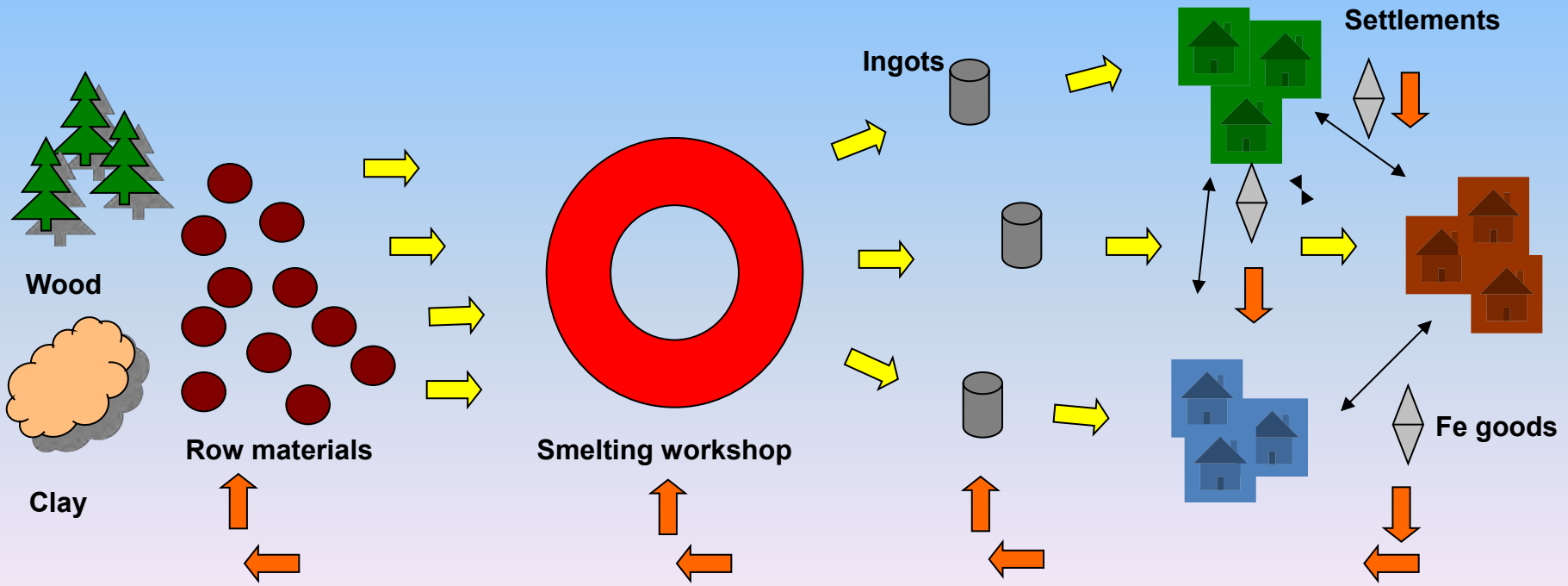
Tasks in the last year:

- Experimental archaeology - furnace replica
- An exhibition will be organized
- An international scientific conference will be organized

Project TransFER:

Iron production along the Drava River in the Roman period and the Middle Ages: Creation and transfer of knowledge, technologies and goods

The benefit of the project would be to complement the standard methodology of the humanities with the methodology of the natural and technical sciences in order to define the process of producing iron from sources of raw materials and the necessary resources, through the technology of smelting in a furnace, to the final product, and its broader social significance.



This is an artistic view of a part of the workshops with two opposite furnaces

Thank you for your attention