

REPORT OF THE INTERNATIONAL WORKSHOP OF INTERCOMPARISON OF RADIOCARBON LABORATORIES: A SUMMARY OF THE MEETING

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In closing this workshop, I must thank all of the delegates for making this meeting so very enjoyable for ourselves, the organisers. So much so that we will give serious thought to inviting you back to Scotland very soon. The meeting has, in our view, been eminently successful in the scientific sense. I believe that we have made uniquely important and fundamental observations and plans for the future of ^{14}C dating. I would like to summarise quickly my personal view of the main findings of the workshop. I would start this by recalling the eight questions posed in my opening address. The questions and my impression of the workshop's answers are as follows:

1. *Question:* How does ^{14}C variability compare at each stage of the laboratory analyses?
Answer: ^{14}C variability increases across the sequential steps of the analytical process. Internal variability is a lesser problem anyway and increases only slightly but external variability is considerable and shows a particularly large increase between Stages 2 and 3, *ie*, associated with pretreatment.
2. *Question:* Are there lab offsets and biases? If so, what are they?
Answer: Yes, lab bias, of 50 – 250 years, is common and is similar to that implied in previous studies.
3. *Question:* Are there performance differences between lab types?
Answer: Yes. For example, there is a suggestion that accelerator labs have problems with more modern material, while liquid scintillation labs show more variability in the counting process.
4. *Question:* Does sample type influence performance?
Answer: There was no evidence in the data for a significant variability with sample type. Henry Polach had too much chloride in the peat sample and mysterious clay in his carbonate sample but the analytical data showed no detectable quality differences.
5. *Question:* Do quoted errors account for the observed variability?
Answer: Generally, no. Two laboratories grossly overestimate errors but most labs seriously underestimate their errors, by a factor of 2 to 3 times. Only 7 labs from 38 passed all three very basic desirable performance criteria at each stage of the study.
6. *Question:* If there is excess variability, can the results help to identify the cause?
Answer: The data from the three stages of the study allow important, if approximate, general estimates of the source of variability. Thus, for gas and liquid scintillation counting labs, about two-thirds of the external variability is introduced by counting and about one-third by pretreatment. For accelerator labs, these ratios are reversed, *ie*, one-third error from target preparation and mass spectrometry, two-thirds from pretreatment. These are important findings. I was particularly pleased that many labs

(eg, of Hertelendi, Horvatinčić, Geyh, Pazdur, etc) have already used this study to identify their problems, change their procedures and reduce their errors. This, of course, is one of the main aims of our work.

7. *Question:* Is there an indicated need for a future intercalibration programme?
Answer: Unanimously, yes, there is a clear need from the ^{14}C labs and ^{14}C users alike.
8. *Question:* If so, what are the requirements and what is the mechanism?
Answer: It is the major achievement of the meeting that it agreed on exactly what is needed and how to meet that need.

The recommendations of the workshop are based on the principles of:

1. Good laboratory practice, in which the modern terminology of 'quality assurance' is adapted to ^{14}C laboratory procedures. Austin Long very expertly proposed such an adaptation.
2. Individual laboratory responsibility but with much increased international help and cooperation focused through a major IAEA initiative in the provision of new reference materials for ^{14}C dating.
3. Increased accountability to the ^{14}C analytical and user communities. All the workshop's recommendations and the resulting QA procedures will, however, be voluntary and flexible to each lab's needs.
4. Regular programmes of 'blind' intercomparisons on natural samples to monitor and encourage progress, this programme to continue, in its next phase, to be led and funded from the UK. The Natural Environment Research Council has already indicated its wish to fund a significant fraction of the total cost and the Science and Engineering Research Council has advised that it will give serious consideration to continued support for the programme.¹ The three Scottish laboratories involved are sufficiently committed to ensure that the next international intercomparison study will indeed take place.

The practical details of the workshop's proposals appeared to me to be as follows:

1. *The IAEA Programme*
 - a. Austin Long will very quickly draft and circulate for comment a document on recommended quality assurance procedures for ^{14}C labs. He will then send the draft to all participants of this workshop and to others. He will then circulate and publish the final recommendations, hopefully by the end of 1989.
 - b. The IAEA will collect, from a variety of agreed sample submitters, sets of new reference materials. These are proposed to be 1) modern cellulose, 2) ~5000-yr charcoal, 3) ~10,000-yr wood, 4) ~25,000-yr wood, 5) ~25,000-yr marine sediments, 6) ~40% modern travertine and 7) ~0% marble. These samples are to be prepared, homogenised and distributable, at low cost, by February 1990. Prospective participants should write to IAEA in Vienna to indicate that they wish to take part in this programme.
 - c. The results of the first round of 'blind' analyses on the new materials should be returned to IAEA by 1 July 1990.
 - d. Specialists will convene in Vienna in October 1990 to present and discuss the first-round results. Anyone can attend this meeting, although, obviously, the cost of attendance must be paid by participants.
 - e. There will be a recommended quality assurance procedure that labs should adapt to their own needs. The recommended procedures will include:

¹Since the meeting, the two UK Research Councils have agreed to share equally the costs of the next intercomparison exercise.

- Regular assay of IAEA reference materials
- Regular assay of in-house lab replicate materials, calibrated with respect to NBS and/or IAEA standards.

Given the limitations on quantities distributable by IAEA and the importance of including the pretreatment stage in the overall replicated procedure, it is my view that the practical emphasis in most laboratories should be placed on regular analysis of in-house secondary or tertiary standards of the most relevant sample type, interspersed by less frequent but, nonetheless, crucial assays of the intercalibrated check samples from IAEA.

2. *The Scottish Programme*

a. The mechanism and philosophy will be similar to those of the previous studies, *ie*, the emphasis will be on blind analysis of a mix of natural materials of different ages, perhaps including occasional duplicates. As before, the project will be organised by the University of Glasgow, the Scottish Universities Research and Reactor Centre and the NERC Radiocarbon Laboratory at East Kilbride. We anticipate that participation and sample shipment costs for the next study will be paid for by the UK Natural Environment Research Council and other UK organisations.

b. There will be increased coordination of interlaboratory guidance and an encouragement of advisory contact between laboratories to address and resolve common problems which may become evident from the study data.

c. There will be a suite of 6 to 10 samples per study per laboratory.

d. There will be no 'blanket' enforcement of laboratory identification or of anonymity, although openness will be encouraged.

e. The timing of the next study will be such as to allow for performance improvement during the first round of the new IAEA programme. This phasing process will also reduce the potential workload for laboratories during 1990. It is therefore proposed that the organisers will immediately make arrangements for selection and collection of the desired materials but that provision of preliminary details and the call for participation will coincide roughly with the IAEA's October 1990 Vienna meeting. The invitation to participate will go to all ^{14}C laboratories.

f. The study will begin around the start of 1991 and will report within one year.

These two programmes, combining regular in-house QA analyses of new reference materials with periodic external blind testing, represent a very major advance in the development of radiocarbon dating and must lead to improvements in the quality and credibility of the method. As such, this ^{14}C workshop is likely to prove to be a most significant event.

The excellence of this meeting's science has been paralleled by a marvelous social programme and it is therefore with mixed feelings that I must now bring the meeting to a close. Thank you all for your contributions. Have a safe journey home. I would also thank our theatre manager. (*Henry Polach thanks Marian Scott.*) Finally, to the strains of the bagpipes and with Roy Switsur carrying and addressing Scotland's national food, I would ask you to stand, raise your whiskey glasses and toast 'the haggis'. The meeting is closed.