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RADIOCARBON DATING OF THE ARCHIVAL FUNERAL COMPLEXES OF THE GLOBULAR AMPHORA CULTURE ON THE SANDOMIERZ UPLAND: GAJOWIZNA, MALICE, MIERZANOWICE AND SANDOMIERZ SITES

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ABSTRACT

The article presents results of a special project aimed at re-examining the grave associated with the Globular Amphora culture in the Sandomierz Upland. The main purpose was to obtain data to establish the absolute chronology of the graves. In total, the reported project produced 25 absolute age determinations of samples from 17 sepulchral features. Some determinations are second attempts to date the same sample in an effort to make calibrated BC ranges more accurate. The samples selected for analyses were taken from osteological material coming from human graves and associated animal deposits (twelve and five features, respectively). The graves discussed in the paper come from Gajowizna (known as *Złota-Gajowizna*), Sandomierz-Kruków, Mierzanowice, site 1, and Malice, site 1. The determinations fit into the range from 4225 ± 25 BP to 4040 ± 35 BP, with the highest concentration occurring in the period of 4200 ± 40 – 4100 ± 35 BP (18 determinations), or in calibrated years 2901–2577 BC (1 sigma) or 2901–2498 BC (2 sigma). The highest calibration probability, amounting in the case of all the dates to almost 90%, is cumulated in the range of 2870–2600 BC (2 sigma). Summing up, the new age determinations of samples from cemeteries on the Sandomierz Upland

are consistent with the knowledge on the chronology of the Globular Amphora culture - Małopolska group gathered by using the traditional typological method and referring to dates for neighbouring regions. The time bracket defined by the new series of radiocarbon dates from the Sandomierz Upland begs important questions about relationships of the Globular Amphora culture communities with other Late and Final Neolithic groups that lived there in the first half of the 3rd millennium BC related to the Złota and Corded Ware cultures.

Keywords: Globular Amphora culture, Late Neolithic, absolute chronology, radiocarbon dating, cemeteries

INTRODUCTION

Materials identified as belonging to the Globular Amphora culture (GAC) are known from over 189 sites on the Sandomierz Upland now (Fig. 1). Most of them are small sites of undefined nature, recorded during surface surveys, therefore their informational value is relatively low. A higher informational potential for chronological studies is shown by 13 excavated settlements, 26 cemeteries and 3 sites having the function of a workshop. Altogether, they yielded about 200 GAC features.¹ The set of eight radiocarbon age determinations that were obtained for them, however, was too small to draw any conclusions on the time brackets of the local GAC group. Furthermore, devising credible chronological schemes was made more difficult by the fact that only a single date, obtained for Grave VIII from Sandomierz-*Kruków*, came from a closed assemblage [Ścibior, Ścibior 1990]. The other dates related to the background area of the flint mine in Krzemionki Opatowskie and it was not clear if they concerned the GAC at all [Borkowski, Zalewski 1992].

Due to these shortcomings of the source base, development schemes devised for the Sandomierz Upland sometimes leave the GAC out and its role in the cultural transformations of the Late Neolithic in Małopolska is outright marginalised. The determination of the chronological position of the GAC Sandomierz-Opatów subgroup and its relationships to other groups living in the same region was one of the aims of National Science Centre, Poland, research project no. 2014/12/S/HS3/00355. It produced altogether 47 new radiocarbon determinations of which

¹ The exact counting of the number of GAC features at the site complex in Złota would call for their comprehensive processing; this, however, went far beyond the project reported in this article.

42 bore out the connection of features being dated to the GAC.² Some were located in the four largest GAC cemeteries on the following sites: *Złota-Gajowizna*, *Mierzanowice*, *Sandomierz-Kruków* and *Malice*. Others were explored at the settlements in *Mierzanowice*, *Złota-Nad Wawrem* and *Gańkowice*. This date series was supplemented by two dates for graves related to the Corded Ware culture, coming into stratigraphic relations with the GAC features [Witkowska, Włodarczak 2021]. By reason of the complexity of issues surrounding the features, dates for cemeteries and settlements shall be discussed in separate articles. In this paper, my main goal is to discuss the ¹⁴C determinations taken from the funeral complexes of the Sandomierz-Opatów subgroup of the GAC.

On the Sandomierz Upland, 54 GAC graves have been discovered so far in 26 cemeteries (Table 1). This number of features, containing the remains of over 80 persons in total, is relatively high and seems to be conducive to chronometric studies. However, in the case of most features, collecting samples for radiocarbon tests has proven impossible. The reason being that in the course of the oldest investigations, which can be characterised as amateurish, carried out on such sites as *Boleszyn*, *Chwałki*, *Jastków*, *Stodoły* or *Wąworków* [Nosek 1967: 167, 188, 191], osteological material was either left unexposed or not collected from the ground. Nor were any charcoals preserved. Similar situations took place, too, at later accidental finds as for instance the discovery of a damaged grave in *Ossolin* in 2009 [Florek 2010]. What is more, most osteological material originating with old planned excavations has been lost or is unavailable for study. For example, this is the case with the human and animal remains from the largest GAC cemetery, from the *Gajowizna* site (known generally as the *Złota-Gajowizna* site), currently stored in the Department of Anthropology, Institute of Immunology and Experimental Therapy, Polish Academy of Sciences, Wrocław, Poland. As this collection was unavailable, the cemetery in *Gajowizna* was dated using single bones left among artefacts. This, however, made it impossible to repeat determinations when laboratory results were inconsistent with archaeological knowledge based on typochronology or when a sufficient amount of collagen could not be extracted. Furthermore, very interesting materials from the cemetery in *Sadowie* have not been made available for study either. They are particularly valuable, having been procured by scrupulously applying modern research methods and are presented in separate publications [Pasterkiewicz 2017; 2020; 2021].

All in all, the reported project covered the examination of samples from 17 GAC sepulchral features located on the Sandomierz Upland (Table 2). This, in turn, allowed researchers to determine the absolute age of the four largest (not counting the site in *Sadowie* mentioned above) cemeteries of the GAC Sandomierz-Opatów subgroup.

² Dates pointing to a different chronology shall be discussed below and in another articles in this volume [Florek, Witkowska 2021; Witkowska, Włodarczak 2021].

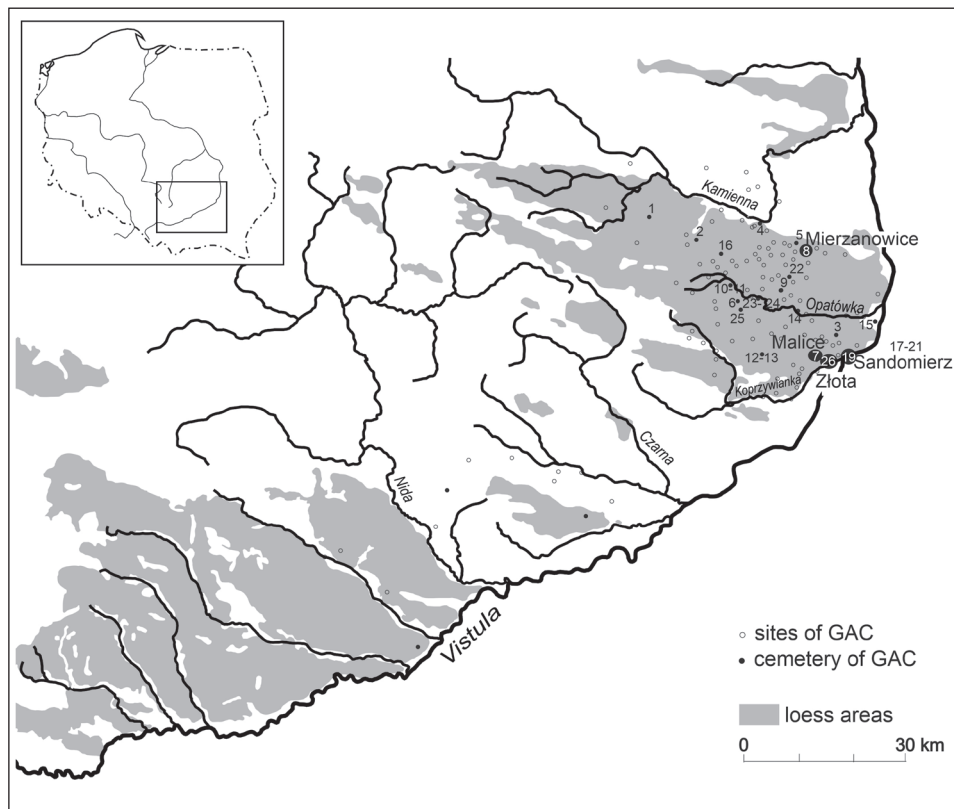


Fig. 1. Cemetery of Sandomierz - Opatów group on the background of other sites of the Globular Amphora culture in Małopolska. The numbering of cemeteries according with Table 1

T a b l e 1

List of cemetery of the Globular Amphora culture in the Sandomierz Upland. The numbering in the table according with Figure 1.

The explain of shortcuts: PMA – State Archaeological Museum in Warsaw; MAK – Archaeological Museum in Krakow; IAI PAN – Institute of Archeology and Ethnology, Polish Academy of Science, Warsaw; MNK – National Museum in Kielce; MOS – District Museum in Sandomierz; PAI – Archaeological Laboratory of the Institute of Archeology and Ethnology of the Polish Academy of Sciences in Igołomia; IA UR – Institute of Archeology, University of Rzeszów; UMCS – Institute of Archeology, Maria Curie-Skłodowska University.

No.	Site	Number of site	Other name of site used in the literature	Number of AZP	Type of site	Discovery	Author and year of discovery	Graves	Number of buried persons	Animal graves	References	Museum collection
1	Boleszyn, district Opatów	2	Nowak's field	217/84-68	single grave	accidental	unknown 1924	1	≥1	0	Jakimowicz 1935; Nosek 1967	PMA
2	Broniszowice, district Opatów		site XII		single grave	accidental	unknown 1973	1	≥1	0	Bąbel 1975	PMA
3	Chwałki, district Sandomierz	1	Dragan's field	59/89-73	single grave	accidental	unknown 1931	1	1	0	Nosek 1967	MAK
4	Grójec, district Ćmielów	24		428/85-71	cemetery	excavation	Krzak 1970	2	≥2	0	Krzak 1974	IAiE PAN
5	Jastków, district Opatów	3		127/85-71	single grave	accidental	unknown before 1930	1	≥1	0	Antoniewicz 1936; Nosek 1967	MNK, MOS
6	Kochów, district Opatów	1		87-70	single grave	accidental	Bargiel 1989	1	≥1	0	Bargiel <i>et al.</i> 1989	UMCS
7	Malice, district Sandomierz	1		70/89-73	cemetery	excavation	Kamińska 1973; Witkowska 2017	2	6	2	Kamińska 1964; Nosek 1967; Witkowska <i>et al.</i> 2021	PAI

No.	Site	Number of site	Other name of site used in the literature	Number of AZP	Type of site	Discovery	Author and year of discovery	Graves	Number of buried persons	Animal graves	References	Museum collection
8	Mierzanowice, district Opatów	1	site I	66/86-72	settlement and cemetery	excavation	Salewicz 1936-1938	5	5	1	Balcer 1963; Bąbel 1979; 1985	PMA
9	Nikisiałka Duża, district Opatów	?		?/87-71	cemetery	survey	Krzak 1969	1	≥1	0	Krzak 1991	?
10	Opatów, district Opatów	2		2/87-70	single grave	accidental		1	≥1	0	Bargiel <i>et al.</i> 1989	-
11	Opatów, district Opatów	6		6/67-70	cemetery	accidental		1	≥1	0	Antoniewicz 1928; Nosek 1967	MNK
12	Ossolin, district Sandomierz	2	manor buildings	4/89-71	single grave	accidental	Pyzik 1957	1	2	0	Pyzik 1960; Nosek 1967	MNK
13	Ossolin, district Sandomierz	40		?/89-71	single grave	excavation	Florek 2009	1	≥1	0	Florek 2010	
14	Pęczyny, district Sandomierz	1		7/88-72	single grave	accidental	Mierzyński 1960	1	≥1	0	unpublished	MNK
15	Rzeczyca Mokra, district Sandomierz	1		50/89-74	single grave	accidental	Zięba 1982	1	6	0	Ścibior 1993a	MOS

No.	Site	Number of site	Other name of site used in the literature	Number of AZP	Type of site	Discovery	Author and year of discovery	Graves	Number of buried persons	Animal graves	References	Museum collection
16	Sadowie, district Opatów	23		136/86-70	cemetery	excavation	Pasterkiewicz 2015-2018	4	≥11	5	Pasterkiewicz 2017	IA UR
17	Sandomierz, district Sandomierz	31	Chwałki – military cemetery	5/89-73	single grave	accidental		1	1	0	Gurba 1956 (published as related to the Ziota culture)	UMCS
18	Sandomierz, district Sandomierz	73	Góry Pieprzowe	23/89-73	single grave	accidental	unknown before 1930	1	1	0	Jakimowicz 1920; Antoniewicz 1936; Nosek 1967	MDS
19	Sandomierz, district Sandomierz	78	Kruków	27/89-73	cemetery	excavation	Ścibior, Ścibior 1984	3	5	2	Ścibior, Ścibior 1990	MOS
20	Sandomierz, district Sandomierz	44	11 Lis-topada street	25/89-73	single grave	accidental	unknown 1937	1	≥1	0	unpublished	MOS
21	Sandomierz, district Sandomierz	43	St. Joseph church	24/89-73	single grave	accidental	collection PTK Sandomierz	1	≥1	0	unpublished	MOS
22	Stodoły, district Opatów	1		22/86-72	single grave	accidental	unknown 1859	1	≥1	0	Przyborowski 1873; Nosek 1967	MAK
23	Wąworków, district Opatów	1	Opatów	1/87-71	single grave	excavation	Antoniewicz 1925	1	≥1	0	Antoniewicz 1936; Nosek 1967	MNK

No.	Site	Number of site	Other name of site used in the literature	Number of AZP	Type of site	Discovery	Author and year of discovery	Graves	Number of buried persons	Animal graves	References	Museum collection
24	Wąwotków, district Opatów	4		24/87-71	single grave	accidental		1	1	0	Kowalski 1975	PMA
25	Włostów, district Opatów		sugar factory	88-71	single grave	excavation	Gąsowska 1959	1	≥1	0	Gąsowska 1962 (published as related to the Złota culture); Nosek 1967	MOS
26	Złota, district Sandomierz	1	Gajo- wiczna	14/90-73	cemetery	excavation	Jakimowicz, Szmit 1926	18	30	12	Krzak 1977	PMA

List of radiocarbon dating of sepulchral features related to the Globular Amphora culture in the Sandomierz Upland. Calibration in OxCal v4.4.2 [Bronk Ramsey 2020]

Site	Feature	Sample	Lab. no.	BP	cal BC (68.2%)	cal BC (95.4%)	Combine BP	Combine/Modelled BC (68.2%)	Combine/Modelled BC (95.4%)
Gajowizna	Feature 1	human bone	Poz-90799	1880±40	[122-216 AD]	[33-244 AD]			
	Feature 3	animal bone	Poz-90800	4100±40	2848-2577	2870-2498			
	Feature 6	animal bone	Poz-90802	4090±40	2846-2505	2868-2493			
	Feature 9	human bone	Poz-90803	3510±40	1892-1767	1943-1699			
	Feature 24	animal bone	Poz-90804	4140±50	2866-2631	2879-2579			
	Feature 27	animal bone	Poz-90806	4200±40	2888-2701	2901-2633			
	Feature 28	charcoal (inner ring) charcoal (outer ring)	Poz-94739 Poz-94740	4435±35 4485±35	3320-3012 3331-3100	3331-2926 3348-3031	D_sequence	3293-3034	3306-3020
Mierzanowice 1	Feature 31	animal bone	Poz-90807	4180±40	2881-2679	2889-2631			
	Feature 1	human bone	Poz-90808	4140±40	2866-2631	2876-2582			
	Feature 3	human bone	Poz-90809	4180±40	2881-2679	2889-2631			
	Feature 127	human bone	Poz-90810	4120±40	2857-2584	2874-2574			
	Feature II	human bone	Poz-90821	4160±40	2874-2671	2884-2588			
Sandomierz 78		charcoal	Gd-2462	4370±70	3092-2905	3332-2885			
	Feature VIII	human bone	AAR-?	4222±23	2895-2776	2901-2701	4202±20	2885-2707	2891-2697
		human bone	Poz-90784	4155±35	2871-2671	2881-2623			
		human bone	GrN-20927	3950±30	2563-2352	2570-2342			
		human bone	Poz-90785	4190±35	2883-2700	2893-2635			

Site	Feature	Sample	Lab. no.	BP	cal BC (68.2%)	cal BC (95.4%)	Combine BP	Combine/ Modelled BC (68.2%)	Combine/ Modelled BC (95.4%)	
Malice 1	Feature 31	animal bone	Poz-94493	4135±35	2862-2630	2874-2581				
		human bone – individual A	Poz-94494	4165±35	2874-2675	2881-2630	4113±25	2848-2585	2865-2575	
			Poz-94495	4060±35	2663-2494	2847-2473				
	Feature 32	human bone – individual B	Poz-94496	4215±35	2893-2705	2905-2672	4220±25	2894-2775	2901-2700	
			Poz-94497	4225±35	2898-2707	2910-2675				
		human bone – individual C	Poz-94499	4130±35	2860-2627	2872-2580	4123±25	2851-2627	2866-2580	
			Poz-94500	4115±35	2852-2584	2871-2574				
			Poz-94501	4090±35	2845-2573	2865-2494	4107±23	2845-2581	2859-2575	
		Feature 33	human bone	Poz-94502	4120±30	2854-2623	2868-2577			
				Poz-94503	4040±35	2622-2488	2836-2468			

Gajowizna

The best explored, traditionally assigned to the village of *Złota-Gajowizna* cemetery, actually belongs to Polanów Złocki according to the Archaeological Record of Poland (in Polish: AZP; Polanów Złocki, site 1, AZP 90-73/14). The 1926 investigations unearthed 30 GAC sepulchral features there clustered in schematically laid out ritual complexes, consisting of human graves and accompanying animal burials and sacrificial pits [Krzak 1977, Fig. 8; for re-interpretation see Witkowska *et al.* 2020, Fig. 8]. In total, the site yielded 18 Late Neolithic human burials and 12 animal deposits [Witkowska *et al.* 2020, Table 1; for other estimates see Krzak 1977: 78–79; Włodarczak, Przybyła 2013, Table 8]. After studying the plan of the cemetery, it seems plausible, as suggested by the authors of the investigations, that in spite of the large number of unearthed features, only a part of it has been exposed [Jakimowiczowa 1927: 33]. Its special characteristic is human graves bearing traces of intentionally lighting a fire in grave chambers and the presence of structural beams in them. Due to the problems mentioned earlier, samples could be collected from only eight features. The age determinations of six of them are related to the GAC: features no. 3, 6, 24, 27, 28, 31.

Feature 3. An animal deposit belonging to a ritual complex (Fig. 2) extending W-E and consisting of two human graves (Features 1 and 6) and two the so-called sacrificial pits (Features 3 and 4). It held the carcasses of eight pigs and single bones of a bear.

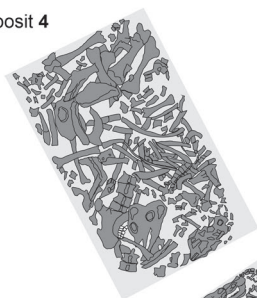
Feature 6. It belonged to the complex mentioned above, a damaged human grave in which an indeterminate number of persons had been buried. Grave goods included three vessels that have subsequently been lost (including at least one with cord ornament), three flint flakes (not preserved) and a double-edged bone point (Fig. 2).

Feature 24. Part of a larger complex oriented NW-SE and consisting additionally of human Grave 14 and sacrificial Pit 25. The function of the feature, due to the presence of both human remains together with grave goods and ten cattle skeletons, is hard to determine [Witkowska *et al.* 2020: 265–267]. The grave goods comprised four vessels, including a small and a large amphora (missing) and a cup and a small amphora (preserved) with a cord ornament (Fig. 3). The artefacts were supplemented by the bones of two pigs and three sheep or goats.

Feature 27. A regular animal deposit connected to human Grave 26. In it, four complete cows, two pigs and sheep or goat bones were deposited together with a partially preserved double-edged bone point (Fig. 4).

Feature 28. A human grave forming part of a ritual complex, comprising also Features 29, 30 and 31, which were arranged along a NW-SE axis. The grave chamber held the remains of a wooden structure that together with loess walls

Animal deposit 4



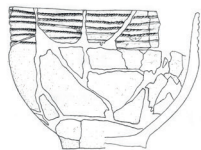
Animal deposit 3

**4100 ± 40 BP**

Grave 1



0 5 cm



Grave 6

4090 ± 40 BP

0 5 cm

Gajowizna site
ritual complex 4-3-1-6

-  outline of feature
-  stones
-  human bones
-  animal bones
-  pottery
-  small equipment

0 50 cm



Fig. 2. Gajowizna site, Sandomierz district. Ritual complex of features 4-3-1-6 with preserved equipment and radiocarbon dates. After Krzak 1977 with changes. Artefacts from grave 1 drawn by B. Witkowska. The legend also applies to other illustrations in the text

Animal deposit with human grave 24

Gajowizna site
ritual complex 14-24-25

Animal deposit ? 25



Grave 14

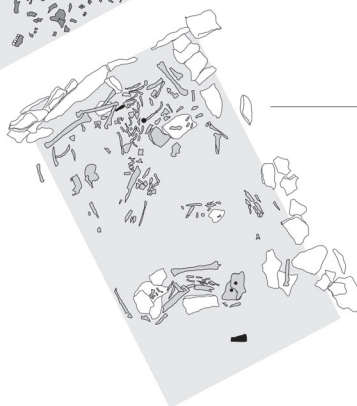


Fig. 3. Gajowizna site, Sandomierz district. Ritual complex of features 14-24-25 with preserved equipment and radiocarbon date. After Krzak 1977 with changes. Artefacts from grave 24 drawn by B. Witkowska

Gajowizna site

ritual complex 26-27

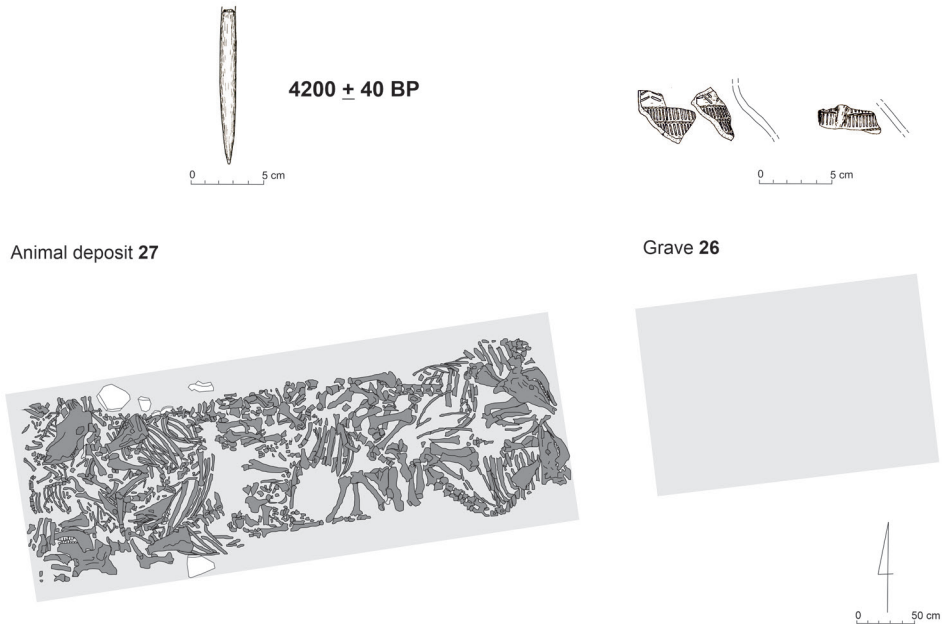


Fig. 4. Gajowizna site, Sandomierz district. Ritual complex of features 26-27 with preserved equipment and radiocarbon date. After Krzak 1977 with changes

bore traces of an intentionally set fire. Two persons lay buried in the grave with goods consisting of a burnt striped-flint axe, Świeciechów flint blade and bones of a cow, a pig and a horse (Fig. 5).

Feature 31. A part of the feature group mentioned above, it was an animal deposit accompanying Feature 30. In it, five cows and one sheep or goat were deposited. No artefacts were found in the feature (Fig. 5).

Sandomierz-Kruków

Another GAC cemetery selected for chronometric studies was the Sandomierz-Kruków site (Sandomierz, site 78, AZP 89-73/27), on which altogether five sepulchral features had been exposed during rescue excavations in 1984 [Ścibior, Ścibior

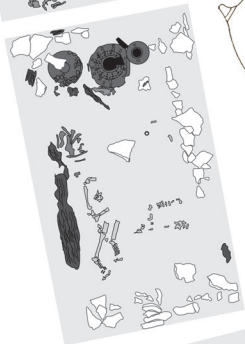
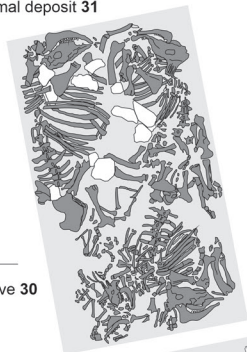
Animal deposit 31

Gajowizna site

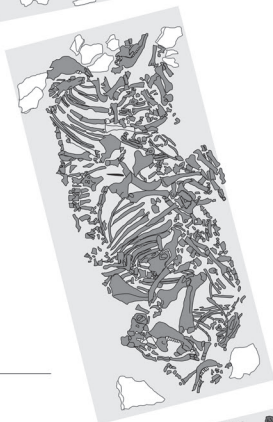
ritual complex 28-29-30-31

4180 ± 40 BP

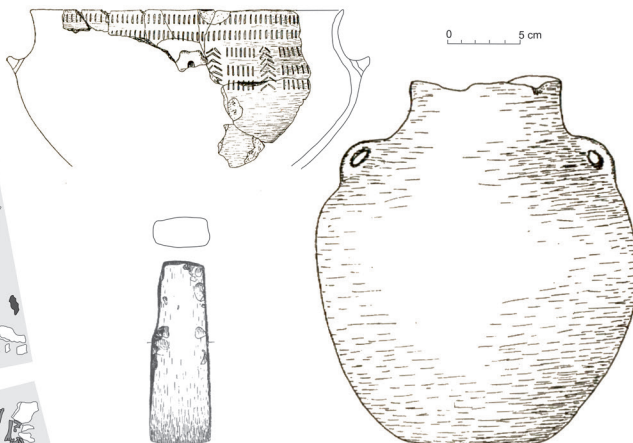
Grave 30



Animal deposit 29



Grave 28



4435 ± 35 BP

4485 ± 35 BP



Fig. 5. Gajowizna site, Sandomierz district. Ritual complex of features 28-29-30-31 with preserved equipment and radiocarbon dates. After Krzak 1977 with changes

Grave II

Sandomierz, site 78

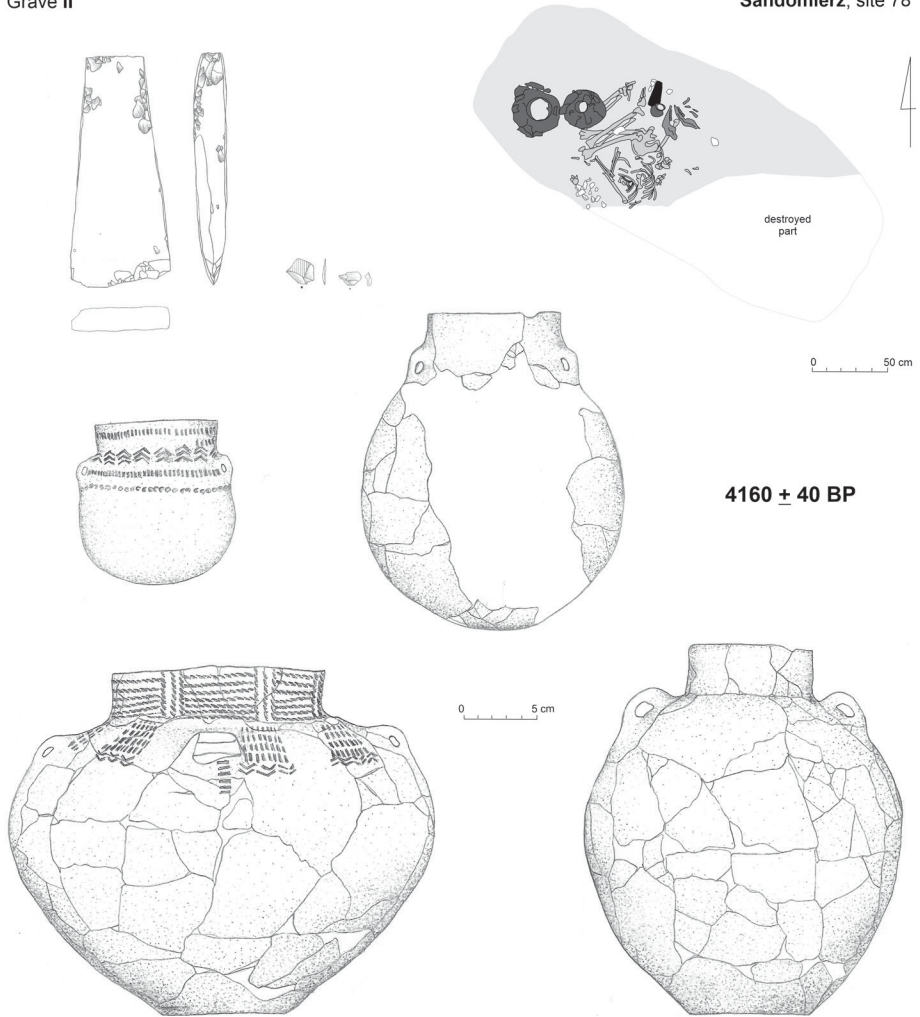


Fig. 6. Sandomierz-Kruków, site 78, Sandomierz district. Grave II with equipment and radiocarbon date. After Ścibior, Ścibior 1990 with changes

Grave VIII

Sandomierz, site 78

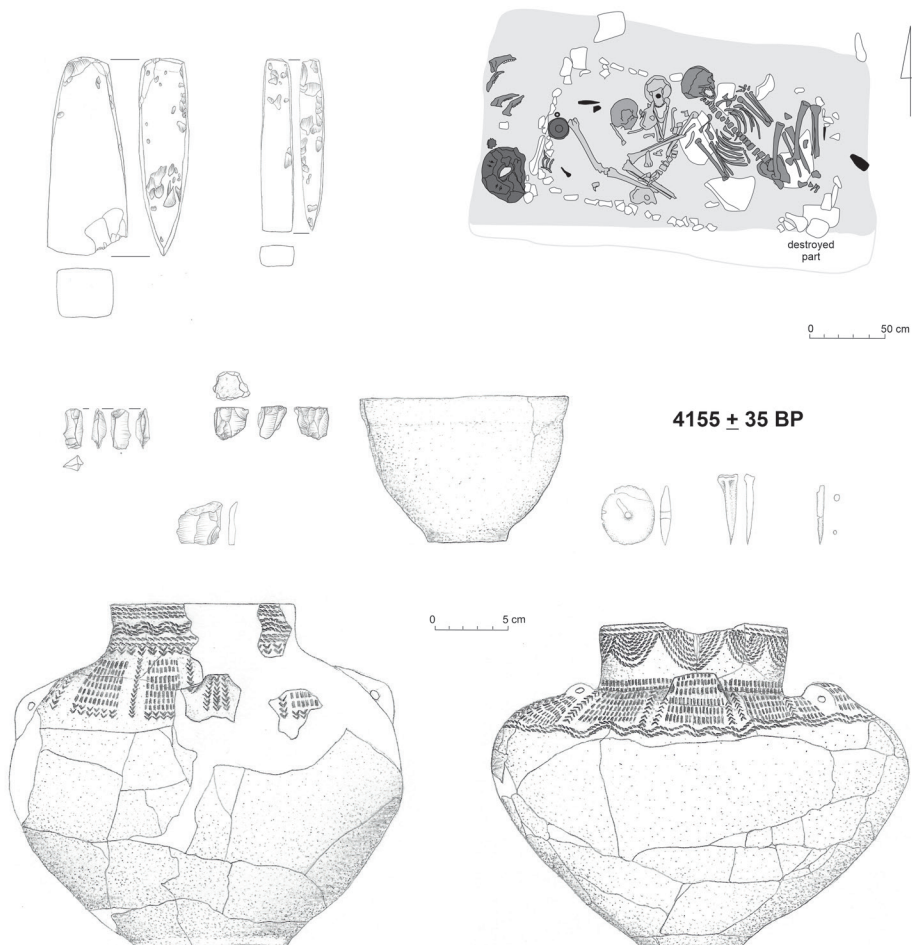


Fig. 7. Sandomierz-Kruków, site 78, Sandomierz district. Grave VIII with equipment and radio-carbon date. After Ścibior, Ścibior 1990 with changes

1990]. The nature of the discoveries and the fact that it has been only preliminarily explored prevents putting any estimate on the size of the site. Human bones found in three GAC graves on the site served to determine its absolute chronology. The bones were also subjected to specialised anthropological analyses [Schroeder *et al.* 2019] that also produced an additional absolute age determination for Grave VIII, carried out in the laboratory of Aarhus University, Denmark.

Grave II. A partially damaged human grave extending NW-SE. In the exposed part, one person was buried with the following grave goods: four vessels (including two with a cord ornament), a striped-flint axe and two flakes: one chipped off a striped-flint axe and the other made of Świeciechów flint (Fig. 6).

Grave VIII. A human grave with three burials, extending W-E with a vestigial stone lining. Besides human remains, it held two richly ornamented four-handled amphorae, an unornamented goblet, one Świeciechów flint axe, one striped-flint chisel, one small Turonian flint core, one splintered piece, one chocolate flint flake, a partially preserved bone point, a bone awl, an amber disk and two wild boar mandibles (Fig. 7).

Grave X. A human grave with a strongly disturbed stone lining and bone remains. The surviving inventory includes a ceramic stamp-ornamented lid, two Świeciechów flint blades and two wild boar tusks (Fig. 8).

Grave X

Sandomierz, site 78



Fig. 8. Sandomierz-Kruków, site 78, Sandomierz district. Grave X with equipment and radiocarbon date. After Ścibior, Ścibior 1990 with changes

Mierzanowice, site 1

Site 1 in Mierzanowice (site 1, AZP 86-72/66) was excavated in 1936–1938. It yielded 36 GAC-related features in total, including seven human graves [Balcer 1963; Bąbel 1979]. The materials from this site have been scattered in storage. For radiocarbon dating, samples from three GAC sepulchral features could be obtained, nonetheless. It must be noted that one of these (Grave 1) has been presented until now in the professional literature as a feature of the Złota culture (ZC) [Salewicz 1937: 41, Bąbel 1979: 76–79], despite the absence of any direct analogies in the ZC artefact inventory.

Grave 1. A double human burial with a stone lining and pavement of large blocks of limestone. The pit outline was not recorded but the arrangement of the better preserved skeleton suggests that the grave was oriented along the SE-NW axis. Its goods consisted of a single vessel, bearing a cord ornament and appliqué bosses next to the vessel base, three flakes, including two of chocolate flint and one of striped flint, a wild boar tusk and animal bones (Fig. 9).

Grave 3. A single human burial with a stone lining; it extended along the SW-NE axis (Fig. 9). Next to the skeleton sat a single vessel with a cord ornament. Found in the pit fill, rough-outs of bifacial axes must be considered as belonging to the Mierzanowice culture, whose feature disturbed the older GAC grave.

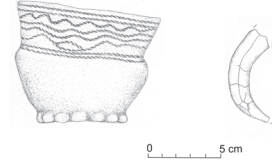
Grave 127. A single human disarticulated burial with a stone lining and pavement accompanied by pottery shards left likely by a vessel that has not been preserved. Other artefacts included one striped-flint axe, one flake and one hammerstone made of the same raw material, fragments of an elephant or mammoth tooth, pig bones and two bone ornaments in the type of a bone buckle (Fig. 9).

Malice, site 1

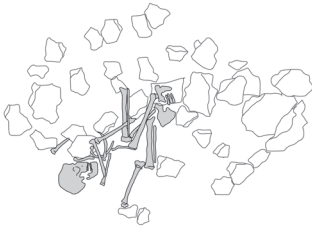
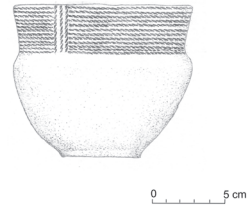
The last GAC cemetery for which absolute chronology was determined is one in Malice where three certain and one hypothetical GAC features were recorded [for details see Witkowska *et al.* 2021]. The first GAC features were discovered there in 1962 [Kamieńska 1964]. The cemetery was revisited in 2017 as part of research project no. 2014/12/S/HS3/00355. One of the purposes of the revisit was to examine a closed GAC assemblage from the Sandomierz Upland and procure new materials for analysis. It was to be more credible as it was to follow the latest research methodology. This demand was necessary because the potential of the source base of the Sandomierz GAC oecumene was critically

Grave 1

Mierzanowice, site I

4140 \pm 40 BP

Grave 3

4180 \pm 40 BP

Grave 127

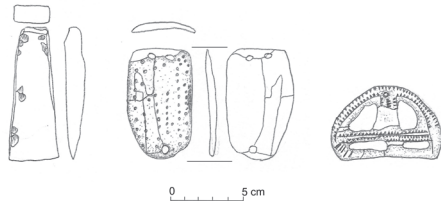
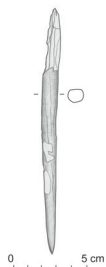
4120 \pm 40 BP

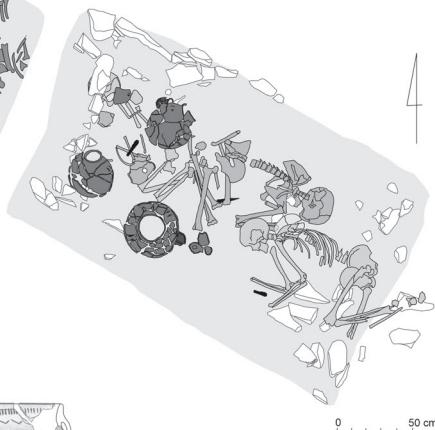
Fig. 9. Mierzanowice, site I, district Opatów. Graves of the Globular Amphora culture with equipment and radiocarbon dates. After Bąbel 1979 with changes. Features drawn by B. Witkowska based on field photos without scale

Animal deposit 31



4135 ± 35 BP

Malice, site 1



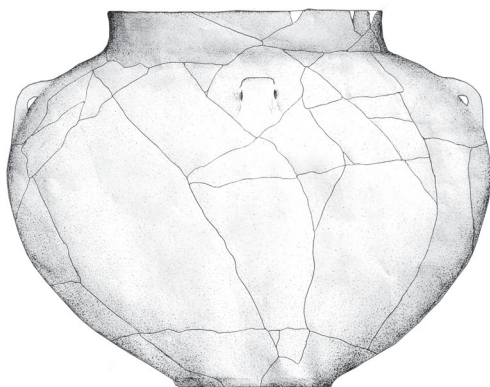
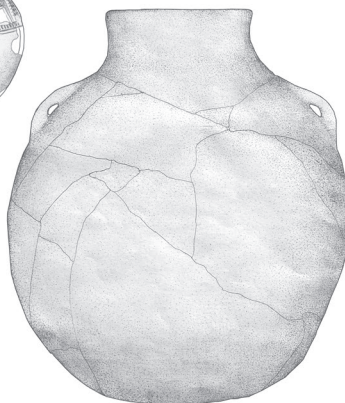
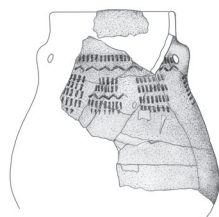
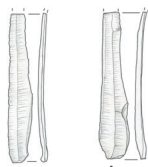
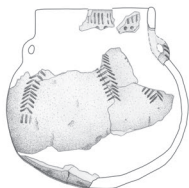
Grave 32

4113 ± 25 BP

4220 ± 25 BP

4123 ± 25 BP

4107 ± 23 BP



0 5 cm

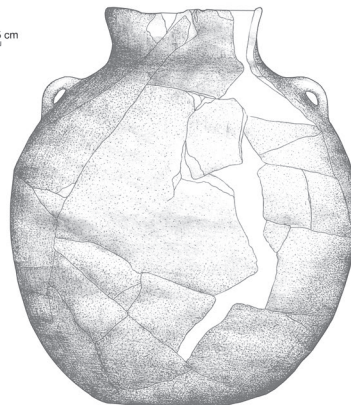


Fig. 10. Malice, site 1, Sandomierz district. Ritual complex of features 31-32 with equipment and radiocarbon dates. Research by B. Witkowska

viewed. The 2017 excavations allowed researchers to observe stratigraphy within a collective grave and record relationships holding among the burials deposited in it. This, in turn, helped model the calibration of radiocarbon dates [Witkowska *et al.* 2021].

Feature 31. An animal deposit accompanying human grave (Feature 32) that contained the bones of an indeterminate number of small ruminants and a pig (Fig. 10). Most of the osteological material is now lost. Among the animal bones, one double-edged bone point was found.

Feature 32. A collective human grave with a vestigial stone lining, oriented along the NW-SE axis. Altogether five persons were buried in it, accompanied by the following grave goods: seven vessels, including three large unornamented amphorae and four small richly ornamented vessels, two Świeciechów flint blades, five flakes of the same raw material and a partially preserved bone awl (Fig. 10).

Feature 33. A single human grave with a pavement of large limestone slabs accompanied by a hypothetical animal deposit designated by number 54. The inventory of the grave consisted of three vessels (including one beaker with a cord ornament and two partially preserved bottom parts of vessels of an indeterminate form), a striped-flint axe and blade, animal bones of indeterminate species (now lost) and a bifacial bone point (Fig. 11).

RESULTS OF RADIOCARBON DATING

In total, the reported project produced 25 absolute age determinations of samples from 17 GAC sepulchral features located on the Sandomierz Upland (Fig. 12; Table 2). Some determinations are second attempts to date the same sample in an effort to make calibrated BC ranges more accurate [Witkowska *et al.* 2021]. The samples selected for analyses were taken from osteological material coming from human graves and associated animal deposits (twelve and five features, respectively).

The only feature dated, using a sample of another material, is human Grave 28 from Gajowizna. In this case the amount of collagen extracted from the burial bones was too small to determine its absolute age. A charred pine beam found in the grave was used instead. Radiocarbon age determinations were obtained for its two extreme tree rings that were dendrochronologically assessed to differ in age by 31 years [Witkowska *et al.* 2020].³ The obtained dates are 4435±35 BP and 4485±35 BP, respectively, with a slightly older determination of the BP age being

³ Dendrochronological studies financed with funds from NSC project no. 2014/12/S/HS3/00355 were carried out by Professor Tomasz Ważny, Nicolaus Copernicus University, Toruń, Poland.

Feature 54 (hypothetical animal deposit)

Malice, site 1

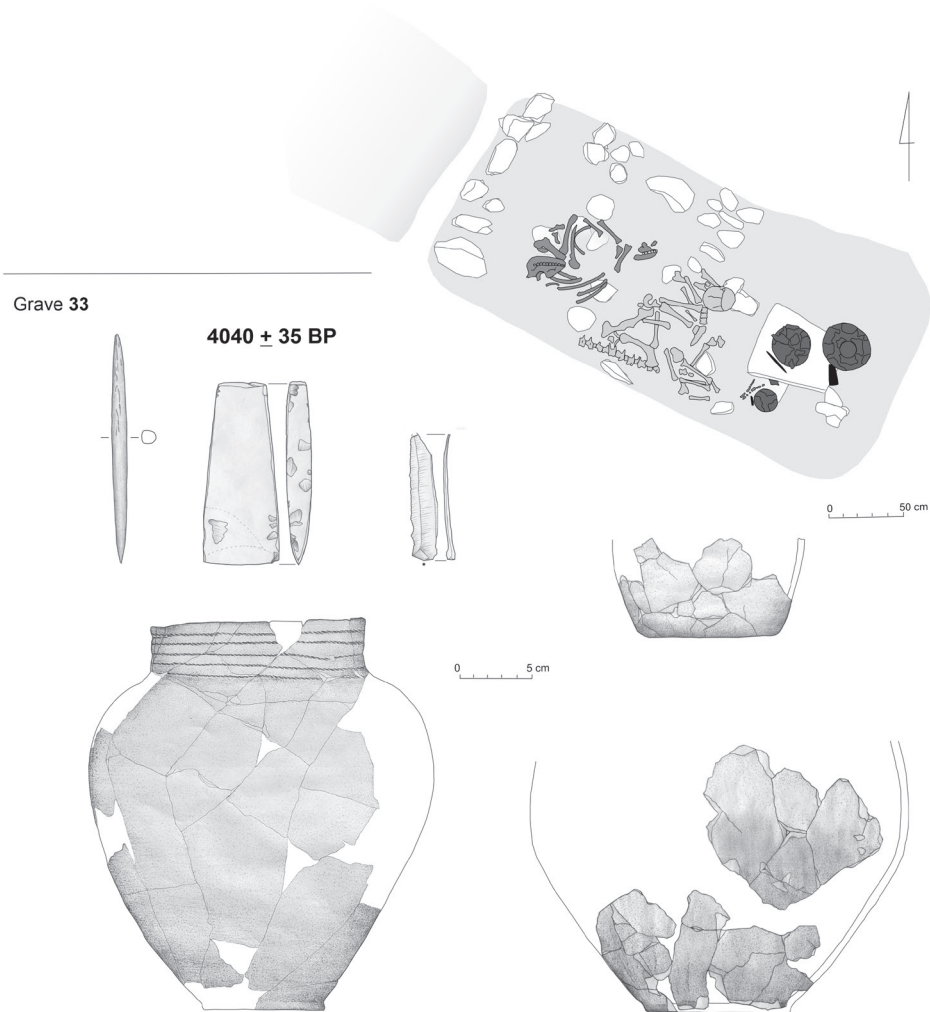


Fig. 11. Malice, site 1, Sandomierz district. Ritual complex of features 33-54 with equipment and radiocarbon date. After Kamińska 1964 with changes; artefacts drawn by B. Witkowska

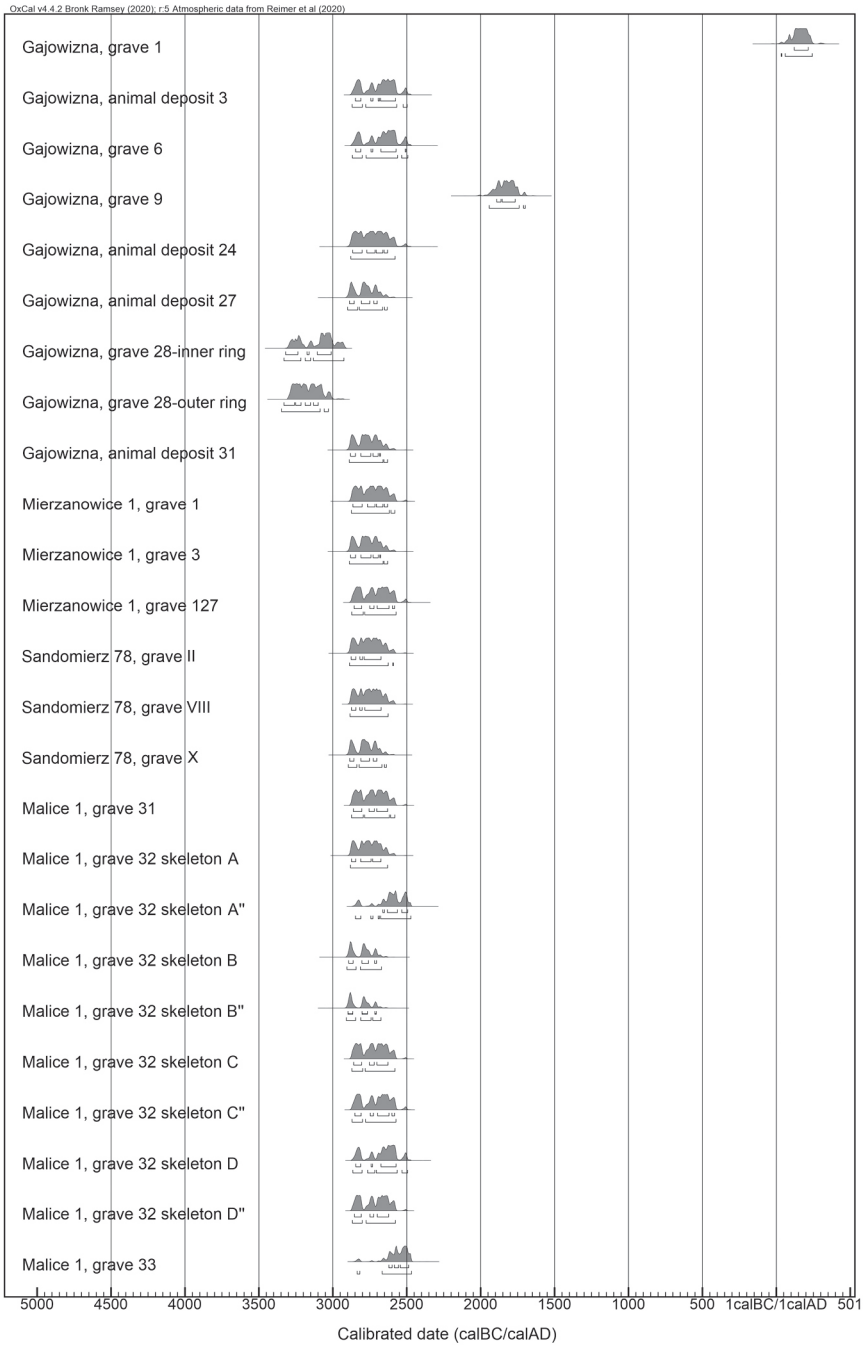


Fig. 12. The calibration of all radiocarbon dates obtained from Globular Amphora graves within the project NSC 2014/12/S/HS3/00355

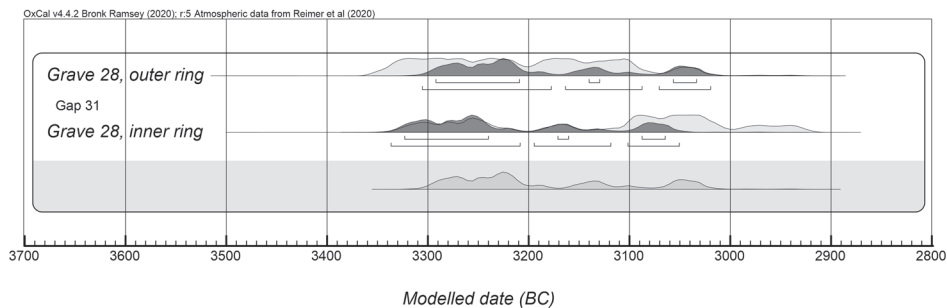


Fig. 13. Gajowizna site, Sandomierz district. The calibration with wiggle matching method of two radiocarbon dates from a fragment of beam found in Feature 28

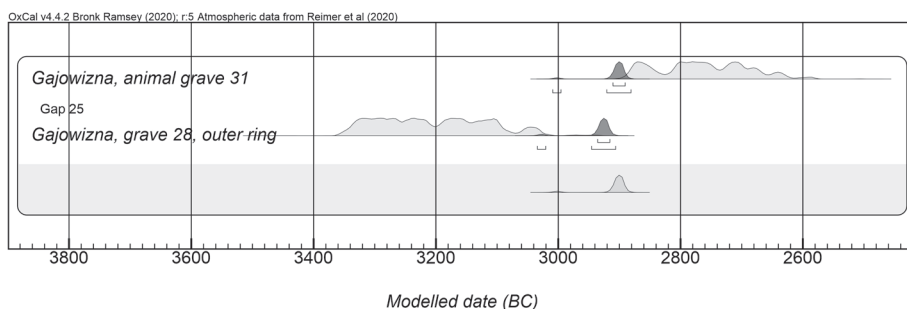


Fig. 14. Gajowizna site, Sandomierz district. The calibration with wiggle matching method of two dates from features 28 and 31 assuming a short distance time separating their formation

obtained for the outer tree ring. This paradoxical situation results from the very nature of the radiocarbon method and should be a warning against constructing chronological models, relying on uncalibrated dates. The calibration ranges of these two determinations largely overlap, producing the following results: 3331–2926 and 3348–3031 BC (2 sigma), respectively.

Relying on *a priori* knowledge on the sequence of samples and the time interval between them, these ranges may be slightly narrowed down to 3333–3025 BC (2 sigma) using modelling (Fig. 13). They are significantly older than the entire series of dates for the Sandomierz-Opatów subgroup and are among the oldest in the whole Polish GAC oecumene [Szmyt 1996, Table 1]. Interestingly enough, they have been confirmed by testing other samples of the same structural element, in this case, three prepared tree rings [Witkowska *et al.* 2020]. The other ^{14}C determinations from Gajowizna and the typological analysis of movable finds from this site argue against adopting so early a chronology of the cemetery. The false seniority

of the sample from Grave 28 results in all likelihood from the special nature of the organic material used for dating. This argument is borne out by the date for Feature 31, forming part of the same ritual complex. A bone of one of the animals deposited in it yielded the result of 4180 ± 40 BP, which is similar to the other absolute age determinations of GAC features on the Sandomierz Upland. Assuming that a short time interval separated features located exactly along the same axis, it is possible to make another attempt to model the actual age of the samples (Fig. 14). In this attempt, the 95.4% probability range is modified to 3010–2882 BC. This observation and the wide calibration brackets of the dates for Grave 28 (405 and 317 years, respectively, in the 2 sigma range) justify the claim that the actual age of Grave 28 is closer to the lower limit of the obtained ranges, or the period to which early graves from the Lublin Upland are dated, such as ones from Klementowice and Raciborowice-Kolonia. For their analogous assemblages the following dates were obtained: 3007–2883 BC and 3011–2902 BC [Włodarczak 2016: Fig. 2; cf. also Bronicki 2021].

Problems following from combining radiocarbon determinations obtained for different raw materials and performed in different laboratories are illustrated by dates for Grave VIII on the Sandomierz-*Kruków* site. For this grave, we have radiocarbon dates determined by four different research centres (Fig. 15; Table 2). They are as follows:

- Gd-4252 4370 ± 70 BP [Ścibior, Ścibior 1990: 195]
- AAR-? 4222 ± 23 BP [Schroeder *et al.* 2019]
- Poz-90784 4155 ± 35 BP
- GrN-20927 3950 ± 30 BP⁴ (letter of A. Lanting to K. Tunia of 1996).

The oldest date, obtained from charcoal, is close to the determination for Grave 28 from Gajowizna and indicates the range of 3332–2885 BC, thus, preceding the so-called Neolithic plateau. Meanwhile, the inventory of Grave VIII, comprising an amphora ornamented with cord impressions and showing affinities with the other dated assemblages from this site, unambiguously points to a later chronology of the feature. It is reflected in two determinations for burial bones that fit into the range of 2891–2697 BC (2 sigma, Table 2). It appears, therefore, that in the case of the determination Gd-4252, we are dealing with an ‘old wood effect’.

The youngest absolute age determination for Grave VIII is the date from the Groningen laboratory; it is significantly younger than the whole pool of GAC dates from the Sandomierz Upland obtained as a result of the current project because its calibration range falls on the second half of the 3rd millennium BC.

⁴ An unpublished date determined in the 1990s and made available by courtesy of Dr. Krzysztof Tunia and Prof. Piotr Włodarczak.

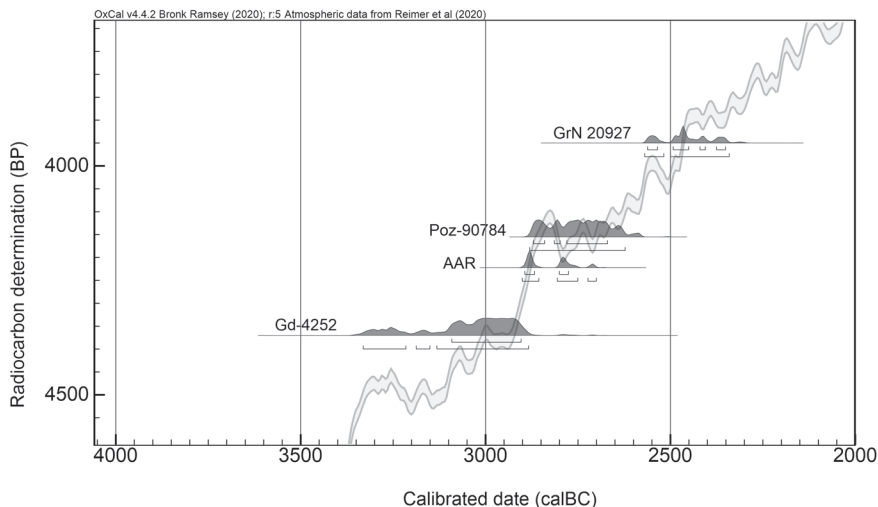


Fig. 15. Sandomierz-*Kruków*, site 78, Sandomierz district. The calibration of all radiocarbon dates obtained from grave VIII

So young radiocarbon dates were obtained for only a few GAC assemblages from the entire range of their occurrence such as the ritual features from Opatowice, site 1 in Kujawy [Koško, Makowiecki, Szmyt 2007: 272], a pit from site 25/5 in Linowo, features from the Katelbogen and Poggenborfer-Forst, Germany [Szmyt 1996, Table 18], and a settlement pit of the GAC eastern group from the site in Peresopnitsa [Kadrow, Szmyt 1996, Table 1]. The only features from south-eastern Poland dated to so late a chronology have so far been a GAC grave from Site 6 in Czulczyce-Kolonia [Bronicki 2019, Table 1; 2021], Grave 523 from Koszyce [Włodarczak, Przybyła 2013, Table 5], Grave 4 from Sadowie [Pasterkiewicz 2020: 68].

In two cases, however, we are faced with a difference between dates analogous to that described above. For the Czulczyce grave, altogether four age determinations have been obtained of which two lean towards the first half of the 3rd millennium BC: 4035 ± 90 BP (Kiev-7831) and 4020 ± 90 BP (Kiev-7830), while the other two reach its second half: 3995 ± 35 BP (Poz-61739) and 3940 ± 85 BP (Kiev-7829). It must be observed, however, that the wide calibration ranges of all the dates largely overlap in the interval of 2623–2411 BC. Grave 523 in Koszyce yielded an impressive number of 22 absolute age determinations [Schroeder *et al.* 2019, Appendix, Dataset S1], for the most part staying in the calibrated range of 2900–2550 BC. Yet, two of the determinations significantly precede this range: 4330 ± 34 BP (AAR-26317) and 4379 ± 32 BP (AAR-28710), while another two provided by another laboratory are significantly younger than this range: 3960 ± 44 (Ua-45618) and 3985 ± 38 (Ua-45619). These examples illustrate well the limitations of the radiocarbon method itself and make us realise the need to accumulate a pool of radiocarbon dates as large as possible for the purpose of cross-checking.

Two human bones from the Gajowizna site have yielded results inconsistent with the classification of features, made using traditional taxonomic analyses. In the case of sample Poz-90799 from Grave 1 (Table 2) what attracts attention is a high (14%) amount of collagen with which a late radiocarbon date correlates ($1180 \pm \text{BP}$ or 53–236 AD). Although in the case of the other feature (Grave 9), the absolute age determination does not differ so much from the expected one ($3510 \pm 40 \text{ BP}$, i.e. 1941–1700 BC), this result can hardly be deemed correct, keeping in mind that the cultural attribution of the feature to the culture in question raises no doubt. Adopting so long a lifespan of the GAC on the Sandomierz Upland would contradict our knowledge on this cultural unit as a whole, for the youngest dates attributed to it derive from the features of the eastern group and do not cross the dividing line of 2300 BC [Kadrow, Szmyt 1996]. Therefore, it appears that – contrary to initial assumptions – the bones used for dating could not come from GAC features. They must have been mixed with other osteological material in the long, reaching almost 100 years, period of storage.

GAC ABSOLUTE CHRONOLOGY ON THE SANDOMIERZ UPLAND

The other 23 age determinations of samples from GAC cemeteries on the Sandomierz Upland (Fig. 16; Table 2) are consistent with the knowledge on the chronology of the GAC Małopolska group gathered by using the traditional typological method and referring to dates for neighbouring regions [Szmyt 1996, Table 18; Włodarczak, Przybyła 2013, Table 5; Włodarczak 2016, Table 1-2; Bronicki 2016; 2019, Table 1]. As mentioned earlier, one of the advantages of the series of dates under discussion is the fact that almost all the determinations were made for the same material and by one laboratory, using uniform procedures and equipment. This has greatly improved the credibility of any comparative studies and is reflected in the cohesion of the determinations. Except for the determinations for charcoal from Grave 28 in Gajowizna, all the credible determinations fit into the range from $4225 \pm 25 \text{ BP}$ to $4040 \pm 35 \text{ BP}$, with the highest concentration occurring in the neighbourhood of 4200 ± 40 – $4100 \pm 35 \text{ BP}$ (18 determinations), or in calibrated years 2901–2577 BC (1sigma) or 2901–2498 BC (2 sigma). It must be noted that the highest calibration probability, amounting in the case of all the dates to almost 90%, is cumulated in the range of 2870–2600 BC (2 sigma; Fig. 17).

These dates, therefore, set the time bracket of GAC settlement on the Sandomierz Upland. Its span, made more credible by a series of 19 radiocarbon determinations for GAC settlement features – that also for the most part fit into the range of 2900–2600 BC [Florek, Witkowska 2021] – is surprisingly short. This

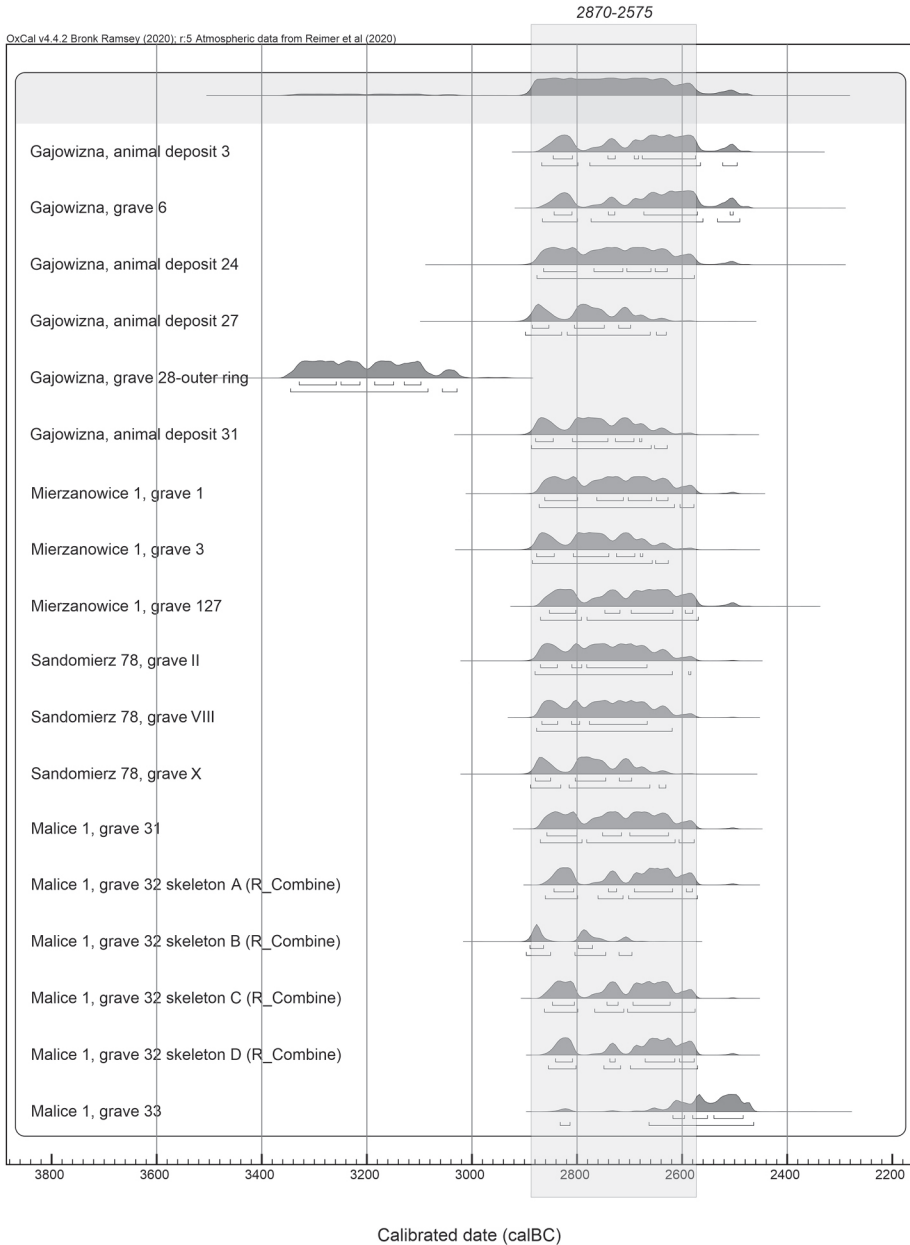


Fig. 16. The calibration of radiocarbon dates of Globular Amphora culture graves from Sandomierz Upland

fact, in turn, makes it necessary to revise the assumptions on the settlement by the Sandomierz-Opatów subgroup that have been made until now.

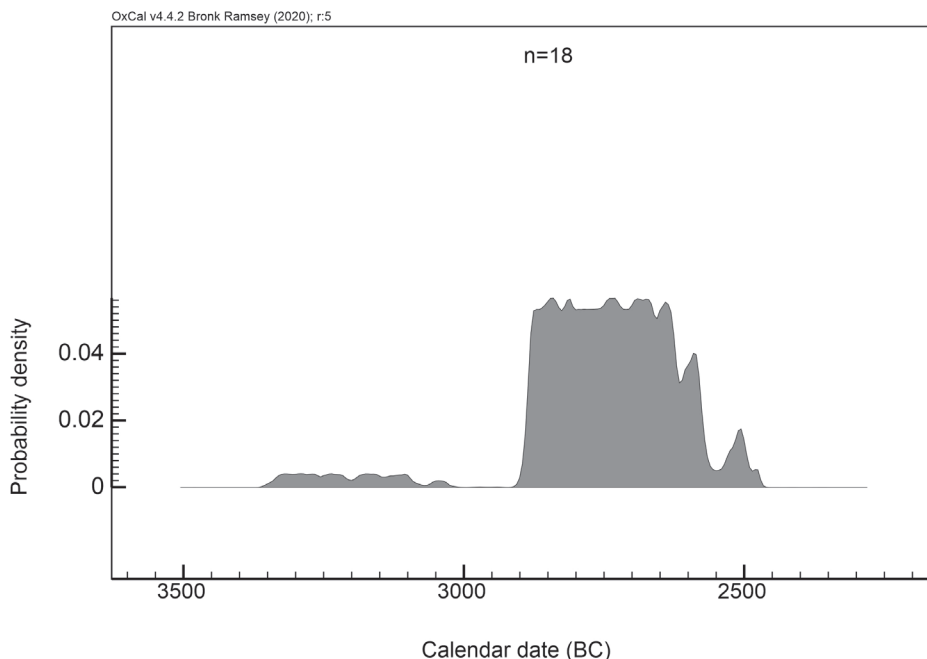


Fig. 17. The graph showing the expressive concentration of the probability 90% in the range 2870-2575 BC for calibration most dates of Globular Amphora culture graves form Sandomierz Upland

DEVELOPMENT SCHEME OF THE GAC SANDOMIERZ-OPATÓW SUBGROUP

The start of GAC expansion onto the Sandomierz Upland has been believed until now to have taken place at the turn of Phases IIb/IIIa, according to the overall chronological scheme of the Kujawy centre of the Polish group [Szmyt 1999, Fig. 25] or roughly in 3000/2900 BC [Włodarczak 2006: 29]. This opinion must have resulted from the interpretation of the first absolute age determination of a Sandomierz-Opatów subgroup funerary assemblage that has been published so far, namely, the date of 4370 ± 70 BP obtained for charcoal from Sandomierz-*Kruków* (3092–2905 BC, 1 sigma). As was shown above, the date has been disproved by two independent laboratories. In the entire pool of newly obtained ^{14}C determinations, only the date from Feature 28 on the Gajowizna site,

made also from charcoal, is equally early. Meanwhile, all the other determinations point to a later date of the beginning of GAC settlement in the area in question. This must have started in the well-advanced Phase IIIa according to the Kujawy periodization.

Nor does the stylistic analysis of GAC pottery found on the Sandomierz Upland supply any credible sources of an early date. The only artefacts suggesting an early origin are stray finds from Chwałki [Gurba 1956, Fig. 1], Grzegorzewice (unpublished collections of the National Museum in Kielce), the Góry Pieprzowe [Antoniewicz 1936: 379], the vicinity of St. Joseph's Church in Sandomierz (unpublished collections of the Regional Museum in Sandomierz) and Wąworków [Antoniewicz 1936: 235, Fig. 33]. These artefacts have no cord ornament and are decorated only with circular stamps or appliqué bosses. Although the style set of the named grave assemblages is quite expressive, there is no certainty, due to the circumstances of their procurement, that they are complete. Since no organic material has been preserved by accidental finders, the assemblages cannot be radiocarbon dated. Nor has it been possible to determine the absolute age of the cordless grave assemblages from Gajowizna because – as mentioned above – the osteological material included in them has been lost. Admittedly, no cord ornament has been recorded in the ceramic inventories of some settlement pits from Site 1 in Mierzanowice, but radiocarbon dates obtained for them do not bear out their early provenance [Florek, Witkowska forthcoming]. Thus, the possibility that the GAC appeared in the area under discussion at the very turn of the 3rd and 4th millennia BC, as suggested in reliance on traditional typology, is poorly evidenced now in terms of chronometry.

GAC grave inventories from the Sandomierz Upland are rather homogeneous and characterised by the co-occurrence of cord-ornamented vessels next to unornamented ones as for instance in Feature 24 from Gajowizna (Fig. 3) or Grave VIII from Sandomierz (Fig. 7) or ornamented ones using different techniques as for instance in Feature 32 from Malice (Fig. 10) and a grave from Rzeczyca Mokra [Ścibior 1993a]. A relatively high incidence of cord ornament in inventories from the area under discussion is considered the marker of a GAC younger development phase in the relevant literature [Wiślański 1966: 76; Szmyt 1996: 35]. By reason of the stylistic homogeneity, it must be assumed that most burials of the GAC Sandomierz-Opatów subgroup are chronologically close to radiocarbon-dated assemblages, i.e. they date back to 2900–2500 BC.

But only few grave features argue for the survival well into the 3rd millennium BC of the GAC settlement on the Sandomierz Upland. A late chronological position of some materials may be suggested by so-called suspended hatched triangles [nos. 12, 14–15 according to the ornament typology developed by Balcer 1963: 139] on an amphora from Broniszewice [Bąbel 1975, Fig. 2] and in the grave inventory from Site 1 in Chwałki [Nosek 1967, Fig. 128]. Possibly, of a similarly late date are also other sharp-angled motifs made with cord impressions [no. 11

acc. to Balcer 1963: 139] such as zigzags on bowls discovered in settlement Pits 170 and 173, Site 1, Mierzanowice [Florek, Witkowska 2021], Pits 2 and 5, Site 4, Mierzanowice [Gardawski, Miśkiewicz 1958, Fig. 8, Table 50] or Feature 26, ‘Nad Wawrem’ site, Złota (unpublished materials of the State Archaeological Museum in Warsaw). Sharp-angled vessel ornamentation motifs are one of the markers of the youngest development phase of the GAC East-Lublin subgroup according to the regional periodization [Bronicki 2019: 226, Table 2]. It must be noted that on the Lublin Upland analogous ornamentation is made above all with incisions and stamp impressions. However, their late chronology is not borne out beyond doubt by radiocarbon dates (*see* above comments on the grave in Czulczyce-Kolonia) [for a different opinion *see* Bronicki 2019: 219; 2021]. Sharp-angled motifs made with a cord are found in the Sandomierz-Kraków group of the Corded Ware culture, where they are considered an influence from the post-Baden environment [Włodarczak 2008: 258].

THE SANDOMIERZ UPLAND, FIRST HALF OF THE 3RD MILLENNIUM BC: CULTURAL CONTEXT

The time bracket defined by the described series of radiocarbon dates for GAC features from the Sandomierz Upland begs important questions about GAC relationships with other Late and Final Neolithic groups that lived there in the first half of the 3rd millennium BC.

One of the vital aspects of the study of the Samborzec-Opatów subgroup is its relation to the ZC. We now know of 15 radiocarbon dates, determining the absolute chronology of the ZC [Włodarczak 2019, Table 4]. The only absolute age determination of the ZC going beyond the range of 2900–2500 BC is the date 4390 ± 100 BP obtained from charcoal for a grave exposed on *Salve Regina Mount* in Sandomierz [Ścibior 1993b; Kruk, Milisauskas 1999: 212–213]. The other dates, obtained from human bones collected from graves, completely fit into the range determined by GAC chronometry (Fig. 18), which proves that these units – the ZC and GAC – were contemporaneous. Meanwhile, at the outset of the project, it was assumed that the lifespan of the GAC Sandomierz-Opatów subgroup at least in part preceded the ZC. However, none of the 42 absolute age determinations for the GAC on the Sandomierz Upland bore out this assumption. Consequently, there is no hard evidence for its acceptance now.

This sheds new light on the possibility of constructing sequential models of cultural transformations in the Late and Final Neolithic in the area under study. Two possible hypotheses therefore should be considered. The first argues for the succession of the two groups, which has been already suggested in the relevant

literature [e.g. Ścibior 1991]. The process of replacing the GAC with the ZC would not involve, however, the fade-out of all GAC traits, which are after all clearly visible in Złota assemblages, especially at its early development stage [Witkowska 2014]. Instead, the process would involve only the change of the funerary rite and the assimilation of certain exogenous elements into material culture. The above process would be reflected in the change from the chamber (cist) grave to the niche structure (*see* hypotheses about the structure of Grave 32 in Malice) [Witkowska *et al.* 2021] and the appearance of patterns originating from different cultural milieus in grave inventories. This scenario appears rather implausible now because it would call for assuming a very high, even unprecedented, dynamic of cultural transformation on the Sandomierz Upland in the Late Neolithic.

The second hypothesis, consistent with the suggested dating of the GAC Samborzec-Opatów subgroup, assumes that only a portion of the GAC population separated from the mother unit under the influence of external stimuli and subsequently formed the genetic substratum from which the ZC arose. What differentiated the GAC Samborzec-Opatów subgroup and the newly forming ZC would be thus the response to stimuli from the GAC eastern group, Baden milieu and early Corded Ware culture. This scenario, however, does not answer the question why new cultural patterns were assimilated only by a portion of the population and what rules governed the coexistence of two human groups following different cultural scenarios in so small an area.

With respect to the Corded Ware culture, there are only eight radiocarbon age determinations available obtained from bones collected from graves located on four sites on the Sandomierz Upland [Włodarczak 2019, Table 3, Fig. 3]. They all refer to the second half of the 3rd millennium BC and are linked to the Kraków-Sandomierz group. Therefore, in the light of the chronometric data, it seems reasonable to assume that the two groups (the GAC and Corded Ware culture) succeeded one another in time (Fig. 19). However, the presence of elements derived from GAC traditions in the Kraków-Sandomierz group [Włodarczak 2006: 129] somewhat complicates this picture. A separate question is the chronological and taxonomic position of the elements of the so-called old-Corded horizon found on the Sandomierz Upland in the contexts of ZC graves and GAC settlement pits. This question shall be discussed in greater detail in a separate work [Witkowska, Włodarczak 2021].

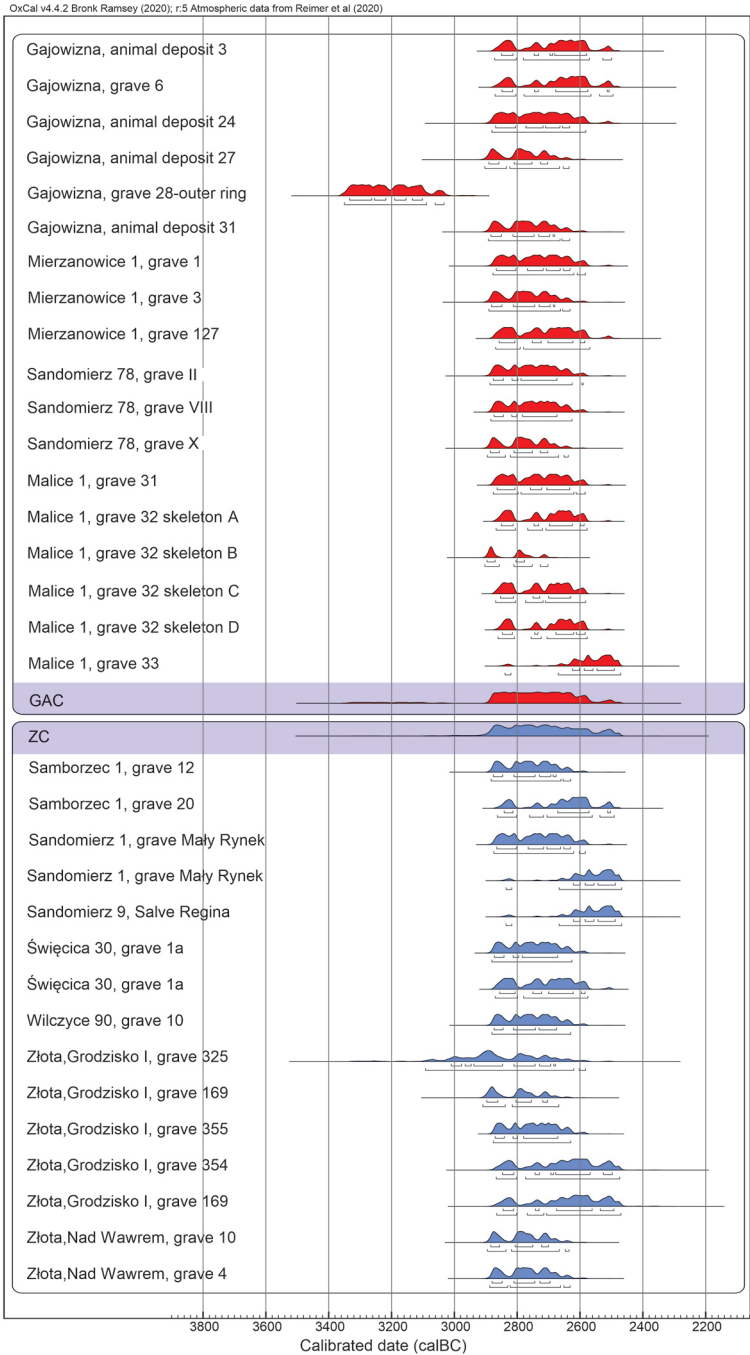


Fig. 18. Comparison of radiocarbon dates from the graves of the Globular Amphora culture (red) from Sandomierz Upland obtained in the project and absolute age determinations of Złota culture graves (blue). Złota culture dates after Włodarczak 2019

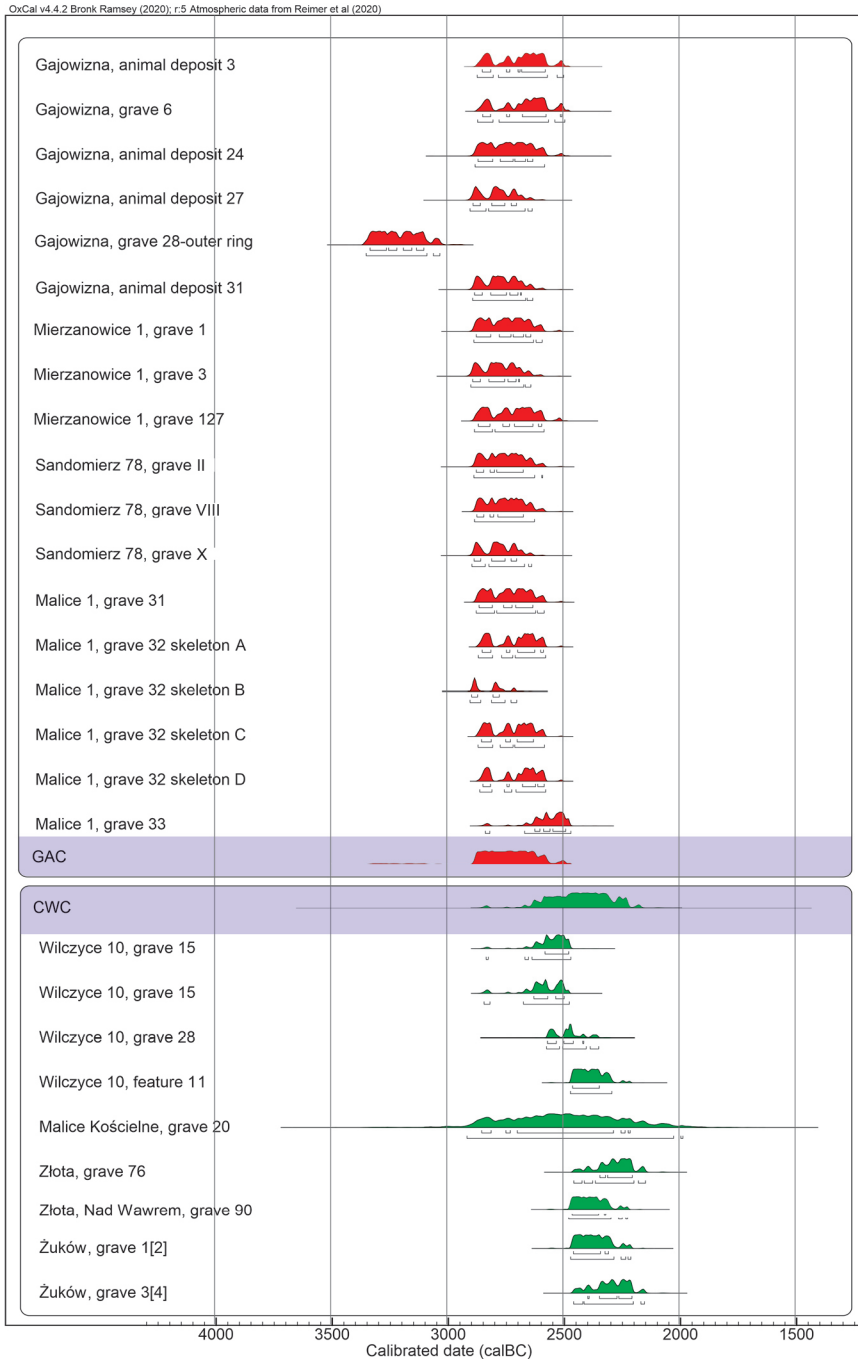


Fig. 19. Comparison of radiocarbon dates from the graves of the Globular Amphora culture (red) and absolute age determinations of Corded Ware graves (green), both list from Sandomierz Upland obtained in the project. Datings of the Corded Ware culture after Włodarczak 2019

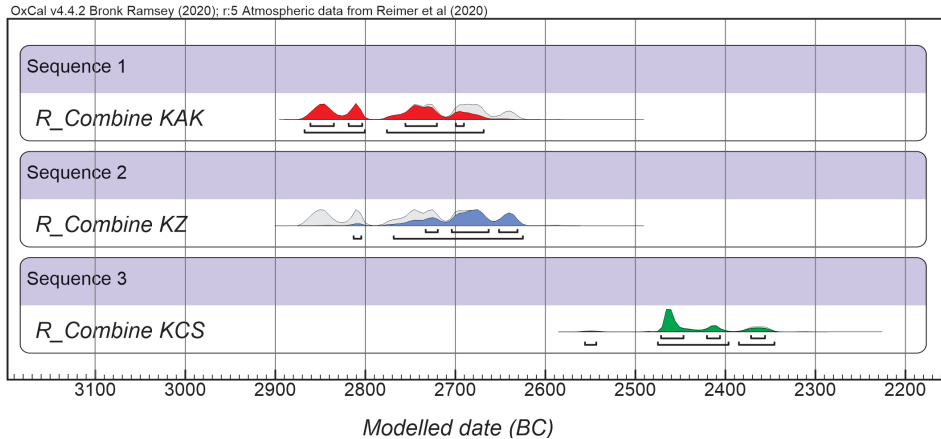


Fig. 20. The development diagram created on the basis of the summary calibration of the all radiocarbon dates of three cultural units existing in the Sandomierz Upland in the 3rd millennium BC

CONCLUSIONS

Obtained as a result of NSC project no. 2014/12/S/HS3/00 355, the series of GAC radiocarbon age determinations from the Sandomierz Upland is now the most numerous among ones referring to the south-eastern group and one of the most numerous in the entire area where this unit is found [Szmyt 1999; Włodarczak 2016; Bronicki 2019]. The new dates helped make the chronological brackets of the GAC in Małopolska more accurate. However, a full reconstruction of transformations unfolding in the first half of the 3rd millennium BC on the Sandomierz Upland is not possible now due to a limited number of absolute age determinations, concerning the other Late and Final Neolithic groups. All what can be done now is to suggest a preliminary development scheme (Fig. 20) that would call for verification with richer chronometric data.

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