

**RUDJER BOŠKOVIĆ INSTITUTE  
RADIOCARBON MEASUREMENTS VI**

DUŠAN SRDOČ, ADELA SLIEPČEVIC\*, BOGOMIL OBELIC,  
and NADA HORVATINČIĆ

Rudjer Bošković Institute, PO Box 1016, 41001 Zagreb, Yugoslavia

The following radiocarbon date list contains dates of samples measured since our previous list (R, 1979, v 21, p 131-137). As before, age calculations are based on the Libby half-life  $5570 \pm 30$  yr and reported in years before 1950. The modern standard is 0.95 of the activity of NBS oxalic acid. Sample pretreatment, combustion, and counting technique are essentially the same as described in R, 1971, v 13, p 135-140, supplemented by new techniques for groundwater processing (R, 1979, v 21, p 131-137) and for soil sample treatment (R, 1977, v 19, p 465-475).

Statistical processing of data has been computerized (Obelić and Planinić, 1977). Sample descriptions were prepared with collectors and submitters. The errors quoted correspond to  $1\sigma$  variation of sample net counting rate and do not include the uncertainty in  $^{14}\text{C}$  half-life.

Calculations of age or percent of modern of speleothems and groundwaters are based on the initial activity equal to 0.85 of the NBS oxalic acid activity multiplied by 0.95.

ACKNOWLEDGMENTS

We thank E Hernaus for preparation of samples and methane synthesis, A Turković for data processing, and P Hojski for technical help.

1. ARCHAEOLOGIC SAMPLES

**Čazma series**

Fragments of wooden pipeline buried in loamy mud, Čazma ( $45^\circ 45' \text{ N}$ ,  $16^\circ 38' \text{ E}$ ) central Croatia. Pipeline used for water supply. Samples date occupation of site. Coll and subm 1977 by H Malinar, Croatian Inst Restoration, Zagreb. *Comment* (HM): expected age: 13th century AD.

**Z-569.**  **$240 \pm 60$**

Fragments of wooden pile supporting the pipeline.

**Z-669.**  **$580 \pm 90$**

Fragments of wooden pipeline.

**Z-578. Krka River**  **$1210 \pm 70$**

Fragments of wood (*Quercus*) 4m below Krka R bed near Hodoš ( $46^\circ 49' \text{ N}$ ,  $16^\circ 19' \text{ E}$ ) Slovenia. Sample dates anthropogenically degraded vegetation. Coll and subm 1977 by A Šercelj, Slov Acad Sci and Arts, Ljubljana.

**Gospodska pećina series**

Charcoal from entrance hall in cave above spring of Cetina R ( $43^\circ 59' 2'' \text{ N}$ ,  $16^\circ 26' 11'' \text{ E}$ ) N Dalmatia. Coll and subm 1977 by M Malez, Yugoslav Acad Sci and Arts, Zagreb (Malez, 1975; 1979).

\* Faculty of Veterinary Medicine, Univ Zagreb, Yugoslavia

**Z-579. 7010 ± 90**

Charcoal from lower hearth in Stratum C containing animal bones of older Holocene (*Cervus* sp, *Capreolus* sp). *Comment* (MM): expected age: beginning of Younger Boreal period.

**Z-580. 5130 ± 90**

Charcoal from upper hearth in the middle of calcite plate, Stratum B. *Comment* (MM): expected age: Older or Younger Atlantic period.

**Z-582. Donja Šatornja 610 ± 70**

Charcoal from burial place No. 2/77 in St Nicholas church, Donja Šatornja (44° 11' N, 20° 41' E) near Topola, Serbia. Sample dates burial site. Coll and subm 1977 by D Madas, Inst Preservation Cultural Monuments, Kragujevac. *Comment* (DM): expected age: 14th century AD.

**Z-586. Tophana, Imotski 230 ± 60**

Fragments of wooden beams found in stony walls of Armory ("Tophana"), Imotski (43° 27' N, 17° 13' E) SE Croatia. Coll and subm 1978 by B Bezić, Regional Inst Preservation Cultural Monuments, Split. *Comment* (BB): expected age: 15th to 16th century AD.

**Z-604. Viganj 240 ± 60**

Fragments of wooden ship 3m below sea surface in port of Viganj (42° 59' N, 17° 4' E) Pelješac peninsula, SE Croatia, Dalmatia. Coll and subm 1979 by Ž Rapanić, Archaeol Mus Split.

**Z-605. Slavkovica 940 ± 80**

Charcoal from burial place No. 43/78, Slavkovica (44° 10' N, 20° 16' E) Serbia. Sample dates necropolis of medieval Serbian state. Coll and subm 1978 by D Madas. *Comment* (DM): expected age: 14th to 15th century AD.

**Kostajnica series**

Fragments of wood from piles and beam found in foundation of fortress walls, Kostajnica near Una R (45° 13' N, 16° 32' E), W Bosnia. Dates sequences of fortress building. Coll and subm 1978 by D Miletić, Croatian Inst Restoration, Zagreb. *Comment* (DM): expected age: 300 yr.

**Z-607. No. 1 220 ± 50**

Fragments of wooden pile.

**Z-608. No. 7 570 ± 60**

Fragments of wooden pile.

**Z-609. No. 5 390 ± 60**

Fragments of wooden pile.

**Z-610. No. 3 120 ± 60**

Fragments of wooden pile.

**Z-611. No. 4** **380 ± 60**

Fragments of wooden beam.

**Notranje Gorice series**

Wooden fragments of pile dwellings in recent humus at Notranje Gorice (45° 59' 30" N, 14° 24' 30" E). Coll 1979 by Z Harej, Fac Arts and Sci Ljubljana; subm by A Šercelj. Dates pile dwellings.

**Z-717. No. 7** **3090 ± 90****Z-718. No. 9** **3720 ± 100****Z-719. No. 61** **4720 ± 100****Z-722. Koprivnička Rijeka, Rudina I** **3750 ± 110**

Charcoal from waste pit at Rudina near Koprivnička Rijeka (46° 07' N, 16° 37' E) NE Croatia. Dates settlement of latest phase of Vučedol culture. Coll by Z Marković, Mus Koprivnica; subm 1979 by M Malez. *Comment* (ZM): expected age: beginning of Early Bronze age (Marković, 1981).

**Privlaka series**

Samples from fortress Gradina (45° 12' N, 18° 51' E) near Vinkovci, E Croatia. Dates settlement stratification and fortification construction. Coll and subm 1979 by Nives Pandžić, Center for Hist Sci, Zagreb. *Comment* (NP): expected age: 1st to 2nd century BC.

**Z-726. Privlaka 1** **2170 ± 80**

Charcoal from fortress walls reinforced with wooden beams, partially carbonized at surface.

**Z-727. Privlaka 2** **6030 ± 100**

Charcoal from partially burned wooden beam in house floor.

**Z-728. Privlaka 3** **5600 ± 120**

Wheat grains in soil 1.7m below floor in ruins of burned house.

**Z-634. Lipe** **1940 ± 80**

Fragments of wooden (*Quercus*) boat 16m long buried in ploughed land overlying lake chalk, 20 to 30cm below surface at Lipe (45° 59' 10" N, 14° 26' 40" E). Continuation of palynol and archaeol investigations of Ljubljansko Barje, swamp with peat bogs and cultivated land, 20km long and 10km wide, S and SW of Ljubljana, Slovenia. Coll 1978 by Tatjana Bregant, Fac Arts and Sci, Ljubljana; subm by A Šercelj. *Comment* (TB): expected period: Neolithic.

**Parti series**

Wooden fragments of pile dwellings in cultural stratum, at 80 to 100cm depth at Parti, SE part of Ljubljansko Barje (45° 59' 20" N, 14° 32' 20" E). Dates pile dwelling settlements. Coll 1979 by T Bregant; subm by A Šercelj. *Comment* (AŠ): expected period: Bronze age. Corresponds to earlier measurements Z-539, -540 (R, 1979, v 21, p 133).

|                         |                   |
|-------------------------|-------------------|
| <b>Z-646. No. 1</b>     | <b>4160 ± 100</b> |
| <b>Z-647. No. 2</b>     | <b>4010 ± 100</b> |
| <b>Z-716. No. 9</b>     | <b>4200 ± 100</b> |
| <b>Z-687. Grabovica</b> | <b>3210 ± 70</b>  |

Charcoal from funeral pyre, 0.5m deep in grave, at Grabovica near Doboj (44° 44' N, 18° 07' E), Bosnia. Date supports archaeol placement of cremation in Bronze age. Coll and subm 1979 by B Belić, Mus Doboj.

#### **Trogir series**

Charcoal from hearth, 3m below surface and 2m below sea level in Lapidary, Trogir (43° 31' N, 16° 15' E) SE Croatia, Dalmatia. Sample assoc with ceramics, bones, and limestone fragments. Coll 1979 by I Babić, Town Mus Trogir; subm by J Radovčić. *Comment* (JR): expected age: 3000 to 4000 yr.

|  |                   |
|--|-------------------|
| <b>Z-696. Trogir I</b>                 | <b>2840 ± 90</b>  |
| <b>Z-697. Trogir II</b>                | <b>3580 ± 100</b> |
| <b>Z-734. Dolmen de Bertrandoune I</b> | <b>4090 ± 80</b>  |

Human bones from lowest part of archaeol level in funerary room of La Bertrandoune dolmen near Prayssac, Lot (44° 31' N, 1° 12' E). Samples were cross-checked using method of chemical pretreatment of bones (Horvatinčić *et al*, ms in preparation.). *Comment*: agrees well with Ly-1220 (R, 1978, v 20, p 19).

#### **Rudnik series**

Fragments of wood and charcoal, Ljubljana-Rudnik (46° 0' 55" N, 14° 32' 30" E) Slovenia. Coll 1980 by T Bregant; subm by A Šercelj. Samples date palynol established age of anthropogenically degraded vegetation in clay.

|  |                   |
|--|-------------------|
| <b>Z-737. Rudnik</b>   | <b>3290 ± 120</b> |
| Fragments of wood assoc with wooden oar buried in peaty humus, Zone I, Trench 3. |                   |
| <b>Z-773. Rudnik</b>   | <b>2700 ± 100</b> |
| Charcoal from marshland, Trench 6, 50 to 60cm depth.                             |                   |

#### II. GEOLOGIC SAMPLES

|  |                  |
|--|------------------|
| <b>Z-572. Lesno brdo</b>   | <b>1780 ± 70</b> |
| Fragments of wood from open profile, 1.5m below surface, Lesno brdo (46° 5' N, 14° 20' E) Ljubljansko Barje, Slovenia. Coll and subm 1977 by A Šercelj. Date supports palynol determined age (Younger Holocene). |                  |

#### **Ledine series**

Peat from bore hole in pond, 1120m above msl on plateau of Mt Jelovica (46° 15' 40" N, 14° 6' 25" E) Slovenia. Coll 1977 by M Zupančič; subm by A Šercelj. Supports palynol established vegetational phases.

|               |             |                  |
|---------------|-------------|------------------|
| <b>Z-573.</b> | <b>0.5m</b> | <b>980 ± 80</b>  |
| <b>Z-574.</b> | <b>1.8m</b> | <b>2220 ± 70</b> |
| <b>Z-575.</b> | <b>3.8m</b> | <b>3600 ± 80</b> |
| <b>Z-576.</b> | <b>4.6m</b> | <b>4020 ± 80</b> |
| <b>Z-577.</b> | <b>6.4m</b> | <b>6960 ± 90</b> |

**Jama Rupa series**

Fragments of wood and charcoal from different layers in “ponor” (swallow hole) Ljubija R between Smrekovac and Golte Mts (46° 24' N, 14° 37' E) Karavanke Mts, Slovenia. Hole entrance, 908m above msl. Coll 1978 by A Kranjc and A Vadnjal, Slovenian Acad Sci and Arts, Postojna; subm by R Gospodarič. Dates sedimentation process. *Comment* (RG): expected age: Holocene.

|  |                  |                 |
|--|------------------|-----------------|
| <b>Z-587.</b>                              | <b>Layer 7</b>   | <b>130 ± 70</b> |
| Wooden fragments from Layer 7, depth 0.7m. |                  |                 |
| <b>Z-588.</b>                              | <b>Layer 8</b>   | <b>120 ± 70</b> |
| Charcoal from Layer 8, depth 0.5m.         |                  |                 |
| <b>Z-589.</b>                              | <b>Layer 2/3</b> | <b>120 ± 60</b> |
| Charcoal from Layer 2/3, depth 2.1m.       |                  |                 |

**Tučić ponor series**

Twig with calcite coating from base of “ponor” Tučić, 147m deep, Ričica R, Gračac polje near Gračac (44° 18' N, 15° 51' E) Lika, Central Croatia. Coll and subm 1978 by S Božičević, Geol Inst Zagreb. Dates period of calcite precipitation (Srdoč *et al*, 1980).

|                    |                 |
|--------------------|-----------------|
| <b>Z-615.</b>      | <b>270 ± 80</b> |
| Fragments of wood. |                 |
| <b>Z-616.</b>      | <b>Modern</b>   |
| Calcite coating.   |                 |

**Učka Tunnel series**

Speleothems from cavern in limestone karst, Učka tunnel (45° 19' N, 14° 13' E) Istria, W Croatia. Discovered during construction of hwy through Mt Učka. Coll and subm 1978 by S Božičević. Dates periods of growth of speleothems, formation of cave, and tectonic changes.

|  |              |                     |
|--|--------------|---------------------|
| <b>Z-617.</b>  | <b>No. 1</b> | <b>&gt;40,000</b>   |
| Base of stalagmite from rock, Hall No 3.               |              |                     |
| <b>Z-618.</b>  | <b>No. 2</b> | <b>&gt;40,000</b>   |
| Base of stalagmite from limestone boulder near siphon. |              |                     |
| <b>Z-619.</b>  | <b>No. 3</b> | <b>10,000 ± 200</b> |
| Base of stalagmite from overturned limestone block.    |              |                     |

**Z-648. No. 4** **28,100 ± 1300**

Base of stalagmite from limestone block.

**Z-649. No. 5** **7330 ± 150**

Base of stalagmite from limestone rock.

+ 1700

**Z-650. No. 6** **31,400**

– 1400

Base of stalagmite from limestone chips.

**Z-645. Volarje** **12,600 ± 220**

Leaves embedded in lake chalk, from open profile in left bank of Soča R near Volarje (46° 12' N, 13° 40' E), Slovenia. Coll by L. Žlebnik, Geol Inst Ljubljana; subm 1978 by A. Šercelj. Palynol analysis dates sample to beginning of last Würm. Sample dates lake chalk sedimentation rate.

**Z-713. Sečovlje** **8900 ± 120**

Organic detritus in core of bore hole V-6, 26.5m deep, salt works Sečovlje (45° 29' 20" N, 13° 38' 25" E) Slovenia. Coll by B. Ogorelec, Geol Inst Ljubljana; subm 1979 by A. Šercelj. Palynol analysis suggests beginning of Holocene.

**Z-714. Erjavčeva cesta** **>40,000**

Sandy peat 5m below surface, Erjavčeva cesta, Ljubljana (46° 3' 35" N, 14° 30' 15" E) Slovenia. Coll and subm 1979 by A. Šercelj. Palynol analysis indicates Pleistocene.

### **Kuk series**

Speleothem from conglomerates in Kuk cave, Bistrica R canyon near Dobro polje (43° 36' N, 18° 31' E), Bosnia. Dates cave stratigraphy. Coll and subm 1979 by E. Kulenović, Geoinženjering, Sarajevo. *Comment* (EK): expected period: Upper Pleistocene.

+ 2290

**Z-723. EK-PE-6** **34,800**

– 1780

Speleothem from conglomerates embedded in sandy-gravel layer, 2.5 to 3m below surface of cave.

+ 5100

**Z-724. EK-3/II** **39,100**

– 3000

Speleothem, 80cm below stratum of calcareous tufa containing fossil bones.

+ 2750

**Z-725. EK-PE-13** **35,000**

– 2080

Speleothem from upper layer of gravel mixed with sand.

**Z-732. Gigića pećina 19,300 ± 430**

Crystalline calcite from dripstone slab, 25 to 50cm thick, Gigića cave above village Resanovci (850m) W Bosnia. Clay stratum, 100cm thick, below dripstone contains animal bones (*Ursus spelaeus*). Coll and subm 1980 by M Malez (Malez *et al*, 1972).

**Babja jama series**

Fragments of wood in dark gray clay, Vogršček (46° 8' N, 13° 43' E) near Most na Soči, Slovenia. "Ponor" (swallow hole), occasionally turns into karst spring. *Comment* (RG): pollen analysis points to Holocene. Coll and subm 1980 by R Gospodarič, Slovenian Acad Sci and Arts, Postojna.

**Z-763. Sample 1 150 ± 80**

Fragments of wood, upper layer.

**Z-764. Sample 2 310 ± 80**

Fragments of wood, lower layer.

**Jama Luknja series**

Stalagmite with embedded human bones in cave below Luknja castle (45° 49' N, 15° 6' E), Krka R valley near Novo Mesto, Slovenia. Coll by A Medle, Speleol Soc Novo Mesto; subm 1980 by R Gospodarič. *Comment* (RG): expected period: Holocene.

**Z-765. Sample 1 1320 ± 110**

Calcite from base of stalagmite close to bone.

**Z-766. Sample 2 230 ± 100**

Calcite, tip of stalagmite, Z-765.

**Z-780. 2450 ± 120**

Dripstone, 1cm thick deposited on human bone.

**Kopačina series**

Snail shells (*Helix* sp) 50cm thick cemented with dripstone from Kopačina Cave near Donji Humac, Brač I, Dalmatia. Shell layer overlies postglacial stratum rich with fauna (*Cervus elephus*, *Capreolus capreolus*, *Sus scrofa*). Coll 1980 and subm by M Malez. Dates formation of snail shell layer between upper humus layer and lower postglacial sediments (Čečuk, in press).

**Z-776. Sample 1 4000 ± 110**

Dripstone with fragments of shells.

**Z-778. Sample 2 7850 ± 140**

Snail shells; most of dripstone removed.

**III. GEOCHEMICAL SAMPLES**

Radiocarbon assays were done in most cases to complete physical and chemical data on water samples from various aquifers, thermal and

mineral springs, etc. Besides radiocarbon and chemical analyses, tritium and stable isotope analyses ( $^{13}\text{C}$ ,  $^{18}\text{O}$ , and  $^2\text{H}$ ) were considered most important for hydrogeologic interpretation of data.

Results of radiocarbon analyses of geochemical samples are presented as percent modern. Where applicable, apparent age of water samples is given, calculated on the assumption that no mixing of water or depletion of radiocarbon content occurred. Calculation of apparent age is based on initial activity equal to 0.85 of modern standard and on the Libby half-life,  $5570 \pm 30$  yr.

*Mineral waters of Slovenia*

**Rogaška Slatina series**

Mineral waters from Rogaška Slatina spa ( $46^\circ 14' \text{ N}$ ,  $15^\circ 39' \text{ E}$ ), E Slovenia. Coll Nov 1980 and subm by J Pezdič, "Jožef Štefan" Inst, Ljubljana. Hydrologic study of mineral waters (table 1).

TABLE 1

| Lab no. | Sample | Well type | % Modern       | Apparent age (yr)            |
|---------|--------|-----------|----------------|------------------------------|
| Z-614   | V-3-66 | Bore hole | $0.6 \pm 0.6$  | $>40,000$                    |
| Z-771   | G-2    | Bore hole | $1.7 \pm 0.3$  | $32,000 \pm 2000$<br>$-1700$ |
| Z-772   | G-4    | Bore hole | $91.0 \pm 0.6$ | Modern                       |

**Radenci series**

Mineral waters from artesian and subartesian wells, Slatina Radenci spa ( $46^\circ 40' \text{ N}$ ,  $16^\circ 05' \text{ E}$ ) near Gornja Radgona, NE Slovenia. Coll Aug 1978 by J Pezdič and A Popovič; subm by I Kobal, "Jožef Štefan" Inst, Ljubljana. Dated to study origin of water (table 2).

TABLE 2

| Lab no. | Sample           | Well type   | Depth (m) | % Modern       | Apparent age (yr)            |
|---------|------------------|-------------|-----------|----------------|------------------------------|
| Z-595   | Jurjev vrelec    | Subartesian | 26        | $2.1 \pm 0.5$  | $31,300 \pm 1500$<br>$-1300$ |
| Z-596   | V-U              | Artesian    | 161       | $22.0 \pm 0.4$ | $12,100 \pm 200$             |
| Z-597   | K-2              | Subartesian | 10        | $1.7 \pm 0.6$  | $33,200 \pm 4300$<br>$-2800$ |
| Z-598   | K-1              | Subartesian | 17        | $1.9 \pm 0.6$  | $31,900 \pm 1700$<br>$-1400$ |
| Z-599   | K-3              | Subartesian | 9         | $8.9 \pm 0.4$  | $19,400 \pm 380$             |
| Z-601   | Zelezni vrelec   | Artesian    | 9         | $0.3 \pm 0.5$  | $>40,000$                    |
| Z-602   | Zdravilni vrelec | Subartesian | 22        | $0.0 \pm 0.0$  | $>40,000$                    |



TABLE 3

| Lab no. | Sample               | Well type | Depth<br>(m) | Location |         | Colln date | % Modern   | Apparent age<br>(yr)       |
|---------|----------------------|-----------|--------------|----------|---------|------------|------------|----------------------------|
|         |                      |           |              | N Lat    | E Long  |            |            |                            |
| Z-680   | Stupnik              | Bore hole | Ca 850       | 45° 41'  | 15° 50' | 6/79       | 1.2 ± 0.5  | + 2600<br>35,700<br>— 1900 |
| Z-733   | Sv Ivan, Zelina      | Bore hole | Ca 790       | 46° 58'  | 16° 15' | 6/80       | 1.6 ± 0.4  | + 2350<br>33,200<br>— 1900 |
| Z-758   | Sv Ivan, Zelina      | Spa       | Surface      | 46° 55'  | 15° 59' | 8/80       | 45.2 ± 0.4 | 5050 ± 100                 |
| Z-736   | Tuheljske toplice    | Spa       | Surface      | 46° 04'  | 15° 47' | 8/80       | 36.1 ± 0.4 | 8150 ± 110                 |
| Z-759   | Krapinske toplice    | Spa       | Surface      | 46° 06'  | 15° 50' | 9/80       | 5.9 ± 0.4  | 21,600 ± 570               |
| Z-761   | Sutinske toplice     | Spa       | Surface      | 46° 03'  | 16° 02' | 10/80      | 7.0 ± 0.4  | 20,100 ± 550               |
| Z-762   | Stubičke toplice     | Spa       | Surface      | 45° 49'  | 15° 56' | 10/80      | 22.2 ± 0.4 | 10,800 ± 200               |
| Z-769   | Šemničke toplice     | Spa       | Surface      | 46° 06'  | 15° 56' | 10/80      | 19.4 ± 0.4 | 11,800 ± 200               |
| Z-774   | Obradovci 2          | Bore hole | Ca 580       | 45° 37'  | 17° 57' | 11/80      | 1.2 ± 0.3  | + 2600<br>33,800<br>— 2000 |
| Z-775   | Sv Jana near Samobor | Spring    | Surface      | 45° 43'  | 15° 36' | 11/80      | 59.2 ± 0.5 | 2830 ± 100                 |

*Thermal waters of Croatia*

**Z-756. Migalovci** **Apparent age: 32,700**  
 $1.7 \pm 0.3 \%$  modern  
 + 1500  
 – 1250

Thermal water from artesian well, 370m deep, at Migalovci (45° 20' N, 18° 01' E) NE Croatia. Coll Aug 1980 by A Vujinac; subm by M Zelenika, Geotehnika, Zagreb. Dated to study origin of water.

**NW and NE Croatia series**

Samples of water from several thermal springs in NW and NE Croatia. Coll and subm 1979 by INA-Naftaplin staff, Zagreb. Dated to study hydrologic properties of thermal waters (table 3).

*Thermal waters and groundwaters of Bosnia and Hercegovina*

Hydrologic investigations of thermal waters and groundwaters in Bosnia and Hercegovina. Coll and subm by Geoinženjering staff, Sarajevo.

**Z-566. Višegradska banja** **37,300**  
 $1.0 \pm 0.3 \%$  modern  
 + 3400  
 – 2300

Thermal water of artesian type, Višegrad spa (43° 47' N, 19° 19' E), Bore hole SB-2. Coll 1977 and subm by N Miošić.

**Z-690. Banja Ilidža** **18,000 ± 350**  
 $8.9 \pm 0.6 \%$  modern

Thermal water from Bore hole B-6 at Ilidža spa near Gradačac (45° 54' N, 18° 25' E). Coll 1979 and subm by D Mulaosmanović.

**Z-698. Banja Tomina Ilidža** **17,650 ± 270**  
 $9.5 \pm 0.4 \%$  modern

Thermal water from Ana spring, Ilidža near Sanski most (44° 41' N, 16° 47' E). Coll and subm by N Miošić.

**Z-729. Gradačac** **5140 ± 130**  
 $43.5 \pm 0.6 \%$  modern

Groundwater, Bore hole GA-4, total depth 110m, Gradačac. Coll 1980 and subm by N Miošić.

**Z-767. Sočkovac** **21,900 ± 550**  
 $5.5 \pm 0.3 \%$  modern

Thermal water from Well OS-2, 76m deep, near Gračanica (44° 40' N, 18° 18' E). Coll 1980 and subm by M Butorac.

**Z-768. Boljanić** **36,400**  
 $0.9 \pm 0.3 \%$  modern  
 + 3500  
 – 2500

Thermal water from Well OB-1, 73.5m deep, Gračanica (44° 41' N, 18° 14' E). Coll 1980 and subm by N Butorac.

**Gata series**

Thermal water from drilled wells at Gata (44° 56' N, 15° 48' E) near Bihać, E Bosnia. Coll July 1979 and subm by N Čubranić, Industroprojekt, Zagreb.

**Z-688. Well B-X** **22.6 ± 0.6 % modern**  
**12,000 ± 200**

**Z-689. Well B-8** **10.8 ± 0.6 % modern**  
**17,900 ± 460**

**Z-757. Kaniža** **0.3 ± 0.3 % modern**  
**>40,000**

Water from artesian well, 250m deep, at Kaniža (45° 07' N, 17° 53' E) near Bosanski Brod, Bosnia. Coll by A Vujinac; subm by M Zelenika, Geotehnika, Zagreb. Hydrologic study for water resource of Kaniža region.

*Groundwaters of Vojvodina*

**Subotica series**

Water from drilled wells, Subotica, N Vojvodina. Coll and subm Jan 1979 by A Tot Bagi. Water resource development, Subotica (table 4).

TABLE 4

| Lab no. | Sample               | Well type | Depth<br>(m) | Location |         | Colln date | % Modern   | Apparent age<br>(yr) |
|---------|----------------------|-----------|--------------|----------|---------|------------|------------|----------------------|
|         |                      |           |              | N Lat    | E Long  |            |            |                      |
| Z-652   | Kelebija             | Drilled   | 128          | 46° 09'  | 19° 35' | 1/79       | 48.7 ± 0.8 | 5740 ± 13            |
| Z-653   | Novi Žednik 1        | Drilled   | 118          | 45° 56'  | 19° 35' | 1/79       | 16.7 ± 0.4 | 14,200 ± 25          |
| Z-654   | Subotica,<br>Well 23 | Drilled   | —            | 46° 06'  | 19° 43' | 1/79       | 42.9 ± 0.7 | 6780 ± 13            |

**Ruma series**

Water samples from drilled wells, Ruma (45° 01' N, 19° 50' E) SW Vojvodina. Coll and subm by M Lazarević, "Jaroslav Černi" Inst, Beograd. Water resource development, Ruma (table 5).

TABLE 5

| Lab no. | Sample         | Well type   | Depth<br>(m) | Colln date | % Modern   | Apparent age<br>(yr) |
|---------|----------------|-------------|--------------|------------|------------|----------------------|
| Z-591   | Fišćrov salaš  | Subartesian | 148          | 5/78       | 21.5 ± 0.4 | 12,500 ± 210         |
| Z-592   | Borkovac       | Subartesian | 280          | 5/78       | 24.7 ± 0.4 | 11,200 ± 170         |
| Z-731   | Hrtkovci, HB-2 | Well        | 60.0         | 2/80       | 68.3 ± 0.7 | 1680 ± 90            |

REFERENCES

- Čečuk, B, in press, Kopačina, Otok Brač-Višeslojno prethistorijsko nalazište: Arheološki pregled, v 22, in press.
- Evin, J, Marien, G, and Pachiaudi, C, 1978, Lyon natural radiocarbon measurements VII: Radiocarbon, v 20, p 19-57.
- Malez, M, Rukavina, D, and Šlišković, T, 1972, Eine neue paläontologische und paläolithische Fundstelle in Westbosnien: Bull Scientifique, sec A, v 17, p 229-231.
- Malez, M, 1975, Einige Probleme des Paläolithikums an der Ostküste des Adriatischen Meeres: Rad JAZU, Knj 371, Razred za prirodoznanost, Knj 17, p 121-153.
- 1979, Die Höhle Gospodska pečina-eine neue paläolithische Fundstelle in Dalmatien: Archéol et hist dalmates Bull, v 72-73, p 1-11.
- Marković, Z, in press, Vučedolska populacija u sjeverozapadnoj Hrvatskoj: Arheol vestnik, v 32, in press.
- Miošić, N, 1980, Radiocarbon dating of thermal waters in Višegrad spa: Fizika, v 12, supp 2, p 169-171.
- Obelić, B and Planinić, J, 1977, Computer processing of radiocarbon and tritium data, in Povinec, P and Usačev, S, eds, Internatl conf low radioactivity measurement and applications, Proc: The High Tatras, Slovenské pedagogické nakladateľstvo, Bratislava, p 117-120.
- Srdoč, D, Breyer, B, and Šliepčević, A, 1971, Rudjer Bošković Institute radiocarbon measurements I: Radiocarbon, v 13, p 135-140.
- Srdoč, D, Šliepčević, A, Obelić, B, and Horvatinčić, N, 1977, Rudjer Bošković Institute radiocarbon measurements IV: Radiocarbon, v 19, p 465-475.
- 1979, Rudjer Bošković Institute radiocarbon measurements V: Radiocarbon, v 21, p 131-137.
- 1980, Radiocarbon dating of calcareous tufa: How reliable data can we expect?, in Stuiver, Minze and Kra, Renee, eds, Internatl radiocarbon conf, 10th, Proc: Radiocarbon, v 22, no. 3, p 858-862.