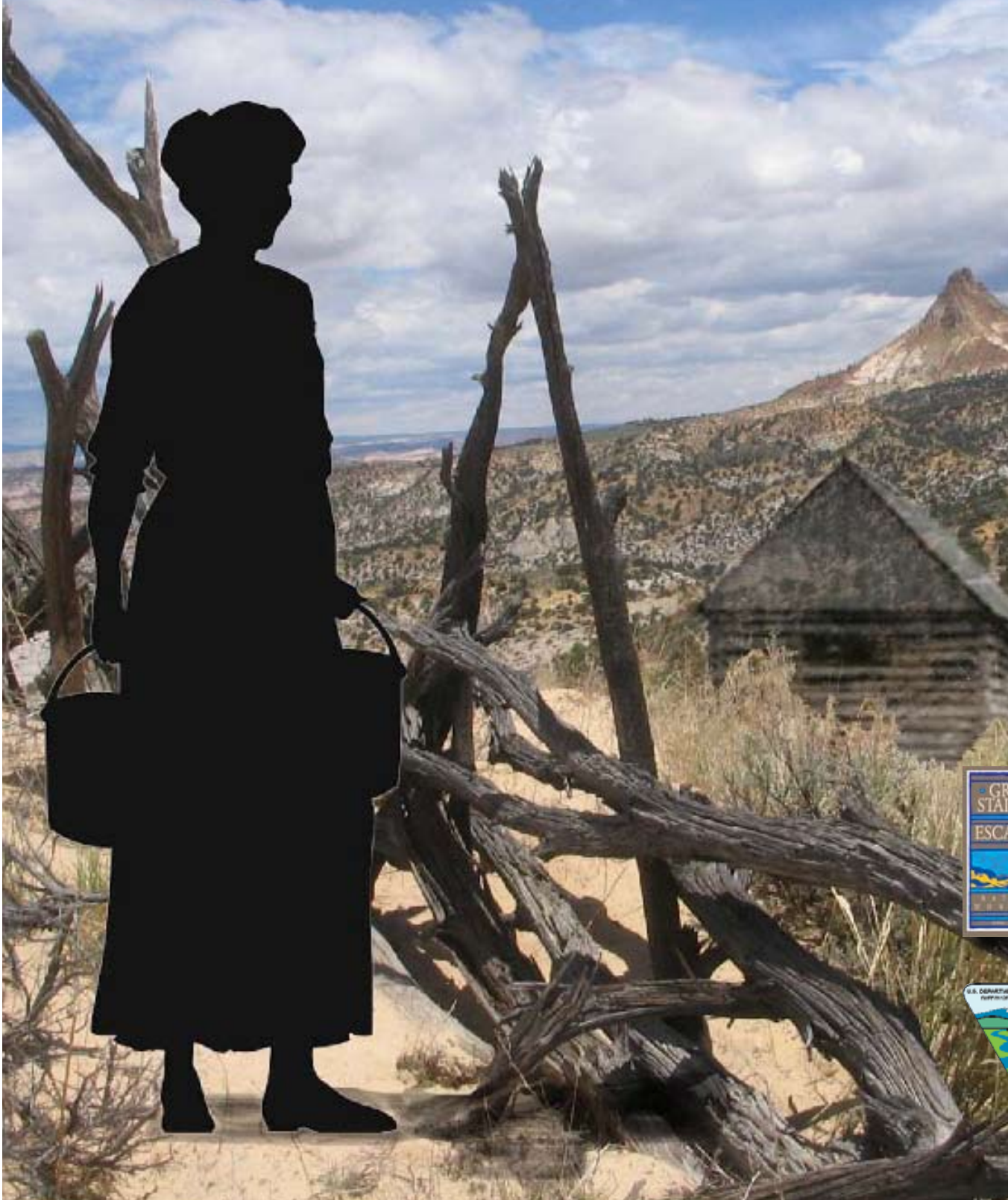


# The Mystery of Molly

## A Study of Dating Techniques

### Teacher Guide



BLM

Grand Staircase-Escalante National Monument



# The Mystery of Molly

## A Study of Dating Techniques

### Grade Level

9-12 and 7-8 (with adaptations)

### Duration

45 Minutes as a team or group activity

90 Minutes for individual students

### Description

Students investigate absolute and relative dating techniques used by scientists to date historic sites and artifacts and apply them to a mysterious, fictional excavation.

### Goals

- Compare and contrast absolute and relative dating
- Evaluate the physical evidence from a fictional cold case and determine the absolute or relative dating techniques that could be used to solve the mystery.

### Academic Content Standards

The following standards are drawn from *Content Knowledge*.<sup>1</sup>

#### World History Standard 1

Understands the biological and cultural processes that shaped the earliest human communities.

##### Level IV (Grades 9-12)

###### Benchmark 1.

Understands the methods by which early human communities are studied and what these studies reveal (e.g., the way in which newly discovered sites and investigative techniques used to examine them affect the study and understanding of human evolution, how common refuse can be studied to make inferences about earlier communities).

###### Benchmark 2.

Understands how different kinds of evidence are used to determine the cultural characteristics of early human communities (e.g., how archaeological evidence demonstrates the influences of climate, geographic location, and economic specialization on everyday life; how nonverbal evidence such as burials, carvings, and paintings can indicate the presence of religion)

##### Level III (Grades 7-8)

###### Benchmark 1.

Understands early hominid development and scientific methods used to determine the dates and evolution of different human communities (e.g., methods employed by archaeologists, geologists, and anthropologists to study hominid evolution)

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<sup>1</sup> *Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education: 4<sup>th</sup> Edition*, Mid-Continent Research for Education and Learning in Aurora, Colorado. <http://www.mcrel.org/standards-benchmarks/>

Physical Science Standard 8

Understands the structure and properties of matter

Level IV (Grades 9-12)Benchmark 8.

Knows how radioactive isotopes can be used to estimate the age of materials that contain them because radioactive isotopes undergo spontaneous nuclear reactions and emit particles and/or wavelike radiation; the decay of any one nucleus cannot be predicted, but a large group of identical nuclei decay at a predictable rate, which can be used to estimate the material's age.

Nature of Science Standard 11

Understands the nature of scientific knowledge

Level IV (Grade 9-12)Benchmark 3

Understands how scientific knowledge changes and accumulates over time (e.g., all scientific knowledge is subject to change as new evidence becomes available; some scientific ideas are incomplete and opportunity exists in these areas for new advances; theories are continually tested, revised, and occasionally discarded)

Benchmark 4

Knows that from time to time, major shifts occur in the scientific view of how the world works, but usually the changes that take place in the body of scientific knowledge are small modifications of prior knowledge.

**Materials**

- *The Mystery of Molly – Student Activity*
- Computer with Internet access – if time allows for internet research.
- Video or DVD *Traces in Time*, produced by GSENM

**Objectives**

1. Investigate different methods of Absolute and Relative Dating to see how they could be applied in *The Mystery of Molly*.
2. Use information obtained from Absolute and Relative Dating to write a resolution to *The Mystery of Molly*.

**Procedures**

This activity will take 90 minutes if done by individual students. To complete the activity in 45 minutes students can work in teams or small groups. The video or DVD *Traces in Time* is a great way to introduce students to the Grand Staircase-Escalante National Monument.

1. This activity begins with a fictional story that sets up the “forensic cold case” of *The Mystery of Molly*. Individual students can read through this introduction quickly.

2. Step 1 – *Absolute Dating* and *Relative Dating* (pages 2-7), consists of a series of short introductions to different dating techniques, followed by internet links and questions to review each methodology. The internet links can be checked out in class or at home. Students can work individually or in groups to speed the activity up.

3. In Step 2 – *The Final Step* (page 8), individual students have the chance to be creative forensic experts. After assessing the data individual students write their own hypotheses about the fictional cold case of “Molly”. To save time with the unit this objective can be assigned as homework.

Adaptations:

This activity is appropriate for both 9-12 grades and 7-8. If used at the 7-8 level it would be more effective to complete Objective 1 as a class.

### Extensions

- Archaeology Unit 2, *Prehistoric Cultures of GSENM*, deals with Seriation.
- Students can research other methods of absolute dating online at these websites:

Obsidian Hydration – Minnesota State University

[http://www.mnsu.edu/emuseum/archaeology/dating/dat\\_obsid.html](http://www.mnsu.edu/emuseum/archaeology/dating/dat_obsid.html)

Lithic Analysis & Obsidian Hydration Laboratory –UCLA

<http://merton.sscnet.ucla.edu/ioa/labs/lithics/lithics.html>

Chronometric Techniques – Potassium-Argon Dating

[http://anthro.palomar.edu/time/time\\_5.htm](http://anthro.palomar.edu/time/time_5.htm)

Chronometric Techniques – Luminescence Dating

[http://anthro.palomar.edu/time/time\\_5.htm](http://anthro.palomar.edu/time/time_5.htm)

### References

#### Books

Bandelier, Adolf F, *The Delight Makers*, Harcourt Brace Jovanovich, Publishers, 1971

Bryson, Bill *A Short History of Nearly Everything*, New York; Broadway Books, 2003

Chesher, Greer K., *Heart of the Desert Wild, Grand Staircase-Escalante National Monument, Bryce Canyon, Utah*; Bryce Canyon National History Association, 2000.

Rutter Michael, *Outlaw Tales of Utah*, Globe Pequot Press, 2003.

#### Websites

About.com – Archaeology

<http://archaeology.about.com/od/dating/>

About.com – Chemistry

<http://chemistry.about.com/od/workedchemistryproblems/a/c14dating.htm>

Chronological Methods, University of California, Santa Barbara

[http://id-archserve.ucsb.edu/Anth3/Courseware/Chronology/01\\_Content.html](http://id-archserve.ucsb.edu/Anth3/Courseware/Chronology/01_Content.html)

Dendrochronology of Bristle Cone Pines

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

History Detectives – Timber Dating

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

Lithic Analysis & Obsidian Hydration laboratory – UCLA

<http://merton.sscnet.ucla.edu/ioa/labs/lithics/lithics.html>

Mesa Verde national Park – Artifacts Collection

[http://www.nps.gov/meve/edu\\_resources/artifacts/index.htm](http://www.nps.gov/meve/edu_resources/artifacts/index.htm)

Nova Online – The Dating Game

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

Obsidian Hydration – Minnesota State University

[http://www.mnsu.edu/emuseum/archaeology/dating/dat\\_obsid.html](http://www.mnsu.edu/emuseum/archaeology/dating/dat_obsid.html)

Record of Time: Chronometric Techniques – Dendrochronology

<http://anthro.palomar.edu/time/Default.htm>

South Dakota State Historical Society Archaeological Resource Center – Artifacts

<http://www.sdsmt.edu/wwwsarc/collectn/collectn.html>

Tree Ring Dating from Waynes Word – An On-Line Textbook of Natural History

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

## Assessment

The writing assignment in Step 2 – The Final Step, *Question 8* (page 8), can be assessed to determine whether or not students understand the five methods of dating used by archaeologists well enough to apply the clues and come up with viable theories about the life and times of Mystery Molly.

## Answer Key

### Question 1

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

*The metal box, the letters, and possibly the broken china*

### 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 12 years, from 1860-1872. Would this be a chronological marker? If so, what information would this give you about the cold case?

*The date the china was sold indicates that it was purchased after 1860.*

### Question 3

A few of the beams were in good enough condition that they were sent to the dendrochronology lab. Scientists in the lab match 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 the information tell you about the excavated house?

*The tree was cut down in 1880, likely indicating the year that the house was built.*

**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 +/- 5 years. What does this tell you about the excavated house?

*The burned charcoal would indicate the year of the fire, so the house probably burned down sometime around 1887.*

**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 unearth 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?

*The depth of the second burned house could indicate that it was buried at the time the other ranch house was built 50 feet away. Blowing sand could have buried the debris, but more than likely it was buried by hand. Molly's bones were apparently in the ruins of the old house.*

**Question 6**

What does the depth of the metal box mean?

*The metal box was apparently buried under the house. A removable floorboard perhaps?*

**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 broken pottery would probably be better used as a chronological marker. Seriation, in general, is used for prehistoric objects. Seriation is used in the desert southwest to date Anasazi potsberds as they evolved in design, composition, and function over a period of time.*

**Question 8**

In the space below, and on another piece of paper if needed, write your hypothesis and conclusion about the life and death of Molly, if indeed she really was Molly. Use the information obtained through the use of absolute and relative dating techniques to back up your hypothesis.

*Answers will vary*

**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.