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The 5th Geoarchaeological Conference

*Late Antiquity and Migration Period in the light of
geoarchaeological records from the eastern Mediterranean, eastern Adriatic
and adjacent regions*

Zagreb, 23rd–24th October 2018

Dynamics of activities related to smelting economy during Late Antiquity and early Middle Ages – case study of Virje and Hlebine

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TransFER



Project: TransFER (2017-2021)

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

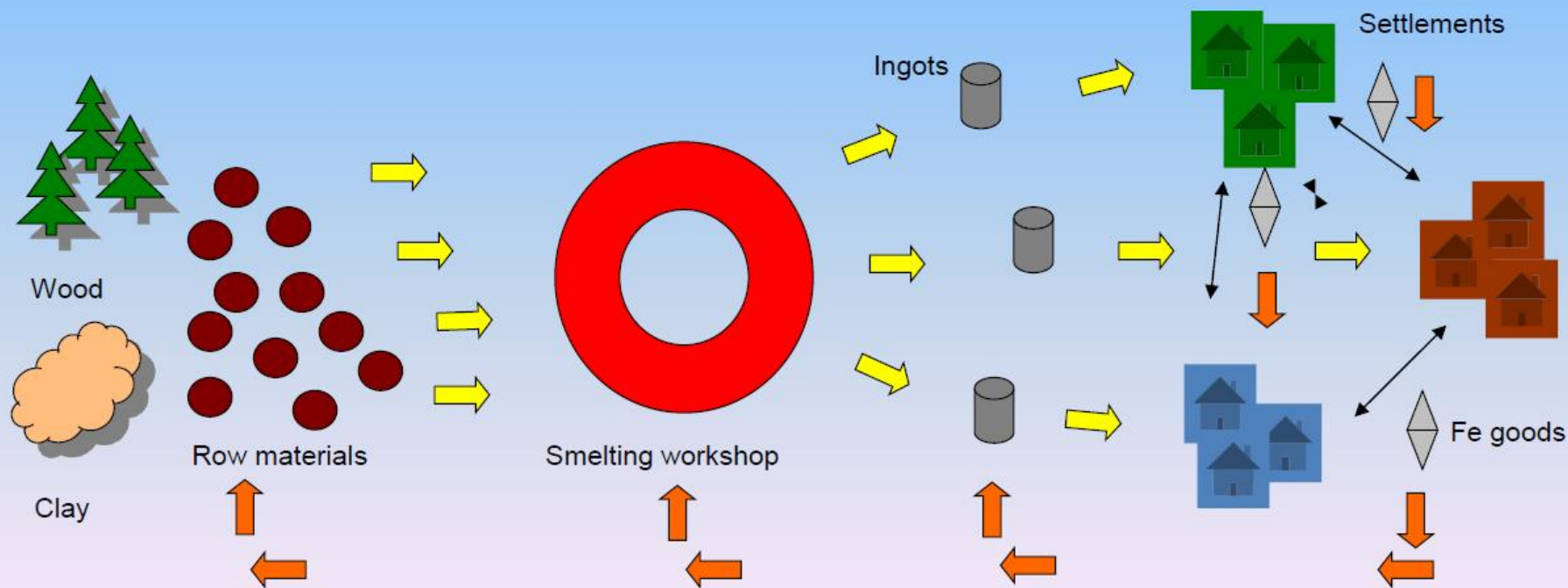
Iron production along the Drava River in the Roman period and the Middle Ages: Creation and transfer of knowledge, technologies and goods

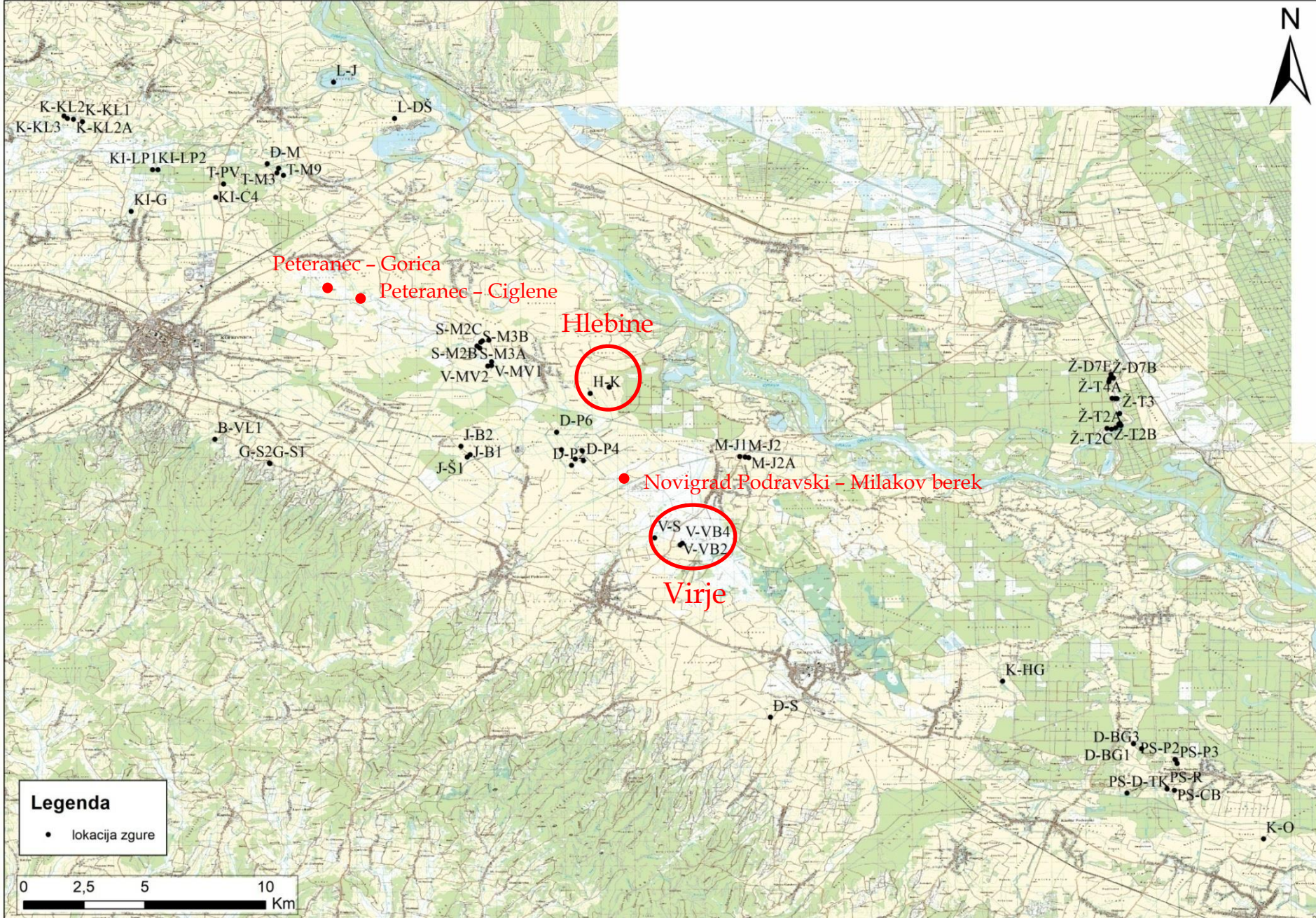
Leader: Phd Tajana Sekelj Ivančan, Institute of Archaeology, Zagreb, Croatia

Funded by: Croatian Scientific Foundation

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



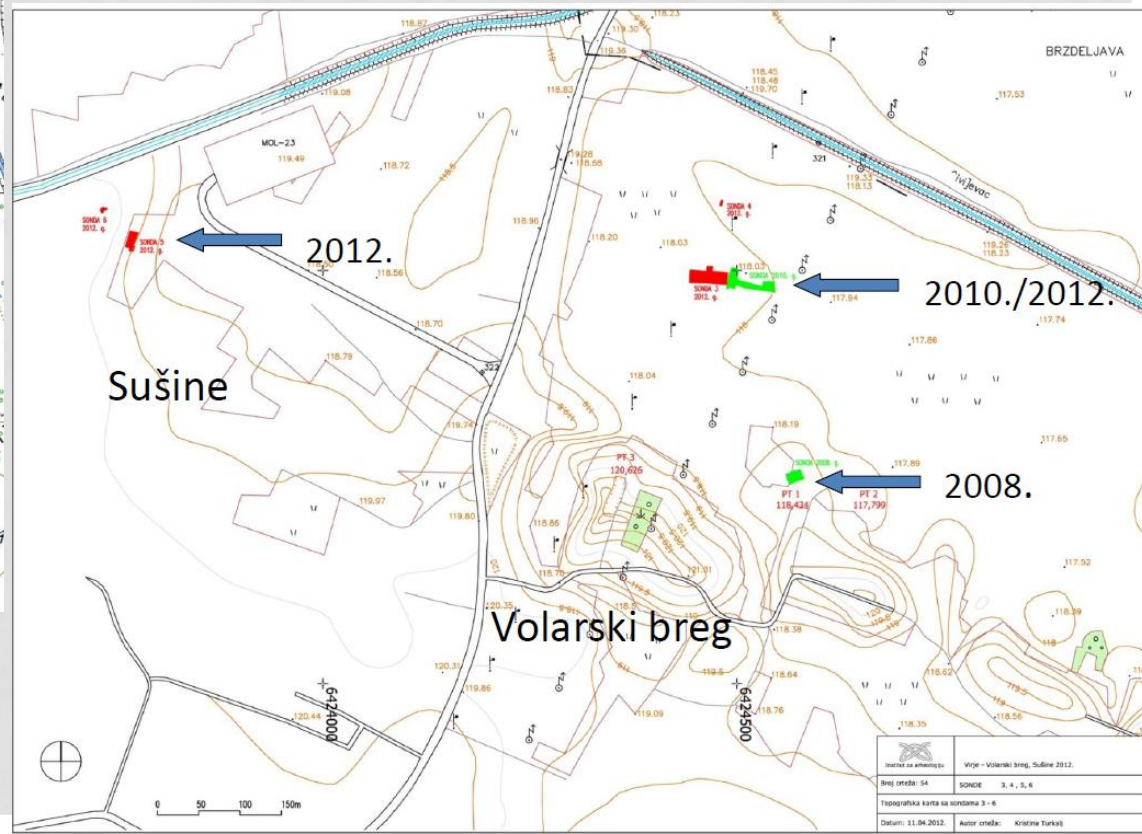
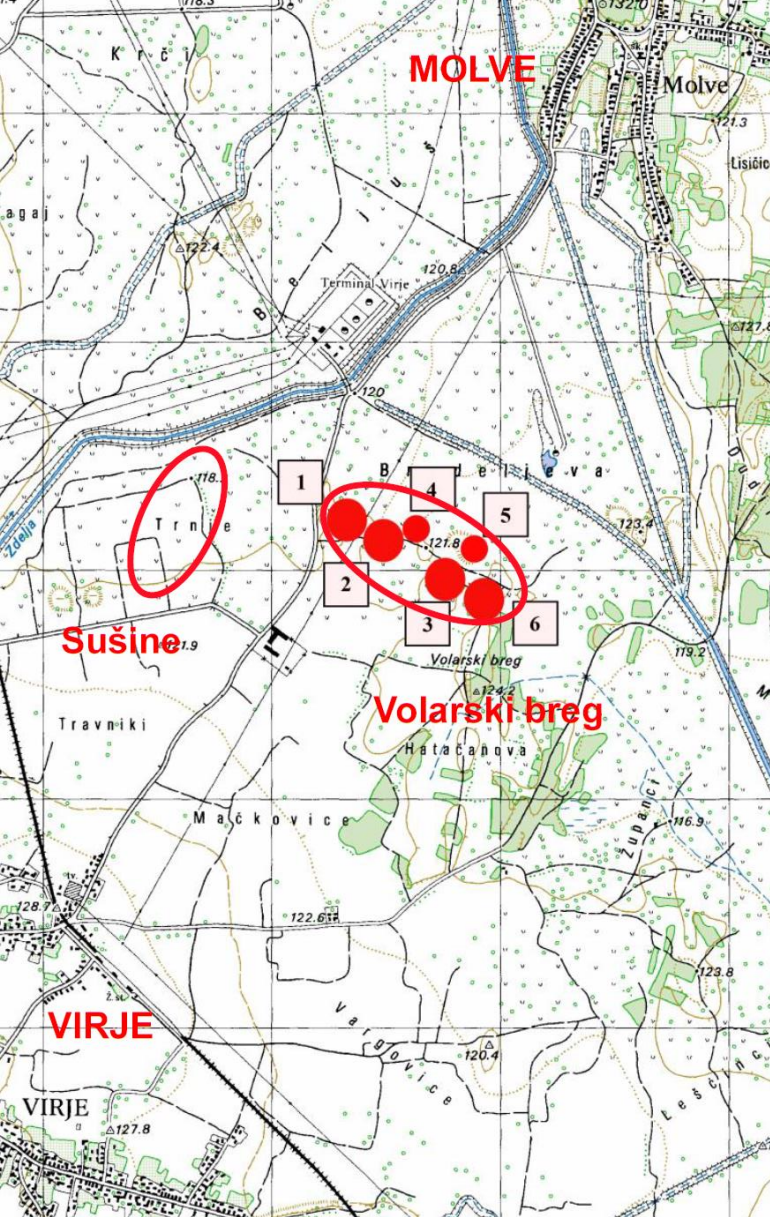


Topographic map of the Drava River basin with positions of archaeological sites with recorded smelting features (slag)
(made by: T. Brenko, Univ. of Zagreb, Faculty of Mining, Geology and Petroleum Engineering, Department for Minerology, Petrology and Mineral sources; Valent et al. 2017: 7)

Virje – Volarski breg and Sušine

- the site is located between villages Virje and Molve in Koprivnica-Križevci County, Croatia
- surface 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



(Tkalčec, Sekelj Ivančan 2017)

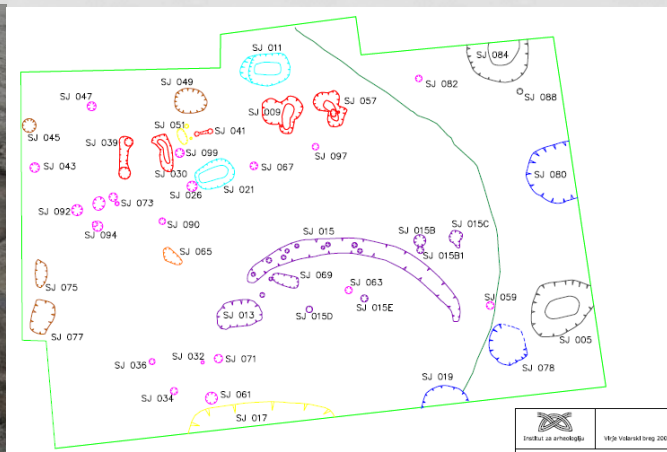
Virje –Volarski breg 2007, surface finds (photo: T. Sekelj Ivančan)



(Sekelj Ivančan 2017; Tkalčec, Sekelj Ivančan 2017; Sekelj Ivančan, Hrovatin 2017; Valent 2018)



(photo: T. Tkalčec)



(made by: K. Jelinčić)

Trench 1 – 230 m²:

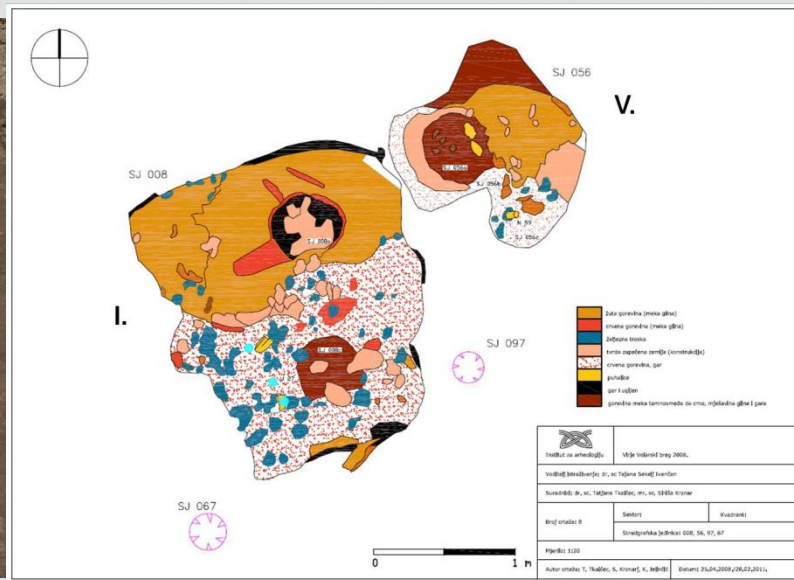
- 5 smelting furnaces *in situ* (red)
- 4 dislocated remains of destroyed furnaces (brown)
- 5 pits with burned bottoms (blue)
- 1 fence and numerous postholes (violet)

(Tkalčec, Sekelj Ivančan 2017;
Valent 2018)

Virje –Volarski breg 2008



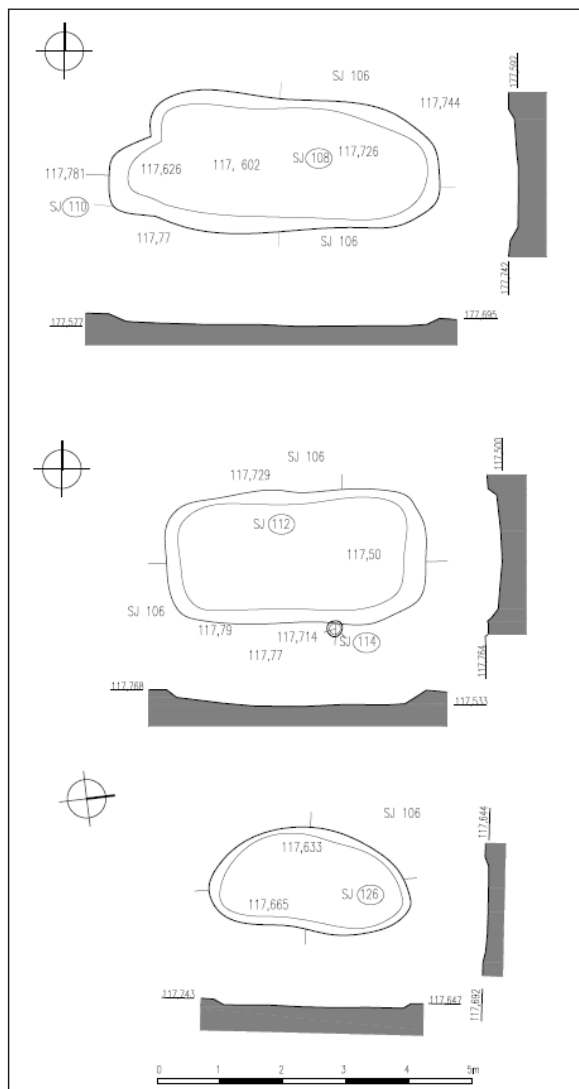
(photo: T. Sekelj Ivančan)



(made by: T. Tkalčec, S. Krznar, K. Jelinčić)

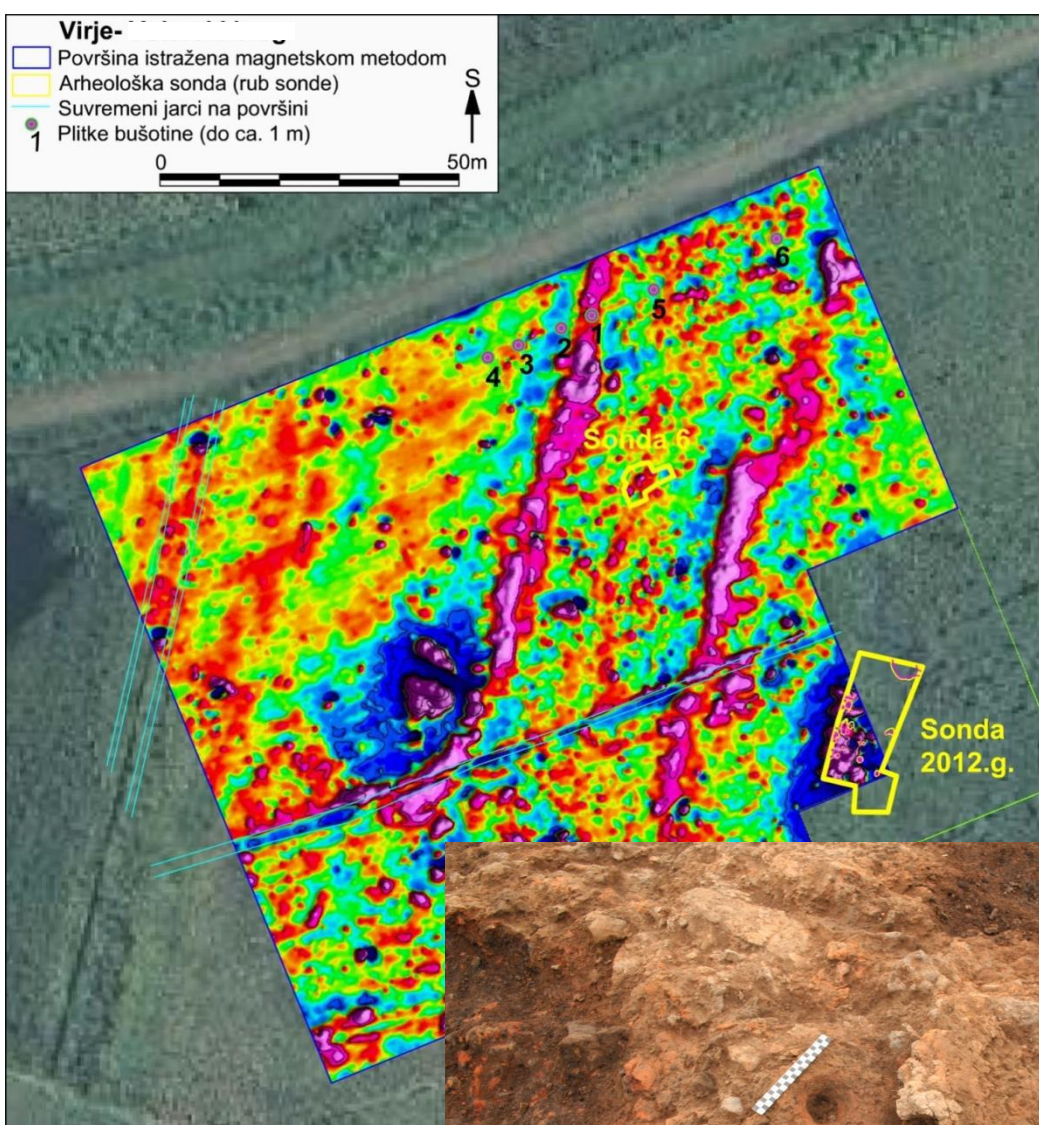
(Tkalčec, Sekelj
Ivančan 2017; Valent
2018)

Virje –Volarski breg 2010, settlement indicators



(Tkalčec, Sekelj Ivančan 2017)





Trench 5 -202 m²
over 1 tone of slag

(Valent 2018)





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

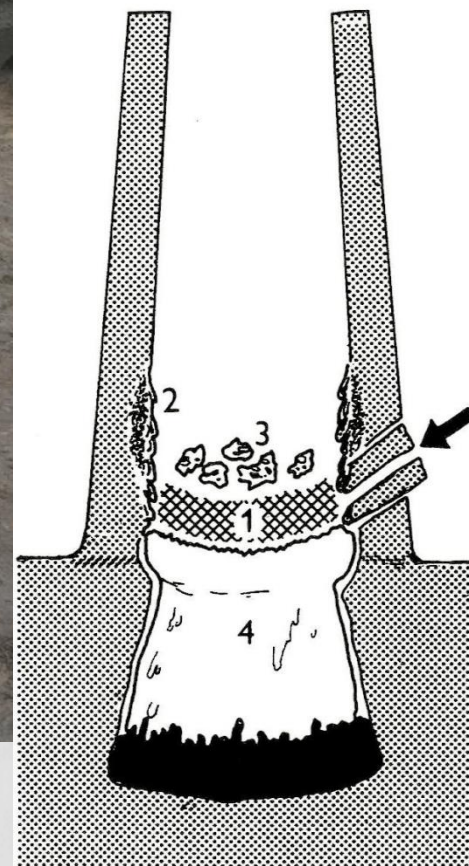


(Tkalc̃ec, Sekelj Ivančan 2017)

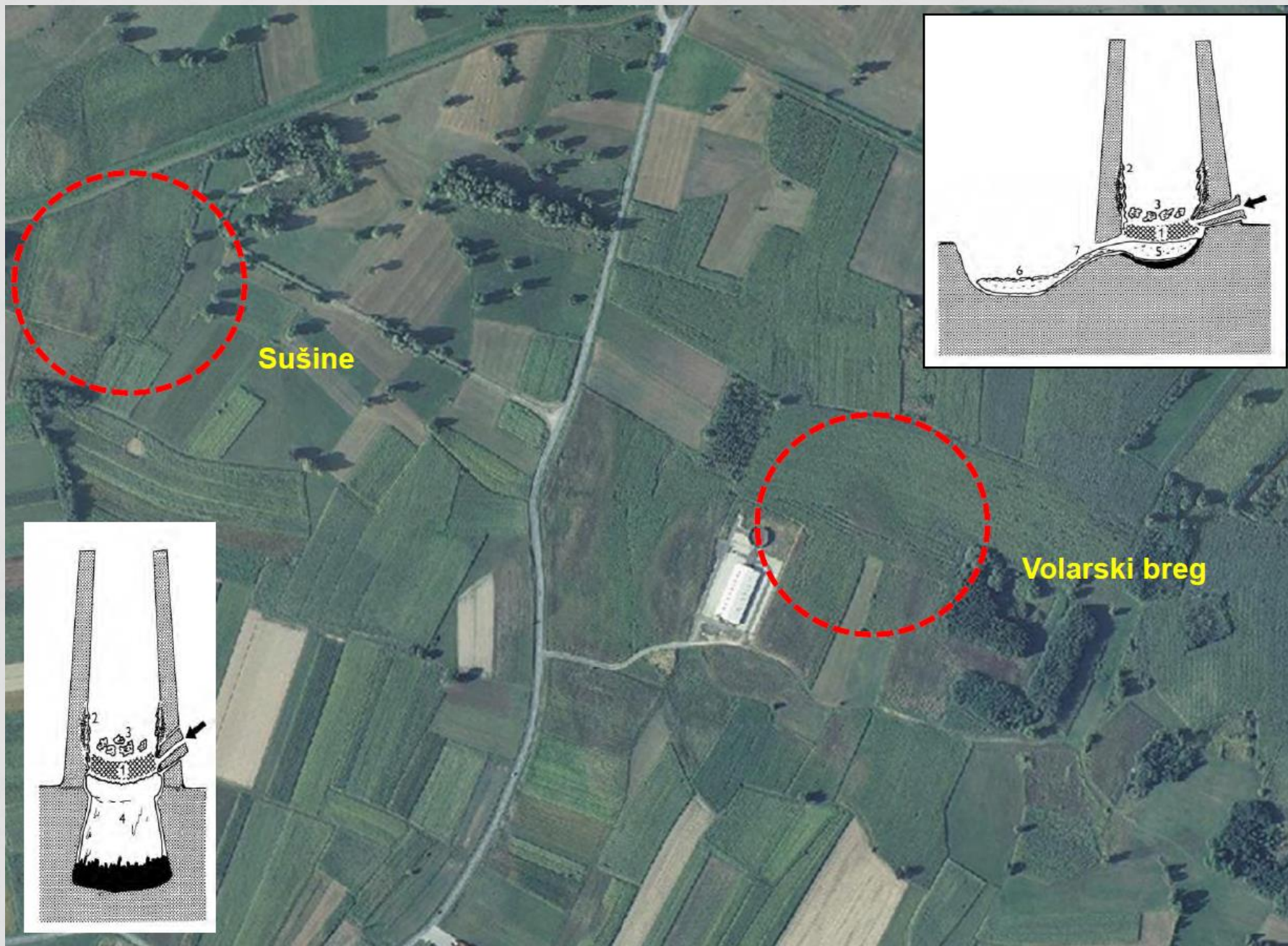
Virje – Sušine 2013

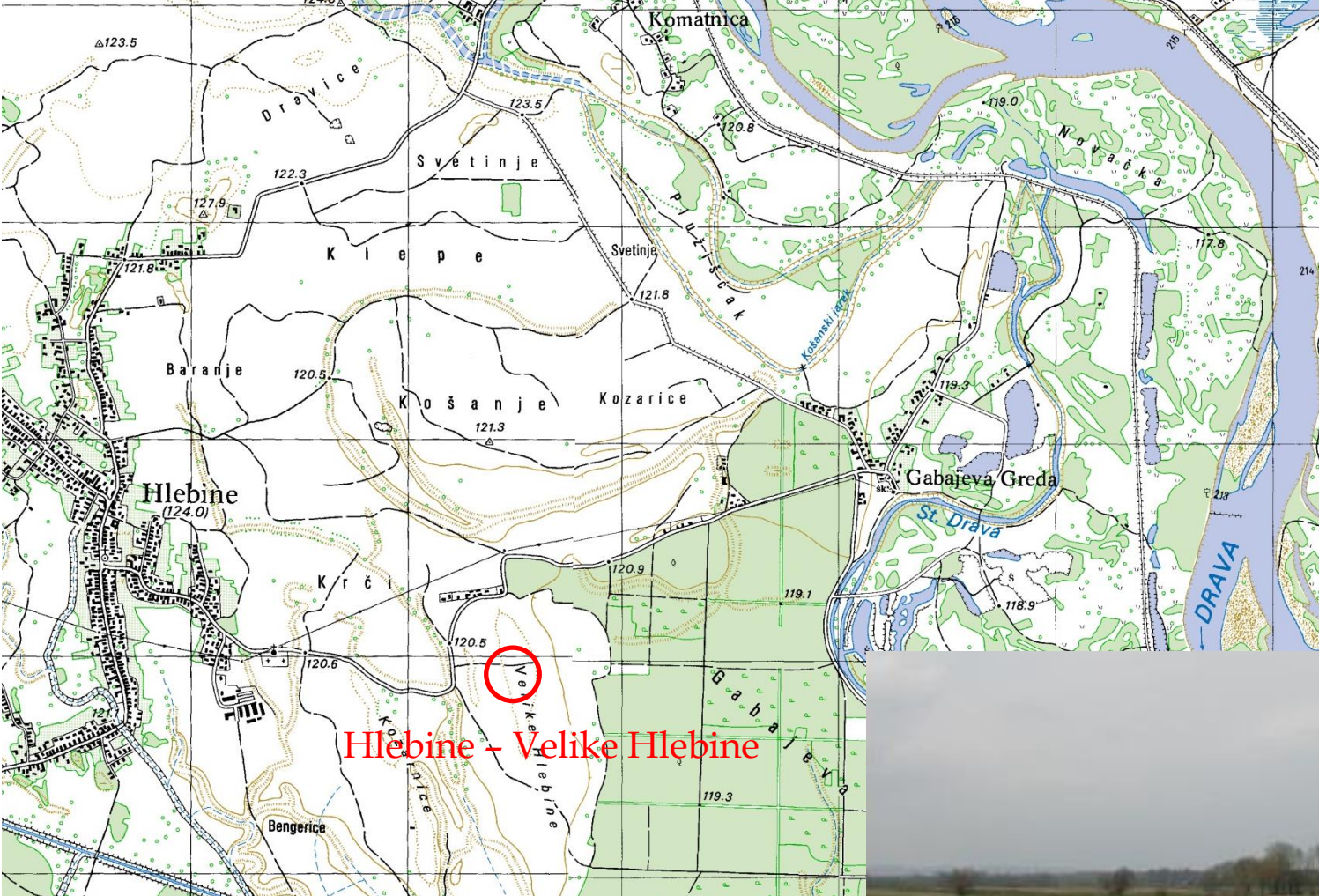


(Pleiner 2000: Pl. IX, Romano-Barbarian sleg pit furnaces in Jutland, Drengsted, Denmark)



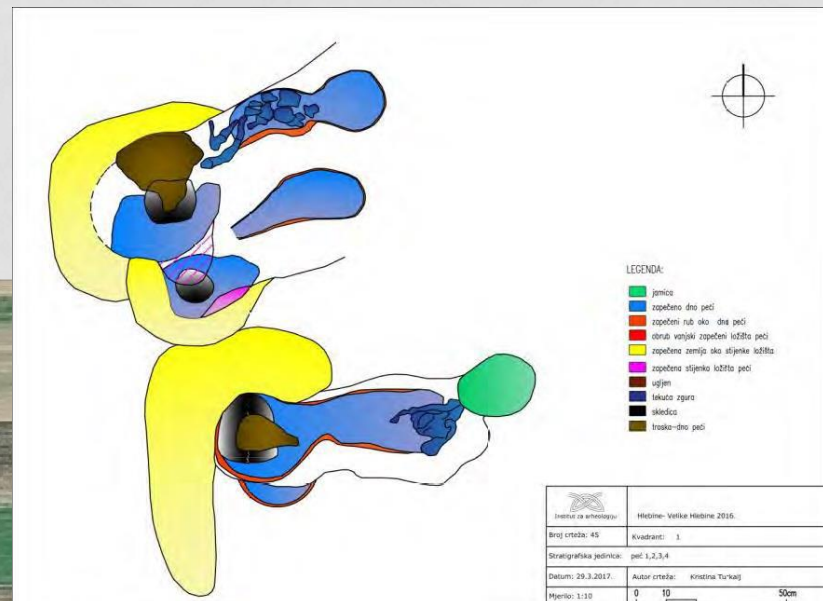
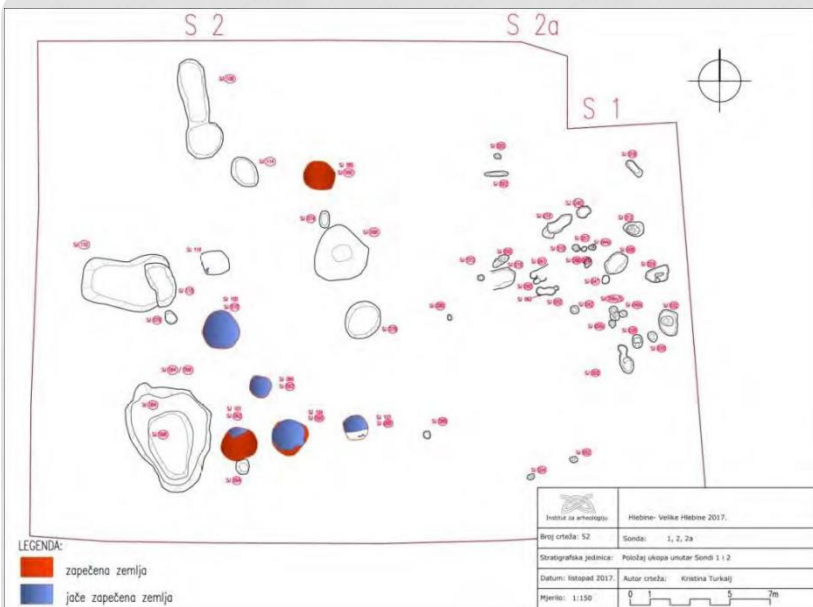
(Pleiner 2000: Fig. 67, Left, slag pit furnace)





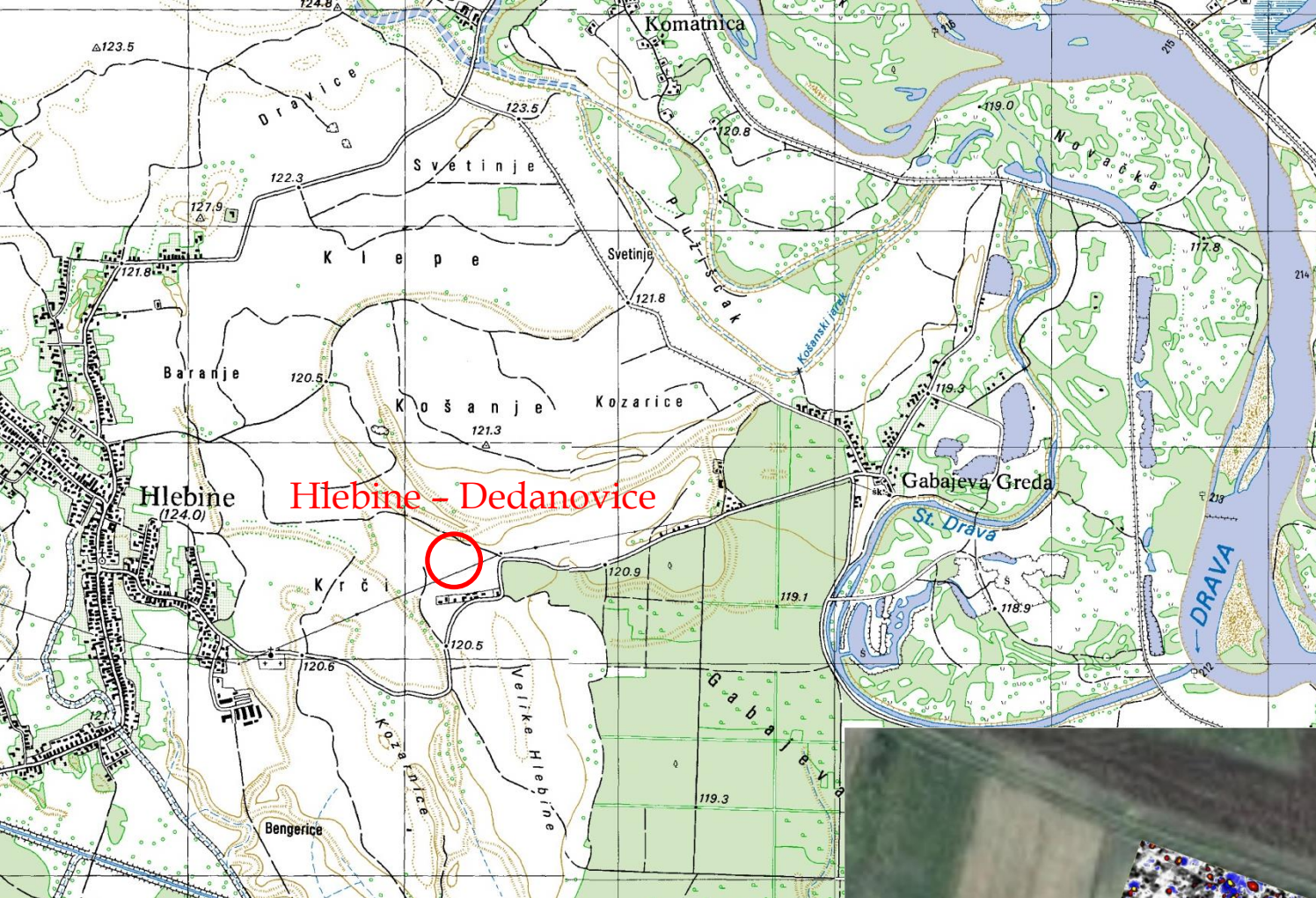
Hlebine – geophysical survey 2015





(made by: K. Turkalj)

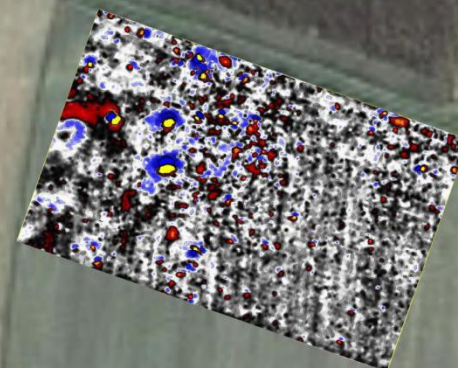
(Valent 2018)



(Valent 2018)

Hlebine - Dedanovice

(B. Mušić, Univerza v Ljubljani, Filozofska fakulteta, Oddelek za arheologijo)



0 40m



Problems:

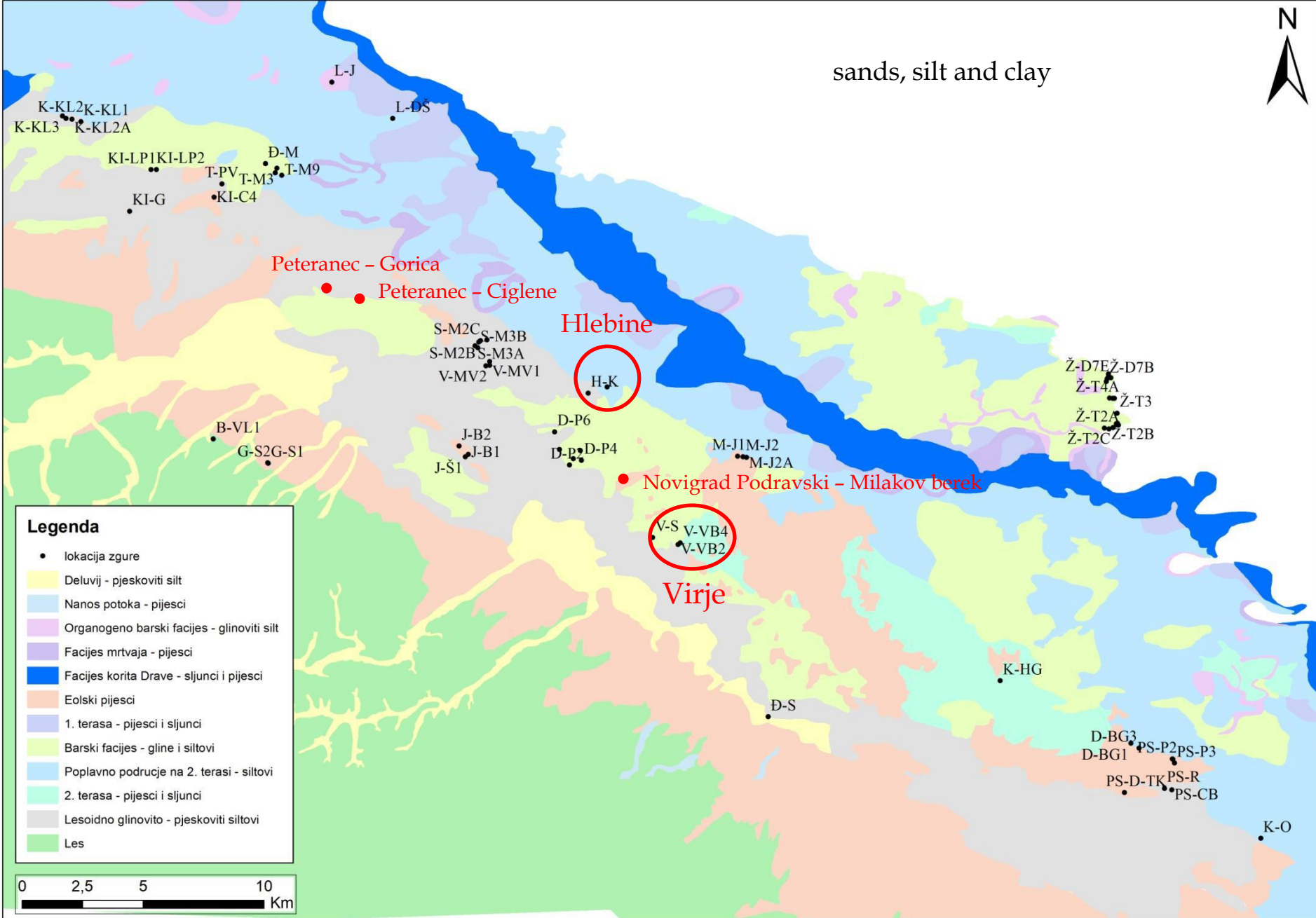
- no remains of material (such as pottery or metal finds) in furnaces or other distinctive elements that would allow dating of archaeological features
- technology of obtaining iron from iron ore remained almost unchanged from the La Tène through Roman period to the Middle Ages
- furnace walls, slag and nozzles have unchanged form through all three periods and can't be dated

(Tkalčec, Sekelj Ivančan 2017)

Most of the sites can only be dated by ^{14}C

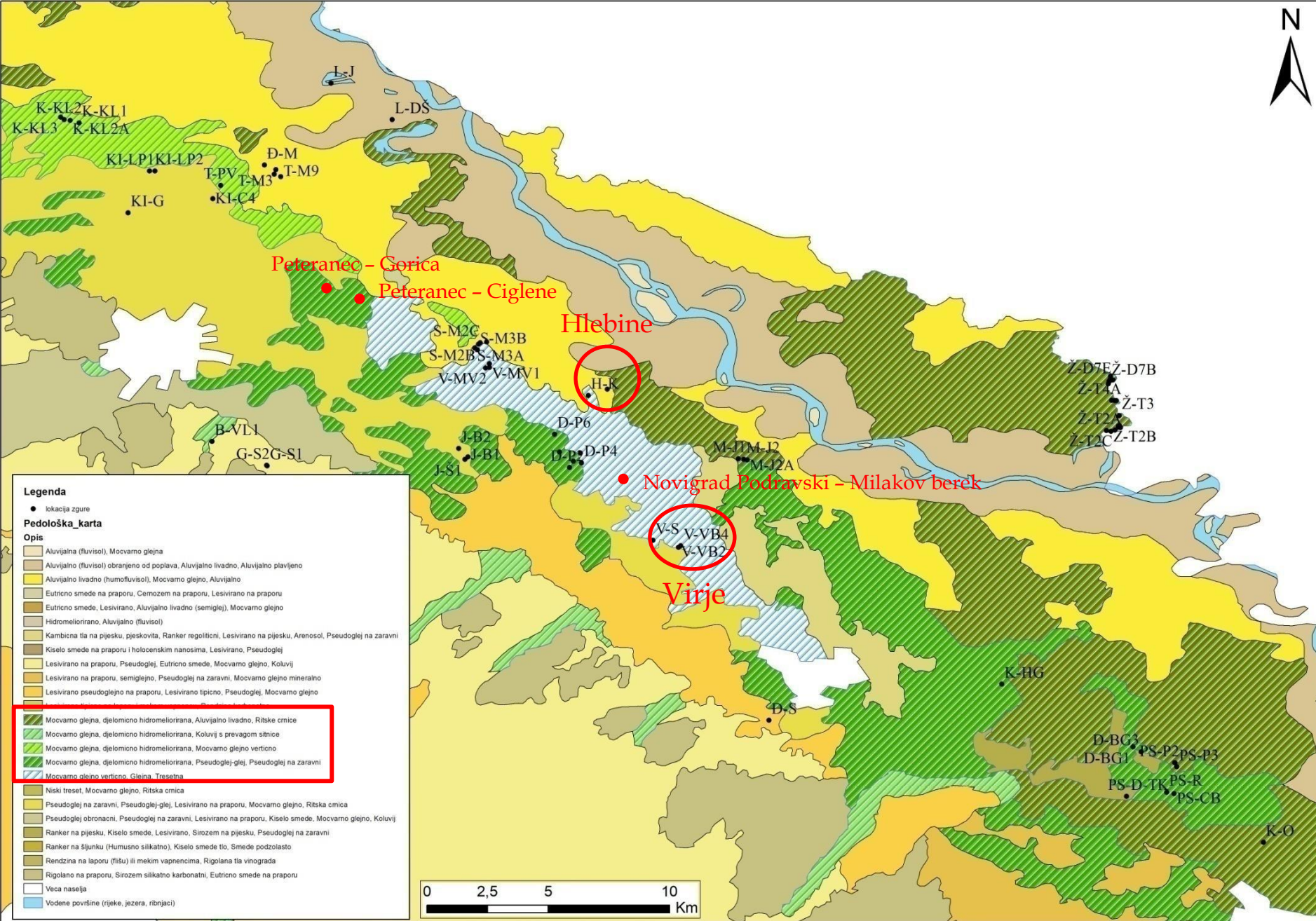


sands, silt and clay



Geologic map of the Drava River basin with positions of archaeological sites with recorded smelting features (slag)

(made by: T. Brenko; Valent et al. 2017: 8)



Pedological map of the Drava River basin with positions of archaeological sites with recorded smelting features (slag)
(made by: T. Brenko; Valent et al. 2017: 9)

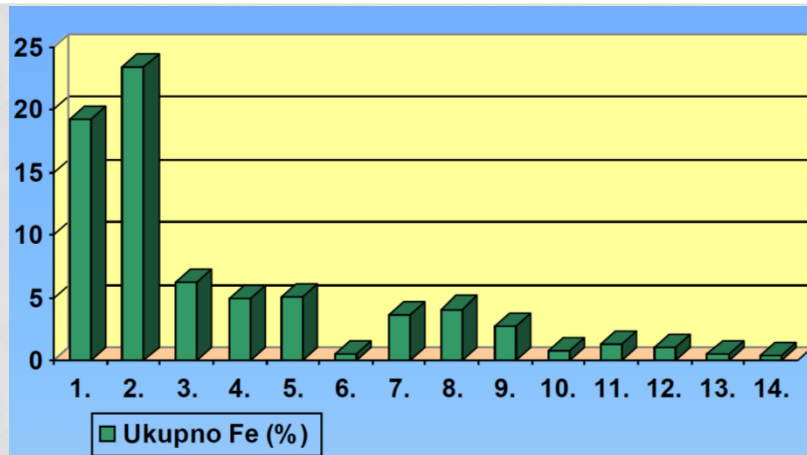


Bacteria *Leptothrix* (better iron deposition)

goethite

oolithic iron ore layer (Valent et al. 2017: 11) is naturally renewed by regular flooding

Virje – Volarski breg 2007 (photo: T. Sekelj Ivančan)



Virje – analysis of the concentration of iron in the soil, 14 samples (T. Marković)



A total of iron, dissolving the soil sample in aqua regia ($\text{HNO}_3:\text{HCl}$):
12 samples = 0,4-5,1 (Total Fe %)

SU 173 = 19,3 (Total Fe %)

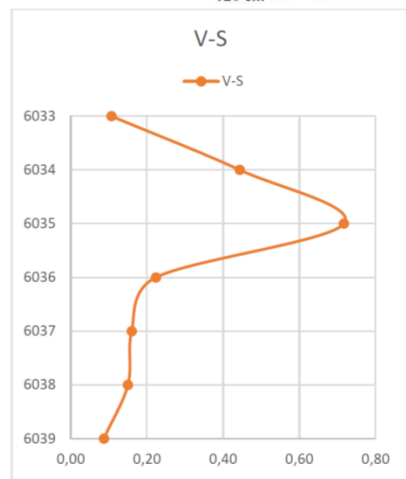
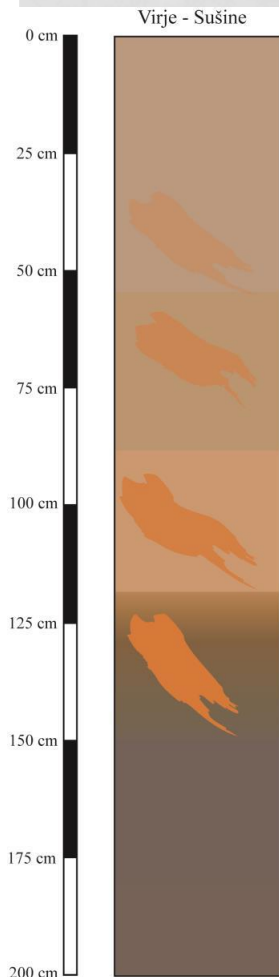
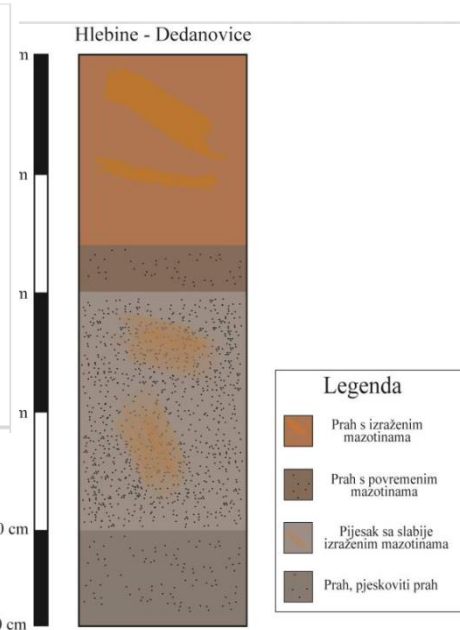
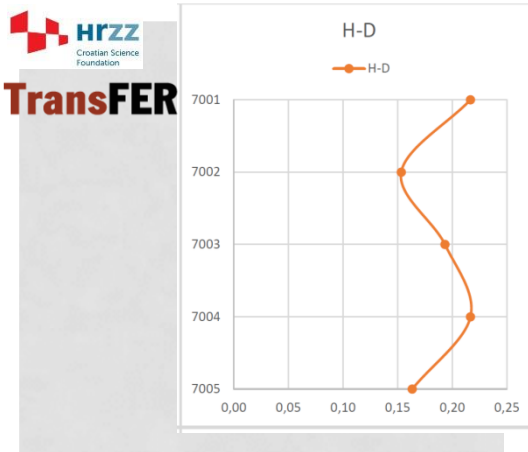
SU 197 = 23,4 (Total Fe %)



20% of Fe = iron ore source

(Sekelj Ivančan, Marković 2016;
Sekelj Ivančan, Hrovatin 2017)





clayey silt

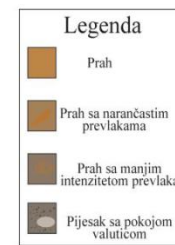
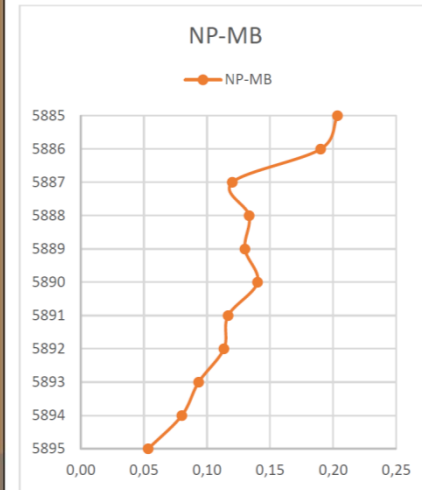
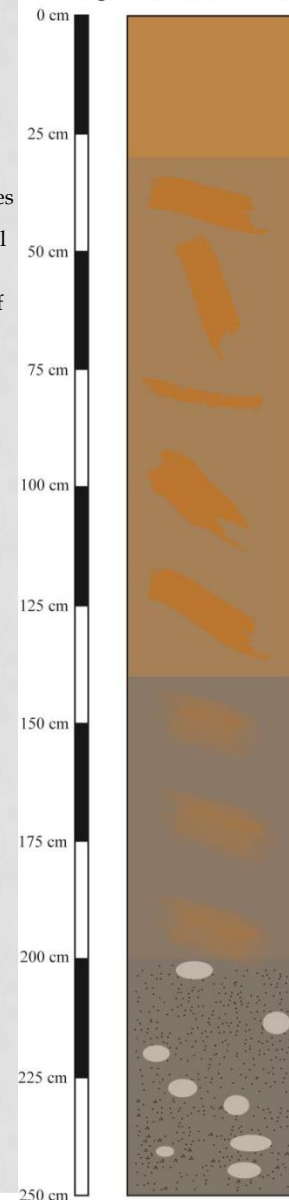
silt with occasional traces

silt with orange traces of middle intensity

silt to clay transition with clear traces
clay

goethit

Novigrad Podravski - Milakov Berek

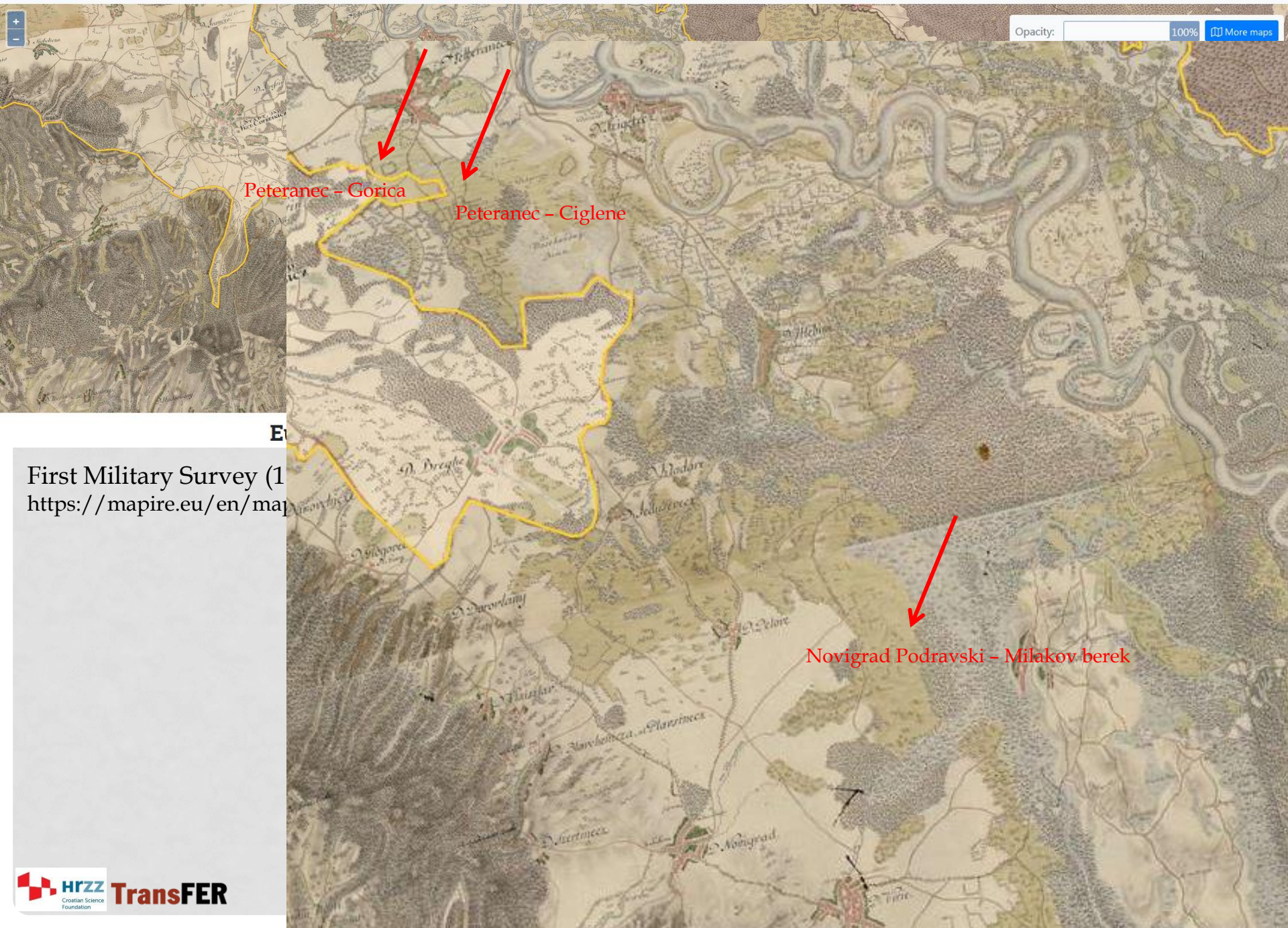


silt

silt with orange traces

silt with traces of low intensity

sand with the occasional gravel



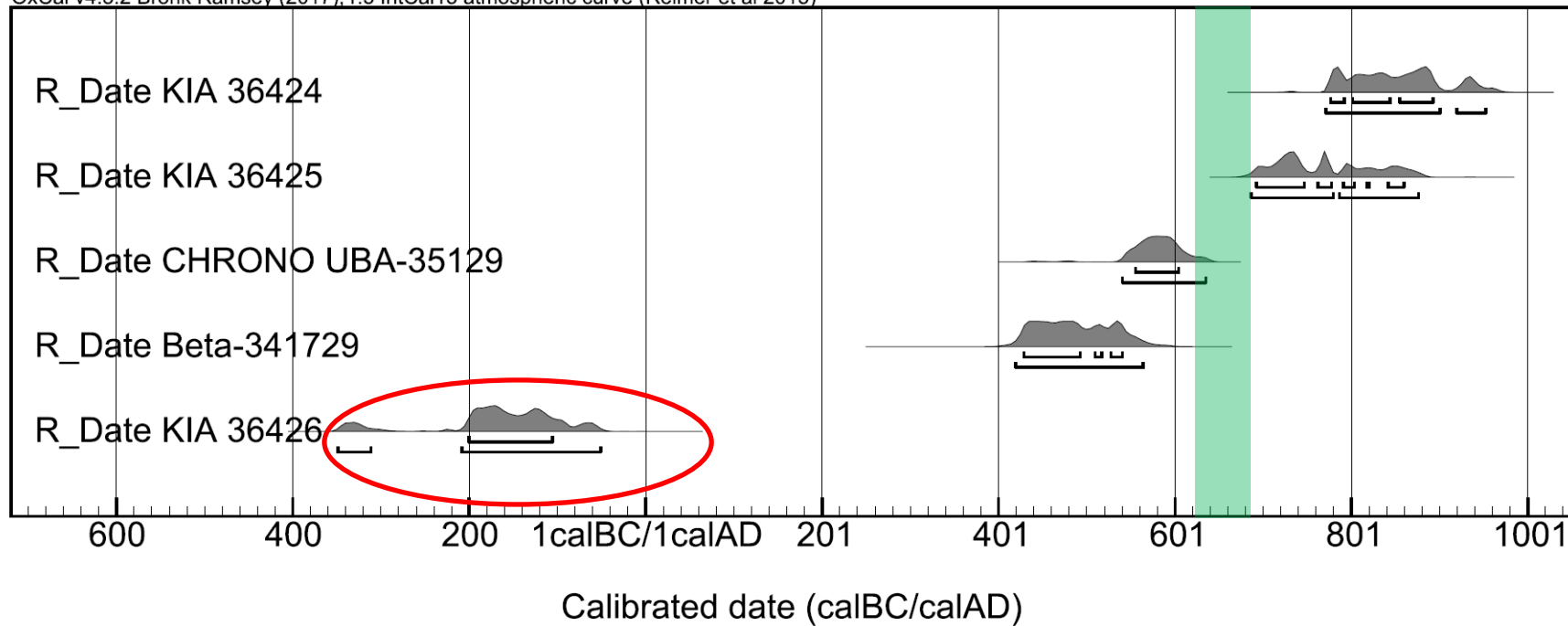
Peteranec - Gorica

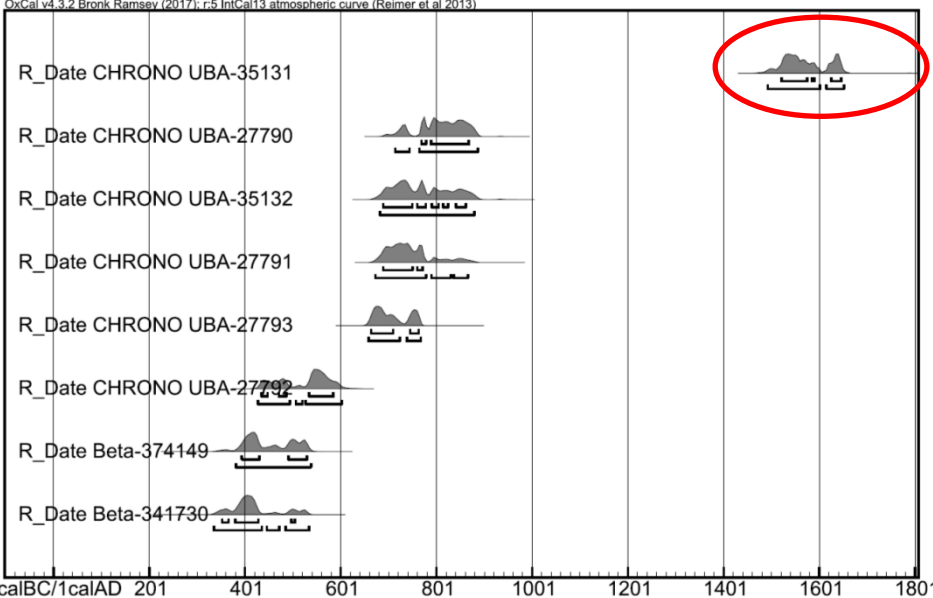
Peteranec - Ciglène

Novigrad Podravski - Milakov berek

First Military Survey (1817-1826)
<https://mapire.eu/en/map>

OxCal v4.3.2 Bronk Ramsey (2017); r:5 IntCal13 atmospheric curve (Reimer et al 2013)

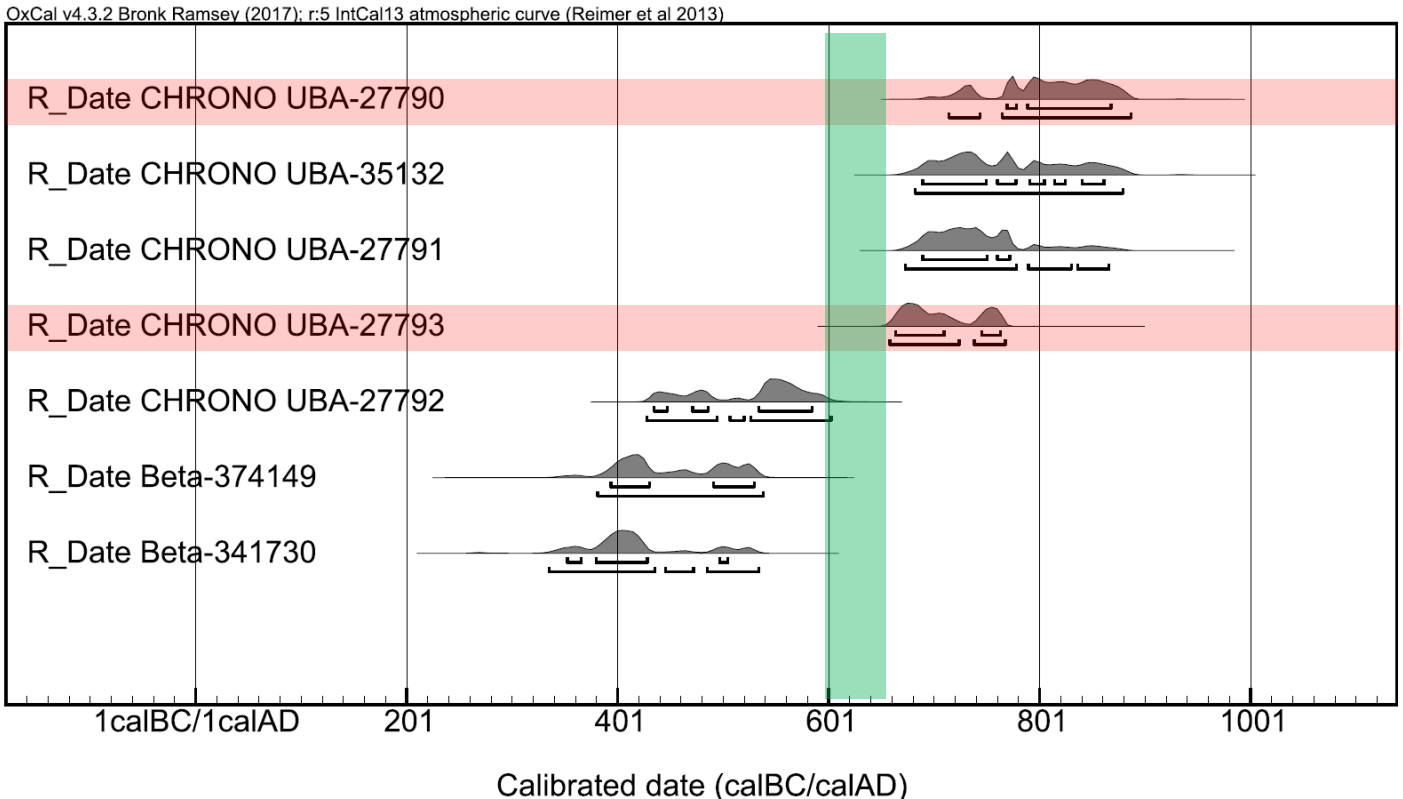


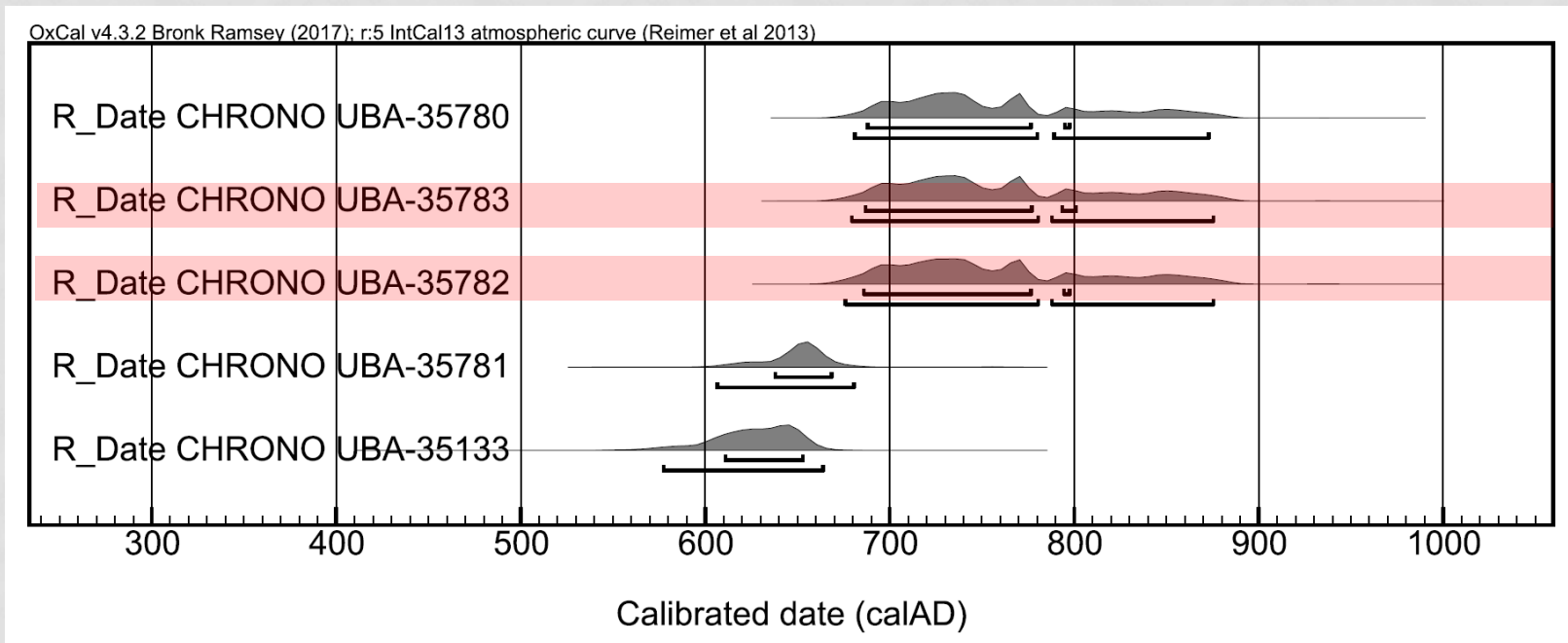


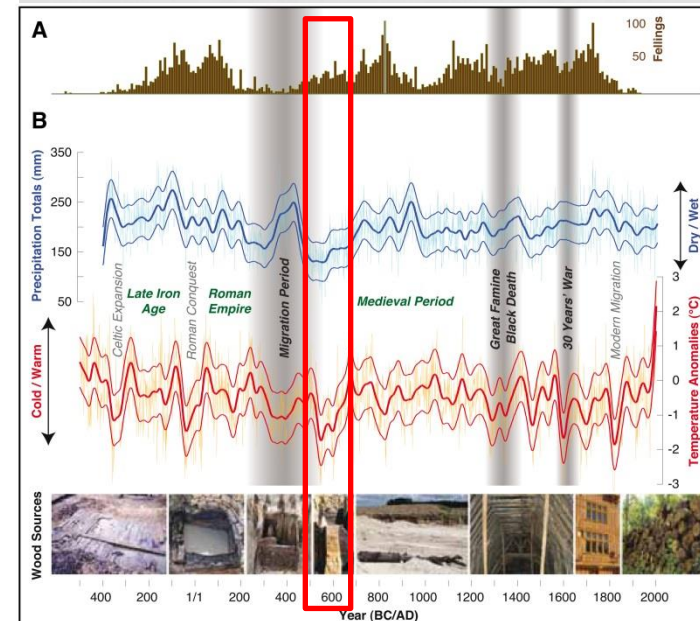
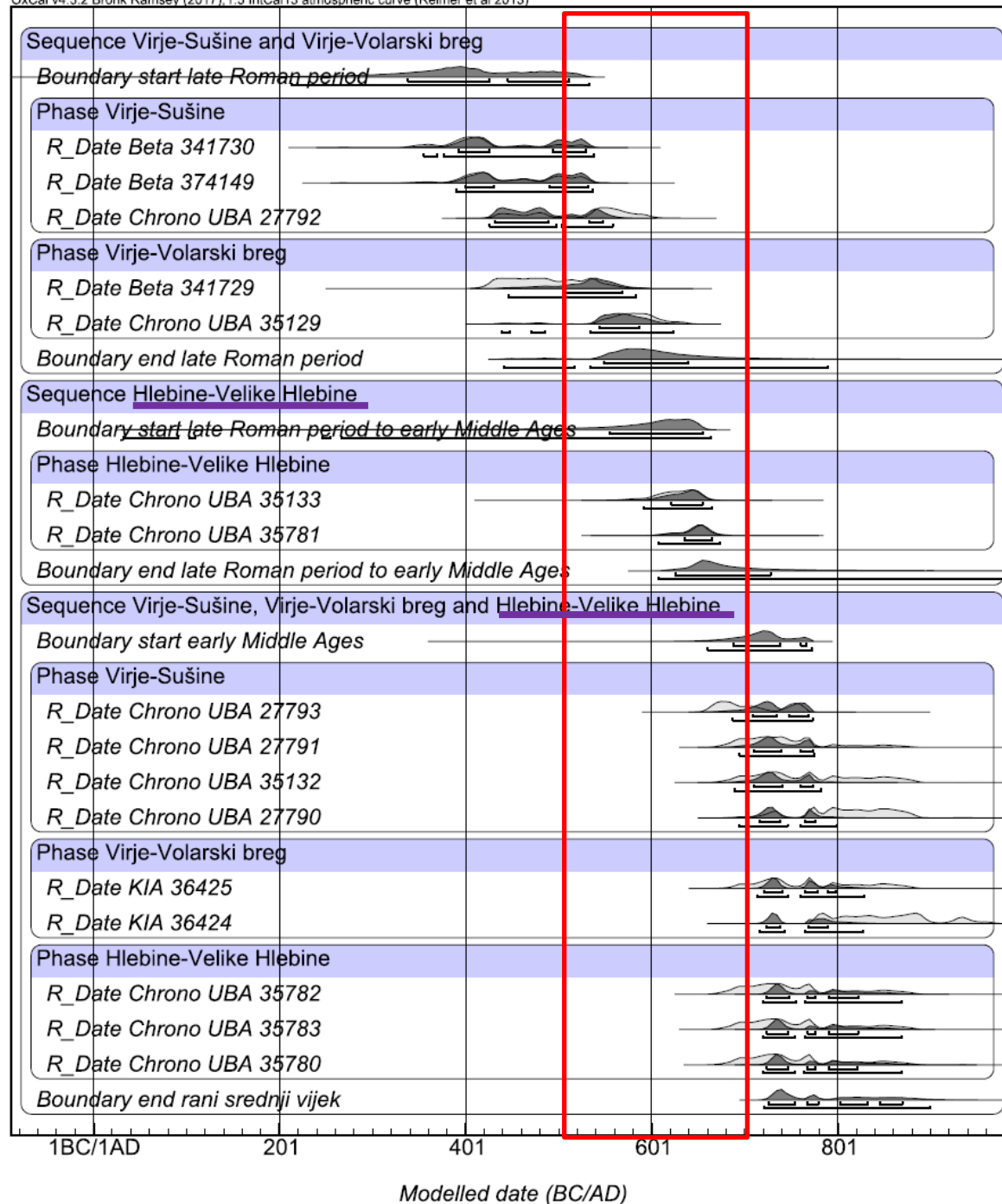
Virje - Sušine

Calibrated date

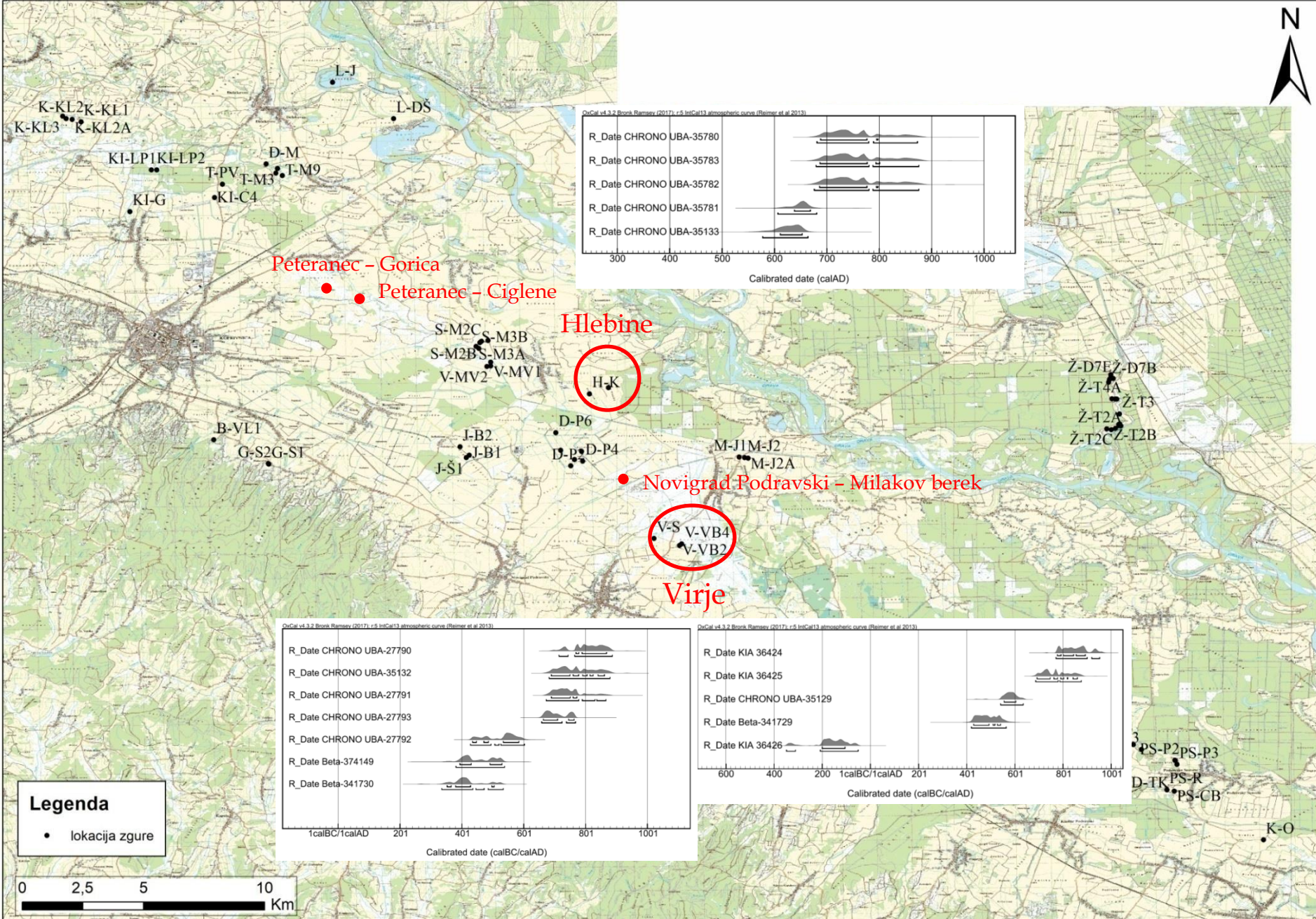
HRZZ Croatian Science Foundation
TransFER



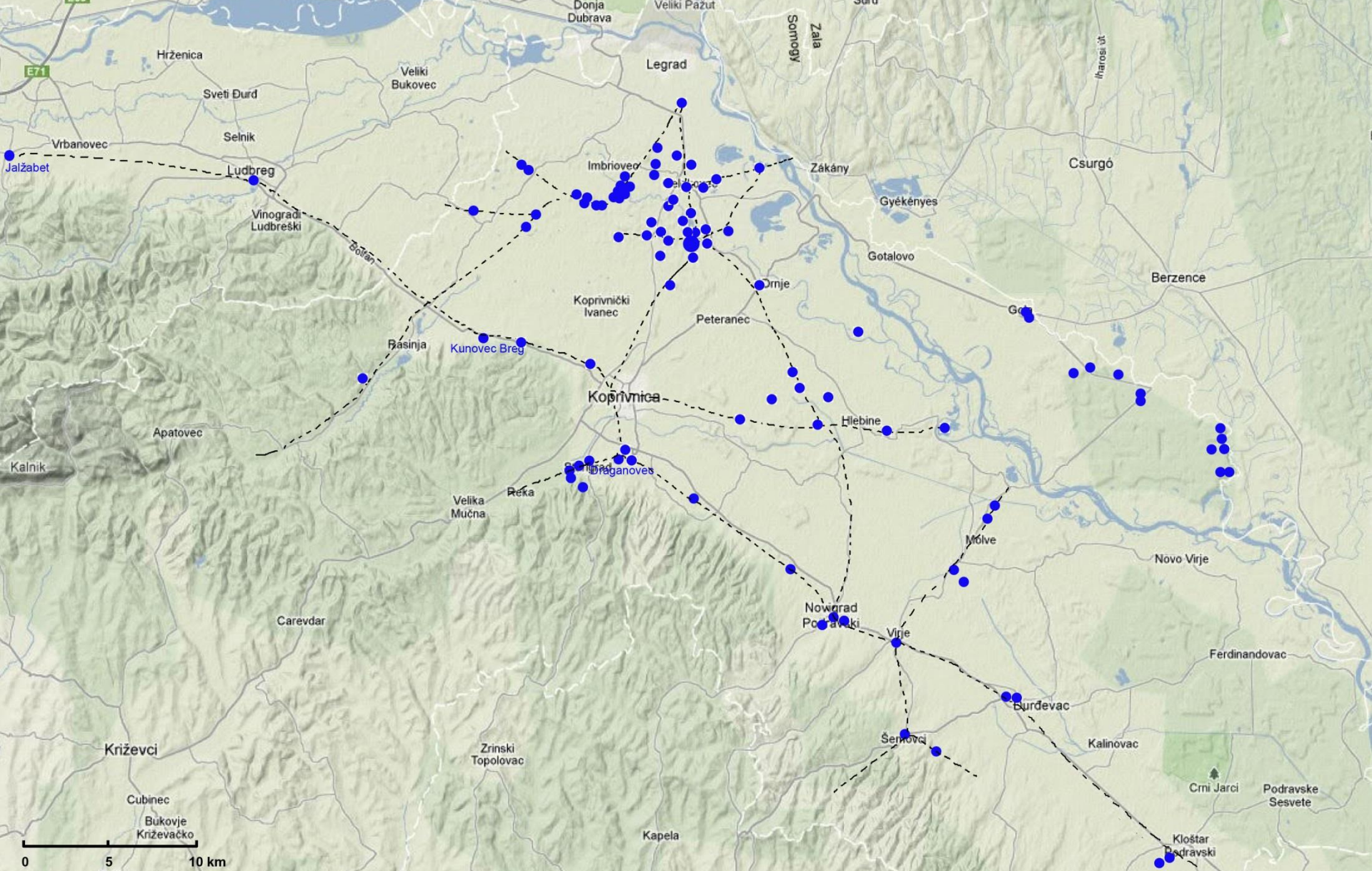




A. Deforestation during the last 2500 years;
 B. Reconstruction of rainfall (April-June) and temperature (June-August) in the last 2500 years. Gray vertical bands mark key events in European history (Buntgen et al. 2011: 580, Fig. 2; 581, Fig. 4; Lubick 2011: Fig. 1)

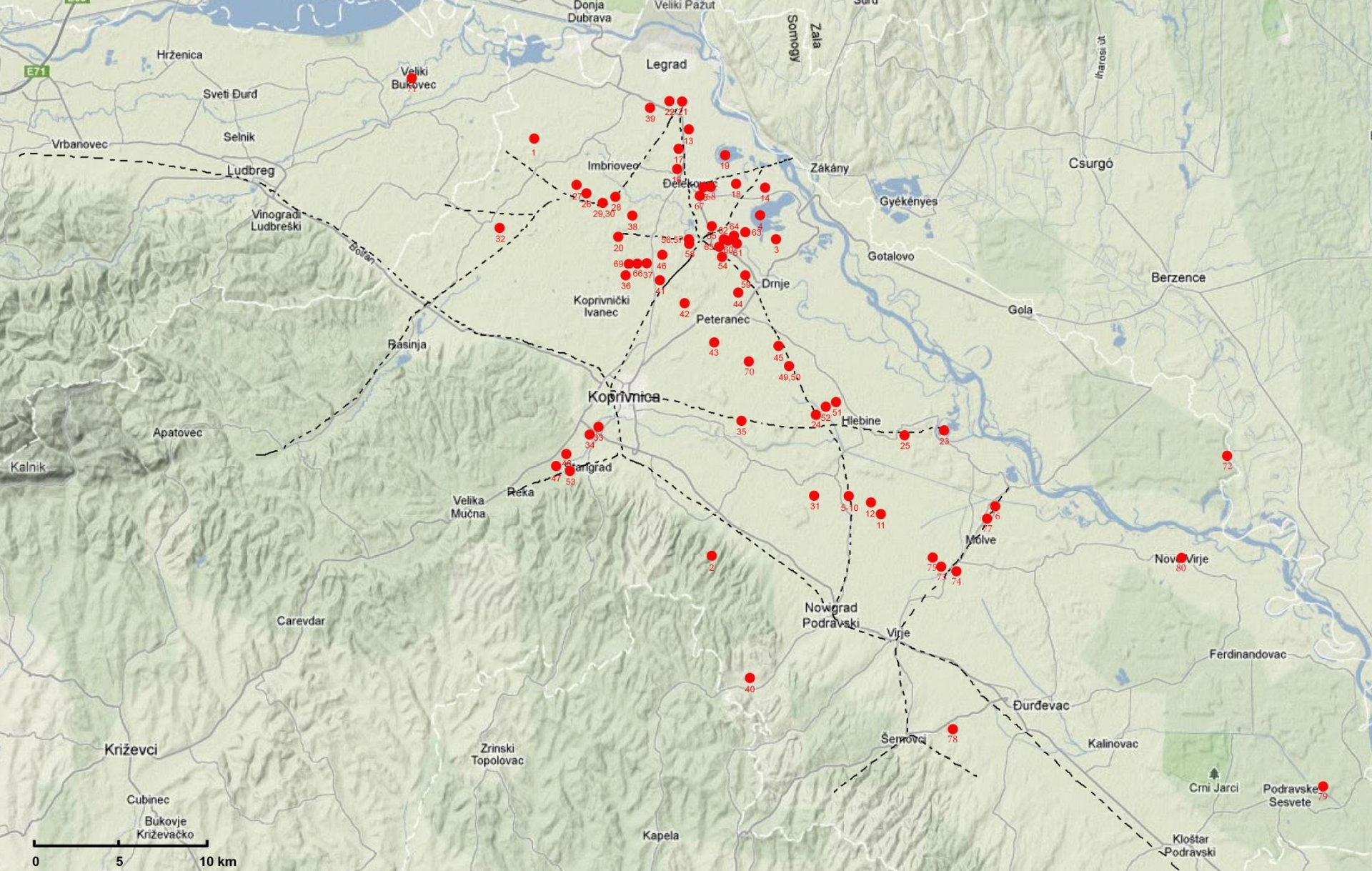


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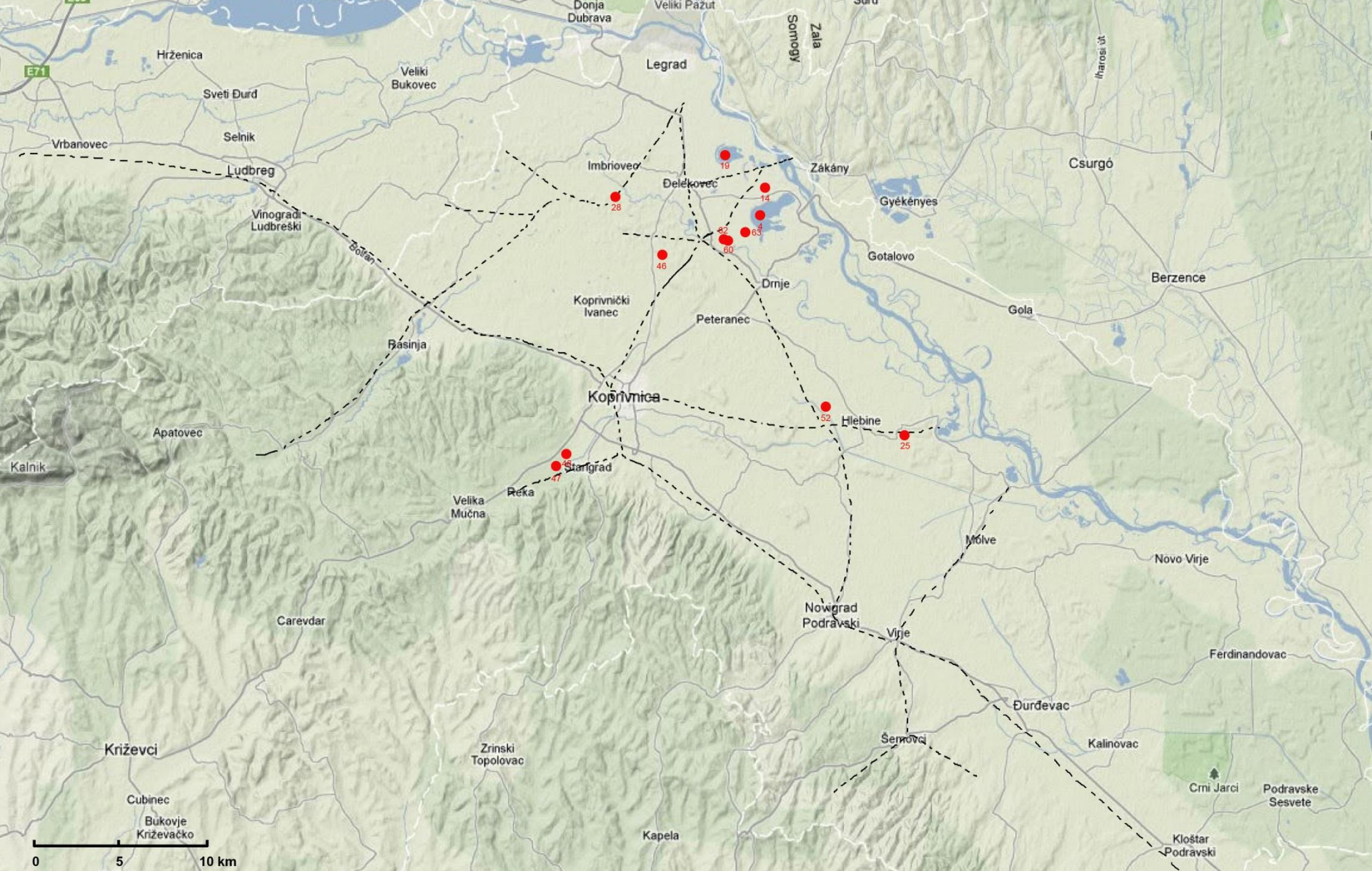
Position of known Roman communications and Roman sites

(Valent, Zvijerac 2017: 465, map 4)



Position of Roman communications and early medieval sites

(Valent, Zvijerac 2017: 466, map 5)



Position of early medieval sites dated from the midd 6th to the end of the 7th century

(Valent, Zvijerac 2017: 466, map 6)

Concluding remarks

- continuity of life from late Roman period through early and late Middle Ages to Modern period in this region
- Virje site – disused short period of time while Hlebine site shows continuity in occupation
- change in occupation positions regarding available deposits of iron ore
- around AD 600 – extremely dry and cold conditions prevailed
- shortage of precipitation could certainly have affected the natural deposition of iron ore
- iron production itself could have continued at some other unexhausted positions for a short period of time (such as Hlebine)