**Acid Mine Drainage Creation and Clean-up Power Hour**

Objectives: The goal of this activity is to help students understand the process by which acid mine or rock drainage is formed, how it becomes metal laden, and ideas about treatment and prevention. Students will use chemistry to simulate the creation and partial remediation of acid mine drainage. The activity should take about 50 minutes plus ample opportunity for conversations about acid mine drainage creation, history, policies, and potential solutions.

Teaching note: It is important to note that **acid rock drainage** (ard) occurs naturally when air and water enter the mountain through seeps and pores to interact with minerals (ie. pyrite), then exit the mountain as ARD in the San Juans since before mining started. **Acid mine drainage** (amd) is formed by humans punching holes in the mountain, allowing air and water to interact with more pyrite. Human caused AMD certainly impacts our water significantly, but it is unknown to what extent each is responsible.



Materials:

* Small beakers (1 per group of 1-3)
* Magnesium (small strips or bits)
* Water (can be tap water)
* pH strips w/ color chart and/or pH probes
* PPE: goggles/gloves for dealing with strong acids and bases
* HCl (or other strong acid) – Muriatic acid from hardware store works well
* NaOH (or other strong base) – Main Line Cleaner or Draino equivalent from hardware store. Make sure it is clear, not with coloring.
* Drawing of mountain with snow/rain infiltration through natural cracks and fissures, mine shafts and tunnels, and into the creek. This can be drawn on a white board as you discuss different component of the process.

Activity Outline:

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| Time | Activity |
| 5-10 | (OPTIONAL INTRO TO SUPERFUND) – What is Superfund and where are the sites? * 1. Superfund formed to clean up **pollution** that has been **abandoned**
	2. Show (interactive) map of EPA Superfund mine sites from their website
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| 5 | Introduce Activity: 1. We will follow a rain drop from cloud to river, exploring how it becomes polluted and cleaned up along the way.
2. Safety rules (PPE) and instructions.
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| 5 | Use a diagram of the mountainside to discuss how water gets into and out of the mountain, contacting minerals along the way. |
| 5 | Complete section 1 on the datasheet, reminding students that we are simulating ground water in the mountain running over metals. |
| 5-10 | Water becomes acidic* 1. Use the Use the diagram of the mountain from earlier to introduce chemistry of

[**Air** + Water + Minerals] -> [ACID]* 1. Depending on level, introduce chemical formula or not.
 |
| 5 | Do section 2 on the data sheet1. Remind students that we are simulating acidic water running through the mountain.
2. Point out: now we have not only acid, but potentially toxic metals (some are OK, like Iron, and others are dangerous, such as Cadmium, Arsenic, Lead, Aluminum).
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| 5-10 | Brainstorm solutions:* 1. Prevention – we must really understand mountain hydrology to prevent water from becoming AMD.
	2. Bulkheads, diversions, brownfield capping and grading.
	3. Active remediation with chemistry: raise pH to extract metals.
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| 5 | Do section 3 of the datasheet  |
| 5 | Wrap-up* 1. Discuss impact/ expense of Active Treatment
	2. Discuss passive treatment as a sustainable, but not always feasible, option
	3. Point out the unsustainable nature of active remediation as it is. State of technology and the need for innovation
	4. Point out the need for remediation, industry responsibility and the value of avoiding legacy environmental problems.
	5. De-brief question, activity, or game recommended, or use the questions on the bottom of the data sheet. Answers to question 2 would be that (1) our stomachs are already acidic (stomach acid) to digest food, but AMD and ARD to dige
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**Data Sheet: Acid Mine Drainage Simulation** Name:

Make all observations as detailed as possible. Consider colors, processes, temperatures, etc.

CAUTION: If you want to use your sense of smell, waft fumes toward yourself with your face away from the reaction. NEVER stick your face over a reaction to smell it. That’s a rookie mistake.

1. Place 1-2 small pieces (shavings or pellets) of magnesium in a small beaker.

Predictions: Will Mg dissolve in water? What will be the pH of the magnesium/ water?

Add water to the beaker and stir. Record observations (did Mg dissolve in water? How do you know? What color is the mixture?):

Water/metal mixture pH \_\_\_\_\_\_\_\_\_\_

2. Prediction: will Mg dissolve in acidic water? What will happen? When acid is added?

Add a small amount of acid to the beaker. Record observations.

If nothing happens, measure and record the pH and repeat.

Observations: did Mg dissolve in acid? Other observations?

Acidic water/metal pH \_\_\_\_\_\_\_\_\_\_

1. Prediction: What will happen when we add base to the beaker?

Add a small amount of base. Measure the pH. Repeat this process until you see precipitate form. Try to identify the pH at which a transition occurs. Measure the pH and record your observations.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| pH before visible changes | pH 1 | pH 2 | pH 3 | pH 4 | pH 5 | pH 6 |
| pH |  |  |  |  |  |  |  |  |  |
| pH when precipitate forms  |  | If your pH is still low, you can add more base and see if additional changes occur.  |
| Observations: |

You can add acid to re-dissolve the precipitate, recording observations and pHs measured.

Notes and Observations:

Questions:

What are the three ingredients required in order for strong acids to form, creating acid rock or mine drainage ?

1. 2. 3.

Many soda drinks, like Pepsi or Coke, have a pH around 2.5-3 and yet we drink them, so why are we concerned with acidic water?