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LIMESTONE AND ACID ACTIVITY

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For the Virtual Center for the Environment (VCE)
A part of the Institute of Natural Resources Analysis and Management (INRAM)

LIMESTONE AND ACID ACTIVITY

TEACHER INFORMATION

ABSTRACT: Students will compare the mass of limestone gravel with acid to the mass of limestone gravel with distilled water, as a control.

GRADE LEVEL (S): 7--12

OBJECTIVES: Students will:

- Record and compare the mass of limestone before and after acid has been added to the limestone.
- Draw conclusions about the affect of acid on limestone.

NATIONAL STANDARDS:

Unifying Concepts and Processes
- Evidence, models, and explanation (5-12)
- Change, consistency, and measurement (5-12)

Science as Inquiry – Development of:
- Abilities necessary to do scientific inquiry (5-12)
- Understandings about scientific inquiry (5-12)

Physical Science
- Properties and changes of properties of matter (5-8)
- Chemical reactions

Earth Science
- Properties of earth materials
- Changes in earth and sky.

NEW MEXICO STANDARDS:

Strand I: Scientific Thinking and Practice

Standard I: Understand the processes of scientific investigations and use inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically.

5-8 Benchmark I:	Use scientific methods to develop questions, design and conduct experiments using appropriate technologies, analyze and evaluate results, make predictions, and communicate findings.
9-12 Benchmark I:	Use accepted scientific methods to collect, analyze, and interpret data and observations and to design and conduct scientific investigations and communicate results.
5-8 Benchmark II:	Understand the processes of scientific investigation and how scientific inquiry results in scientific knowledge.

9-12 Benchmark II:	Understand that scientific processes produce scientific knowledge that is continually evaluated, validated, revised, or rejected.

Strand II: Content of Science

Standard I (Physical Science): Understand the properties of matter, the characteristics of energy, and the interactions between matter and energy.

5-8 Benchmark I:	Know the forms and properties of matter, and how matter interacts
9-12 Benchmark I:	Understand the properties, underlying structure, and reactions of matter.

Standard III (Earth and Space Science): Understand the structure of Earth, the solar system, and the universe, the interconnections among them, and the processes and interactions of Earth's systems.

5-8 Benchmark II:	Describe the structure of Earth and its atmosphere and explain how energy, matter, and forces shape Earth's systems.

MATERIALS:

- Distilled water
- 100ml plastic graduated cylinders
- two 150ml beakers
- Dilute hydrochloric acid
- Ten pieces of limestone, approximately 1cm in diameter
- labels
- Lab aprons
- Lab goggles

BACKGROUND: The primary mineral in limestone is calcite or calcium carbonate ($CaCO_3$). When carbon dioxide (CO_2) reacts with water, carbonic acid is produced, see BUBBLES IN YOUR WATER ACTIVITY. When an acid, such as carbonic acid, reacts with limestone, the limestone decomposes:

$$CO_2 + H_2O \longrightarrow H_2CO_3;\ CaCO_3 + H_2CO_3 \longrightarrow Ca^{+2} + 2HCO_3^{-1}$$

This reaction is reversible, when water that is saturated with dissolved calcium carbonate and carbon dioxide enters a cave the carbon dioxide leaves the solution and calcium carbonate is deposited:

$$\uparrow CO_2 + H_2O \longleftarrow H_2CO_3 + CaCO_3\downarrow \longleftarrow Ca^{+2} + 2HCO_3^{-1}$$

This is primarily how various cave deposits are produced. The rate of growth of a stalactite from the ceiling of a cave can vary from 0.2mm to 2.0mm per year.

In this activity hydrochloric acid (HCl) will be reacted with limestone to produce calcium chloride ($CaCl_2$) and carbon dioxide:

$$CaCO_3 + 2HCl = CaCl_2 + H_2O + CO_2\uparrow$$

PROCEDURES:

- Wear goggles and lab aprons.
- Make 10% hydrochloric acid by adding 10ml of concentrated hydrochloric acid to 90ml of distilled water. Always add the acid to the water.
- Break a large piece of limestone into smaller pieces that are about 1cm in diameter. Each group will use ten pieces of limestone.
- Students will work in groups of two.
- The students should place a label with their names on each of two beakers. Write acid, HCl, on one, and water, H_2O, on the other. A plastic cup could be used instead of the beaker.
- Add five pieces of limestone to the beaker labeled acid and weigh the beaker, record this on the LIMESTONE AND ACID CHART as "Mass of Dry Beaker plus Stones Before Acid Reaction."
- Add another five small pieces of limestone to the beaker labeled water and weigh the beaker, record this on the LIMESTONE AND ACID CHART as "Mass of Dry Beaker plus Stones Before Acid Reaction."
- The beaker with the water will be the control.
- Add 30ml of dilute hydrochloric acid to the "acid beaker."
- Add 30ml of distilled water to the "water beaker."
- When most of the bubbling has stopped in the "acid beaker" carefully pour off the liquid into the sink.
- Add a second 30ml of dilute hydrochloric acid to the "acid beaker."
- When most of the bubbling has stopped in the "acid beaker" carefully pour off the liquids from both beakers into the sink.
- Rinse both beakers with distilled water and pour the distilled water into the sink, allow them to dry over night.
- When the beakers and their contents have dried, find the mass of each of the beakers and their contents; record the mass on the LIMESTONE AND ACID CHART as Mass of Dry Beaker plus Stones After Acid Reaction.
- Subtract the "Mass of Dry Beaker plus Stones After Acid Reaction," from the "Mass of Dry Beaker plus Stones Before Acid Reaction."
- Record the difference on the LIMESTONE AND ACID CHART.
- Repeat this procedure for the beaker with the limestone that was in the distilled water.
- I have found it useful to make a transparency of the Class Acid, Base, and Bubble Chart. The students can record their results or you could wait till everyone has cleaned up and ask each group what their results are.
- The total time for the reaction to occur twice would be about 45 minutes counting rinse time between the two acid reactions. If the acid solution were diluted to a 5% solution the reaction would be about 23 minutes.
- Record each results for the acid reaction and the distilled water. Calculate the class averages. Ask the students about the bubbles.
- I like the students to keep a chart of the class results to illustrate the importance of having more than one set of results.

CONCLUSIONS:

Allow the students to draw conclusions from the class result chart. Why did the limestone mass decrease, and where did it go? If carbon dioxide dissolves in water as it flows through the soil making carbonic acid, what would it do to limestone? Ask the students why there was only water in one beaker.

REFERENCES:

Gillieson, David. 1996. Caves: Processes, Development, and Management. Oxford, England: Blackwell Publishers

National Research Council. 1996, National Science Education Standards. Washington: National Academy Press

New Mexico Department of Education. 2003. New Mexico Science Content Standards, Benchmarks, and Performance Standards. http://164.64.166.11/cilt/standards/science/index.html

LAB EXTENSION:

As an extension to this lab the students could place five pieces of limestone into plastic bottles with 30ml of distilled water and shake the while the acid reaction is bubbling. They could use this to compare physical weathering of limestone to chemical weathering of limestone. This would involve modifying the charts such as the one below for the students results as well as the class average chart.

	5 pieces of Limestone with Acid	5 pieces of Shaken Limestone with Water	5 pieces of Unshaken Limestone with Water
Mass of Dry Beaker plus Stones Before Acid Reaction			
Mass of Dry Beaker plus Stones After Acid Reaction			
Difference: Mass before - Mass after			

Class Results

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Difference in Limestone with Acid	Difference in Limestone with Water
Total =	**Total =**
Average =	**Average =**

CONCLUSIONS: Continue conclusions on the back if needed.

SAMPLES

LIMESTONE AND ACID CHART

Student Name Lily Tanaka and Chris Monocada

Class 3rd Date 10 March, 2004 .

	5 pieces of Limestone with Acid	5 pieces of Limestone with Water
Mass of Dry Beaker plus Stones Before Acid Reaction	82.3g	89.1g
Mass of Dry Beaker plus Stones After Acid Reaction	78.6g	89.1g
Difference: Mass before - Mass after	3.7g	0.0g

Class Results

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Difference in Limestone	Difference in control: marbles
3.7g	0.0g
3.5g	0.1g
2.9g	0.0g
3.9g	0.0g
4.0g	0.0g
3.6g	-0.2g
Total = 21.6g	**Total** = -0.1g
Average = 3.6g	**Average** = -0.017 = 0.0

CONCLUSIONS:

STUDENT LIMESTONE AND ACID ACTIVITY

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LIMESTONE AND ACID ACTIVITY

Student Name_____

Class_____Date_____

QUESTION: How does acid affect limestone?

MATERIALS:

- Distilled water
- 100ml plastic graduated cylinders
- two 150ml beakers
- Dilute hydrochloric acid
- Ten small pieces of limestone, approximately 1cm in diameter
- labels
- Lab aprons
- Lab goggles

METHODS:

- Wear goggles and lab aprons.
- Work in groups of two.
- Place a label with your names on each of two beakers. Write acid, HCl, on one beaker label, and water, H_2O, on the other.
- Add five pieces of limestone to the beaker labeled acid and weigh the beaker, record this on the LIMESTONE AND ACID CHART as "Mass of Dry Beaker plus Stones Before Acid Reaction."
- Add another five small pieces of limestone to the beaker labeled water and weigh the beaker, record this on the LIMESTONE AND ACID CHART as "Mass of Dry Beaker plus Stones Before Acid Reaction."
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- Rinse both beakers with distilled water and pour the distilled water into the sink, allow them to dry over night.
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- Subtract the "Mass of Dry Beaker plus Stones After Acid Reaction," from the "Mass of Dry Beaker plus Stones Before Acid Reaction."
- Record the difference on the LIMESTONE AND ACID CHART.
- Repeat this procedure for the beaker with the limestone that was in the distilled water.

RESULTS: See: **LIMESTONE AND ACID Chart**

LIMESTONE AND ACID CHART

Student Name_____

Class_____Date_____

	5 pieces of Limestone with Acid	5 pieces of Limestone with Water
Mass of Dry Beaker plus Stones Before Acid Reaction		
Mass of Dry Beaker plus Stones After Acid Reaction		
Difference: Mass before - Mass after		

Class Results

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Difference in Limestone	Difference in control: marbles
Total =	**Total =**
Average =	**Average =**

CONCLUSIONS: