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Radiocarbon and thermoluminescence dates from the Pre/Early Dynastic cemetery of Minshat Abu Omar (North-Eastern Nile Delta)

The site of Minshat Abu Omar was discovered in 1966 (Müller 1966; 1975) as part of a survey in which an attempt was made to determine the provenance of objects sold by an Egyptian art dealer in the Eastern Delta. In the course of this survey, surface finds indicating a cemetery site of the Pre/Early Dynastic and Greco-Roman times were discovered at Minshat Abu Omar. Only some years later was a concession obtained from the (then) Egyptian Antiquities Service and excavations were started at the site by the Munich East Delta expedition in the year 1978 and continued until 1990 financed by the German Research Foundation (Kroeper & Wildung 1985; 1994; 2000).

The site is situated on a *gezira* hill, a sandy island, typical of the Delta, rising above (before the building of the Aswan dam) the flood plain of the surrounding cultivated fields (Wunderlich & Andres 1991; Andres & Wunderlich 1992).

The significance of this archaeological site in the 70's and 80's was the sites unique position in the easternmost part of the Delta. At the beginning of the excavation it had been the general opinion among most Egyptologists that the Delta, in the Predynastic period, was a swampy and uninhabitable area. The find situation up to the end of the 50's seemed to support this premises. During the survey in the 60's however, Müller already noted several sites at which finds indicated the presence of early settlements in the area of the Eastern Delta. The excavation of Minshat Abu Omar were the first to confirm, on a large scale, the presence of a cemetery and, as it turned out later, settlement, of this early time period. In the following years a large amount of early settlements were confirmed through various surveys and excavations by various missions. Excavation carried out by the Supreme Council of Antiquities over the last 20 years in the Eastern Delta have also added to the overall increase of information available to date.

Minshat Abu Omar (MAO)

During 10 excavation season 3050 graves were excavated of which 420 were dated to the Pre/Early Dynastic Period (ca. 3300-2850 BC). The major grave groups which were distinguished at MAO dated to the Pre/Early Dynastic time have significant differences in burial display, indicating not only a social but also internal chronological differences. Graves of this time period have been mostly dated according to ceramic analysis based on sequence dating which was first developed by Petrie (1901) on discovering an, until then, unknown cultural complex. In his system of "Sequence Dates" for finds from the Nagadian cemeteries in Upper Egypt he had devised an internal chronological sequence based on the development of certain particular ceramic types. This sequence was followed despite all known shortcomings (Hendrickx 1996; 1999) with little revision until the publication of Kaiser (1957:69-77) who refined and regrouped Petrie's "Sequences" by means of a "Stufen" chronology (steps/phases); more recently Hendrickx (1996:36-69) has made some revisions of Kaiser's "Stufen" chronology. However it is interesting to note the lasting importance of Petrie's basic work of "Sequence Dates" which after 100 years and despite the additional material available today from various newer excavations is still the foundation on which today's discussions, changes and revisions of the chronology of the Pre/Early Dynastic Period are based.

The internal sequence of graves in Minshat Abu Omar based on the ceramic assemblages and various other factors, has resulted in an internal chronology with ranges of not more than ca. 50 - maximum 1 50 years. Horizontal stratigraphy was unfortunately not applicable in the dating of the graves at Minshat Abu Omar since the original surface of the *gezira* is not known due to various factors. Also very little overlapping occurred throughout the cemetery of the Pre/Early dynastic graves. The Greco-Roman cemetery on the other hand was so crowded that, especially in the northern area of the cemetery, very frequent overlapping and cutting of graves of the same general time period occurred.

Over the years many attemps have been made to determine a more precise absolute dating of the Predynastic/Early Dynastic Period by means of C^{14} dates (Midant-Reynes & Sabatier 1999: 83-108); the results of published dates from various sites throughout Egypt were collected and presented by Hendrickx (1999:13-82) and is also available in a database form. In the following we present the available dates from Minshat Abu Omar.

Samples from Minshat Abu Omar

Since very little organic material was preserved in the cemetery of MAO samples collection (including human bones and shells as well as charcoal) were carried out with the utmost care. According to the instructions of various laboratories samples were not touched with fingers, not exposed to sunlight for any extent of time, not placed near cigarette ashes, were immediately wrapped in aluminium foil and then placed in a plastic bag. In this way 40 samples were taken (including 3 geological samples and three samples belonging to "late" graves).

Of these samples 32 were processed and resulted in dates for 25 Pre/Early Dynastic graves. Rather naively perhaps we had hoped at first that the samples would be able to provide some information as to absolute dates for grave groups with established internal chronology (no samples are available from MAO grave group II). Description of the samples and results of the radiocarbon analyses are given below. The samples were processed in the years 1988-94 (for full date set see below Table 7 at the end of the paper).

Samples from the graves MAO I

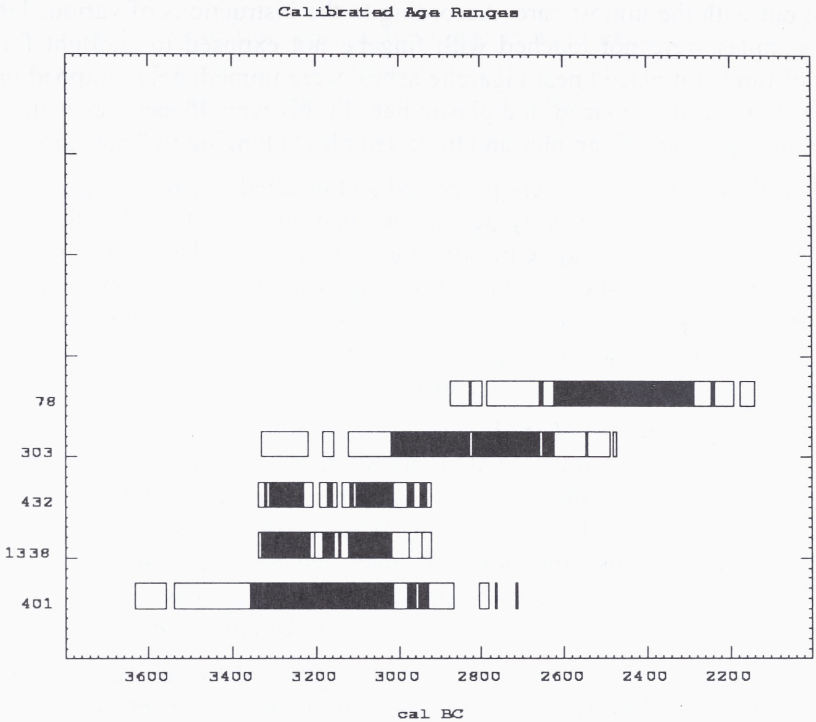
The oldest grave group (MAO I) shows the position of the body within the graves to be in a fixed scheme: the body is placed on the right side in a contracted position, head to the North, facing West. Graves of this group are characterized by offerings consisting mostly of small size ceramic vessels but also some stone artefacts and jewellery can be present. Only in rare cases do the offerings exceed 8 pieces (Kroeper & Wildung 1994; 2000; Kroeper 1996).

This oldest group of graves in MAO estimated to belong to the period prior to "0" Dynasty is expected to be dated on the basis of other evidence in the range of ca. 3250-3100 BC. In five graves of this group it was possible to obtain samples for C^{14} dating (Table 1). The result of samples KN 3068, 3609 and 3061 fit well within this time period. Unsatisfactory is the long range, in part due to the fact that the samples were small. It must also be noted that the calibration curve shows a high number of wiggles especially in the date range of 4480-4520 bp. As can be seen the CalAge p(95%) range can span, in all cases, more than 550 years and is therefore not very helpful in establishing some sort of absolute dating for the internal chronological sequence of the graves.

That the sample KN 3062 falls outside of the range is not too surprizing since human bones, especially those containing little collagen are not ideal testing material and error expectancy is higher. According to Aitken (1974:42) "... reliable dating of bone or shell may require a kilogram or more of material".

Table 1. Grave Group MAO I.

Time scale of calibrated age range BC according to grave nos.



Lab.-Nos.	14C-Age BP	±	CalAge p(68%) calBP	±	CalAge p(68%) calBP-range	CalAge p(68%) calBC	±	CalAge p(95%) calBC-range	Material	Grave nos.
KN 3068	4480	150	5120	200	5520 - 4720	3170	200	3570 - 2770	charcoal	401 (Fig. 1a.)
KN 3609	4450	65	5100	140	5380 - 4820	3150	140	3430 - 2870	shell	1338
KN 3061	4440	55	5090	140	5370 - 4810	3140	140	3420 - 2860	shell	432 (Fig. 1b.)
KN 3168	4250	130	4800	200	5200 - 4400	2850	200	3250 - 2450	shell	303 (Fig. 2a.)
KN 3062	3970	120	4430	190	4810 - 4050	2480	190	2860 - 2100	human bones	78 (Fig. 2b.)

*Data series is calibrated by 2-D Dispertion Calibration Program version CAL PAL Feb. 2003.

Samples from the graves MAO III

The organization and appearance of burials belonging to group MAO III changes in that the bodies are now placed on the left side facing east (Kroeper & Wildung 1994; 2000; Kroeper 1996). The average number of offerings placed in the grave is much higher than in the previous group and the general funerary effort/work output undertaken for the burial speaks of a change in offering ritual and/or religious and social necessity. On the basis of other analysis the age of the graves is expected to be between ca. 3100 and 3000 BC.

Table 2. Grave Group MAO III.

Lab.-Nr.	14C-Age BP	±	CalAge p(68%) calBP	±	CalAge p(68%) calBP-range	CalAge p(68%) calBC	±	CalAge p(95%) calBC-range	Material	Grave nos.
Hv 9566	7815	570	8760	630	10020 - 7500	6810	630	8070 - 5550	from contents of vessel	49
Hv 9567	6005	280	6860	320	7500 - 6220	4910	320	5550 - 4270	from contents of vessel	126
KN 3069	3950	55	4390	90	4570 - 4210	2440	90	2620 - 2260	human bones	126

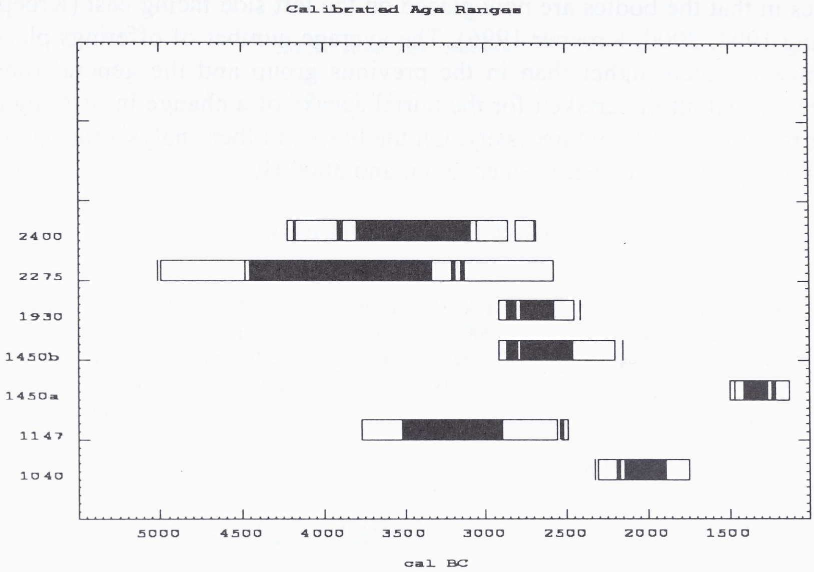
* data series is calibrated by 2-D Dispertion Calibration Program version CAL PAL Feb. 2003.

Since so little charcoal or other material was available from this group of graves an attempt was made at testing material which was inside the vessels found in these graves (Table 2). However it seems that the material tested from the pots of graves 49 and 126 was, in this case mixed with older geological material, the dates of 8070- 5550 BC being completely outside of the expected range. The two samples HV 9567 and KN 3069 were both taken from the same grave 126: one sample (as just mentioned) being from the contents of a vessel and the second sample from the bones of the burial. The result is a range of error for the same grave of more than 2000 years! Clearly the samples were not useful for testing the age of this burial - one being probably contaminated while the sample of human bones had too little collagen left in the bones.

Samples from the graves MAO IV

Grave group MAO IV dated to the 1st Dynasty provided much more testing material since the graves were more solidly constructed and some ceramic vessels were covered with a lid and sealed at the top. The grave construction sometimes includes wooden beams so that charcoal samples could be collected more frequently. The group as such represents the richest graves in the cemetery with offerings in one grave reaching 127 objects. The expected date is ca. 3000-2880 BC (Table 3).

Table 3. Graves of Group MAO IV.
Time scale of calibrated age range BC according to grave nos.



Lab.-Nos.	14C-Age BP	±	CalAge p(68%) calBP	±	CalAge p(68%) calBP-range	CalAge p(68%) calBC	±	CalAge p(95%) calBC-range	Material	Grave nos.
SI 6630	3660	100	3990	140	4270 - 3710	2040	140	2320 - 1760	charcoal	1040 (Fig. 3a)
KN 3607	4500	250	5140	320	5780 - 4500	3190	320	3830 - 2550	charcoal	1147 (Fig. 3b)
GD 4143	3070	70	3260	90	3440 - 3080	1310	90	1490 - 1130	charcoal	1450a
KN 3759	4060	140	4560	200	4960 - 4160	2610	200	3010 - 2210	charcoal	1450b
GD 4566	4120	100	4640	140	4920 - 4360	2690	140	2970 - 2410	from contents of vessel	1930 (Fig. 4a)
KN 4441	5080	500	5760	590	6940 - 4580	3810	590	4990 - 2630	charcoal	2275
KN 4443	4750	300	5410	380	6170 - 4650	3460	380	4220 - 2700	charcoal	2400
KN 3608	4250	120	4790	180	5150 - 4430	2840	180	3200 - 2480	charcoal	1363 (Fig. 4b)
KN 3606	4300	900	4780	1090	6960 - 2600	2830	1090	5010 - 650	charcoal (contents of vessel)	0886

* data series is calibrated by 2-D Dispertion Calibration Program version CAL PAL Feb. 2003.

Samples from grave 1590 (MAO Group IV; Fig. 5)

A special case within the graves of group MAO IV is grave 1590 dated, with very high probability, to the end of Dynasty I (ca. 2880 BC) based on an inscription on one of the vessels in the grave.

Due to the large size and extensive and solid construction of the grave a series of material for testing was able to be collected and the resulting dates are given below.

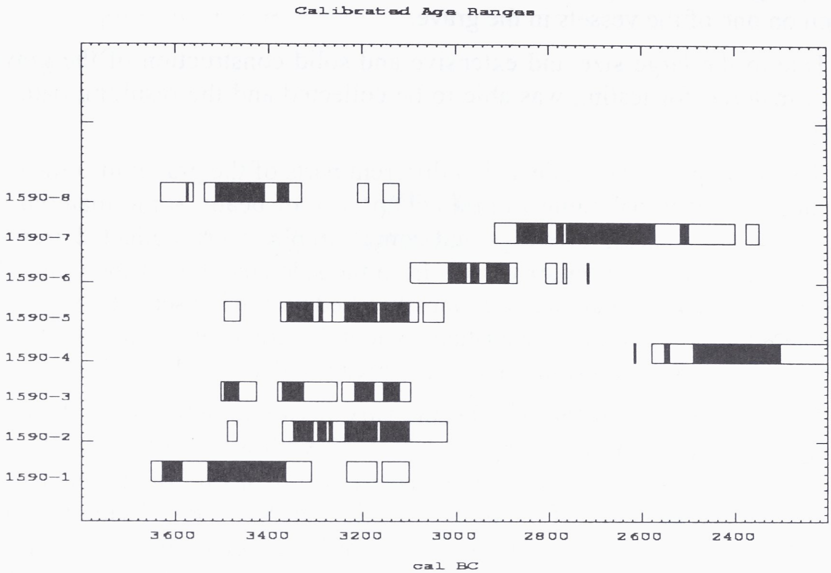
The 8 samples were collected in different parts of the grave: in some cases larger pieces of charcoal came from a collapsed roof beam, some material was found on the floor under offerings and some samples were collected from remains of charred material out of vessels from the side chamber of the grave. The storage pots in the side chamber were mostly filled with what seem to be remains of food and dung used to prepare a ritual meal at the grave site. Noticeable is that the dates below once again result in a large spread of dates (Table 4-5).

Even samples from the roof beams vary between 3440 BC to 2410 BC. The only date without a large range is KN 3762 with a date of 2960 BC. This sample consisted of charred remains of seeds found in one of the pots in the grave. Plant material is one of the best available materials for C^{14} samples due to the limited lifespan of plants. The wood might have been cut prior to its use, however one can hardly believe that it could have been kept for hundreds of years before being used!

In general the dates from MAO have clearly shown the limitation of this method as applied for fine dating within a known context. Usually the material itself (such as the internal chronology of the cemetery) provides the archaeologist with a much finer dating net that the C^{14} dates can. A much larger amount of sequences and a more complicated analyses of the result might provide better information but most probably not better than the archaeological evidence itself can provide.

Table 4. Grave 1590 from the end of 1st Dynasty (Fig. 5).

Time scale of calibrated age range BC according to grave nos.



Lab.-Nos.	14C-Age BP	±	CalAge p(68%) calBP	±	CalAge p(68%) calBP-range	CalAge p(68%) calBC	±	CalAge p(95%) calBC-range	Material	Sample No. in graphic
GD 2660	4680	90	5420	120	5660 - 5180	3470	120	3710 - 3230	charcoal	1
GD 5216	4580	50	5260	150	5560 - 4960	3310	150	3610 - 3010	charcoal	2
KN 4442	4642	56	5390	80	5550 - 5230	3440	80	3600 - 3280	charcoal (from the beam)	3
KN 3761	4540	60	5190	110	5410 - 4970	3240	110	3460 - 3020	charcoal (from the beam)	4
GD 5125	4520	60	5170	110	5390 - 4950	3220	110	3440 - 3000	charcoal	5
KN 3762	4320	55	4910	60	5030 - 4790	2960	60	3080 - 2840	charcoal (charred plants remains in pot)	6
KN 3763	4110	110	4630	150	4930 - 4330	2680	150	2980 - 2380	charcoal	7
GD 6233	3930	70	4360	100	4560 - 4160	2410	100	2610 - 2210	charcoal (beams)	8

* data series is calibrated by 2-D Dispertion Calibration Program version CAL PAL Feb. 2003

Table 5.

Samples from the Early Dynastic grave MAO 1590.

RADIOCARBON CALIBRATION PROGRAM* CALIB REV4.4.
Copyright 1986-2002 M Stuiver and PJ Reimer
*To be used in conjunction with: Stuiver, M., and Reimer, P.J., 1993, Radiocarbon, 35, 215-230.
Annotated results (text) - calout.doc. xport file - calout.csv

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SAMPLE0001
GD 2660
1590 charcoal
Radiocarbon Age BP    4680 +/-   90
Calibration data set: intcal98.14c              (Stuiver et al., 1998a)
  % area enclosed        cal AD age ranges          relative area under
                                                 probability distribution
  68.3 (1 sigma)      cal BC 3627- 3584                  0.178
                             3531- 3365                  0.822
  95.4 (2 sigma)      cal BC 3650- 3311                  0.917
                             3236- 3170                  0.043
                             3161- 3103                  0.039

SAMPLE0002
GD 5125
1590 charcoal
Radiocarbon Age BP    4520 +/-   60
Calibration data set: intcal98.14c              (Stuiver et al., 1998a)
  % area enclosed        cal AD age ranges          relative area under
                                                 probability distribution
  68.3 (1 sigma)      cal BC 3351- 3306                  0.220
                             3299- 3278                  0.092
                             3273- 3264                  0.035
                             3238- 3168                  0.351
                             3163- 3102                  0.303
  95.4 (2 sigma)      cal BC 3490- 3470                  0.014
                             3372- 3020                  0.986

SAMPLE0003
GD5216
1590 charcoal
Radiocarbon Age BP    4580 +/-   50
Calibration data set: intcal98.14c              (Stuiver et al., 1998a)
  % area enclosed        cal AD age ranges          relative area under
                                                 probability distribution
  68.3 (1 sigma)      cal BC 3496- 3465                  0.186
                             3375- 3328                  0.365
                             3220- 3175                  0.235
                             3158- 3120                  0.214
  95.4 (2 sigma)      cal BC 3504- 3426                  0.202
                             3382- 3257                  0.373
                             3245- 3098                  0.425

SAMPLE0004
GD 6233
1590 charcoal
Radiocarbon Age BP    3930 +/-   70
Calibration data set: intcal98.14c              (Stuiver et al., 1998a)
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  % area enclosed       cal AD age ranges              relative area under
                                                       probability distribution
  68.3 (1 sigma)      cal BC 2551- 2541                     0.044
                             2491- 2304                     0.956
  95.4 (2 sigma)      cal BC 2617- 2612                     0.004
                             2581- 2201                     0.996

SAMPLE0005
 KN 3761
 1590 charcoal
 Radiocarbon Age BP   4540 +/-   60
 Calibration data set: intcal98.14c                    (Stuiver et al., 1998a)
  % area enclosed       cal AD age ranges              relative area under
                                                       probability distribution
  68.3 (1 sigma)      cal BC 3362- 3307                     0.282
                             3294- 3284                     0.035
                             3269- 3265                     0.016
                             3238- 3168                     0.355
                             3163- 3102                     0.313

  95.4 (2 sigma)      cal BC 3498- 3461                     0.041
                             3376- 3080                     0.918
                             3069- 3027                     0.041

 SAMPLE0006
 KN 3762
 charcoal
 Radiocarbon Age BP   4320 +/-   55
 Calibration data set: intcal98.14c                    (Stuiver et al., 1998a)
  % area enclosed       cal AD age ranges              relative area under
                                                       probability distribution
  68.3 (1 sigma)      cal BC 3016- 2978                     0.320
                             2968- 2948                     0.142
                             2935- 2883                     0.538
  95.4 (2 sigma)      cal BC 3097- 2868                     0.979
                             2805- 2782                     0.016
                             2768- 2763                     0.003
                             2716- 2713                     0.002

 SAMPLE0007
 KN 3763
 1590 charcoal
 Radiocarbon Age BP   4110 +/-  110
 Calibration data set: intcal98.14c                    (Stuiver et al., 1998a)
  % area enclosed       cal AD age ranges              relative area under
                                                       probability distribution
  68.3 (1 sigma)      cal BC 2869- 2803                     0.233
                             2783- 2767                     0.050
                             2764- 2570                     0.667
                             2516- 2500                     0.050
  95.4 (2 sigma)      cal BC 2915- 2401                     0.988
                             2378- 2350                     0.012

 SAMPLE0008
 KN 4442
 1590 charcoal
 Radiocarbon Age BP   4642 +/-   56
 Calibration data set: intcal98.14c                    (Stuiver et al., 1998a)
  % area enclosed       cal AD age ranges              relative area under
                                                       probability distribution
  68.3 (1 sigma)      cal BC 3515- 3409                     0.809
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		3383- 3358	0.191
95.4 (2 sigma)	cal BC	3631- 3577	0.075
		3571- 3561	0.005
		3538- 3332	0.874
		3213- 3187	0.021
		3156- 3123	0.025

References for calibration datasets:

Stuiver, M., and Braziunas, T.F., (1993), The Holocene 3:289-305.
Stuiver, M., Reimer, P.J., and Braziunas, T.F., (1998b) Radiocarbon 40:1127-1151. (revised dataset)
Stuiver, M., Reimer, P.J., Bard, E., Beck, J.W., Burr, G.S., Hughen, K.A., Kromer, B., McCormac, F.G., v.d. Plicht, J., and Spurk, M. (1998a), Radiocarbon 40:1041-1083.
McCormac, F.G., Reimer, P.J., Hogg, A.G., Higham, T.F.G., Baillie, M.G.L., Palmer, J., Stuiver, M., (2002), Radiocarbon 44: 641-651.

COMMENTS:
* This standard deviation (error) includes a lab error multiplier.
** 1 sigma = square root of (sample std. dev.^2 + curve std. dev.^2)
** 2 sigma = 2 x square root of (sample std. dev.^2 + curve std. dev.^2)
where ^2 = quantity squared.
[ ] = calibrated with an uncertain region or a linear extension to the calibration curve
0* represents a "negative" age BP
1955* or 1960* denote influence of nuclear testing C-14

NOTE: Cal ages and ranges are rounded to the nearest year which may be too precise in many instances. Users are advised to round results to the nearest 10 yr for samples with standard

Thermoluminescence dates from Minshat Abu Omar

Whereas in living organism the concentration of C^{14}increases steadily, at death this process ceases (time 0) and decomposition occurs. This controlled loss measurement is the basis of radiocarbon dating - the older the object the weaker the signal.

In thermoluminescence dating the process can be seen to be an additive one, meaning the signal increases with age. Light is emitted when a crystalline material such as quartz, calcite and various feldspars is heated to ca. 500°. Since these minerals are often added to potters clay and then fired to temperature of 700 to 1100 any geological TL is driven off setting the "clock" at zero. Thereafter gradually the TL energy builds up again and the natural TL measured in the laboratory is directly related to the total radiation the ceramics have experienced since the time zero set by the original firing (Fleming 1976:111).

The causes of inaccuracy are quite different from those of C^{14} dating where contamination with more recent carbon and variance in constancy (systematic deviations) are the major problems. The following are some of the requirements for an accurate TL date (Aitken 1974: 109ff.).

- the test sherds should have been buried to a minimum depth of 30cm or more for a least 2/3 of their burial time,
- they should have been at least 30 cm away from any boundary such as for example walls, floors or rock surfaces,
- they should not be unnecessarily exposed to light or ultraviolet rays,
- after firing they should not have been heated again,
- soil saturation: give a rough estimate of how the average water content of the soil relates to that of the sample supplied,
- it is important to know if the water table is or has been anywhere near to the context concerned and if there is any seasonal or long term information about variations in rainfall.

On the basis of the above information it seemed clear that usually only a few of the criteria could be satisfied by most archaeological excavations. The major problem in MAO is the question of water level and rainfall over thousands of years. Nevertheless a test with 10 sherds taken from ceramic vessels found in well dated graves was undertaken by the Rathgen Forschungslabor in Berlin more with the intent to test and expand the comparative material for the TL method than to receive a relevant date for the internal chronology of the cemetery of Minshat Abu Omar. One sherd dating to a Neolithic cemetery at Kadero in the Sudan was added as a chronological test piece (Table 6).

The test unfortunately has confirmed the opinion of Prof. Riederer and Dr. Goetheke that due to the many unpredictable variables of the samples from Minshat Abu Omar and the high age of the sherds the test series would not yield very accurate results.

In general the TL method seems to be particularly suited for differentiation of modern forgeries from ancient objects but not for a fine dating of archaeological objects.

Table 6. TL - samples from Minshat Abu Omar.

Sample MAO	H^2O max %	H^2O 30 max %	Alpha-zählung cts ks-1	Th ppm	U ppm	K^2O %	a-Wert $Gy.um^2$	Orts-dosis mGy	Äquivalent-dosis Gy	Age B. C. a	Grave-Group	Grave Nos./ ceramic vessel	expected age BC ca.
1	14,0	4,2	9,98			1,03	0,0959	0,30	881,5	1138	MAO I	202/7	3250-3100
4	14,9	4,4	4,29	5,64	1,88	3,08	0,1198	0,30	1547,7	2813	MAO I	840/3	3250-3100
9	29,2	8,8	5,46			2,56	0,0631	0,30	1495	3680	MAO I	1187/3	3250-3100
12	14,9	4,5	6,98	5,71	2,59	2,07	0,0887	0,30	1351	2710	MAO I	1500	3250-3100
35	13,3	4,0	6,91	7,21	2,11	1,87	0,1119	0,30	1490	3076	MAO III	127/7	3100-3000
36	11,3	3,4	7,54			1,01	0,1657	0,30	1211	2021	MAO III	127/9a	3100-3000
50	12,8	3,8	6,53			1,78	0,0972	0,30	1136	2227	MAO III	1513/4	3100-3000
69	31,1	9,3	6,27			1,48	0,1159	0,30	1088	2469	MAO III	2385/9	3100-3000
98	25,7	7,71	3,86			2,11	0,0962	0,30	1161,7	3041	MAO IV	1930/13	3000-2880
105	20,4	6,1	4,79			1,67	0,0679	0,30	1034	2994	MAO IV	2275/14	3000-2880
Sudan Kadero	16,9	5,1	10,75			1,57	0,1412	0,30	1946	3050	Neolithic Sudan	Kadero	4500

Results from Rathgen Forschungslabor - Christian Goedicke

Table 7. Result of all ^{C14} samples processed from Minshat Abu Omar.

Lab.-Nos.	14C-Age BP	±	CalAge p(68%) calBP	±	CalAge p(68%) calBP range	CalAge p(68%) calBC	±	CalAge p(95%) calBC range	Material	Excavation Nos.
Hv 9568	2430	± 65	2530	± 140	2810 - 2250	580	± 140	860 - 300	from contents of vessel	0058 MAO "late"
Hv 9569	3945	± 145	4400	± 220	4840 - 3960	2450	± 220	2890 - 2010	filling in Mumie	0116 "greco-roman"
Hv 9566	7815	± 570	8760	± 630	10020 - 7500	6810	± 630	8070 - 5550	from contents of vessel	49; MAO III; 0-1. Dyn.
KN 3062	3970	± 120	4430	± 190	4810 - 4050	2480	± 190	2860 - 2100	human bones	0078; MAO I; predynastic
Hv 9567	6005	± 280	6860	± 320	7500 - 6220	4910	± 320	5550 - 4270	from contents of vessel	0126; MAO III; 0-1 Dyn.
KN 3069	3950	± 55	4390	± 90	4570 - 4210	2440	± 90	2620 - 2260	human bones	0126; MAO III; 0-1 Dyn.
KN 3606	4300	± 900	4780	± 1090	6960 - 2600	2830	± 1090	5010 - 650	charcoal (contents of vessel)	0886/8; MAO IV; 1-2nd Dyn.
SI 6630	3660	± 100	3990	± 140	4270 - 3710	2040	± 140	2320 - 1760	charcoal	1040; MAO IV; 1-2nd Dyn.
KN 3607	4500	± 250	5140	± 320	5780 - 4500	3190	± 320	3830 - 2550	charcoal	1147; MAO IV; 1-2nd Dyn.
KN 3609	4450	± 65	5100	± 140	5380 - 4820	3150	± 140	3430 - 2870	Muschel	1338; MAO I; predynastic
KN 3608	4250	± 120	4790	± 180	5150 - 4430	2840	± 180	3200 - 2480	charcoal	1363 MAO IV; 1-2nd Dyn.
GD 4143	3070	± 70	3260	± 90	3440 - 3080	1310	± 90	1490 - 1130	charcoal	1450; MAO IV; 1-2nd Dyn.
KN 3759	4060	± 140	4560	± 200	4960 - 4160	2610	± 200	3010 - 2210	charcoal	1450; MAO IV; 1-2nd Dyn.
GD 2660	4680	± 90	5420	± 120	5660 - 5180	3470	± 120	3710 - 3230	charcoal	1590; MAO IV; 1-2nd Dyn.
GD 5125	4520	± 60	5170	± 110	5390 - 4950	3220	± 110	3440 - 3000	charcoal	1590; MAO IV; 1-2nd Dyn.
GD 5216	4580	± 50	5260	± 150	5560 - 4960	3310	± 150	3610 - 3010	charcoal	1590; MAO IV; 1-2nd Dyn.

GD 6233	3930 ± 70	4360 ± 100	4560 - 4160	2410 ± 100	2610 - 2210	charcoal (beams)	1590; MAO IV; 1-2nd Dyn.
KN 3761	4540 ± 60	5190 ± 110	5410 - 4970	3240 ± 110	3460 - 3020	charcoal (beam)	1590; MAO IV; 1-2nd Dyn.
KN 3762	4320 ± 55	4910 ± 60	5030 - 4790	2960 ± 60	3080 - 2840	charcoal (contents of vessel)	1590; MAO IV; 1-2nd Dyn.
KN 3763	4110 ± 110	4630 ± 150	4930 - 4330	2680 ± 150	2980 - 2380	charcoal	1590; MAO IV; 1-2nd Dyn.
KN 4442	4642 ± 56	5390 ± 80	5550 - 5230	3440 ± 80	3600 - 3280	charcoal (beam)	1590; MAO IV; 1-2nd Dyn.
GD 4566	4120 ± 100	4640 ± 140	4920 - 4360	2690 ± 140	2970 - 2410	from contents of vessel	1930/7 MAO IV; 1-2nd Dyn.
KN 4441	5080 ± 500	5760 ± 590	6940 - 4580	3810 ± 590	4990 - 2630	charcoal	2275; MAO IV; 1-2nd Dyn.
KN 4443	4750 ± 300	5410 ± 380	6170 - 4650	3460 ± 380	4220 - 2700	charcoal	2400 MAO IV; 1-2nd Dyn.
GD 6232	9000 ± 110	10080 ± 170	10420 - 9740	8130 ± 170	8470 - 7790	1-2m under p. niv.	geo-sample
KN 3020	7590 ± 65	8370 ± 60	8490 - 8250	6420 ± 60	6540 - 6300	shells	geo-sample
SI 6634	2645 ± 170	2720 ± 230	3180 - 2260	770 ± 230	1230 - 310	"late burial"	Kom B
GD 5713	5240 ± 60	6040 ± 90	6220 - 5860	4090 ± 90	4270 - 3910	shells ca.2,5m under p. niv.	shell

The data series is calibrated by 2-D Dispertion Calibration Program version CAL PAL Feb. 2003 Lahey LF95v5.7 + Winteracter 5.0.
CALPAL
COLOGNE RADIOCARBON CALIBRATION & PALAEOCLIMATE RESEARCH PACKAGE.
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Bernhard Weninger)
Olaf Jöris
Uwe Danzeglocke

References

AITKEN, M. J. 1974. *Physics and archaeology*. 2nd edition.

ANDRES, WOLFGANG and JÜRGEN WUNDERLICH. 1992. Environmental Conditions for Early Settlement at Minshat Abu Omar, Eastern Nile Delta, Egypt. In: E.C.M. van den Brink (ed.), *The Nile Delta in Tansition; 4^th^ - 3^rd^ millennium BC. Proceedings of the Seminar held in Cairo, 21.-24. October 1990, at the Netherlands Institute of Archaeology and Arabic Studies*: 157-166. Tel Aviv.

FLEMING, STUART. 1976. *Dating in Archaeology*. London.

HENDRICKX STAN. 1999. La chronologie de la prehistoire tardive et des débuts de l'histoire de l'Egypte. *Archéo-Nil* 9:13-81.

.... 1999. La chronolgie del préhistoire tardive et des débuts de l'histoire de l'Egypte. *Archéo-Nil* 9:13-82.

KAISER, WERNER. 1987. Zum Friedhof der Nagadakultur von Minshat Abu Omar. *Annales de Service des Antiquites d' Egypte* 71: 119-125.

KROEPER, KARLA.1996. Minshat Abu Omar - Burials with palettes. In: J. Spencer (ed.), *Aspects of Early Egypt*: 70-92, pl. 6-11. British Museum Press. London.

KROEPER, KARLA and DIETRICH WILDUNG. 1985. *Minshat Abu Omar. Münchner Ostdelta Expedition, Vorbericht 1978-1984*. Schriften aus der Ägyptischen Sammlung 3.

.... 1994. *Minshat Abu Omar. Ein vor- und frühgeschichtlicher Friedhof im Nildelta I. Gräber 1 - 114*. Philipp von Zabern Verlag. Mainz.

.... 2000. *Minshat Abu Omar II. Ein vor- und frühgeschichtlicher Friedhof im Nildelta. Gräber 115-204*. Philipp von Zabern Verlag. Mainz.

MIDANT-REYNES, BEATRIX and PHILIPPE SABATIER. 1999. Préhistoire Egyptienne et Radiocarbone. *Archéo-Nil* 9: 83-107.

MÜLLER, HANS WOLFGANG. 1966. *Bericht über im März/April 1966 in das östliche Nildelta unternommene Erkundungsfahrten*. Bayrischen Akademie der Wissenschaften, Philosophisch-Historische Klasse, Sitzungsberichte, Jahrgang 1966, Heft 8.

.... 1975. Neue frühgeschichtliche Funde aus dem Delta. *Revue d'Egyptologie* 27: 180-194, pl. 15-17.

PETRIE, W.M.F. 1901. *Diospolis Parva. The Cemeteries of Abadiyeh and Hu*. 1898-1899. Egypt Exploration Fund 20. London.

WUNDERLICH, JÜRGEN and WOLFGANG ANDRES. 1991 Late Pleistocene and Holocene Evolution of the Western Nile Delta and Implications for its Future Development. In: H. Brückner and U. Radtke (eds), *Von der Nordsee bis zum Indischen Ozean*: 105-120. Stuttgart.

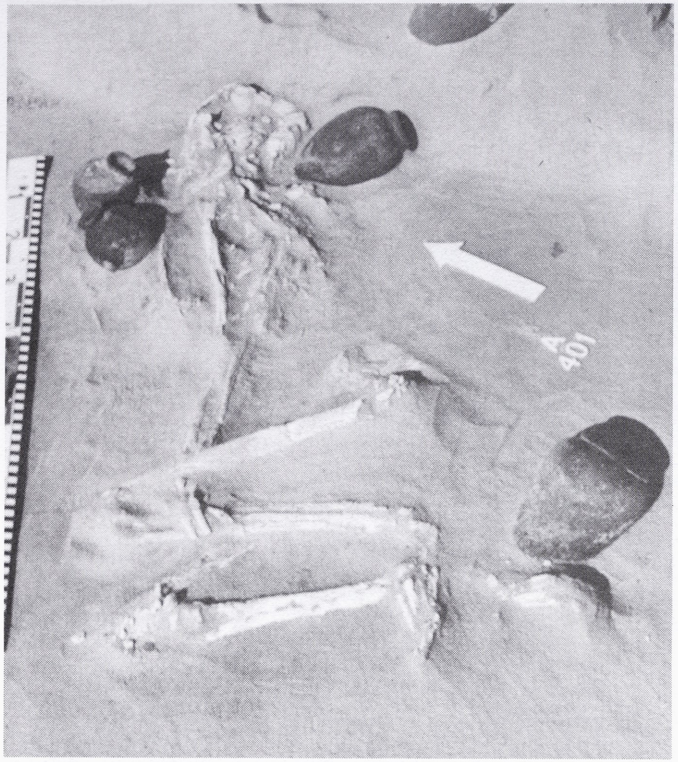

Fig. 1a. Grave MAO 401.

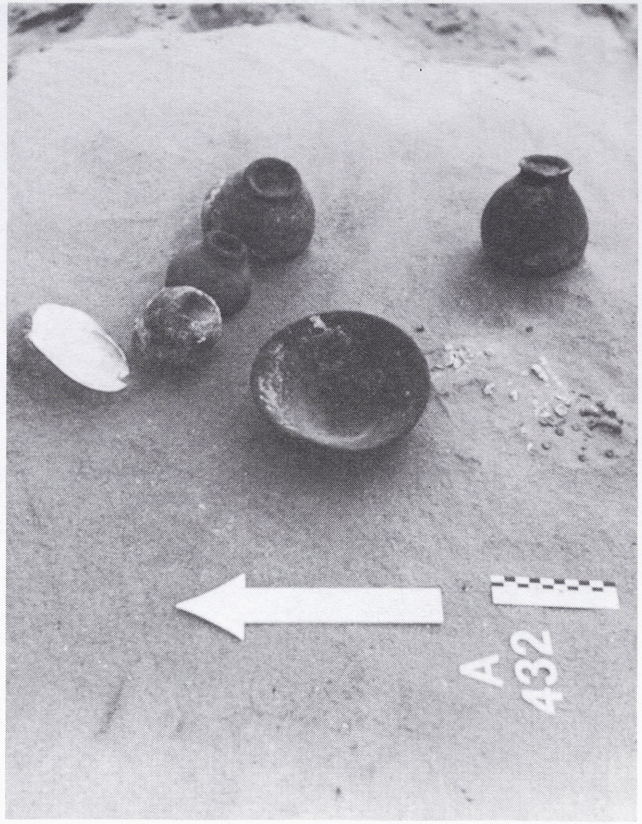

Fig. 1b. Grave MAO 432.

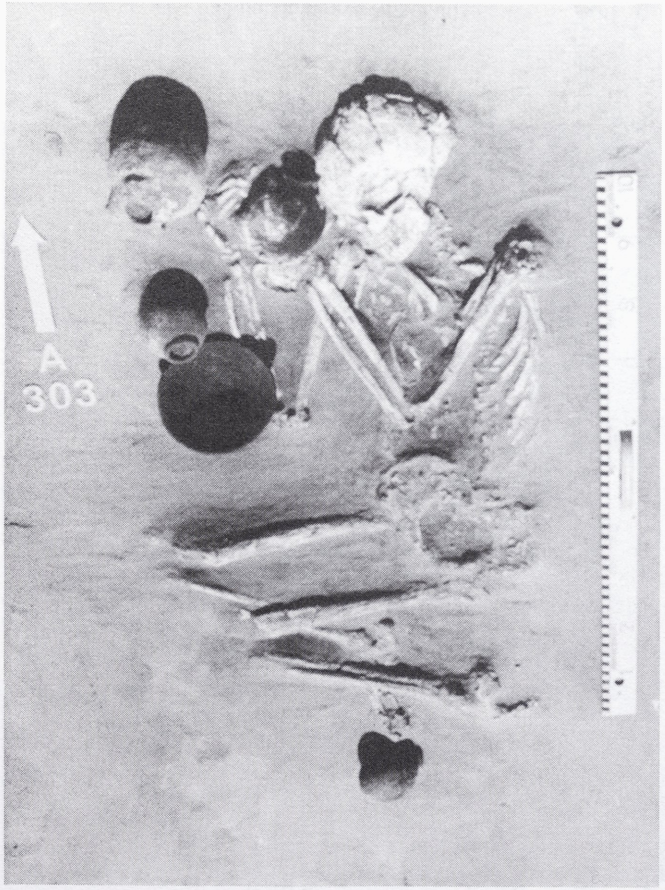

Fig. 2a. Grave MAO 303.

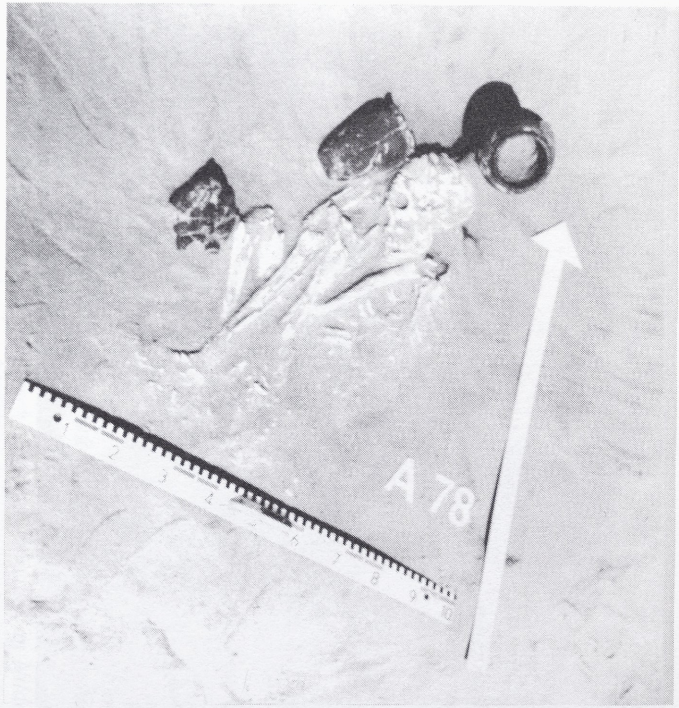

Fig. 2b. Grave MAO 78.

Fig. 3a. Grave MAO 1040.

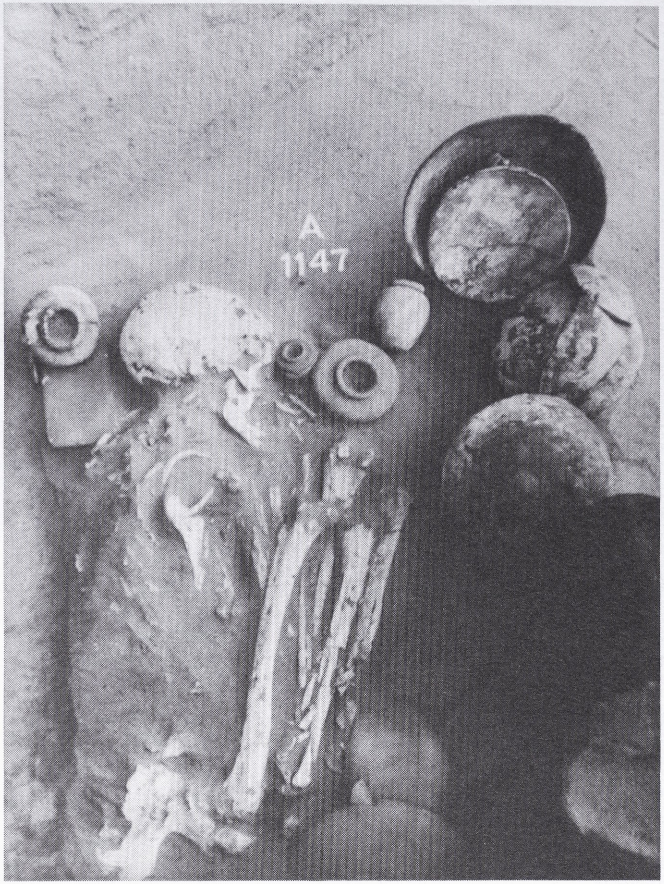

Fig. 3b. Grave MAO 1147.

Fig. 4a. Grave MAO 1930.

Fig. 4b. Grave MAO 1363.

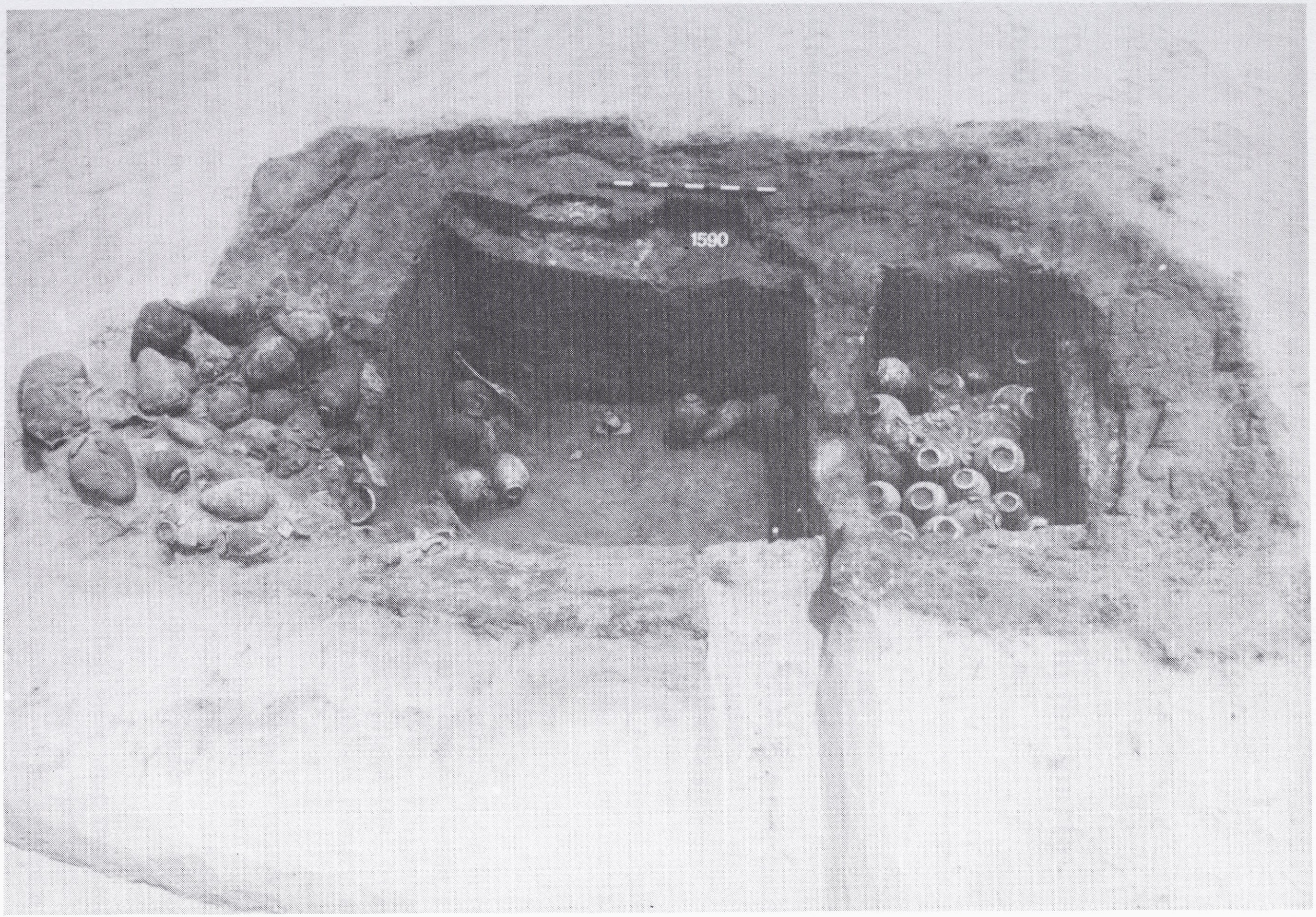

Fig. 5. Grave MAO 1590.