Forensic Geology Investigation: An Introduction to Geoscience and the Scientific Method

Brief Description: Students use a map, soil, and minerals to solve a murder. This activity is set up as an escape room. To begin the students are given an envelope with some evidence, i.e., the data (Figure 1). They are asked to determine who murdered the victim and how, i.e., create a hypothesis. By solving the riddle students can open box one which contains more evidence (Figure 2). After reviewing the new evidence, the students may revise their initial conclusion. This step is repeated with box 2 (Figure 3). In the final step, students solve the murder and use the evidence to support their conclusion. This activity is an analogy for the scientific method. The evidence is the data, and the accused murderer and weapon is the hypothesis. The wrap up discussion with the class should emphasize that scientific results evolve as more data becomes available. In addition to mimicking the scientific process, students are introduced to basic geoscience skills such as observations, mineral identification and latitude and longitude.

This is the first assignment in our physical geology lab. It has been chosen because it is engaging, requires students to work collaboratively (helping them get to know other students on the first day of class), demonstrates the relevance of geology to society, and introduces several geoscience skill the students will use in future labs.

No previous knowledge is necessary. The activity is designed this way because this is the first lab the students attend. At our university, some students may attend lab before they have even attended a lecture. The instructor and learning assistants can act as geoscience experts to help answer questions.

Learning Goals:

- Describe the methods of inquiry that lead scientific knowledge. (General Education: Natural World)
- Use graphical, symbolic, and numerical methods to analyze, organize, and interpret natural phenomena. (General Education: Natural World)
    - Students will use maps and chemical formulas as evidence to determine the cause of a murder and the guilty suspect.
- Formulate hypotheses and identify relevant variables to test hypotheses. (General Education: Natural World)
    - Students will create a hypothesis about who the murderer is and how the crime was executed. Students will be given new data and asked to re-evaluate their original hypothesis.

Skills:

- Students will make observations of mineral and soil samples.
- Students will use a key to identify minerals.
- Students will use latitude and longitude to find locations.
- Students will create and test hypothesis.

- Students will work collaboratively to solve a murder.

Materials:

- 2 lockable boxes per student group. We created 6 sets for a class of 24 students.
- 1 combination lock with numbers per group
- 1 combination locks with numbers per group
- 4 distinctly different types of soils

Notes on the minerals

Box 1 contains five minerals. The selection was based on what was available at our university. To make this activity feasible at your school, you may need to change the minerals based on what you have available. Here are the keys to remember:

- One mineral must have a toxic element for the cause of death. In this example we used cinnabar for its high mercury content. Another possibility could be galena for the lead content. There is a red powder spilled in the crime scene photo. If a mineral other than cinnabar is used as the poison, the color of the powder should be changed. This image was created with Microsoft copilot and could be altered in the same way.
- If you change the minerals in the activity, you will also need to change the identification key.
- When powdered mercury is dangerous. To minimize the danger to the students the cinnabar should not be powdered. To prevent powdering we have taken four precautions:
    - Box 1 (with the minerals) is labeled "FRAGILE, do not shake."
    - The minerals are mounted in transparent boxes. We used party favor boxes.
    - The mineral identification key does not use hardness as an identifying characteristic.
    - The learning assistants have been instructed to stop students from powdering samples.

Initial Evidence Envelope (Figure 1)	*Box 1: Minerals (Figure 2)*	*Box 2: Soils (Figure 3)*
Crime Scene Photo Periodic Table Simplified Mineral Key Suspect Cards Map Soil Sample from Murder Site	Cinnabar Pyrite Galena Magnetite Mica (Biotite) 4-digit Combination lock- Code 3876	4 different soil samples. One should match the sample in the evidence envelope. 4-Digit Combination Lock with code: MICA_

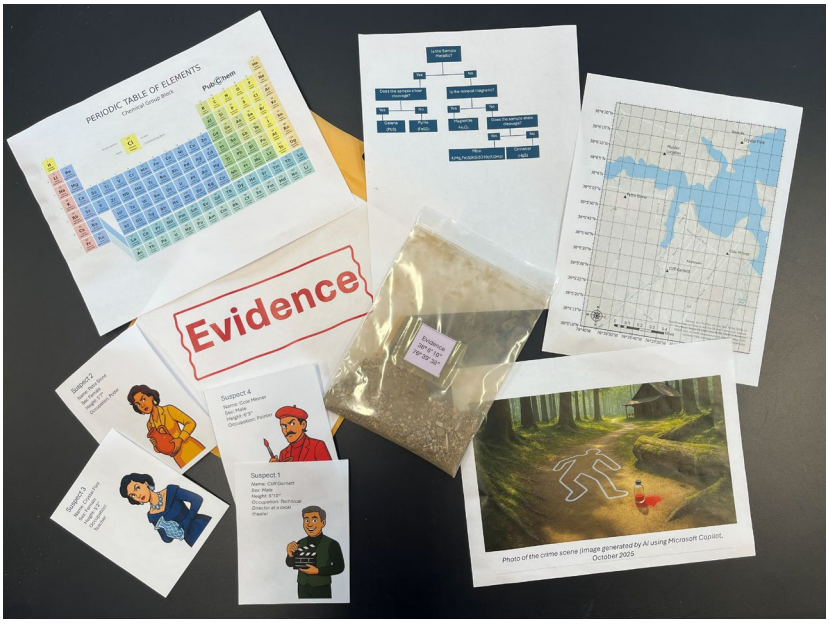

Figure 1. Initial Evidence Envelope

Figure 2. Box 1 Minerals

Figure 3. Box 2 Soils

Overview Activity:

Students are initially given a map, descriptions of the suspects, soil found at the murder location, simplified mineral identification key, black light, photo of the victim with red powder, and a box with a 4-digit numeric combination lock. Mineral key must include the chemical formula.

Create a hypothesis about who the killer is and how they killed the victim.

Clue 1: Feeling lost? Then look at the path ahead. Up or Down then Left or Right — it's all in the degree. The right coordinates will set you free.
Solution: 3876 (the lat/long degrees from the map)

Box opens and students retrieve the mineral samples. Students need to identify the minerals and recognize that galena and cinnabar are high in lead and mercury, respectively. Both substances could have been used to poison the victim. On the crime scene photo there is jar of red powder that has been tipped over. This should suggest cinnabar was the poison.

Review your original hypothesis. Given the data you now have, would you change your original hypothesis? If necessary, create a new hypothesis.

Clue: Clue 2: Like an orange I will peel and like a book I have sheets! I'm found hiding in granite and schist, I glitter when the light hits me just right.
Solution: Mica (The last digit on the letter lock has a blank.)

Box containing 4 soil samples opens. One of the samples matches the soil found at the murder scene. Coordinates on the sample bags are the locations of the suspects homes.

Review your original hypothesis. Given the data you now have, would you change your original hypothesis? If necessary, create a new hypothesis.

Follow Up Discussion: Ask the teams to share their conclusion and the evidence, i.e. data, they used to support that conclusion. The 2 key points are that (1) the hypothesis may change over time as more information is found and (2) communicating the findings with other detectives, or scientists, can strengthen the interpretation.

Key Point 1: The students were asked to revise their initial hypostasis 2x as they reviewed new data. Ask the students how the new data altered or supported the initial hypothesis.

Key Point 2: Teams may have different conclusions. If you do have teams with different conclusions, ask them how they arrived at that conclusion. Did either team overlook some evidence? Was there a mis-interpretation? This communication between groups can help everyone come to a stronger conclusion.

Suspect Cards

Suspect 1

Name: Cliff Garnett
Sex: Male
Height: 5’10”
Occupation: Technical Director at a local theater

Suspect 2

Name: Petra Stone
Sex: Female
Height: 5’7”
Occupation: Potter

Suspect 3

Name: Crystal Flint
Sex: Female
Height: 5’2”
Occupation: Teacher

Suspect 4

Name: Cole Minner
Sex: Male
Height: 6’3”
Occupation: Painter

Soil Labels

Flint	Crime	Stone	Garnet	Minner
Evidence 38° 6’ 18” 76° 39’ 8”	Evidence 38° 6’ 10” 76° 39’ 38”	Evidence 38° 5’ 54” 76° 39’ 52”	Evidence 38° 5’ 33” 76° 39’ 29”	Evidence 38° 5’ 41” 76° 39’ 6”
Evidence 38° 6’ 18” 76° 39’ 8”	Evidence 38° 6’ 10” 76° 39’ 38”	Evidence 38° 5’ 54” 76° 39’ 52”	Evidence 38° 5’ 33” 76° 39’ 29”	Evidence 38° 5’ 41” 76° 39’ 6”
Evidence 38° 6’ 18” 76° 39’ 8”	Evidence 38° 6’ 10” 76° 39’ 38”	Evidence 38° 5’ 54” 76° 39’ 52”	Evidence 38° 5’ 33” 76° 39’ 29”	Evidence 38° 5’ 41” 76° 39’ 6”
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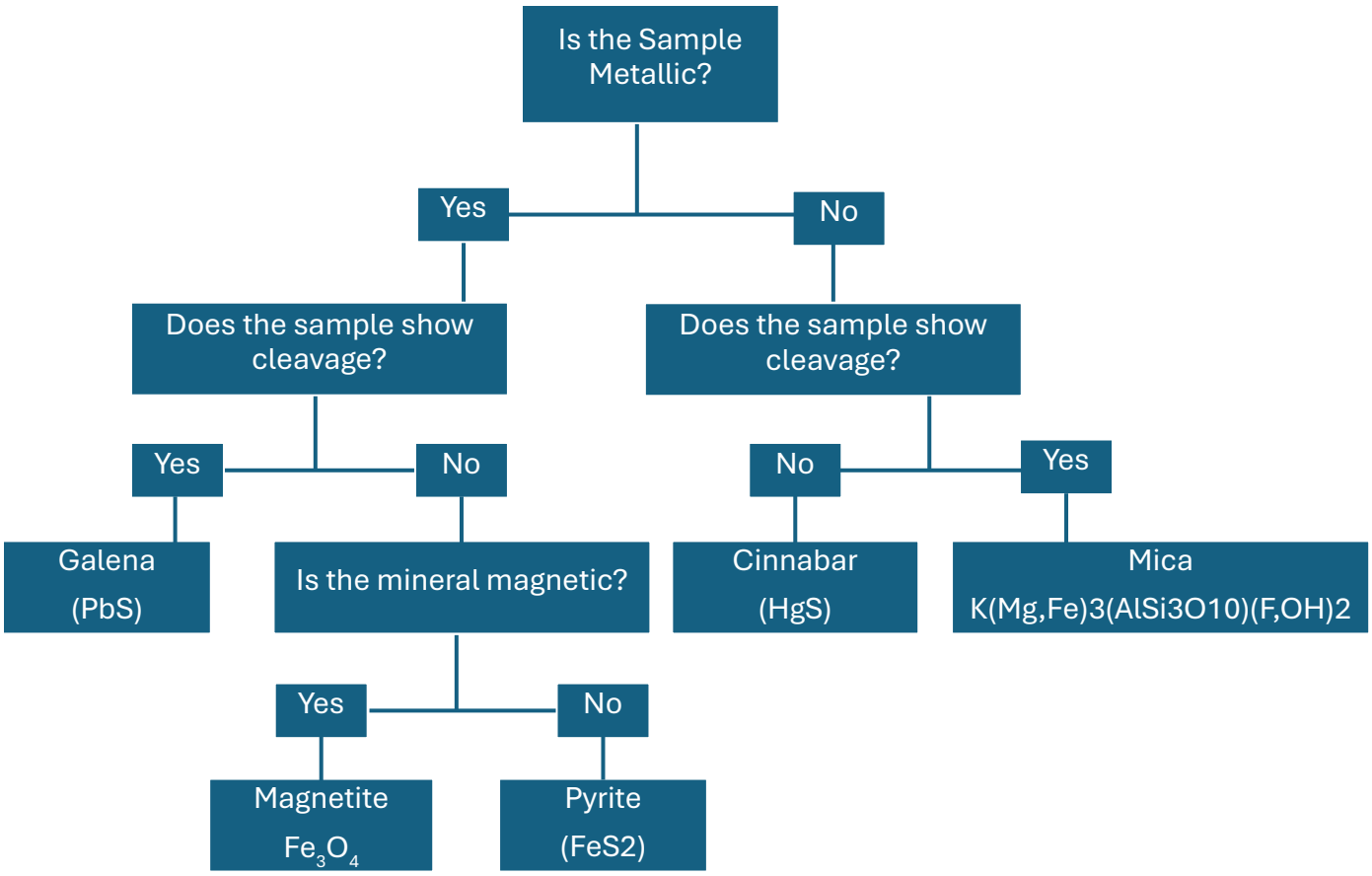
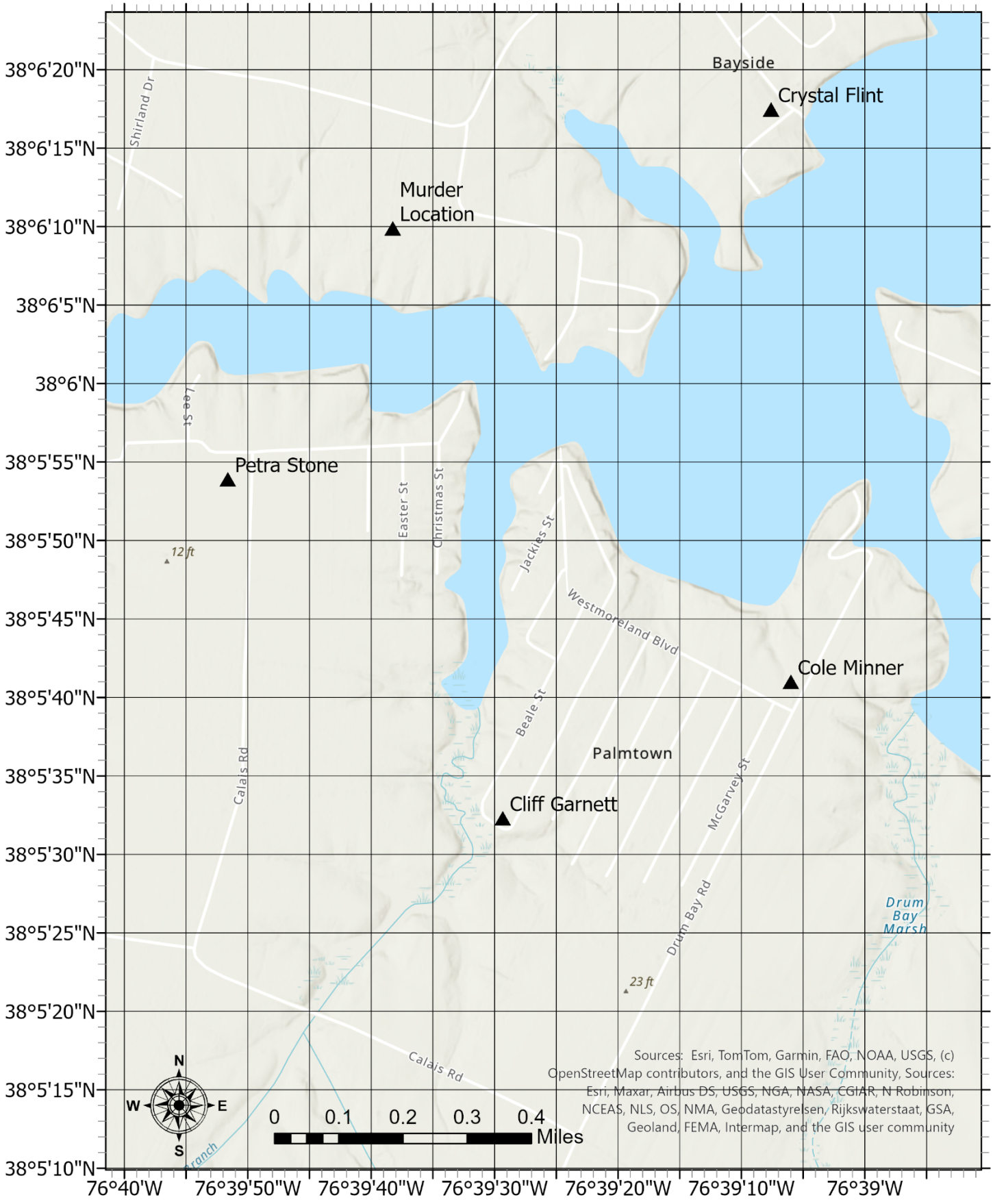
Mineral Key


Is the Sample Metallic?
Yes
No
Does the sample show cleavage?
Does the sample show cleavage?
Yes
No
No
Yes
Galena (PbS)
Is the mineral magnetic?
Cinnabar (HgS)
Mica K(Mg,Fe)3(AlSi3O10)(F,OH)2
Yes
No
Magnetite Fe_3O_4
Pyrite (FeS2)

Map


Bayside
Crystal Flint
Murder Location
Petra Stone
Cole Minner
Cliff Garnett
Palmtown
Shirland Dr
Lee St
Easter St
Christmas St
Jackies St
Westmoreland Blvd
Beale St
Calais Rd
McGarvey St
Drum Bay Rd
Drum Bay Marsh
12 ft
23 ft
38°6'20"N
38°6'15"N
38°6'10"N
38°6'5"N
38°6'N
38°5'55"N
38°5'50"N
38°5'45"N
38°5'40"N
38°5'35"N
38°5'30"N
38°5'25"N
38°5'20"N
38°5'15"N
38°5'10"N
76°40'W
76°39'50"W
76°39'40"W
76°39'30"W
76°39'20"W
76°39'10"W
76°39'W
N
W
E
S
0
0.1
0.2
0.3
0.4
Miles
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community, Sources: Esri, Maxar, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap, and the GIS user community

Crime

Scene

Photo

Photo of the crime scene (Image generated by AI using Microsoft Copilot, October 2025

Example Consultant Responses

Cinnabar can be dangerous if powdered. Discourage students from shaking the locked box with the samples.

Responses for the Clue 1

- Explain the units for lat/long

Responses for the Minerals

- Explain and show students the difference between metallic and non-metallic luster.
- Explain and show students examples of cleavage.
- Encourage students to do their own research on the common uses of minerals.
- Students may need help with the abbreviations in the chemical formulas.

Responses for soil:

Student Handout

Name: _____

On October 25, 2025, Clayton Rift was found dead in a wooded area just north of Green Lake. The scene suggests foul play. Clayton, or Clay for short, was a healthy 35-year-old male with no underlying health problems. He was an art teacher at the local high school and adored by his students. He recently was nominated for teacher of the year. On the weekends Clay often volunteered at the local theater to build sets for amateur productions. Everyone interviewed was shocked by his death.

You must solve this murder. Before you begin, review the items in the evidence envelope. The problem is that the detective at the crime scene did a terrible job categorizing the evidence he collected. They even placed some evidence in locked boxes and forgot the code to open the locks. What a mess!

Luckily you took a geology class in college because forensic geology is a powerful crime solving tool. Detectives can use minerals, rocks, or soil to link suspects to a crime scene or rebut an alibi. The chemical composition of materials can be analyzed for potential toxins or to identify the source. Geophysical equipment can be used for finding buried weapons or bodies.

If you need help solving this murder, call in a geologic consultant, i.e. a learning assistant or your instructor. The consultants can answer any geoscience question your team has, but they have no experience with this murder case.

After reviewing the materials in the envelope, but before opening either of the locked boxes, create a hypothesis that includes who murdered the victim and how the victim was killed.

This hypothesis is a good start, but the evidence is weak and circumstantial. No judge will issue an arrest warrant based on this evidence. You must open the locked boxes to examine the remaining evidence.

Clue 1: Feeling lost? Then look at the path ahead. Up or Down then Left or Right — it's all in the degree. The right coordinates will set you free.

Now that you have opened the next box, you have more evidence. Does this new information contradict or support your initial hypothesis? If necessary, rewrite your hypothesis.

Why did you need to change the hypothesis?

Clue 2: Like an orange I will peel and like a book I have sheets! I'm found hiding in granite and schist, I glitter when the light hits me just right.

Now that you have opened the next box, you have more information. Does this new information contradict or support your initial hypothesis? If necessary, rewrite your hypothesis.

Why did you need to change the hypothesis?

Conclusion

Who did it? _____

How do you know? List the evidence that led you to this conclusion.

How did the murderer kill the victim? _____

How do you know? List the evidence that led you to this conclusion.

Why did your original hypothesis change?


Evidence