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Radiocarbon dates from Kadero revised

Introduction

The first radiocarbon dates from Kadero were published by Randi Haaland in her Ph.D. dissertation in 1981 (Haaland 1981: 55). A year later Lech Krzyżaniak has published them again together with another four analyses (Krzyżaniak 1982). Three of them were coming from Northern and Southern middens and the differences between them according to L. Krzyżaniak were also visible in pottery and flint materials (Krzyżaniak 1982: 38; 1984: 310-311).

In 1987 the radiocarbon dates previously published by R. Haaland were corrected for the isotopic fractionation (S 13-C) (Haaland 1987:61) and in the archaeological literature double dates of the same samples (uncorrected and corrected) began to circulate unless Krzyżaniak is always in favour of uncorrected samples (Krzyżaniak 1992: 116). In that last publication he gives another date – for the first time from the grave (No. 60), with very large standard deviation.

Lech Krzyżaniak has in his disposal a series of another dates but never has published them. However basing on that unpublished 14C analyses he has published a general chronological frames of the Kadero site: between 5960 and 5030 14C years B.P. or ca. 4850-4250 cal B.C. Details of radiocarbon analyses from Kadero were supposed to be publish by Peter Breunig (Krzyżaniak 1991:516) in the planned Kadero I volume but finally was performed by J. Kabaciński in the volume on Kadero site that was published already after the death of Lech Krzyżaniak (Kabaciński 2010).

In 2008 Lange has published a list of 22 radiocarbon dates from Kadero site. Part of them (6 analyses) were signed as coming from Kadero 1 while the others from Kadero (Lange 2006: 319). Both, dated samples from graves and from settlement area were included in the list however without any separation or detailed label and to that publication, but not always to a whole the set of dates shown there, a number of researchers of the Sudanese Neolithic refer (Salvatori Usai 2008: 146, 151-152; Sadiq 2010:34; 2012: 146-147).

In the monograph of Kadero site the analyses made in Gliwice Radiocarbon Laboratory were omitted, instead a set of new 4 dates from Kadero cemetery were respected (Kabaciński 2010:418). Altogether in the archaeological literature 26 radiocarbon dates from the Neolithic site of Kadero are published and another one from a Meroitic grave.

In order to clarify above inconsistency we decided to revise all available information on the radiocarbon dating of Kadero site.

1. Context of the radiocarbon dates

Source analysis allow us to establish that 23 samples from the Kadero site were subjected to 14C analysis. In a few cases double analyses were performed on the same sample, either by analysis of its second part or the results of the already analysed material were modified. Most of the dates are related with the Early Neolithic, only very few with the Late Neolithic and the Post-Meroitic Period. Details of radiocarbon analyses including its calibration are shown in Table 1.

Nine dates are made on materials from 8 Neolithic graves, 11 from the northern midden and 3 from the southern midden and 1 from the Post-Meroitic grave (Fig. 1).

2. The graves

Nine dates were made on samples taken from the graves. Results of dating as well as detailed context are presented below.

Grave No. 60

Grave of male 35-45 years old on the depth 25-75 cm below the surface. This is a very rich grave and deceased was buried with a mace-head (Fig. 2). Inside the grave were found also seven pottery vessels: three small red polished bowls decorated with semicircural panels of impressed dots, three big deep black-topped bowls, big red polished bowl (Fig. 2), two bracelets of hippopotamus ivory, hippopotamus tusk, diadem composed of 5 strings of the beads made of perforated Red See shells of Engina mendicaria, necklace of carnelian beads, rhyolite axe, flint and quartz nodules, cores backed blade and segments (Krzyżaniak 2011: 96-137).

Table 1. List of radiocarbon dates from Kadero site. Calibration of dates made with the help of OxCal Program version 4.2 and IntCal13 calibration curve (Bronk Ramsey 2009)

Lab. No.	14C b.p.	Dated context	Dated material	cal BC									references
				68.2%		95.4%		99,70%		μ	σ	m	
				from	to	from	to	from	to				
Poz-4014	5565±35	Grave 220	Aspatharia sp. shell	-4447	-4361	-4458	-4346	-4502	-4331	-4404	33	-4403	Kabaciński 2011
Gd-6167	5510±100	Grave 114	Nilotic bivalves	-4459	-4258	-4551	-4055	-4691	-3993	-4352	115	-4359	Sadig 2012 after Lange 2006; Salvatori, Usai 2008
Poz-4012	5550±70	Grave 202	Aspatharia sp. shell	-4454	-4342	-4539	-4262	-4682	-4169	-4402	65	-4401	Kabaciński 2011
Poz-4165	5415±40	Grave 202	Aspatharia sp. shell	-4331	-4255	-4350	-4079	-4361	-4053	-4274	54	-4283	Kabaciński 2011
Poz-4057	5380 ± 40	Grave 203	charcoal	-4331	-4076	-4341	-4050	-4444	-3979	-4208	88	-4222	Kabaciński 2011
Gd-6162	5260 ± 120	Grave 101	Nilotic bivalves	-4237	-3969	-4341	-3800	-4455	-3696	-4095	139	-4100	Sadig 2012 after Lange 2006; Salvatori, Usai 2008
Poz-4308	4150 ± 30	Grave 243	charcoal	-2867	-2671	-2876	-2628	-2882	-2581	-2749	72	-2745	Kabaciński 2011
Poz-4164	1660 ± 30	Grave 132	charcoal	348	418	260	529	254	536	384	43	388	Kabaciński 2011
Kn-3334	5800±700	N midden	?	-5471	-3981	-6235	-3105	-7349	-2456	-4721	766	-4713	Sadig 2012 afterLange et. all 2006
Kn-2821	5500 ± 70	N midden	Nilotic bivalves	-4448	-4266	-4496	-4176	-4546	-4053	-4350	76	-4353	Krzyżaniak 1982; Salvatori Usai 2008; Kabaciński 2011; Sadig 2012 after Lange 2006

Lab. No.	14C b.p.	Dated context	Dated material	cal BC						μ	σ	m	references
				68.2%		95.4%		99,70%					
				from	to	from	to	from	to				
Kn-2822	5610 ± 55	N midden	Nilotic bivalves	-4487	-4369	-4545	-4346	-4681	-4329	-4441	57	-4438	Krzyżaniak 1982; Salvatori Usai 2008; Kabaciński 2011; Sadig 2012 after Lange 2006
Kn-2823	5380 ± 65	N midden	Nilotic bivalves	-4331	-4076	-4341	-4050	-4444	-3979	-4208	88	-4222	Krzyżaniak 1982; Salvatori Usai 2008; Kabaciński 2011; Sadig 2012 after Lange 2006
Gd-5653	5450 ± 70	N midden	Nile oyster	-4366	-4182	-4451	-4066	-4497	-4040	-4285	87	-4293	Salvatori Usai 2008; Sadig 2012 after Lange 2006
Gd-5651	5370 ± 60	N midden	Fresh water shell	-4327	-4075	-4335	-4051	-4361	-3985	-4200	86	-4204	Sadig 2012 after Lange 2006
Gd-6164	5510 ± 120	N midden	?	-4493	-4237	-4611	-4046	-4729	-3966	-4349	140	-4357	Salvatori Usai 2008; Sadig 2012 after Lange 2006
Gd-5649	5430 ± 60	N midden	Fresh water shell	-4346	-4236	-4438	-4056	-4452	-4046	-4266	77	-4281	Lange 2006
Gd-5652	5420 ± 70	N midden	Fresh water shell	-4351	-4084	-4439	-4049	-4460	-3992	-4248	90	-4267	Salvatori Usai 2008; Sadig 2012 after Lange 2006
Gd-5648	5720 ± 50	N midden	Fresh water shell	-4652	-4494	-4690	-4458	-4726	-4368	-4571	65	-4567	Salvatori Usai 2008; Sadig 2012 after Lange 2006
Gd-6161	5690 ± 80	N midden	?	-4669	-4451	-4706	-4365	-4799	-4332	-4541	92	-4536	Salvatori Usai 2008; Sadig 2012 after Lange 2006
Gd-5650	5480 ± 60	N midden	Terrestial shell	-4437	-4260	-4458	-4178	-4499	-4053	-4329	68	-4333	Sadig 2012 after Lange 2006
Gd-5647	5960 ± 70	N midden	Fresh water shell	-4937	-4770	-5024	-4691	-5207	-4582	-4851	88	-4848	Salvatori Usai 2008; Sadig 2012 after Lange 2006

Lab. No.	14C b.p.	Dated context	Dated material	cal BC									references
				68.2%		95.4%		99,70%		μ	σ	m	
				from	to	from	to	from	to				
Gd-6198	5380 ± 65	N midden	bone	-4338	-4072	-4442	-3992	-4487	-3961	-4211	105	-4222	Salvatori Usai 2008; Sadig 2012 after Lange 2006
SMU-482	5280 ± 90	S midden	Nilotic bivalves	-4232	-3995	-4331	-3956	-4366	-3789	-4122	106	-4122	Krzyżaniak 1982; Salvatori Usai 2008; Kabaciński 2011; Sadig 2012 after Lange 2006
T-2189	5030 ± 70	S midden	Nilotic bivalves	-3943	-3716	-3965	-3665	-4040	-3640	-3830	82	-3832	Krzyżaniak 1982; Salvatori Usai 2008; Kabaciński 2011; Sadig 2012 after Lange 2006
T-2189-corr	5460 ± 70	S midden	Nilotic bivalves	-4369	-4236	-4456	-4071	-4518	-4041	-4298	86	-4304	Haaland 1987; Kabaciński 2011; Sadig 2012 after Lange 2006
T-2188	5260 ± 90	S midden	Nilotic bivalves	-4229	-3983	-4331	-3821	-4356	-3778	-4103	110	-4104	Krzyżaniak 1982; Salvatori Usai 2008; Kabaciński 2011; Sadig 2012 after Lange 2006
T-2188-corr	5700 ± 100	S midden	Nilotic bivalves	-4684	-4454	-4770	-4350	-4908	-4262	-4556	109	-4551	Haaland 1987; Kabaciński 2011; Sadig 2012 after Lange 2006

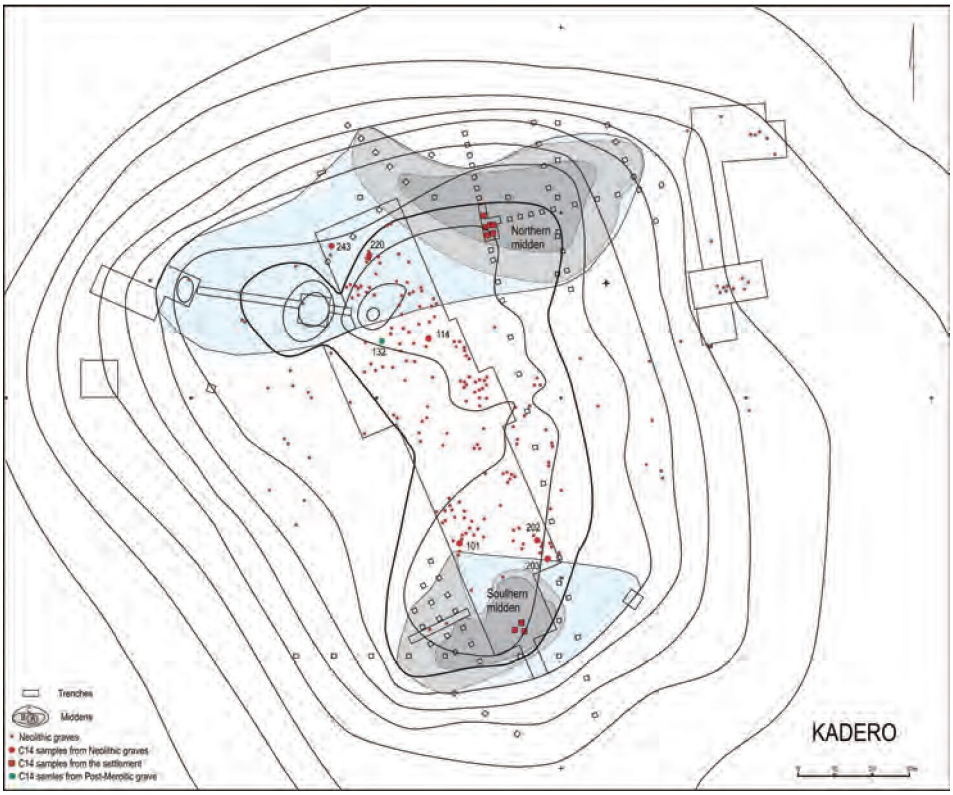

Fig. 1. Map of Kadero site with location of samples submitted to radiocarbon analysis

Charcoal sample (KN3334 and KN3335) was collected for radiocarbon analysis from the grave pit (Krzyżaniak 1983: 25; 1992: Tab.3). It gives the date: 5800 ± 700 b.p. Calibration of that date (Fig. 3) points the age of the sample with a wide range 6235-3105 years cal BC (with probability 95,3%) and median 4713 years cal BC.

Grave No. 114.

GGrave of a male 20-30 years old found on the depth 45-80 cm below the surface. This is one of the richest burials in Kadero (Fig. 4). The grave was furnished in six pottery vessels: two big restricted black-topped bowls, deep restricted bowl decorated with groups of incised parallel lines, big bowl decorated with groups of incised parallel lines; two caliciform beakers decorated with incised bands filled with comb impressions (Fig. 4); quartz, chert, agate segments and crescents, some

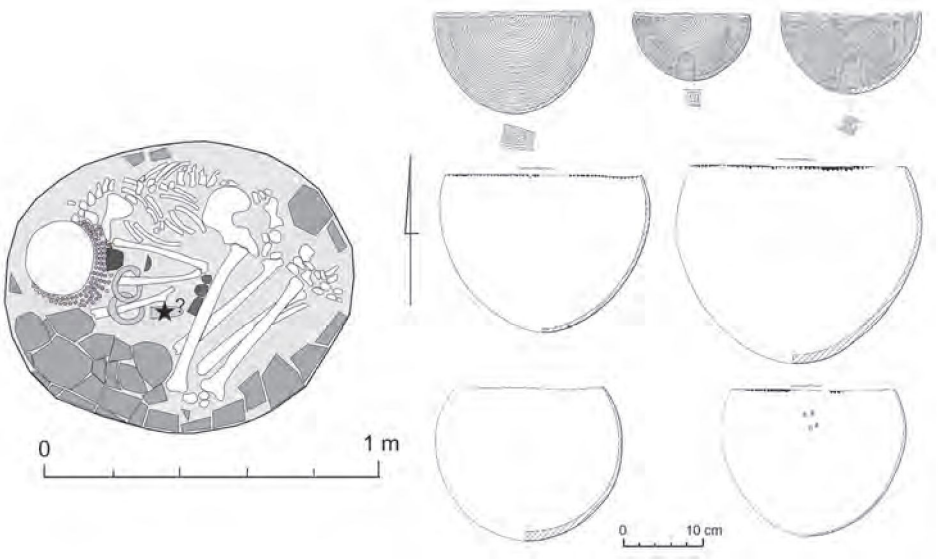

Fig. 2. Kadero site. Grave No. 60 and pottery from the grave

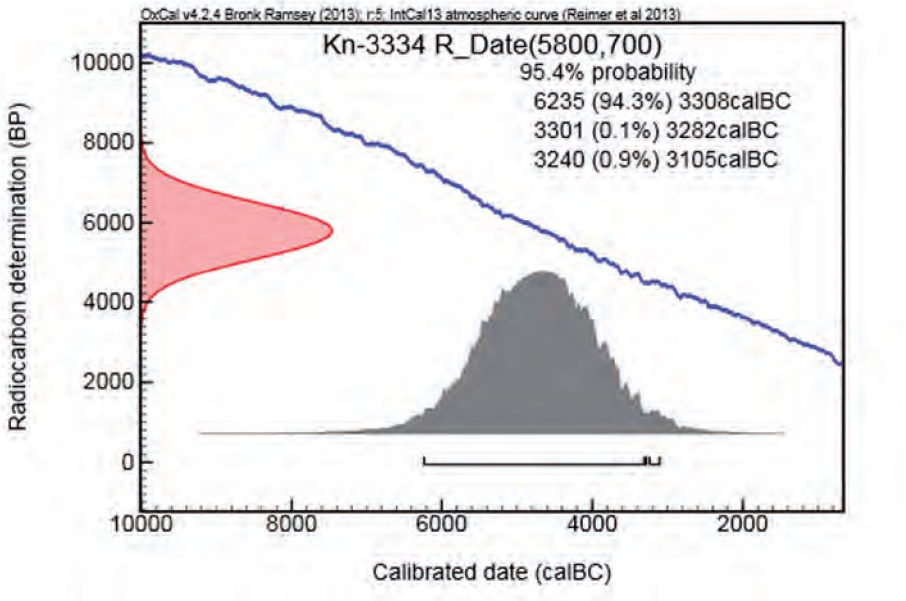

Fig. 3. Kadero site. Results of calibration of sample KN 3334/KN 3335 from grave No. 60

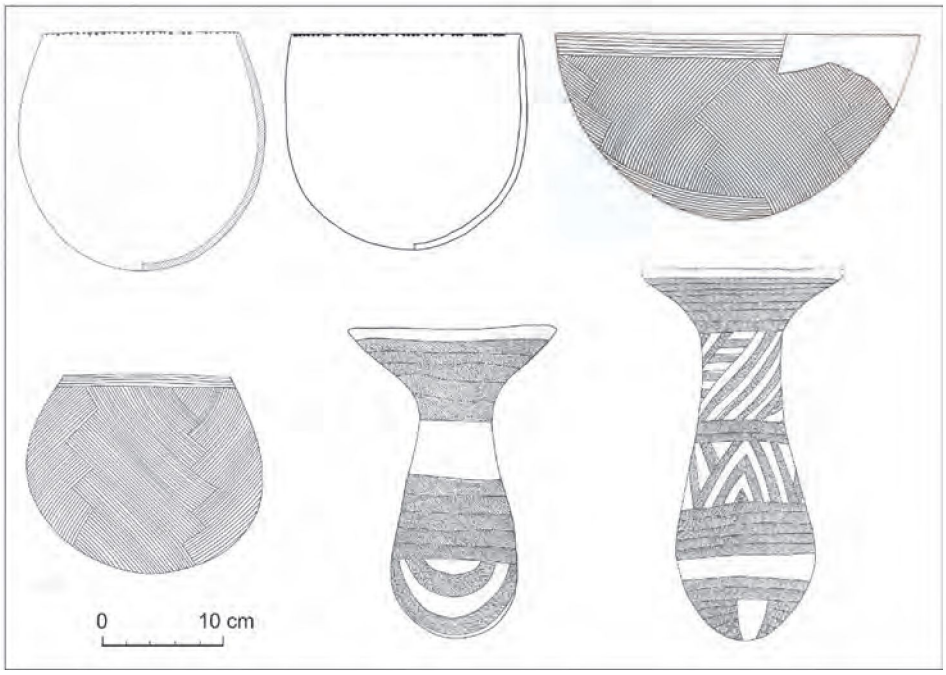

Fig. 4. Kadero site. Grave No. 114 and pottery from the grave

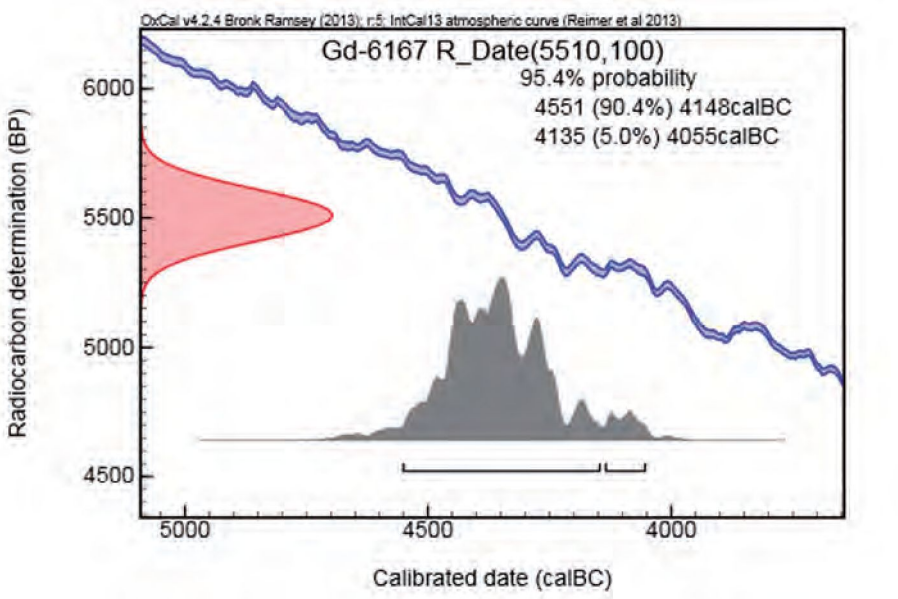

Fig. 5. Kadero site. Results of calibration of sample Gd-6167 from grave No. 114

with remains of mastic, quartz flakes; sandstone palette, lumps of green malachite and red ochre, marine shell and shell of Nile bivalve (Krzyżaniak 2011: 130-131).

The radiocarbon dating was made on the Nile bivalve shell – sample No. Gd-6167 – with the result 5510 ± 100 b.p. After the calibration (Fig. 5) the age of the sample is placed between 4551 and 4055 years cal BC (with probability 95,4%) and median 4359 years cal BC.

Grave No. 220

Grave of a child (Infans I) found on the depth 80-120 cm below the surface (Fig. 6). The grave was furnished with a medium size, deep bowl decorated with impressed decoration (Fig. 6:1), forty carnelian beads, three zeolite labrets and a shell of a Nile bivalve (Krzyżaniak 2011:181-182).

Shell of *Aspatharia* sp. submitted for dating (Poz-4014) produced the radiocarbon date 5565 ± 35 b.p. Calibrated age of that date is between 4458 and 4346 years cal BC (probability 95,4%) and median 4403 years cal BC (Fig. 7).

Grave No. 202

Grave of a child (Infans I) on the depth 25-55 cm below the surface (Fig. 8,). The grave was furnished with two medium size, deep bowls of combed ware (Fig.

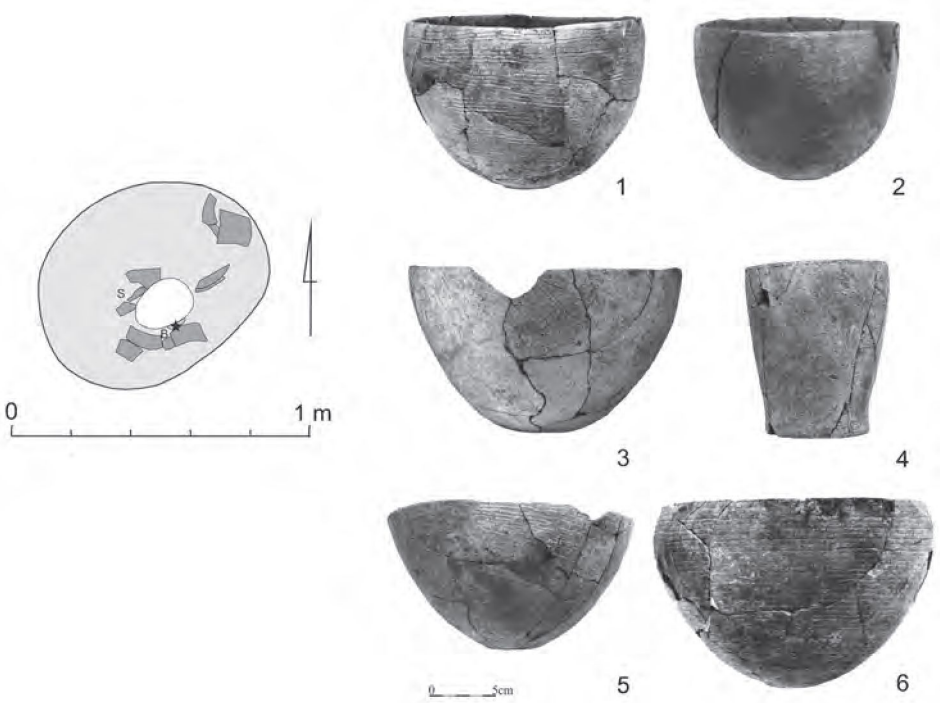

Fig. 6. Kadero site. Grave No. 220 (left) and pottery from: 1 – grave 220; 2-3 – grave 202; 4-6 – grave 203

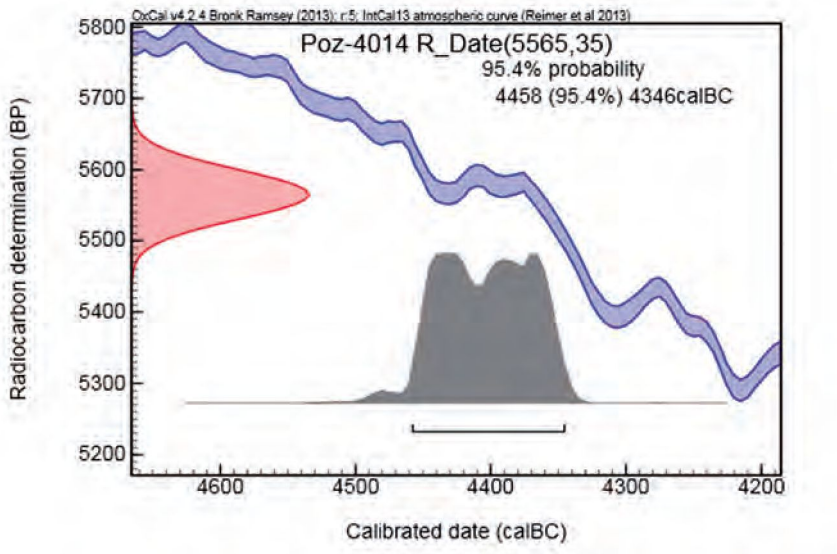

Fig. 7. Kadero site. Results of calibration of sample Poz-4014 from grave No. 220

6.2-3), sandstone palette, twelve carnelian beads, seven beads of Red sea shells and two shells of different size of the Nile bivalve (Krzyżaniak 2011: 171-172). The radiocarbon dating was made on both bivalve shells (Poz-4012 and Poz-4165) and the results are as follows: 5550 ± 35 b.p. and 5415 ± 40 b.p. respectively. Calibrated age (with probability 95,4%) of the first sample is placed between 4539 and 4262 years cal BC and median 4401 years cal BC while the second between 4350 and 4079 years cal BC and median 4283 years cal BC (Fig. 9-10).

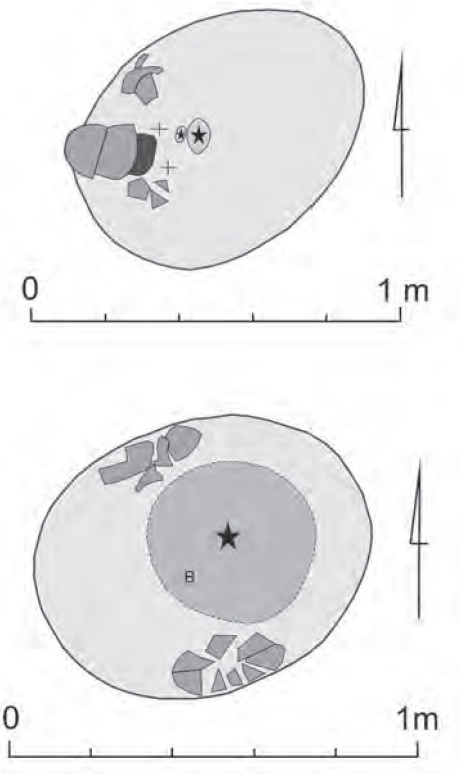

Fig. 8. Kadero site. Grave No. 202 (upper) and grave No. 203 (lower)

Grave No. 203

Grave of a child (Infans I) on the depth 45-82 cm below the surface (Fig. 8). The grave was furnished in three pottery vessels: deep cup with flat base decorated with incised triangles, medium size open bowl with combed surfaces, medium size bowl decorated with incised horizontal lines (Fig. 6.4-6); fourteen carnelian beads, single amazonite bead (Krzyżaniak 2011: 173). On the bottom of the grave red discoloration (ochre) with a small pieces of the charcoal was recorded. That charcoal was submitted for radiocarbon dating (Poz-4057) and the result was 5380 ± 40 b.p. The age of the sample after calibration (with probability 95,4%) is placed between 4341 and 4050 years cal BC and median 4222 years cal BC (Fig. 11).

Grave No. 101

Grave of a child (4 years old) on depth 40-55 cm below the surface (Fig.12). The grave was furnished with three pottery vessels: medium size deep bowl decorated with incised semicircular panels, medium size deep bowl of combed ware, fragment of a medium size deep bowl partly decorated with semicircular incised panels (Fig.12); sandstone palette; shell of Nile bivalve (Krzyżaniak 2011: 121-122). The

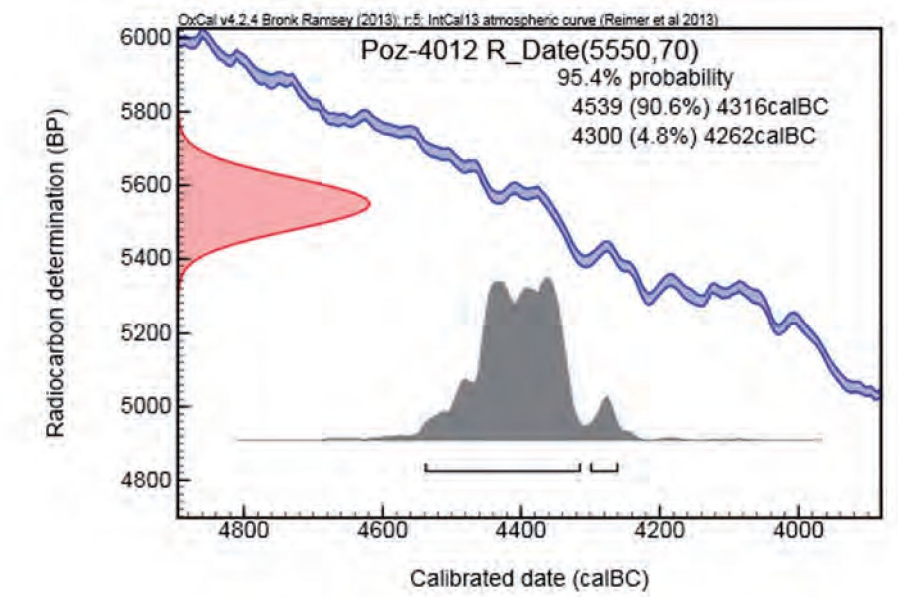

Fig. 9. Kadero site. Results of calibration of sample Poz-4012 from grave No. 202

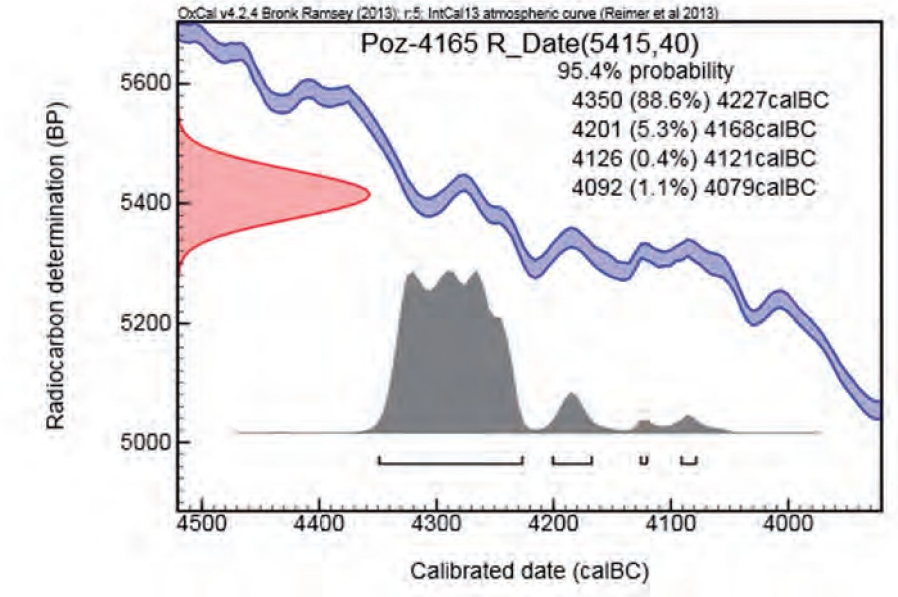

Fig. 10. Kadero site. Results of calibration of sample Poz-4165 from grave No. 202

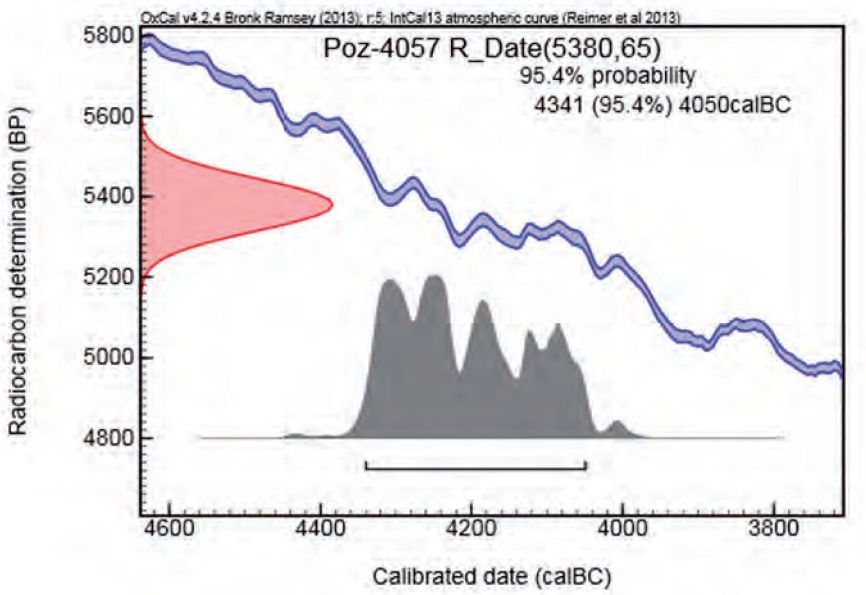

Fig. 11. Kadero site. Results of calibration of sample Poz-4057 from grave No. 203

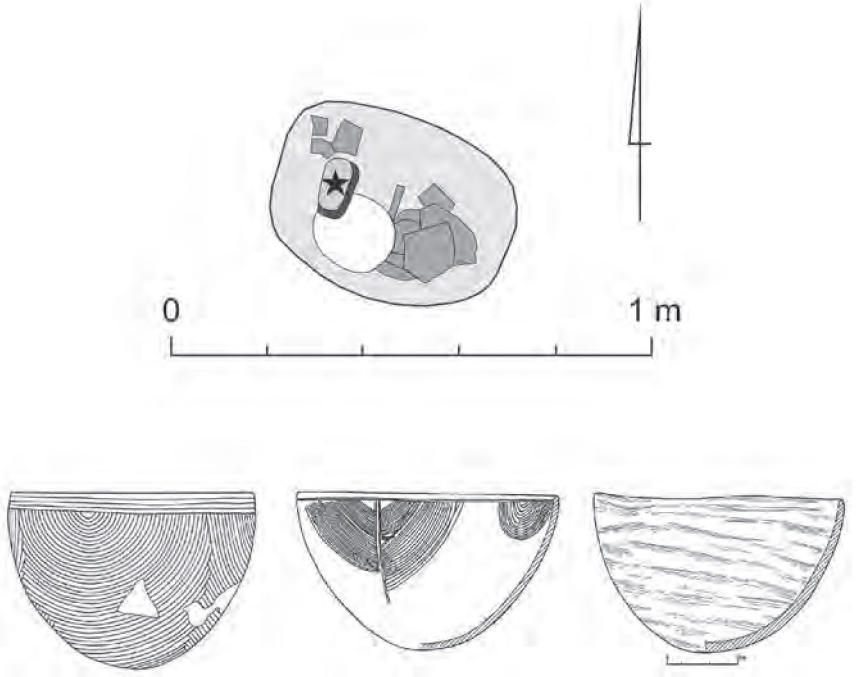

Fig. 12. Kadero site. Grave No. 101 and pottery from the grave

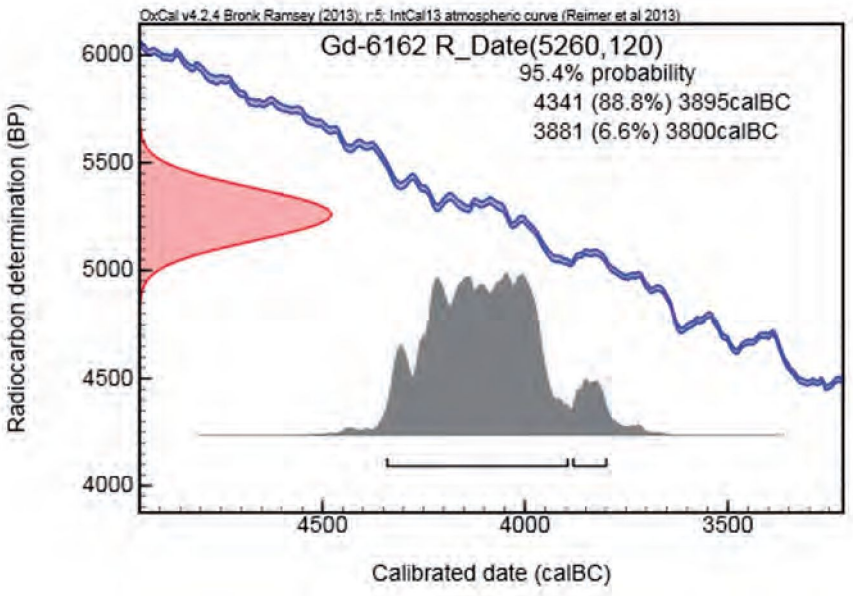

Fig. 13. Kadero site. Results of calibration of sample Gd-6162 from grave No. 101

radiocarbon dating was made on the Nile bivalve shell (Gd-6162) with the result 5260 ± 120 b.p. The calibrated age of the sample (with probability 95,4%) is between 4341 and 3800 years cal BC (Fig. 13) with median equal 4100 years cal BC.

Grave No. 243

Grave of an adult male in contracted position the depth 62-90 cm, unfurnished (Fig. 14). On the bottom of the grave a charred wood was recognized from which a sample for the radiocarbon dating was taken (sample Poz-4308) (Krzyżaniak 2011: 194). It gives the radiocarbon age 4150 ± 30 b.p. that after calibration (Fig. 14) is between 2876 and 2628 years cal BC (with probability 95,4%) and median value of 2745 years cal BC.

Grave No.132

Grave of the female 30-40 years old buried on the depth 105 cm. The body was positioned on the right side with the arms along the body (grave is partially destroyed in modern times) (Fig. 15). On the bones are preserved remnants of the textiles which might have been fragments of the shroud. (Krzyżaniak 2011: 211-212). The fragments of the clothes was used for the radiocarbon dating (Poz-4164) with the result 1660 ± 30 b.p. After the calibration it is between 260 and 529 years cal AD and median 388 years cal BC (Fig. 15).

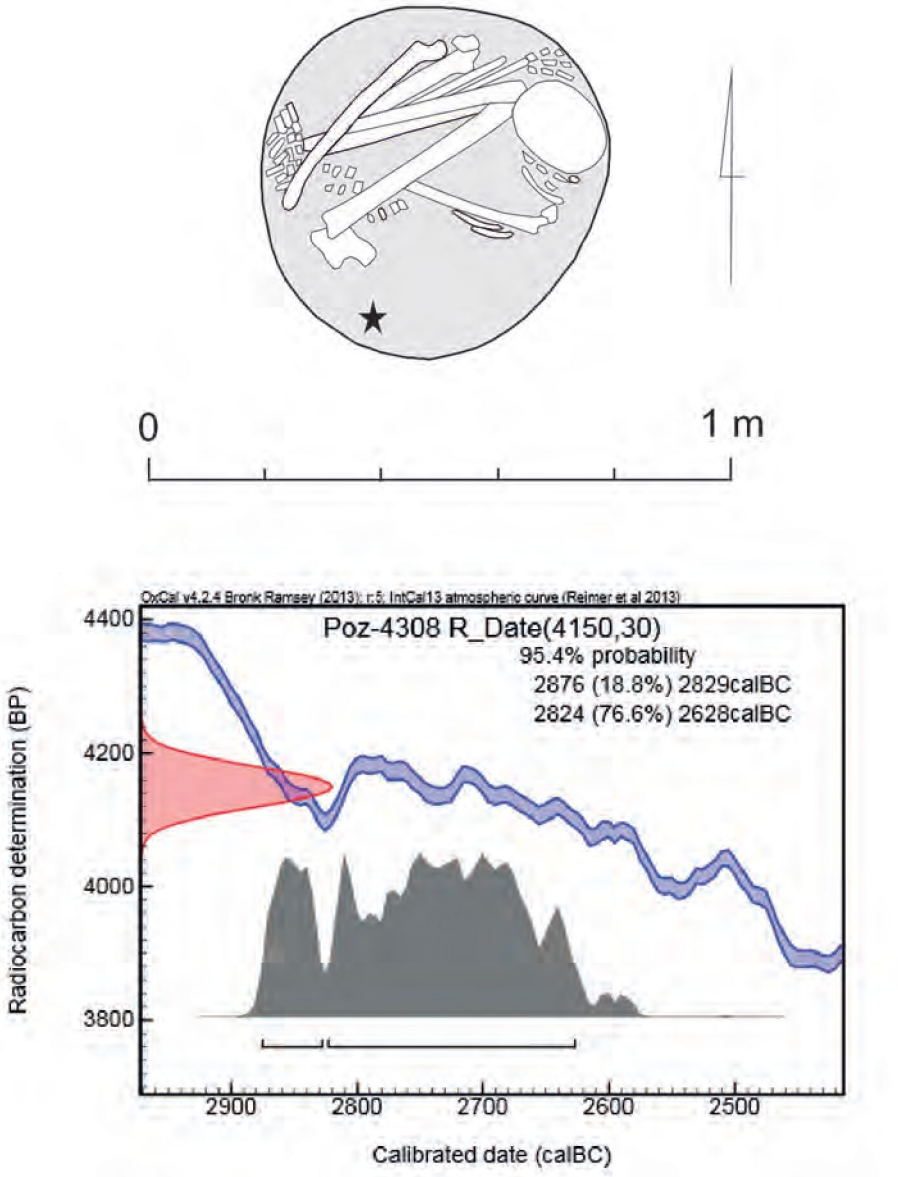

Fig. 14. Kadero site. Grave No. 243 and results of calibration of sample Poz-4308 from the grave

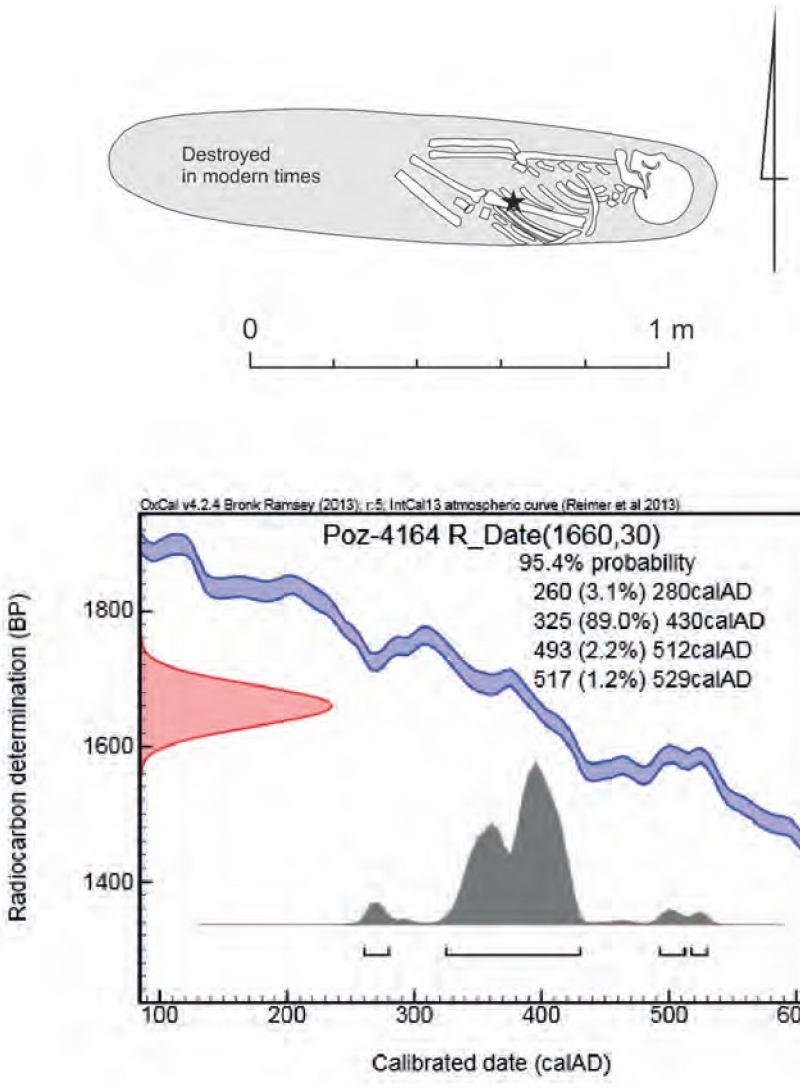

Fig. 15. Kadero site. Grave No. 132 and results of calibration of sample Poz-4164 from the grave

3. The settlement

3.1. The northern midden

From the northern midden the set of eleven radiocarbon dates is available. All of them were collected from the small trench located in the place when the depth of the accumulated settlement debris was the thickest (Fig. 1). All the dates were made on the shells of a Nile oyster, Nile bivalve or fresh water shell. Charcoals were collected from the depth of ca. 10-30 cm. Details of all eleven dates are shown in Table 1. The oldest radiocarbon age of the sample from the northern midden is 5960 ± 70 b.p. (GD-5647) while the youngest 5370 ± 60 b.p. (Gd-5651). The calibrated age of all the radiocarbon dates (Fig. 16) shown the age of the midden between 5024 and 4051 years cal BC with probability of 95,4%.

3.2. The southern midden

Three samples were collected from the trench located at the central part of the southern midden (Fig. 1). All of them are the Nilotic bivalves found close to each other. Two younger dates made on that samples come from the depth ca. 8-10 cm whereas the older was collected deeper – ca. 8-30 cm. However the nature of the Kadero middens– lack of reliable stratigraphy – makes the position of each sample in the strata useless for chronological control.

The two older radiocarbon dates from the southern midden are almost identical: 5280 ± 90 b.p. (SMU-482) and 5260 ± 90 b.p. (T-2188). The younger one is 5030 ± 70 b.p. (T-2189). The age range of the southern midden after calibration with the probability of 95.4% is between 4331 and 3665 years cal BC (table 1; Fig. 17). If we consider the Trondheim Laboratory correction of results of two samples dating (see Table 1) than the oldest date from the southern midden is 5700 ± 100 b.p. (T-2188-corr) and the youngest 5280 ± 90 b.p. (SMU-482). Than the calibrated age of that midden is substantially older with the range between 4770 and 3956 years cal BC (Table 1; Fig. 18).

4. Discussion on the radiocarbon dates from Kadero

Twenty six radiocarbon analyses from the Kadero site are one of the longest series of dates from one site ever done for the Sudanese Neolithic. However there is a number of problems that makes interpretation of that sequence difficult. The two basic issues are as follows:

(a) Radiocarbon analyses from Kadero were made between ca.1980 and 2000 in five different laboratories. During that time the methodology of radiocarbon

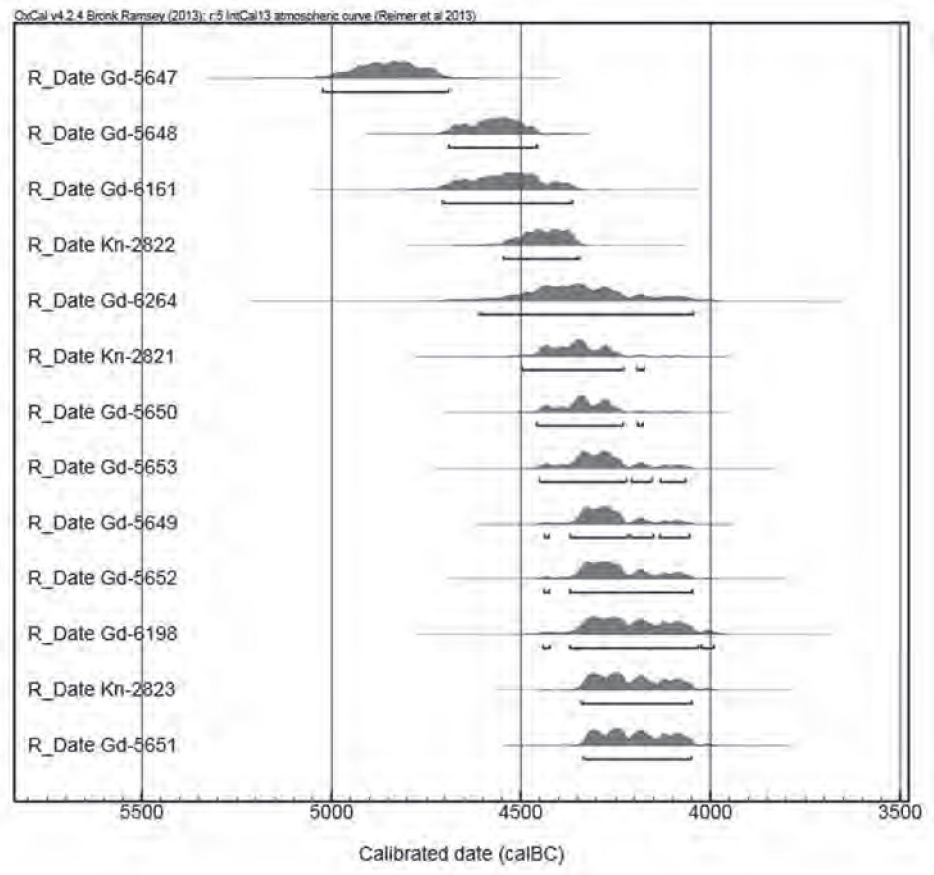

Fig. 16. Kadero site. The northern midden. Multiplot showing the results of calibration of radiocarbon samples

dating has substantially changed and that differences, not only between the laboratories but also within each laboratory, difficult to follow, influenced the precision of dating and its results.

(b) Different materials were the subject of radiocarbon dating, like charcoal, charred wood or cloth found from grave pit filling as well as shells of Nile bivalves and mollusks discovered either in the grave filling or in the sediments of the middens. Especially in that last case the possibility of large fresh water reservoir effect during the dating should be taken into account even if it is partially controlled by the observations on the archaeological content of features. In the case of charcoal, if a bulk sample is dated, what is the case of Kadero samples, the final radiocarbon age of the sample is an averaged result of each charcoal piece age included in the

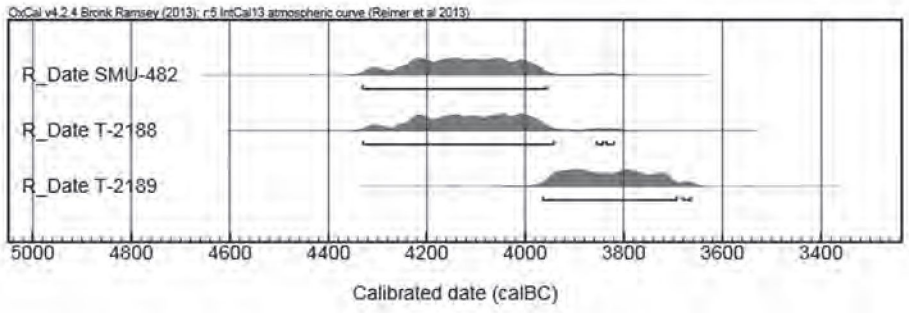

Fig. 17. Kadero site. The southern midden. Multiplot showing the results of calibration of radiocarbon samples (Trondheim Laboratory analyses without correction)

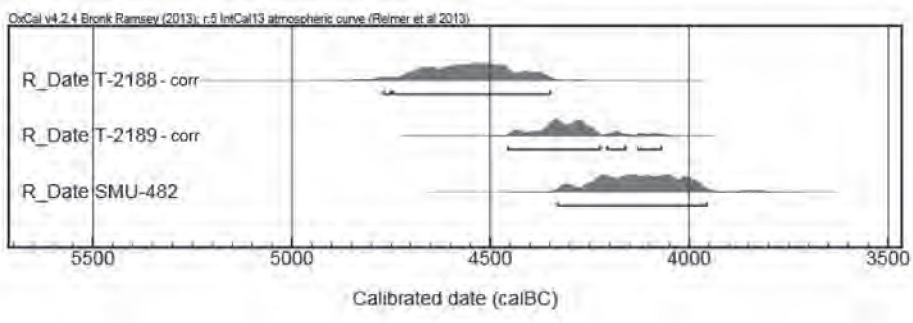

Fig. 18. Kadero site. The southern midden. Multiplot showing the results of calibration of radiocarbon samples (corrected Trondheim Laboratory analyses)

sample, what not necessary reflect the real radiocarbon age of the dated event (e.g. inhumation). Additionally, in the case of charcoals from grave pits we cannot be sure that they are connected with burials as the settlement activity on the site was very intensive and on the other hand no traces of burial practices with the use of fire were recorded during the excavations.

Analysing the calibrated age of all the dates from different archaeological contexts of the site some observations on relative chronology can be made (Fig. 19). The beginning of the settlement at Kadero can be dated slightly after 5000 years cal BC on the northern midden and occupation continue there up to ca. 3900 cal BC. The southern midden is younger. Depending on the corrected or non-corrected dates it began at the earliest after 4700 years cal BC or even later, after ca. 4300 years cal BC and finished ca. 3900 cal BC or ca. 3700 years cal BC.

The cemetery lasted no more than 500-600 years, between 4450 and 3900 cal BC. Assuming that the Neolithic people lived and were buried all the time on the same

place, we should rather accept corrected 14C dates from the southern midden made in the Trondheim Laboratory and the youngest calibrated age from that area – sample analysed in the SMU Laboratory - dates the latest phase of the occupation there. That is possible that there is a lack of the oldest graves in the record, synchronous with the beginning of the settlement in Kadero. – older than 4500 cal BC. Most probably they were eroded before the start of excavations of the site.

Conclusions

Six dated graves fit very well into the Early Neolithic. Not only the dates but also equipment of the graves confirms its, relatively long, chronology.

The dating of grave No. 243 is much younger as compared to the sequence shown on Fig. 18. The deceased was buried jest in contracted position in the same way as in other Neolithic graves. Because the grave is unfurnished, only the position of the body and the preservation of the bones are the arguments connecting this grave to the Neolithic. However we should remember that ca.60 % of the Neolithic graves in Kadero are unfurnished (Krzyżaniak 2011: 58) as well as many graves on the other Neolithic cemeteries in the Sudan.

This date is younger than the other dates collected on the Neolithic sites in the Central Sudan as Shaheinab, Umm Direiva, Nofalab, Zakiab, Ghaba, even Late neolithic Kadada (Sadiq 2012: 146-147). But similar dates are known from the Nofalab 2 (Sadiq 2012: 147), Shaqadud cave in Butana (Marks 1984:32), Jebel Tomat and Jebel Moya between the Blue and White Nile (Clark and Stemmler 1975; Sadiq 2012:149). For the lack of sites dated after three thousands until one thousand BC, that period was often considered as a gap in the occupation of the central Sudan (Haaland 1987: 224-225; Sadiq 2012: 149). It was interpreted as a shift toward the nomadic pastoral agriculture (Reinold and Krzyżaniak 1997: 13). The dates from Nofalab 2, associated with the material related to Shaheinab and the sites connected with as a late Khartoum Neolithic horizon (Sadiq 2012: 148) and the date from the grave 243 at Kadero, which is the burial typical for the Neolithic customs suggest that the Neolithic continues in the Central Sudan also at the beginnings of the 3rd millennium BC and not necessary this area was depopulated. It is possible to solve this problem by the radiocarbon analysis of other unequipped graves with the bodies in the contracted position.

Grave No. 132, because of the position of the body in the grave, was supposed by Lech Krzyzaniak to be a Christian one. Based on its radiocarbon age we can now suggest that the youngest phase of the cemetery at Kadero belongs rather to the early Post-Meroitic times than the to the Medieval period.

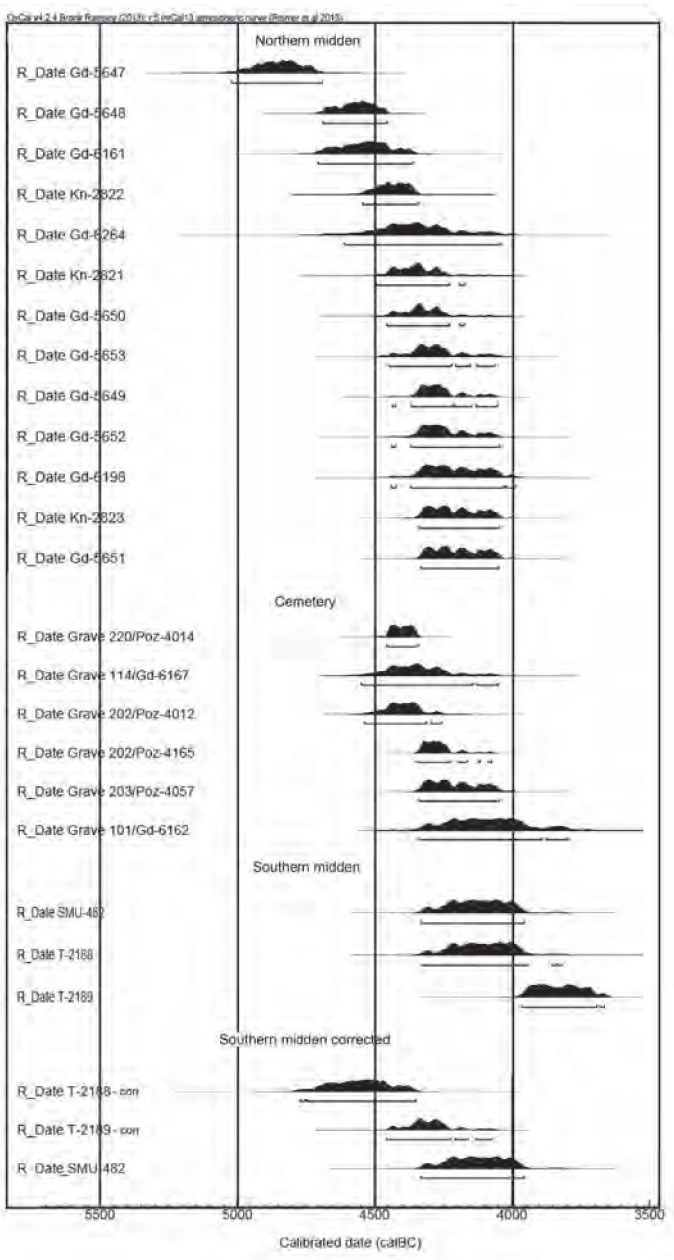

Fig. 19. Kadero site. Multiplot showing the results of calibration of radiocarbon samples for different part of the site (grave No. 60 is excluded from the plot due to extremely large standard deviation)

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