

RADIOCARBON DATING AND ICELANDIC ARCHAEOLOGY

Vilhjálmur Örn Vilhjálmsson

ABSTRACT

This article deals with the application of radiocarbon dating in Icelandic archaeology. Results of some of the ^{14}C datings do not match the conventional date for the settlement of Iceland. An attempt has been made to explain this discrepancy by a reservoir effect-hypothesis which has neither been sufficiently tested nor proven. Most of the irregular dates derive notably from a single laboratory. A number of alternative explanations for the discrepancy are given in this study, among them the fact that some radiocarbon laboratories do not ask for, or execute, a detailed wood-analysis prior to dating.

Introduction

Most Icelandic ^{14}C dating samples have been handed in at laboratories with the hope that the dates they will provide are consistent with the traditional date for the settlement of Iceland (Icel. Landnám), at the end of the ninth century. Unfortunately, neither the ^{14}C dating method, nor the samples, have been able to provide definite proof for the traditional literary date of the landnam. If not questioned, a number of dating results have turned out to indicate a settlement in Iceland somewhat earlier than the conventional and hitherto accepted date for the Icelandic landnam.

For several years the results of ^{14}C datings made on Icelandic samples have repeatedly been questioned. Results which are unexpectedly old have either been explained by extraordinary factors or rejected as being less accurate than dates obtained by the local method of tephrochronology. On the other hand some ^{14}C dates, seemingly older than the conventional landnam, have in later years by a single archaeologist, been interpreted as indicating a much earlier and hitherto unknown settlement in Iceland (Hermanns-Audardóttir 1989).

The discussion about the uncertainty of the ^{14}C method for Icelandic archaeology has caused confusion for archaeological as well as geological research in Iceland. Moreover, it is clear that some Icelandic

archaeologists and geologists have not always understood the character of the method, its inaccuracy and all the possible pitfalls which have to be taken into account, before results of a radiocarbon date are presented.

The landnam

The settlement of Iceland has played an important, and maybe an over-important role for much research in Iceland, both within literary and scientific research subjects. The landnam has also been the main goal for the people who collected ^{14}C samples in Iceland. At the present the most widely accepted date for the earliest habitation in Iceland is obtained through written sources from the 12th century and later. The date which is most often used is 874 AD (Vilhjálmsson 1988:322). Long before the problematic and seemingly too high ^{14}C dates emerged and were used uncritically as proof of a landnam before the traditional settlement, there existed a number of theories about an earlier landnam. The best known of these is the alleged landnam of supposedly Irish hermits (Icel. Papar) and of an overall Celtic/Christian settlement.

Archaeological research and dating in Iceland can not at this moment provide any proof for an earlier landnam than the Norse landnam of the 9th century. There are so far no material remains to be found in museums or from recent excavations which can indi-

cate a Celtic habitation or an earlier Norse settlement in Iceland which predates the accepted historical landnam with more than fifty to hundred years. A few artifacts could have already been old when people brought them to Iceland. Archaeologically though, we must be open minded towards the fact that people might have arrived in Iceland from about 800 AD.

¹⁴C dating and tephrochronology

The method of tephrochronology used for this period of history in Iceland consists of dating by volcanic tephra (layers of ash and pumice) (Thórarinnsson 1981, Vilhjálmsón 1988). The layers are dated relatively by using information on volcanic eruptions in written sources or by estimations of the increase of soil between layers of ash, which have an allegedly known date, obtained from documents (Vilhjálmsón 1988, 1989, 1990).

This method is a relative dating method and contains a weakness. Whatever correlation a geologist makes between the ash in the ground and historical dates, the result will always depend on the reliability of the information for the dates in the written sources. Despite this and probably due to the very solid belief in the reliability of all written sources, which many of the scientists of the older generation in Iceland have in common, the method of tephrochronology has been proclaimed to be absolute. The absoluteness should derive from the use of written sources, which on the other hand are most often composed or transcribed more than 200 years after the volcanic eruption that produced the ash.

The father of Icelandic tephrochronology, the late S. Thórarinnsson, nevertheless declared the method absolute and the ¹⁴C method to be less accurate as a method of dating in Iceland (Thórarinnsson 1981;112). Thus the tephrochronological method gained a solid status as the main method of dating for Icelandic archaeology and geology, and was not questioned until recently.

The Settlement Tephra

The Settlement Tephra-layer (Icel. Landnámslag; also called VII a+b, Vö, LaL. etc.) is one of the best known Icelandic tephra-layers. It is at present, by a highly speculative estimation of soil increase and correlation with acidity-measurement results from Greenland ice-cores, dated to 898 AD (Larsen 1982; 63, Vilhjálmsón 1988, 1990, in press B). This layer has earlier been dated as often and as differently as

the names it has received. As the layer originally was located just above sterile prehistoric soil, it was immediately linked to the landnam and thus to its traditional dating in the late 9th century (Thórarinnsson 1944;192-203). The date has thus been reached by a circular argument.

This layer, which can be found over large parts of Iceland, and its uncertain dates have been used repeatedly in Icelandic archaeology. It is not uncommon that due to its presence in, or near turf walls of buildings, the buildings are subsequently dated to the landnam period (eg Ólafsson 1987;348). This happens, even though it is most often impossible to decide how long the tephra has been imbedded in the peat for, before it was cut and used as building material.

Many archaeological sites in Iceland have been dated by this layer, although the artifactual material could not confirm the date. In one case, where a farm-ruin was dated to the 9th century due to the Settlement tephra found in a turf wall, the results of three ¹⁴C datings were ignored and not published with other results from the excavation (Magnússon 1970). The results (K-1243, K-1244 & K-1245; Tauber 1968;321) clearly reveal a later date for the farm.

For many years no systematic ¹⁴C datings were made, in order to compare the reliability of tephrochronology with the allegedly less reliable results of ¹⁴C samples. In the 70's and 80's, when several of ¹⁴C samples from Iceland were dated, it became clear that ¹⁴C dating did not bring a verification to the tephrochronological dates or, for that matter, to the conventional date for the Icelandic Landnám. No ¹⁴C results or traditional archaeological dates have so far fully confirmed or matched a tephrochronological date (Vilhjálmsón in press A). Attempts to verify the tephrochronological date of the Settlement tephra with the help of ¹⁴C datings of organic material in relation with the Settlement tephra have all failed (Hallsdóttir 1987, Vilhjálmsón, in press A). This is partly due to the fact that the dated material was peat from wet bogs, which is not the most ideal material when precise dates are needed (Mook & Waterbolk 1985;30, Taylor 1987;62). The range of probability of calibrated ¹⁴C dating results from the period of 800-1100 AD is also too great to expect dates that can verify the allegedly exact dates of tephrochronology.

High ¹⁴C values

As ¹⁴C samples with apparently older date than the

conventional date for the Icelandic landnam became more common, voices that had announced the possibility of extraordinary disturbing factors about all organic remains from Iceland, and thus causing older dates, became louder. In many archaeological and geological reports it was stated that according to Dr. Olsson of Uppsala University, ^{14}C dating results from Iceland could not be taken for granted (Thórarinnsson 1977;35, Ólafsson 1980;66, Hermannsdóttir 1986;99, Jónsson 1982;196, Dyring 1984;3, Teitsson 1984;11). A possible effect of inactive CO_2 from the surrounding ocean (The Island Effect) and from volcanic activity on the material in the samples was given as a reason for the high ^{14}C ages. This was also stated in a short paper in Radiocarbon (Olsson 1983). No results of systematic studies or experiments accompanied this statement. Since then these hypotheses have been vividly used to explain dates which did not match tephrochronological dates and dates which are apparently too old for archaeological material. According to the hypothesis all ^{14}C dates from Iceland have received wrong, and too old dates.

It has been pointed out, though, that calibrations according to the Stuiver & Pearson calibration curve (1986) might have an effect on attempts to date relatively narrow time spans for Icelandic archaeology and geology. Due to great variation of global ^{14}C values throughout time and specially at the time of the Landnám-/ Viking Age, dates which earlier had seemed far too old for these periods became relatively more understandable after a calibration. Several external factors on the samples, which might have also caused the high values, were also mentioned (Vilhjálmsen 1988).

The old ^{14}C ages and the archaeologist

The discussion about the reservations regarding Icelandic ^{14}C results has evidently influenced the archaeological treatment of a number of ^{14}C dates from archaeological excavations in Iceland.

Most of the dates derive from excavations in Reykjavík and the island of Heimaey. Else Nordahl who supervised the excavation of a farm-site in Reykjavík in the 1970's, chose only to publish the ^{14}C years (BP- values) of the thirtyone analyses from the excavation (Nordahl 1988, Vilhjálmsen, in press B). The dates were processed at the Uppsala radiocarbon laboratory. No calibrations, were presented when the excavation was published in 1988 and the

author chose a little reluctantly to use the date of the Settlement Tephra instead. She explains the many values of the ^{14}C results, which are apparently too high, and the internal discrepancy between results with I.U. Olssons hypotheses. An interesting aspect of the dates from Reykjavík is that many dates from the same structure varied very considerably, and in many cases the stratigraphy did not match the ^{14}C dating results (Vilhjálmsen in press B).

On the other hand Margrét Hermanns-Audardóttir, who excavated a farm in Herjólfssdalur on the island of Heimaey, south of Iceland chooses to take nine radiocarbon dates from the Uppsala laboratory for granted (Hermannsdóttir 1986, Hermanns-Audardóttir 1989;45-54). She does not use the calibrated results as a whole range of possibilities but only the oldest values obtained by the calibration. Apart from this, she rejects analyses made by Icelandic tephrochronologists, without factual reasons. Despite no archaeological dating evidence and an extremely insufficient historical and archaeological method, where facts and earlier research are obviously not taken into consideration or are misquoted (Rafnsson 1990) she concludes, with the help of the ^{14}C results that a predominately Christian Norse society was already existing in Iceland in the 7th century AD. The results which she published in her doctoral thesis at the University of Umeå, Sweden in 1989 have been criticized and can unfortunately not be looked upon as an important contribution to the discussion of the Icelandic landnam.

On the other hand, it is worth mentioning that three of the samples from Heimaey (U-2531; U-2533; U-4402) all have calibrated ^{14}C dates which are in a fairly good accordance with the traditional date for the settlement and one date which is far out of range (U-2532). Yet another date (U-4403, see Table 1) of material from the Herjólfssdalur farm site, has been withheld by the Uppsala laboratory (Olsson in press), and is therefore not published, together with the other nine dates from Heimaey. If the character of the sample U-4403 as well as its date had been known to the excavator of the Herjólfssdalur site prior to the final publication, it is possible that the excavator would have used the results of the radiocarbon analyses in a more moderate way than has been the case. The existence of U-4403 makes the discrepancy between the dates from Herjólfssdalur greater, and gives less reason to use the ^{14}C dating results as definite proof for a landnam in the 7th century AD.

The Faroese landnam

On The Faroe Islands ^{14}C dates from pollen-analytical work, with older ages than the conventional, archaeological date for the Faroese landnam, have been used as an argument for the habitation of Irish hermits, or other people on the islands prior to the Norse settlement (Jóhansen 1985;58). The ^{14}C samples used for this argument were all peatbog samples, which were not taken in connection with a habitation site or any archaeological investigations (Arge 1989 A;111, Arge 1989 B). ^{14}C dated peat, as other soil samples, has a limited value to infer age in archaeological and historical contexts (Taylor 1987;62). Whether the old ^{14}C ages from the Faroes are caused by the island effect or by bad choice of samples, there is no archaeological evidence available to prove an earlier landnam, which they might indicate (Arge 1989 A). The high ^{14}C results obtained on the Faroe Islands have already been used by Hermanns-Audardóttir in support of her theory on an earlier landnam in Iceland (Hermanns-Audardóttir 1989;67). On the other hand, Hermanns-Audardóttir does not mention the factual discussion and critiques Jóhansens results have received (eg Krogh 1986;3-6, Arge 1989 A, 1989 B).

The causes and frequency of early dates

Reservoir effects

I.U. Olsson has recently given a more detailed explanation for the alleged influences of inactive CO_2 on the ^{14}C contents in samples from Iceland (Olsson in press). She argues that the ^{14}C concentration has been lower in Iceland than in other areas where material which is used as a base for calibrations derive from. Thus she concludes that the Stuiver and Pearson 1986 calibration curves for recent times can not be applied on Icelandic dating results without special corrections. Again the reasons given are reservoir age effects, that is a volcanic or thermal activity, as well as dissolved CO_2 from the surrounding ocean.

Olsson has analyzed vegetational samples from near thermal and volcanic stations to support the hypothesis. It should be noted though that Olsson has collected relatively few samples near only 2 thermal and volcanic sources in Iceland. When dated, all of them gave quite higher ^{14}C values than expected. But it must be noted that effects of inactive CO_2 from volcanic eruptions or hot springs are limited to only a small radius around the source (Chatters et al 1969, Libby & Libby 1973, Bruns et al 1980, Saupé

et al 1980).

If an archaeological sample receives a date which is too old, and is not from an area where either a volcano or some hot springs exist in the neighborhood, it is impossible to blame the unexpected value on a volcanic effect. An archaeologist or a ^{14}C laboratory cannot determine whether charred birch from a hearth in a farm-ruin derives from a woodland one hundred meters or one kilometer away from the farm, or ten meters or ten kilometers away from a source which emits inactive carbon. They cannot determine which eruption or hot spring emitted the old CO_2 , or at which time it influenced the material which is ^{14}C dated. It is also doubtful that birch for fuel was collected near a volcano. Usually the volcanic products have taken care that nothing grows near a volcano and volcanoes of Iceland do not emit great quantities of CO_2 all the time. A volcanic effect can therefore hardly be given the credit for the few apparently early ^{14}C ages from Iceland. On the Faroe Islands, where unexpectedly high dating results have also been obtained and related to an earlier landnam, there are no hot springs or active volcanoes.

The Island Effect and low activity of ^{14}C in arctic areas is a much more feasible explanation for dates from Iceland which are seemingly too old. There is a lower activity of ^{14}C in Spitzbergen, Iceland, Greenland and the Faroe Islands than in Sweden or central Europe according to Olsson (Olsson in press). But the vegetational samples which have so far been collected in the North Atlantic, with the purpose of measuring ^{14}C activity derive from quite different areas with relatively different weather conditions which might effect the results. The time of the collecting as well as periodic influences of pollution should also be taken into consideration. It is also of the utmost interest to know if the samples for the measurements of ^{14}C activity from Iceland were collected at the coast or fifty to hundred kilometers inland. Measurements from the coast of Spitzbergen or from the weather exposed Faroe Islands cannot necessarily be compared to samples collected in an inland valley of Iceland, where oceanic effects are much smaller than at the coast.

Furthermore many ^{14}C results of Icelandic material have not been corrected for isotope fractionation, based on the measured $^{13}\text{C}/^{12}\text{C}$ ratio, which can result in systematic errors for certain types of samples. Dating results of charcoal lacking this correction might cause dates which are slightly too high. This does not count for the Uppsala dates for Heimaey

and Reykjavík or the Copenhagen dates for the farm site at Stöng (See Table 1).

Contamination

Contamination of organic samples after formation is a possibility which has to be borne in mind when ^{14}C datings from Iceland are discussed. Contamination by organic infiltration, especially in peat, might occur, but can in most cases be removed by chemical treatment. This ought not to be a problem with charcoal samples, unless the peat of house-constructions has caused the contamination of the charcoal. In Iceland some soils are volcanic soils, so called andosols which are highly porous soils with a very high pH content high content of water as well as carbon due to tephra (Ugolini & Zasoski 1979;83-84; 99;102). In Iceland there is also a massive erosion which volcanic soils are very vulnerable towards. Soil containing about 3000 year old tephra has in some cases been windborn and deposited on top of historic remains (Vilhjálmsson 1989;90 fig 12-15). Graves have been dug into soils with very old volcanic ash etc. Is it not possible that this factor could influence organic material? Humic acids of ash-derived soils have been found to be more complex than those from non-ash soils, because they contained higher percentages of the complex gray humic acids (Ugolini & Zasoski 1979;103). It might preferably be a good idea to look at the chemical composition of the soils of Iceland when ^{14}C samples are collected. This has never been done in Iceland but in a series of other countries with volcanic soils, eg Japan.

Laboratory process

If a closer look is taken at all of the ^{14}C results obtained from archaeological material from Iceland, we can see that a total of 79 samples have been dated conventionally at nine different laboratories abroad. 19 or 24% of the samples which most likely are local material, can when used uncritically be interpreted to be older than the conventional date for the settlement of Iceland. 48 or 61% of all conventional ^{14}C dates have been obtained at the ^{14}C laboratory at Uppsala. Notably 18 out of the 19 dates, or 95% of the unexpected dates, have also been reached at the Uppsala laboratory (See Table 1). It should also be noted, although this might not be significant, that all the unexpected ^{14}C dates are produced on charcoal or wood.

Does this indicate that the high dates the laboratory at Uppsala is getting are caused by different labora-

torial methods than at the other eight laboratories, which have not produced dates which are too old? This is hardly the case, although the possibility is worth looking into. It is more likely that the laboratory at Uppsala has received the most dating requests from Iceland and that the samples have traditionally been related to the settlement of Iceland. The laboratory is informed about the expectations of the archaeologist and the request is in most cases that the result should become younger than 874 AD and be in accordance with tephrochronological dates.

It is obvious that the conventional date for the Icelandic landnam, whether it is right or not has influenced I.U. Olsson in her quest for explaining her hypotheses and unexpected ^{14}C results from Iceland. Olsson has accepted the traditional date. But how does she know it is right? She is informed by Icelandic geologists and archaeologists and also bases her knowledge on the traditional date for the Icelandic landnam. There are still no archaeological remains which can yield other information. But how can we be sure that the same kind of apparently old ^{14}C dates we find in Iceland or on the Faroe Islands, where we in both cases are comparing the ^{14}C dates with a conventional landnam date, are not being obtained with material elsewhere, where they didn't have a landnam?

Along the coasts of Norway or Ireland people were busy leading their lives in the Viking Age as their ancestors had done before them. If, for instance, a farm on the west coast of Norway, with no datable artifact, is ^{14}C dated to 500-700 cal AD, how can that be challenged if the real age is 700-900 AD. There was a continuing settlement in Norway and the archaeologist can not challenge the dates with a magical date as 874 AD. Dissolved carbonate from the sea was also most likely to come in with the westerly and northerly winds as in Iceland and on the Faroe Islands, so they must definitely obtain incorrect and old dates on the coasts of Norway or Ireland and other coastal areas too, if the island effect theory is correct.

According to the Trondheim Natural Radiocarbon Measurements List in the journal of Radiocarbon, there does not seem to be a high frequency of unexpectedly high results from archaeological samples in Norway. Some results have been irregular (Myhre 1980;135-138, Nydal et al 1985;586). But there have also been obtained irregular archaeological ^{14}C dating results in, for example, Sweden (Cinthio 1980;121-122). If one browses through the date lists from different laboratories in the journal of Radio-

carbon, it is easy to find documentation of dates that are not in accordance with archaeological dates. Whether these discrepancies are caused by an island effect, poor laboratory method, or wrong archaeological dates is another matter.

In Ireland, due to its humid climate and insular character, one would expect the island effect to be just as effective as in Iceland, Spitzbergen, Greenland, and the Faroe Islands. Today, Ireland is in possession of the World's second longest tree-ring chronology. High-precision ^{14}C analyses have now been carried out extensively on samples of the precisely known tree-ring age of Irish oaks (Baillie & Pilcher 1983; Baillie 1985; Pearson et al. 1986). The high-precision calibration curves thus obtained in Ireland and elsewhere (Stuiver & Pearson 1986), do not indicate a reservoir effect like the island effect, which has been introduced for Iceland.

Whether the effect of oceanic CO_2 is important for Icelandic ^{14}C datings or not, the influence which the island effect is supposed to have on vegetation (predominately wood) has to be explained and proven. Why the effect is related to Iceland, Greenland, the Faroe Islands, and Spitzbergen, but not, for instance to Norway, Ireland, or Newfoundland is also an important question worthy of an answer.

Age before human use

As most of the Icelandic ^{14}C dates with unexpectedly high results are processed at a single laboratory the causes might possibly be sought in the process which this laboratory applies. The first part in the process of ^{14}C dating is the determination of the sample. All the samples in question are local wood. But has the wood been divided into felling, sapwood, heartwood, branches, or roots before it was dated, and can the age of the wood before use be roughly estimated? Is the wood from branches and twigs, or from the heart of the tree? The ^{14}C laboratories in Sweden do not normally make extensive anatomical analyses on wood from archaeological sites, as for instance is done at the Copenhagen laboratory. Analyses of the dated wood from Reykjavík have been reported in the following way: "It can be noted that all the samples were birch" (Nordahl 1988;113). No extensive wood-analysis on the samples from Reykjavík have been published. Five out of nine dated samples from Heimaey have, though, been determined in an acceptable way (Hermanns-Audardóttir 1989;45; 178), but two of the samples have not received a wood-analysis at all.

It is quite hard to exclude the possibility of an old age, before use, of betula samples from Iceland, which were charred in the settlement period. Prior to the time of settlement trees had not been utilized by humans or cattle, and were thus likely to be old. There was probably also decayed wood and dead forest around, of a considerable age, conserved by the relatively cold climate and limited biological decomposition. Dry wood is lighter and easier to transport than hewn wood. If the first settlers had some kind of practical and economical sense they would have utilized the decayed wood as they utilized and charred driftwood together with local wood on the island of Heimaey (Hermanns-Audardóttir 1989;178). If old decayed birch was used as fuel, it is far easier to understand why some ^{14}C samples from Iceland have obtained dates which predate the conventional and archaeological date for the Settlement of Iceland.

So far, most samples dated conventionally in Iceland have been charred wood (Table 1). In most cases the wood has been of local trees, birch (betula), or willow (salix). Driftwood or secondary wood has been ^{14}C dated only in a few cases. Interestingly animal bones from Heimaey (Hermanns-Audardóttir 1989;121-127) or Reykjavík (pers. comm. Berit Sigvallius, Statens Historiska Museum, Stockholm) have not been dated to check if they are of other dates than the wood or charcoal, which have provided all the apparently irregular dates.

There is also the extraordinary possibility that the charred birch from Herjólfssdalur and Reykjavík, used for ^{14}C dating, is driftwood as suggested by Claus Malmros (Mahler & Malmros, forthcoming) and not local wood. If that is the case, all discussion on the Island Effect or the Merovingian settlement can be forgotten, or at least critically reviewed. Birch could in fact have drifted to Iceland like it does today. Birchbark of Siberian birch can, for instance, be found in waste amounts on the shores of Strandasýsla in Northwest Iceland. Strandasýsla is the district in Iceland, which receives most driftwood. Driftwood on the beaches of Strandasýsla mostly originates from the Yenisey river area in Siberia (pers. information Haukur Ragnarsson, Icelandic Forestry Service, Mógilsá). Research on the origins and types of Icelandic driftwood is now in progress (by Ivar Samset, information: Haukur Ragnarsson).

AMS datings

The first AMS datings made on archaeological

material in Iceland have also presented problematic results. In 1989 to 1991, fourteen samples from different localities in the valley of Thjórðardalur in Southern Iceland were dated at the AMS laboratory in Uppsala. Apart from one sample, all the samples received dates which were much older than archaeologically expected. Human bones from a Christian cemetery, which are dated in the 11th or 12th century received dates which were 200-400 years too old. Two samples of sawn off pieces of cow bone, which were also dated conventionally at the ¹⁴C laboratory in Copenhagen respectively received a date that matched a conventional date as well as a date which became approximately two hundred years older. Pieces left over after conservation of a comb belonging to a type which is dated to 1150-1225 AD (Vilhjálmsen 1989;81-82fig 5) received a calibrated date of 782-1106 AD. Earlier, all conventional radiocarbon dates from Thjórðardalur have yielded dates from around 1010-1260 cal AD (see table 1).

The corrected ¹³C ratio of the AMS dates turned out to be normal. Two of the samples (Ua-1423/Ua-1424) were redated in order to check the results, but still gave old ¹⁴C ages. The samples were thoroughly associated with an archaeological context and consist of well-defined material such as bone and charred birch. The reasons for the apparently old ¹⁴C ages can not be explained, except possibly by the volcanic effect hypothesis and the island effect hypothesis. Many of the samples collected in Thjórðardalur either derive from, or are surrounded, by layers of prehistoric acidulous, volcanic pumice which is approximately three thousand years old. Possibilities for contamination from pumice, which might have contained "old" secondary CO₂ which was absorbed slowly into the organic samples, must therefore also be considered. Other non-detectable impurities with a chemical composition similar to that of the sample and other external factors might also account for the unexpected results.

Systematic AMS datings of, for instance, woollen items from ethnological collections in Iceland, with a known date, could provide a good basis for testing the island effect and the volcanic CO₂ effect.

Conclusion

If the problem with ¹⁴C dates which seem to be too old, from archaeological and geological contexts in Iceland are to be solved, a much better cooperation

between scientists than we now have is needed (Moe 1988, Vilhjálmsen 1988;323, 1990). Laboratories which hold back important dating results (eg U-4403), without the knowledge of the archaeologist who submitted the samples, do not show a sufficient will for cooperation. The alleged influence of CO₂ from the sea and the volcanoes has to be studied systematically and not at random. A one-way co-operation between ¹⁴C laboratories and tephrochronologists does not solve the questions related to the application and the alleged problems of the ¹⁴C dating method in Iceland. Archaeologists have to intervene actively in this discussion, and with interest and much more knowledge of scientific methods, and try to understand them fully (eg Kankainen 1990;31-32). After all, it is the archaeologist who should be most interested in having this problem solved.

We are confronted with the fact that conventional archaeological ¹⁴C dates are relative results of a laboratory process. Relative, because they are dependent on so many factors which are more common now than when the method was originally introduced. Although the method produces absolute results of single measurements, it does not necessarily produce exact and unquestionable results all the time.

It is quite possible that a series of factors could all have affected one single ¹⁴C dating result from Iceland in some way or another. That clearly underlines that ¹⁴C dating is not the best suited method to use, when precise periods such as the landnam of Iceland, or the beginning of something, is to be determined. ¹⁴C dates of Icelandic material should for the time being first and foremost be used as a reference and not as proof, unless a series of dates are fairly consistent, also with the results of traditionally dated archaeological material. The same counts for tephrochronological dating.

It must also be stressed that the presently accepted date for the landnam of Iceland is not to be regarded as a definite, unchallenged national treasure, which scientists should fight for or guard with their personal honour. Any doubts about that date should in fact be tested in an appropriate way and not be fought for in a nationalistic manner, where all factual reasons are lost in the quest for an imaginative, earlier landnam with its glorious, Christian ancestry.

Table 1. ^{14}C dates from archaeological investigations in Iceland. The dates are calibrated with the help of the C.I.O. Groningen Radiocarbon Calibration Program. The samples were dated between 1959 and 1991.

LABORATORY Number	MATERIAL	BP VALUE	CALIBRATIONS 1 sigma 68 % prob. cal AD	2sigma 95 % prob. cal AD
BIRMINGHAM = Birm				
Papey:				
Birm-1128	charred birch	940 $\pm$ 60	1026-1160	990-1221
COPENHAGEN = K				
Bergthórshvoll:				
K-580	charred birch	1010 $\pm$ 100	900-1160	790-1230
Reykjavík, Grjótagata:				
K-949	Charred birch and other pulverised remains of tree	1340 $\pm$ 100	600-810	450-940
Hvitárholt:				
K-1243	charred birch	970 $\pm$ 100	970-1181	880-1267
K-1244	charred birch	890 $\pm$ 100	1030-1221	961-1282
K-1245	charred birch	910 $\pm$ 100	1020-1212	900-1275
Reykjavík, Sudurgata 7:				
K-4271	charred birch	1100 $\pm$ 75	862-1016	716-1112
Stöng 1983-4:				
K-4488	bones, cow and sheep	840 $\pm$ 50	1126-1260	1042-1269
K-4489	bones, cow and sheep	890 $\pm$ 65	1042-1212	1022-1254
K-4490	charred birch	860 $\pm$ 50	1050-1236	1038-1257
K-4491	birchbark	950 $\pm$ 65	1018-1158	970-1226
K-4492	charred birch	930 $\pm$ 65	1026-1162	986-1233
Stöng 1986:				
K-5014	charred birch	1220 $\pm$ 50	722-880	672-934
Stöng 1939:				
K-5365	bone, cow	970 $\pm$ 50	1008-1158	974-1174
K-5366	bone, cow	800 $\pm$ 50	1181-1269	1054-1281
HARWELL = HAR				
Kópavogstingstadur:				
HAR-2092	charcoal, salix or poplar	900 $\pm$ 70	1036-1206	1014-1257
HAR-2093	charcoal, not analysed	150 $\pm$ 70		
HAR-2155	charcoal, salix or poplar	1180 $\pm$ 130	710-970	610-1160
KIEL=Ki				
Granastadir:				
Ki-2854	charred birch	1070 $\pm$ 50	898-1012	860-1034
Ki-2855	charred birch	1032 $\pm$ 80	892-1150	802-1172
Ki-2856	charred birch	1110 $\pm$ 60	882-998	786-1016

LABORATORY Number	MATERIAL	BP VALUE	CALIBRATIONS 1 sigma 68 % prob. cal AD	2sigma 95 % prob. cal AD
LUND=Lu				
Dalasýsla:				
Lu-2999	charred birch	1140±50	822-970	778-992
Lu-3000	charred birch	1150±50	814-961	772-992
SASKATCHEWAN = S				
S-66	charred hay and grains	920±60	1034-1162	1006-1233
STOCKHOLM = St				
Papey:				
St-3368	driftwood	1440±100	450-670	390-790
St-3604	charred birch	980±100	961-1181	820-1260
St-3605	charred birch	935±100	1010-1212	900-1267
St-4191	driftwood, pinus pumila	1665±100	250-520	130-590
St-4192	driftwood, picea sp.	260±245	1450-1870	1300-1360
St-8348	not analysed	925±80	1020-1202	980-1260
TRONDHEIM = T				
Dagverdarnes:				
T-?	charcoal, results only published in newspapers = 680 BP			
UPPSALA = U				
Reykjavík, Tjarnargata 4:				
U-2082	wood chips, larch	1140±70	810-974	712-1016
U-2167	birch	1190±90	716-951	668-1260
Reykjavík, Adalstræti 14:				
U-4030	charred birch	305±100	1450-1670	1420-1880
U-2530	charred birch	1330±80	630-780	562-884
Reykjavík, Adalstræti 18:				
U-2592	charred birch	1140±90	802-976	690-1018
U-2593	charred birch	960±90	988-1170	896-1249
U-2617	charred birch	1280±120	650-880	550-1000
U-2618	charred birch	685±110	1245-1400	1050-1440
Reykjavík, Sudurgata 3-5:				
"bottom layer"				
U-2534	charred birch	970±75	1004-1160	896-1225
		1000±75	965-1160	888-1210
U-2680	birch chips	1375±70	598-758	536-852
U-2720	birch	1270±90	664-856	626-959
U-2741	charred birch	1330±40	654-758	646-772
U-2743	birch	1140±65	814-974	718-1014
"oldest smithy"				
U-2671	charred birch	1150±55	812-961	724-1000
U-2672	charred birch	1345±60	632-768	560-856
U-2678	birch	1210+260/-250		
U-2682	birch	1090±80	862-1022	718-1156
U-2719	birch	1360±60	614-758	560-782
U-2721	charred birch	1050±85	884-1150	784-1166

LABORATORY Number	MATERIAL	BP VALUE	CALIBRATIONS 1 sigma 68 % prob. cal AD	2sigma 95 % prob. cal AD
"longhouse"				
U-2676	charred birch	1260±55	672-848	666-882
U-2679	charred birch	1080±60	896-1004	798-1032
U-2681	charred birch	1255±65	674-852	652-932
U-2744	charred birch	1245±60	682-854	658-894
U-2745	charred birch	1275±60	666-792	656-880
U-2746	charred birch	1090±65	890-1004	782-1030
U-2747	charred birch	1245±80	680-858	654-958
U-2748	charred birch	1250±65	678-854	654-936
"gully"				
U-2739	charred birch	1310±70	652-778	616-880
"slabhouse"				
U-2677	birch	1250±100	670-870	630-980
"young smithy"				
U-2535	charred birch	810±70	1164-1273	1038-1281
U-2740	charred birch	1280±65	662-794	650-886
U-2742	charred birch	1150±60	810-963	718-1006
"granary"				
U-2674	grains of barley and other seeds	1060±55	898-1018	822-1152
Papey:				
U-4014	charred larch and birch	1090±80	862-1022	718-1156
Herjólfssdalur, Heimaey:				
U-2529	not analysed	1260±60	672-850	660-886
U-2531	charred birch	1060±65	896-1020	798-1156
U-2532	charred birch	550±60	1310-1428	1288-1440
U-2533	not analysed	1240±60	686-855	660-934
U-2660	charred birch	1390±60	596-678	548-768
U-2661	charred birch	1340±60	642-766	596-854
U-2662	charred birch	1240±50	688-853	674-886
U-2663	charred birch	1300±60	664-772	644-872
U-4402	charred birch	1035±65	896-1034	876-1164
Herjólfssdalur, Heimaey: A date withheld by the laboratory until other results from Heimaey had been published.				
U-4403	larch	1070±75	888-1020	780-1158
Grela, Hrafnseyri:				
U-2899	charred birch	1070±60	896-1012	794-1038
U-2900	charred birch	1130±60	822-890	776-1014
Adalból, Hrafnkelsdalur:				
U-4327	charred birch	1110±65	876-1006	778-1024
Faxagil, Hrafnkelsdalur:				
U-4328		1030±65	896-1038	882-1164
UPPSALA AMS = Ua				
Thjórsárdalur:				
Stöng:				
Ua-1419	bone, cow, same bone as K-5365	970±40	1010-1156	996-1162
Ua-1420	bone, cow, same bone as K-5366	1080±40	896-998	890-1014
Ua-1421	bone, sheep	1200±40	786-880	688-938
Ua-1422	bone, sheep	1035±50	900-1030	888-1154

LABORATORY Number	MATERIAL	BP VALUE	CALIBRATIONS 1 sigma 68 % prob. cal AD	2sigma 95 % prob. cal AD
Skeljastadir 1939:				
Ua-1423	human rib bone	1200±50	770-890	682-951
Ua-1424	human rib bone	1015±50	961-1150	894-1158
Sámsstadir 1971:				
Ua-1425	charred birch and birchbark	1150±50	814-961	772-992
Ua-1426	fragments of a bonecomb	1130±55	826-980	782-1006
Stöng 1984:				
Ua-1427	charred birch	1120±50	882-982	796-1006
Stöng 1986:				
Ua-1428	charred birch	1205±50	728-888	680-949
Skeljastadir 1939:				
Ua-1714	human thigh bone, same individual as in Ua-1423	1190±80	718-947	674-980
Ua-1715	human thigh bone, same individual as in Ua-1424	1160±100	780-980	670-1030
Ua-1945	human thigh bone, same bone as in Ua-1714	1290±80	652-851	604-936
Ua-1946	human thigh bone, same bone as in Ua-1715	1110±80	828-1016	712-1152

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