

# Protocols for the Collection, Identification and Interpretation of Archaeological Charcoal and Wood

Dr Robyn Veal, University of Cambridge, updated July 2014

## Overview

Archaeological charcoal can be collected by hand, recovered by dry sieving, and also by flotation of standard sized soil samples. Archaeological wood may also be found in excavation but it is generally rare unless preserved through anaerobic, or very dry conditions. The appropriate method(s) of collection for a particular site are normally agreed after preliminary field assessment and consideration of the detailed research questions to be answered. Wood and charcoal can be used in three ways:

C14 Dating;

Palaeo-environmental reconstruction;

Economic reconstruction: knowledge about cultural practices relating to wood use, forest management, cropping methods and cycles, artefact manufacture from wood, building practices, questions of sustainability, fuel supply.

Sometimes archaeological charcoal can be collected for all three purposes, but it will depend on the site, the time period and the project goals. Large quantities of archaeological wood are not normally found except in more recent deposits or those where anaerobic conditions exist (e.g. waterlogged sites). But it can also be collected, sampled and identified, if found. Following collection in the field, post-excavation activities are normally carried out in a laboratory environment. The following outline provides in the first instance, details of collection and handling/storage strategies for each use. Secondly, methods and requirements for identification and analysis in the laboratory are discussed, and finally, lists of equipment required for each of the stages are provided.

### **1. a) Collection of Charcoal for C14 Dating**

**Sampling:** strategic selection from stratigraphic contexts in small quantities; for AMS – as little as 5mg – 10mg is required.

**Storage in field:** Careful selection and storage of the charcoal is made in situ – and as soon as possible after exposure in excavation, avoiding contamination from root systems nearby, interstitial mineralisation, air and sunlight. Charcoal that has originated from twigs or small branches is chosen if possible – older wood provides a date of the death of the branch/tree, rather than the date of the deposit. As much of the external substrate is removed as is reasonably possible using a trowel, leaf, or brush. Touching of the sample is avoided. Double bagging of samples is carried out to ensure there will be no further contact with the atmosphere or other pollutants. (Labels are not put inside the inner bag – papers, glue and other such things usually contain carbon, and therefore contaminate the sample.)

C14 samples are usually stored in a light proof container. Wet wood or wet charcoal are not dried out – but just stored immediately. Preservation of the integrity of the shape and physical structure of the material is not needed.

### **1. b) Excavation of Charcoal for Palaeoenvironmental Reconstruction or Cultural / Economic Analyses**

It should be noted that storage needs here are different from those for charcoal for C14 in that ‘contamination’ is not a consideration for excavators in the field – since the main goal is identification of the taxon, and the charcoal specialist can work around intra-cellular

contamination (sometimes this provides useful information about the original wood cropping practice and/or the taphonomy of the deposit). However, preservation of the shape/ size of the charcoal *is* quite important; and wet storage is highly undesirable.

**Sampling: For palaeo-environmental reconstruction** – collection of as many samples over as wide a choice of depositional environments is the most useful, with the charcoal specialist making sub-sampling decisions at the microscope (if necessary) in conjunction with knowledge of stratigraphy, phasing, and project goals. Collection from excavated contexts (preferably), or from vertical cores, or vertical samples from excavated sections may be carried out. Industrial, urban and habitat depositional environments are considered. General collection from all deposits, including secondary contexts is desirable (collection from primary deposits, while useful, only tells us about the activities relating to that deposit, not overall trends of fuel or wood consumption). Strategic comparison of the charcoal data with appropriate pollen sets provides a complement and contrast to the pollen data – arboreal pollens will in general be less well-represented (to varying degrees) in the palynological record. In charcoal there will be a bias *towards* the arboreal taxa – with shrubs and lianas being under-represented. In both cases, firm dating (either by absolute or relative methods) of the deposits is necessary for useful interpretation of the data.

**Sampling: For cultural and economic questions** – usually this involves the collection of charcoal in and around urban and/or industrial environments. Charcoal in refuse deposits, and ‘ambient’ urban charcoal found (usually) in about 2/3 of all urban deposits provide an average picture of wood use for fuel. Burnt furniture and construction timbers are rarer to find. Sampling by dry sieving of all substrates excavated, using a mesh of 4 or 5 mm square, and/or hand collection of charcoals whenever seen, tend to produce the most appropriately sized charcoal for examination. Recovery by flotation (over 1mm or 0.5 mm mesh) of a fixed sample size of soil, often used in the recovery of other environmental artefacts, can also be carried out and would be the preferred method for samples collected from cores or from vertical section samples. Flotation is not always the best method of collecting charcoal as the washing and drying tends to fragment charcoals more, (but flotation is necessary for collection of seeds, etc). Any convenient method of collection within an excavation’s protocol can normally produce useful results. It will depend on the characteristics of the site and the charcoal. For charcoals especially associated with industrial or other contexts where there is an interest in testing the absolute burn temperature of the processes concerned, then collection of the smallest and most damaged charcoals is also desired. This is achieved by taking unprocessed ‘grab’ samples (1-2 handfuls) of soil that are part of the context of interest, and which contain fragmentary traces of charcoal (i.e. <2mm in size). Dry sieving over a series of mesh sizes is carried out later to isolate microscopic charcoals for future processing.

**Storage:** The main goal of storage in this instance is to preserve the charcoal’s physical size, shape and state so it can be examined in all of its three dimensions under the microscope (although this is not important in the case of microscopic charcoals collected for reflectance/burn temperature testing). Wet charcoal is allowed to dry gently in the shade. Acid free tissue in the field is essential if drying is not possible – as this will wick away some of the moisture as well as supporting individual fragments. Before storing, as much soil / clay is removed as possible using a trowel or brush (easier after drying). A rigid container to transport the bagged samples from site to the artefacts management area also helps reduce fragmentation. Individual fragments of a size over 10mm are wrapped each in their own piece of acid free – and placed in between cushioning layers. If there is a lot of charcoal, individual wrapping may not be practical (sub-sampling in the laboratory will occur).

## **2. c) Collection of archaeological wood**

Quantities of actual wood fragments are unusual in an archaeological setting unless they have been preserved in anaerobic conditions. Occasionally partially mineralised woods are found. In general, the protocols in 1.b) apply, excepting that: wood fragments found preserved in wet conditions must be kept wet and stored away from light and extremes of temperature as soon as possible. Dry wood fragments can be handled as if they were charcoal. Any wood of any large size, or that is considered to be an artefact, or part of an artefact, (including building timbers) must first be examined by the archaeobotanist and/or conservator in situ. An appropriate strategy for excavation and preservation will be agreed. A small section (usually 1 cm<sup>3</sup> is cut from an appropriate part of the artefact to minimise damage and processed into thin sections for identification. For large timbers, consideration can be given to coring or a transverse cut to carry out dendrochronological analysis. Preliminary identification of the taxon, and discussion with a dendrochronologist is recommended. Annual growth ring (AGR) count needs to be around 70-100 years for dendrochronological analysis to be possible or worthwhile. Ring count can be estimated usually with the preliminary identification. Portable digital microscopes now make examination in situ possible (using a laptop for power).

## **3. Laboratory analyses:**

### **Preliminary processing and sub-sampling**

Soil volumes are normally recorded for every context, thus allowing calculation of the density of ecofacts. Charcoal volumes per context are measured. Sub-sampling of excavated charcoals may be necessary depending on volumes and quality of charcoal. Sub-sampling sometimes requires the use of graded sieves. Normally all of the charcoal fragments of most contexts are analysed, down to approximately 2 or 3mm in size. In general sampling a greater diversity of contexts will retrieve more charcoal taxa and provide a more representative selection than over-analysing fewer, larger samples. A cumulative taxa graph is a useful measure of sampling sufficiency with regard to possible discovery of all taxa in a context. The number of fragments is plotted against the cumulative number of taxa. As the cumulative count approaches its maximum, the graph, which commences typically with a steep gradient, tends to follow a logarithmic curve, flattening off to horizontal as the maximum number of taxa is approached. Sometimes this graph is made after adjusting measurements to a logarithmic scale, a transformation that corrects for upward skewness (typically occurs in the early stages as the first taxa are identified quickly).

### **Identification by Light Microscopy**

Wood fragments are sometimes fractured for examination (as for charcoal), depending on preservation level, or alternatively thin sections may be made for examination under a transmitting light microscope (up to X1000). Identification of charcoal is carried out using reflected light microscopic examination of the three sections: Transverse (TS), Tangential Longitudinal (TLS) and Radial Longitudinal (RLS), except that reflective bright or darkfield light is used on hand or blade fractured charcoal surfaces instead of transmitted light through thin sections. Wood identification is made by comparing the three-dimensional features of the charcoal or wood sections with published sources on wood and with modern charcoal reference material. A comprehensive reference collection of Italian woods has been assembled, and access to the University of Cambridge, Kew Gardens and University College London, slide and charcoal reference collections can also be made for rarer taxa if necessary. It would be expected that as a project proceeded, collection and charring of modern reference woods local to the site would also be carried out.

A data recording sheet is used to roughly sketch fragment characteristics and record basic details and microphotographs are taken to build a microphotographic database of type or unusual specimens. A summarised version of these details is recorded in a database. Besides taxonomic identification, tree ring patterns are also measured and counted (where possible) to explore forestry management and cropping regimes.

### **Measuring Burn Temperature through ‘Reflectance’**

A method of measuring the ‘reflectance’ (shininess) of specially resin mounted charcoal samples can also be undertaken for samples of special contextual association (e.g. iron smelting or working). Reflectance is linearly related to the absolute burn temperature of the charcoal and can give information on whether raw wood or charcoal was used as fuel; and what temperature different parts of the fire might have reached.

### **Methods of Quantification**

Fragment count and/or weight are used to broadly quantify the charcoal in the first instance. Various other standard graphical and statistical analyses are carried out including: taxon abundance measurements (ubiquity and percentage frequency analysis); fragmentation and preservation indices; taxa diversity; ring counts and patterns. Ring count and curve analysis may be useful as it may help identify if cropping practices were sustainable or not. The presence of many flat curves in a context indicates use of stem (trunk) wood; high curves indicate the use of twig/branch wood. For ring counts: high counts indicate old wood; low counts: young or fast growing wood; rings very close together with a flat curve may indicate stem wood grown in a higher montane area (cooler climate).

### **Density, Indeterminates, Differential Preservation of Taxa**

The purpose of these indices is to examine taphonomy, in particular to examine assumptions of uniform deposition, preservation and recovery rates. Both depositional and preservational bias can be substantially attributed to cultural factors. Depositional circumstances may reflect different cultural choices of woods for different uses, and/or taxa availability, as well as the heat of the fire used. Preservational bias is far more difficult to assess, since many factors contribute including: preservation characteristics of ‘hard’ vs ‘soft’ woods; water or resin content; heat of fire; soil characteristics, compaction, trampling and bioturbation, among other factors.

## **4. Summary: (Optimal) List of Field Equipment (hand collection and dry sieving)**

Trowel / leaf for excavating

Brush for cleaning desirable (child’s paintbrush will suffice)

X6, or better, X10 hand lens

Tweezers can also be useful (normal size from a dissecting set)

Acid free tissue and aluminium foil (both if possible)

Sample bags, and/or rigid storage containers (small and large sizes)

Lightproof container (only necessary for C14 samples)

Indelible markers

Adhesive paper tape on which to write provenance details temporarily while drying charcoal

Finds tray or other temporary infield storage (raised sides assist in wind protection)

### **Field Equipment for Flotation Recovery**

This list presumes water is recycled, and there is no electricity. The device is constructed using three large plastic rubbish bins to cycle water; mesh of various dimensions to wash over the soils, and hand pumps connected by plastic tubing. Most of these items are obtainable in any location, except for the mesh and hand pumps (which should be purchased in advance):

- 3 large plastic bins (or similar)
- 2 marine hand valve pumps (1 is a spare)
- 6-8 m of flexible plastic tubing (2cm diameter)
- Sundry plumbing plastic fittings (right-angles, joiners, etc, to facilitate joining pumps to piping (purchasing these in advance is sometimes advisable)
- Cleats/clamps to seal joins
- Timber (ply or similar) to construct a light frame for hand pump
- Screw clamps – 2 for clamping valve and frame in place (plus spares)
- Plastic wash bucket to support primary washing mesh
- Wire – medium gauge (support mesh), and for general use
- Aluminium strips (to construct mesh supports)
- Nails, screws, wing-nuts
- Basic tools: hammer, basic screwdriver set
- Mesh of various ratings (depending on archaeological questions):
  - at least 1mm and 500 microns – approximately 12 pieces of each size, each 1m square
- Buckets (for carrying water, and for collecting soil samples)

The cost of constructing a full flotation kit is fairly low in terms of the basic equipment, which can be found almost anywhere in the world. Difficulties can be found in acquiring the plastic plumbing fittings of the right size (best to buy in advance along with the hand pumps, but these are relatively inexpensive). Total cost to construct is about €500. More than half of this price is the mesh, and this price will vary depending on wear and tear and precise requirements. A helpful paper with photographs is Shelton, China, and Chantel White. 2010. "The Hand-Pump Flotation System: A New Method for Archaeobotanical Recovery." *Journal of Field Archaeology* 35 (3): 316-326.

### **Field and Laboratory Equipment for Collecting and Processing Reference Woods**

- Pruning saw
- Indelible pens/paper/plastic tape for labelling
- Large plastic bags
- Flower/leaf press (optional – acid free tissue and some heavy books will do)
- Aluminium foil (to char wood in furnace)
- Storage bags for each wood type

### **Laboratory Identification**

- Reflecting and transmitting microscope to X1000; small stereomicroscope for preliminary examination and orientation, and for tree ring curve analysis
- Camera and software for photographing type specimens
- Microscope slides, Bluetack (holds charcoal in place) (some researchers use fine sand in a flat container), range of scalpel(s) and blades for fracturing charcoal
- Saffrinin blue and other stains for wood slide manufacture
- Glycerin
- Microtome (slicing wet woods, and freshly boiled modern woods)
- Micro plastic bags for restoring fragmented and identified charcoal; larger storage bags

[rjv33@cam.ac.uk](mailto:rjv33@cam.ac.uk)