I am enthralled by the past. As a student of history, one of my main interests for a possible career, is archeology. I would love to be able to excavate sites and determine how people lived, when they lived, and how they interacted. Archeologists use many techniques in order to understand the past. They may examine soil samples to determine the age of artifacts in a certain layer of soil. Artifacts may be compared to known artifacts: for example if an archeologist is trying to determine if Alexander the Great entered southern India, then he or she would compare artifacts found in Southern India with those of ancient Macedonia. Today in archeology, math and science essential to find precise dates of artifacts. This is done using the process known as Radiocarbon Dating.

In 1896 Becquerel discovered radioactivity, unleashing a series of scientific breakthroughs permeating into the study of archeology (Barker 120). Carbon-14 is a radioactive isotope of carbon. An isotope is an atom with the same chemical properties but with a different number of neutrons (Oxtoby 19). Barker states that, “The atoms of which [radioactive substances] are composed have a tendency to change their internal structures to a more stable configuration” (120).

All living things contain carbon-14. This is because in the upper atmosphere there is, “dynamic activity of nuclear processes as cosmic radiation first encounters the many types of atoms that make up our air” (Fleming 56). The collisions of neutrons in the atmosphere produce the chemical reaction of Nitrogen-14 into Carbon-14 plus hydrogen (Fleming 56). The equation is as follows.

$$^{14}N + n \rightarrow {}^{14}C + H$$ (Fleming 56)

Most of this radioactive carbon becomes oxidized to form carbon dioxide. The majority of this carbon dioxide is incorporated into the ocean, but much of it is transported into the food chain through the process of photosynthesis (Fleming 56). Therefore every living thing must contain Carbon-14 along with Carbon-12 which is also in carbon dioxide.

The process of stabilization that Barker writes about is known as radioactive decay. Carbon-14 decays by the process of Beta decay. Oxtoby writes that:

> If an unstable nuclide contains fewer protons than do stable isotopes of the same mass number, it is called "proton deficient." Such a nucleus can decay by forming one of its neutrons into a proton and emitting a high-energy electron , also called a beta particle, and an antineutrino (v). (Oxtoby 454)

The resulting equation according to Oxtoby is,

As the Carbon-14 again becomes Nitrogen-14, Carbon-12, which is already stable does and therefore does not change at all.

Radioactive isotopes decay in a manner so that in a given unit of time a certain percentage of the mass will decay (Hughes-Hallet 17). This is known as exponential decay. The best way to understand this change is to find the time period necessary for one half of the substance to decay. This time period is called a half-life. For Carbon-14 the half-life is approximately 5730 years (Hughes-Hallet 17). This means from a sample of eight grams of carbon-14 after 5730 years only four grams will remain, after 11460 only two grams will remain, and after 22920 only one gram will remain. The rate of decay can be graphed as follows. (See Appendix 1)

The graph illustrates clearly that the function of grams of carbon-14 decreases in a decreasing manner. This means that the amount of carbon-14 decreases less and less as time goes by so that for each progressing year a smaller amount of carbon-14 decays.

All living things contain carbon-14. During life as the carbon-14 decays it is replaced by more carbon-14 through photosynthesis and the food chain (Michels 14).

When the organism dies however it no longer takes in more carbon-14. Michels states that: “There is no longer any process by which carbon-14 from the atmosphere can enter the body. At that time the radioactive disintegration process takes over in an uncompensated manner” (149).

It is therefore possible to find the approximate date of death of an organism by finding the amount of carbon-14 in the object and using it to find the age. In order to do this, however, it is necessary to know the starting amount of carbon-14. This can be done easily by finding the amount of carbon-12. Carbon-12 is a stable form of carbon and therefore will not decay. Since carbon-12 and carbon-14 exist in a constant ratio in living things, the starting amount of carbon-14 can be determined by knowing the ratio of the same thing when living. For example, if one is dating a wooden coffin, then the ratio of C-14 to C-12 in a living tree is used to find the starting amount of Carbon-14.

In an exponential decay problem, one takes the starting amount and multiplies it by a factor of decay. For carbon-14 that factor is one half because we know the half-life is 5730 years. This we must raise to a power of the date that we are looking for divided by the half-life of 5730. The resulting equation is as follows:

$$C= Co\ (1/2)^{\wedge}(t/5730)$$ (Hughes-Hallett 18)

Where C is the amount of Carbon-14 left after t years, Co is the starting amount, and t is the age for which we are looking.

A hypothetical example:

Archeologists uncover a skeleton in New Mexico. They take a sample of the bone and in a laboratory find it has a ratio of 9 C-12 molecules for each C-14 molecule. (this is hypothetical because in reality the ratios would be a tiny amount of c-14 to c-12) they are able to use the equation from above.

Therefore: 1/9=5/9(0.5)^(t/5720)

In order to solve:

1. Divide both sides by 5/9 yielding

   1/5=(0.5)^(t/5730)

2. Take the log of both sides.

   log 1/5= log[(0.5)^(t/5730)

3. Use the property log (X^Y)= Ylog X

   log 1/5= t/5730(log(0.5)

4. Divide both sides by log(0.5)

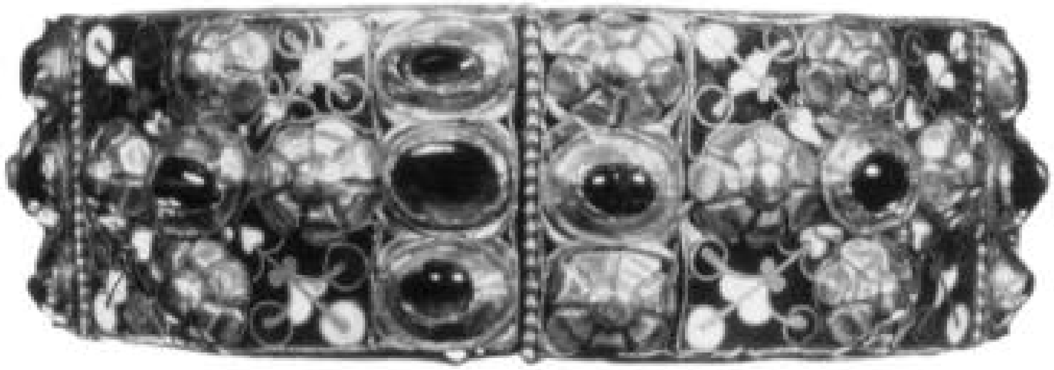
   log 1/5 / log0.5=t/5730

5. Multiply both sides by 5730

   13304.64798

Archeologists would then determine that the person died around the year 11300 BC, which would prove that people had in fact traveled as far south as New Mexico by that time.

Archeologists used carbon dating to authenticate Charlemange Crown, given to him by the Pope in his coronation as the holy Roman Emperor in the year 800 AD.



(Tuniz 1)

The archeologists at first assumed that they would not be able to date the crown because it was made out of inorganic substances. After an examination however, they discovered that the stones were held in place by beeswax and clay. Beeswax is an organic material, and they were therefore able to use the radiocarbon process to date the crown. Its approximate date proved that it could in fact be the real crown and ruled out the possibility that it was a modern fake (Tuniz 1).

The whole process of Carbon dating assumes that there has been a constant rate of carbon-14 in the atmosphere. This has been proven to be true over a period of thousands of years by comparing the results of carbon dating of Sequoia trees that can be dated by counting the rings. While the amount of Carbon-14 stayed constant for years, today it has changed, due mostly to the effects of nuclear testing. This means that humans for example do not have the same amount of C-14 as we once did. To compensate researchers use the pre 1950 level of C-14 to calibrate their measurements (Michels 150).

By using mathematics we are able to understand . Radi. We will also be able to discover which artifacts are hoaxes and which are true historical evidence. In the future mathematics will be a crucial aide for archeologists and historians to piece together the story of human kind.