Radiocarbon and other
Dating Technologies (TG 3)

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Team Leader

Report of the Meeting "ARCANE Dating Project: Building the Chronologies"
Blaubeuren (Germany) 27-30 April 2007

Summary

The meeting, held in Blaubeuren for two full days included the participation of TG03 members, the ARCANE project organizers, the person in charge of the database and some of the people from the regional group responsible for dating.

The main themes discussed were:

1. Presentation of the ARCANE project and methodology
2. Radiocarbon and dendrochronology dating methods in relation to synchronization of different chronological schemes
3. Key archaeological sites with continuous stratigraphy.
4. Database for the collection and presentation of dating data.

1. Presentation of the ARCANE project and methodology by Marc Lebeau and Pierre de Miroschedji.
Details of the ARCANE project and methodology were presented. Particular attention was given to the definition of benchmarks, that are the basis for building the chronological sequence, the definition of primary assemblages, composite assemblages and the artificial assemblages.
It was stressed that only the radiocarbon and dendro data from the primary and possibly composite assemblages will be used in the database, and not the dendro or radiocarbon obtained from artificial assemblages.
The importance of the key well stratified sites was also noted. The collection of data should be screened based on their quality and not on the quantity.

2. Examples of ^{14}C and dendrochronological application for solving chronological questions.

Jan Heinemeier presented the recently published (Science 312, 2006) results regarding the Tera Eruption. The results obtained indicated an earlier date (1627-1600 BC) for the eruption, supporting the high chronology. The presentation was followed by discussion about the accuracy and precision of counting the rings, the observation the tree was alive during the eruption and the possibility of old CO_2 emission from the magma chambers being taken up

by the tree. This again shows the importance of the many variables that should be independently checked in order to assure the accuracy and precision of the date. This includes knowing the environment, choice of the material, analytical precision and data interpretation. The first variable to be checked is the link between the sample and the context. While the analytical precision can be very high (in this specific case using the wiggle matching method it was 27 years with for 95% confidence) the relation between context and sample cannot be expressed as a number.

Otto Cichocki presented dendrochonology procedures from collection in the field to the determination of the age. While radiocarbon dating of short-lived material is related to the end of the phase, and charred wood remains are avoided because of the old wood effect, dendrodating of wood is related to the constructional phase of the archaeological feature. More applications involving both dendrochronology and radiocarbon dating are encouraged.

Elisabetta Boaretto presented the dating of the transition between Iron Age I and II in Israel. The program involved hundreds of measurements from sample recovered from secure context. The work represents a good basis for the ARCANE because of the collaboration of dating experts and archaeologists.
The methodology used involved strict control of archaeological context, identification of suitable material for dating and emphais on the analytical quality. The modeling of the data distinguished between outliers and misfits and therefore a strict methodological procedure to remove the misfit and outliers had to be defined. The example has highlighted the difficulties when a large area and many sites are involved.
The sequence of Tel Yarmouth was presented and discussed as an example of a well stratified site, with primary assemblages and 30 radiocarbon determinations. Outliers and misfits were pointed as examples of the problem that will be faced in the ARCANE project.

3. Archaeological sites were presented to show the type of resolution that would be required and also the significance of the radiocarbon dates. The presentation of key sites offered the opportunity to identify the primary assemblages and benchmarks. The radiocarbon data should be also related to cultural assemblage and also to written material that are the basis for the Egyptian and Mesopotamia chronologies.
Pierre de Miroschedji presented the Tel Yarmouth site: a key site for the South Levant region.
Jean-Paul Thalmann presented Arqa for the North Levant region. This site is particularly rich in wood charcoal for dendrochronology
Uwe Finkbeiner presented Emar for the Middle Euphrates region.
Marc Lebeau presented Beydar for Jezirah region.

After the presentations a discussion took place regarding the synchronization between these regions according to the known list of kings and archaeological findings.

4. The database for radiocarbon and for the dendrochronology data was discussed. The different keywords and parameters that will be included in the database, were finalized. To comply with the scope of ARCANE, only ^{14}C and dendrochronological dates from primary and composite assemblages will be considered for building the chronology. Radiocarbon dates from artificial assemblages will not be included in the database. They could be added in the comment field. With this approach we will avoid introducing noisy data.

It was stressed that the most important data for radiocarbon are the laboratory label, the sample number and the radiocarbon date. The laboratory label and number identify the date in a unique way and are necessary to trace back the dating procedure used in the lab.
In the database there will be a link to the to OxCal software in order to be able to determine the calibrated age.
In addition to context, the quality of dating data depends also on the material preservation and the analytical data.
The discussion focused on the material and analytical data that would be relevant for a further quality assessment of the radiocarbon date and dendro data. During this discussion there were some interesting exchanges of data and methodology between the radiocarbon experts. Material type (e.g. seeds, charcoal bones etc), collection method (e.g. floatation or in situ), type of method used for analytical measurement (AMS, LSC or GPC), fraction measured (e.g. humic fraction), and pre-treatment applied. The stable isotope ratio ($\delta^{13}C$) will also be included.
Some fields in the database will be for identify the material type and in particular will relate to the characterization of the material after pre-treatment (e.g. percent of carbon in the sample after pretreatment, percent of material left after pretreatment, C/N ratio, infrared spectrum etc).
These data are sometimes provided by the lab to the archaeologists. They are often completely ignored in the final analysis of the data. In cases where these data are not given then the Dating group members will contact the specific laboratory in order to request these data.

Dendrochronology database was also finalized. Laboratory label and sample ID number are essential. The information provided by each laboratory might be very variable, and be less or more informative for defining the quality of the measurement.
Because for both techniques (14C and Dendrochronology) there is no standard way to present the results, it will be higly advisable to include in the database also the report (pdf, or doc) provided by the lab.

A letter describing collection procedure of future samples and how to deal with the data, will be prepared and sent to the archaeologists.

MEETING PROGRAM

Day 1: Friday 27 April

Arrival at Blaubeuren

Day 2: Saturday 28 April

9:00 - 10:00 Welcome and presentation of the ARCANE program (Lebeau, Miroschedji)
10:00 - 11:00 Database presentation (Jean Paul Thalmann)
11:00 - 11:30 Coffee break
11:30 - 12:30 Database presentation (Jean Paul Thalmann)
12:30 - 14:00 Lunch
14:00 - 14:45 High precision radiocarbon dating: the case of the Minoan eruption on Santorini (Jan Heinemeier)
14:45 - 15:30 C-14 and Dendrochronology - choice of samples and interpretation of Results (Otto Cichocki)
15:30 - 16:00 Sub-century chronological differences: limit of radiocarbon (E. Boaretto)
16:00 - 16:30 Coffee break
16:30 - 18:30 Discussion
18:30 Dinner

Day 3 Sunday 29 April

9:00 - 10:30 Presentation of key regions and sites for the ARCANE program. (Lebeau, de Miroschedji, Thalmann, Finkbeiner)
10:30 - 11:00 Coffee break
11:00 - 12:30 Continuation of the morning discussion and how to include 14C, TL and Dendro dates in the database. Definition of the dating database
12:30 - 14:00 Lunch
14:00 - 16:00 Strategies for the data collection and modeling.
16:00 - 16:30 Coffee break
16:30 - 18:30 Conclusion and preparation of the data collection guidelines.
18:30 Dinner

Day 4 Monday 30 April

Departure from Blaubeuren

LIST OF PARTICIPANTS AND SPEAKERS

Participants:
Elisabetta Boaretto (Israeli), Weizmann Institute of Science and Bar Ilan University
Jan Heinemeier, (Danish), Aarhus University
Otto Cichocki (Austrian) Vienna Institute for Archaeological Science
Eva Wild (Austrian), University of Vienna
Katleen Deckers (German), Universität Tübingen
Pierre de Miroschedji (French), Centre de Recherche Français de Jérusalem
Jean-Paul Thalmann (French), Université de Paris I Panthéon-Sorbonne
Uwe Finkbeiner (German), Universität Tübingen
Marc Lebeau (Belgian) European Centre for Upper Mesopotamian Studies, Brussels
Peter Fisher (Sweden) University of Gothenburg

Absent:
Walter Kutschera (Austrian), University of Vienna
Peter Kuniholm (American), Cornell University
Gordon Cook (British) Scottish Universities Environmental Research Centre
Marian Scott (British), University of Glasgow