

# A Survey of Archaeological Samples Dated in 1988

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# A SURVEY OF ARCHAEOLOGICAL SAMPLES DATED IN 1988

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Abstract: A survey is given of archaeological samples dated in 1988 at the Nordic Laboratory for Thermoluminescence Dating. A total of 67 samples were dated. The results were corrected for short-term fading of feldspars as measured for samples stored at room temperature for four weeks or at 100°C for two weeks. The beta dose from potassium and rubidium in feldspar, and the alpha dose from uranium and thorium in quartz and feldspar were included assuming alpha efficiency factors of 0.1 for quartz and 0.2 for feldspar.

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CONTENTS

## INTRODUCTION

TL dating results for archaeological materials from the Nordic countries completed in 1988 are presented. The dated materials included ceramics, bricks, burnt clay and burnt stones. A total of 67 samples are discussed (Table 1): 18 from Denmark, 34 from Sweden and 15 from Finland. Results for samples dated in previous years are described in Mejdahl (1984, 1985, 1986, 1987a and 1988).

Table 1. Archaeological samples from the Nordic countries dated in 1988 at the Nordic Laboratory for TL dating.

| Material | No. of samples | Percent |
|---|---|---|
| Ceramics | 21 | 31 |
| Burnt clay | 1 | 2 |
| Burnt stones | 45 | 67 |
| Total | 67 | 100 |

The TL dating technique used is as described in Mejdahl (1988). Two fractions of alkali feldspars and a quartz fraction were obtained by heavy liquid separation and HF etching. Short-term fading was determined by storing irradiated samples at 100°C for two weeks and appropriate age corrections were made. Samples exhibiting a short-term fading greater than 15% were discarded in most cases. Gamma and cosmic ray dose rates were measured on site by scintillation counting. The beta dose rates stated in the tables are infinite matrix dose rates. The average dose to a grain will depend on its size and its content of potassium (K), rubidium (Rb), uranium (U) and thorium (Th). The contributions from Rb and Th were calculated from the measured contents of K and U, respectively (Mejdahl 1987b). Sources of error and dating uncertainties are discussed in Mejdahl (1989).

TL DATING RESULTS, DENMARK

1. Højgård, Gram

The excavation carried out in 1987 by Haderslev Museum (j.no. HAM 1706) under the direction of Per Ethelberg (Ethelberg 1989) was a continuation of excavations carried out in 1984 and 1985 (Ethelberg 1986). The excavations comprised a considerable number of Bronze Age longhouses. Many of the houses were characterized by having pits of burnt stones inside at the west end, a feature unknown from other periods. The material extracted for TL dating comprised ceramics from a posthole in House I and burnt stones from pits in House XIV. The TL dates and relevant data are shown in Tables 2 and 3.

TL dates for burnt stones from the 1985 excavation are discussed in Mejdahl (1986). Severe short-term fading problems were encountered for some of these samples. At that time we obtained fading corrections by storing samples at room temperature, but this turned out to be inadequate. The study of short-term fading of these samples lead to our present procedure: storage at 100$^{0}$C for two weeks.

Table 2. Water uptake W (saturation), gamma and beta dose rates, U (uranium) content of grains, fading of feldspars and TL dates for samples of ceramics (C) from House I and burnt stones (S) from pits in House XIV at Højgård.

| TL no. | Material | W(%) | Dose rate (Gy/ka) | | U | Fading | TL date |
|---|---|---|---|---|---|---|---|
| | | | Gamma | Beta | (ppm) | 100$^{0}$C | |
| R-871101 | C | 16 | 0.53 | 2.49 | 0.10 | 0.82 | 1240+-200 BC |
| R-871102 | C | 18 | 0.53 | 3.28 | 0.10 | 0.90 | 1480+-250 BC |
| R-881103 | S | 2 | 0.96 | 1.16 | 0.30 | 0.94 | 1730+-200 BC |
| R-881106 | S | 2 | 0.86 | 5.47 | 0.20 | 0.90 | 1260+-200 BC |
| R-881108 | S | 2 | 0.84 | 5.56 | 1.50 | 0.94 | 1390+-200 BC |
| R-881110 | S | 2 | 0.84 | 6.68 | 1.30 | 0.87 | 1350+-200 BC |
| R-881111 | S | 2 | 0.84 | 3.02 | 0.50 | 0.93 | 1350+-200 BC |
| R-881113 | S | 4 | 0.94 | 0.41 | 0.10 | 1.00 | 1270+-200 BC |

The TL dates may be compared with a number of radiocarbon dates from Copenhagen (K) and the AMS laboratory, Uppsala (Ua). The radiocarbon dates have been calibrated using tables from Stuiver and Becker (1986). TL and calibrated C-14 dates are assembled in Fig. 1.

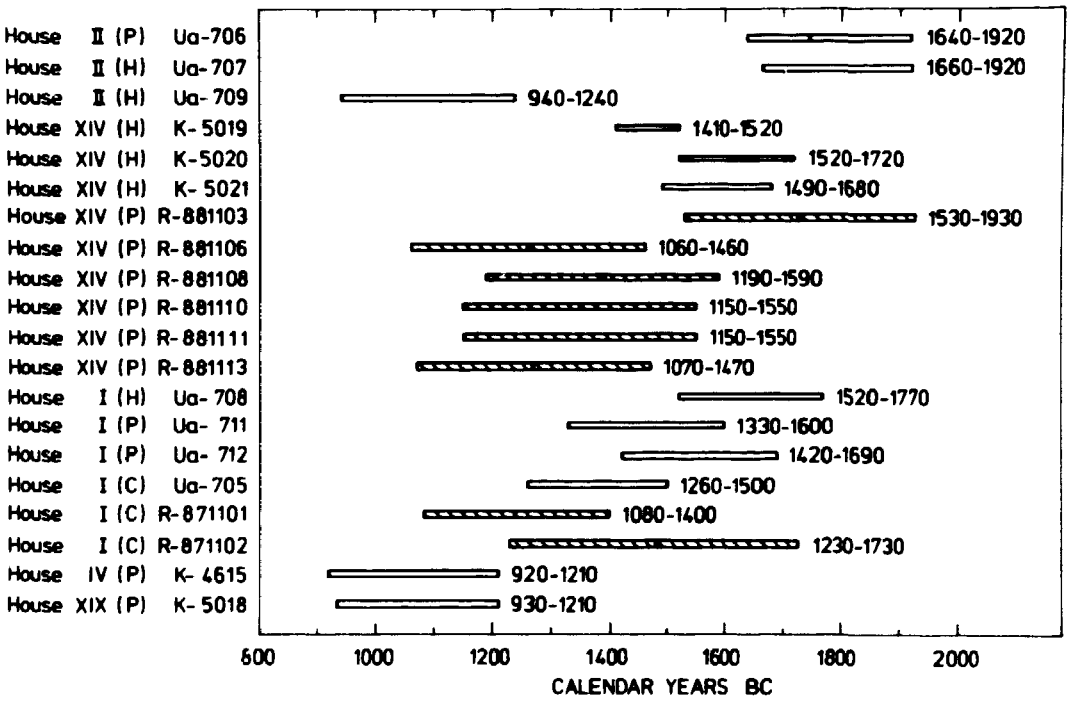


Fig. 1. TL and C-14 dates for samples from Højgård. The symbols signify: P = pit, H = posthole, C = ceramics. Except when marked C the TL dates are for burnt stones. The C-14 dates are for charcoal, except Ua-705 which was charred food remains on ceramics. The pit from which the charcoal for K-4615 was taken was stratigrafically younger than House IV. Modified from Ethelberg (1989).

It is clear from Fig. 1 that the TL dates have a somewhat larger uncertainty than the C-14 dates. The uncertainty of a TL date is caused mainly by measurement errors and is usually 5-6% of the age. Expressed in years, it, therefore, increases with increasing age and from about 1000 BC it exceeds that of a C-14 date.

A comparison of TL and C-14 results is possible for House I and House XIV. When comparing the two methods, it should be noted that, especially for charcoal, the C-14 method dates an event, the formation of wood, which may preceed the application by a hundred years or more.

For House I there is good agreement between most of the results. It is especially interesting to note the agreement of Ua-705, made on charred food remains on ceramics with the TL dates obtained for the ceramics. The C-14 dates for charcoal are somewhat older than that for food remains. A comparison of Ua-705 and Ua-708 indicates that the charcoal could be from wood that was more than 200 years old at the time of burning.

For House XIV, six TL dates may be compared with three C-14 dates obtained at the Copenhagen laboratory. Five of the TL dates are clearly more recent than two of the C-14 dates. Considering that the charcoal used could have been from old wood, it is not possible to tell whether the apparent age difference is significant.

## 2. Sdr. Novrupvej, near Esbjerg

The site was excavated in 1986 by Esbjerg Museum (j.no. ESM 1525) under the direction of Ulla Mejdahl (U. Mejdahl 1989). Earlier TL dates for ceramics and burnt stones from the site have been discussed by Mejdahl (1988). The present dating problem concerned a house (House VII) from the Late Single Grave period. Inside the house two cooking pits with burnt stones were found. The question was whether the pits were contemporaneous with the house or from a later period. The placing of pits inside houses, a common feature in the Bronze Age, is unknown in earlier periods.

Two burnt stones, both from pit GE were dated. Dose rate data and TL dates are shown in Table 3.

Table 3. Dose rate data and TL dates for burnt stones from pit GE in House VII, Sdr. Novrupvej.

| TL no. | W(%) | Dose rate (Gy/ka) | | U | Fading | TL date |
|---|---|---|---|---|---|---|
| | | Gamma | Beta | (ppm) | $100^{o}C$ | |
| R-882007 | 3 | 0.65 | 6.75 | 1.0 | 0.95 | 1610+-200 BC |
| R-882009 | 3 | 0.65 | 2.75 | 0.8 | 0.92 | 2290+-250 BC |

The large difference between the two results precludes the assignment of the pit to one or the other of the two periods in question.R-882007 is regarded as the more reliable because of the higher beta dose rate and because it is based on four grain sizes as against two for R-882009. However, a Stone Age date for some of the stones cannot be excluded and the problem, therefore, remains unsolved.

## 3. Jens Kusksvej, Tjæreborg

The site, an extensive habitation area, was excavated by Esbjerg Museum (ESM 1566) in the period 1987-89 under the direction of Palle Siemen. The TL dating comprised two burnt stones from pit FA near House VI. The estimated age was Late Bronze or Early Pre-Roman Iron Age. Dose rate data and TL dates are shown in Table 4.

Table 4. Dose rate data and TL dates for burnt stones from pit FA near House VI.

| TL no. | W(%) | Dose rate (Gy/ka) | | U | Fading | TL date |
|---|---|---|---|---|---|---|
| | | Gamma | Beta | (ppm) | 100°C | |
| R-882004 | 1 | 0.70 | 0.24 | 0.15 | 1.00 | 730+-160 BC |
| R-882006 | 2 | 0.81 | 0.26 | 0.20 | 0.95 | 700+-150 BC |

The stones contained no K-feldspar and the beta dose rate was exceptionally low. The result for R-882004 was based exclusively on quartz, while quartz and sodium feldspar were used for R-882006. The results agree well with the estimated age.

## 4. Damgård I, Albertslund

The site, a habitation place, was excavated in 1987 by Søllerød Museum (j.no. SØL 297) under the direction of Eliza Fonnesbech-Sandberg. Ceramics from postholes in two houses III and XV were dated. House III was

estimated to be from the Early Germanic Iron Age and the age of House XV was expected to be within the period Late Roman Iron Age - Viking Age. Dose rate data and TL ages are shown in Tables 5 and 6.

Table 5. Dose rate data for ceramics from Damgård I.

| TL no. | W(%) | Dose rate (Gy/ka) | | U | Fading |
|---|---|---|---|---|---|
| | | Gamma | Beta | (ppm) | 100°C |
| R-883901 | 11 | 1.07 | 2.28 | 0.20 | 0.91 |
| R-883902 | 7 | 1.11 | 3.21 | 0.20 | 0.94 |

Table 6. TL dates for ceramics from Damgård I.

| TL no. | House | Postholes | TL date |
|---|---|---|---|
| R-883901 | XV | (531,532) | 1360 +- 160 BC |
| R-883902 | III | (493,500) | 140 +- 120 AD |

The result for R-883902 is consistent with the expected age within the uncertainty. However, the TL date for R-883901 is considerably older than expected. House XV was small and had a very unusual construction. The excavator does not exclude the possibility that it could be from the Bronze Age as indicated by the TL dates. Alternatively, the hole from which the material was taken might not belong to House XV.

## 5. Torstorp-skolen, Høje Taastrup

The site, a farmstead, was excavated in 1987 by Søllerød Museum (j.no. SØL 293) under the direction of Eliza Fonnesbech-Sandberg. The habitation was estimated to date from the Early Germanic Iron age. Ceramics and burnt clay from postholes were submitted for TL dating. Dose rate data and TL dates are shown in Tables 7 and 8.

Table 7. Dose rate data for ceramics (C) and burnt clay (L) from Torstorp-skolen.

| TL no. | Material | W(%) | Dose rate (Gy/ka) | | U | Fading |
|---|---|---|---|---|---|---|
| | | | Gamma | Beta | (ppm) | 100°C |
| R-883903 | C | 14 | 1.00 | 3.47 | 0.20 | 0.91 |
| R-883904 | L | 21 | 0.93 | 2.02 | 0.30 | 0.89 |

Table 8. TL dates for ceramics (C) and burnt clay (L) from Torstorp-skolen.

| TL no. | Material | House | Postholes | TL date |
|---|---|---|---|---|
| R-883903 | C | I | 94 | 520+-150 AD |
| R-883904 | L | III | 195 | 280+- 90 AD |

The result for R-883903 has a rather large uncertainty because it is based on only two grain size fractions. By contrast, the result for R-883904 is based on seven grain size fractions and has a standard mean error of only 3%. Within the uncertainty the results agree with the archaeological estimate, but indicate that the two houses may have a slightly different age. From a study of the house types the excavator agrees that the two houses were probably not contemporaneous. She estimates, however, that House I followed immediately after House III. This estimate is not in conflict with the two TL dates.

## 6. Lykkebækparken, Køge

The site, comprising two farmsteads, was excavated in 1987 by Køge Museum (KØM 1287) under the direction of Svend Åge Tornbjerg. The estimated age of the farmsteads was 300-600 AD. The site was situated a few hundred metres from the Iron Age village Bellingegård excavated in 1983. The TL dating of clay and ceramics from Bellingegård is described

in Mejdahl (1984). From Lykkebækparken two samples of ceramics found in postholes were submitted for TL dating. Dose rate data and TL dates are shown in Tables 9 and 10.

Table 9. Dose rate data for ceramics from postholes from Lykkebækparken.

| TL no. | W(%) | Dose rate (Gy/ka) | | U | Fading |
|---|---|---|---|---|---|
| | | Gamma | Beta | (ppm) | $100^{o}C$ |
| R-882201 | 16 | 0.97 | 3.31 | 0.20 | 0.87 |
| R-882202 | 13 | 1.03 | 3.41 | 0.20 | 0.92 |

Table 10. TL dates for ceramics from postholes from Lykkebækparken.

| TL no. | House | Posthole | TL date |
|---|---|---|---|
| R-882201 | I | 2 | 560 +- 70 AD |
| R-882202 | II | 1 | 580 +- 150 AD |

The result for R-882202 has a rather large uncertainty because the sample was very small. The results agree well with the archaeological estimate and indicate that the two houses were contemporaneous with the latest phase at Bellingegård.

## TL DATING RESULTS, SWEDEN

### 1. Gumbalde and Ajvide, Gotland

The Stone Age habitation at Gotland has been studied extensively by Inger Österholm (1989). Ceramics from two of the areas studied, Mölner-Gullarve and Ajvide, were submitted for TL dating in 1986. Dating re-

sults are discussed in Mejdahl (1987a). In 1988, ceramics from Gumbalde and an additional series of ceramics from Ajvide were submitted for dating.

The samples received were large, 250-350 g, but it turned out that they had all been tempered with crushed limestone. The amount of quartz and feldspar larger than 0.1 mm was, therefore, extremely small. In some cases where separation of quartz and alkali feldspar was not possible, the dating was made on a mixture of quartz and feldspar. Dose rate data and TL dates are given in Tables 11 and 12.

Table 11. Dose rate data for ceramics from Gumbalde (G) and Ajvide (A). A gamma dose rate of 0.65 Gy/ka was assumed for all samples based on measurements at two places at Ajvide.

| TL no. | Locality | W(%) | Dose rate (Gy/ka) | | U | Fading |
|---|---|---|---|---|---|---|
| | | | Gamma | Beta | (ppm) | 100°C |
| R-880601 | G | 14 | 0.65 | 2.78 | 0.30 | 0.95 |
| R-880602 | G | 14 | 0.65 | 2.94 | 0.20 | 0.91 |
| R-880603 | A | 15 | 0.65 | 2.61 | 0.20 | 0.97 |
| R-880604 | A | 15 | 0.65 | 2.31 | 0.20 | 0.98 |
| R-880605 | A | 14 | 0.65 | 2.68 | 0.20 | 0.97 |
| R-880606 | A | 17 | 0.65 | 2.81 | 0.20 | 0.86 |
| R-880607 | A | 16 | 0.65 | 3.22 | 0.20 | 0.97 |
| R-880608 | A | 16 | 0.65 | 3.42 | 0.20 | 0.98 |
| R-880609 | A | 10 | 0.65 | 2.34 | 0.20 | 0.94 |
| R-880610 | A | 11 | 0.65 | 2.37 | 0.20 | 0.92 |
| R-880611 | A | 9 | 0.65 | 2.65 | 0.20 | 0.93 |
| R-880612 | A | 9 | 0.65 | 2.24 | 0.20 | 0.93 |

Table 12. TL dates for ceramics from Gumbalde (G) and Ajvide (A). The designations in the column "Minerals" have the following meaning: FA = alkali feldspar, QF = mixture of quartz and feldspar (unseparated sample treated with 10% HF for 40 minutes).

| TL no. | Locality | Sample no. | Minerals | Grain size (mm) | TL date |
|---|---|---|---|---|---|
| R-880601 | G | S1 | FA | 0.1-0.3 | 3480+-300 BC |
| R-880602 | G | S2 | FA | 0.1-0.5 | 3000+-300 BC |
| R-880603 | A | S13 | QF | 0.1-0.5 | 1420+-300 BC |
| R-880604 | A | S14 | FA | 0.1-0.5 | 2320+-300 BC |
| R-880605 | A | S15 | FA | 0.1-0.5 | 1820+-300 BC |
| R-880606 | A | S16 | QF | 0.1-0.5 | 2930+-300 BC |
| R-880607 | A | S17 | QF | 0.1-0.3 | 2390+-300 BC |
| R-880608 | A | S18 | QF | 0.1-0.5 | 2290+-300 BC |
| R-880609 | A | S19 | QF | 0.1-0.5 | 4190+-400 BC |
| R-880610 | A | S20 | FA | 0.1-0.5 | 3710+-400 BC |
| R-880611 | A | S21 | FA | 0.1-0.5 | 3210+-400 BC |
| R-880612 | A | S22 | QF | 0.1-0.5 | 2700+-400 BC |

In spite of the large uncertainties of the results a certain consistency is apparent. The two samples from Gumbalde appears to be of the same age. Excluding S13 with a bronze Age date and S16, the remaining results for samples from Ajvide fall into two groups: S14, S15, S17 and S18 with TL dates around 2000-2300 BC and S19-S22 which are considerably older. The division into two groups is parallelled by the water up-take values in Table 11 which indicate that the ceramics in the two groups have different fabrics. However, because of the extremely small samples available for dating it is not possible to draw detailed conclusions from the results.

## 2. Eklundshov, Botkyrka

The site at Eklundshov (fornl. 254) comprised settlements from different periods: Mesolithic, Neolithic and Late Bronze/Early Iron Age. It was excavated in 1986 by Per Gustafsson, Eva Olsson and Agneta

Åkerlund, Riksantikvarieämbetet, Stockholm. Burnt stones for TL dating were extracted from three hearths A2, A11 and A40. Two of the hearths, A2 and A40, had been excavated before the measuring of gamma radiation and had to be reconstructed around the probe of the scinttillation counter.

Since it was impossible to reconstruct precisely the position of the stones taken for daten, the gamma dose rate measured may be different from that experienced by the stones in situ. The resulting uncertainty in gamma dose rate is estimated to be around 15%. Dose rate data and TL dates are shown in Table 13.

Table 13. Dose rate data and TL dates for burnt stones from Eklundshov. W is rot given because the beta dose rate was measured on wet samples.

| TL no. | Unit | Dose rate (Gy/ka) | | U | Fading | TL date |
|---|---|---|---|---|---|---|
| | | Gamma | Beta | (ppm) | 100°C | |
| R-864102 | A2 | 1.37 | 6.38 | 0.20 | 0.95 | 5570+-400 BC |
| R-864103 | A2 | 1.37 | 6.38 | 0.10 | 0.82 | 5240+-400 BC |
| R-864104 | A11 | 1.23 | 5.18 | 0.20 | 0.93 | 560+-150 BC |
| R-864105 | A40 | 1.37 | 3.07 | 0.15 | 0.94 | 1100+-200 BC |
| R-864107 | A40 | 1.37 | 4.94 | 0.20 | 0.96 | 360+-200 BC |
| R-864108 | A40 | 1.37 | 4.16 | 0.15 | 0.96 | 780+-200 BC |

The TL ages for A2 are clearly Mesolithic, as expected, while the remaining four are consistent with a Late Bronze/Early Iron Age date. The results for A40 show a relatively large scatter which, probably, is caused by the uncertainty in gamma dose rate. The mean value of the three results for A40 is 750 BC with a standard mean error of +- 214 years.

Charcoal from A2 has been submitted for radiocarbon dating at Uppsala. A preliminary result for the sample is around 7500 BP, in good agreement with the TL dates.

## 3. Masmo, Huddinge

The site, a habitation area, was excavated in 1984 by Agneta Åkerlund and Eva Olsson, Riksantikvarieämbetet, Stockholm. From the occurrence of pitted ware ceramics the site was estimated to be Neolithic. However, some Iron Age hearths were also found. Three sherds of pitted ware ceramics were submitted for TL dating but one was too small for dating. Dose rate data and TL dates are shown in Table 14.

Table 14. Dose rate data and TL dates for pitted ware ceramics from Masmo

| TL no. | Unit | W(%) | Dose rate (Gy/ka) | | U | Fading | TL date |
|---|---|---|---|---|---|---|---|
| | | | Gamma | Beta | (ppm) | $100^{o}C$ | |
| R-884102 | FA 117 | 13 | 1.22 | 4.21 | 0.40 | 0.82 | 2320+-200 BC |
| R-884103 | FA 143 | 13 | 1.22 | 3.91 | 0.20 | 0.96 | 1830+-200 BC |

A late Neolithic or Early Bronze Age is indicated by the results.

The TL ages are more recent than the period of production and primary use of the vessels estimated by the excavators on the basis of shape and decoration. It is conceivable that some sherds could have been exposed to secondary heating since earlier TL measurements on similar sherds (unpublished) gave older results.

## 4. Frösunda Berg

A number of burnt stones from the ancient hill-fort at Frösunda Berg were submitted for TL dating by Michael Olausson, The Archaeological Research Laboratory, University of Stockholm. Dose rate data and TL dates are given in Table 15.

Table 15. Dose rate data and TL dates for burnt stones from the ancient hill-fort at Frösunda Berg, Raä 3, A1, Schakt 2.

| TL no. | W(%) | Dose rate (Gy/ka) Gamma | Beta | U (ppm) | Fading 100°C | TL date |
|---|---|---|---|---|---|---|
| R-874410 | 1 | 1.32 | 5.34 | 1.00 | 0.98 | 90+-150 BC |
| R-874411 | 2 | 1.32 | 2.28 | 0.35 | 0.98 | 490+-150 AD |
| R-874413 | 1 | 1.32 | 3.58 | 0.40 | 1.00 | 440+-100 AD |
| R-874414 | 2 | 1.32 | 3.22 | 2.00 | 0.97 | 100+-150 AD |

Table 15 shows that the grains have exceptionally large uranium contents. For R-874414 the contribution from uranium and thorium in the grains amounts to about 25% of the total dose rate. Because the uncertainty in the determination of uranium and thorium is rather large, the result for R-874414 must be treated with caution.

Taking the results at face value they indicate the presence of two phases of the hill-fort, one around 460 AD and the other about 100 AD.

Three radiocarbon dates were obtained for Frösunda Berg and the results are listed in Table 16.

Table 16. Radiocarbon dates for material from the hill-fort at Frösunda Berg.

| Lab No. | Unit | C-14 date | Cal. C-14 date *) |
|---|---|---|---|
| Ua-434 | Schakt 1 | 1700 BP +- 100 | 430 - 190 AD |
| Ua-923 | Schakt 2 | 1665 BP +- 115 | 530 - 230 AD |
| St-11510 | Schakt 2 | 1535 BP +- 70 | 600 - 430 AD |

*) Stuiver and Becker (1986).

Ua-434 and St-11510 were from burnt wood in the wall construction while Ua-923 was taken underneath the lowest stones in the wall where the context was less certain.

The two most recent TL dates agree well with the radiocarbon dates.

## 5. Lingsberg near Vallentuna

The ancient hill-fort at Lingsberg (fornl. 266) is included in the studies of ancient hill-forts carried out by Michael Olausson. A number of burnt stones and a sample of burnt clay from an adjacent kiln have been dated earlier (Mejdahl 1986). The present study comprised a burnt stone from a different locality A5 at Lingsberg. Dose rate data and the TL date obtained are given in Table 17.

Table 17. Dose rate data and TL date for a burnt stone from A5 at the ancient hill-fort at Lingsberg.

| TL no. | W(%) | Dose rate (Gy/ka) | | U | Fading | TL date |
|---|---|---|---|---|---|---|
| | | Gamma | Beta | (ppm) | 100°C | |
| R-874417 | 1 | 1.77 | 4.01 | 0.40 | 0.97 | 190+-150 BC |

The locality A5 was interpreted by the excavator as a place for fire-assisted cutting of stones for the wall of the hill-fort. Stones found at the hill-fort were identical with those found at A5.

The TL date 190 +- 150 BC (R-871417) is thus taken to indicate the time of construction of the hill-fort while the TL date 180 +- 110 AD (average of three dates, Mejdahl 1986) obtained for burnt stones from the wall of the hill-fort is seen as the time of its destruction. The TL dates fit well into this interpretation.

## 6. Kyrktorp, Grödinge

During excavation of the Iron Age site at Grödinge in 1987 by P. Gustafsen, E. Olsson and A. Åkerlund a trench was made in the ancient hill-fort at Kyrktorp (fornl. 583, A1) and samples were taken for C-14 dating (not yet completed). During a visit to Kyrktorp in October 1987 by Michael Olausson and the author burnt stones were taken from the trench section for TL dating. Dose rates and TL dates obtained for two stones are given in Table 18.

Table 18. Dose rate data and TL dates for burnt stones from the ancient hill-fort at Kyrktorp, fornl. 583, Al.

| TL no. | W(%) | Dose rate (Gy/ka) Gamma | Beta | U (ppm) | Fading $100^{o}C$ | TL date |
|---|---|---|---|---|---|---|
| R-874419 | 1 | 1.24 | 5.76 | 0.50 | 1.00 | 220+-120 BC |
| R-874420 | 2 | 1.24 | 2.53 | 0.40 | 0.97 | 350+-150 BC |

The results agree well with the age expected by Michael Olausson.

## 7. Birka, Björkö

Excavations at the Viking Age habitation at Birka (Raä 118) are carried out by Lena Holmquist Olausson, The Archaeological Research Laboratory, University of Stockholm. In 1987, part of the city wall was excavated (Olausson 1988) and in 1988 the excavation was extended to the habitation area next to the wall. During the 1988 excavation a number of burnt stones were extracted for TL dating. Dose rate data and TL dates for these stones are given in Tables 19 and 20.

Table 19. Dose rate data for burnt stones from Birka.

| TL no. | W(%) | Dose rate (Gy/ka) Gamma | Beta | U (ppm) | Fading $100^{o}C$ |
|---|---|---|---|---|---|
| R-880902 | 5 | 1.62 | 3.48 | 0.20 | 0.92 |
| R-880905 | 2 | 1.44 | 3.01 | 0.10 | 0.89 |
| R-880907 | 1 | 1.46 | 4.20 | 0.10 | 0.93 |
| R-880909 | 3 | 1.46 | 7.01 | 0.20 | 0.98 |
| R-880911 | 2 | 1.40 | 2.34 | 0.08 | 1.00 |
| R-880915 | 4 | 1.54 | 3.69 | 1.50 | 0.93 |
| R-880916 | 2 | 1.29 | 5.60 | 0.20 | 0.96 |

Table 20. TL dates for burnt stones from Birka.

| TL no. | Locality | TL date |
|---|---|---|
| R-880902 | Town wall, area C | 950+- 50 AD |
| R-880905 | Hearth, A105 | 860+- 80 AD |
| R-880907 | Hearth, A104 | 710+- 80 AD |
| R-880909 | Hearth, A104 | 920+- 60 AD |
| R-880911 | Pit, A128 | 860+-100 AD |
| R-880915 | Pit from Smithy, A106 | 240+-160 AD |
| R-880916 | Layer 4 (304, 206) | 730+- 60 AD |

Two radiocarbon dates have been obtained for the wall (Olausson 1988): 1160+-100 BP (St-11204) and 1165+-70 BP (St-11512). Calibrated (Stuiver and Becker 1986) they give the following ranges:

St-11204: 694-990 AD
St-11512: 775-979 AD

The TL date (R-880902) falls within the range of the radiocarbon dates. However, since the stone submitted for dating came from the oldest part of the wall, a somewhat older date was expected.

The TL dates are too few to ascertain whether there might be age differences between the three hearths/pits A104, A105 and A128. The rather large difference between the dates for the two stones from A104 contributes to obscuring any age differences. The most probable interpretation is that the constructions are contemporaneous within the dating uncertainty. The average TL date is 840+-50 AD. The uncertainty is the statistical mean error of the four results.

Pit A106 was interpreted as waste from a smithy. It was thought that the pit might be from a younger phase. The TL date (R-880915), on the other hand, indicate that the pit might be older than the Viking period. It should be noted that the sample was not well suited for dating, because the grains had an exceptionally high content (1-2 ppm) of uranium. Because the uranium might be associated predominantly with a small number of darker grains present in the sample, it is very difficult to obtain an accurate estimate of the alpha dose contribution from

internal uranium and thorium. However, even with these reservations, the TL date for A106 is distinctly older than those of the other constructions at the site.

Layer 4 is a cultural layer containing remains of a structure which was burnt down, possibly the oldest house at the site. The TL date, 730 AD (R-880916) agrees with this assumption, but shows that the house still belongs to the Viking period.

## TL DATES, FINLAND

### 1. Kuhmoinen, Linnavuori

Burnt stones from a number of hearths and a wall from the ancient hillfort at Kuhmoinen were submitted for TL dating by Jukka-Pekka Taavitsainen. Gamma dose rates were measured on site by Högne Jungner. Dose rate data and TL dates are given in Table 21.

Table 21. Dose rate data and TL dates for burnt stones from Kuhmoinen.

| TL no. | Locality | W(%) | Dose rate (Gy/ka) | | U | Fading | TL date |
|---|---|---|---|---|---|---|---|
| | | | Gamma | Beta | (ppm) | 100°C | |
| R-871309 | Mound 3 | 2 | 1.25 | 2.80 | 0.25 | 0.94 | 1070+-70 AD |
| R-871310 | Mound 3 | 2 | 1.25 | 2.16 | 0.30 | 0.88 | 1080+-50 AD |
| R-871313 | Mound 3 | 3 | 1.25 | 2.49 | 0.30 | 0.93 | 1070+-50 AD |
| R-871315 | Mound 11 | 3 | 1.38 | 2.68 | 0.15 | 0.93 | 1270+-50 AD |
| R-871319 | Mound 20 | 3 | 1.17 | 2.48 | 0.30 | 0.92 | 1100+-50 AD |
| R-871322 | Wall | 2 | 1.29 | 2.84 | 0.25 | 1.00 | 1070+-60 AD |
| R-871323 | Wall | 3 | 1.29 | 3.16 | 0.20 | 0.89 | 1140+-60 AD |
| R-871325 | Mound 24 | 3 | 1.11 | 2.26 | 0.40 | 0.91 | 1040+-90 AD |

On archaeological grounds Jukka-Pekka Taavitsainen estimates the age of Kuhmoinen to the range 1025-1300 (Taavitsainen, letter of 15 December 1988). All TL dates are well within this range.

## 2. Nukkumajoki, Inari

Christian Carpelan, Department of Archaeology, University of Helsinki, is carrying out an extensive study of ancient Saami winter dwelling sites near Lake Inari, North Finland. A large number of hearths with burnt stones were excavated and in 1987 a number of burnt stones from hearths were submitted for TL dating. The environmental gamma radiation was measured on site by Högne Jungner. Dose rate data and TL dates are given in Table 22.

Table 22. Dose rate data and TL dates for burnt stones from hearths of Nukkumajoki, 68°53′ N, 27°05′ E.

| TL no. | Hearth no. | W(%) | Dose rate (Gy/ka) Gamma | Beta | U (ppm) | Fading 100°C | TL date |
|---|---|---|---|---|---|---|---|
| R-871332 | N2k7 | 3 | 0.80 | 2.18 | 0.10 | 0.94 | 1610+-40 AD |
| R-871334 | N2k16 | 2 | 0.78 | 1.75 | 0.05 | 0.85 | 1500+-40 AD |
| R-871335 | N2k16 | 2 | 0.78 | 3.87 | 0.10 | 1.00 | 1450+-40 AD |
| R-871336 | N4k3 | 1 | 0.73 | 1.16 | 0.10 | 0.96 | 1540+-60 AD |
| R-871339 | N4k8 | 2 | 0.64 | 2.11 | 0.10 | 0.91 | 1530+-50 AD |
| R-871340 | N4k8 | 2 | 0.64 | 3.11 | 0.40 | 0.94 | 1520+-50 AD |
| R-871342 | N68k3 | 3 | 0.64 | 2.30 | 0.20 | 0.97 | 1390+-60 AD |

A large number of radiocarbon datings have been made (a total of 79) of bone, wood and charcoal samples from Nukkumajoki 2 (N2). From a careful discussion of dates for wood and charcoal Carpelan and Kankainen (1988) conclude that this site was occupied between AD 1480 and AD 1580. The three TL dates for N2 are consistent with this estimate. Also the remaining four TL dates agree with expected ages. N68k3 (R-871342) was expected to be older than the other dates.

CONCLUSION

A total of 67 TL dates representing 15 sites are discussed. TL dates for 11 of these sites agree well with expected ages or radiocarbon dates. The remaining 4 sites will be discussed briefly.

Højgård, Gram. Bronze age habitation place with habitation (not necessarily continuous) over the period 1000-1900 BC according to radiocarbon dates. Two TL dates for ceramics agree well with an AMS date obtained for charred food remains on the ceramics. In general, however, the TL dates (for burnt stones) are about 250 years more recent than the C-14 dates. Because the C-14 dates were made on charcoal, the possibility exists that at least part of the difference could be explained by the inherent age of the wood at the time of burning.

Sdr. Novrupvej, near Esbjerg. The problem at hand was whether cooking pits found inside a house from the Late Single Grave period belonged to the house or whether they were from the Bronze Age. Two burnt stones from the same pit gave TL ages that differed by nearly 700 years and the problem could, therefore, not be solved. It is not inconceivable that two stones from different periods can be found in the same pit. In the present case one would have to assume that the pit was made in the Bronze Age and that a burnt stone from the earlier period had accidentally ended up in the pit. The problem could be clarified by dating more stones from the pits.

Damgård I, Albertslund. Two samples of ceramics from two different house were dated. One of the TL dates was consistent with the estimated age: Early Germanic Iron Age while the other was much older and indicated Early Bronze Age.

There are three possible explanations of the discrepancy:

1) The older TL date is in error. It is extremely unlikely, however, that the date could be in error by 1500 years.

2) The hole from which the sample was taken does not belong to the house in question.

3) The house is from the Bronze Age.

The excavator considers both 2) and 3) as possibilities. The house was small and of a very irregular construction, a feature known from Bronze Age houses in the area.

Masmo, Huddinge. Two single sherds of pitted ware ceramics were dated and the TL dates indicated Late Neolithic or Early Bronze Age. This is in contrast with the expected age which was the central part of the Neolithic. There is no immediate explanation of this discrepancy. The excavator suggested that the sherds might have had a secondary heating, but there was not sign of this.

For the majority of sites the TL dates have been consistent with other dating evidence and have provided valuable information. The method is most useful within the last three millennia where the uncertainty is comparable to that of the radiocarbon method. TL dating has been particularly useful for dating ancient Swedish hill-forts with their abundance of burnt stones.

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**Abstract (Max. 2000 char.)**

A survey is given of archaeological samples dated in 1988 at the Nordic Laboratory for Thermoluminescence Dating. A total of 67 samples were dated. The results were corrected for short-term fading of feldspars as measured for samples stored at room temperature for four weeks or at 100°C for two weeks. The beta dose from potassium and rubidium in feldspar, and the alpha dose from uranium and thorium in quartz and feldspar were included assuming alpha efficiency factors of 0.1 for quartz and 0.2 for feldspar.

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