Interpreting River Sediments

Adapted from: #435 Reading River Sediments, A Simulated Mining Activity for Molybdenum. Lab-Aids, Inc. 1996.

Grade Level: Intermediate and Advanced

Duration: 40 minutes

Setting: Classroom

Summary: Students test hypothetical sample sites to determine the location of a rich molybdenum deposit.

Objectives: Students will be able to
-describe the processes of ionization and deposition;
-describe how mining companies use the property of ionization to locate rich mineral deposits;
-use basic topographic map skills to efficiently locate a molybdenum deposit.

Vocabulary:
Meander, deposition, ionization, topographic maps

Related Module Resources:
- *See the "Other Stream Geology Topics" section of the Module Resource Binder.*

Materials (Included in Module):
- 16 wet erase markers [Extra Stuff Bin-Box 2]

Lab Aids Cardboard Box: [loose]
- 15 Ruby Ridge quadrangle topographic maps
- 15 Sample Site Number Envelopes each containing 24 cards
- 24 sediment samples
- 15 Chemplates
- Lab-Aids dollars
- 21 Spatulas
- 3 Molybdenum test solution

Additional Materials (NOT Included in Module):
- none

ACADEMIC STANDARDS:

7th Grade
4.1.7.B Understand the role of the watershed.
- Explain factors that affect water quality and flow through a watershed.

12th Grade
4.1.12.C Analyze the parameters of a watershed.
- Interpret physical, chemical and biological data as a means of assessing the environmental quality of a watershed.
- Apply appropriate techniques in the analysis of a watershed (e.g., water quality, biological diversity, erosion, sedimentation).

BACKGROUND:

On its way to a waterway, water runoff picks up sediment and other solids that either become suspended or dissolved in the water. Many minerals and elements bind to soil particles in sediment. That sediment enters waterways when eroded soil is picked up by runoff, suspended in it, and washed into streams and rivers. As water curves or **meanders** its way through the stream channel, it slows down considerably on the inside of curves. At this reduced velocity, **deposition**, or settling out of suspended solid material, often occurs. Solids that dissolve in water do so because of **ionization**, the process of adding or subtracting electrons from atoms, giving the atoms an electric charge. This electric charge allows the atoms to become attracted to and stick to water molecules. Some minerals will ionize and travel along with the water, chemically reacting with the surfaces of river sediments that have been deposited in the stream. The closer an area of the watershed is to a mineral deposit, the greater the detectable amount of the mineral in the water and surrounding sediments.

Many minerals that ionize and dissolve in water are of economic importance and the levels of these mineral ions in the water and river sediments can be measured to determine the location of mineral deposits. One such economically important mineral is molybdenum.

Molybdenum is a component of steel and is a strengthening ingredient of alloys. The properties of molybdenum allow steel to be hardened and to stay strong at high temperatures. Molybdenum has even

been used in the construction of prosthetic joints. Other uses of molybdenum include pigments and chemical catalysts. Molybdenum also plays a role in human metabolism; however, dietary requirements for the element are low and deficiency is not generally a problem. Plants also only require a small amount of molybdenum but the element is critical for nitrogen metabolism and protein synthesis, so it is often included in fertilizer.

Because of these important and lucrative uses of molybdenum, steel and fertilizer companies and their molybdenum suppliers mine molybdenum. To pinpoint the location of molybdenum (and mineral deposits in general), mining companies head to the field to collect samples. Molybdenum ionizes and attaches to water molecules and also attaches to clay particles and other organic matter in the soil, which sometimes erodes into and is deposited on the bottom of waterways. Sampling is costly, so specimens should be taken along strategic spots in the river system to increase the efficiency with which mining companies locate molybdenum deposits. The closer the section of a river is to the molybdenum deposit, the greater the levels of that mineral in the water. If companies do not discover traces of the mineral at a given point, they can be fairly certain that there are no metal deposits upstream of that point, since water and the sediment loads it carries flow from upstream to downstream.

One way that testing companies select sample sites and determine the relative upstream/downstream location of those sites is to locate them on topographic maps. **Topographic maps** are specialized maps that give graphic representations of earth surface features, indicating their relative positions and elevations. The brown lines are called contour lines and they indicate elevation. For the purposes of this activity, students need only understand how to read the elevation of contour lines and to remember that water (and the traces of molybdenum it carries) always travels downhill, perpendicular to contour lines.

OVERVIEW:

Students will use basic topographic map reading skills and their understanding of watersheds to come up with a strategy to find a molybdenum deposit. Student teams will compete with each other for the best utilization of time and money in their search.

PROCEDURE:

Teacher Preparation:

1. Locate the wet erase markers (in the "Extra Stuff Bin"-Box B) Ruby Ridge quadrangle topographic maps, 24 sediment samples, Chemplates, Lab-Aids dollars, sample site number cards, spatulas, and molybdenum test solution in the module. (They are in the cardboard box labeled "Lab Aids".) Organize the aforementioned materials (except for the samples) in such a way as to facilitate their distribution to students. Set up the samples in a convenient location (where the students can line up to receive samples from the teacher) and set up a place to collect the money from the companies.

2. Make photocopies of the Interpreting River Sediments Data Sheet for your students.

Student Activity:

1. Stimulate a classroom discussion on erosion, deposition, and how the shape of a stream relates to the location of deposition. Also teach students about the important uses of molybdenum and how mining companies use the ionization property of minerals to pinpoint mineral deposits.

2. Briefly discuss basic topographic map skills. Explain that the brown lines are called contour lines and they indicate elevation. For the purposes of this activity, students need only understand how to read the elevation of contour lines and to remember that water (and the traces of molybdenum it carries—either dissolved in water or attached to sediment particles) always travels downhill, perpendicular to contour lines.

3. Divide the class into "companies" of 2-4 students. Explain the scenario: Students are part of a mining company that seeks to pinpoint the location of a rich molybdenum deposit, which they will then mine and sell to a fertilizer or steel manufacturing company for profit.

4. Distribute a wet erase marker, Ruby Ridge quadrangle topographic map, a set of sample site number cards, $5,000 of Lab-Aids dollars, a bottle of molybdenum test solution, and a Chemplate to each group. In addition, each student should receive a student worksheet.

5. Companies need to name themselves and should come up with a plan to quickly and efficiently test different sample sites. Sample sites each cost $500 to test. With $5,000 to spend, companies will only be able to test a maximum of 10 sites. The goal of each company is to be the first to find the most likely spot that molybdenum is entering the water in the shortest amount of time, using as little money as possible. The winning team is the company that finds the molybdenum source the quickest and the company that spends the least amount of money finding the hot spot.

6. Allow companies to begin testing by sending a representative with a Chemplate, money, and the correct sample site cards to purchase samples from the teacher. (Note: Sample site cards are used to keep the samples that are bought confidential, since there are always people poking around and listening in on other companies in hopes of stealing cheap information.)

7. Students should line up to buy their samples from the teacher as they become ready to purchase their first sample(s). This line should continue throughout the activity to reduce quarrels over which group should get their sample(s) first.

8. The teacher should stockpile the money, look at the sample site number card(s), and distribute samples accordingly. A sample consists of one spatula-full of sediments from its respective storage container. The samples should be placed into separate wells on the Chemplate. If the representatives purchase more than one sample, it is up to them to remember the order of the samples on their Chemplate.

9. The representatives should then return to their groups with the samples. One drop of molybdenum test solution should be placed on each sample. Groups should wait 10-15 seconds for a full color development and then compare the color to the data chart (identical to the one below) on the student worksheet.

Color	Molybdenum Concentrations (parts per billion)
Yellow	less than 0.1ppb
Blue	0.1-1.0ppb
Blue-Green	1.1-10.0ppb
Red	greater than 10.0ppb

10. All results should be recorded in the data table on the student data sheet.

11. Continue sampling until all companies either find where the molybdenum is coming from or run out of money. As they finish, have the representatives turn in their data sheets. The teacher should write the current time at the top of the data sheets as they are turned in.

12. Use this answer key to check students' work after all companies have found the molybdenum "hot spot". The hot spot is defined as the site with the highest concentration of molybdenum.

Color	Test Site Numbers
Yellow	1-15, 23
Blue	20-22, 24
Blue-Green	17-19
Red (the hot spot)	16

NOTE: Chemplates can easily be rinsed off into a bucket to catch sediments. The water can be poured down the drain or dumped outside before dumping the settled sediments in the trash or outside.

DISCUSSION:

How did you use the topographic map to determine testing sites?
Answers will vary but should include use of contour lines and knowledge of how water flows over the land. See background information.

What were some of the strategies you used to be the fastest and cheapest company?
Answers will vary.

What happened to the molybdenum concentrations the farther one got from the source?
In general, pollution decreases in concentration as it moves down through the watershed and further away from its source.

If site 3 were the molybdenum deposit, how would sites 1 and 2 be affected? What about sites 4-9?
Sites 1 and 2 would not be affected and would have no molybdenum concentrations in them. Sites 4, 6, and 7 would likewise not be affected. Sites 5, 8, and 9 would have decreasing concentrations of molybdenum, respectively. This occurs because sites 5, 8, and 9 are downstream from site 3.

If the molybdenum deposit were between the words "Bear" and "Ridge" on the map, how would the different sites be affected?
Sites 10, 11, 22, and 23 would have decreasing concentrations of molybdenum, respectively. Site 14 would also show molybdenum concentrations, while site 13 would not show molybdenum concentrations.

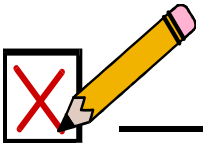
EVALUATION:

- Define ionization and deposition.
- Describe how water moves in relation to contour lines.
- Explain how traces of minerals move through a watershed.
- Describe how distance traveled relates to concentration of minerals.
- Identify some potential risks to watersheds due to mining.
- Describe the economic importance of molybdenum.

EXTENSIONS AND MODIFICATIONS:

- Pick a new site for a molybdenum deposit. Make color-coded dots on note cards for the new concentrations at the sites. Use the color-coded note cards as results that would have been found if tested at the sites. Place the cards in envelopes. Play again, distributing envelopes to groups as they buy them.
- Use a copy of the watershed you live in to designate a mineral deposit and other sites. Number the sites according to the answer chart. Use the sediments and chemicals provided or use color-coded note cards as described above.
- Have groups of students create their own game and switch with other groups.

NOTES (PLEASE WRITE ANY SUGGESTIONS YOU HAVE FOR TEACHERS USING THIS ACTIVITY IN THE FUTURE):



DATA SHEET: INVESTIGATING RIVER SEDIMENTS

Name_____Date_____

Group Partners_____

Company Name_____

Color	Molybdenum Concentration (parts per billion)
Yellow	less than 0.1ppb
Blue	0.1-1.0ppb
Blue-Green	1.1-10.0ppb
Red	greater than 10.0ppb

Test Site Number	Color	Concentration Range