Determining Sedimentation Rates of Caves and Rockshelters

Time, Sedimentation and Archaeological Formation Analyses

The purpose of this discussion is to introduce you to *chronometric* ("time measurement") *analysis* of archaeological deposits- this is, studying the dimension of time as it relates to the processes that shaped the archaeological records of occupations at an archaeological site. This will be considered in a general way in Lab Exercise 6 and explicitly in Lab Exercise 7.

To accomplish this, we will use radiocarbon dating to define the absolute time scale for site occupations and for geologic processes such as deposition and soil formation. Our other data will include: artifact and bone densities in the archaeological sediments, bone condition (taphonomy) and archaeological features (hearths, pits, burials). All of our data come from a Paleolithic site in France: Grotte du Canard.

Rates of Sedimentation

Rates of sedimentation are controlled by a number of geologic factors in any given sedimentary environment. Here we are concerned with rockshelter sedimentation, as we discussed above. Patterns of sedimentation and weathering in rockshelters are largely controlled by climate, although other factors such as kind of bedrock need to be dealt with.

To calculate the rate of sedimentation, we have to compare two dimensions of a site: the thickness of the deposits and the time it took for those deposits to accumulate. Thus, we need to measure the thickness of the deposits, and we need some control on the time factor. Usually we measure time by obtaining radiocarbon dates from materials buried at different depths within the deposits (charcoal, wood, etc.). The more dates we have, the better our age estimates.

Note that we will be using radiocarbon dates to infer the *rate* of a process (sedimentation) as part of our analysis. We are not concerned at this point in how old the sediments and the associated archaeological materials are. This rate is calculated as follows:

$$R_s = \frac{T}{t}$$

where

R_s = rate of sedimentation in centimeters (cm) per year (yr)
T = thickness (cm) of stratum or interval between radiocarbon dates
t = length of time interval in years (yr), calculated as the difference between the older date and the younger date bracketing the stratum or interval

Example: If 50 cm of sediment accumulated in 1,000 years, the rate of sedimentation is: 50 cm/l000 yr = 0.05 cm/yr.

The net rate of sedimentation is calculated using the oldest (deepest) and youngest (most· shallow) dates in a series of stratigraphic units, each of which has its own rate of sedimentation.

You could compare this to the annual (net) rainfall, which is the sum of individual monthly rainfall amounts.

The rate of sedimentation is an important aspect of site analysis for two principal reasons:

The rate of sedimentation defines the **rate of burial,** which directly increases the potential for **preservation** of artifacts, features and bones. Rapid burial promotes good preservation. Slow rates of sedimentation increase the chance that artifacts and features will be disturbed or that they will deteriorate during exposure to weathering agents. Rapid burial also increases the vertical separation of features, artifacts and bones deposited during sequential occupations of a site. With slow sedimentation, the records of separate occupations can become mixed on the same surface, making it difficult to "see" the patterns of repeated occupations.

Second, the rate of sedimentation is also a control on the **density** of artifacts in a stratum. Artifact density is the number of artifacts per volume unit (usually expressed as cubic meters [m^3]) of excavated site matrix. We correct density to a volume unit, so that excavations of different sizes can be compared.

Volumetric artifact density (D_v) is therefore the number of artifacts per volume unit of excavated sediment, and is calculated as follows:

$$D_v = \frac{n}{v}$$

where

n = number of artifacts recovered, and
v = the volume of the excavated area in cubic meters (length x width x depth = m^3)

Artifact density can tell us how often a site was occupied, or for how long it was occupied. However, to estimate artifact densities, we must control for rate of sedimentation. This is because slow sedimentation allows for accumulation of many artifacts over a long period. Similarly, rapid rates of sedimentation "dilute" the artifacts in the matrix, giving the impression of low artifact density, compared to a similar sequence of occupations at a site where rates of sedimentation were slow.

Ideally, we should measure artifact densities against time rather than volume of matrix, since time is a factor that is pertinent to studying the duration and intensity of occupations of a site. For this reason, we can calculate the density of artifacts relative to time.
This parameter is called the **chronometric density** (D_c)**.** It is calculated as follows:

$$D_c = \frac{D_v}{t}$$

This measure has the dimensions: "artifacts per cubic meter per year."