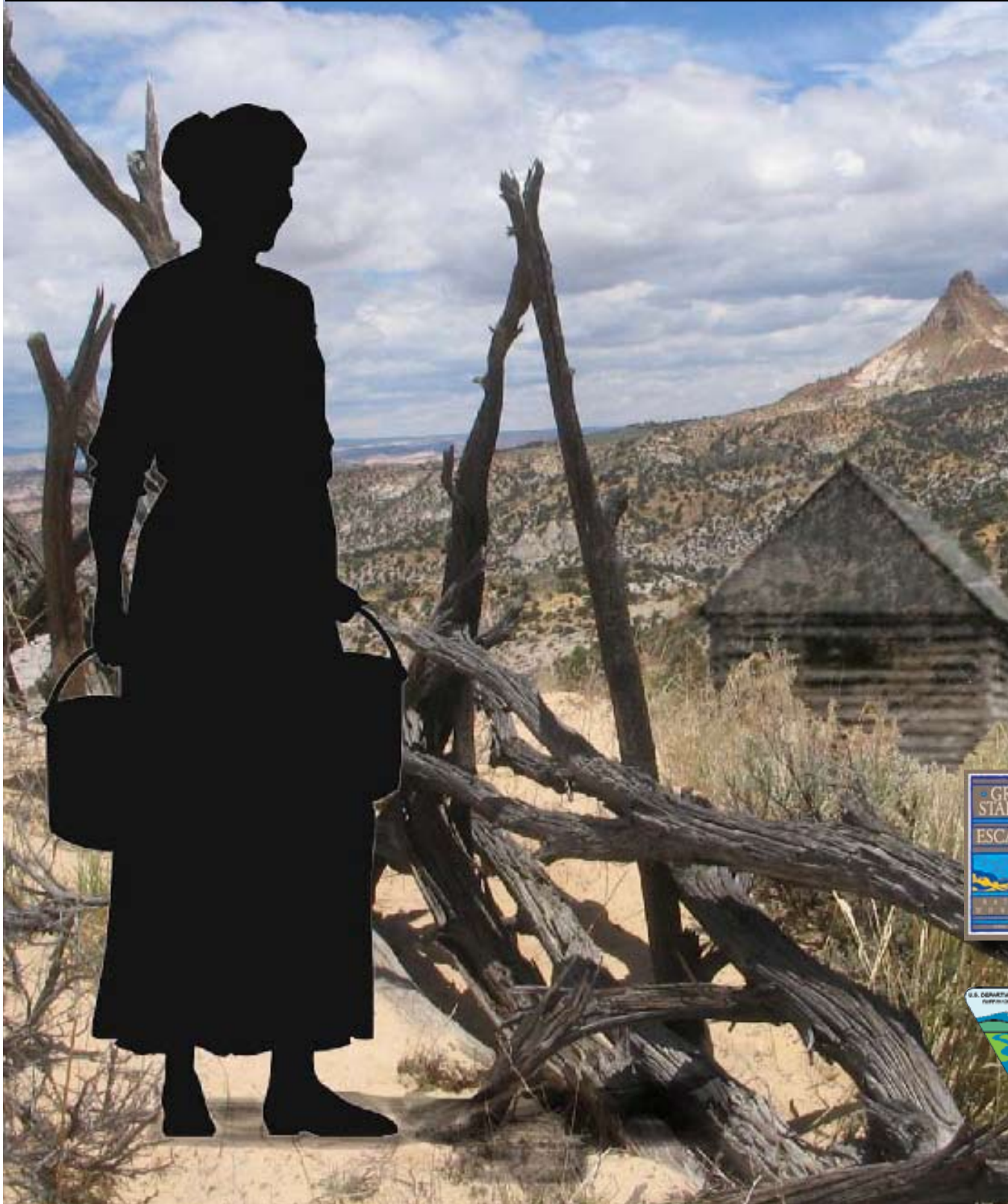


The Mystery of Molly

A Study of Dating Techniques

Student Activity



BLM

Grand Staircase-Escalante National Monument



The Mystery of Molly

A Study of Dating Techniques

Archaeologists and *anthropologists*, who study human cultures, often find themselves doing forensic science. When historic and prehistoric sites are excavated they need to be dated. In this activity you will learn about different dating methods and see how they would be applied to solve a fictional cold case.

We begin this activity with a mystery, and a disclaimer. First, the disclaimer: *The following story is a bald-faced lie. Names and dates have been randomly chosen and have absolutely no relationship to actual people or events.*

A Fictional Cold Case



Our tale begins with an old ranch house in Glass Eye Canyon that burned to the ground in 1964. At that time the Bureau of Land Management, the agency that managed the area, decided that the charred timbers and stone rubble from the fireplace would be left untouched. Over the years the old ruin became a hazard, so the BLM sent a crew in to clean it up.

In June 2004 two men were digging up an old watering system in an abandoned corral when they made an interesting discovery – not more than fifty feet from the burned down ranch house were more charred beams. They dug a bit further, but stopped when they saw some bones and broken china. The crew leader decided it was time to call in archaeologists.

When the archaeologists arrived they immediately started recording the site. Measurements were taken to determine the dimensions and depth of the new discovery. Every shovel of dirt and debris was sifted. All items found were bagged and tagged while the depth and exact location of each find was carefully documented.

Several old beams were excavated that appeared to be locally cut. Beneath the beams, on top of the burned wood floor, was an entire skeleton. The skeleton was charred but mostly intact. Scattered around on the burned floor was more broken china. Just under the burned floor in a shallow hole scraped in the ground, a twelve inch square metal box was unearthed. The bottom of the metal box bore an inscription of a manufacturer's date of 1883.

Analysis of the bones and teeth indicated that the skeleton was that of a female in her late 20's or early 30's. Her skull had been crushed near the left temple. The china had a distinct old English pattern of roses and butterflies.

When the metal box was opened a smaller wooden box was found inside. The box was filled with old letters, all addressed to Molly. The letters were dated between 1884 and 1887. Several of the letters were signed by "Robert Parker." Other letters were signed with only the first names of Tom, Dick, and Harry.

To solve mysteries like the Mystery of Molly, scientists have several different techniques, or methods that help them date sites and artifacts. These different methods are classified into two categories: **Absolute** and **Relative** dating.

Absolute Dating

There are many different methods of absolute dating including: chronological markers, dendrochronology, radiocarbon dating, thermoluminescence, obsidian-hydration, and potassium-argon dating.

- Potassium-argon dating is not used to date archaeological sites in the New World because there are no sites old enough. Potassium-argon dates volcanic material and is useful for sites dated between 50,000 and 2 billion years ago.
- Thermoluminescence is based on the fact that electrons in mineral emit light, or luminesce, when they are heated. Thermoluminescence is used to date ceramics that are 300 to 100,000 years old.
- Obsidian-hydration dates *obsidian* tools and flakes resulting from the process of *flint-knapping*. Archaeologists don't often use obsidian-hydration dating because there are many variables and not enough accuracy.

The three methods scientists would probably use with the evidence in the story of Molly are chronological markers, dendrochronology, and radiocarbon dating. These methods are described on the following pages. Read the information about each of them and determine how they would apply to the Mystery of Molly.

Chronological Markers

Step 1: Read about chronological markers

Chronological markers include objects or artifacts that have specific dates inscribed or printed on them. Coins, tombstones, newspapers, and written documents with dates are all chronological markers.

Designs or photos can also be chronological markers. Every Olympics has a different logo that can be used to date that specific event. Photos may have dates in them, like those taken of people holding newspapers. Photos can also depict specific events in history, like the raising of the flag by Marines at Iwo Jima on February 23, 1945.



Step 2: Apply chronological markers to the mystery of Molly

Question 1

Which of the artifacts unearthed by archaeologists would be chronological markers?

Question 2

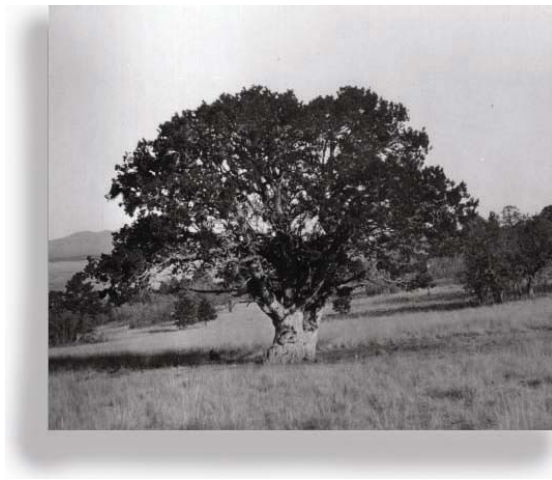
The pattern on the broken pottery was traced to a company in England that made china from 1752-1882 and sold the pattern found at the dig for twelve years, from 1860-1872. Would this be a chronological marker? If so, what information would this give you about the cold case?

For more information about chronological markers visit this web site:

http://archaeology.about.com/cs/datingtechniques/a/timing_2.htm

Dendrochronology

Step 1: Investigate dendrochonology



Dendrochronology is also called tree-ring dating. Tree-ring dating is based on the growth rings of trees which vary with seasonal and annual precipitation and temperature. Trees of the same species growing in the same area will have matching growth ring patterns for the period of time during which they were both alive.

By taking a core sample from a tree, or by taking an entire cross section of the tree trunk when it's cut down, scientists can match the growth rings to samples stored in museums and laboratories and learn how old the tree is and what weather patterns were like during the tree's lifetime.

Dendrochronology can be used to date structures built with wood, especially if there are large beams. Scientists can core the beams and then compare the rings to tree ring data collected in the same area. They can use this information to determine when the tree was cut down and therefore when the structure was built.

There is a great slide show about dendrochronology at the following web site:

History Detectives – Timber Dating

<http://www.pbs.org/opb/historydetectives/techniques/timber.html>

Step 2: Apply dendrochronology to the mystery of Molly

Question 3

A few of the beams were in good enough condition that they were sent to the dendrochronology lab. Scientists in the lab matched the growth rings of the charred beams to charts made from other trees in the region. The tree had been cut down in 1880. What does this information tell you about the excavated house?

For more information about Dendrochronology visit these web sites:

Dendrochronology of Bristle Cone Pines

<http://www.sonic.net/bristlecone/dendro.html>

Tree Ring Dating

<http://waynesword.palomar.edu/treedate.htm>

Chronometric Techniques – Dendrochronology

http://anthro.palomar.edu/time/time_4.htm

Radiocarbon Dating

Step 1: Investigate radiocarbon dating



Radiocarbon dating is based on the fact that all living organisms are carbon-based. Everything that has ever lived has carbon in it. In fact, anything that has ever lived has not one, but two forms of carbon in it.

Carbon 14 (C14) is a radioactive element found in both the atmosphere and in living organisms. When an organism is alive, the amount of C14 in that organism is the same as the C14 in the atmosphere. When a living organism dies it stops taking in C14 and the element begins to decay.

The half-life rate of C14 is 5,730 years. This means that it takes 5,730 years for half of the C14 that was in the organism when it was alive to decay. Comparing the amount of C14 in a dead organism to atmospheric levels provides an estimate of when it died. C14 can be used reliably for about ten half-lives, or 57,000 years.

Radiocarbon dating can be used on charcoal, wood, shells, bone, antlers, peat, and nearly anything else that contained carbon in its life cycle.

Questions about the use of radiocarbon dating have been raised because atmospheric levels of C14 have fluctuated from time to time in Earth’s history. Extensive burning of fossil fuels at the start of the Industrial Revolution resulted in an increase in atmospheric C14. The use of fossil fuels today is affecting levels of C14, but scientists are keeping accurate records so radiocarbon dating can be used on more recent objects.

An interesting development in radiocarbon dating has been the correlation of tree-ring dating with radiocarbon dates. When dates from tree-ring patterns and the date from radiocarbon dating of the same tree sample correlate, scientists can verify both the tree-ring and C14 dates. As with all science, the more samples you can test the better.

If you need some help understanding radiocarbon dating try this web site:

The Dating Game

<http://www.pbs.org/wgbh/nova/first/radiocarbon.html>

Step 2: Apply radiocarbon dating to the mystery of Molly

Question 4
Charcoal from the burned wood in the house was sent to a radiocarbon dating lab for analysis. The radiocarbon date of the charcoal came back from the lab as 1887, +/- five years. What does this date tell you about the excavated house?

For more information about radiocarbon dating visit this web site:

Chronometric Techniques – Radiocarbon Dating

http://anthro.palomar.edu/time/time_5.htm

Relative Dating

Relative dating doesn't yield precise dates but it does put historic sites and artifacts into a time frame of "older and newer." Two methods of relative dating are stratigraphy and seriation. Read the information about each of them and determine how they would apply to the mystery of Molly.

Stratigraphy

Step 1: Investigate stratigraphy

Stratigraphy is based on the Law of Superposition which states that younger strata will be deposited on top of strata that are older. So stratigraphy is the study of sediment strata, or layers, and how these strata came to be the way they are now.

Where specific artifacts are found in sediment strata is a good indicator of how old, or new, they are. For example, if a piece of pottery is found .5 meters (20 inches) below the soil surface and another piece of pottery is found at 1.5 meters (59 inches) below the surface, survey says that the potsherd from 1.5 meters is older than the potsherd from .5 meters. Makes perfect sense, doesn't it?

Step 2: Apply stratigraphic analysis to the mystery of Molly

Question 5

The second burned house was unearthed about .3 meters below the soil surface. Archaeologists recorded Molly's remains under .5 meters of soil. The charred timbers and pottery were unearthed within five centimeters of that depth. The metal box was found at a depth of 1 meter. What do the different depths of artifacts and Molly's bones tell you about this historic site?

Question 6

What does the depth of the metal box mean?

Seriation

Step 1: Investigate seriation

Seriations are also called artifact sequences. When archaeologists study potsherds they record variations in composition, shape, style, and decoration. This information forms the basis for developing seriations that chronicle artifact evolution over hundreds or thousands of years. Pottery, like fashion, changes over time.

Step 2: Apply seriation to the mystery of Molly

Question 7

Pottery was found at the site and the pattern was traceable, as you already learned in the discussion of chronological markers. Could this broken pottery be used in seriation and as a chronological marker? Explain your answer.

The Final Step

So who was Molly?

Throughout the southwest desert there are geologic features named after someone named Molly. Could this be her?

How did she die?

Was Molly murdered?

Could jealousy have been a motive?

Why were her remains left in the burned rubble?

Was she tragically killed in a fire with no loved ones around to retrieve her bones for burial?

Why was another ranch house built so close?

To hide a murder?



Molly's Nipple
Grand Staircase-Escalante National Monument

Since this is a fictional story there is no answer. That's up to you.

Vocabulary:

Archaeologist

One who studies past human life and culture by the recovering and examination of remaining material evidence, such as graves, buildings, tools, and pottery.

Anthropologist

One who studies the origin, the behavior, and the physical, social, and cultural development of humans.

Flint-knapping

The activity, largely carried out by prehistoric people, of chipping and splitting flint to make tools.

Obsidian

A jet-black volcanic glass, chemically similar to granite and formed by the rapid cooling of molten lava, that was used by early civilizations for manufacturing tools and ceremonial objects.

Seriation

Arrangement or position in a series.

Stratigraphy

The study of rock strata, especially the distribution, deposition, and age of sedimentary rocks.