

RUDJER BOŠKOVIĆ INSTITUTE RADIOCARBON MEASUREMENTS XV

Bogomil Obelić¹ • Ines Krajcar Bronić • Nada Horvatinčić

Rudjer Bošković Institute, P.O.Box 180, 10002 Zagreb, Croatia

INTRODUCTION

In this report we present dating of archaeological samples performed since 1995 in the Radiocarbon Laboratory of the Rudjer Bošković Institute. Several samples from the period before 1995, which were not included in our previous data lists, are given as well. Sample preparation, proportional counter technique, and processing of data are essentially the same as reported earlier (Srdoč et al. 1971, 1979; Obelić 1989). The quality assurance and quality control system according to ISO 17025 has been improved within the IAEA TC Regional Project on Quality Control and Quality Assurance for Nuclear Analytical Techniques. The laboratory participated in ¹⁴C intercomparison studies (Horvatinčić et al. 1990; Krajcar Bronić et al. 1995; Bryant et al. 2001; Radiocarbon 2001). We use Oxalic Acid I as modern standard, and anthracite and marble as background standards.

Age calculations follow the conventional protocol (Mook and van der Plicht 1999) based on Libby half-life of 5570 ± 30 yr and using AD 1950 as the reference year. Ages and standard deviations (1σ error) of samples are adjusted for stable isotope fractionation to normalized concentration ratio ($\delta^{13}\text{C} = -25\text{‰}$) according to recommendations in Stuiver and Polach (1977) and using the default $\delta^{13}\text{C}$ values. Calibrated ages are calculated from non-rounded ¹⁴C conventional ages by using the program OxCal v.3.0 (Bronk Ramsey 1995, 1998) with 1σ error (confidence level 68.2%). When several calendar age ranges are obtained, probability for each interval is given. Probabilities less than 5% are omitted. In reports both the conventional ¹⁴C ages and the calibrated range intervals are rounded.

ARCHAEOLOGICAL SAMPLES

CROATIA

Andautonia Series

Wood collected from Roman settlement Andautonia (Figure 1), village Ščitarjevo (45°46'N, 16°07'E), 101 m asl, near Zagreb, NW Croatia. Submitted 1995 by D Nemeth–Ehrlich (Z-2594 and Z-3005) and 2000 by D Doračić (Z-2979), Archaeological Museum, Zagreb. Previous measurements: Z-146 (Srdoč et al. 1971) and Z-283 (Srdoč et al. 1975).

Z-2594 Andautonia 1

pMC: 101.1 ± 1.1

Wood from thermal well between objects B and C. Expected age: 1st century

Comment: (DNE) Result does not confirm the presumption.

Z-2979 Andautonia 2

1900 ± 90

Wood from well B-20, 3.5 m depth (cal AD 20–220, 68.2%).

Z-3005 Andautonia 3

2000 ± 75

Wood, B-15, from planking of burned grave (cal 100 BC–AD 90, 68.2%).

¹Corresponding author. Email: Bogomil.Obelic@irb.hr.

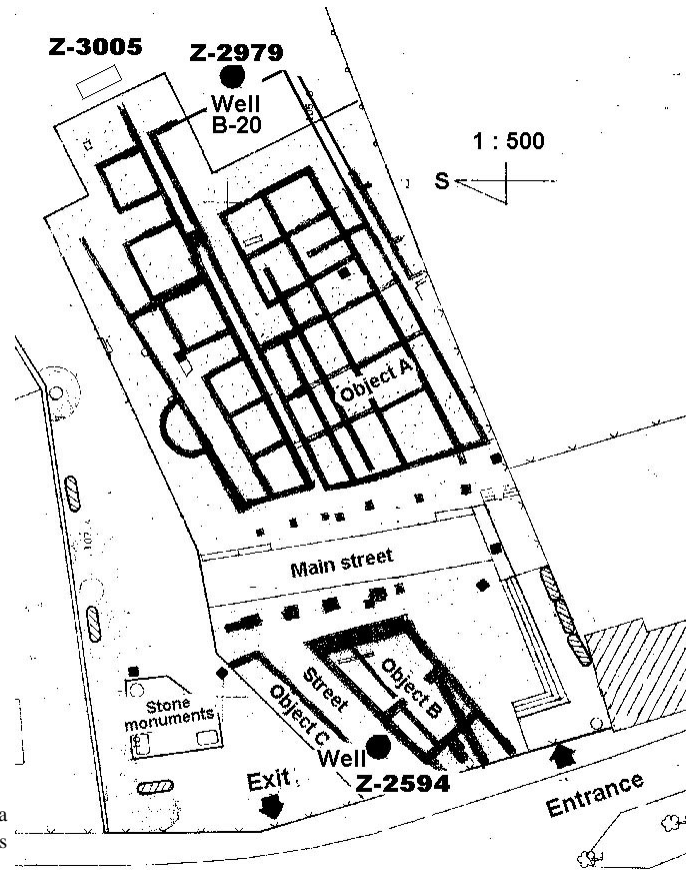


Figure 1 Archaeological site Andautonia near Zagreb with locations where samples were taken for ¹⁴C analyses

Z-2809 Bošnjaci–Vjerovi

80 ± 70

Inner part of oak monoxyle below water, Bošnjaci–Vjerovi (45°03'01"N, 18°45'20"E), 76 m asl, near Županja, Slavonia, E Croatia. Collected 1997 by K Bušić-Jelić and submitted 1998 by B Marijan, Županja Regional Museum (cal AD 1680–1730, 17.4%; AD 1810–1930, 49.3%).

Comment: (BM) treatment of samples for permanent exhibition in Regional Museum.

Z-2716 Bršljanka

460 ± 70

Human bones belonging to one or two persons found in Bršljanka Cave near Lupoglav (45°21'09"N, 14°06'22"E) in Istria, W Croatia. Submitted 1997 by F Boras, State Commission for War and Post-war Victims, Zagreb (cal AD 1390–1530, 48.8%; AD 1570–1630, 14.9%).

Z-2823 Čačinci

370 ± 90

Human bones found in catacombs of the church in Slatinski Drenovac near Čačinci (45°33'13"N, 17°42'28"E), 222 m asl, Slavonia, E Croatia. Suspected victims of WWII buried in this church. Collected 1998 by T Tomić and submitted by L Skavić, Commune of Čačinci (cal AD 1470–1660, 68.2%).

Comment: (TT) Expected Middle Ages.

Čakovec Old Town Series

Wood from base construction of entrance fortress of Old Town Čakovec (46°23'26"N, 16°26'28"E), Medimurje, NW Croatia (Figure 2). Determination of time of construction of various phases of the Old Town. Collected and submitted 1993 by S Petr-Marčec, Regional Museum of Medimurje, Čakovec. Previous measurements: Z-2436, Z-2437 (Obelić et al. 1994).

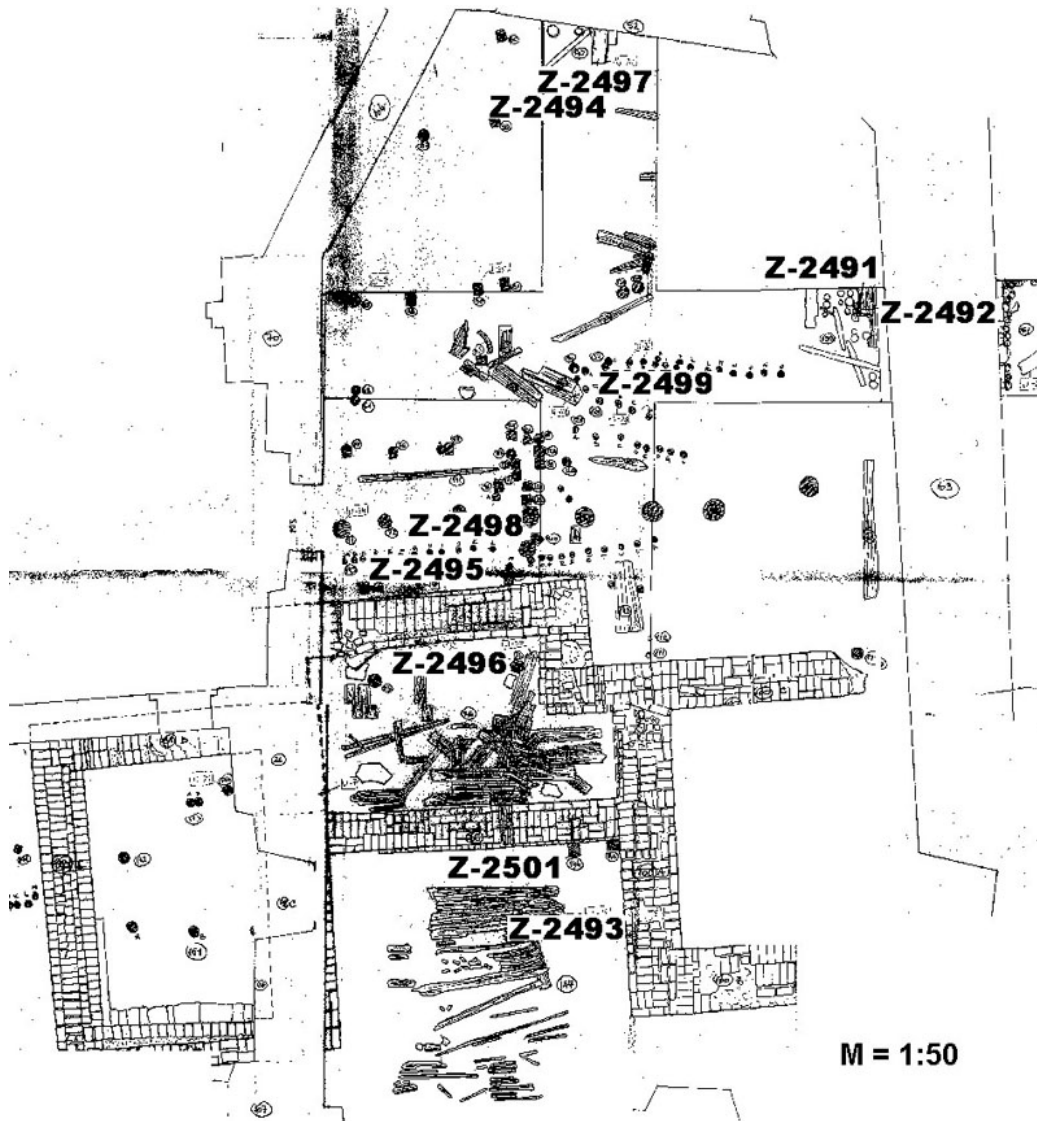


Figure 2 Old Town Čakovec, entrance fortress, with locations of samples taken for ¹⁴C analyses

Z-2501 Čakovec Old Town 1 **825 ± 95**

Buried wooden post from construction, U-36, No. 144. Oak (*Quercus petrea* or *Quercus robur*), 163.18 m asl (cal AD 1060–1090, 8.0%; AD 1120–1140, 5.1%; AD 1150–1290, 55.1%).

Comment: (SP) Expected age: 14th–15th century.

Z-2491 Čakovec Old Town 2 **355 ± 80**

Wood found in soil, grilled shape pylon of the base construction of ramparts, U-37, No.158/8. Alder (*Alnus glutinosa* Geartn.), 161.80 m asl (cal AD 1460–1640, 68.2%).

Comment: (SP) Expected age: 15th–16th century.

Z-2492 Čakovec Old Town 3 **400 ± 80**

Wood found in soil, grilled shape pylon of the base construction of ramparts, U-38, No.161. Alder (*Alnus glutinosa* Geartn.), 161.70 m asl (cal AD 1430–1530, 41.6%; AD 1560–1630, 26.6%).

Comment: (SP) Expected age: 15th–16th century.

Z-2493 Čakovec Old Town 4 **635 ± 60**

Wooden board from construction found in soil, U-39, No.147/6. Oak (*Quercus petrea* or *Quercus robur*), 163.85 m asl (cal AD 1295–1330, 26.7%; AD 1340–1395, 41.5%).

Comment: (SP) Expected age: 14th–15th century.

Z-2494 Čakovec Old Town 5 **350 ± 55**

Wooden post found in soil, pier of the bridge, U-40, No.59. Oak (*Quercus petrea* or *Quercus robur*), 163.49 m asl (cal AD 1480–1530, 25.5%; AD 1550–1640, 42.7%).

Comment: (SP) Expected age: 14th–15th century.

Z-2495 Čakovec Old Town 6 **360 ± 80**

Small wooden post from construction supporting earthen dam, U-41, No. 80/d. Oak (*Quercus petrea* or *Quercus robur*), 163.40 m asl (cal AD 1450–1530, 29.3%; AD 1540–1640, 28.9%).

Comment: (SP) Expected age: 14th–15th century.

Z-2496 Čakovec Old Town 7 **515 ± 65**

Wooden board from construction found in soil, U-42, No. 146/10. Juniper (*Picea excelsa*), 163.23 m asl (cal AD 1320–1360, 18.0%; AD 1380–1450, 50.2%).

Comment: (SP) Expected age: 14th–16th century.

Z-2497 Čakovec Old Town 8 **375 ± 80**

Wooden board from base construction of ramparts, U-43, No. 143. Oak (*Quercus petrea* or *Quercus robur*), 162.00 m asl (cal AD 1440–1530, 36.2%; AD 1550–1640, 32.0%)

Comment: (SP) Expected age: 14th–15th century.

Z-2498 Čakovec Old Town 9 **415 ± 80**

Wooden post from construction found in soil, U-44, No. 55. Oak (*Quercus petrea* or *Quercus robur*), 163.76 m asl (cal AD 1420–1530, 48.2%; AD 1570–1630, 20.0%).

Comment (SP): Expected age: 14th–15th century.

Z-2499 Čakovec Old Town 10**460 ± 80**

Small wooden post from construction supporting earthen dam, found in soil, U-45, No. 132b. Oak (*Quercus petraea* or *Quercus robur*), 162.87 m asl (cal AD 1390–1520, 59.2%; AD 1590–1620, 5.5%).

Comment (SP): Expected age: 14th–16th century.

Z-2560 Čilipi**1570 ± 95**

Human bones found below basement of a house, Čilipi (42°33'01"N, 18°17'04"E), 126 m asl near Dubrovnik. Collected 1993 by N Grbić, Dubrovnik, and submitted by Đ Miljanić, Rudjer Bošković Institute, Zagreb (cal AD 400–610, 68.2%).

Z-2503 Donji Miholjac–Šašnato Polje**30,200 +1900/–1550**

Metatarsal bone of giant deer (*Megaceros giganteus*) found 4 m deep in Holocene and Upper Pleistocene alluvium at site Šašnato Polje near Donji Miholjac (45°45'39"N, 18°10'02"E), E Slavonia. Collected 1987 by M Malez, and submitted 1994 by M Paunović, Croatian Academy of Sciences and Arts, Zagreb. The site was unearthed 1987 by a floating dredger during exploitation of gravel from Drava River alluvium. Among other faunal remains a fossil human mandible was found, showing the traits, which resemble in many aspects to that of the late and more progressive Neanderthals in SE Europe (Winkler and Paunović 1992).

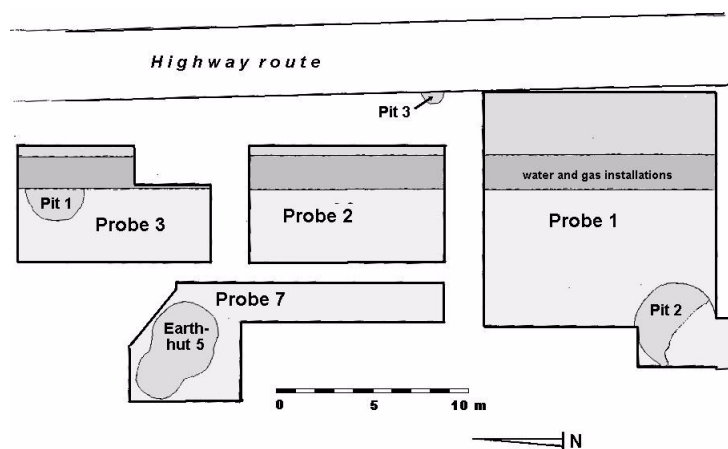


Figure 3 Excavations at Đakovo loop highway (site Grabrovac) with locations of pits where ^{14}C samples were taken

Đakovo–Grabrovac Series

Wood and charcoal samples from archaeological excavations on the Đakovo loop highway route at site Grabrovac near Đakovo (45°18'30"N, 18°24'38"E), 108 m asl, Slavonia, E Croatia (Figure 3). Collected 1997 and submitted 1998 by A Durman, Faculty of Philosophy, Zagreb.

Comment: (AD) Unlike most prehistoric settlements found in Slavonia, which were condensed on tells, this one was scattered at the edge of Jošava Lake. Therefore objects of particular cultures scarcely overlap and each culture could occupy its own zone. Previous archaeological investigations at this site established three culture layers: Sopot (4500–4000 BC), Baden (3350–3000 BC) and Litzen (2000–1800 BC).

- Z-2735 Grabrovac 1** **3550 ± 100**
Wood, probe 1, pit 2 (bottom) (cal 2030–1740 BC, 68.2%).
Comment: (AD) Late Vučedol culture (Eneolithic, 2500–2200 BC).
- Z-2736 Grabrovac 2** **3750 ± 100**
Wood, probe 1, pit 2 (cal 2310–2010 BC, 65.1%).
Comment: (AD) Late Vučedol culture (Eneolithic, 2500–2200 BC).
- Z-2740 Grabrovac 3** **3620 ± 100**
Charcoal, probe 3, pit 1 (cal 2140–1870 BC, 62.8%).
Comment: (AD) Late Vučedol culture (Eneolithic, 2500–2200 BC).
- Z-2741 Grabrovac 4** **3220 ± 90**
Charcoal, probe 7, earth–hut 5 (cal 1610–1400 BC, 68.2%).
Comment: (AD) Litzen culture (late phase of Early Bronze age, 2000–1800 BC).
- Z-2757 Grabrovac 5** **3330 ± 100**
Charcoal, probe 7, earth–hut 5 (cal 1740–1500 BC, 68.2%).
Comment: (AD) Litzen culture (late phase of Early Bronze age, 2000–1800 BC).
- Z-2758 Grabrovac 6** **3250 ± 80**
Charcoal probe 7, earth–hut 5 (2) (cal 1620–1430 BC, 68.2%).
Comment: (AD) Litzen culture (late phase of Early Bronze age, 2000–1800 BC).
- Z-2847 Đurđić** **200 ± 85**
Human bones (femur or tibia) found 102 cm depth in grave X near St George church, village Đurđić (45°47'31"N, 16°50'33"E), 155 m asl, near Bjelovar, C Croatia. Mixed with parts of constructive material, buried in soil without coffin. Collected and submitted 1998 by G Jakovljević, Municipal Museum Bjelovar (cal AD 1630–1700, 17.8%; AD 1720–1820, 21.4%; AD 1830–1890, 10.9%; AD 1910–1950, 10.1%)
Comment: (GJ) Expected Late Middle Ages.
- Gabajeva Greda Series**
- Wood from 14 m long monoxyle boat found in gravel-pit Prosenica I at Gabajeva Greda, Hlebina near Koprivnica (46°09'35"N, 16°57'49"E), 117 m asl, N Croatia. Below water level. Submitted 1999 by H Malinar, Zagreb.
Comment: (HM) Establishing of age for valorization of the monoxyle to be presented in Koprivnica Regional Museum.
- Z-2903 Gabajeva Greda 1** **125 ± 85**
Wood, top of the bow, 30 cm below surface (cal AD 1670–1770, 27.7%; AD 1800–1950, 40.5%).
- Z-2904 Gabajeva Greda 2** **240 ± 70**
Wood, left side after first frame (rib) of the boat, patch on the hole (cal AD 1520–1590, 16.5%; AD 1620–1690, 21.7%; AD 1730–1810, 29.3%; AD 1920–1950, 5.7%).
- Z-2905 Gabajeva Greda 3** **pMC: 102.7 ± 1.2**
Wood from core, lower part of the bow.

Comment: (HM) Expected the oldest sample within the series. Result does not confirm the presumption.

Z-2906 Gabajeva Greda 4 **95 ± 80**

Wood, left side of the boat (cal AD 1680–1740, 19.0%; AD 1800–1930, 47.6%).

Comment: (HM) The outermost part, tree rings expected to be the youngest.

Z-2907 Gabajeva Greda 5 **310 ± 80**

Oakum, most probably served to choke up the boat, right side of the boat (cal AD 1680–1740, 19.0%; AD 1800–1930, 47.6%).

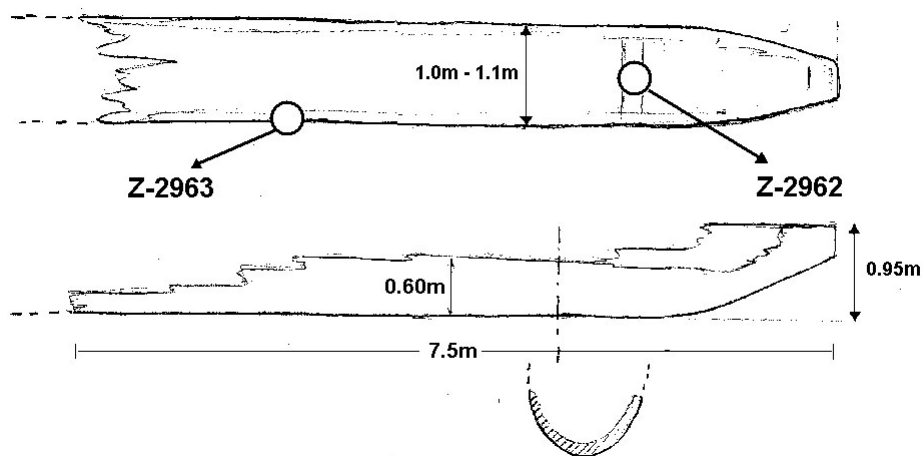


Figure 4 Monoxyle found near Ivanja Reka

Ivanja Reka Series

Oak (*Quercus* sp.) monoxyle (Figure 4) found in gravel pit Svibovski Otok close to Sava River, Ivanja Reka village (45°48'N, 16°07'E), 120 m asl near Zagreb, 6 m deep in wet sand below 3 m layer of soil and humus. Water level varies depending on season. Collected and submitted in 2000 by D Habuš-Skendžić, Sesvete Regional Museum.

Z-2962 Ivanja Reka 1 **435 ± 65**

Wood, central part of monoxyle corresponding to the core of trunk (cal AD 1410–1520, 59.9%; AD 1590–1620, 8.3%).

Z-2963 Ivanja Reka 2 **325 ± 70**

Wood, outer part of monoxyle (cal AD 1490–1650, 68.2%).

Jalžabet–Bistričak Series

Charcoal samples from the grave (Tumulus II) (Figure 5) found below humus in sand soil, village Jalžabet, location Bistričak, near Varaždin (46°15'39"N, 16°28'30"E), 168 m asl, NW Croatia. Collected 1989 and submitted 2001 by M Šimek, Municipal Museum Varaždin.

Comment: (MŠ) Expected age: 7th–6th century BC, Hallstatt culture (Šimek 1998).

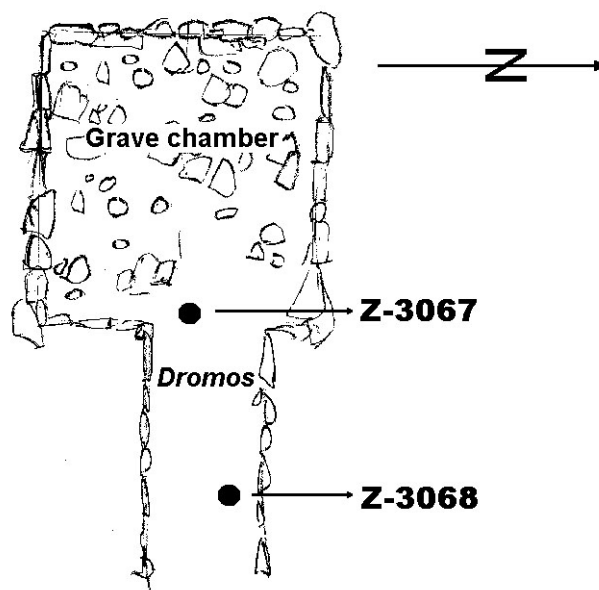


Figure 5 Jalžabet–Bistričak, Tumulus II, excavations 1989

Z-3067 Jalžabet–Bistričak 1 **2350 ± 100**
Charcoal, U1K, cover of grave, segment II, 30 cm depth (cal 800–650 BC, 13.8%; 550–350 BC, 45.0%; 300–200 BC, 9.4%).

Z-3068 Jalžabet–Bistričak 2 **2440 ± 100**
Charcoal, U2D, entrance to grave (“dromos”) 55–70 cm depth (cal 760–680 BC, 19.4%; 670–630 BC, 7.3%; 560–400 BC, 38.6%).

Z-2645 Kašljevac **3350 ± 100**
Human bones from mass graveyard in forest Lipov Breg at village Kašljevac near Bjelovar (45°53′N, 17°00′E), 172 m asl. Submitted 1996 by F Boras, State Commission for War and Post-war Victims, Zagreb (cal 1770–1510 BC, 68.2%).

Z-2852 Klana–Gomance **17,100 ± 400**
Fossil animal bone (shoulder-blade of *Bos* sp.) found in a profile of the alluvial strata in the valley Gomance at Klana village (45°26′56″N, 14°22′43″E) near Rijeka, W Croatia, during the geological mapping of Quaternary sediments in the Kvarner region. Collected 1988 and submitted 1999 by Lj Marjanac, Croatian Academy of Sciences and Arts, Zagreb.

Comment: (LjM) Investigation of sediment genesis and reconstruction of paleoenvironment in Pleistocene.

Z-2520 Motovun **415 ± 65**
Wood sample from tree stump found 4.5 m depth at the edge of Mirna riverbed sediment, 500 m upstream from Motovun bridge (45°20′10″N, 13°49′41″E), 9 m asl, in Istria. Collected and submitted 1994 by J Rubinić, Istrian Water Authorities, Labin (cal AD 1420–1530, 54.4%; AD 1590–1630, 13.8%).

Comment: (JR) Dating to establish dynamics of filling up of Mirna River valley by eroded sediments. Some stumps were found 30 years ago, during works on river melioration.



Figure 6 Phallic stalagmite, the focus of ritual in Nakovana Cave sanctuary

Nakovana Cave Series

Illyrian sanctuary from Hellenistic times in Nakovana Cave above village Nakovana (43°00'N, 17°05'E), 318 m asl, near Orebić on Pelješac peninsula, S Dalmatia. In the middle chamber a central phallic stalagmite (Figure 6) surrounded by a remarkable quantity of imported artifacts, including thousands of high quality Hellenistic pottery fragments was found. The stalagmite clearly served as the focus of ritual. Dating of the base of the stalagmite (Z-3024) and charcoal below carbonate crust overlying the Hellenistic layer near the stalagmite (Z-3025). Samples were collected and submitted in year 2000 by S Forenbaher, Institute of Anthropological Research, Zagreb.

Comment: (SF) Sample Z-3024, taken from the base of the phallic stalagmite, dates the beginning of its growth. It was submitted in order to test the hypothesis that the stalagmite must have been transferred from its original position and placed on a prehistoric layer of Neolithic age. Estimated age of the Neolithic layer, based upon diagnostic potsherds contained within it, is ≥ 5500 BP. Date of the base of the stalagmite post-dates the Neolithic layer for at least 500 years. The two dates follow normal stratigraphic sequence, the lower being the older. Consequently, the hypothesis that the stalagmite must have been transferred from elsewhere and placed on the Neolithic layer is rejected. The dates by themselves do not solve the question whether the stalagmite has grown in situ, or has been transferred from a different position. Charcoal sample Z-3025 was taken from carbonate crust precipitated over Hellenistic layer, dated by ceramics to between the 4th and 1st centuries BC, and was expected to be younger than 1st century BC. It dates precipitation of the crust after abandonment of the sanctuary (Royal Ontario Museum 2000; Forenbaher and Kaiser 2001).

Z-3024 Nakovana Cave 1 **4940 ± 90**

Stalagmite, middle part of bottom (the oldest part). Conventional ^{14}C age corrected for initial activity $A_0 = 85\%$ gives 3630 ± 85 .

Z-3025 Nakovana Cave 2 **1520 ± 75**

Charcoal below carbonate crust precipitated over Hellenistic layer dated by ceramics to 4th–1st century BC (cal AD 430–620, 68.2%).

Nova Bukovica Series

Charcoal samples found during systematic excavations of late Bronze and early Iron Age necropolis with cremation tombs in tumulus No. 4 on the site Sjenjak at Nova Bukovica, 7 km SW from Slatina (45°40'N, 17°46'E), 117 m asl, Slavonia. Collected 1997 and 1998 and submitted 1999 by K Minichreiter, Institute of Archaeology, Zagreb.

Comment: (KM) Bronze needle for man's clothes found in one of tumuli dates 700–500 BC, before arrival of Celts. The pottery found in tombs was manufactured in Baierdorf-Velatice style and is similar to Dalj, Donja Dolina, and Marijanec-Kaptol cultures (Minichreiter 1998).

Z-2926 Nova Bukovica 1 **2810 ± 75**
Charcoal, lower beam, burning site 11, probe C/1 (cal 1050–890 BC, 56.9%; 880–830 BC, 11.3%).

Z-2927 Nova Bukovica 2 **2115 ± 100**
Charcoal, southern beam, grave 20, probe E/6 (cal 360–290 BC, 12.6%; 240 BC–1 AD, 55.6%).

Z-2929 Nova Bukovica 3 **2970 ± 90**
Charcoal, grave 30, probe A/7 (cal 1320–1040 BC, 67.3%).

Z-2930 Nova Bukovica 4 **2630 ± 90**
Charcoal, grave 47, probe A/5–A/6, 1.17–1.3 m depth (cal 910–750 BC, 51.7%; 640–590 BC, 8.6%).

Z-2931 Nova Bukovica 5 **2670 ± 110**
Charcoal from urn, grave 47, probe A/5–A/6, 1.41–1.60 m depth, north (cal 1000–760 BC, 63.9%).

Z-2932 Nova Bukovica 6 **2630 ± 90**
Charcoal, grave 47, probe A/5–A/6, 1.75 m depth, center of pit, bottom (cal 980–780 BC, 68.2%).

Osijek–Herrmann's Winery Series

Charcoal and bone from Neolithic site (Sopot culture) found during the construction of collector for municipal sewerage at location Herrmann's Winery in town Osijek (45°33'04"N, 18°41'38"E), 98 m asl, E Slavonia. Cultural layer reaches up to 2 m and in some parts, in pits and trenches, even more. Collected 1998 by J Šimić, Osijek Regional Museum, and submitted by N Radić, Rudjer Bošković Institute, Zagreb.

Z-2830 Herrmann's Winery 1 **5210 ± 120**
Charcoal from fireplace, 1.80–2.00 m depth. Bottom of cultural layer (cal 4230–4180 BC, 7.7%; 4170–3930 BC, 53.2%; 3860–3810 BC, 7.3%).

Z-2831 Herrmann's Winery 2 **5600 ± 100**
Human bone found 1.9 m depth below cultural layer. Partly in clay and partly at the border of a pit (cal 4540–4340 BC, 68.2%).

Comment: (JŠ) Expected age 6000 yr.

Otok Series

Samples from archaeological site Otok near Vinkovci (45°08'48"N, 18°53'02"E), 85 m asl, E Slavonia. Collected 1970 by N Dimitrijević, Faculty of Philosophy, Zagreb. Submitted 1998 by A Durman (Z-2761 and Z-2762) and 1999 by I Jurić, Faculty of Agronomy (Z-2913), Zagreb. Samples Z-2761 and Z-2913 from the same finding.

Comment: (AD) Sopot culture (Neolithic).

Z-2761 Otok 1 **5650 ± 125**
Grain from a ceramic pot surrounded by charcoal found below floor of a house, depth 0.70–0.80 m, quadrant 10/ij (cal 4620–4350 BC, 67.2%).

Z-2913 Otok 2 **5555 ± 125**
Charred grain (*Triticum aestivum* L.), same as Z-2761, identified as *Thell sp. vulgare* (J McKey, Institute of Genetics, Uppsala, Sweden) (cal 4540–4310 BC, 59.3%; 4300–4250 BC, 8.9%) (Jurić et al. 2001).

Comment: (IJ) Expected age 5000 yr

Z-2762 Otok 3 **5330 ± 120**
Charcoal, quadrant 10/ij, depth 0.77 m (cal 4330–4290 BC, 7.1%; 4260–4040 BC, 57.6%).

Z-2642 Pakrac **355 ± 90**
Human bones from mass graveyard in Pakrac (45°26'53"N, 17°11'42"E), 203 m asl, W Slavonia. Collected 1996 by B Vukušić, Pakrac, and submitted 1996 by F Boras and V Jukić, State Commission for War and Post-war Victims, Zagreb (cal AD 1450–1640, 68.2%).

Comment: (FB) Possible remains of WWII prisoners from neighboring prison Šeovica or victims executed in 1946. According to indications of archaeologist V Herc from Čazma (personal communication), the remains from Pre-Turkish period (late Middle Ages).

Pećinovac Series

Charcoal in clay layers from Pećinovac Cave near Kanfanar (45°07'N, 13°50'E), 150 m asl, Istria. Excavations performed to preserve the cultural heritage in Croatia during the construction of the highway "Istrian Y" on the route Rovinj-Žminj. Collected 1998 by D Brajković and submitted by M Paunović, Croatian Academy of Sciences and Arts, Zagreb.

Z-2790 Pećinovac 1 **2000 ± 100**
Charcoal from hearth, 45–50 cm depth (cal 120 BC–AD 90, 59.5%; AD 100–130, 5.3%).

Comment: (MP) Expected Middle Ages.

Z-2791 Pećinovac 2 **3890 ± 110**
Charcoal from hearth, 70–100 cm depth (cal 2500–2190 BC, 65.8%).

Comment: (MP) Expected Bronze Age.

Premantura Series

Charcoal from Pećina na Gradini Cave (code PRM 99), Premantura (44°48'47"N, 13°54'40"E), 60 m asl, Istria. Collected and submitted 1999 by D Brajković, Institute of Palaeontology, Croatian Academy of Sciences and Arts, Zagreb.

Comment: (DB) Expected Roman period.

Z-2854 Premantura 1 **1645 ± 130**
Charcoal from fireplace, mixed with clay, probe I, layer 2 (cal AD 240–550, 68.2%).

Z-2855 Premantura 2 **1580 ± 90**
Charcoal from fireplace, mixed with clay, probe II, layer 4/5 (cal AD 400–600, 68.2%).

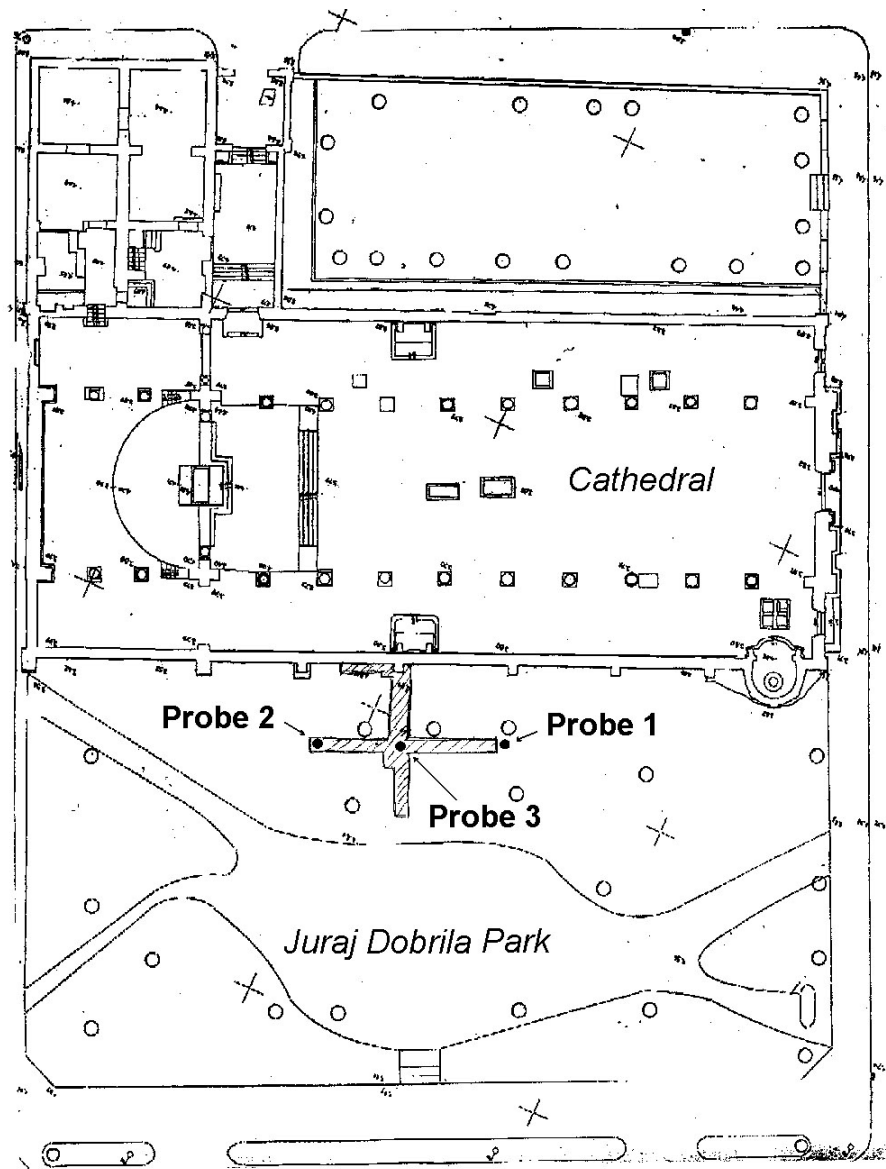


Figure 7 Ground plan of Juraj Dobrila Park and the Cathedral in Pula showing positions of three drilling probes from which samples were taken

Pula Series

Wood and bone samples collected during geological drilling in Juraj Dobrila Park at the line of antique wall uncovered NW of and parallel to the wall of the Cathedral in Pula ($44^{\circ}52'06''\text{N}$, $13^{\circ}50'53''\text{E}$), Istria. Groundwater level at 3.20 m depth. Three drilling probes were taken (Figure 7): Probe 1: 0–4.30 m limestone slabs and traces of mortar, 4.30–5.20 m crushed small lime material, darker sand and sea sediment, 5.20–10 m wooden pilots and muddy material, 10–13.50 m clayey mud and fragments of rocks. Probe 2: 0–5.20 m stone material, 5.20–7.40 m wooden pilots, 7.40–8.20 m

mud, wood, ceramics and shells, 8.20 m bedrock. Probe 3: 0–5.60 m stone and sand, 5.70–6.10 m wood, 6.10–6.50 m mud, half-crushed pebbles, 6.50–8 m rinsed mud and crushed stone, 8–9.70 m bedrock. Collected and submitted 1995 by K Mihovilić, Archaeological Museum of Istria, Pula.

Z-2587 Pula 1 **205 ± 90**
Bones, probe 1, 1.15–1.60 m depth, separated from the surrounding charcoal (cf. Z-2590) (cal AD 1630–1710, 18.5%; AD 1720–1890, 39.9%; AD 1910–1950, 9.9%).

Z-2590 Pula 2 **200 ± 90**
Charcoal separated from bones, probe 1, 1.15–1.60 m depth (cf. Z-2587) (cal AD 1630–1700, 17.8%; AD 1720–1820, 29.2%; AD 1830–1890, 11.1%; AD 1910–1950, 10.1%).

Z-2588 Pula 3 **pMC: 99.7 ± 1.6**
Bones, probe 1, 1.30 m depth.

Z-2589 Pula 4 **2060 ± 100**
Wood, probe 1, 5.3–6.9 m depth (cal 210 BC–AD 60, 68.2%).

Z-2580 Pula 5 **2080 ± 100**
Wood, probe 1, 6.25–6.85 m depth. Visible 30–35 tree-rings (cal 210 BC–AD 30, 66.2%).

Z-2581 Pula 6 **2200 ± 100**
Wood, probe 2, 6.40–7.40 m depth (cal 390–160 BC, 66.0%).

Z-2582 Pula 7 **1980 ± 100**
Wood, probe 3, 5.70–6.10 m depth (cal 120 BC–AD 140, 68.2%).

Pupićina Cave Series

Charcoal samples from Pupićina Cave near village Vranje (45°19'N, 14°10'E), 250 m asl in Istria. Collected and submitted 1995 and 1996 by P Miracle, Cambridge University, England, and S Forenbaher, Institute of Anthropological Research, Zagreb (Miracle and Forenbaher 1998; Miracle 2002). Charcoal associated with hearths, trash and living floors left by human occupants of the cave. Charcoal removed in the field from natural sedimentological units.

Comment: (PM) Samples from specific quadrants are from individual chunks of charcoal. Aim of the study: dating of stratigraphy: transition Neolithic to Bronze Age; dating of Pleistocene–Holocene transition; environmental changes in Istria.

Z-2577 Pupićina Cave 1 **3200 ± 150**
Charcoal, quadrant M13 CD, level 13 (cal 1690–1290 BC, 67.0%).

Comment: (PM) Expected Bronze Age.

Z-2573 Pupićina Cave 2 **3340 ± 110**
Charcoal, quadrant M13 CD, level 14 (cal 1750–1490 BC, 68.2%).

Comment: (PM) Expected Bronze Age.

Z-2629 Pupićina Cave 3 **4750 ± 160**
Charcoal, quadrant N17, level 110 (cal 3750–3300 BC, 66.5%).

Z-2630 Pupićina Cave 4 **4740 ± 250**
Charcoal, quadrant N16, level 117 (cal 3800–3100 BC, 68.2%).

- Z-2575 Pupićina Cave 5** **6590 ± 240**
Charcoal, quadrant M13 CD, levels 20 and 21 (cal 5750–5290 BC, 68.2%).
Comment: (PM) Expected Neolithic.
- Z-2634 Pupićina Cave 6** **9480 ± 180**
Charcoal, quadrant N14C, level 202 (cal 9150–8600 BC, 68.2%).
Comment: (PM) Upper midden. Expected Mesolithic.
- Z-2635 Pupićina Cave 7** **8700 ± 170**
Charcoal, quadrant N14C, level 203 (cal 8000–7550 BC, 63.7%).
Comment: (PM) Upper midden. Expected Mesolithic.
- Z-2572 Pupićina Cave 8** **9580 ± 180**
Charcoal, quadrant O14 B + ABCD, level 25 (cal 9220–8740 BC, 68.2%).
Comment: (PM) Lower midden. Expected Mesolithic.
- Z-2578 Pupićina Cave 9** **8330 ± 210**
Charcoal, quadrant O13 B, level 27 (cal 7580–7080 BC, 68.2%).
Comment: (PM) Lower midden. Expected Mesolithic.
- Z-2576 Pupićina Cave 10** **10,000 ± 270**
Charcoal, quadrant O14 ABCD and O13 ABCD, levels 29–30 (cal 10,200–9200 BC, 68.2%).
Comment: (PM) Expected Early Mesolithic.
- Z-2636 Pupićina Cave 11** **11,100 ± 300**
Charcoal, quadrants N15A and N15B, level 207 (cal 11,550–10,900 BC, 68.2%).
Comment: (PM) Expected Early Mesolithic.
- Z-2574 Pupićina Cave 12** **10,600 ± 200**
Charcoal, quadrants O14 D and O13 ABCD, levels 31–34 (cal 11,000–10,350 BC, 67.0%).
Comment: (PM) Expected Late Upper Paleolithic.
- Z-2631 Pupićina Cave 13** **10,000 ± 180**
Charcoal, quadrants O14D, O14B and O14C, level 35 (cal 10,000–8600 BC, 68.2%).
Comment: (PM) Expected Late Upper Paleolithic.
- Račinovci Series***
- Monoxylo boat found in Sava riverbed at Račinovci near Županja (44°51'59"N, 18°57'13"E), E Slavonia, 79 m asl. Collected 2000 and submitted 2001 by B Marijan, Županja Regional Museum.
- Z-3026 Račinovci 1** **330 ± 65**
Wood, outer part (cal AD 1490–1640, 68.2%).
- Z-3027 Račinovci 2** **465 ± 70**
Wood, inner part (cal AD 1390–1500, 62.0%).

Z-3072 Senj**1340 ± 105**

Charred grains found at foundations of a burned Roman house at Mala Placa square in town Senj (44°59'22"N, 14°54'21"E), 0 m asl, SW Croatia. Collected 1956 by B Ljubović, Municipal Museum Senj, and submitted 2001 by S Lulić, Rudjer Bošković Institute, Zagreb (cal AD 600–810, 66.4%).

Z-2462 Sinj**1160 ± 135**

Wooden part of a Frankish spear, well preserved, found in Cetina riverbed in Sinj valley (43°42'4"N, 16°40'20"E), 293 m asl, Dalmatia. Submitted 1993 by A Milošević, Sinj Regional Museum. Wood species: ash-tree (*Fraxinus* sp. L.) determined at the Faculty of Forestry, Zagreb (cal AD 710–750, 5.6%; AD 760–1000, 62.6%).

Comment: (AM) Expected age: end of 8th and beginning of 9th century, times of Charlemagne and formation of the first Croatian state.

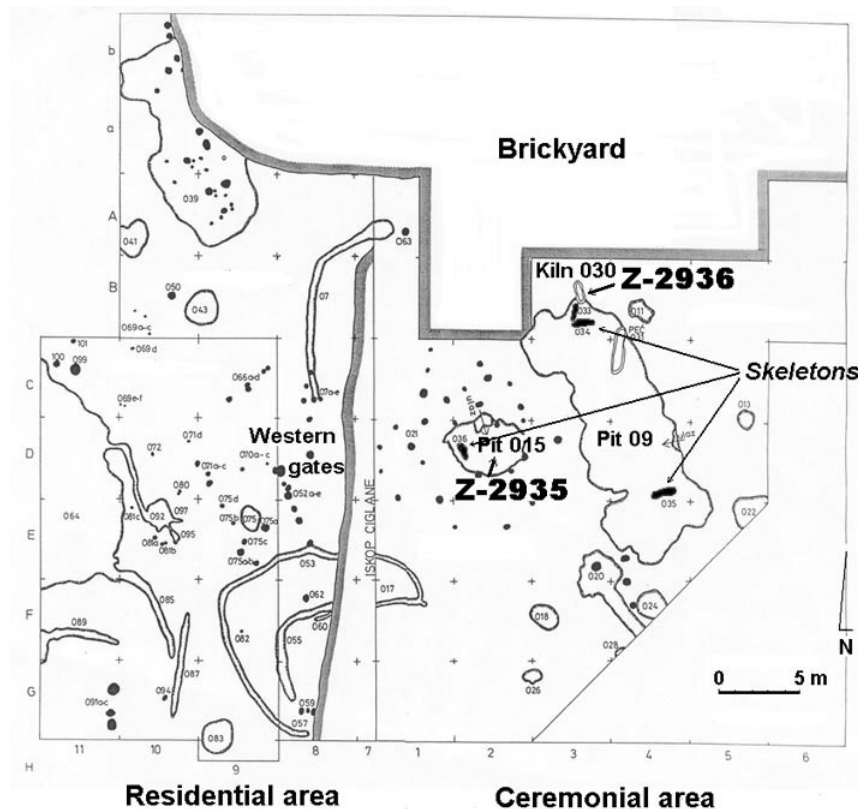


Figure 8 Map of the site Slavonski Brod–Galovo. Sampling locations for ^{14}C dating are shown, as well as positions of human skeletons.

Slavonski Brod–Galovo Series

Charcoal from archaeological site Galovo (Figure 8) at the eastern part of Slavonski Brod city limits (45°09'31"N, 17°59'12"E), 78 m asl, Slavonia. Ceremonial and burial area site of the early phase (Linear A phase) of the Starčevo culture. The ceremonial area is separated from the residential area of the settlement by wooden fences among which there are several passages ("Western Gate",

Figure 8). One-layered location with no mixture of different cultures. Collected 1997 and submitted 1999 by K Minichreiter, Institute of Archaeology, Zagreb.

Comment: (KM) The same phase of Starčevo culture as Zadubravlje (cf. Z-2921 to Z-2925, this article), but difference up to 2000 years possible. Expected age: 8000–6000 yr (Minichreiter 1996–1997; Krajcar Bronić et al. 2002).

Z-2935 Slavonski Brod–Galovo 1 **6185 ± 130**
Charcoal from SE and E part of pit 015, probe D/2, 1.56 m depth. A male skeleton is found in the west part of the pit (cal 5300–4960 BC, 68.2%).

Z-2936 Slavonski Brod–Galovo 2 **6830 ± 110**
Charcoal, SE from pit 09, kiln 030, quadrant C/3, 1.60–1.80 m depth. A cattle horn, ritually buried, is found below pieces of pottery with animal bones and stone tools in the pit centre. Two skeletons of grown-up persons were found close to the kiln 030 in the northern part of the pit, and a skeleton without skull in the southern part (cal 5810–5620 BC, 64.9%).

Z-3083 Sotin **570 ± 115**
Human bones, partly charred, from mass grave near the church in Sotin (45°17'40"N, 19°05'40"E), 122 m asl, E Slavonia. Submitted 2001 by M Šlaus, Croatian Academy of Sciences and Arts, Department of Archaeology, Zagreb (cal AD 1290–1450, 68.2%).

Comment: (MŠ) Suspected remains of victims of war 1991–1995 in Croatia.

Z-2966 Sućidar **1760 ± 80**
Human bone from grave found at foundation of a family house, Sućidar in Split (43°32'25"N, 16°17'58"E), Dalmatia. Collected and submitted 2000 by Š Andelinović, Split (cal AD 210–390, 59.6%).

Stenjevec Series

Samples from Old-Croatian graveyard found in yard near the church in Stenjevec (45°49'N, 15°53'E), 129 m asl, near Zagreb. Submitted 1995 by K Simoni, Archaeological Museum, Zagreb.

Z-2545 Stenjevec 1 **220 ± 90**
Charcoal from ceramic fire-place or kiln dug from soil (cal AD 1520–1570, 7.9%; AD 1620–1700, 18.7%; AD 1720–1820, 25.9%; AD 1830–1880, 7.3%; AD 1910–1950, 8.5%).

Z-2546 Stenjevec 2 **2720 ± 80**
Wood from a tomb below skeleton (cal 940–800 BC, 63.9%).

Comment: (KS) Expected age of skeleton: 10th–13th century AD.

Z-2547 Stenjevec 3 **2640 ± 150**
Wooden beam or monoxyle, partly destroyed, near mediaeval necropolis (cal 980–520 BC, 68.2%).

Z-2824 Varaždin–Herczer Palace **590 ± 90**
Animal bones found in layer of gravel and dark soil below cellar No.2 of Herczer palace, Varaždin (46°18'35"N, 16°20'11"E), 153 m asl, N Croatia. Collected and submitted 1998 by M Šimek, Municipal Museum Varaždin (cal AD 1300–1420, 68.2%).

Comment: (MŠ) Probably basements of an older building. Expected Middle Ages.

Vinkovci Series

Archaeological rescue excavations at several sites in town Vinkovci (45°17'31"N, 18°48'05"E), 87 m asl, E Slavonia. Collected 1996 and 1998, and submitted 1997, 1998, and 1999 by M Krznarić-Škrivanko, Vinkovci Municipal Museum.

Comment: (MK) Investigation of continuity and way of life of Sopot culture (Dimitrijević 1968, 1979).

A) Site Ervenica

Charcoal from Neolithic layers excavated from pit III, Matije Gupca street No. 137. Open type settlement of the oldest (I-B) phase of Sopot culture at the left bank of Bosut River (Krznarić-Škrivanko 1997, 1999).

Comment: (MKŠ) Expected age: before 4500 BC. Both dates do not confirm expectation. Possibility of flooding from Bosut River.

Z-2755 Ervenica 1 **880 ± 65**
Charcoal found in soil, pit III, quadrant C-4, V/MG-137, 1.55 m depth (cal AD 1040–1100, 24.8%; AD 1110–1220, 43.4%).

Z-2829 Ervenica 2 **765 ± 70**
Charcoal from fireplace, pit III, quadrant C-4, V/MG-137, 1.55 m depth (cal AD 1180–1300, 68.2%).

B) Tell Sopot

Charcoal from eponymic Neolithic tell Sopot, 3 km SW from Vinkovci. Samples Z-2909 and Z-2911 belong to house basements denoted as stratigraphic unit (s.u. further on) 20 from Phase II of Sopot culture. Samples Z-2752, Z-2753, Z-2754, Z-2826 and Z-2827 belong to burned-down wooden construction of a 4 × 6 m house s.u. 11 from Phase III. Both settlements Ervenica and Sopot belong to Sopot culture, although with no direct connection (Iskra-Janošić and Krznarić-Škrivanko 1997, Krznarić-Škrivanko 1998a, 1998b, 1999, 2000).

Z-2752 Tell Sopot 1 **5675 ± 120**
Charcoal from wooden subconstruction below the floor of a house, quadrant E-6, 1.05–1.25 m depth (cal 4680–4630 BC, 5.8%; 4620–4360 BC, 62.4%).

Comment: (MK) Expected age: 3700–3600 BC.

Z-2753 Tell Sopot 2 **5790 ± 125**
Charcoal from wooden subconstruction below the floor of a house, quadrant C/D-4, 1.05–1.25 m depth (cal 4780–4490 BC, 68.2%).

Comment: (MKŠ) Expected age: 3700–3600 BC.

Z-2754 Tell Sopot 3 **5360 ± 130**
Charcoal, part of wooden construction of prehistoric house s.u. 11, quadrant G-9, s.u. 2 (cal 4320–4270 BC, 14.4%; 4260–4040 BC, 53.8%).

Comment: (MKŠ) Expected age: 3450–3350 BC.

Z-2826 Tell Sopot 4 **6340 ± 100**

Charcoal, part of wooden construction supporting wall of house s.u. 11, probe Sopot III, block 5, quadrant I6, 2.11 m depth (cal 5470–5210 BC, 65.7%).

Comment: (MKŠ) Expected age: 4300 BC.

Z-2827 Tell Sopot 5 **5380 ± 100**

Charcoal from house s.u. 11, probe Sopot III, block 5, quadrant I6, 2.11 m depth (cal 4340–4210 BC, 36.8%; 4200–4140 BC, 13.5%; 4130–4040 BC, 17.9%).

Z-2909 Tell Sopot 6 **5220 ± 100**

Charcoal from wooden wall construction of burned house s.u. 20, quadrant I-6, block 5, 2.11 m depth, (cal 4230–4180 BC, 8.9%; 4170–3940 BC, 59.3%).

Comment: (MKŠ) Expected age: 4300 BC.

Z-2911 Tell Sopot 7 **5330 ± 90**

Charcoal from fallen wooden wall construction of house s.u. 20, quadrant J-6, block 5, 3.54–3.67 m depth (cal 4250–4040 BC, 66.1%).

Comment: (MKŠ) Expected age: 4600 BC.

C) Tell Market**Z-2912 Tell Market** **1680 ± 150**

Charcoal from overthrown floor board taken during rescue excavations at Vinkovci Market in Duga Ulica street No. 40, 1.92 depth, within the W ramparts of Roman town *Colonia Aurelia Cibalae*. Foundation with rests of Starčevo ceramics was found 2 m deep (Dizdar and Krznarić-Škrivanko 1999/2000, Iskra-Janošić 2000, 2001) (cal AD 210–550, 68.2%).

Comment: (MKŠ) Expected Starčevo culture (ca. 5000 BC). Dated material may not have originated in levels from which it was recovered.

D) Dirov Brijeg**Z-2828 Dirov Brijeg** **2190 ± 80**

Charcoal found at hill Dirov Brijeg in Josipa Kozarca street, Vinkovci, pit I, 1.60 m depth, from a fortified La Tène settlement inhabited by Celtic tribe Scordians from 2nd and 1st century BC until the Roman conquest (Dizdar 2001) (cal 380–160 BC, 66.3%).

Zadubravljje–Dužine Series

Charcoal samples from Starčevo culture settlement (Linear A phase) Dužine at village Zadubravljje (45°09'48''N, 18°09'10''E), 88 m asl near Sava River. Rescue archaeological excavations at the area of 6200 m² on highway route E-70 Zagreb–Belgrade, 17 km E from Slavonski Brod, Slavonia. The architecture of the Early Neolithic “craft” settlement shows a high level of practical organization of the settlement (Figure 9). The settlement consists of several units with distinct purposes (residential area, food storage and preparation, stone-tool workshop, pottery workshop and cloth manufacture) with accompanying structures (well, ceremonial area) necessary for the existence of a tribal community. The same phase of Starčevo culture as Slavonski Brod–Galovo (cf. Z-2935 and Z-2936, this article) (Minichreiter 1993, Krajcar Bronić et al. 2002). Collected 1989 and 1990 and submitted 2000 by K Minichreiter, Institute of Archaeology, Zagreb.

Comment: (KM) Expected age: 8000–6000 yr.

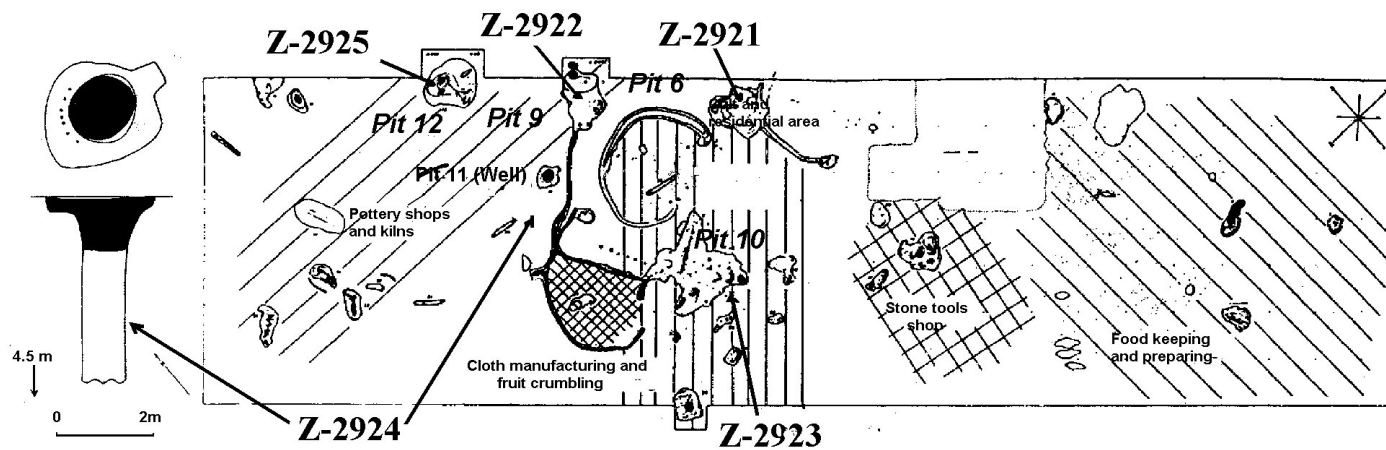


Figure 9 Map of the site Zadubravljje–Dužine with marked most important pits and locations where charcoal samples for ^{14}C analyses were taken from. On the left-hand side the plan of the well is shown.

Z-2921 Zadubravlje–Dužine 1 **6710 ± 110**
Charcoal from residential pit No. 6, quadrant A/14-A/15, 1.3–1.5 m depth (cal 5720–5530 BC, 68.2%).

Z-2922 Zadubravlje–Dužine 2 **6700 ± 100**
Charcoal from SW part of working pit No. 9 containing two ovens with hemispherical domes, probably used for baking of bread and two cylindrical kilns for firing of pottery vessels. Quadrant A/18, 1.56–1.79 m depth (cal 5720–5530 BC, 68.2%).

Z-2923 Zadubravlje–Dužine 3 **6990 ± 120**
Charcoal from SE part of large housing pit No.10, quadrant D-E/15, 1.71 m depth. In the west area of pit 10 fragments of pottery and animal bones are found, and below them a ritually buried cattle horn (cal 5990–5940 BC, 12.2%; 5930–5740 BC, 56.0%).

Z-2924 Zadubravlje–Dužine 4 **7610 ± 140**
Charcoal from well No. 11 from the center of the settlement, quadrant C/19, depth 3.90–4.1 m (cal 6600–6340 BC, 57.8%; 6320–6250 BC, 9.1%).

Comment: (KM) The oldest known Neolithic well in Europe. Constructed at the early phase of the settlement (Minichreiter 1993, 1997).

Z-2925 Zadubravlje–Dužine 5 **6260 ± 130**
Charcoal, working pit No.12 with a cigar-shaped kiln and a domed kiln for firing of pottery. Quadrant A/20-21, 1.7–1.9 m depth (cal 5370–5040 BC, 68.2%).

Županja–Dubovo-Košno Series

Charcoal taken during rescue archaeological excavations on the highway route E-70 Zagreb-Belgrade near Županja, (45°04'35"N, 18°41'52"E) 83 m asl, Slavonia, E Croatia. Collected and submitted 2000 by B Marijan, Županja Regional Museum.

Comment: (BM) According to the artifacts, the site belongs to Sopot culture. Expected age: 6500 years (Marijan 2000).

Z-2969 Županja–Dubovo-Košno 1 **6220 ± 140**
Charcoal, No. 152 mixed with soil exposed to groundwater, pit, quadrant H-8, s.u.160 (cal 5320–4990 BC, 68.2%).

Z-2973 Županja–Dubovo-Košno 2 **6530 ± 100**
Charcoal, No. 214 from earth-hut, quadrant F-38, s.u. 148, western part (cal 5620–5580 BC, 7.4%; 5560–5460 BC, 38.0%; 5450–5370 BC, 22.9%).

Z-2998 Županja–Dubovo-Košno 3 **6220 ± 100**
Charcoal from earth hut exposed to groundwater, quadrant R-38/39, s.u. 1144 (cal 5300–5050 BC, 68.2%).

Z-3045 Županja–Dubovo-Košno 4 **6320 ± 100**
Charcoal, quadrant Z-43d, PU 339, s.u. 1804 (cal 5390–5200 BC, 51.2%; 5170–5140 BC, 5.1%).

Z-3046 Županja–Dubovo-Košno 5 **6380 ± 100**
Charcoal, quadrant H-49d, PU 228, s.u. 308 (cal 5480–5290 BC, 67.0%).

Z-3047 Županja–Dubovo-Košno 6 **4680 ± 90**
Charcoal, quadrant M-42/43, PU 682, s.u. 281 (cal 3630–3580 BC, 12.4%; 3540–3360 BC, 55.8%).

Z-3048 Županja–Dubovo **2920 ± 90**

Charcoal, quadrant E-23b, s.u. 2, found in destroyed archaeological layer at site Dubovo, 350 m east from Dubovo-Košno on the highway route. Collected and submitted 2000 by B Marijan (cal 1310–970 BC, 65.9%).

Comment: (BM) Expected age: 3300 yr; probably Bronze Age culture group “Barice-Gredani” (Marijan 2000).

SLOVENIA**Z-2836 Bohova near Maribor** **1780 ± 90**

Charcoal from the archaeological site Bohova (46°30′50″N, 15°39′30″E), 262 m asl, near Maribor (quadrants 296, 297/S II, s.u. 120) on the highway route, N Slovenia. Submitted 1999 by M Culiberg, Institute of Biology, Scientific Research Center of the Slovenian Academy of Sciences and Arts, Ljubljana (cal AD 130–350, 66.2%).

Comment (MC): Expected Roman age.

Cerknica Lake Series

Peat sediment from the borehole in the eastern part of the Cerknica Lake (45°44′10″N, 14°24′50″E), 550 m asl, SW Slovenia. Collected and submitted 2000 by M Culiberg.

Z-2977 Cerknica Lake 1 **2630 ± 70**

Peat, 122–130 cm depth (cal 900–760 BC, 67.1%).

Z-2978 Cerknica Lake 2 **9170 ± 100**

Peat, 268–275 cm depth (cal 8530–8490 BC, 7.9%; 8480–8270 BC, 60.3%).

Čatež Series

Charcoal from archaeological site Šentvid above Čatež (45°53′22″N, 15°36′09″E), 370 m asl, E Slovenia. Collected 1997 and submitted 1998 by A Jovanovič, Brežice Regional Museum, Slovenia.

Z-2750 Čatež 1 **1860 ± 90**

Charcoal in soil from the interior of a house, s.u. 011, quadrant C/8, 0.5 m depth (cal AD 50–260, 64.3%).

Comment: (AJ) Expected period: beginning of Romanization.

Z-2751 Čatež 2 **1950 ± 90**

Charcoal in soil, s.u. 010, quadrant D/13, 1 m depth (cal AD 50–140, 59.2%).

Comment: (AJ) Expected age: 10th–8th century BC.

Z-2541 Črniče **>37,000**

Wood sample, *Pinus* trunk (40 cm in diameter) was found in the clay sediment during the construction of the highway route near Črniče in Vipava Valley (45°53′30″N, 13°46′30″E), 120 m asl, W Slovenia. Collected and submitted 1995 by A Šercelj and M Culiberg, Institute of Biology, Scientific Research Center of the Slovenian Academy of Sciences and Arts, Ljubljana.

Črnomelj Series

Charcoal mixed with soil from the route of local sewerage in town Črnomelj (45°34′36″N, 15°11′24″E), 140 asl, SE Slovenia. Digging on the fluvial plane of Lahinja River below the town.

All layers under groundwater influence. Collected and submitted 1997 by P Mason, Institute for Protection of Cultural Heritage, Novo Mesto.

Z-2780 Črnomelj 1 **2560 ± 140**
Charcoal, probe 12, Hallstatt layer of waste material, quadrant 32, s.u. 275 (cal 830–510 BC, 62.9%).
Comment: (PM) Expected Iron Age, 4th century BC.

Z-2781 Črnomelj 2 **2155 ± 80**
Charcoal, probe 12, layer of charred material in Hallstatt culture, quadrant 32, s.u. 317 (cal 360–280 BC, 20.9%; 260–90 BC, 46.6%).

Comment: (PM) Expected age: 4th century BC.

Z-2782 Črnomelj 3 **2055 ± 260**
Charcoal, probe 4, foundation from Hallstatt culture layer, quadrant 20, s.u. 145 (cal 400 BC–AD 250, 68.2%).

Comment: (PM) Expected age: 4th century BC.

Z-2783 Črnomelj 4 **1530 ± 115**
Charcoal, probe 5, burned board from the grave, s.u. 125 (cal AD 420–640, 68.2%).

Comment: (PM) Expected age: 6th–7th century AD.

Z-2784 Črnomelj 5 **1985 ± 95**
Charcoal, probe 5, La Tène layer of charred and waste material, quadrant 59, s.u. 154 (cal 110 BC–AD 130, 68.2%).

Comment: (PM) Expected age: 2nd to 1st century BC.

Z-2785 Črnomelj 6 **2020 ± 96**
Charcoal, probe 5, La Tène layer of charred and waste material, quadrant 64, s.u. 154 (cal 170 BC–AD 80, 68.2%).

Comment: (PM) Expected age: 2nd to 1st century BC.

Z-2786 Črnomelj 7 **2030 ± 100**
Charcoal, probe 6, La Tène layer of charred and waste material, quadrant 66, s.u. 154 (cal 170 BC–AD 80, 68.2%).

Comment: (PM) Expected age: 2nd to 1st century BC.

Z-2787 Črnomelj 8 **2050 ± 100**
Charcoal, probe 6, La Tène layer of charred and waste material, quadrant 67, s.u. 154 (cal 200 BC–AD 60, 68.2%).

Comment: (PM) Expected age: 2nd to 1st century BC.

Z-2788 Črnomelj 9 **2050 ± 100**
Charcoal, probe 6, La Tène layer of charred and waste material, quadrant 72, s.u. 154 (cal 180 BC–AD 70, 68.2%).

Comment: (PM) Expected age: 2nd to 1st century BC.

Z-2789 Črnomelj 10 **1810 ± 95**
Charcoal, probe 6, La Tène layer of charred and waste material, quadrant 75, s.u. 154 (cal AD 120–350, 64.5%).

Comment: (PM) Expected age: 2nd to 1st century BC.

Dolga Vas Series

Archaeological excavations on the Lendava loop highway route at village Dolga Vas (46°35'16"N, 16°26'30"E), 190 m asl, site Gornje Njive, near Murska Sobota, NE Slovenia. At the area of 4400 m², clearly recognizable settlement phases from Copper Age, Bronze Age, Roman period and Middle Ages are uncovered. Collected 1997 by B Kerman and submitted 2000 by I Šavelj, Murska Sobota Regional Museum.

Comment: (BK) Samples taken from sectors I, II and XIII belong to Roman period, from sector IV to Middle Ages and prehistory, and from sectors V and XVIII to Middle Ages.

Z-2939 Dolga Vas 1 **2030 ± 75**
Charcoal from pit with wooden well, sector I, quadrant 14-15, s.u. 019 (cal 160–130 BC, 6.9%; 120 BC–AD 60, 61.3%).

Z-2941 Dolga Vas 2 **2010 ± 100**
Charcoal from ruin, sector I, quadrant 19, s.u. 020 (cal 170–130 BC, 6.2%; 120 BC–AD 90, 58.3%).

Z-2942 Dolga Vas 3 **1890 ± 100**
Charcoal from ruin, sector I, quadrant 19, s.u. 020 (cal AD 1–250, 68.2%).

Z-2943 Dolga Vas 4 **2090 ± 160**
Charcoal from ruin, sector I, quadrant 19, s.u. 020 (cal 360–280 BC, 11.3%; 260 BC–AD 70, 56.9%).

Z-2945 Dolga Vas 5 **1860 ± 70**
Charcoal from entrenchment, 20–40 cm depth, sector I, quadrant 26, s.u. 023 (cal AD 70–250, 68.2%).

Z-2946 Dolga Vas 6 **1615 ± 60**
Charcoal from pit or entrenchment, sector II, quadrant 34–35, s.u. 121 (cal AD 380–540, 68.2%).

Z-2947 Dolga Vas 7 **1990 ± 120**
Charcoal from ruin, 40–60 cm depth, sector II, quadrant 23, s.u. 020 (cal 170 BC–AD 130, 68.2%).

Z-2948 Dolga Vas 8 **1800 ± 75**
Charcoal from ruin, 20–40 cm depth, sector II, quadrant 34, s.u. 020 (cal AD 120–340, 68.2%).

Z-2949 Dolga Vas 9 **1680 ± 85**
Charcoal from melting furnace, 40–60 cm depth, sector II, quadrant 23, s.u. 122 (cal AD 240–440, 65.6%).

Z-2950 Dolga Vas 10 **1555 ± 60**
Charcoal from melting furnace, 60 cm depth, sector II, quadrant 23, s.u. 122 (cal AD 430–570, 68.2%).

Z-2951 Dolga Vas 11 **1075 ± 70**
Charcoal from oven, NE half, sector II, quadrant 6, s.u. 007 (*cf.* Z-2952 and Z-2960) (cal AD 890–1030, 68.2%)

Z-2952 Dolga Vas 12 **1575 ± 60**
Charcoal from oven, 20–40 cm depth, sector II, quadrant 6, s.u. 007 (*cf.* Z-2951 and Z-2960) (cal AD 420–560, 68.2%).

- Z-2960 Dolga Vas 13** **1880 ± 70**
Charcoal from oven, NE half, 20–40 cm depth, sector II, quadrant 6, s.u. 007 (cf. Z-2951 and Z-2952) (cal AD 60–240, 68.2%).
- Z-2953 Dolga Vas 14** **1670 ± 100**
Charcoal from mediaeval pit, sector IV, quadrant 69, s.u. 045 (cal AD 240–470, 59.5%; AD 480–540, 8.7%).
- Z-2954 Dolga Vas 15** **3140 ± 110**
Charcoal from prehistoric pit, sector IV, quadrant 42, s.u. 032 (cal 1530–1250 BC, 67.2%).
- Z-2955 Dolga Vas 16** **740 ± 65**
Charcoal from mediaeval pit, sector V, quadrant 73, s.u. 072 (cal AD 1210–1310, 63.8%).
- Z-2956 Dolga Vas 17** **1785 ± 70**
Charcoal from hearth, sector XIII, quadrant 180, s.u. 172 (cf. Z-2957) (cal AD 130–340, 68.2%).
- Z-2957 Dolga Vas 18** **1820 ± 75**
Charcoal from hearth, 20–40 cm depth, sector XIII, quadrant 180, s.u. 172 (cf. Z-2956) (cal AD 120–260, 54.9%; AD 280–330, 9.2%).
- Z-2958 Dolga Vas 19** **1755 ± 70**
Charcoal, vertical post, 40–60 cm depth, sector XVI, quadrant 231, s.u. 266 (cal AD 210–390, 65.9%).
- Z-2959 Dolga Vas 20** **840 ± 70**
Charcoal from mediaeval entrenchment from sector XVIII, quadrant 251, s.u. 282 (cal AD 1150–1280, 60.9%).

Dolnji Lakoš Series

Samples of vegetable detritus from the borehole at Dolnji Lakoš near Lendava (46°33'30"N, 16°26'00"E), 160 m asl. Bronze age site at the vicinity. Collected and submitted 1996 by M Culiberg. Previous ¹⁴C measurements: Z-1467, Z-1468, Z-1469 (Srdoč et al. 1987).

- Z-2668 Dolnji Lakoš 1** **4285 ± 115**
Detritus, 175–185 cm depth (cal 3040–2840 BC, 40.0%; 2820–2660 BC, 24.5%).
- Z-2669 Dolnji Lakoš 2** **5855 ± 160**
Detritus, 185–195 cm depth (4860–4520 cal BC, 62.3%).
- Z-2934 Gradišče nad Bašljem** **960 ± 85**
Charred *Avena* grain, Gradišče nad Bašljem, near Preddvor (46°19'40"N, 14°24'10"E), 873 m asl, N Slovenia. Quadrant 3/44, layer 2/2. Collected by T Knific, National Museum of Slovenia, and submitted 1999 by M Culiberg (cal AD 990–1190, 68.2%).

Comment: (MC) Expected Early Slavic time.

Izola Series

Wood found in layers with organic material during archaeological investigation in old part of town Izola (Isola) (45°32'08"N, 13°40'07"E), Slovenian Littoral. Collected 1995 by F Bonin and submitted by S Karinja, Maritime Museum in Piran, Slovenia.

Z-2600 Izola 1 **845 ± 75**
Wood (cal AD 1060–1090, 6.9%; AD 1120–1140, 5.3%; AD 1150–1280, 56.0%).

Z-2601 Izola 2 **1535 ± 105**
Wood (cal AD 420–620, 68.2%).

Z-2508 Koper Road **1290 ± 80**
Wood sample (*Quercus*, sp.), 120 cm depth, rest of building material, basement of a road at Prešern square in Koper (Capodistria) (45°32'48"N, 13°43'45"E), Slovenian Littoral. Rescue excavations during reconstruction of the road. Collected and submitted 1994 by M Erič, Archaeological Department, Faculty of Philosophy, Ljubljana (cal AD 650–810, 64.9%).

Comment: (ME) Expected age: AD 600 to 1000.

Z-2965 Lendava **2070 ± 75**
Subfossil wood (*Quercus* sp.), sample MS-S2, tree rings 188–198, archaeological excavations of Roman well, 0.5 to 3.0 m depth, Lendava (46°34'23"N, 16°27'01"E) near Murska Sobota, NE Slovenia. Collected and submitted 2000 by T Levanič, Biotechnical Faculty, Department of Wood Science and Technology, Univ of Ljubljana (cal 180 BC–AD 20, 68.2%).

Comment: (TL) Expected age: AD 200–300.

Z-2518 Ljubljansko Barje Boat **3600 ± 110**
Wood from a boat found at Ljubljansko Barje peat bog, Ljubljana (46°03'21"N, 14°30'30"E), 272 m asl. Collected 1994 by pupils of School in Nature within the framework of the movement "Science to Young People" and submitted by J Pezdič, Jožef Stefan Institute, Ljubljana (cal 2140–2070 BC, 10.7%; 2060–1860 BC, 45.7%; 1850–1770 BC, 11.8%).

Ormož–Hajndl Series

Wood from rescue excavations on highway route at archaeological site Klanče–Hajndl, west part of town Ormož (46°24'39"N, 16°09'05"E), 202 m asl. Collected 1999 by I Žižek, and submitted 2000 by S Olić, Municipal Museum Ptuj.

Z-2975 Ormož–Hajndl 1 **2480 ± 75**
Wood, prehistoric well, Hajndl 2, sector 34, quadrant 742. s.u. 649B (cal 770–510 BC, 65.9%).

Comment: (SO) Expected Hallstatt period.

Z-3004 Ormož–Hajndl 2 **2880 ± 80**
Wood, No. 30, Hajndl 2, sector 34, s.u. 653, 74/A (cal 1130–920 BC, 60.2%).

Comment: (SO) Expected Bronze Age to early Halstatt period.

Ormož–Hardek Series

Charcoal from location Hardek, east part of Ormož (46°24'39"N, 16°09'05"E), 202 m asl, NE Slovenia during rescue excavation on Ormož loop highway. Collected by I Žižek, Ptuj Regional Museum, and submitted 1997 by S Forenbacher, Institute for Anthropological Research, Zagreb (samples Z-2721, Z-2729 and Z-2742) and 1999 by M Culiberg (Z-2933).

Z-2721 Ormož–Hardek 1 **24,100 ± 1100**
Wood, quadrant 184/XI.

Z-2729 Ormož–Hardek 2 **4130 ± 160**
Charcoal, quadrant 124/VIII (cal 2890–2470 BC, 68.2%).

Z-2742 Ormož–Hardek 3 **5200 ± 120**
Charcoal, mixed sample from quadrants 258/XIV and 259/XIV (cal 4230–4190 BC, 6.2%; 4170–3930 BC, 49.9%; 3880–3800 BC, 12.2%).

Z-2933 Ormož–Hardek 4 **5290 ± 110**
Charcoal from oak, probe 1, quadrant 5A, pit 2 (cal 4250–3980 BC, 68.2%).

Comment: (MC) Expected: Neolithic.

Z-2556 Piran **2100 ± 100**
Wood found 115 cm below sea level in harbor of Piran (45°32'N, 13°34'E), Slovenian Littoral. Found together with 23 fragments of different kinds of wood during archaeological investigations of old Roman harbor. Collected and submitted 1994 by S Karinja, Maritime Museum Piran (cal 250–320 BC, 6.2%; 210 BC–AD 20, 60.6%).

Ptuj Series

Charcoal from rescue excavations in Ptuj (46°25'17"N, 15°52'11"E), 220 m asl, NW Slovenia. Collected and submitted 2000 by M Lubšina-Tušek, Regional Institute for Protection of Cultural Heritage Maribor, branch office Ptuj.

A) School Parking Place–Volkmerjeva Ulica Street

Z-3013 Ptuj–Parking Place 1 **1650 ± 70**
Charcoal, oven No. 2, lime-kiln, quadrants 24, 25, 26 and 27 (cal AD 330–470, 48.5%; AD 480–540, 14.9%).

Z-3015 Ptuj–Parking Place 2 **5870 ± 130**
Charcoal, pit 10, the oldest phase of Eneolithic object 2, quadrants 28, 29 (cal 4860–4550 BC, 64.8%).

Z-3019 Ptuj–Parking Place 3 **1760 ± 95**
Charcoal, oven No. 3 from Roman period (cal AD 130–160, 6.4%; AD 170–390, 61.8%).

Z-3020 Ptuj–Parking Place 4 **2160 ± 70**
Charcoal, oven No.1, quadrant 28 (cal 360–280 BC, 21.8%; 260–90 BC, 46.4%).

Comment: (MLT) Expected Bronze age. Date does not confirm expectation. Possible mixing with younger material.

B) Koresova Ulica Street

Comment: (MLT) Expected Roman period.

Z-3021 Ptuj–Koresova Ulica 1 **2955 ± 110**
Wood, lower part of barrel hope, well 1, sample IV, parcel 1119/51 (cal 1320–1010 BC, 67.5%).

Z-3022 Ptuj–Koresova Ulica 2 **1950 ± 60**
Wood from the construction of well 2, sample VI, parcel 1119/51 (cal AD 1–130, 63.7%).

C) Other samples from Ptuj

Z-2988 Ptuj–Viktorina Ptujkega **2960 ± 60**

Charcoal from Grave 2 found during reconstruction of street Viktorina Ptujkega. Collected M Lubšina-Tušek and submitted 1999 by S Olič (cal 1300–1050 BC, 68.2%).

Comment: (SO) Expected Iron age.

Z-2989 Ptuj–Mali Grad **1840 ± 70**

Charcoal from grave construction (Grave 2) found in a yard at location Mali Grad. Collected M Lubšina-Tušek and submitted 1999 by S Olič (cal AD 80–260, 65.4%).

Comment: (SO) Expected Roman period.

Slavnik Series

Samples of dark grey clay, sediment of a former lake in the karst basin Zajezeri near Podgorje (45°31'10"N, 13°56'30"E), 480 m asl, at the foothills of Slavnik Mt., SW Slovenia. Collected and submitted 1994 by A Šercelj.

Z-2542 Slavnik 1 **525 ± 135**

Clay, 150–160 cm depth (cal AD 1290–1520, 65.5%).

Z-2543 Slavnik 2 **2490 ± 110**

Clay, 190–200 cm depth (cal 790–510 BC, 65.5%).

Z-2544 Slavnik 3 **2500 ± 100**

Clay, 255–256 cm depth (cal 790–510 BC, 67.4%).

Z-3052 Šentpavel **1840 ± 70**

Charcoal (No.34) from the archaeological site Šentpavel (46°06'40"N, 14°36'10"E), 285 m asl near Domžale (quadrant A3/B3, s.u. 022) on the highway route. Collected 1999 by M Novšak, company Arhej, Sevnica and submitted 2001 by M Culiberg (cal AD 80–260, 66.0%).

Comment: (MC) Expected Roman times.

Šiman Series

Charcoal from archaeological site Šiman, northern from Žalec, village Gotovlje near Celje (46°14'54"N, 15°13'52"E), uncovered during rescue archaeological excavations on the highway route Ljubljana-Maribor. Collected and submitted 1995 and 1996 by S Olič.

Z-2819 Šiman 1 **1660 ± 90**

Charcoal, quadrant L-38, s.u. 008, 281.70 m asl (cal AD 320–470, 54.6%; AD 480–540, 12.1%).

Z-2820 Šiman 2 **1810 ± 115**

Charcoal from pit in sterile clay, 50 cm below humus, quadrant J-36, s.u. 009, 282.40 m asl (cal AD 80–350, 67.2%).

Z-2821 Šiman 3 **3700 ± 150**

Charcoal from Bronze Age pit with pottery and flintstone artifacts, quadrant K-39/4 (cal 790–510 BC, 67.4%).

Z-2621 Škocjan na Krasu **2100 ± 80**

Charcoal from prehistoric site Škocjan na Krasu (45°31'48"N, 13°47'30"E), 135 m asl, SW Slovenia. Rescue excavations uncovered remains from late Bronze Age, Iron Age and Antique period. Sample PN 6 from s.u. 12 was taken from one of six beams found at the basement of a burned house. Collected 1996 by P Turk, University of Ljubljana, Slovenia (cal 210 BC–AD 10, 68.2%).

Comment: (PT) Stratigraphically between late Bronze Age (13th to 12th century BC) and Antique layers (1st century AD).

Škocjanski Zatok Series

Marine sediment. Borehole in Rižana riverbed, Škocjanski Zatok near Koper (45°32'20"N, 13°44'40"E), Slovenian Littoral. Carbonate admixtures of detritus, chalk lime-stone, alluvial deposits and mollusks. Only organic part measured. Collected 1994 by A Šercelj and submitted by M Culiberg.

Z-2522 Škocjanski Zatok 1 **4730 ± 120**

Organic sediment, 4.25 m depth (cal 3640–3370 BC, 68.2%).

Z-2524 Škocjanski Zatok 2 **3480 ± 140**

Organic sediment, 3.50 m depth (cal 1980–1610 BC, 66.8%).

Z-2525 Škocjanski Zatok 3 **985 ± 90**

Organic sediment, 1.9 m depth (cal AD 970–1180, 68.2%).

Z-2846 Vrtičnik **2330 ± 100**

Charcoal from an urn (barrow No.5, KK 1/97, layer 2), Vrtičnik near Tupaliče (46°14'50"N, 14°26'40"E), 533 m asl. Collected 1997 by M Ogrin, Museum of Gorenjska and submitted 1999 by M Culiberg (cal 400–170 BC, 68.2%).

Comment: (MO) Hallstatt–Urnfield culture.

BOSNIA AND HERCEGOVINA**Z-2165 Laminci Jaružani** **pMC: 98.9 ± 1.0**

Cow bone found in location Čakljeva Humka, Laminci Jaružani near Bosanska Gradiška (45°06'N, 17°22'E), 95 m asl, NW Bosnia. Submitted 1989 by B Čović, State Museum in Sarajevo.

Z-3097 Lištani **1695 ± 95**

Charcoal, square C2 b/d, 0.40–0.60 m depth, found near the base of a building, Lištani near Livno (43°49'35"N, 17°00'28"E), SW Bosnia. Submitted 2001 by M Marić, Franciscan Monastery in Livno (cal AD 230–440, 64.4%).

Comment: (MM) Expected 1st to 6th century AD.

Livno Series

Charcoal from St John cemetery at Livno (43°49'35"N, 17°00'28"E), 789 m asl, SW Bosnia. Collected 1994 by B Marijan and submitted by B Vrdoljak, Franciscan Monastery in Livno.

Z-2533 Livno 1 **1705 ± 95**

Charcoal (Kr.32) from pit at the cemetery together with Roman amphorae (cal AD 210–440, 67.2%).

Comment: (BM) Expected Roman period.

Z-2534 Livno 2**940 ± 225**

Charcoal (Kr.14A) from St John cemetery (church), together with many other findings, including Old-Croatian ones (cal AD 890–1280).

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