Tatjana Tkalčec, Tajana Sekelj Ivančan
Institute of archaeology
Ulica Ljudevita Gaja 32
10000 Zagreb, Croatia

New Evidence of Iron Smelting and Smithing at the Turn of Antiquity and the Middle Ages in the Area of Continental Croatia

International scientific conference
“Changes of the northern part of the Middle Danube region and its vicinity at the turn of Antiquity and the Middle Ages”,
Nitra, April 25 – 26, 2017.

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

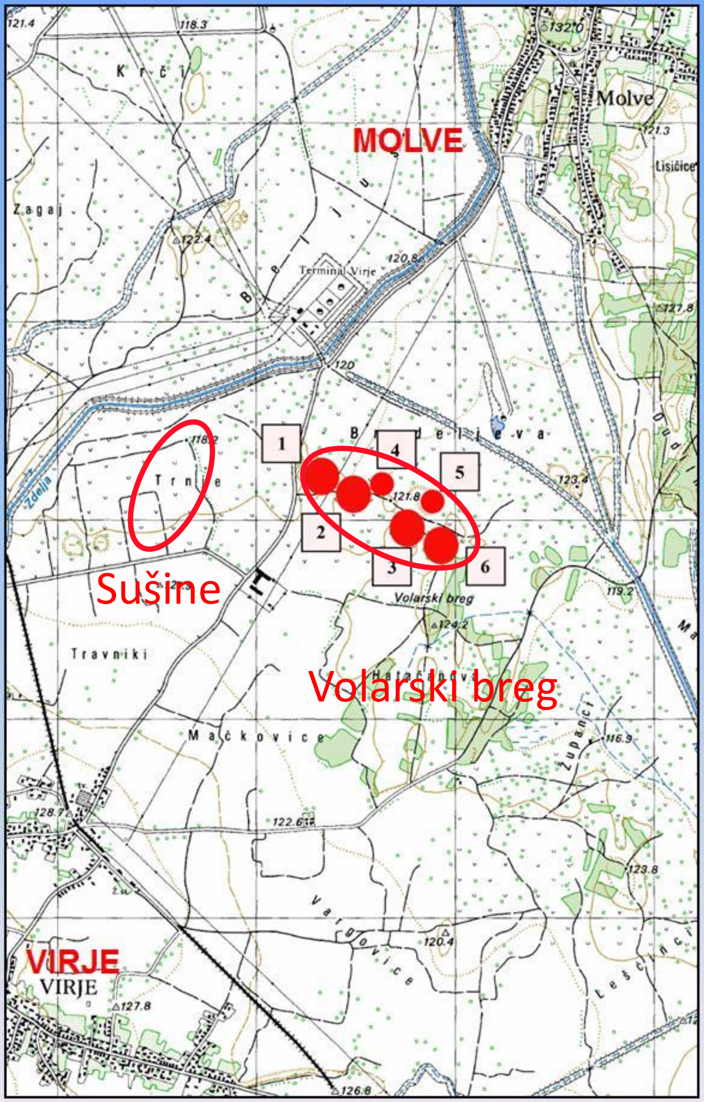
The archaeological site Virje-Volarski breg

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

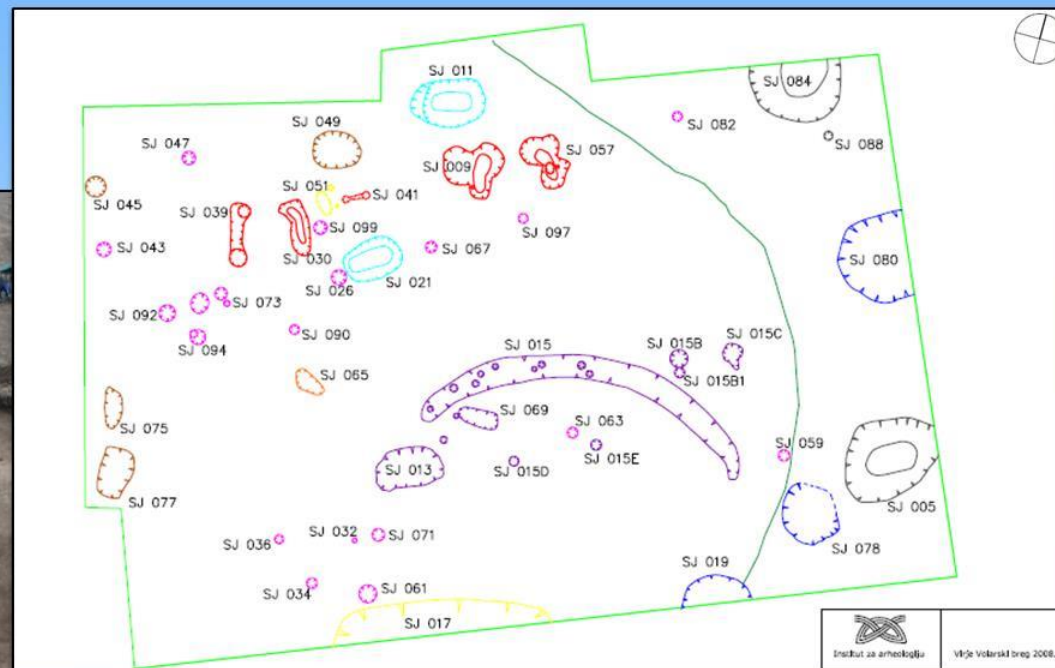

1


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)



Problem - in furnaces have been no material remains and other distinctive elements and / or man-made objects that would allow dating of archaeological unit,

- technology of obtaining iron from iron ore remained almost unchanged from the La Tene through Antiquity to the Middle Ages,

- wall furnace, slag and nozzles are unchanged form through all three periods and can not be dated

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%)

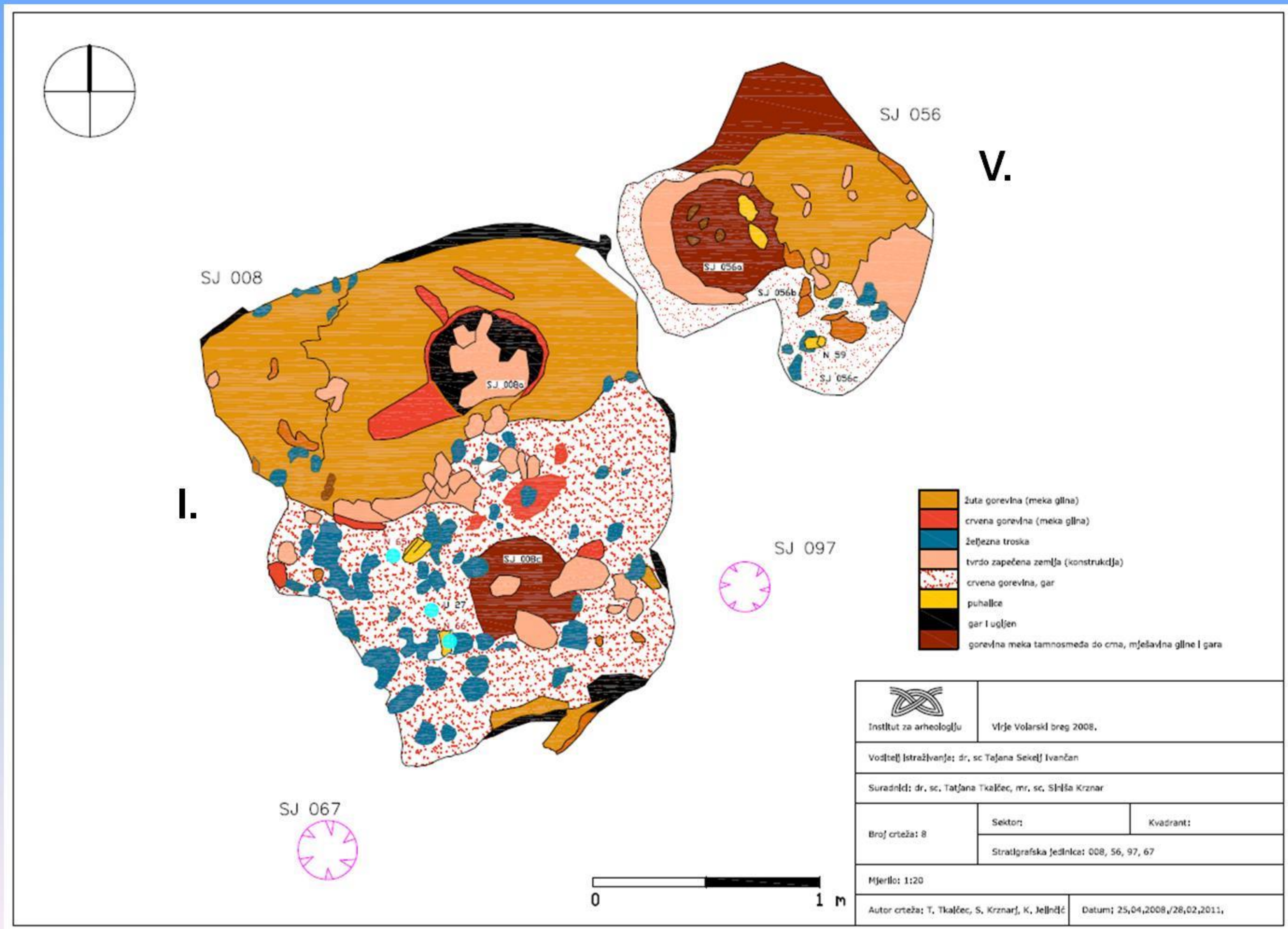
PREHISTORY

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

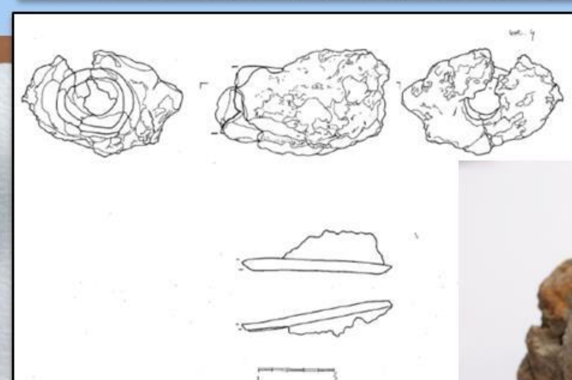
Analysis 14C:
Leibniz-Labor für Altersbestimmung und Isotopenforschung
Christian-Albrechts-Universität Kiel, Germany

Two smelting furnaces visible after the removal of humus

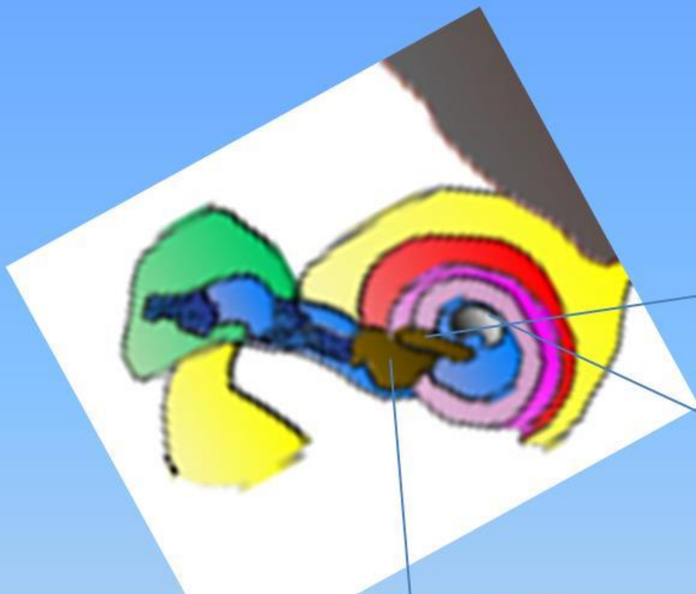
Smelting furnaces I and V

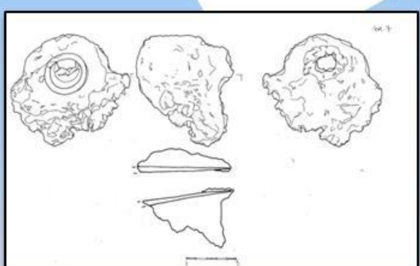


Smelting furnace I



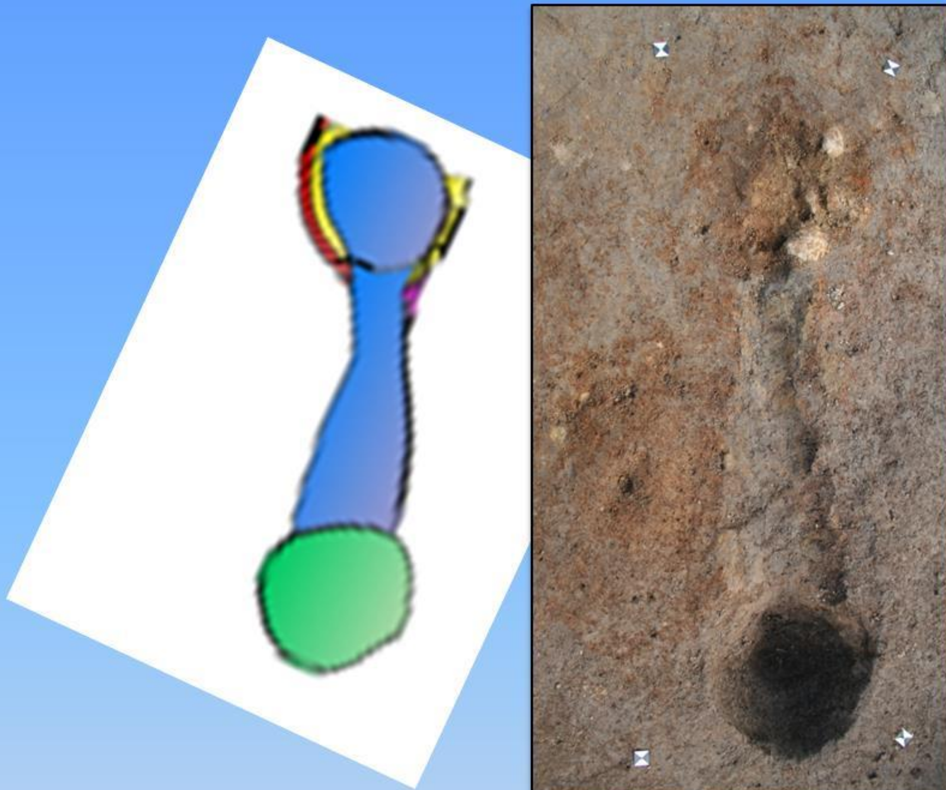
Smelting furnace V

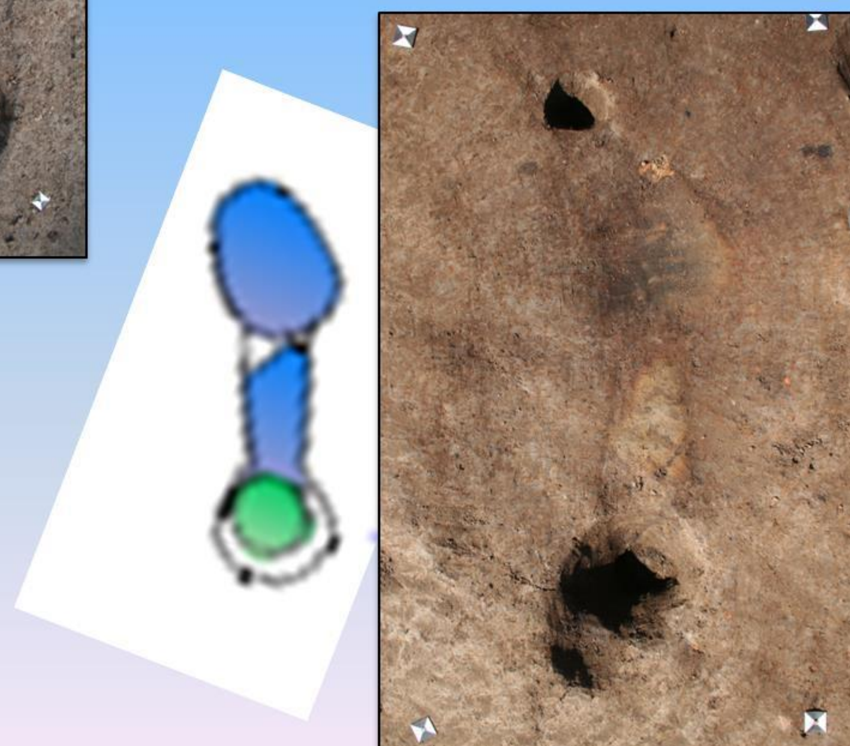




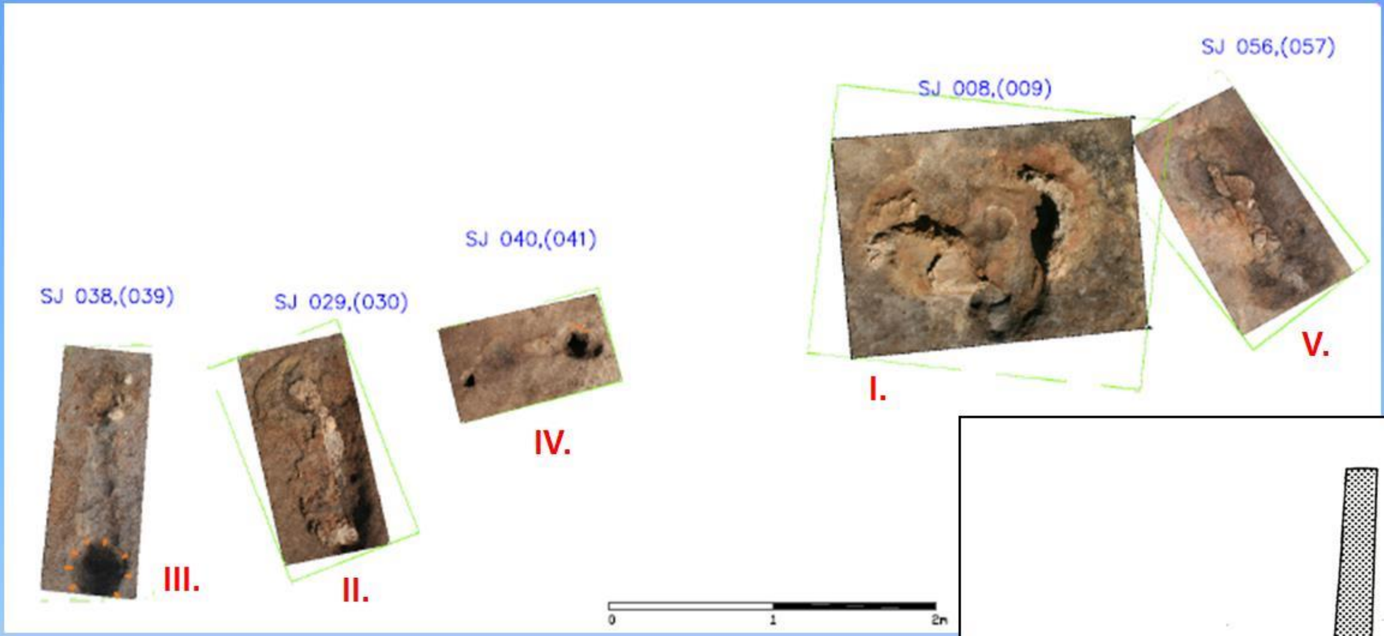
Smelting furnace II

Smelting furnace III



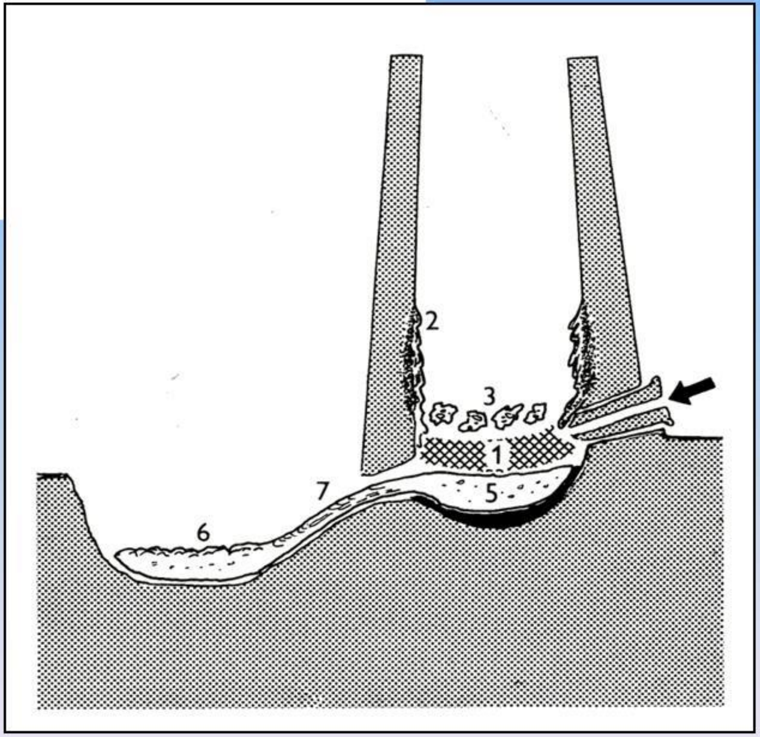


Smelting furnace IV



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/.

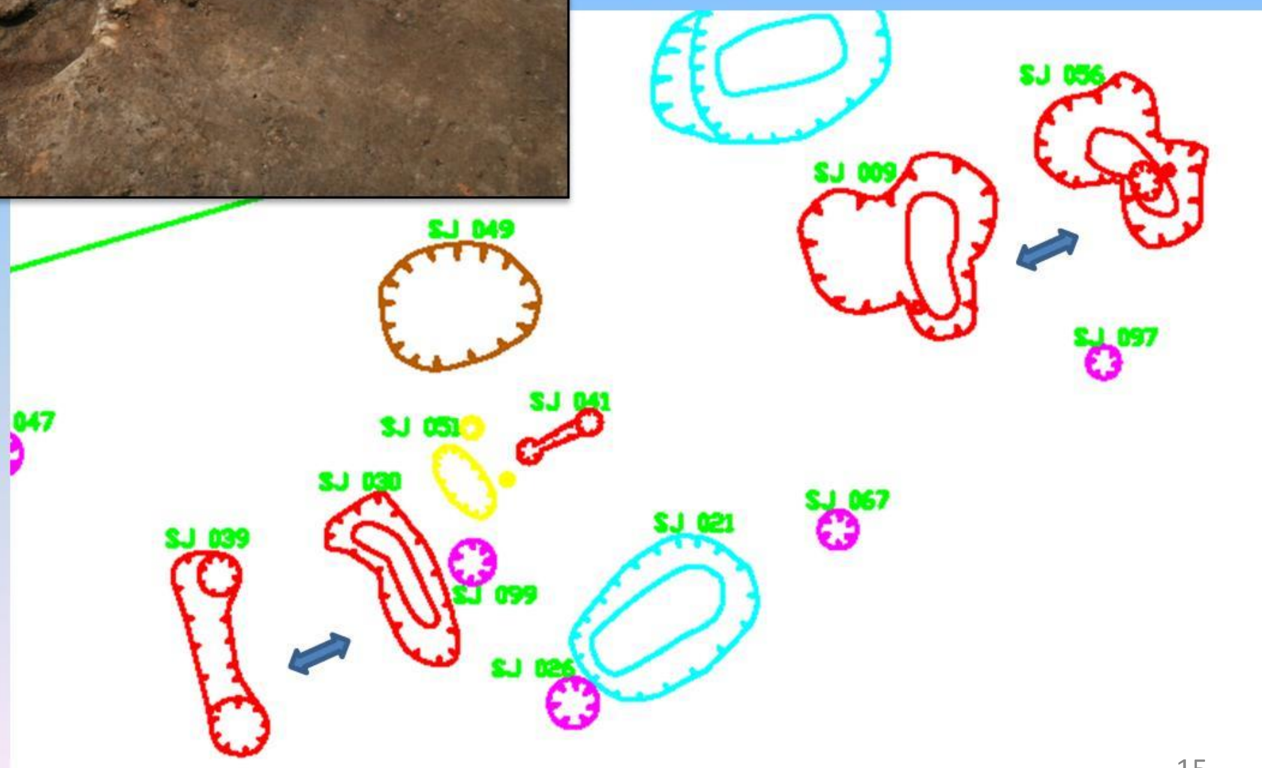


(Pleiner 2000: 258, Fig. 67)

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

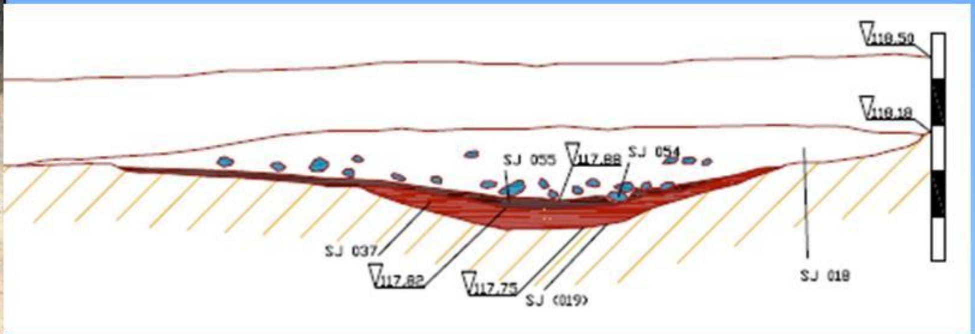
Furnace I.

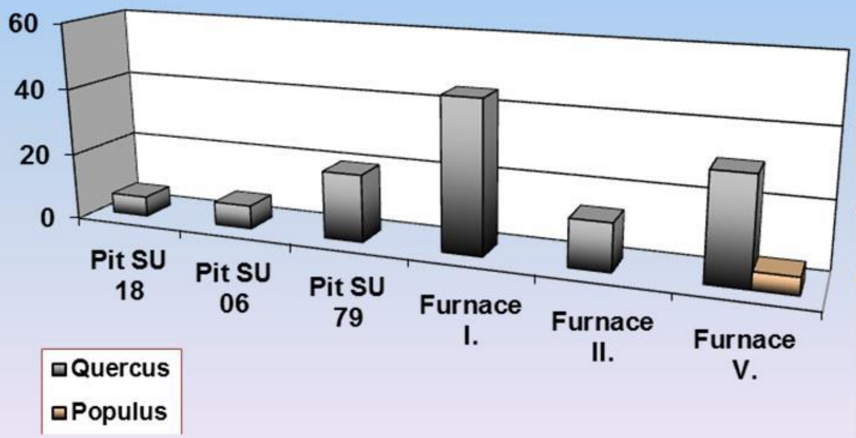
Furnace V.



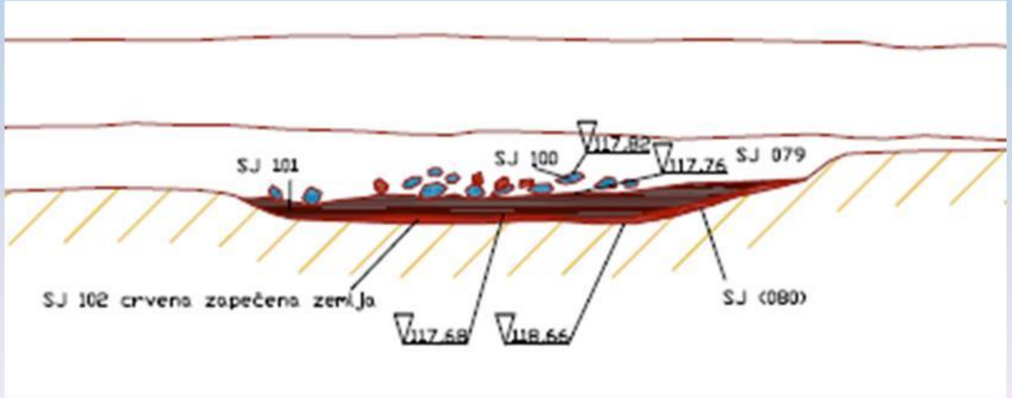
Pits for making charcoal

Pit SU 18

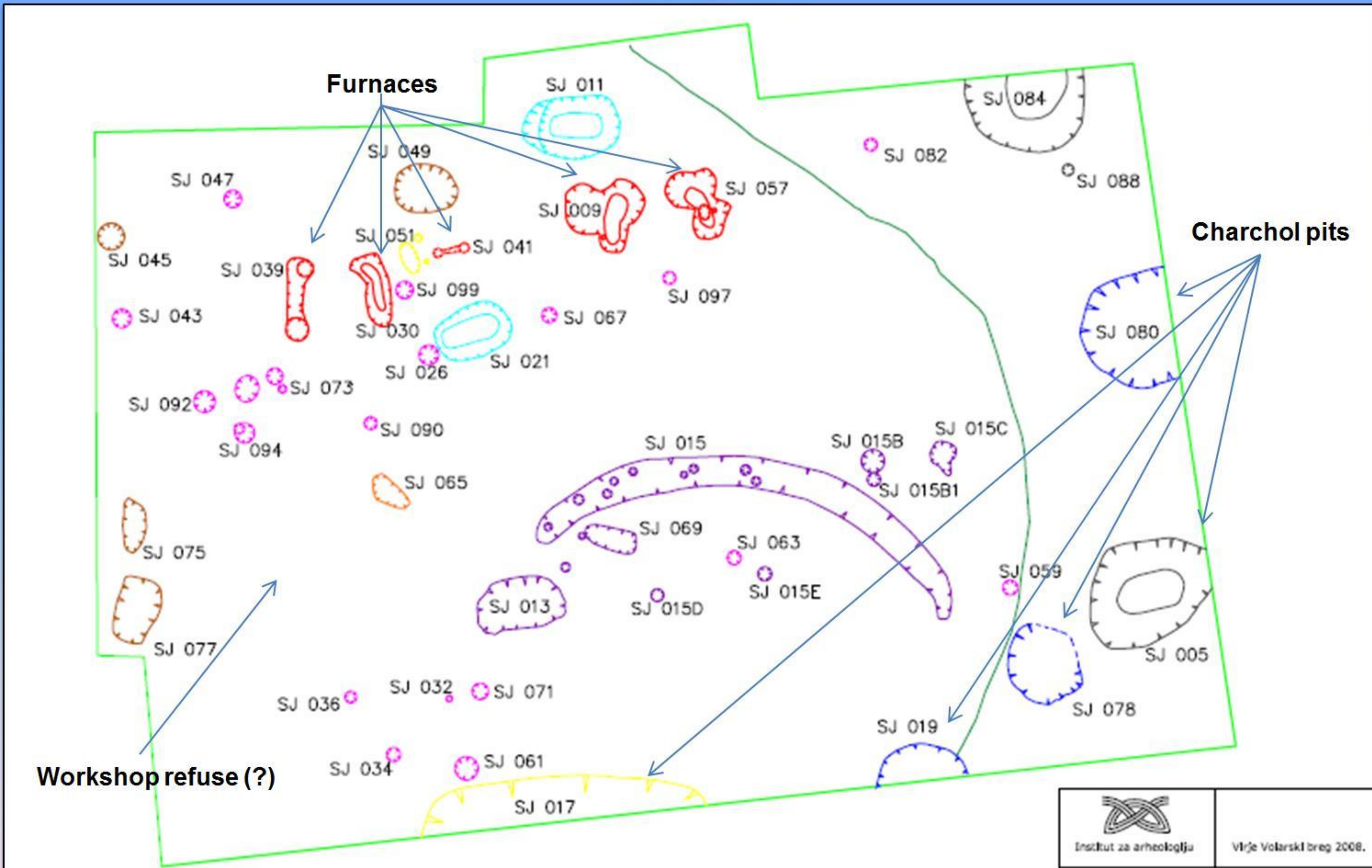




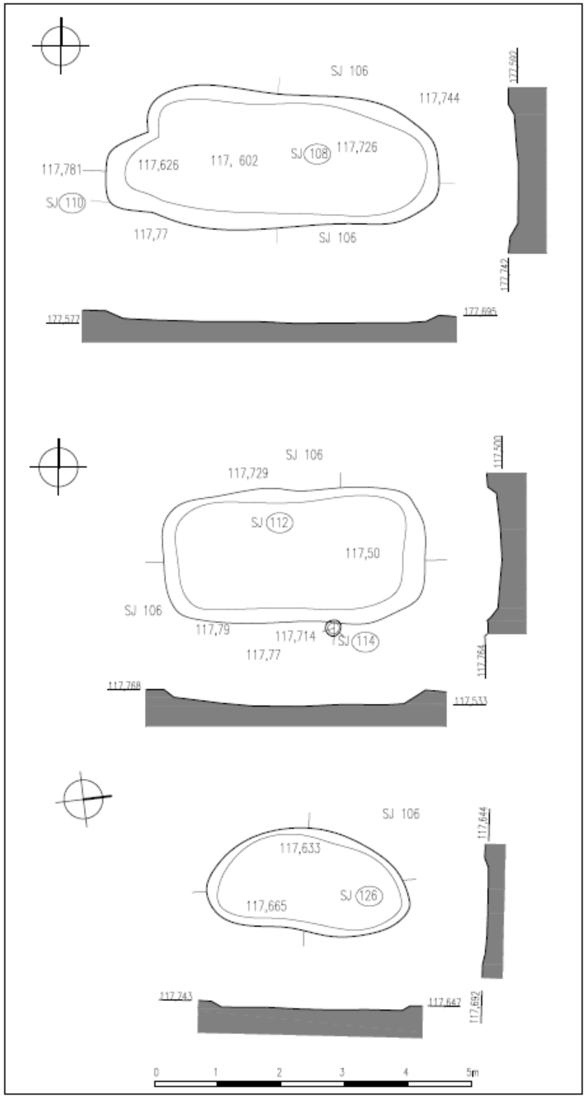
Pit SU 79



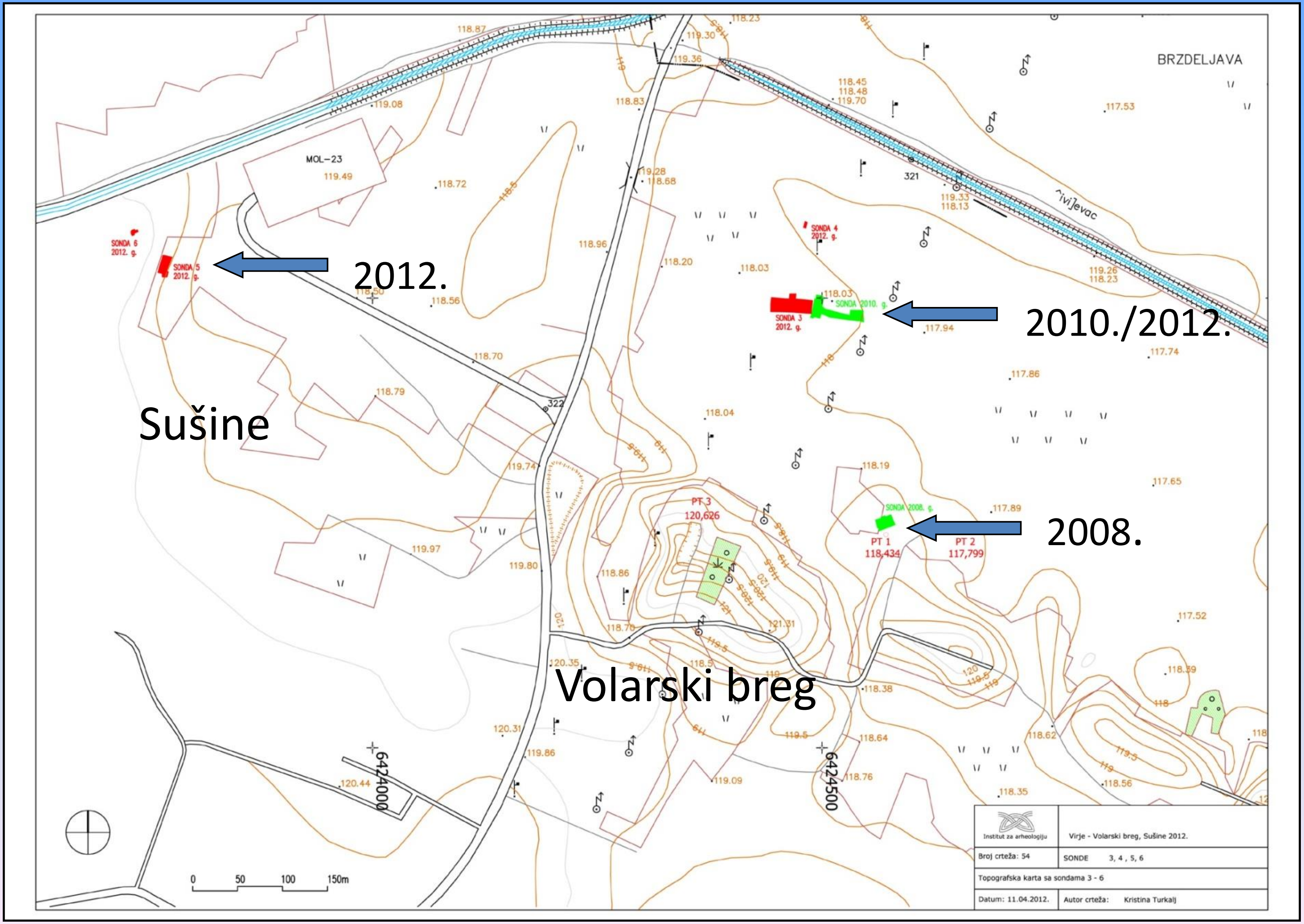
It seems the work in the smelting workshop was organized according to activities



Position Volarski breg - 2010

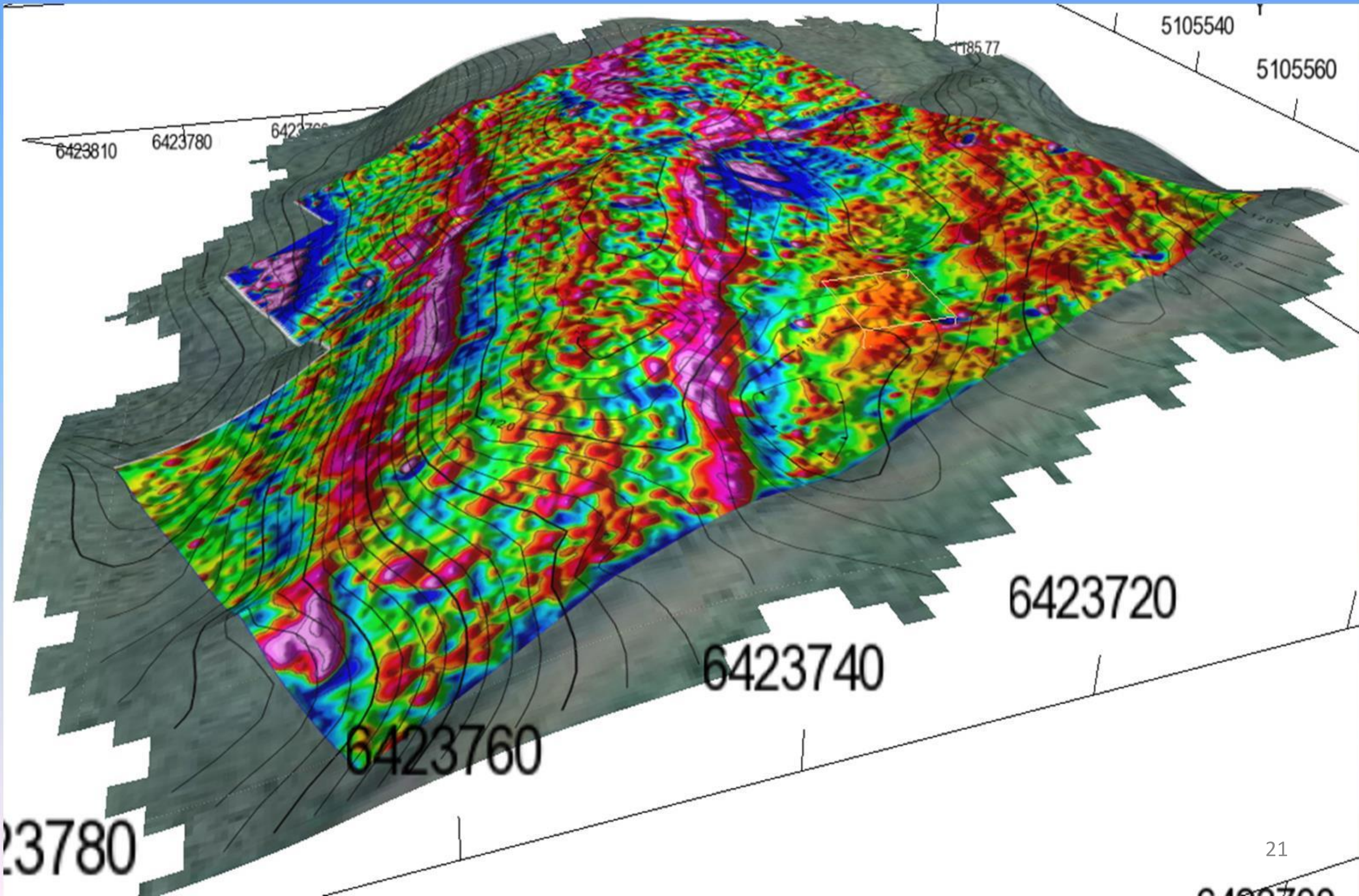


Virje – positions and investigation trenches - 2008 to 2012

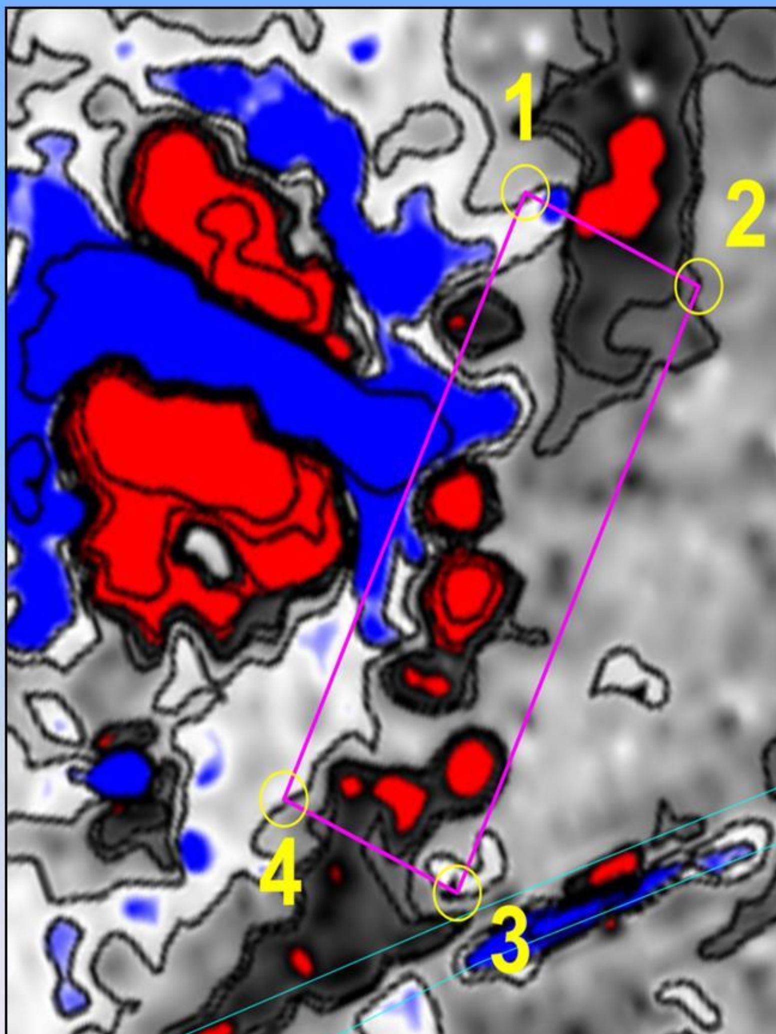


Sušine – surface finds, 2012

Results of the magnetic method on digital terrain model



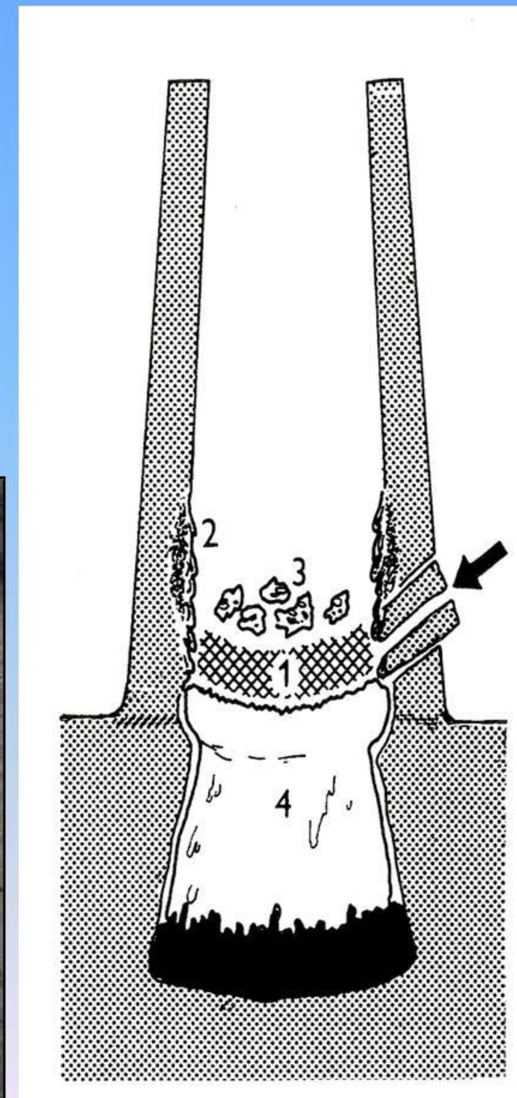
Comparison of results of geophysical and archaeological research - furnace



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

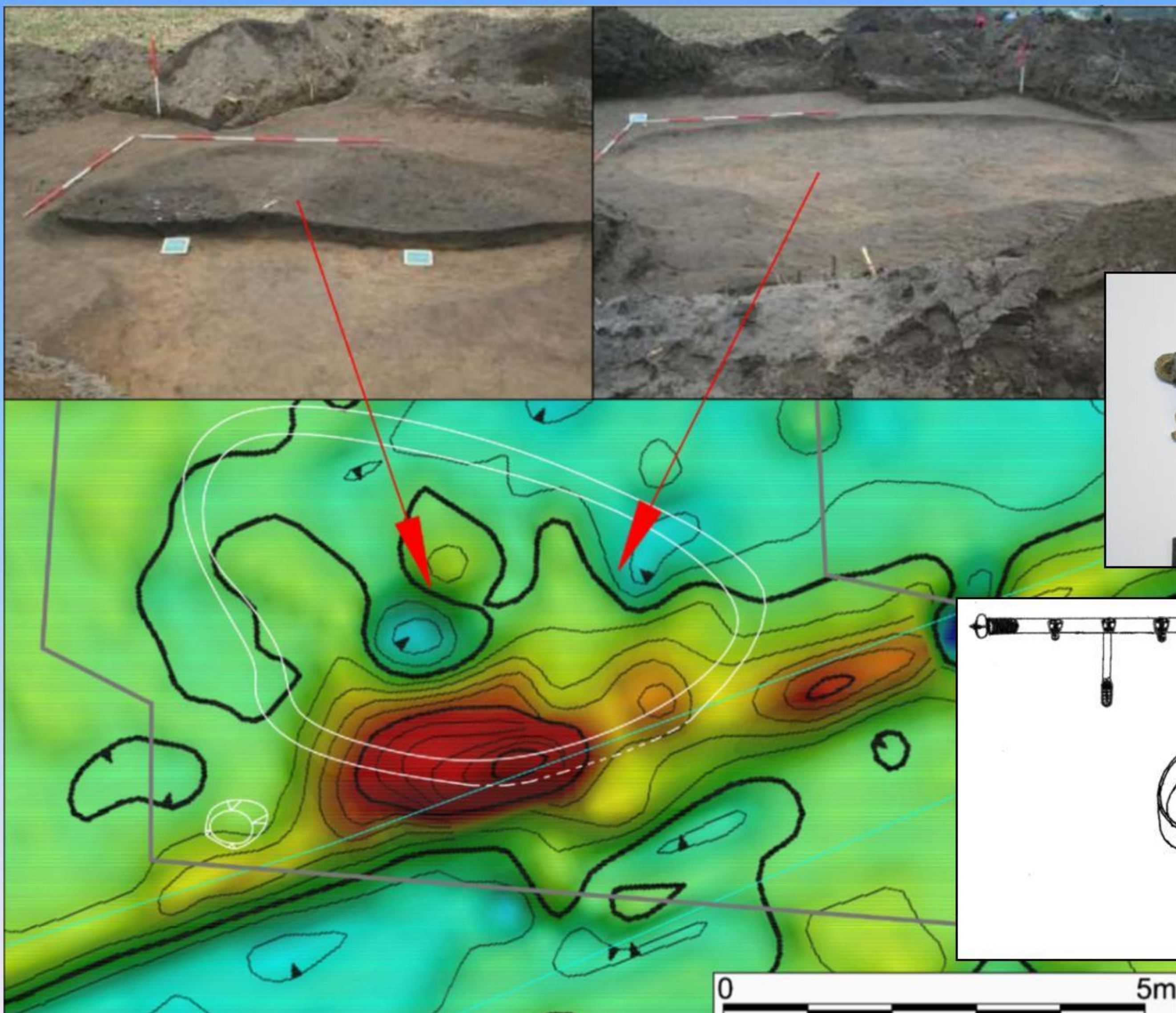
Position Sušine 2013 - smelting furnaces in situ

(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



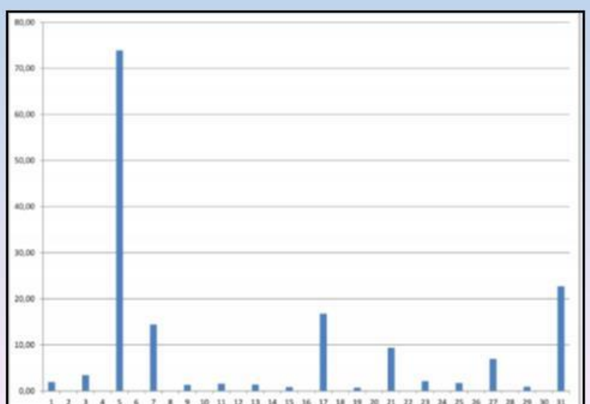
**Part of the belt –
the second half of the 8th
and beginning of the 9th
century**

Source of raw materials?

Analysis of the concentration of iron in the soil :
Dr. sc. Tamara Marković, dipl.ing.geol.

A total of iron,
dissolving the soil sample in aqua regia (HNO_3:HCl):
12 samples= 0,4-5,1 (total Fe (%))

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



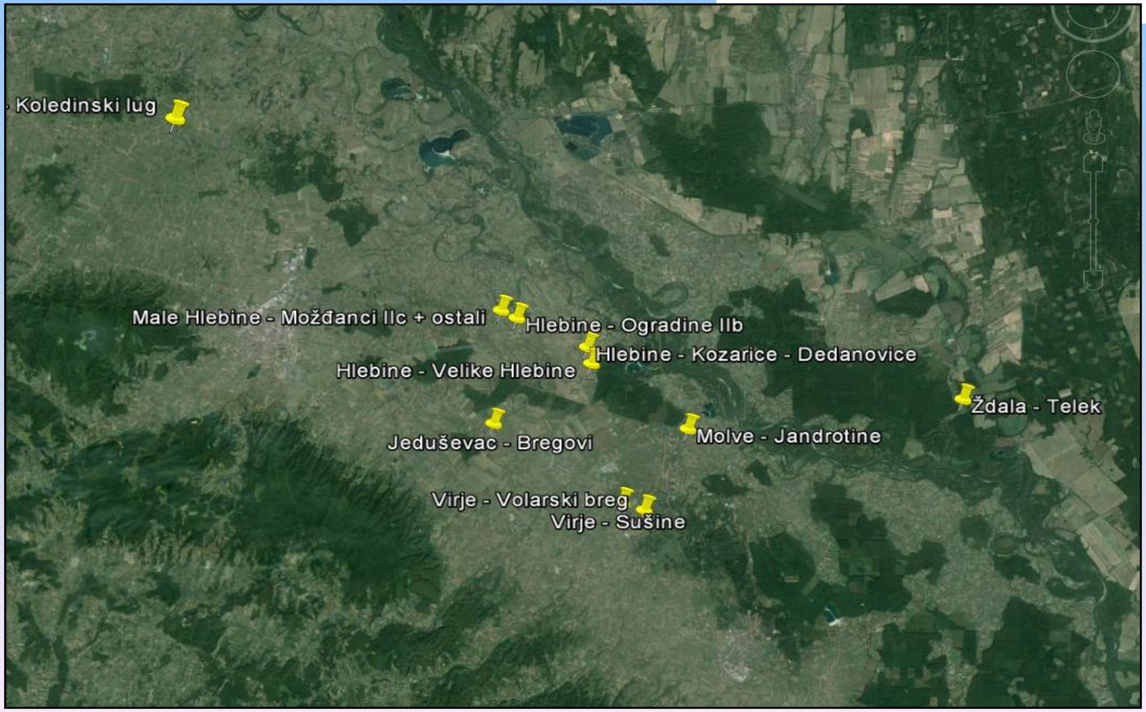
Analys: Gearh d.o.o., doc. dr. sc. Branko Mušič, Slovenia

The results of measurements of the magnetic susceptibility on samples from the excavation - a wide range of measured values:

1. One group of samples below 5x10-3 SI;
2. Another group of samples significantly above this value = samples archaeological assemblages interpreted as furnaces

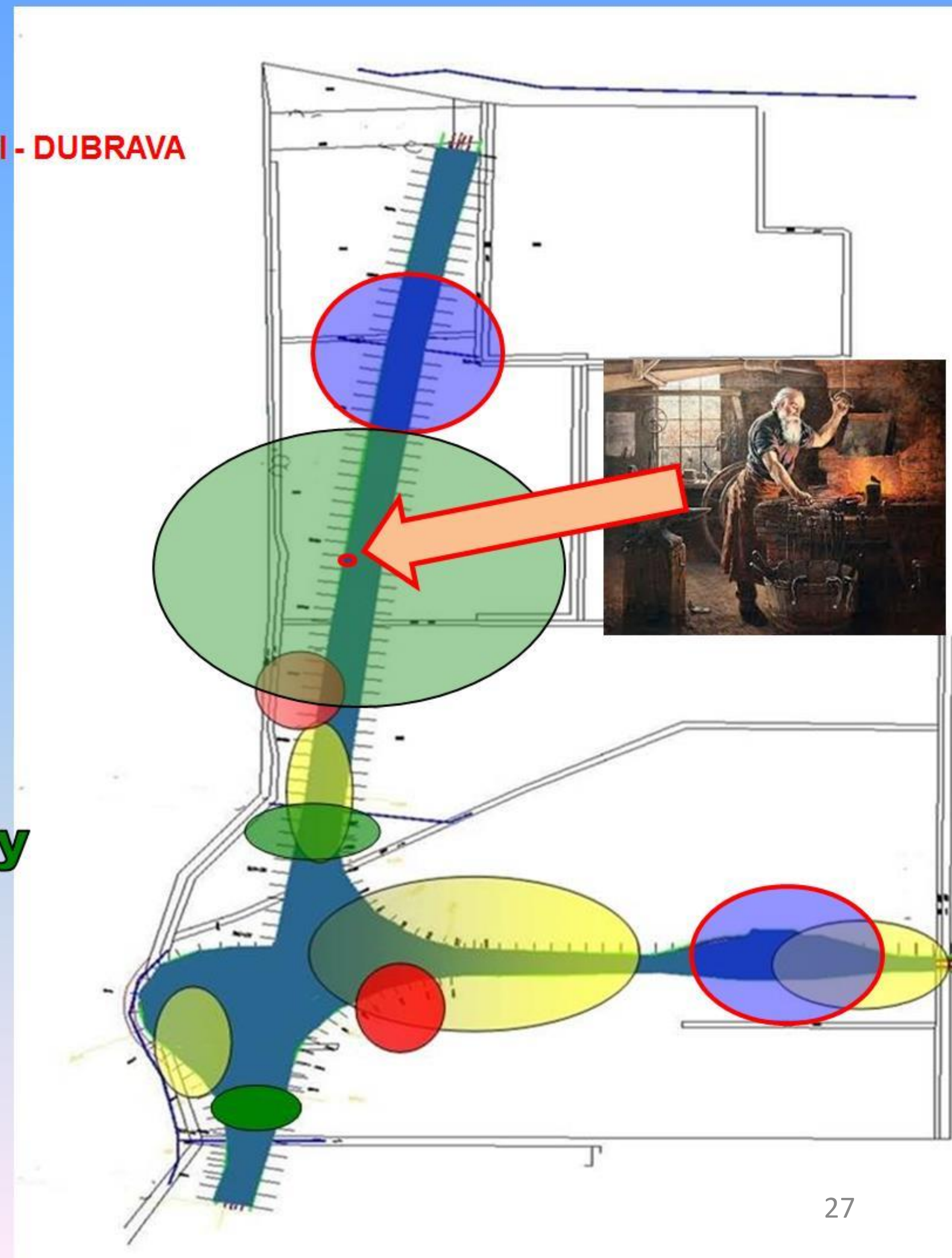
Archaeological sites with traces and / or findings of smelting activities in Croatian and Hungarian part of the Drava valley

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



Virje – Volarski breg and Sušine and several new potential sites in Podravina Region

The archaeological site Čepinski Martinci - Dubrava



Lasinja/Retz-Gajary

Baden

Bronze Age - cemetery

Bronze Age - settlement

Late Antiquity and Early Middle Age settlements

ČMD - 1

SU 5976

Radiocarbon analysis

SU 5976 - *Radiocarbon Age - BP* 1253±23

Isotoptech Zrt.

HEKAL AMS Lab, MTA ATOMKI - Isotoptech Zrt
Bem ter 18/c
H-4026 Debecen
Hungary

One Sigma Ranges: [start:end] relative area
[cal BP 1179: cal BP 1187] 0,144406
[cal BP 1203: cal BP 1256] 0,855594
Two Sigma Ranges: [start:end] relative area
[cal BP 1088: cal BP 1110] 0,034301
[cal BP 1124: cal BP 1138] 0,016645
[cal BP 1145: cal BP 1159] 0,02271
[cal BP 1172: cal BP 1275] 0,926344

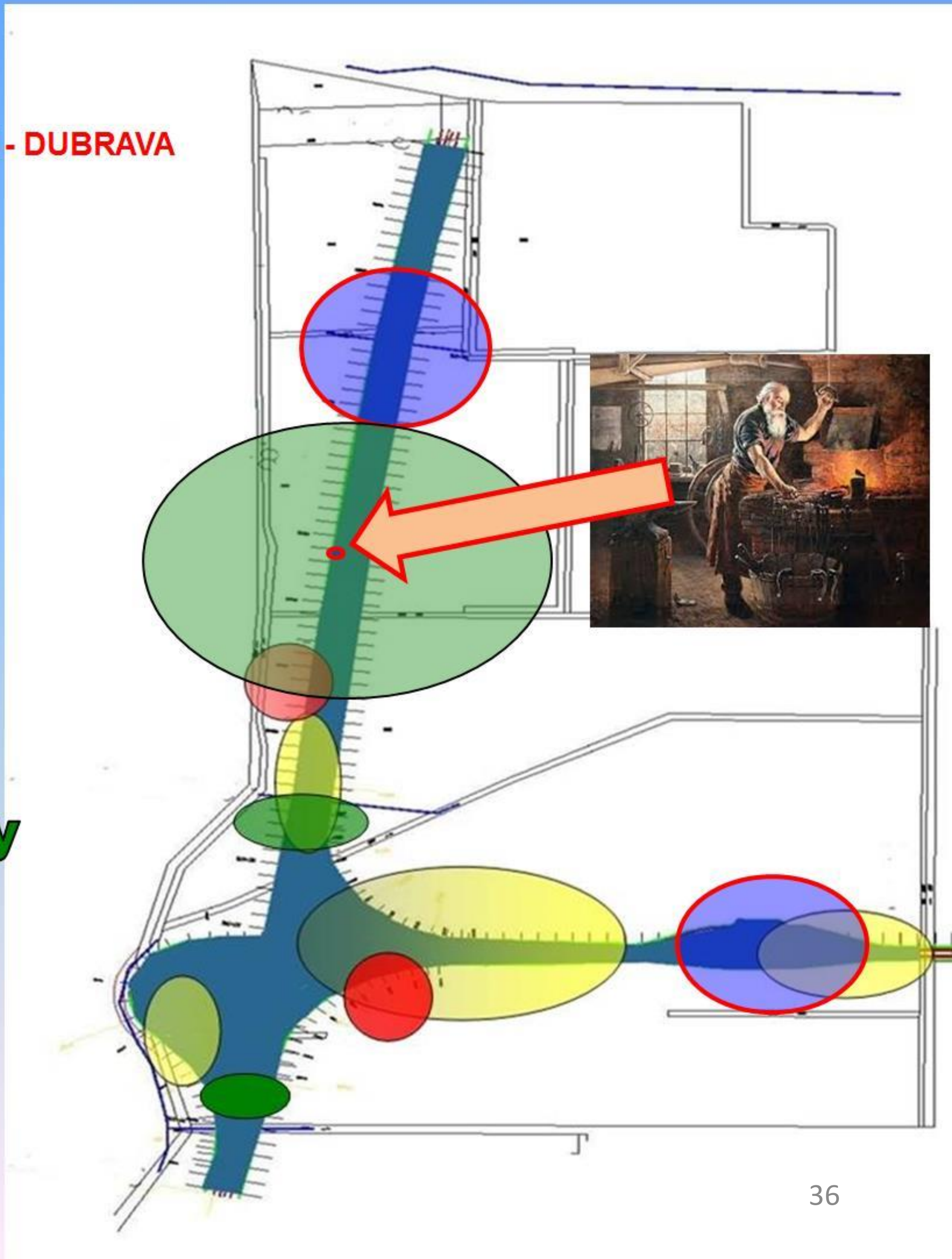
Conventional 14C age (yrs BP) (± 1σ) 1253±23
Calibrated calendar age (cal BP) (1σ) 1179 – 1256

14C-age BP: 1253 ± 23
Calendric Age calBP: 1215 ± 33
68% range calBP: 1181 - 1248

Calendric Age calAD: 735 ± 33

CALPAL

The archaeological site Čepinski Martinci - Dubrava



Lasinja/Retz-Gajary

Baden

Bronze Age - cemetery

Bronze Age - settlement

Late Antiquity and Early Middle Age settlements

Project: TransFER (2017-2021)

Proizvodnja željeza uz rijeku Dravu u antici i srednjem vijeku: stvaranje i transfer znanja, tehnologija i roba

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

Leader: Phd Tajana Sekelj Ivančan, Institute of Archaeology, Zagreb, Croatia
Funded by: Croatian Scientific Fundation

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

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