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

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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

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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)
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

(Tkalčec, Sekelj Ivančan 2017; Valent 2018)
Virje – Volarski breg 2010, settlement indicators

(Tkalčec, Sekelj Ivančan 2017)
Virje – Sušine 2012 (photo: T. Sekelj Ivančan)

(Tkalčec, Sekelj Ivančan 2017)
Trench 5 – 202 m²
over 1 tone of slag

(Valent 2018)
Pleiner 2000: Pl. IX, Romano-Barbarian slag pit furnaces in Jutland, Drengsted, Denmark

Virje – Sušine 2013

(Tkalčec, Sekelj Ivančan 2017)

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

(Pleiner 2000: Fig. 67, Left, slag pit furnace)
(Sekelj Ivančan, Hrovatin 2017)
Hlebine – geophysical survey 2015

(Tkalčec, Sekelj Ivančan 2017)
(made by: K. Turkalj)

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

(B. Mušič, Univerza v Ljubljani, Filozofskfa fakulteta, Oddelek za arheologijo)
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 trough Roman period to the Middle Ages
• furnace walls, slag and nozzles have unchanged form through all three periods and can’t be dated

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

(Tkalčec, Sekelj Ivančan 2017)
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) goethit oolithic iron ore layer (Valent et al. 2017: 11) is naturally renewed by regular flooding
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 (HNO₃: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
First Military Survey (1782–1785)


Peteranec – Gorica

Peteranec – Ciglene

Novigrad Podravski – Milakov berek
Hlebine – Velike Hlebine
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)
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)
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 mid 6th to the end of the 7th century.

(Valent, Zvijerac 2017: 466, map 6)
Position of early medieval sites dated from the end of the 7th to the end of the 8th century

(Valent, Zvijerac 2017: 467, map 7)
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)