Gold rush!

SATIS revisited
SUPPORTING HOW SCIENCE WORKS

Guidance for teachers

James and the gold rush

Downloads

- Presentation
  - slide 1 – starter stimulus
  - slide 2 – Gold-collecting equipment
  - slide 3 – Gold-collecting equipment
  - slide 4 – Gold-collecting equipment
- Information sheet – James
- Information sheet – Gold claims map
- Activity sheet – James and the gold rush

Running the activity

This activity uses Presentation slides 1–4.

Set the scene by giving students a little background about the 'gold rush'.

In 1848, news spread across America that gold had been discovered in California. Thousands made the long journey west to seek their fortune. This mass migration was called the gold rush.

Slide 1
The starter stimulus slide prompts students to consider what lengths *they* would go to, to seek their fortune. The journey to get to California involved either a hazardous sea journey, or a harsh and risky trek across mountain ranges, on foot or by horse. Both routes took many months.

Slides 2–4
These slides show original photographs of prospectors using various types of tools and equipment for extracting gold. Ask students to consider how the equipment is being used in each case, and where the gold deposits might be (on the valley side, under ground, or mixed with gravel in the bed of flowing streams).

Slide 2 shows high-pressure hoses being used to wash material from the sides of the valley, and a system of sluices or channels, which have barriers at the bottom to trap the heavier gold particles as water washes the mixture of soil and other materials through.

Slide 3 shows picks, shovels and large mallets being used to break up rocks, and a mine shaft propped up with timber.

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Slide 4 shows a pan used to shake sediment with water. Any heavy gold particles settle to the bottom of the pan, while lighter materials such as sand, mud and gravel are washed over the side, leaving the gold behind. The rocker works in a similar way to a sluice. Water carrying sediment flows through it, while it is rocked like a cradle to sift out the gold. The rocker can deal with larger amounts of material than a pan.

Put students into pairs and give them a copy of 'Information sheet – James', to read through. This allows students to consider, through the eyes of James, the choices made by prospectors 160 years ago. It introduces students to three different types of gold deposit and the equipment needed to obtain gold from each.

Now give students a copy of 'Information sheet – Gold claims map'. Using the two Information sheets, students can complete 'Activity sheet – James and the gold rush'.

Answers for Activity sheet – James and the gold rush

1

Type of claim	Type of gold deposit	Equipment
River channel and bank	Tiny fragments of gold may be mixed with the gravel in the active channel of the riverbed.	• Pan or rocker
Hillside (along the sides of the river valley)	Layers of gravel from an earlier course of the river lie along the valley sides and may contain tiny fragments of gold.	• High-pressure hose, plus a system of sluices (channels)
Hard rock	Some rocks contain veins of the mineral quartz. The quartz may contain smaller veins, grains or lumps of gold. These may be discovered by cutting through the rock to the quartz vein.	• Picks, shovels, mallets and timber to prop up mine shafts • Equipment to crush rocks • Sluices or rockers to separate gold

2

Claim number	Type	Advantages	Disadvantages
7, 8, 9, 10, 11 or 12	River bank	Can start looking for gold straight away with very cheap equipment.	Cold, wet work – and slow, even with the purchase of a rocker to help.
13, 14, 15, 16, 17 or 18	Hillside	With suitable equipment, large quantities of gravel can be processed reasonably quickly.	More expensive to set up, and may need people to help (and share the profits).
1, 2, 3, 4, 5 or 6	Hard rock	Potential to find substantial quantities of gold if there are suitable veins.	Technically more challenging (mine workings and shafts need to be dug, and propped up to prevent collapse), and physically hard work. Will probably need more people to help (and share the profits).

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Differentiation

Suggestions for students who would benefit from additional support

Show students slides 2, 3 and 4. Discuss the methods and equipment they show, and complete 'Activity sheet – James and the gold rush' together as a group.

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What happened next?

Downloads

- Presentation
  - slide 1 – starter stimulus
  - slide 5 – Mercury analysis – comparison of lab results
  - slide 6 – Mercury analysis – Lake Engelbright
  - slide 7 – Mercury analysis – all lakes and reservoirs
- Information sheet – James: what happened next …
- Activity sheet A – Hannah
- Activity sheet B – Hannah (simplified version)

Running the activity

This activity uses Presentation slides 1, 5, 6 and 7.

Give students a copy of 'Information sheet – James: what happened next ...' to read through. Now show students slide 1 again. If they had gone to California in search of gold, would they have tried to make as much money as they could, or would they have considered what impact their actions might have on the environment, and on future generations?

You may wish to show students a copy of the Hazcard for mercury, and discuss the harmful effects this element can have on humans and other living organisms. You should point out that at the time of the gold rush, people were unaware of these harmful effects and rarely, if ever, considered the environmental impacts of commercial activities such as mineral extraction. Would they make a different decision now, if they worked for a mining company? It should be noted that mining companies no longer use mercury amalgam to extract gold (although it does still happen with individuals working outside the law).

Move students on to the present day to consider a team of environmental scientists working in California. Concerns have been raised that fish caught in the old gold-mining area may be contaminated by mercury. If levels of mercury in fish are found to be above 1 mg kg^{-1} (the FDA action level – see below), the fish is unsafe to eat.

Samples of fish from a wide range of locations were sent to two different laboratories. Each laboratory used a different technique (cold-vapour atomic-absorption spectroscopy or cold-vapour atomic-fluorescence spectroscopy) to determine the mercury concentrations in the fish samples.

Further details of this investigation and analysis can be found in the report entitled *Mercury Bioaccumulation in Fish in a Region Affected by Historic Gold Mining: The South Yuba River, Deer Creek, and Bear River Watersheds, California, 1999* by Jason T. May, Roger L. Hothem, Charles N. Alpers, and Matthew A. Law. This report is available at:

http://ca.water.usgs.gov/archive/reports/ofr00367/ofr00367.pdf

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The FDA (United States Food and Drug Administration) sets 'action levels' for contaminants because it is economically impractical to grow, harvest or process raw products that are totally free of non-hazardous, naturally occurring, unavoidable contaminants. For mercury in fish, the FDA action level is 1 mg kg^{-1}. Fish cannot be sold if the mercury level is higher than this. Below this level, fish is considered safe to eat.

(For details about how safe limits of substances are calculated, see the *SATIS Revisited* unit called *Pesticides and food*, at **www.satisrevisited.co.uk/pesticides.asp**).

Give students either a copy of 'Activity sheet A – Hannah' or 'Activity sheet B – Hannah (simplified version)' to work through.

Answers for Activity sheet A – Hannah

1 It is important that the results are consistent. Widely different results for the same fish would suggest that there is a problem with the analysis, method or equipment.

2 The detection of mercury in the supposedly blank sample would imply that some kind of contamination of the samples is occurring as they are being prepared for analysis (or that the test itself is faulty).

3 **a)** Hannah should take note of these different results. But since this investigation is looking at trends rather than absolute values, this discrepancy may not invalidate the whole investigation – so she need not be very concerned.

b) The testing procedure used at lab G tends to produce lower mercury readings than that used at lab H.

4 **a)** graph **Z**

b) graph **Y**

c) graph **X**

5 The results are clustered around the diagonal, which suggests a good agreement between findings from the two labs.

6 **a)** The greater the mass of the fish, the greater the level of mercury present.

b) smallmouth bass

c) green sunfish

d) Smallmouth bass have the most mercury in their tissues, so they are likely to be the top predators in the food web. This is because mercury levels increase (it accumulates) as you move up the food chain.

7 **a)** Camp Far West Reservoir

b) 1 mg kg^{-1}

c) Spotted bass from Camp Far West reservoir may not be safe to eat, because of high mercury levels (above FDA action level).
Largemouth bass from Lake Combie have fairly high levels of mercury, although these are mostly below the FDA action level.

8 More data would be needed on the number and types of mine, past use of mercury and the flow of rivers into the reservoirs.

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Answers for Activity sheet B – Hannah (simplified version)

1 true
2 false
3 From this, Hannah should be expect all the results from lab H to be slightly **higher** than the results from lab G.
4 **a)** graph **Z**
b) graph **Y**
c) graph **X**
5 **A**
6 **a)** Hannah concludes that the **larger** the mass of the fish, the **larger** the level of mercury present.
or
Hannah concludes that the **smaller** the mass of the fish, the **smaller** the level of mercury present.
b) **Smallmouth bass** contain the highest levels of mercury.
7 **a)** Camp Far West Reservoir
b) 1 mg kg^{-1}
c) Spotted bass from Camp Far West reservoir may not be safe to eat, because of high mercury levels (above FDA action level).
Largemouth bass from Lake Combie have fairly high levels of mercury, although these are mostly below the FDA action level.

Differentiation

Suggestions for students who would benefit from additional support

Some students may need support in interpreting the scatter graphs. Starting with an everyday example such as a standard height/weight chart may be helpful. 'Activity sheet B – Hannah (simplified version)' is provided, in which the questions structured in a more supportive way.

Suggestions for students who would appreciate additional challenge

Provide students with a copy of Figure 1 from the report on which this activity is based, entitled *Mercury Bioaccumulation in Fish in a Region Affected by Historic Gold Mining: The South Yuba River, Deer Creek, and Bear River Watersheds, California, 1999*, by Jason T. May, Roger L. Hothem, Charles N. Alpers and Matthew A. Law, which is available at:

http://ca.water.usgs.gov/archive/reports/ofr00367/ofr00367.pdf

Figure 1 is a map of the area studied, and shows the boundaries of the watersheds. Explain that all the water in a particular watershed drains into the named river – so, for example, all water in the Bear River Watershed drains into the Bear River.

Noting the distribution of gold-mining activity across the different watersheds, ask students to try to explain why fish in Camp Far West Reservoir have particularly high levels of mercury.

Students could try to put together a food web showing the fish species mentioned in the activity.