INTERPRETATION OF EXPECTED AND UNEXPECTED RESULTS FROM MULTI-METHOD ANALYSES OF A PWC POTTERY CONTEXT

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Abstract

This paper reports on the Pitted Ware Culture site Masmo 2 in Eastern Middle Sweden, where multi-method datings were carried out. The methods applied were *radiocarbon dating* of charcoal from features and of organic crusts on sherds, *luminescence dating* of the tempering of ceramic samples, *artefact dating* and *shoreline dating*. Interpretations of temporal relationships presuppose reliable dates, and in this case the dates from the various methods do not always agree. The author calls for more joint attempts at correlating dates between methods and rejects the separation of observation from interpretation in excavation strategy.

Introduction

Chronological determinations are not the ultimate purpose of this paper. The purpose is rather to explain the relationship between particular archaeological remains when one is attempting to find out about the past. But in order to form chronological judgements, we must obtain an understanding of the reliability of the available methods.

There is seldom an abundance of information available concerning the chronological relations of site remains, and it is therefore regarded as a good idea to make use of several methods, so that the results can be compared. There are both *relative* archaeological dating methods (Gräslund 1987, 1996) and *absolute* scientific methods (Aitken 1990) available for placing traces from the past in their temporal context. Relative dating methods are based on interpretations of likenesses and distincions and are capable of suggesting that one thing is older than another, while absolute dating methods are based on measurable quantities and are particularly important for dating remains from prehistoric settlement sites, since there are generally very few means of doing this. Absolute dates have considerable uncertainty margins, however, and are in a way approximate, too. No absolute dating method is ready to use without discussion, *i.e.* as a routine procedure (*cf.* I. Olsson 1989:173).

This paper is concerned with two relative dating methods (artefact dating and shoreline dating) and two absolute dating methods (radiocarbon dating and luminescence dating). Some results deviate from the expected ages more than can be readily accepted. The importance of getting to know the temporal distribution of finds during the fieldwork is stressed, and the difficulties encountered in evaluating dates obtained by different methods against each other are pointed out.

The Masmo site

The starting point for this paper is the Stone Age site at Masmo on the Södertörn Peninsula, *ca* 20 km south of Stockholm (Fig. 1). The site was found and characterised as

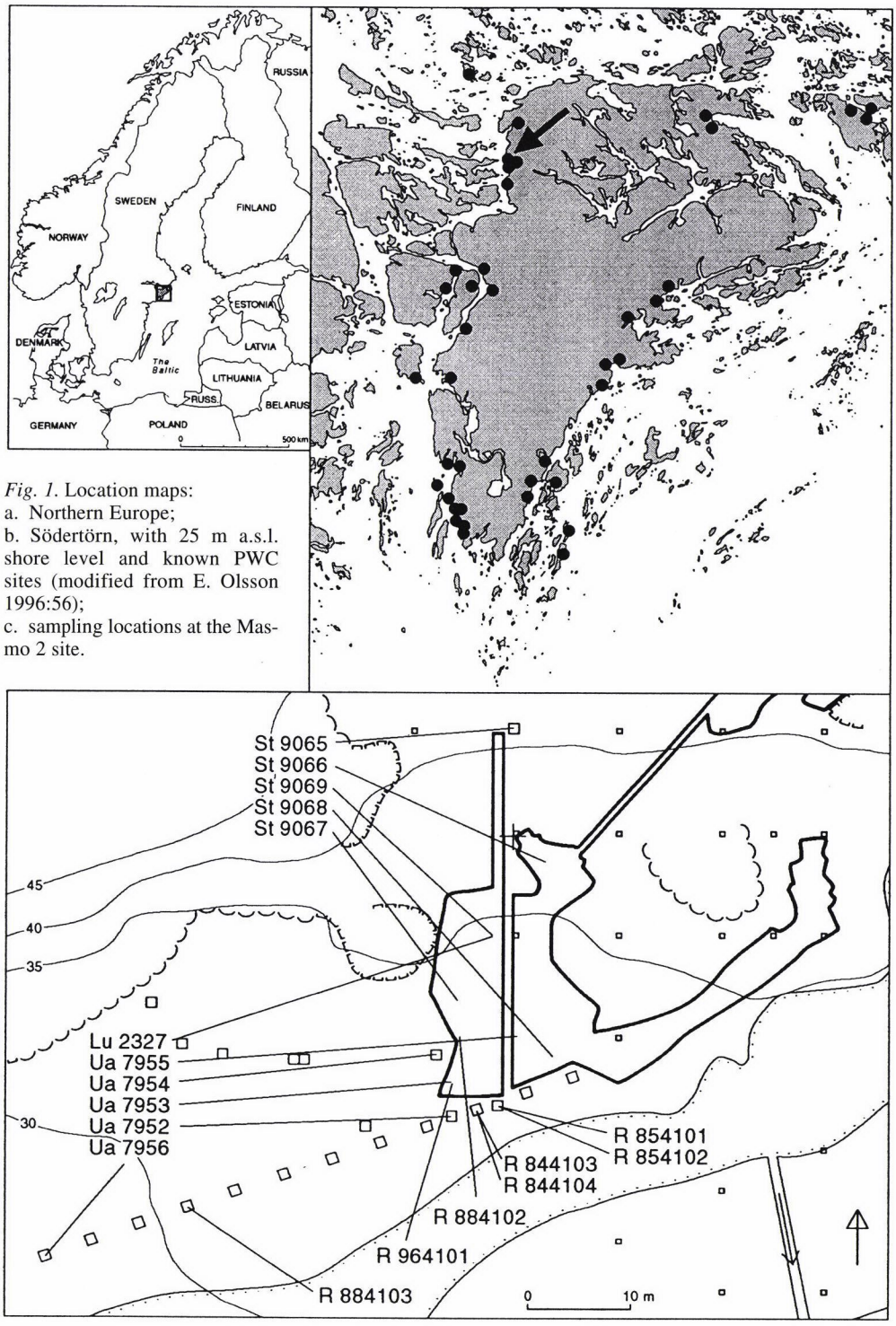

Fig. 1. Location maps:
a. Northern Europe;
b. Södertörn, with 25 m a.s.l. shore level and known PWC sites (modified from E. Olsson 1996:56);
c. sampling locations at the Masmo 2 site.

a Pitted Ware Culture (PWC) site in 1935, and was partially excavated in the early 1980s. Post-excavation analysis has been a drawn out process, and the delayed report is now in preparation (Åkerlund & E. Olsson ms). At present, some 40 PWC sites are known in the Södertörn area, half of which have been preliminarily excavated. They are located only in connection with the contemporary coast (Fig. 1b). Hearths and waste pits were found at Masmo 2 together with large numbers of PWC sherds with a richly diversified decoration.

Questions

The main topic of interest is to find out whether the many different types of pottery represent different stages of production or whether they are characteristic of various contemporary groups. It was regarded as possible that the settlement remains at this open site might represent different periods in time, but are there artefacts or circumstances within the area suggesting recurring visits? Can the remains be regarded as an accumulation of repeated deposits, or do they represent a mass deposit of short duration? To answer these questions, the results obtained by artefact dating, shoreline dating, luminescence dating and radiocarbon dating have been reviewed.

Artefact dating

PWC pottery has been subdivided by a number of archaeologists (the best-known assemblages being Säter and Fagervik), and different pottery types have traditionally been regarded as representing different settlement stages, *i.e.* the grouping is assumed to correspond to a chronological variation. At some sites a vertical stratigraphy has been observed, supporting the general idea that lime tempering increases with time, while vessel-wall pitting decreases (Löfstrand 1974). It has also been shown that decorations with comb impressions increase with time, while vertical lines decrease (Welinder 1978:101).

There was no clear vertical variation at Masmo 2, but there is a tendency for a horizontal variation. From a preparatory recording by E. Olsson, it was apparent that pottery of rock-tempered ware decorated with long vertical lines dominated at higher altitudes, while pottery of lime-tempered ware decorated with comb impressions dominated at lower altitudes. This variation has traditionally been interpreted as representing non-contemporary visits within the Neolithic, and corresponds most closely to the Fagervik II and III assemblages.

A sample representing the *c.* 70 kg of sherds recovered has been examined technologically by B. Hulthén, who prepared a manuscript on the subject in 1988, but will now reassess the interpretations in the light of the experiences of the last decade. She described the pottery as qualitatively variable and difficult to arrange in a system, and noticed that a considerable amount of the Masmo 2 pottery consists of completely reduced ware, indicating that the pots had been fired in a kiln or covered pit. Based on experiences from Southern Scandinavia in the mid-1980s, it has been suggested that this type of firing was not practiced in middle Sweden until the Bronze Age or Iron Age. Hulthén also noted that the rim forms and decoration deviated from the prevailing Neolithic picture. Sherds expected by Hulthén to date from the Iron Age are depicted in the upper left corner of Fig. 2. These are completely reduced and are decorated with long lines drawn distinctly, as if with a metal implement. The smallest sherd is of black, polished fineware.

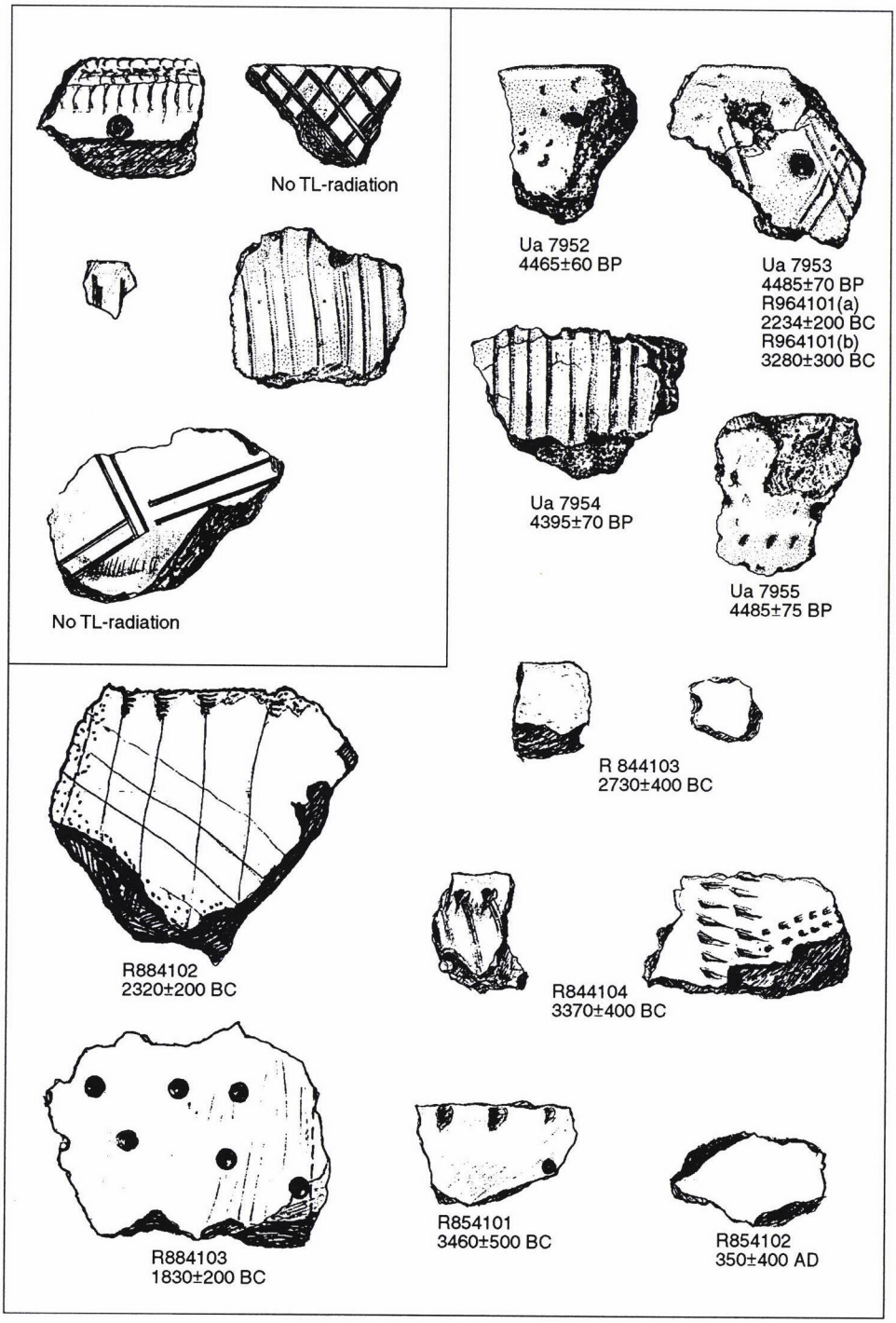

Fig. 2. Pottery from the Masmo 2 site. Examples of sherds of deviating ware and decoration assumed to be of Iron Age origin are shown in the upper left corner. Samples with R-numbers have been luminescence dated. (some samples comprised more than one sherd). Ua numbers refer to organic crust on the sherds, which was radiocarbon dated by accelerator mass spectrometry (Ua 7956 and Lu 2327 are not depicted). Drawings by B. Hulthén & F. Sieurin-Lönnqvist. Scale 1:2.

To elucidate whether any of the pitted pottery was made markedly later than is traditionally considered likely, rock-tempered sherds have been subjected to luminescence dating and the organic crusts on the rock-tempered and lime-tempered sherds to radiocarbon dating.

Shoreline dating

Shoreline chronologies have been constructed on the assumption that the pattern of shore displacement is well known and well dated and that the sites lay close to the shore. Shoreline dating represents a *terminus post quem* situation, *i.e.* it provides the earliest possible date for a site. It is difficult within archaeology, however, to decide at what altitude above the contemporary shore settlement actually took place. It has been regarded as likely that most of the sites in the coastal district were located "close" to the shore, but that the character of the activity decided the distance from it (Åkerlund 1996:27).

The known PWC sites on Södertörn are restricted to the altitude interval 35–25 metres above present sea level (m a.s.l.; Fig. 1b). According to the mainly regressive curve by Risberg *et al.* (1991), the shoreline now located at 35 m a.s.l. in the Södertörn subregion existed around 5000 ^{14}C years BP and that at 25 m a.s.l. around 4000 ^{14}C years BP. From this it follows that the earliest possible date for the PWC sites is 5000 ^{14}C years BP.

The remains at the PWC site Masmo 2 are distributed over sloping terrain at 35–27 m a.s.l., which suggests that activities had been going on "close" to the shore around 5000–4000 ^{14}C years BP. Pottery of what has been regarded as an older type (*cf.* above) coincided with higher specific altitudes than pottery of a younger type. In the light of the shoreline dating the finds were expected to represent different periods of the Neolithic, and support the idea that PWC settlements followed the retreating shore. To elucidate this, organic crusts on sherds representing the different types and altitudes were radiocarbon dated (Fig. 1c).

Radiocarbon dating

There are now about 50 radiocarbon dates from PWC sites in Eastern Middle Sweden, covering the interval *ca* 3900–1975 cal BC (E. Olsson & Edenmo ms; Fig. 3).

Five apparently undisturbed features (three hearths, one hearth pit and one waste pit) were selected for the radiocarbon dating of charcoal to elucidate when activities had been going on at the site (Fig. 1c). With the aim of dating controlled connections, samples from cultural layers were avoided, as Masmo 2 was an open site. Only one sample (St 9069, from a waste pit) gave the expected date, and four of these (St 9065–9058, from hearths) got an Iron Age date (Fig. 3). In order to be sure that the unexpected ages proceeded from chemically well prepared samples, one of the samples with enough charcoal was analysed a second time, with a similar result (St 9068a, 9068b).

With the purpose of finding out when the pots were used, it was decided to date the carbonised organic crust on sherds of various expected ages. In 1984, the conventional technique was used on organic crust on several sherds of rock-tempered ware found in the upper part of the site thought to be derived from the same vessel (Lu 2327). In 1996, four samples of rock-tempered ware from the upper part of the site were dated by accelerator mass spectrometry (AMS, Ua 7952–7955). One sample of

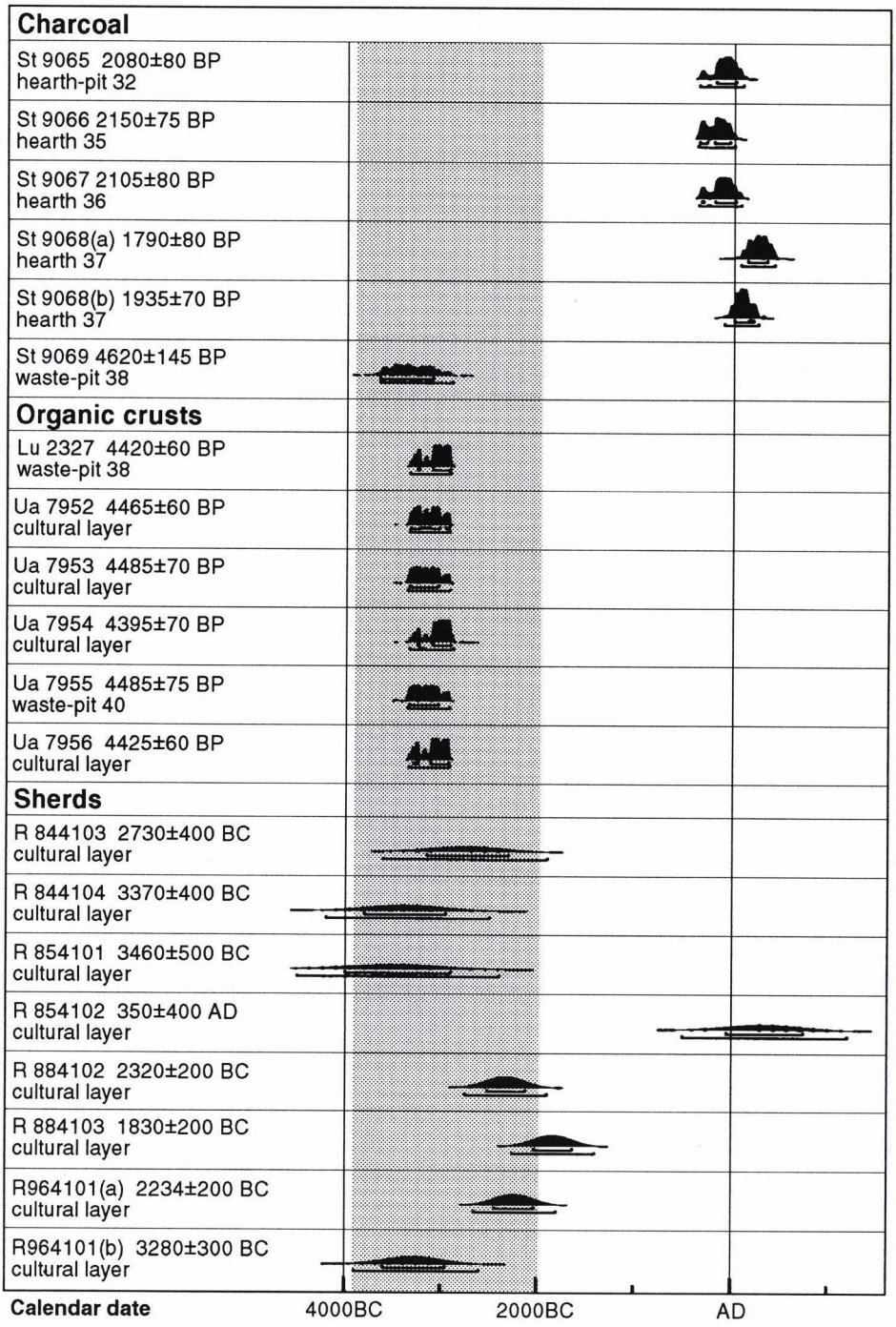

Fig. 3. Summary of radiocarbon and luminescence dates for the Masmo 2 site. The samples were analysed at the Laboratory for Isotope Geology at Riksmuseet in Stockholm (St), the Radiocarbon Dating Laboratory in Lund (Lu), the Tandem Accelerator Laboratory in Uppsala (Ua) and the Nordic Laboratory for Thermoluminescence Dating at Risø (R). Radiocarbon dates are calibrated according to OxCal v2 (Stuiver *et al.* 1993). The shaded area indicates the time of the PWC sequence in Eastern Middle Sweden (*cf.* Olsson & Edenmo ms).

lime-tempered ware, undecorated and found at the lowest altitude of finds, was also dated by the AMS-technique (Ua 7956), and was assumed to be younger than those at higher altitudes. All samples were assigned concordant Neolithic dates (Figs 1c and 3).

Radiocarbon dates are not immediately valid, but require attention to be paid to certain factors which affect the interpretation of the results. Since the method is carried out on organic material, the internal age of each sample must be noted. In the first case, the sample material was charcoal, which unfortunately was not identified before dating. This means that there is uncertainty about the internal ages of these samples, which disturbs the ages. In the second case, the sample material was an organic crust on pottery, which is usually interpreted as food remains with a low internal age.

Yet another factor, which must be considered is the existence of variations in atmospheric radiocarbon, which means that the ^{14}C age must be calibrated to get a calendar age. The dates presented here have been calibrated according to OxCal version 2 (Stuiver *et al.* 1993), but the Neolithic dates are in a complicated period in this respect, where the radiocarbon age after calibration corresponds to a large number of calender years. The dates are in good agreement one with another, however.

Luminescence dating

It was decided to date the rock-tempered sherds by luminescence (TL and OSL) to find out if some of the pottery had been produced more recently. This method, in which the minerals are regarded as containing records of the radiation to which they have been exposed since a given zeroing event, has been found to be well suited to burnt inorganic material. One advantage with this method is that it is not disturbed by the internal age of the sample itself. The age is expressed as a central value and standard deviation. The standard is based on the assumption that radiation was constant, and the method does not require calibration. There is a tendency for the standard deviation to increase in proportion to the age of the sample. It was thought possible in this case to elucidate whether the pottery had been produced in the Neolithic or in the Iron Age, and dates with a poorer precision were regarded as acceptable.

Altogether six samples from the middle and lower parts of the site were TL dated on three occasions during the 1980s, and two more sherds of presumed Iron Age origin (depicted in the upper left corner of Fig. 2) were measured but did not give enough radiation. A certain caution was exercised in the choice of sherds, as they would be destroyed in the analyses, with the consequence that small undecorated pieces (R 844103, R 854102) were chosen rather than large decorated ones. In two cases, the product from a solitary sherd was insufficient and then two (R 844103) or more sherds (R 844104) were run together. Five samples gave a Neolithic date and one (R 854102) an Iron Age date (Fig. 3). The latter was of reduced ware but not decorated.

One sherd, from which the organic crust had previously been scraped off and radiocarbon dated (Ua 7953), was OSL-dated in 1996. The laboratories were informed in advance of the attempt at a comparison. On receiving the result, which was 2234±200 BC (R 964101), I revealed that it was a thousand years younger than the radiocarbon date and somewhat later I received another result, this time of 3280±300 BC (R 964101b). The first one does not agree with the radiocarbon date, but the second one does. The distressing thing in this situation is to have to resolve which one is *the* result.

Discussion

It was assumed in general that an assemblage of PWC finds would give Neolithic dates, although the presence of hearths dated by radiocarbon to the Iron Age is not unusual in PWC contexts (Welinder 1973:113–114, Segerberg & Possnert 1990, Gustafsson ms), as they indicate secondary visits to the area. There were no artefacts recognisable as produced in the Iron Age found during excavation at Masmo 2, and it was only noticed in the post-excavation analysis that there were pottery sherds of deviating ware and decoration. Six radiocarbon-dated organic crusts and seven luminescence-dated sherds provide support only for the presence of Neolithic pottery. Since the samples dated included sherds of expected Iron Age origin, it can be concluded that the expected dates of some of the items of pitted pottery are contradicted by the absolute dates. In addition, there was one sherd which was dated by luminescence to the early Iron Age. This one was not decorated, and the date cannot be checked by comparing the item with the traditional Neolithic pottery types. It could represent a later form of handicraft, but in accordance with the example of R 964101, it can be questioned whether this measurement was completed. Another possibility is that it had been exposed to secondary burning in connection with forest fires or other events involving fire.

The shoreline dating, which assumed a relative difference in age between the pottery types found at various altitudes above the present sea level, was contradicted by the fact that the radiocarbon dates of sherds at 34 and 27 m a.s.l. at Masmo 2 were the same. An alternative interpretation for this frequent recurrence of different types of pottery at certain altitudes is that pottery deposited some distance away from the shore represents contemporary but different activities from those that took place close to the shore. To investigate whether there were differences in other remains, which would have confirmed that activities some distance away from the shore had differed from those practiced close to it, it would have been necessary to excavate both areas in the same way. The dates were received after the excavation, however, and such a possibility had not been taken into account during the fieldwork. In the present situation it could not have lead to any further investigation in any case. The excavation was brought about by exploitation of the upper part of the area, and the assignment did not include excavating the lower part but only the digging of test pits to make a rough comparison of the remains.

The radiocarbon dates also seem to indicate the same ages for rock-tempered sherds with long vertical lines as for lime-tempered sherds with comb impressions. An alternative to the conventional interpretation that the different types correspond to different stages of pottery production is that they represent different contemporary pottery traditions. The radiocarbon dates indicate a short period of usage during the Neolithic. The luminescence dates do not agree so closely, but then the luminescence method was not chosen in order to separate between dates within the Neolithic, but, knowing of its poorer precision, in order to indicate whether the pottery had been produced in the Neolithic or the Iron Age.

The comparison of the results obtained by these two scientific methods involves a number of uncertainty factors. The luminescence method has no known systematic error comparable to that of radiocarbon dating, and the ages obtained mean two different things. In some cases in which TL and radiocarbon dates have been compared, the TL ages are generally younger than the radiocarbon ones (Mejdahl 1985:589, Taavitsainen 1990:47, Gustafsson *et al.* ms). In the Masmo 2 case, a half of the luminescence dates pointing to the Neolithic are younger than those obtained by radiocarbon. It is not possible in all excavations to check the dates between methods, and therefore I would welcome more attempts at correlating dates obtained by different methods in

order to achieve a better general understanding of the possibilities and uncertainties associated with each.

In reply to the initial questions, it can be said that all the methods used provided support for activities at the site during the Neolithic, in addition to which there are radiocarbon-dated hearths and one luminescence-dated sherd without decoration that are indicative of Iron Age activities. The Neolithic radiocarbon dates seem to point to the same age, whereas the luminescence dates are not so concordant. No dates are precise enough to answer the question of contemporaneity or repetition in Neolithic ceramic deposition, however. If the question is unrealistic, because it requires utopian precision to answer it, then what realistic improvements in precision are to be expected in the future?

Excavations as experiments in interpretation

A normal excavation procedure involves observations and documentation to provide data for future analyses and interpretations, and this was also the case at Masmo. We received the dates long after the conclusion of the fieldwork, which means that they could not influence the direction in which it was continued. If we had had the dates indicating Iron Age elements during the excavation, we could have deliberately searched for Iron Age remains around the excavated area. It might then have been possible to characterize the Iron Age activity.

The strategy employed here, in which interpretations take place afterwards, is only compatible with a view of research which presupposes that all the data are easily identifiable and reproduce objectively what has actually happened. A more appropriate strategy would be one in which excavations are conceived of as experiments in interpretative activities. Questions are asked at numerous points and a series of decisions are taken during the excavation. If deliberations, interpretations and choices could become part of interdisciplinary cooperation, they would increase the possibility of perceiving new connections. A reconsideration of our procedures to allow such a relationship to develop is not merely a matter of methodology, but represents a re-evaluation of field archaeology and the roles played by all the researchers involved.

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