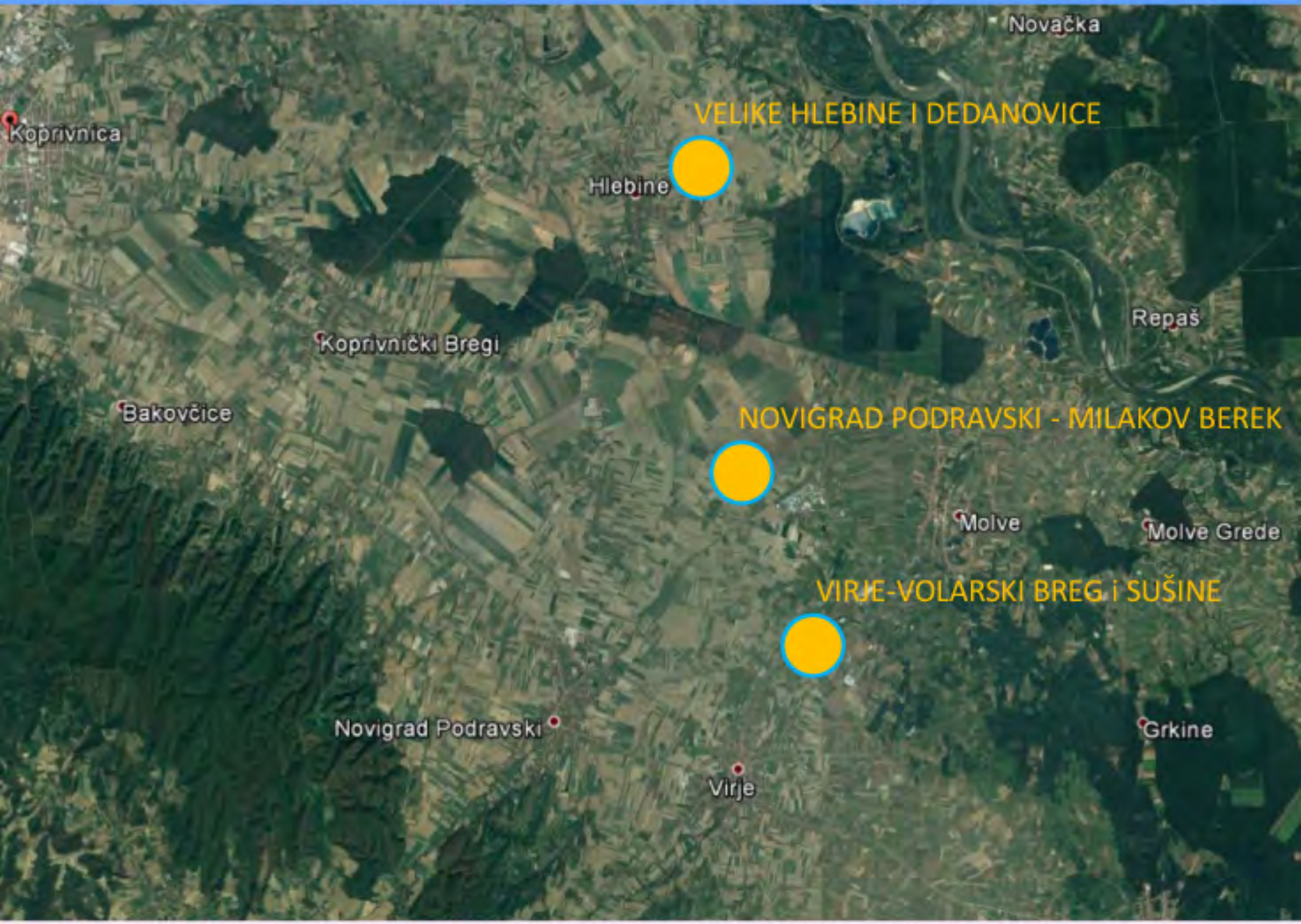


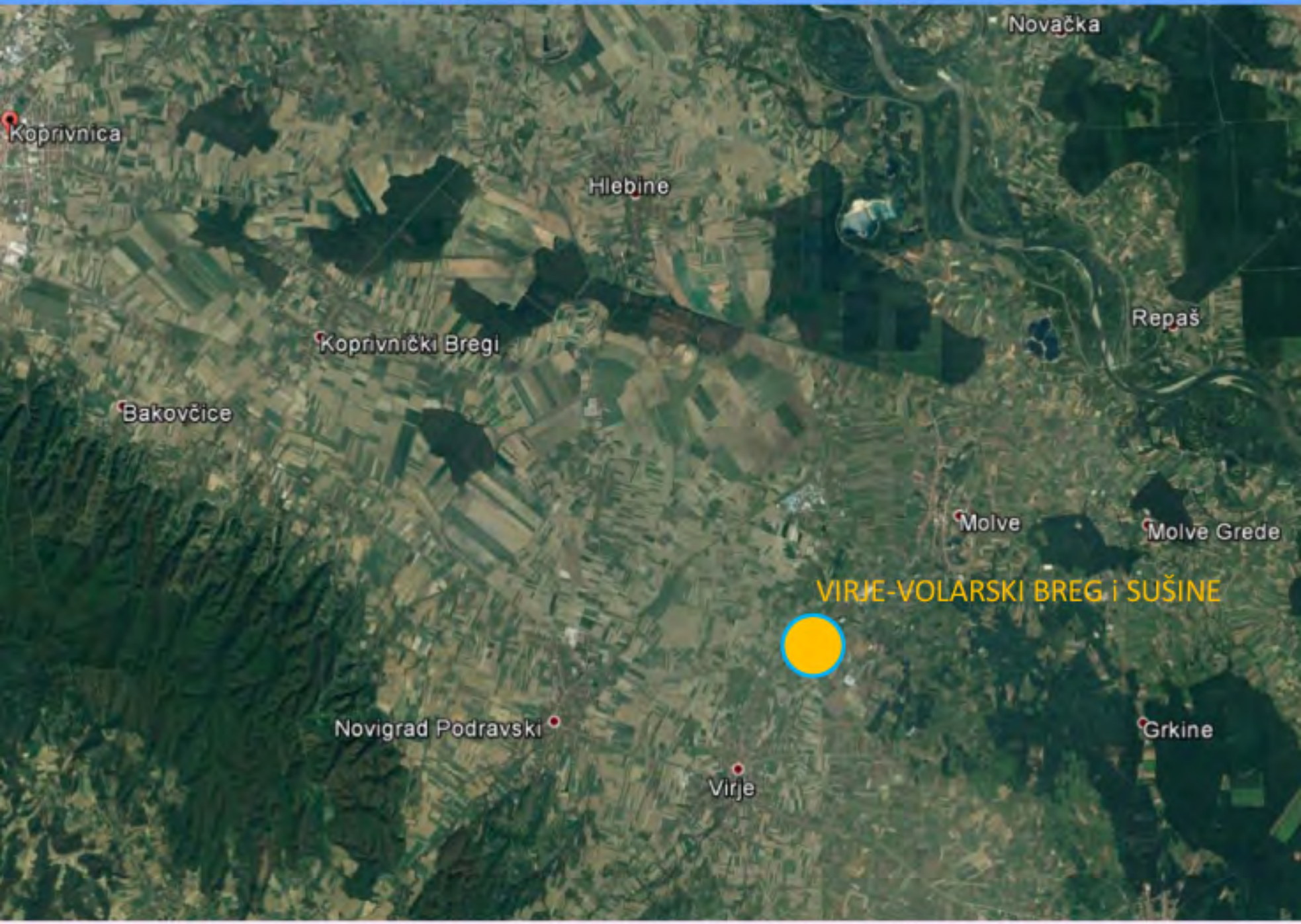
TRANSFER – IRON PRODUCTION ALONG THE DRAVA RIVER IN THE ROMAN PERIOD AND THE MIDDLE AGES: CREATION AND TRANSFER OF KNOWLEDGE, TECHNOLOGIES AND GOODS. THE CASE STUDIES OF VIRJE AND VELIKE HLEBINE.

Head of the the project: dr. Tajana Sekelj Ivančan

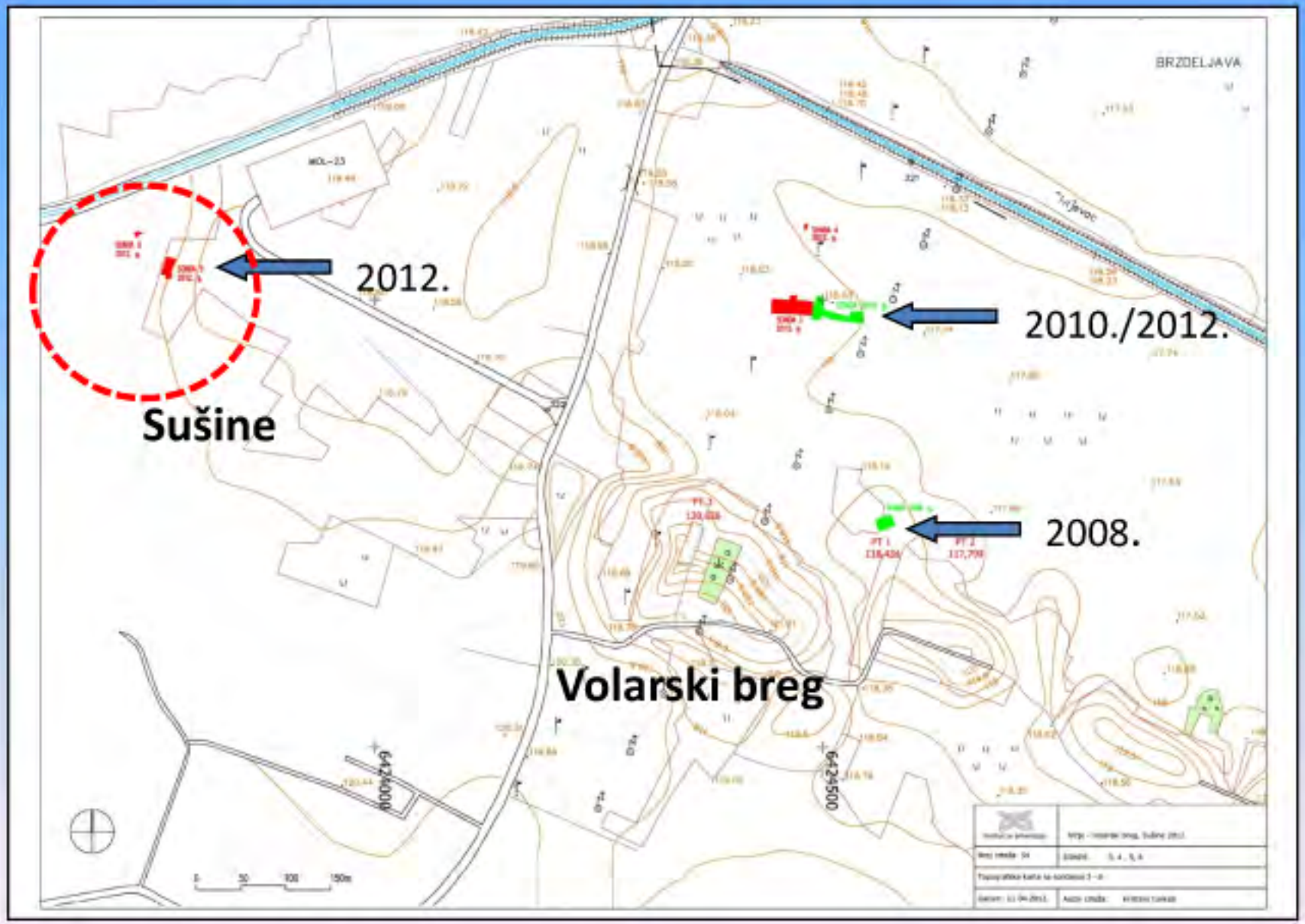
Branko Mušič, Tajana Sekelj-Ivančan, Sibila Borojević Šoštarić, Igor Medarić, Barbara Horn, Stanko Ružičić and Tomislav Brenko

Zagreb. 01.12.2017


Novačka
VELIKE HLEBINE I DEDANOVICE
Koprivnica
Hlebine
Repaš
Koprivnički Bregi
Bakovčice
NOVIGRAD PODRAVSKI - MILAKOV BEREK
Molve
Molve Grede
VIRJE-VOLARSKI BREG i SUŠINE
Novigrad Podravski
Grkine
Virje

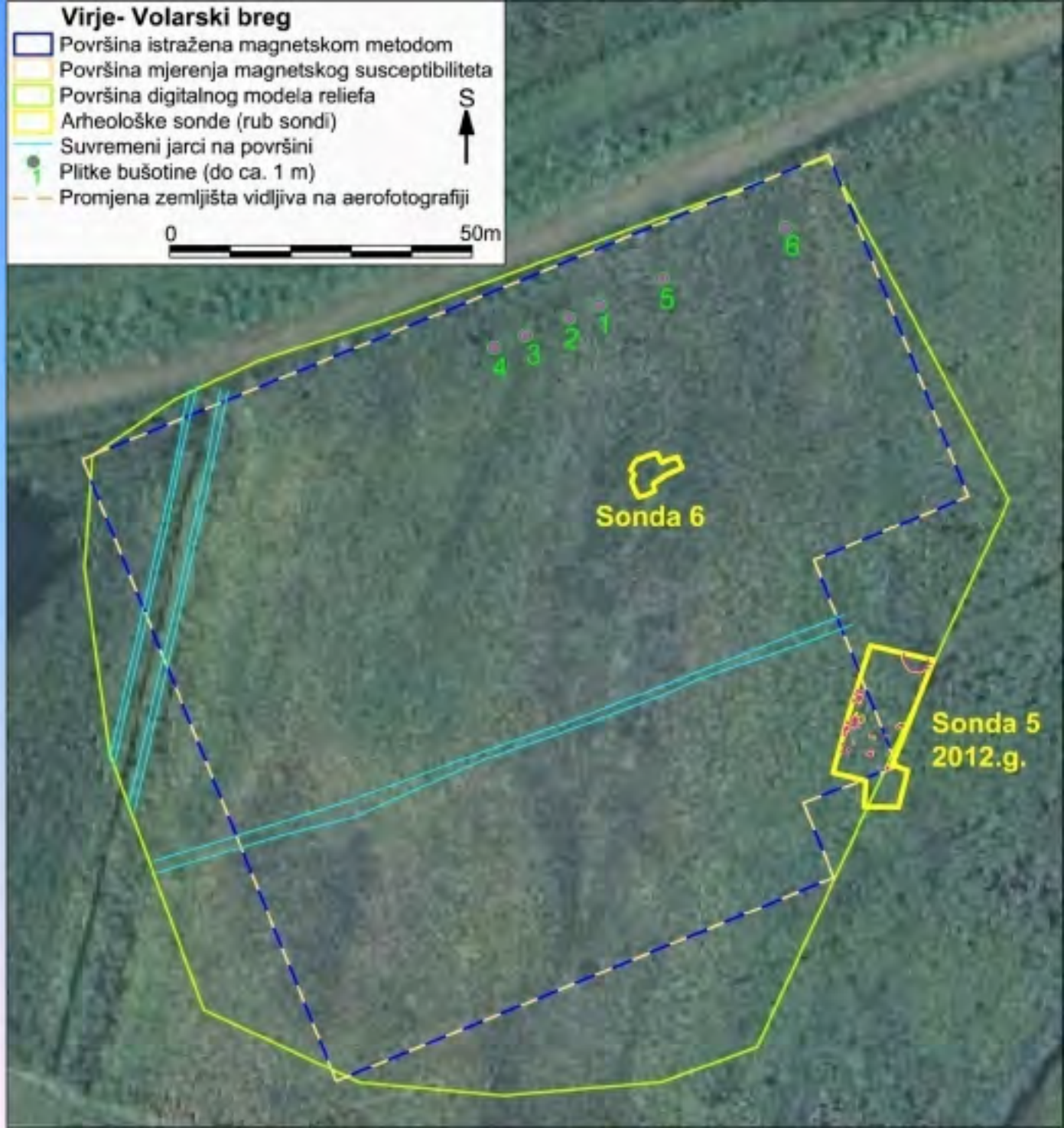

Novačka
Koprivnica
Hlebine
Repaš
Koprivnički Bregi
Bakovčice
Molve
Molve Grede
VIRJE-VOLARSKI BREG i SUŠINE
Novigrad Podravski
Grkine
Virje

Virje – arheološke sonde v letih 2008-2012

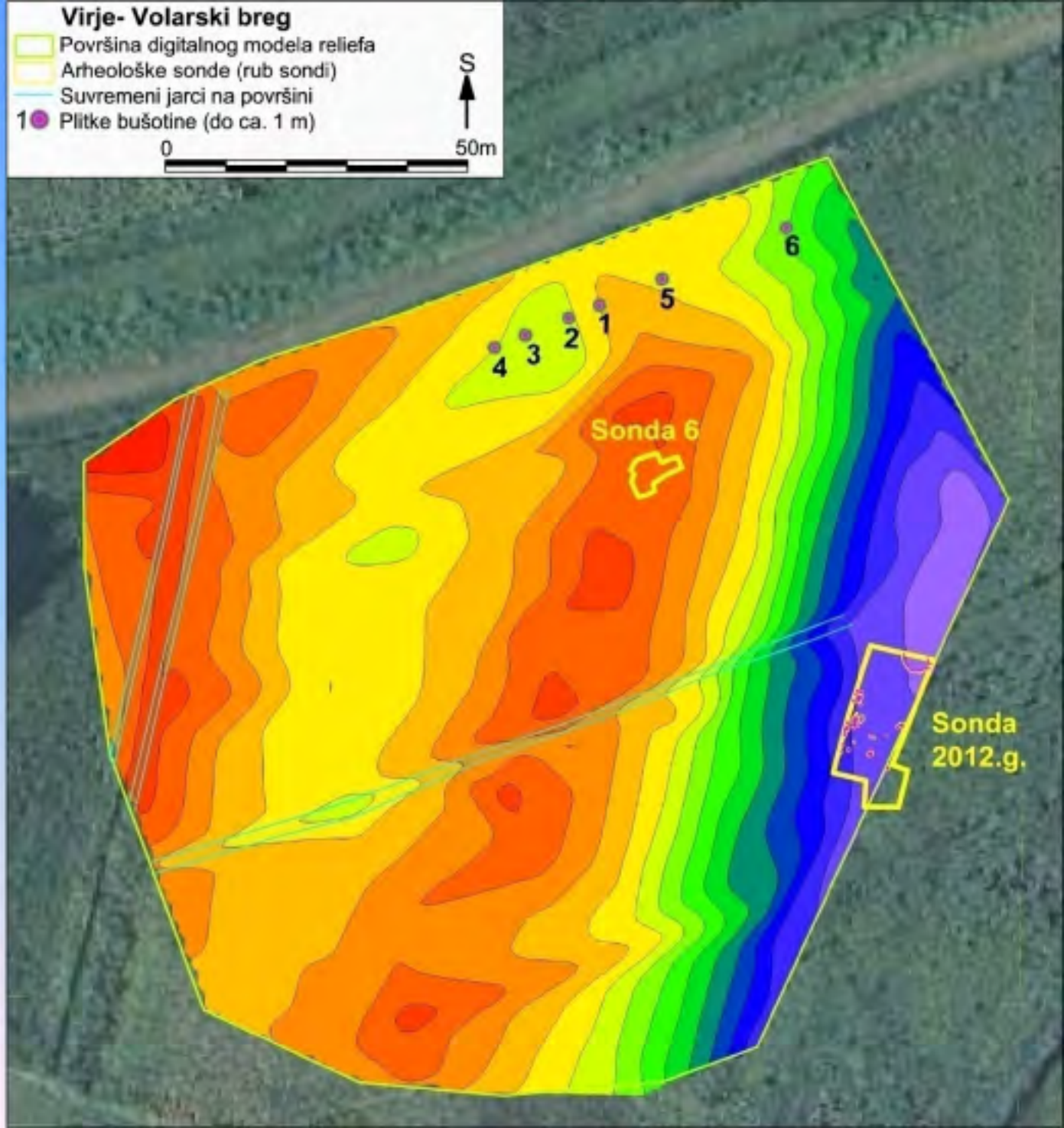




POVRŠINE ISTRAŽENE GEOFIZIČKOM METODOM



DIGITALNI MODEL RELIEFA
umjesto
LIDAR-a

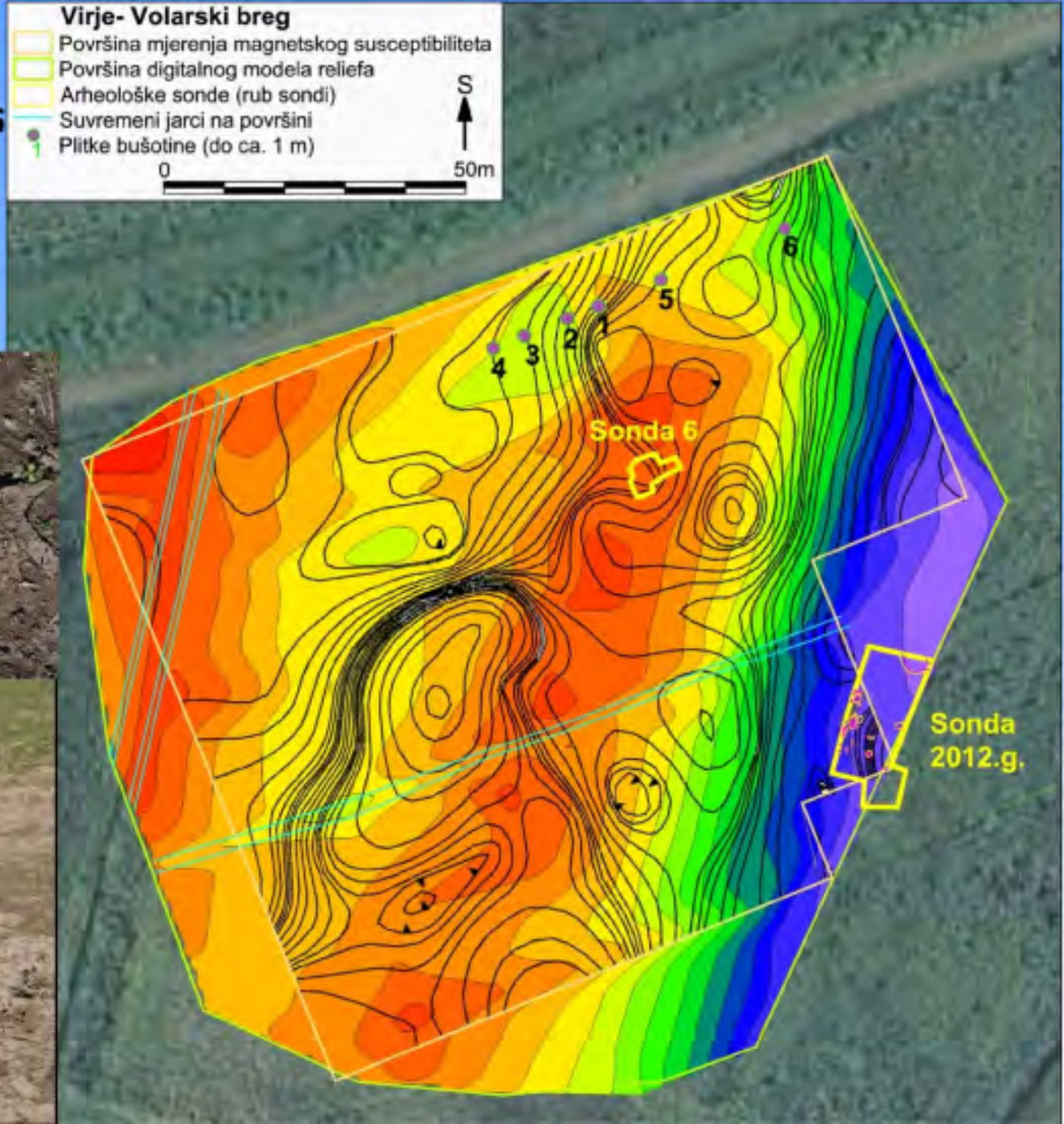


DIGITALNI MODEL RELIEFA i KARTIRANJE MAGNETSKOG SUSCEPTIBILITETA

(Kappameter KT-5)





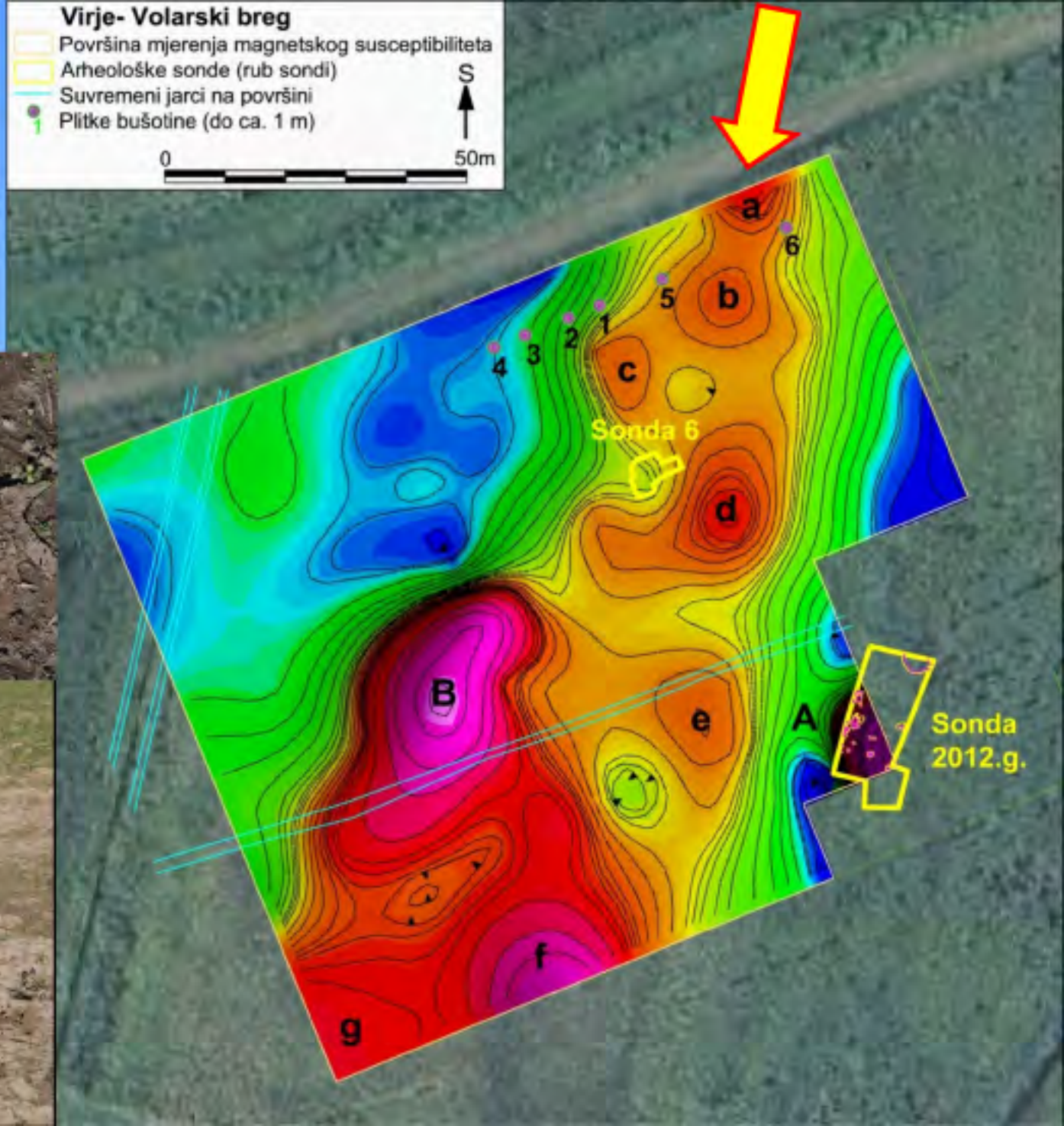


KARTIRANJE MAGNETSKOG SUSCEPTIBILITETA

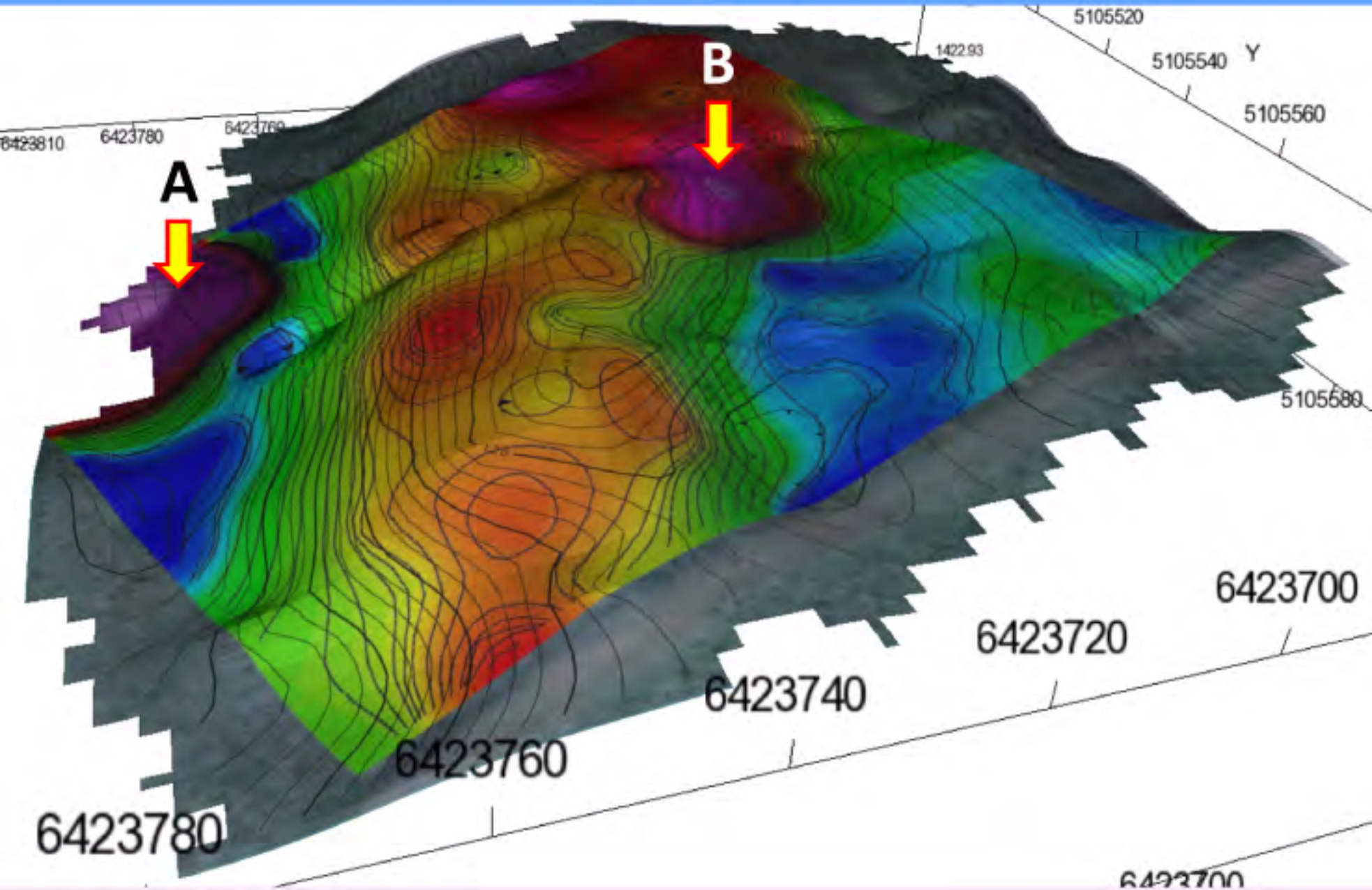
(Kappameter KT-5)







REZULTATI KARTIRANJA MAGNETSKOG SUSCEPTIBILITETA NA DIGITALNOM MODELU RELIEFA

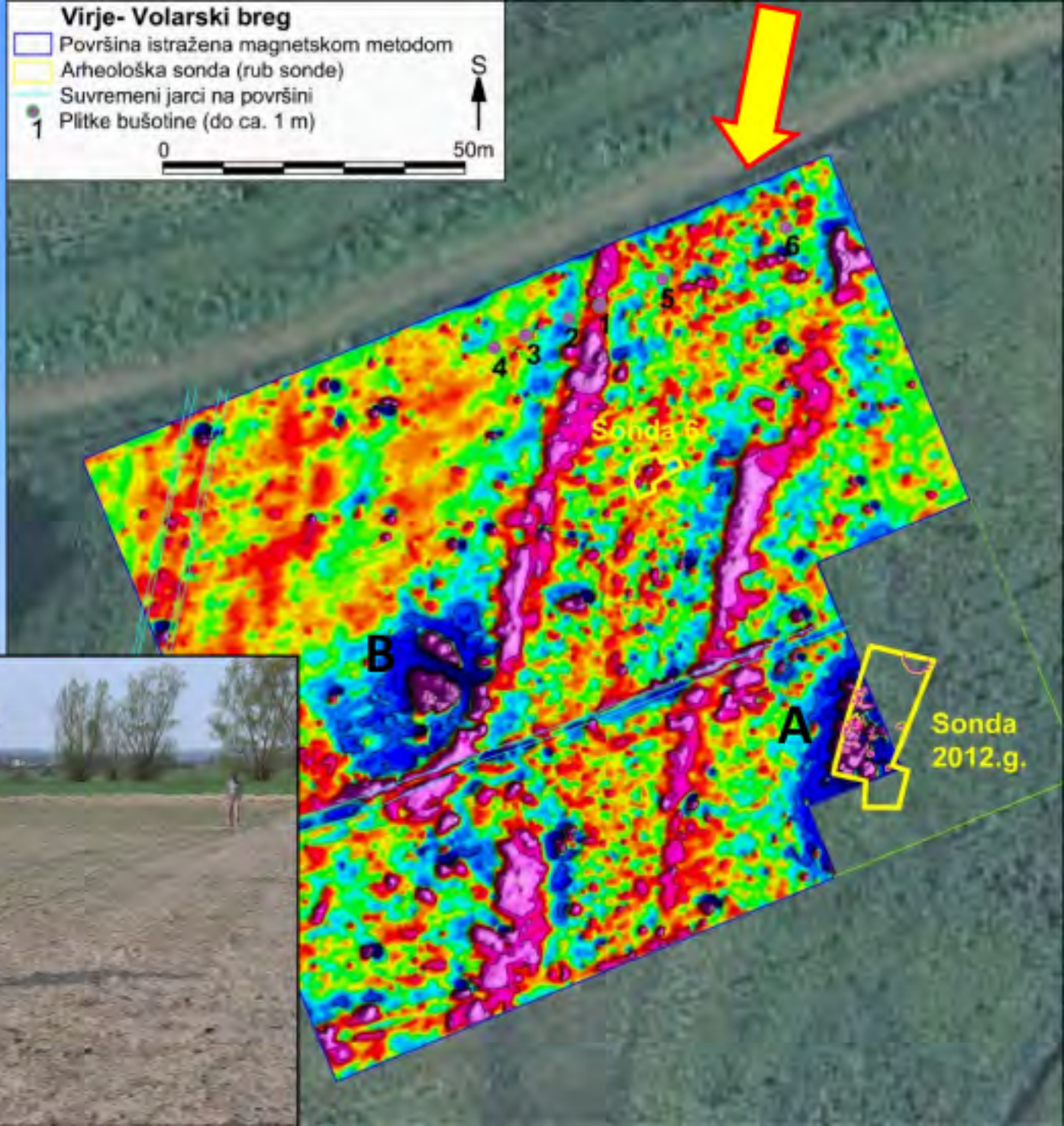


MAGNETSKA METODA

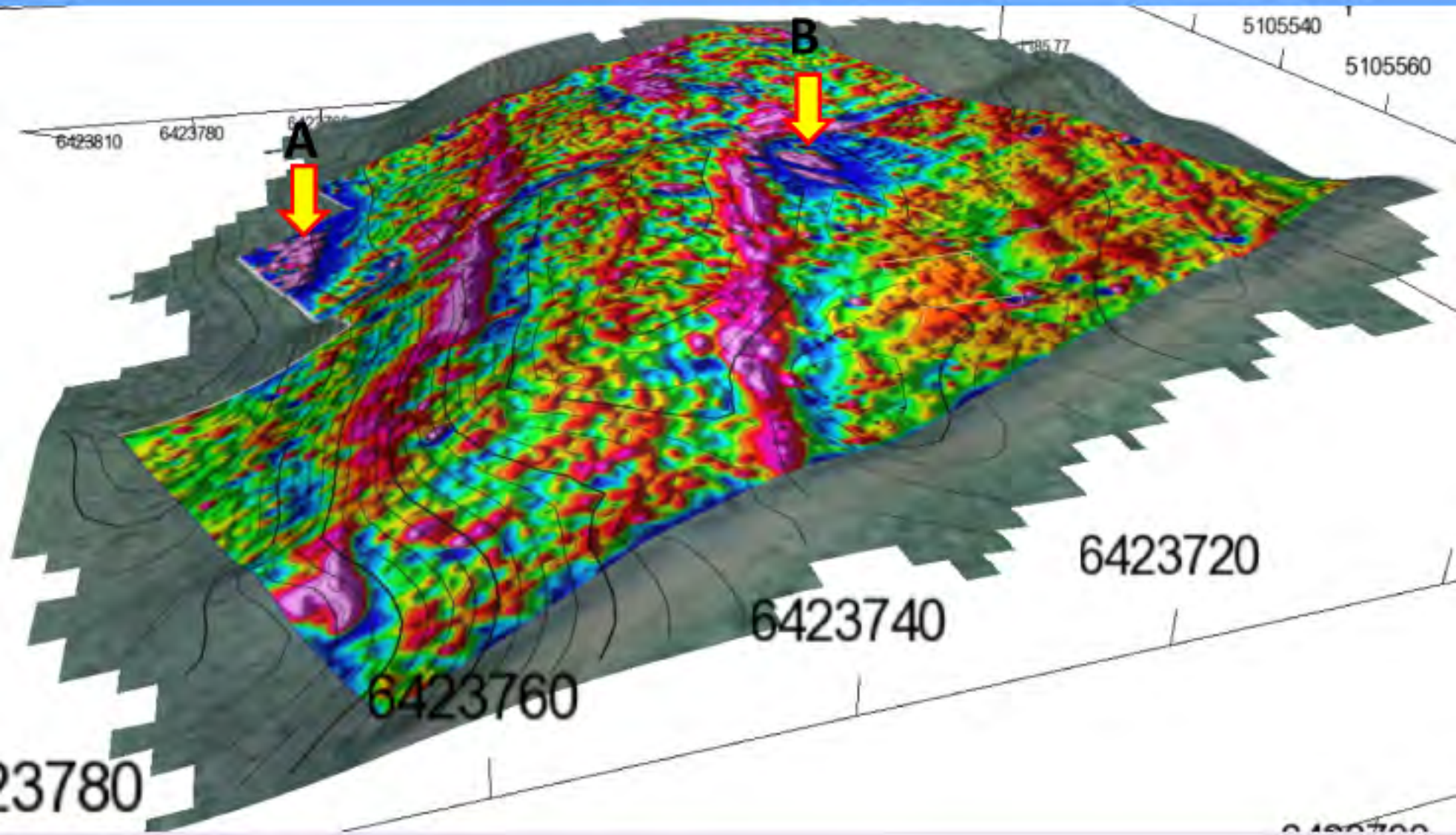
Gradient magnetskog polja

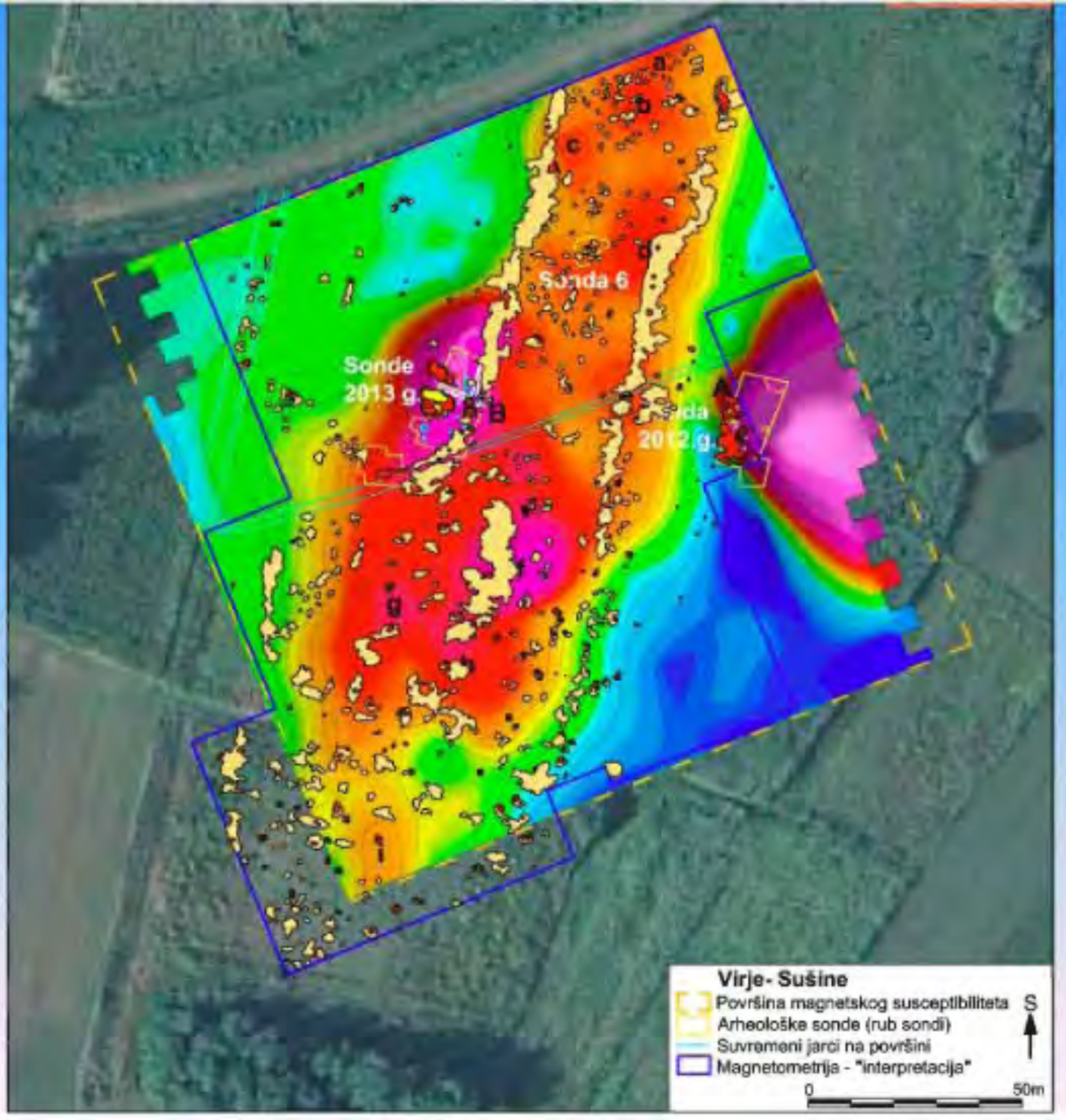
(Geometrics G-858)

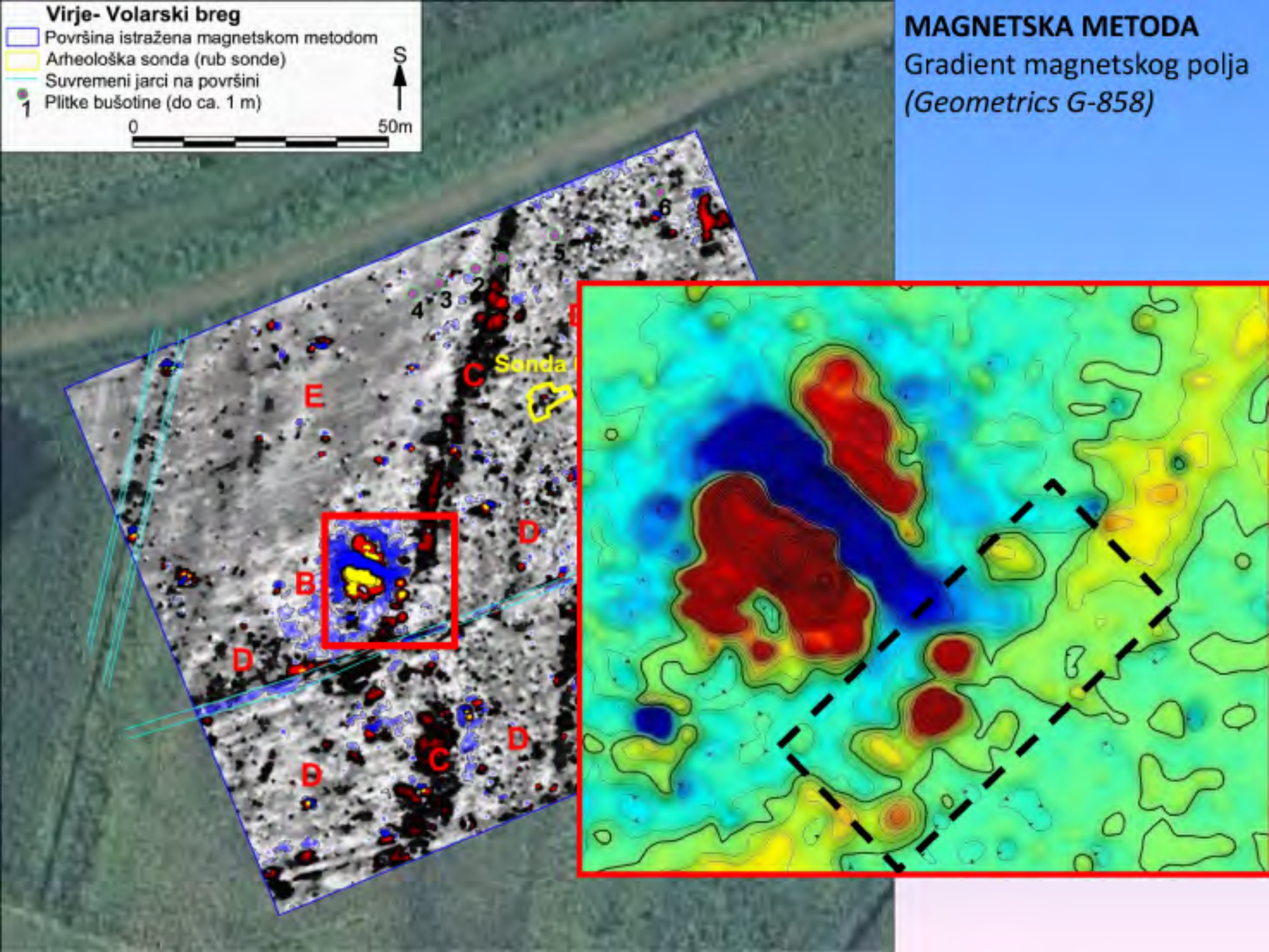


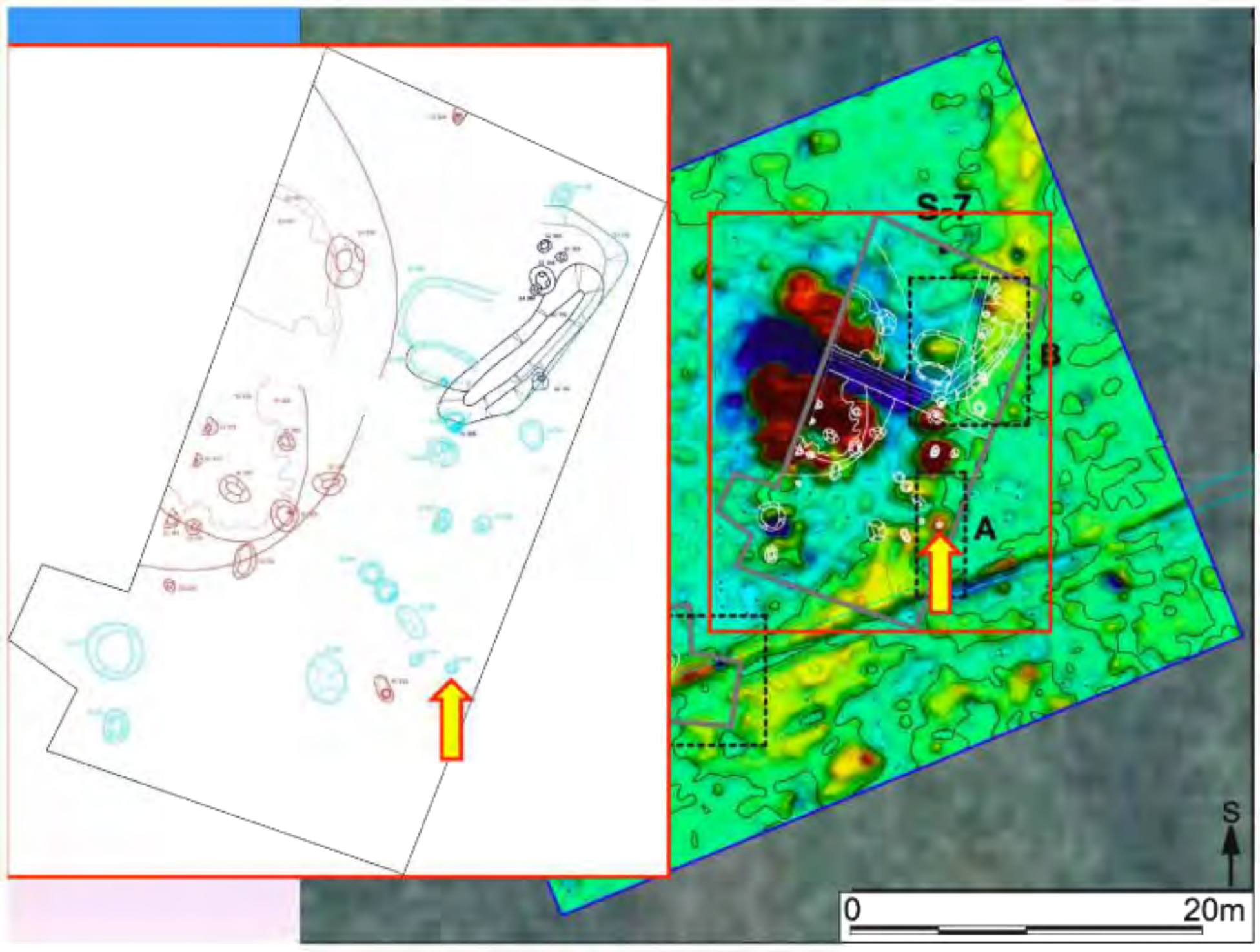


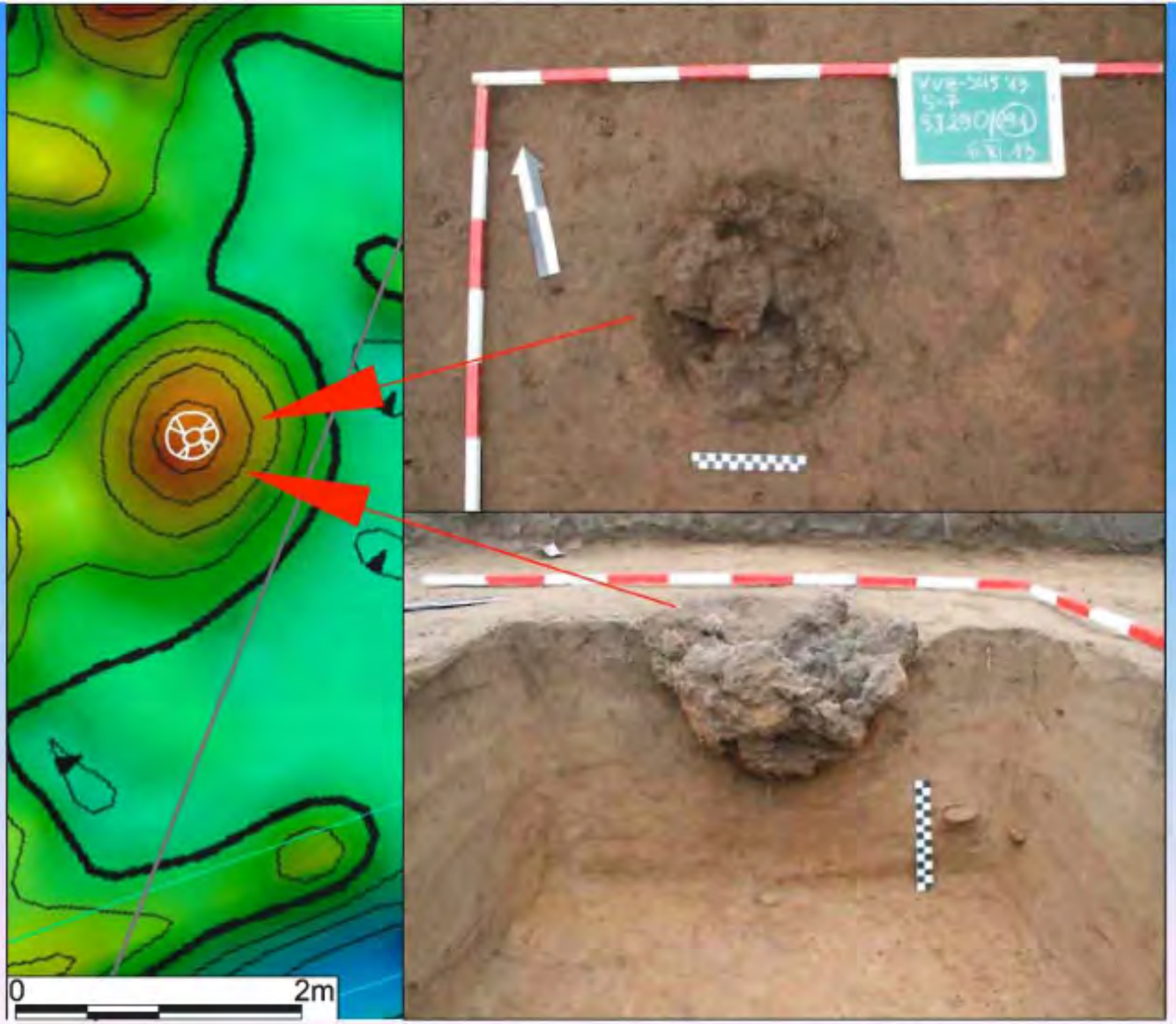
REZULTATI MAGNETSKE METODE NA DIGITALNOM MODELU RELIEFA

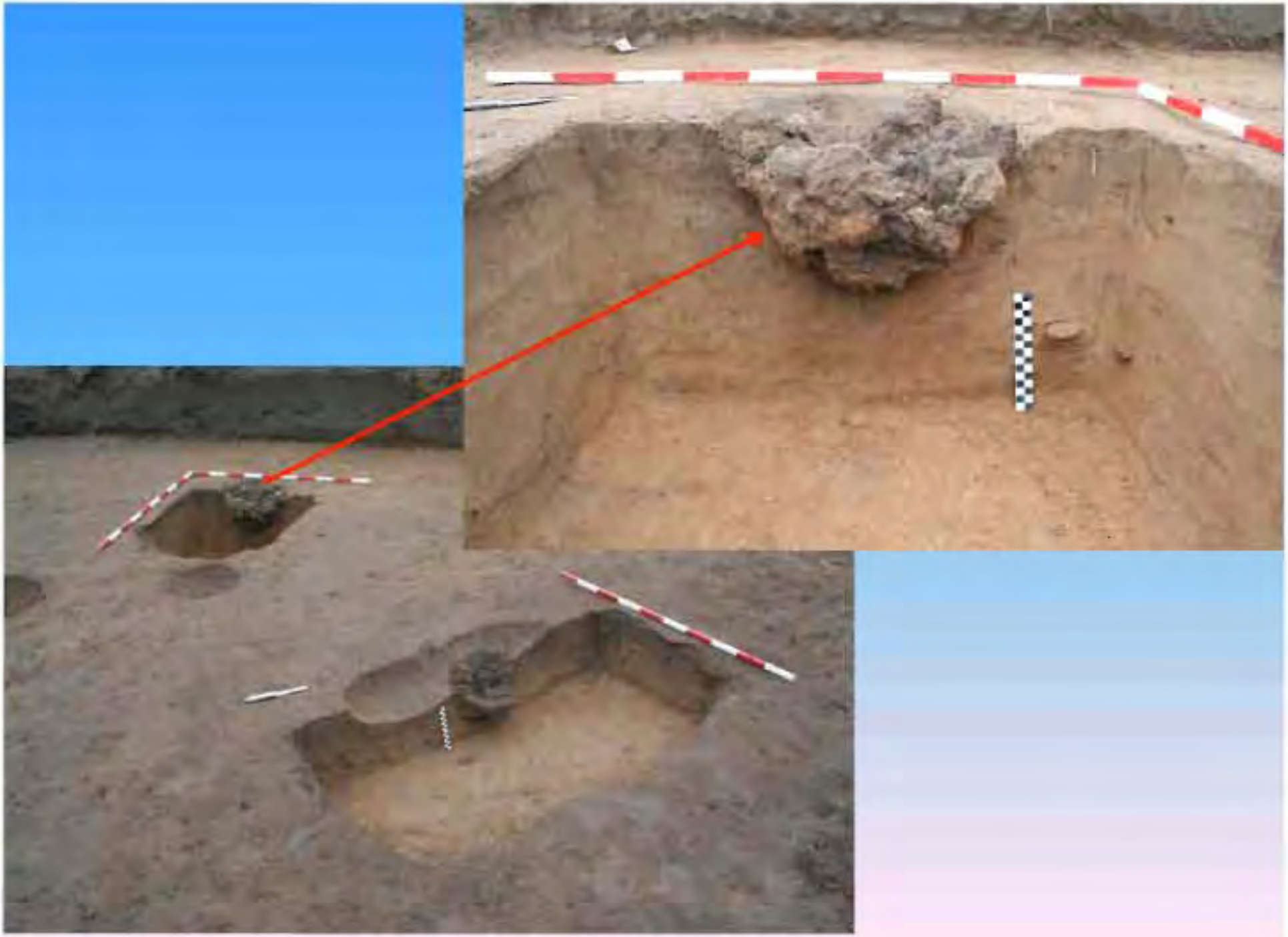


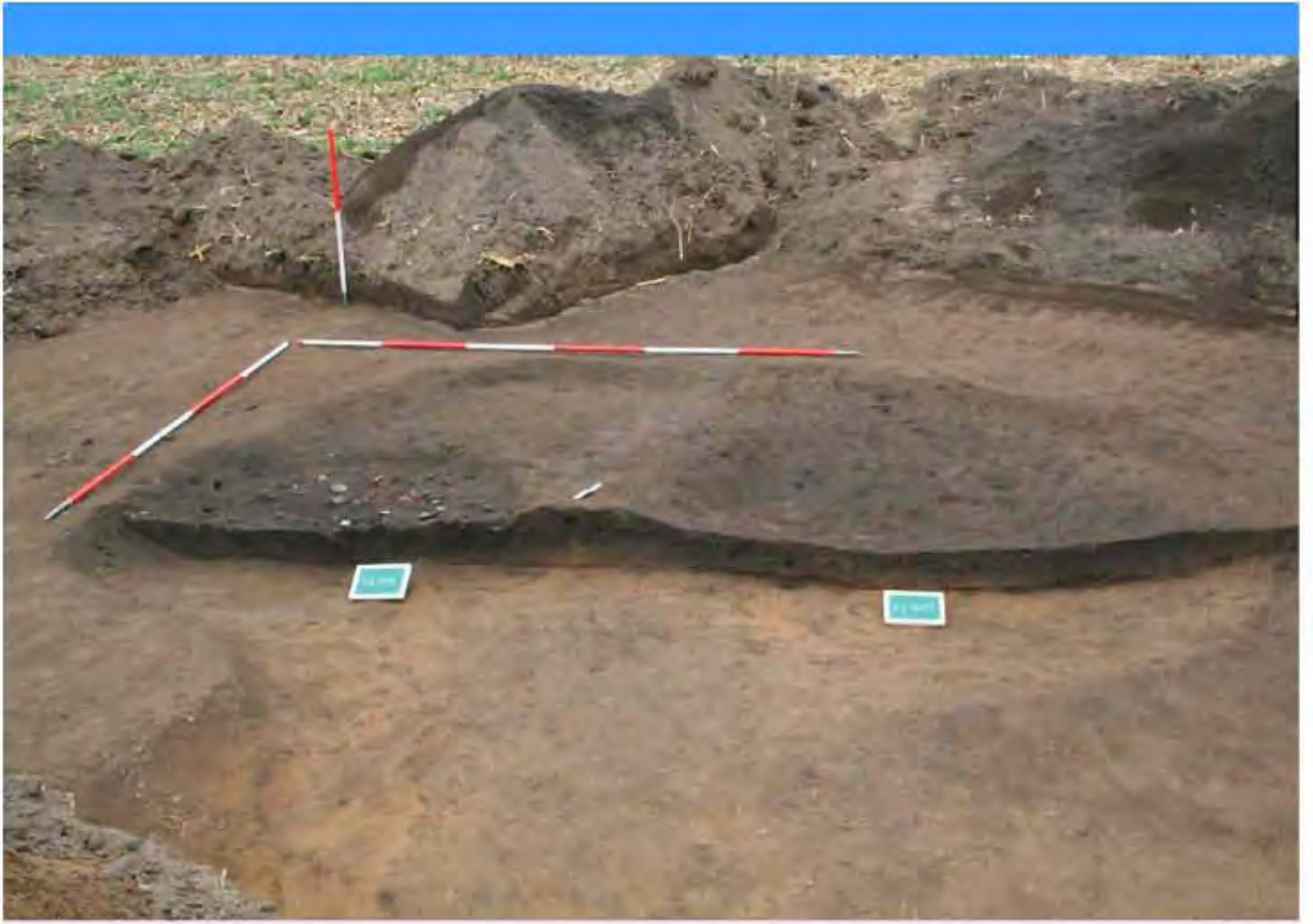

Sonda 6
Sonde
2013 g.
2012 g.
Virje- Sušine
Površina magnetskog susceptibiliteta
Arheološke sonde (rub sondi)
Suvremeni jarci na površini
Magnetometrija - "interpretacija"
S
0
50m


Virje- Volarski breg
Površina istražena magnetskom metodom
Arheološka sonda (rub sonde)
Suvremeni jarci na površini
Plitke bušotine (do ca. 1 m)
S
0
50m
MAGNETSKA METODA
Gradient magnetskog polja
(Geometrics G-858)
1
2
3
4
5
6
C
E
D
B
D
C
D
D
Sonda


S-7
B
A
S
0
20m

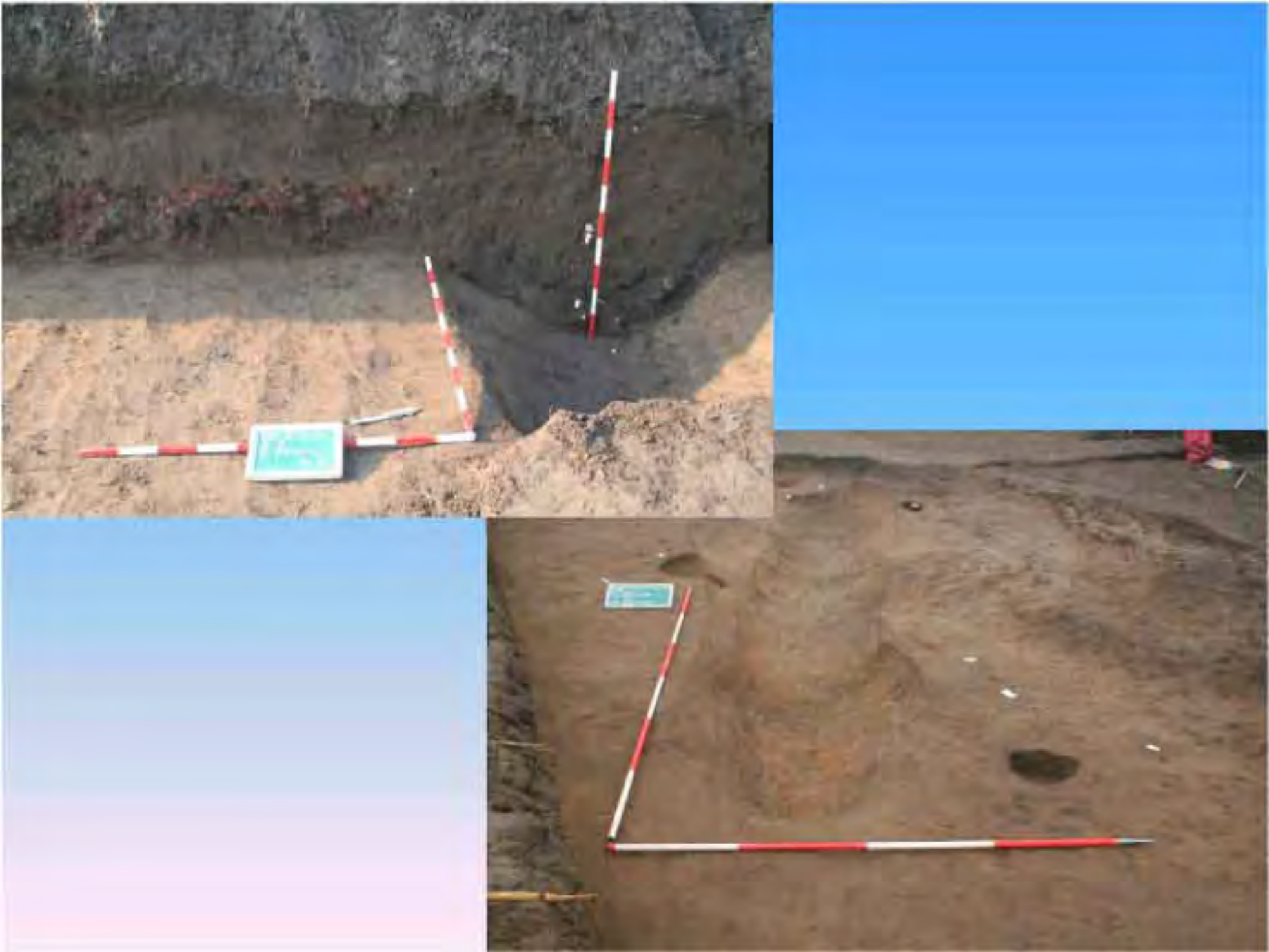

0
2m

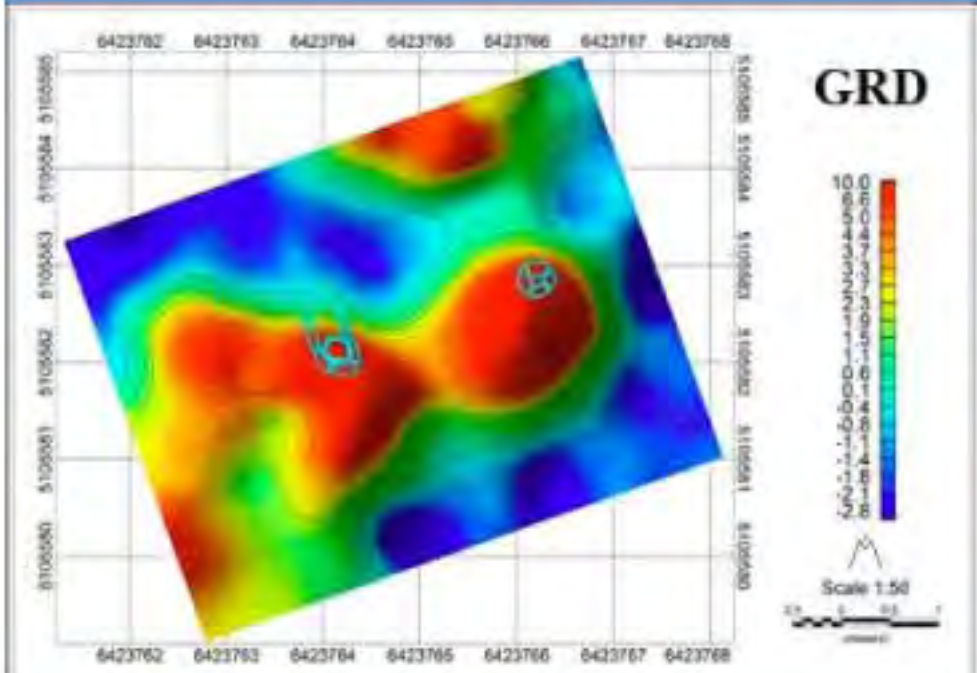


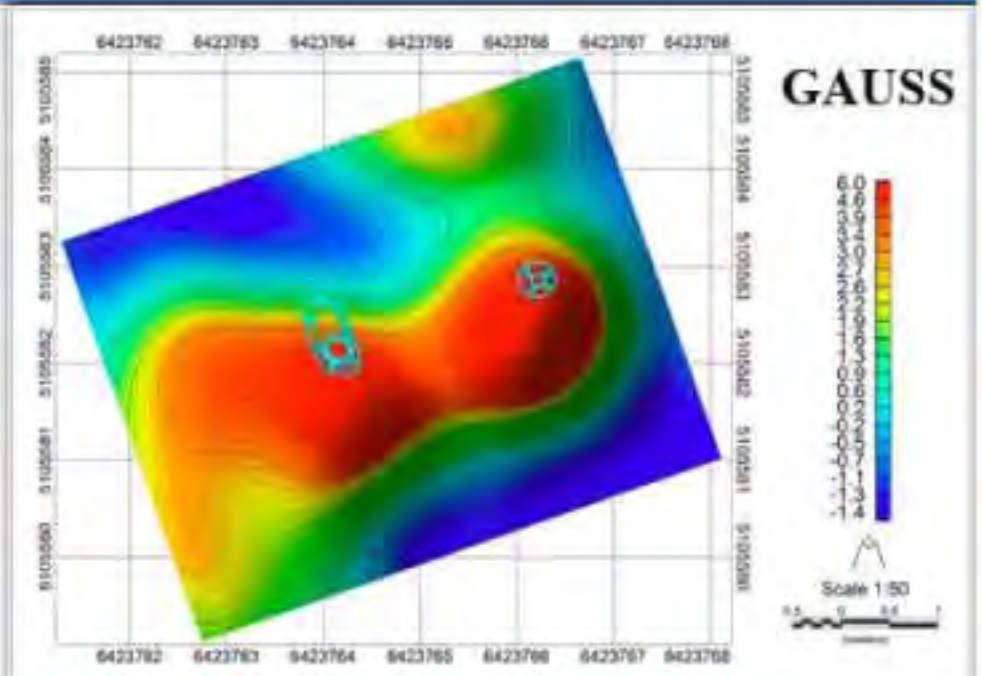


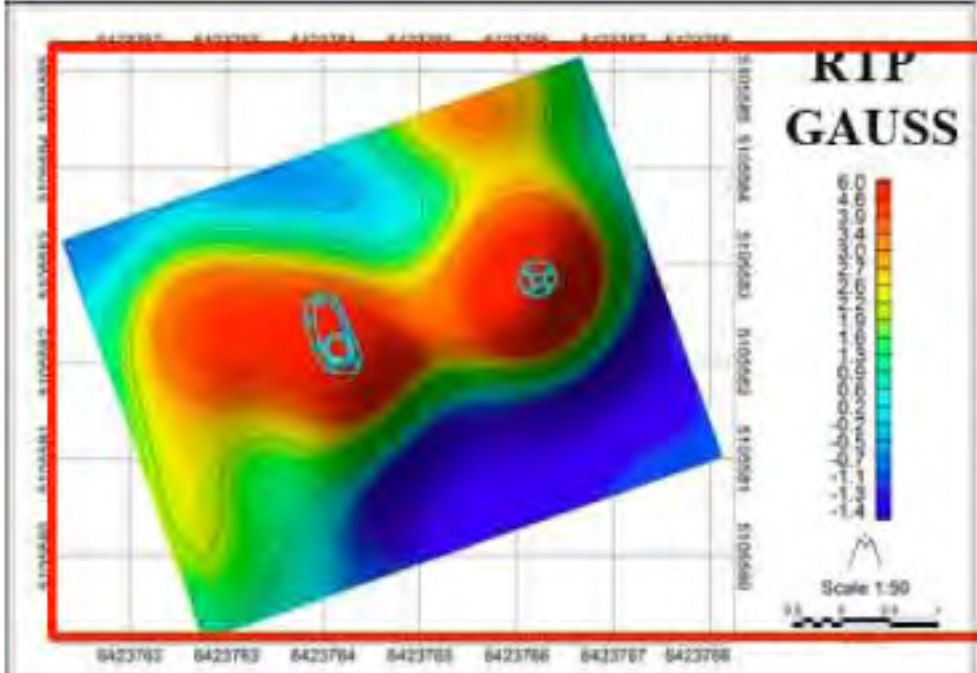


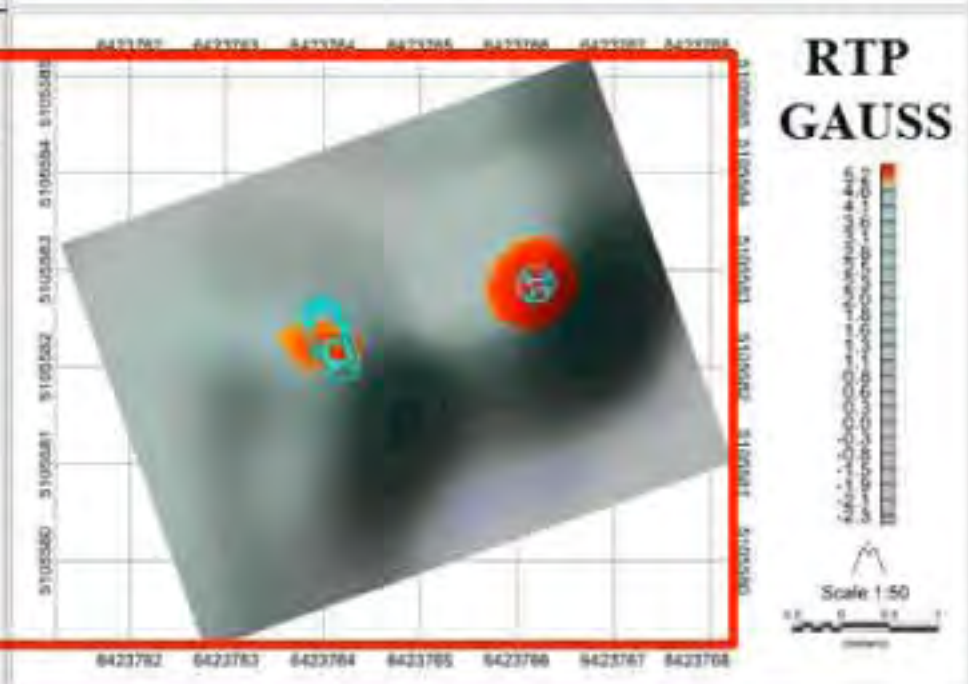


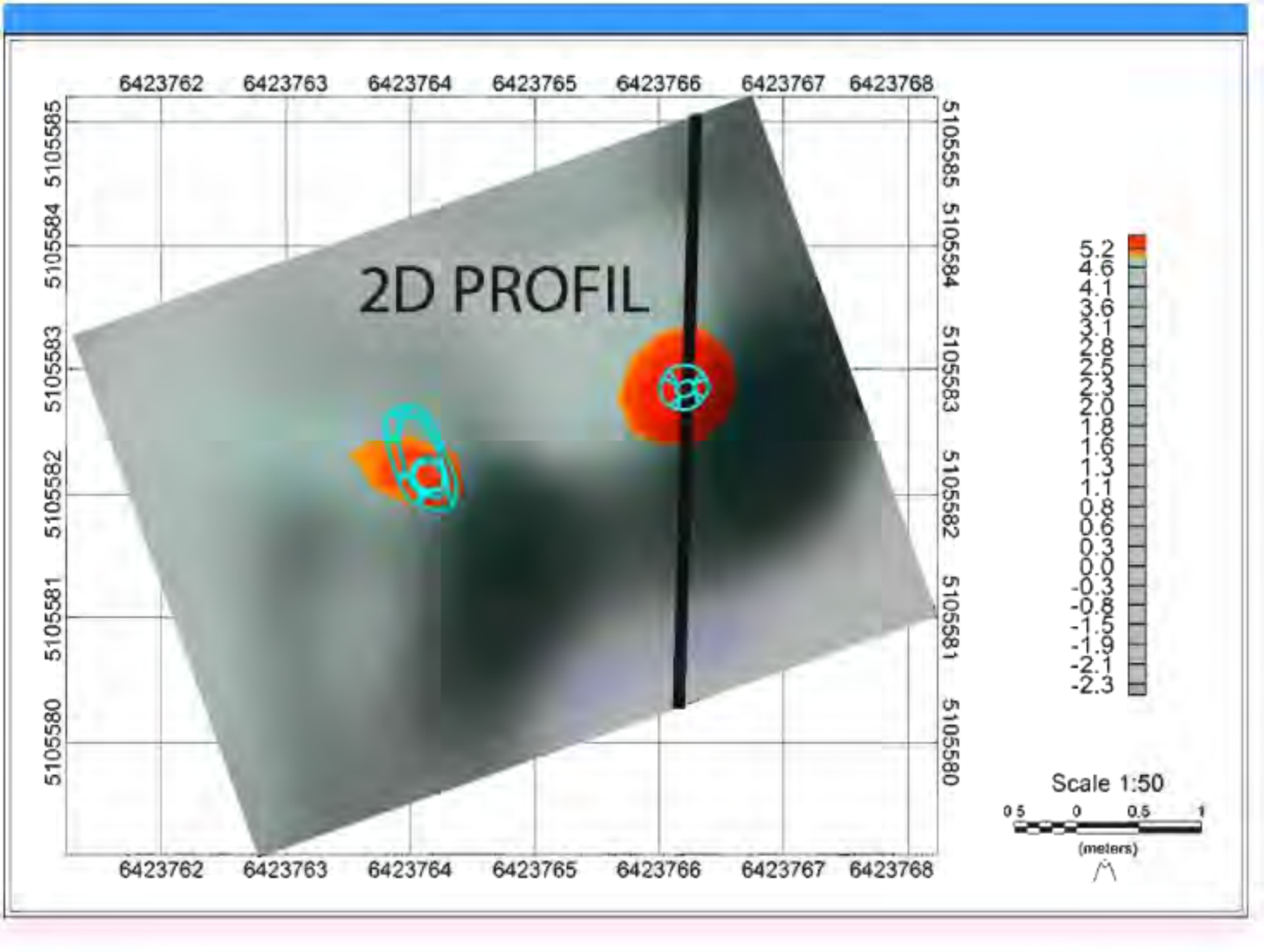


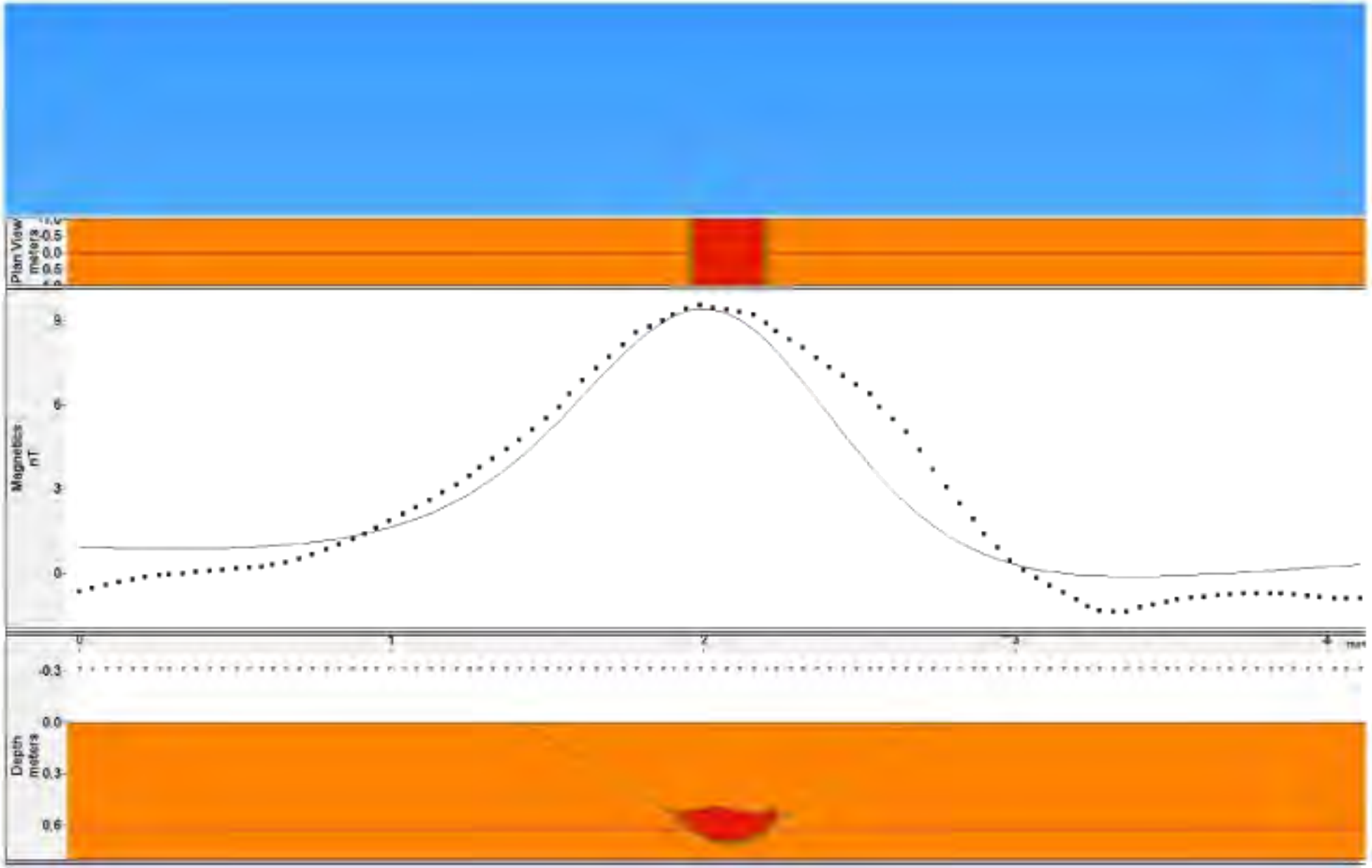

GRD
Scale 1:50


GAUSS
Scale 1:50


RTP
GAUSS
Scale 1:50

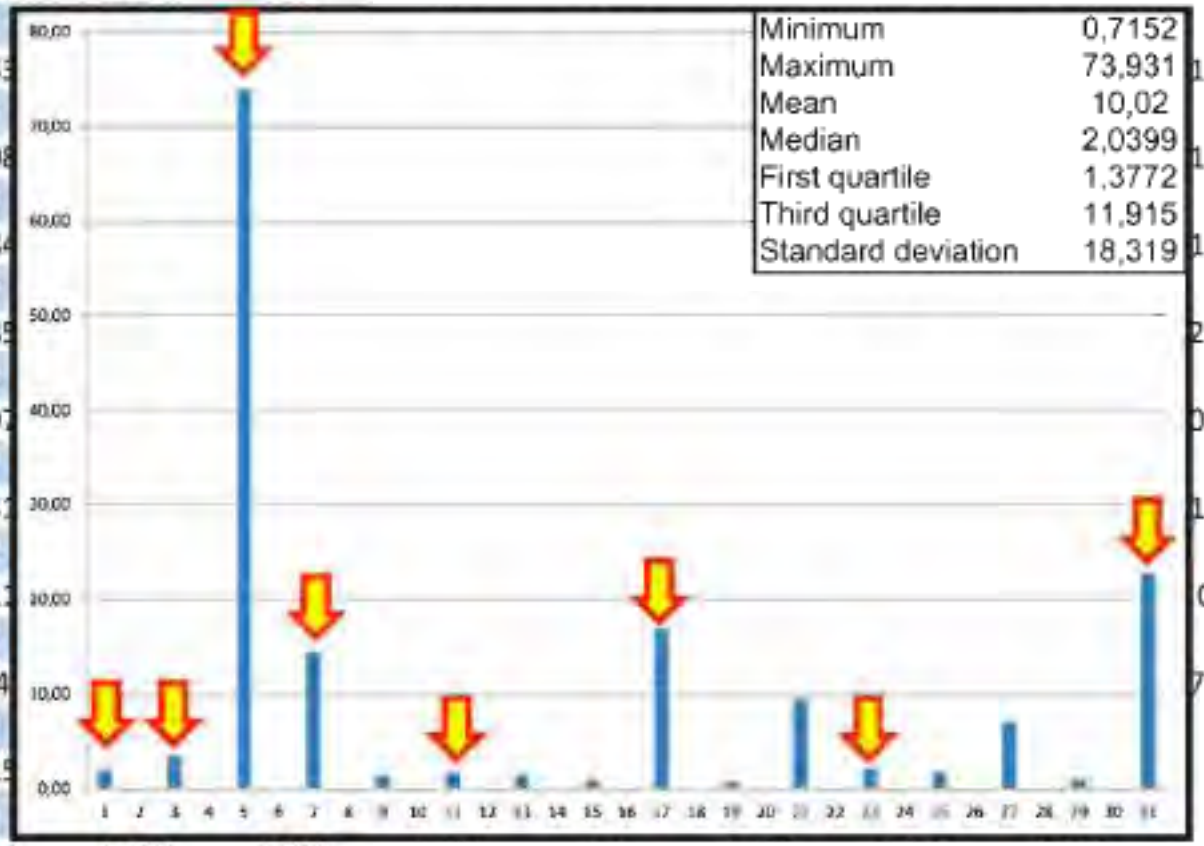

RTP
GAUSS
Scale 1:50

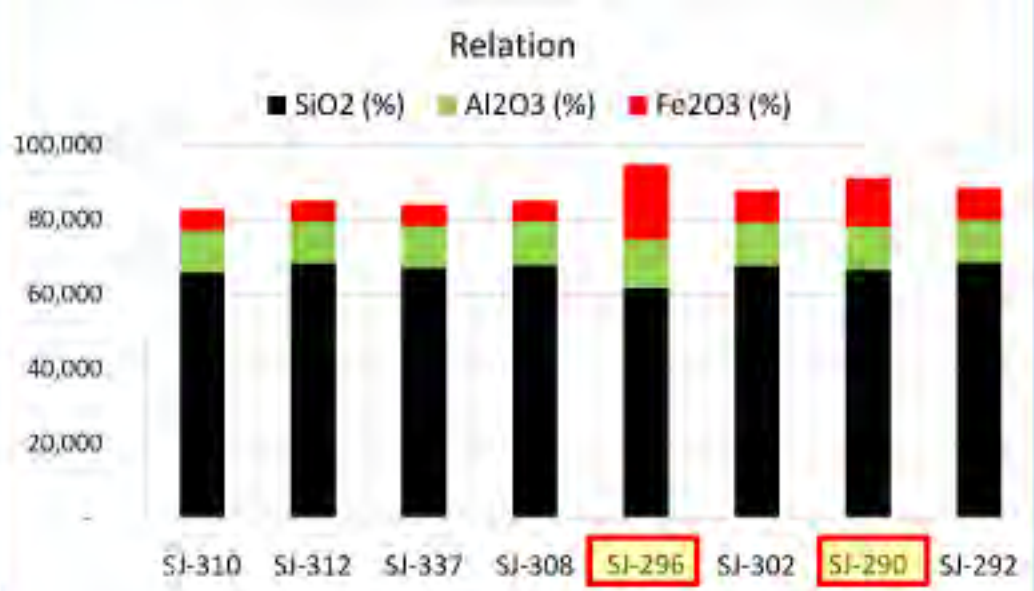

2D PROFIL
6423762
6423763
6423764
6423765
6423766
6423767
6423768
5105585
5105584
5105583
5105582
5105581
5105580
Scale 1:50
0.5
0
0.5
1
(meters)


Plan View
meters
-0.5
0.0
0.5
Magnetics
nT
9
6
3
0
0
1
2
3
4
meters
-0.3
Depth
meters
0.0
0.3
0.6

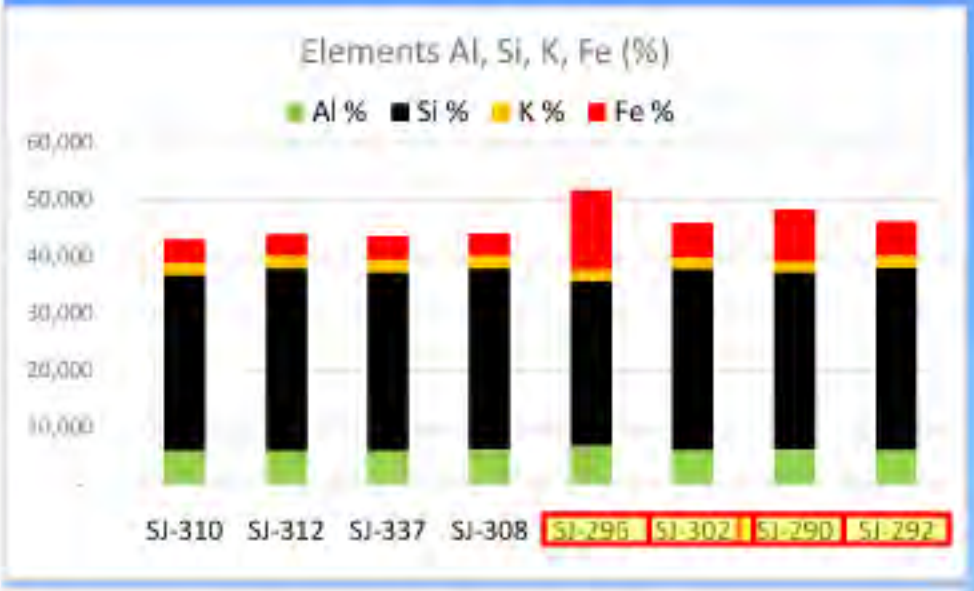
Vrijednosti magnetskog susceptibiliteta po uzorcima

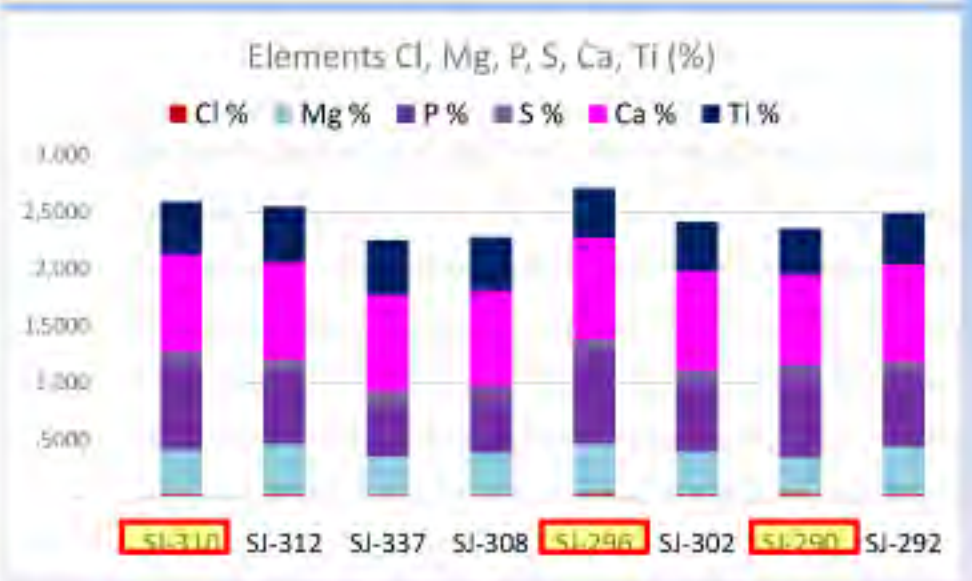
										srednja vrijednost
VIRJE	S7	SJ - 312	U - 185							
1,406	2,48	2,118	2,809	1,469	1,432	2,185	1,581	2,319	1,599	1,98
VIRJE	S7	SJ - 310	U - 178							
2,233	3,439	3,651	6,468	4,734	2,396	3,714	2,419	3,015	2,524	3,46
VIRJE	S7	SJ - 296	U - 158							
83,04	56,97	87,94	76,9	74,73	76,44	71,93	66,95	71,86	72,55	73,93
VIRJE	S7									
15,04	16,43								16,29	14,43
VIRJE	S7									
1,32	1,308								1,293	1,34
VIRJE	S7									
1,393	1,484								1,615	1,61
VIRJE	S7									
1,211	1,285								2,041	1,41
VIRJE	S8									
0,877	0,797								0,789	0,85
VIRJE	S7									
17,17	20,41								15,29	16,80
VIRJE	S8									
0,713	0,711								0,81	0,72
VIRJE	S9									
6,716	9,14								7,334	9,40
VIRJE	S7									
2,011	2,415									2,14
VIRJE	S7									
1,658	1,604	1,616	1,729	1,641	1,9	1,897	1,513	1,999	1,647	1,72
VIRJE	S7	SJ - 302	U -154							
8,792	6,206	6,472	5,661	7,207	8,049	6,052	5,454	7,015	8,392	6,93
VIRJE	S7	SJ - 351	U - 200							
0,968	1,142	0,713	0,76	0,865	1,029	0,881	1,053	0,948	1	0,94
VIRJE	S7	SJ - 290	U -163							
22,61	21,55	17,05	29,51	22,31	25,29	21,71	21,17	25,11	20,74	22,71

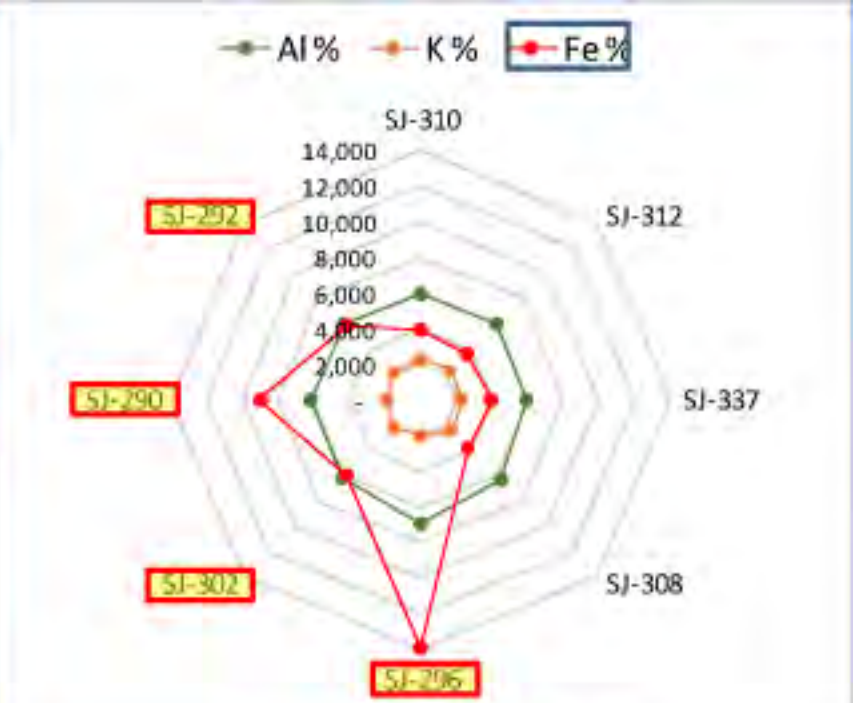


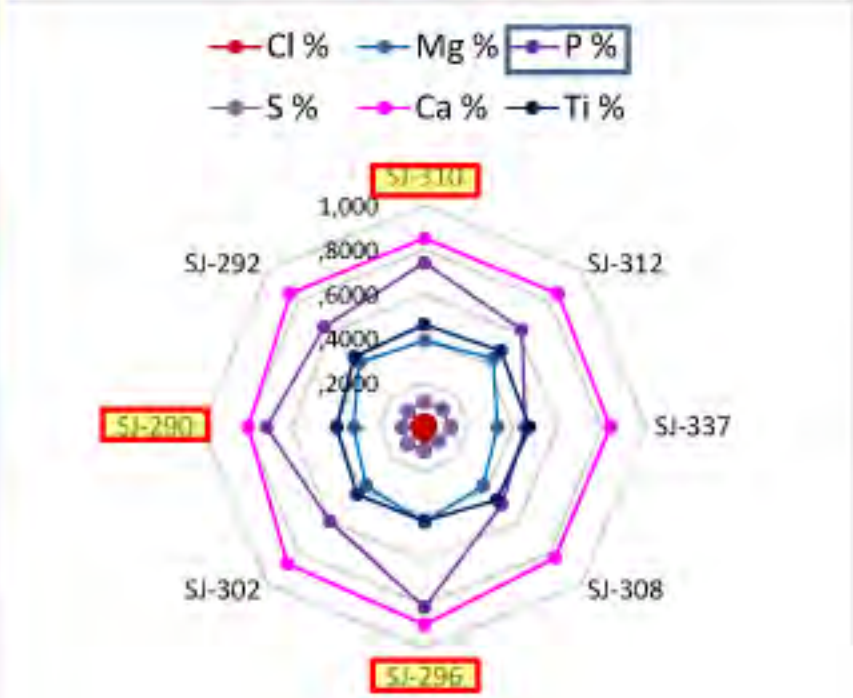

Relation
SiO2 (%)
Al2O3 (%)
Fe2O3 (%)
100,000
80,000
60,000
40,000
20,000
-
SJ-310
SJ-312
SJ-337
SJ-308
SJ-296
SJ-302
SJ-290
SJ-292

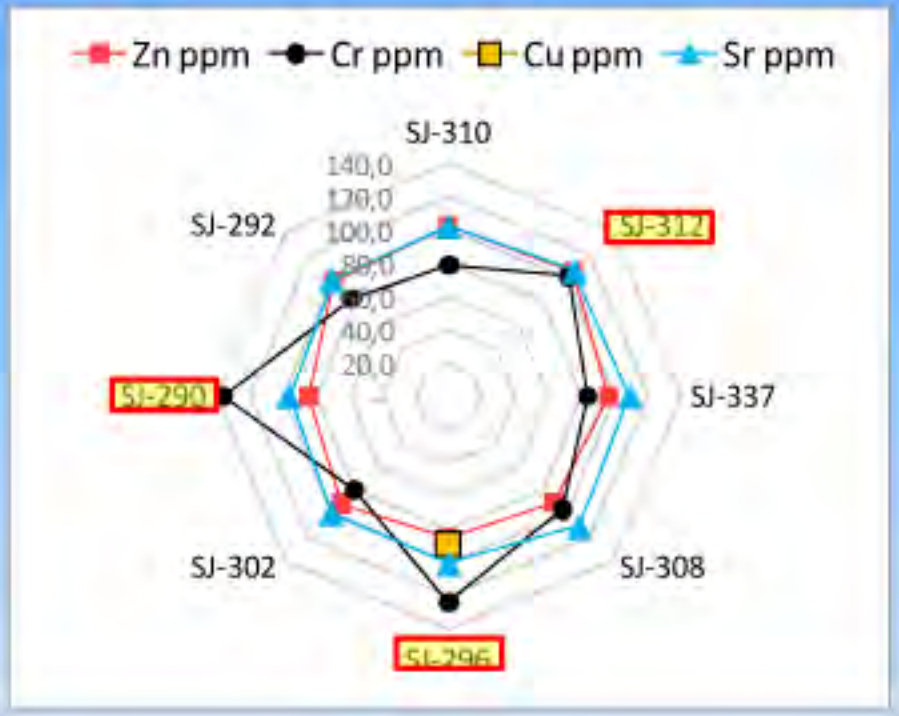

Relation
MgO (%)
CaO (%)
K2O (%)
TiO2 (%)
P2O5 (%)
MnO (%)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
SJ-310
SJ-312
SJ-337
SJ-308
SJ-296
SJ-302
SJ-290
SJ-292

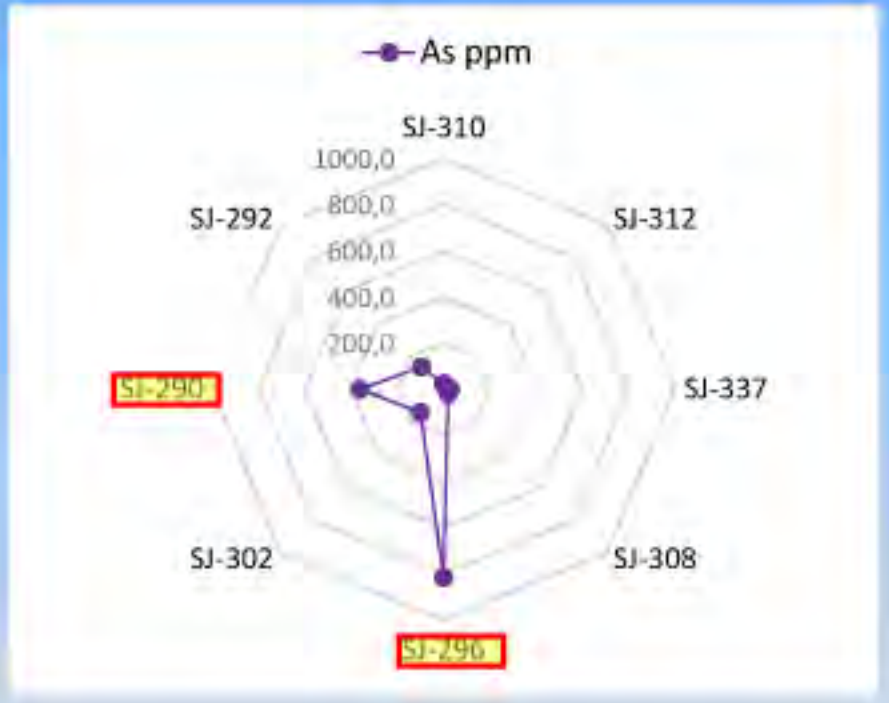

Elements Al, Si, K, Fe (%)
Al %
Si %
K %
Fe %
60,000
50,000
40,000
30,000
20,000
10,000
-
SJ-310
SJ-312
SJ-337
SJ-308
SJ-296
SJ-302
SJ-290
SJ-292


Elements Cl, Mg, P, S, Ca, Ti (%)
Cl %
Mg %
P %
S %
Ca %
Ti %
3,000
2,5000
2,000
1,5000
1,000
,5000
SJ-310
SJ-312
SJ-337
SJ-308
SJ-296
SJ-302
SJ-290
SJ-292


Al %
K %
Fe %
SJ-310
14,000
12,000
10,000
8,000
6,000
4,000
2,000
-
SJ-312
SJ-337
SJ-308
SJ-296
SJ-302
SJ-290
SJ-292


Cl %
Mg %
P %
S %
Ca %
Ti %
SJ-310
1,000
,8000
,6000
,4000
,2000
SJ-312
SJ-337
SJ-308
SJ-296
SJ-302
SJ-290
SJ-292

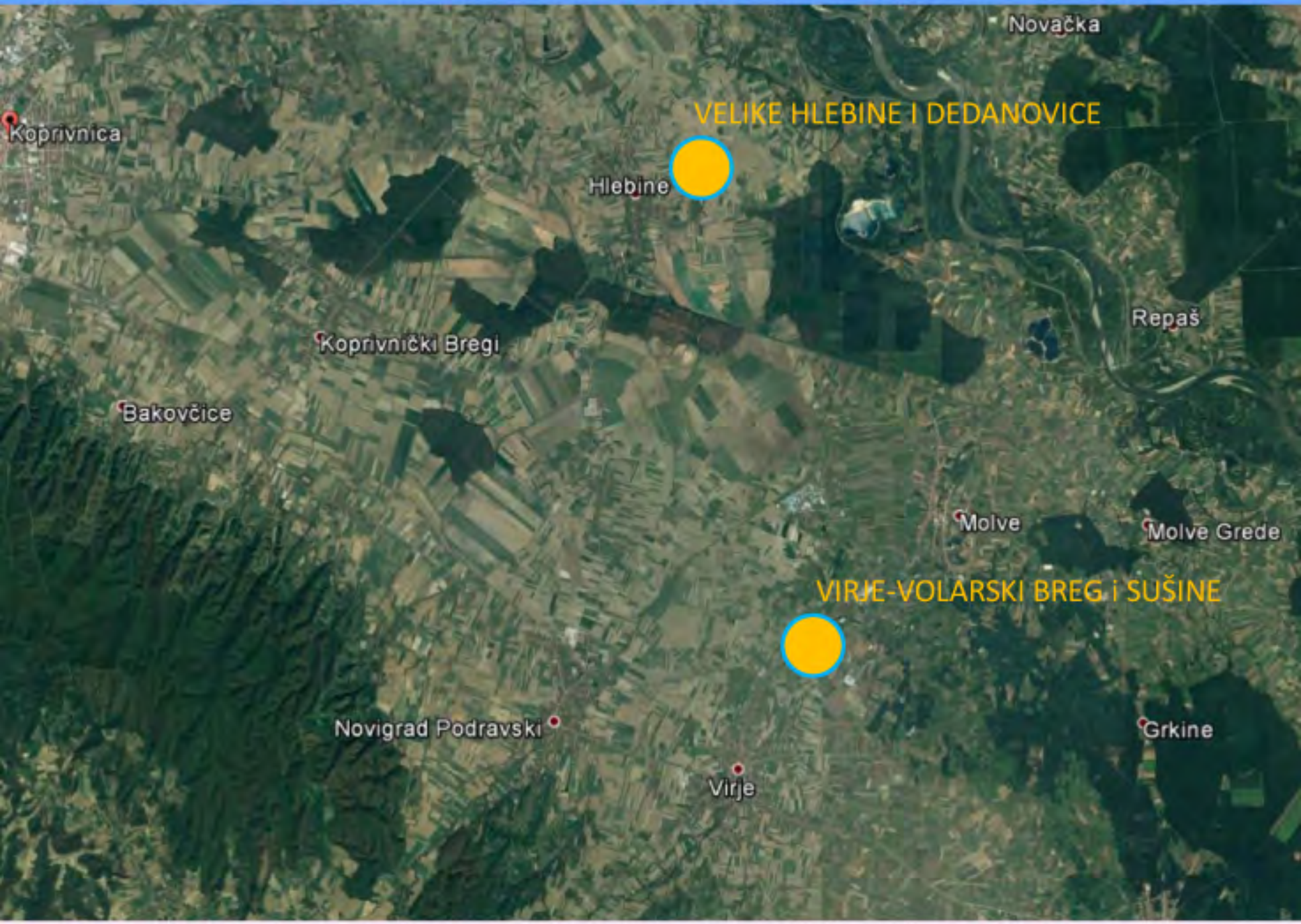

Zn ppm
Cr ppm
Cu ppm
Sr ppm
SJ-310
SJ-312
SJ-337
SJ-308
SJ-296
SJ-302
SJ-290
SJ-292
140,0
120,0
100,0
80,0
60,0
40,0
20,0


As ppm
SJ-310
SJ-312
SJ-337
SJ-308
SJ-296
SJ-302
SJ-290
SJ-292
1000,0
800,0
600,0
400,0
200,0

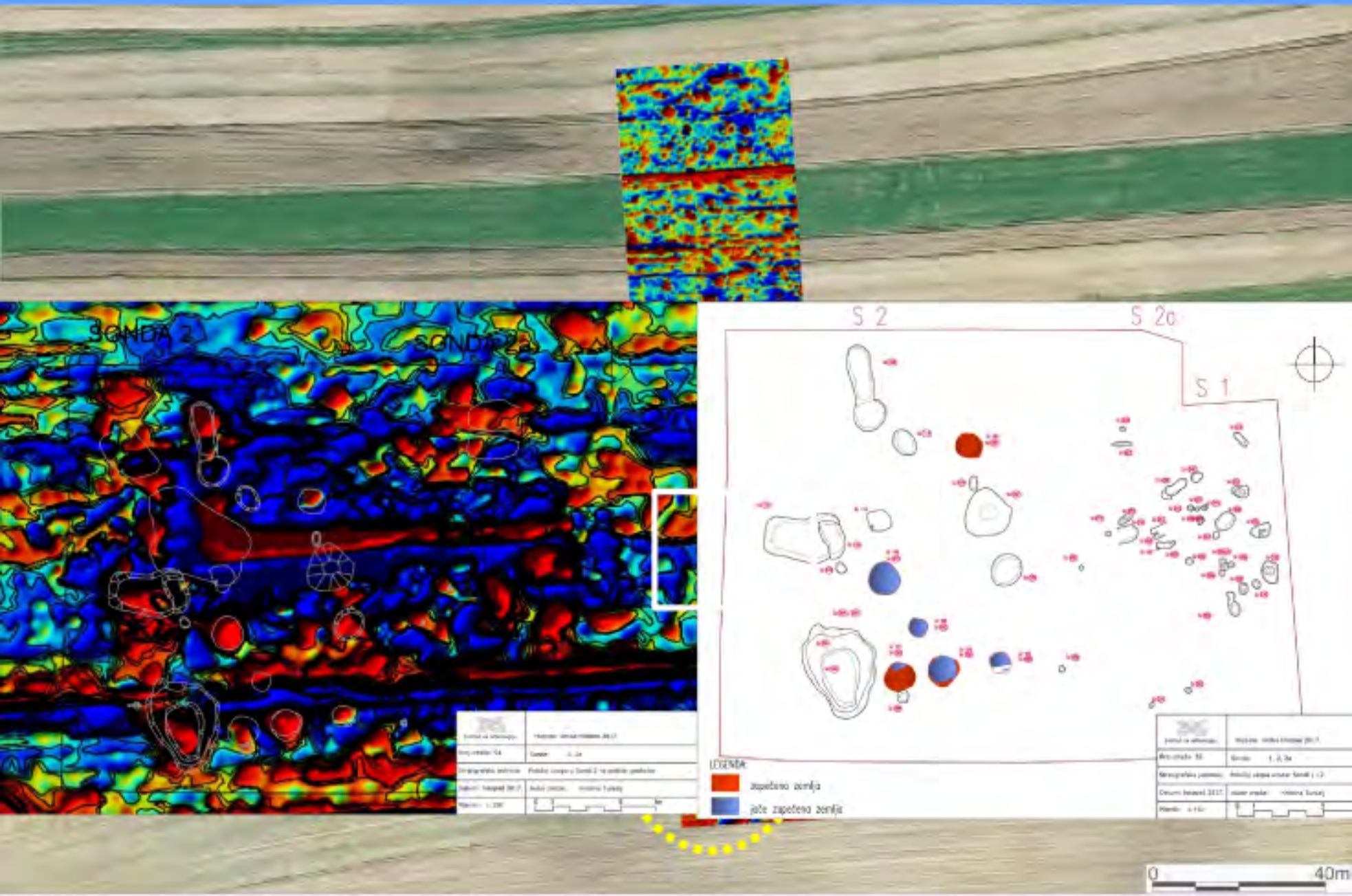
Vrijednosti magnetskog susceptibiliteta po uzorcima

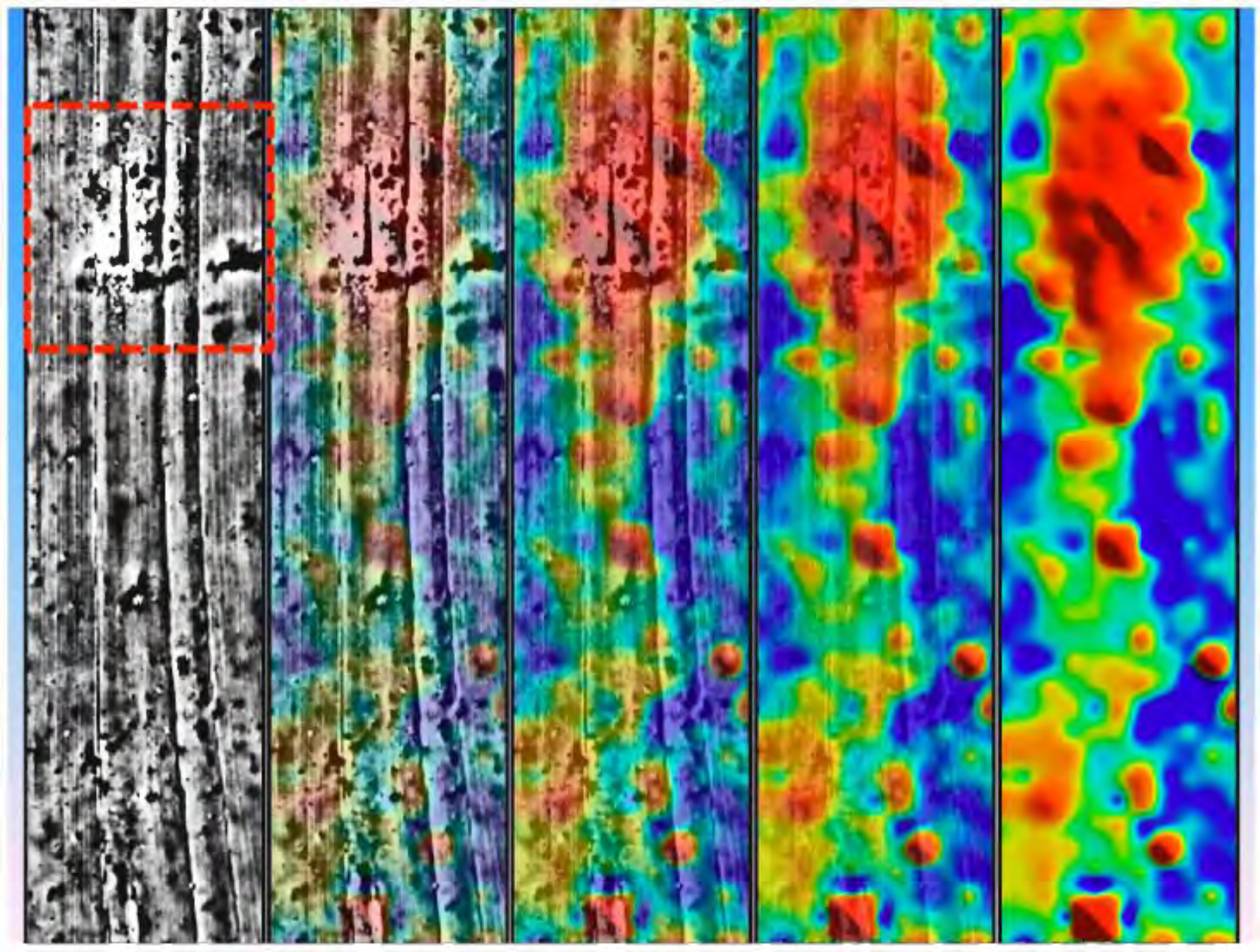
										srednja vrijednost
VIRJE	S7	SJ - 312	U - 185							
1,406	2,48	2,118	2,809	1,469	1,432	2,185	1,581	2,319	1,599	1,90
VIRJE	S7	SJ - 310	U - 178							
2,233	3,439	3,651	6,468	4,734	2,396	3,714	2,419	3,015	2,524	3,46
VIRJE	S7	SJ - 296	U - 158							
83,04	56,97	87,94	76,9	74,73	76,44	71,93	66,95	71,86	72,55	73,93
VIRJE	S7	SJ - 292	U - 165							
15,04	16,43	14,84	14,24	13,3	15	12,73	13,1	13,33	16,29	14,43
VIRJE	S7	SJ - 294	U - 167							
1,32	1,308	1,234	1,289	1,438	1,327	1,509	1,289	1,434	1,293	1,34
VIRJE	S7	SJ - 337	U - 174							
1,393	1,484	1,275	1,196	2	2,17	1,927	1,648	1,399	1,615	1,61
VIRJE	S7	SJ - 304	U - 176							
1,211	1,285	1,29	1,318	1,239	1,898	1,236	1,332	1,254	2,041	1,41
VIRJE	S8	SJ - 336	U - 160							
0,877	0,797	0,732	0,72	0,922	0,77	1,263	0,859	0,747	0,789	0,85
VIRJE	S7	SJ - 302	U - 169							
17,17	20,41	16,8	15,23	17,23	19,09	15,6	18,12	13,07	15,29	16,80
VIRJE	S8	SJ - 334	U - 180							
0,713	0,711	0,766	0,824	0,636	0,682	0,687	0,641	0,682	0,81	0,72
VIRJE	S9	SJ - 306B	U - 172							
6,716	9,14	11,52	13,76	13,13	8,641	8,772	5,397	9,583	7,334	9,40
VIRJE	S7	SJ - 308	U - 156							
2,011	2,415	2,062	2,121	2,29	1,906	2,457	2,098	1,962		2,14
VIRJE	S7	SJ - 298	U - 152							
1,658	1,604	1,616	1,729	1,641	1,9	1,897	1,513	1,999	1,647	1,72
VIRJE	S7	SJ - 302	U -154							
8,792	6,206	6,472	5,661	7,207	8,049	6,052	5,454	7,015	8,392	6,93
VIRJE	S7	SJ - 351	U - 200							
0,968	1,142	0,713	0,76	0,865	1,029	0,881	1,053	0,948	1	0,94
VIRJE	S7	SJ - 290	U -163							
22,61	21,55	17,05	29,51	22,31	25,29	21,71	21,17	25,11	20,74	22,71

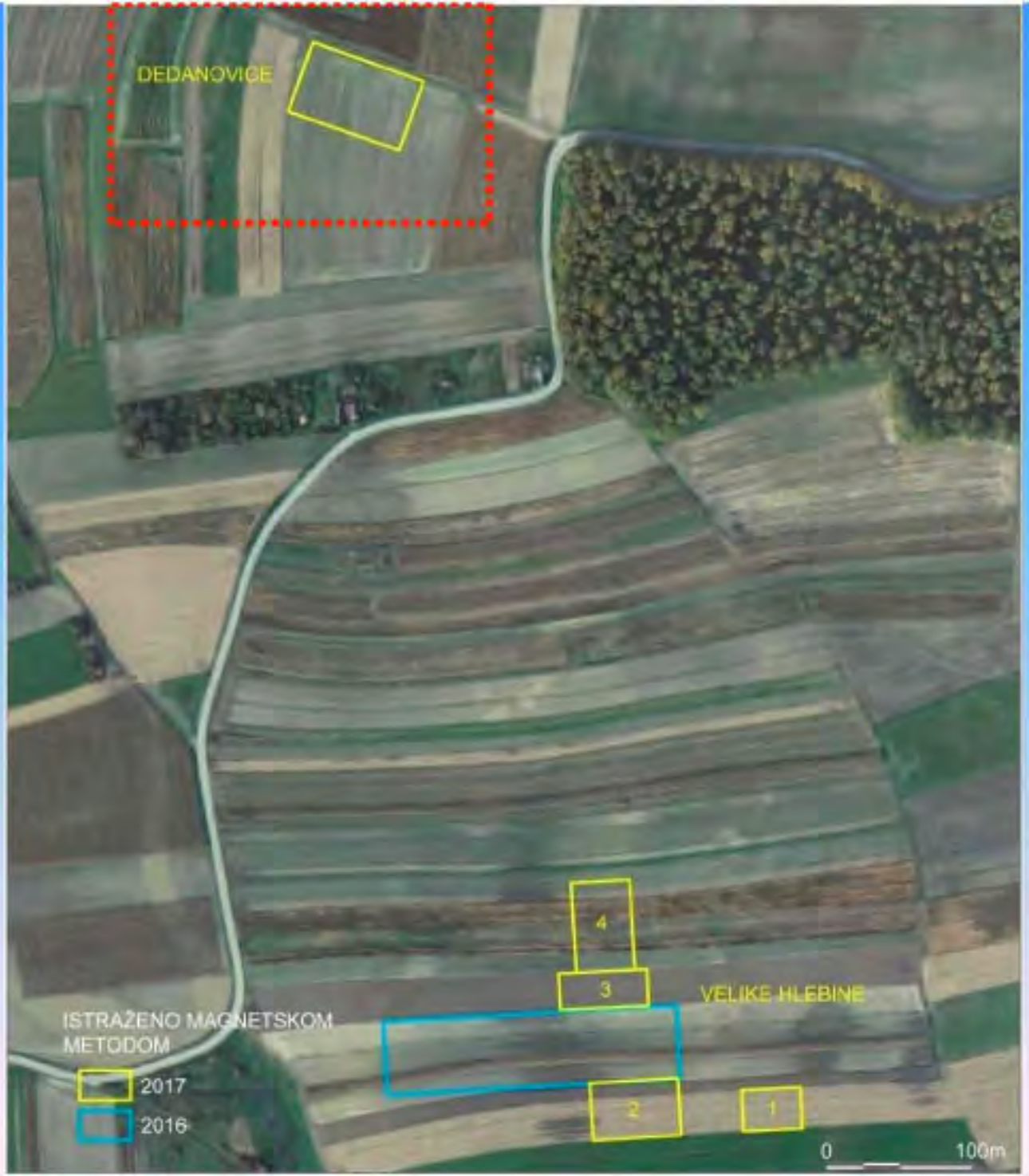



Novačka
VELIKE HLEBINE I DEDANOVICE
Koprivnica
Hlebine
Repaš
Koprivnički Bregi
Bakovčice
Molve
Molve Grede
VIRJE-VOLARSKI BREG i SUŠINE
Novigrad Podravski
Grkine
Virje

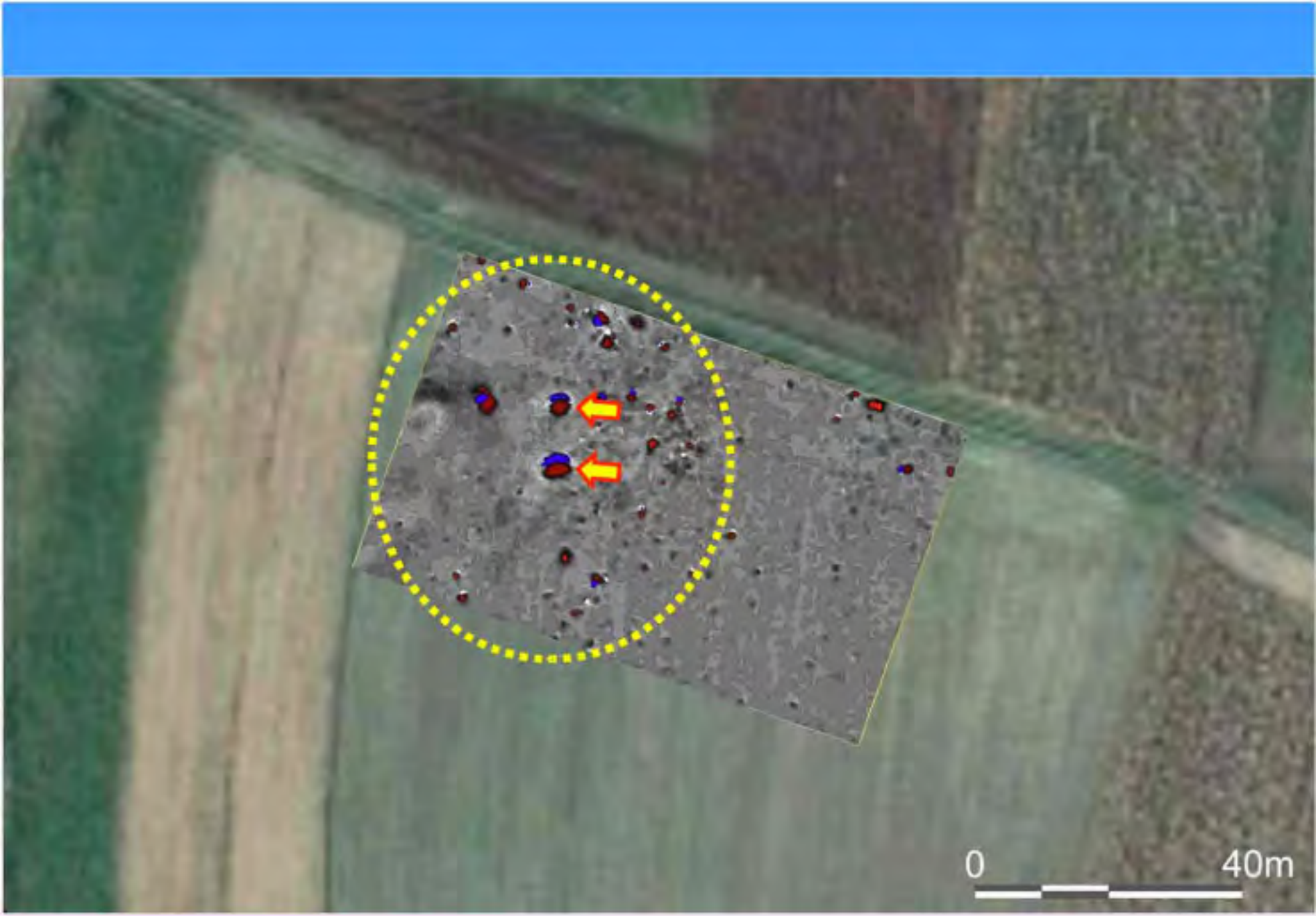

DEDANOVICE
4
3
VELIKE HLEBINE
ISTRAŽENO MAGNETSKOM METODOM
2017
2016
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SONDA 2
SONDA 2a
S 2
S 2a
S 1
LEGENDA
zapečeno zemlja
još zapečeno zemlja
0
40m

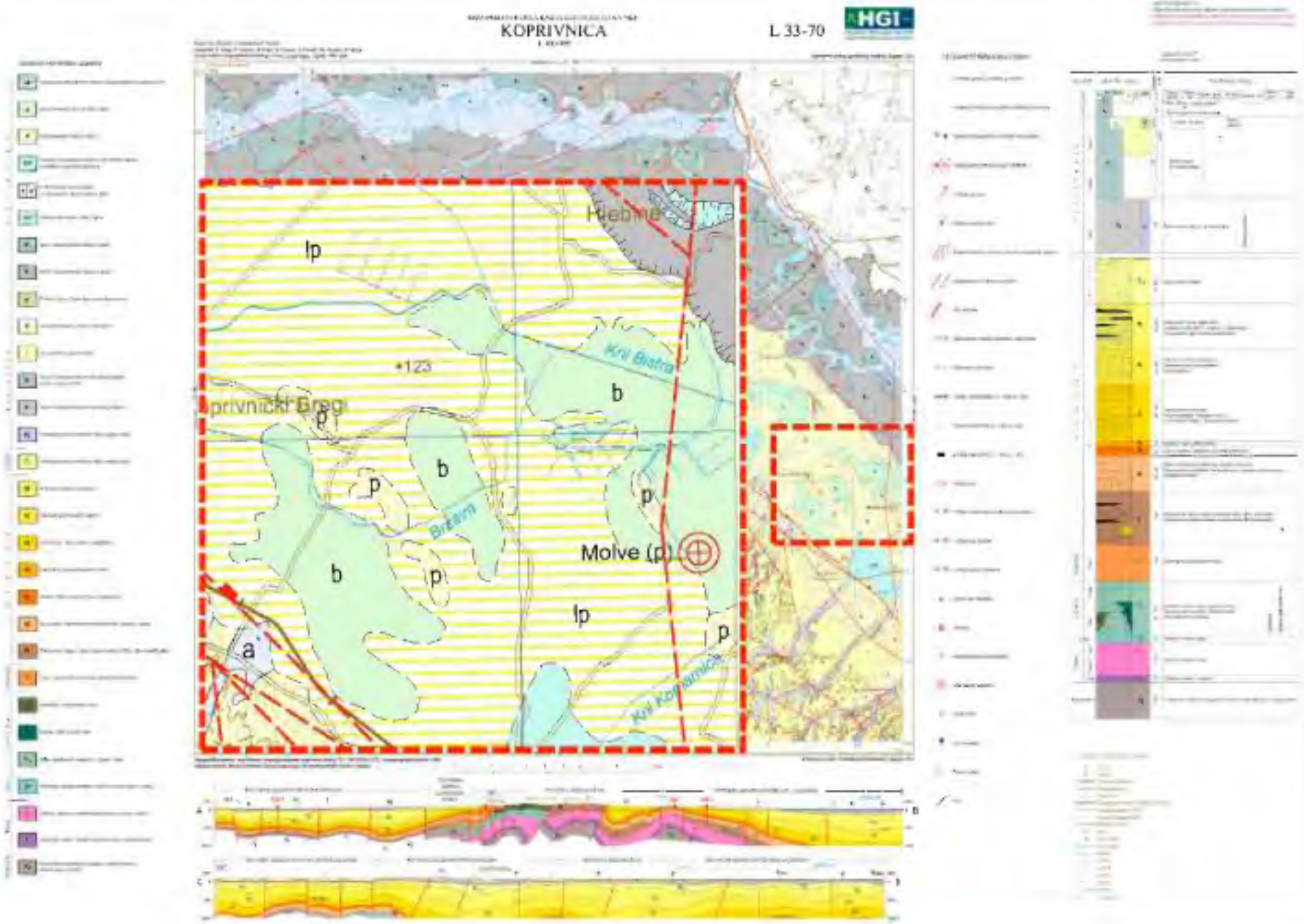


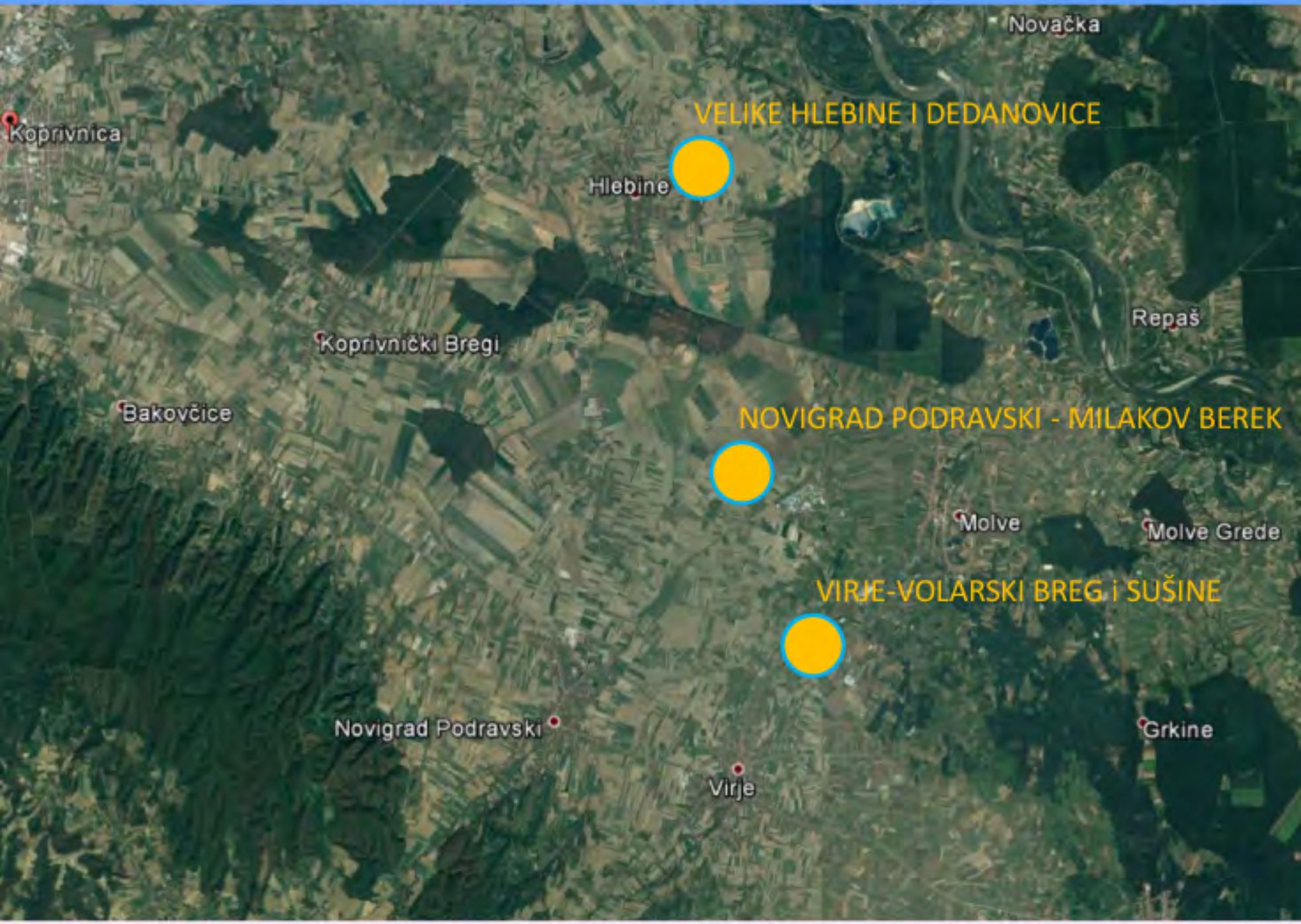

DEDANOVICE
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3
VELIKE HLEBINE
ISTRAŽENO MAGNETSKOM METODOM
2017
2016
2
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100m


0
40m


0
40m


0
40m


KOPRIVNICA
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Hlebine
Kri Bistra
+123
Koprivnički Bregi
b
p
Bistrica
Molve (p)
a
Kri Koprivnica


Novačka
VELIKE HLEBINE I DEDANOVICE
Koprivnica
Hlebine
Repaš
Koprivnički Bregi
Bakovčice
NOVIGRAD PODRAVSKI - MILAKOV BEREK
Molve
Molve Grede
VIRJE-VOLARSKI BREG i SUŠINE
Novigrad Podravski
Grkine
Virje

N

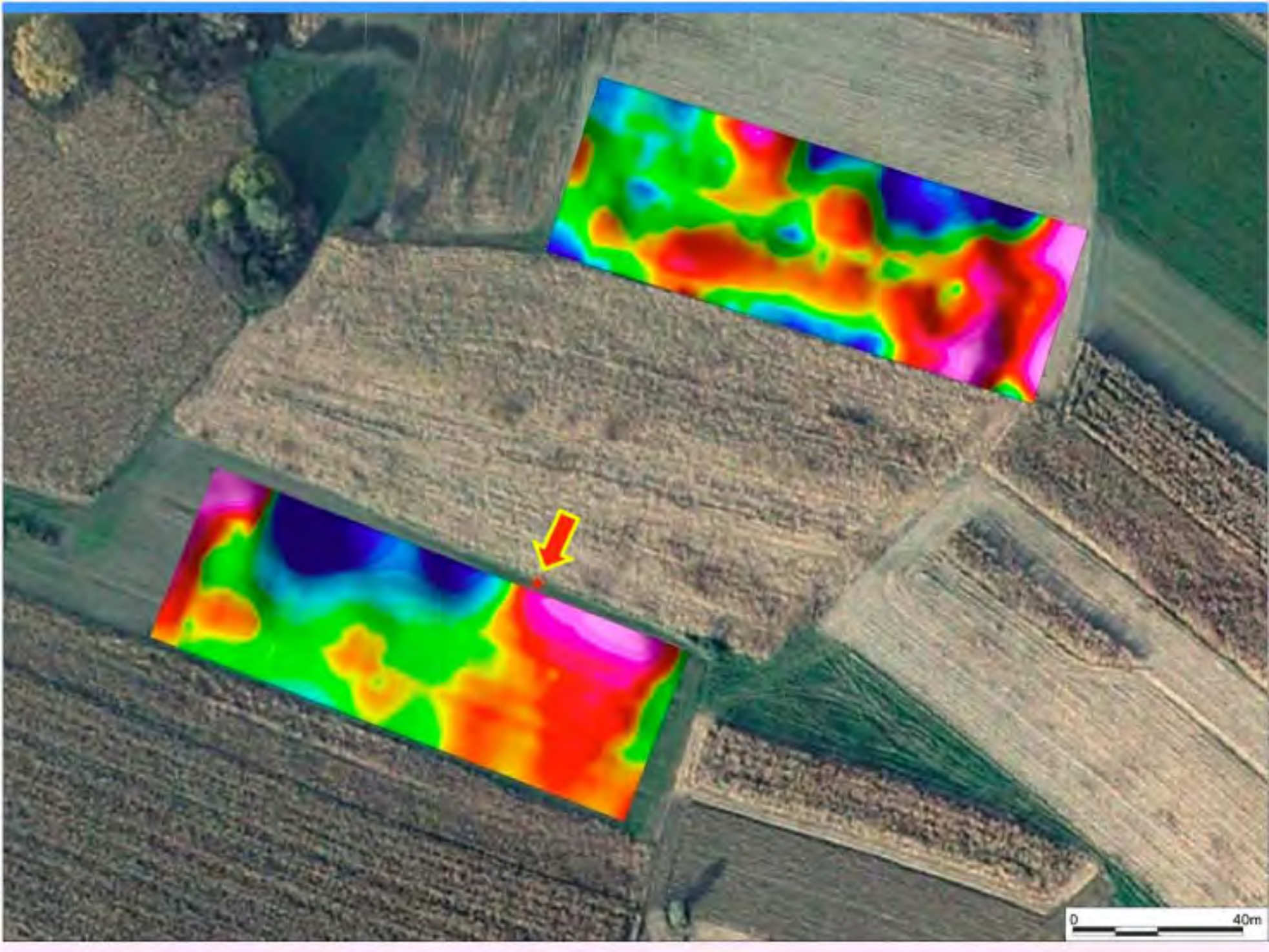
Legenda

- lokacija uzorkovanja
- Lesoidno glinovito - pjeskoviti siltovi
- Barski facijes - gline i siltovi

0 0,25 0,5 Km

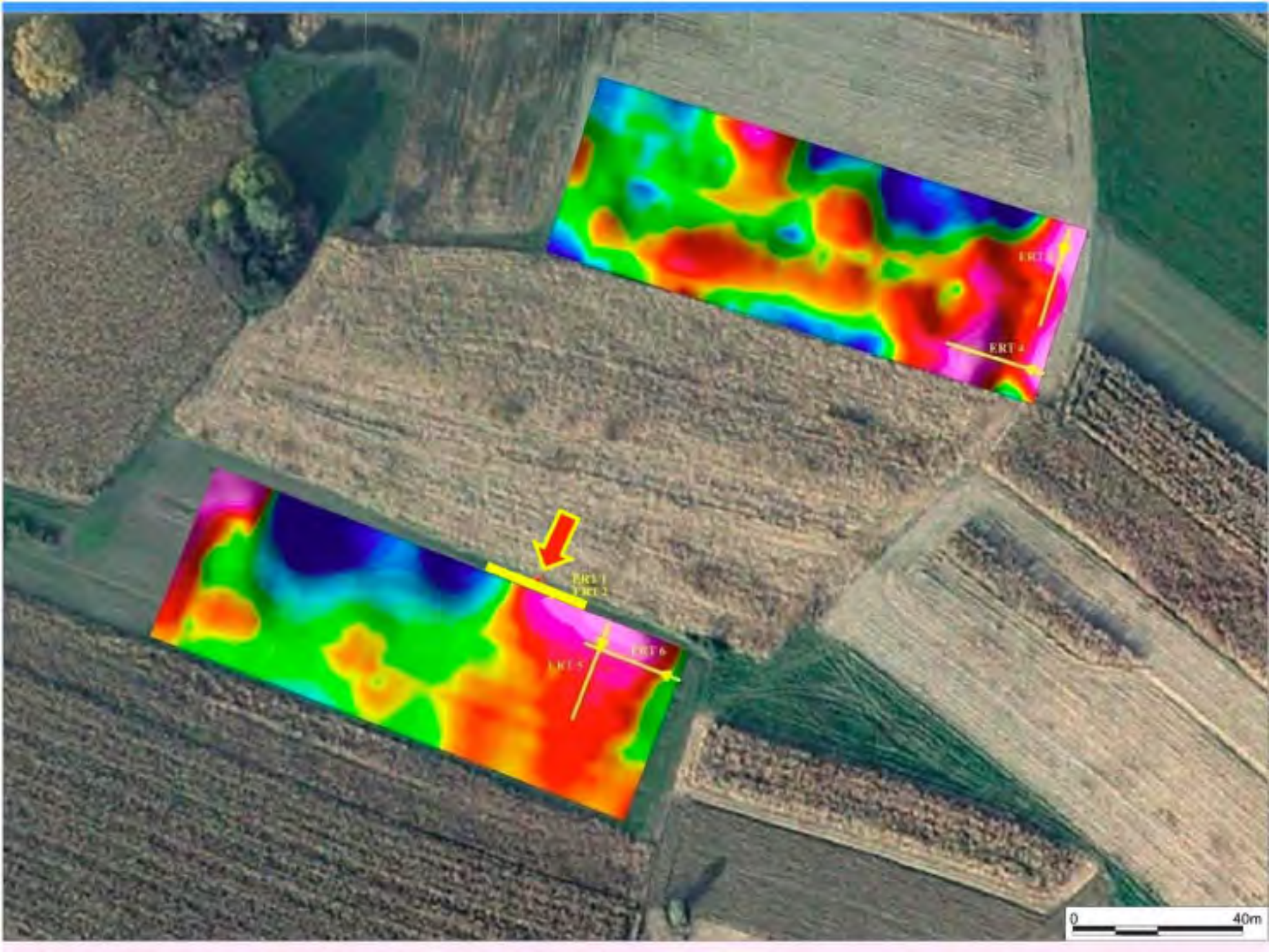
Fe-oxides




0
40m

2D resistivity tomography




ERT 4
ERT 6
0
40m

2D resistivity tomography

