Creating $CaCO_3$

with Science, Art, Math, and Language Arts Extensions

ADAPTED FROM ENVIRONMENTAL EDUCATION IN SCHOOL: HOW POLYPS BUILD REEFS

Objective

Students will be able to explain the role of transforming calcium carbonate from seawater to coral reef skeleton.

Overview

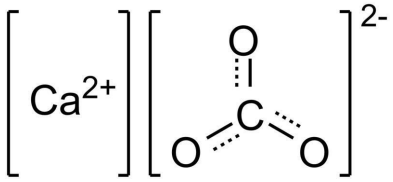
This activity uses a chemistry demonstration to teach about the production of coral skeletons. The demonstration shows students that under certain conditions, solid materials can be extracted from a solution. The source of coral reef skeletons, and therefore reef rocks themselves, is material dissolved in seawater. The chemical reaction demonstrated here is not the same chemical reaction that occurs in the coral polyp, but instead is a demonstration to show that solids can be produced from dissolved substances.

Background Information

How do polyps build reefs? Ocean water contains a large amount of salt. Unlike sodium, calcium combines with carbonate ions to form a relatively insoluble substance, calcium carbonate. This only happens when a slight acidity is present. Within the zooxanthellae, the correct acidic conditions occur for the calcium carbonate to form. Calcium carbonate is relatively insoluble in water, so it precipitates out. Within the polyp, the algae transport the $CaCO_3$ to the base of the polyp.

Materials

- 6 mason jars
- 1 tsp of flour, sugar, salt, sand, and baby powder
- 1 cup vinegar
- 1 stick of chalk
- 7 tsp baking soda
- Two 250ml containers
- One 500ml container
- Hammer



Vocabulary

- $CaCO_3$
- Solution
- Precipitate
- Dissolving

Standards

SC.K.P.8	SC.2.L.17	SC.3.P.9	SC.5.P.8	SC.8.P.9
SC.K.P.9	SC.2.P.8	SC.4.L.14	SC.5.P.9	SC.912.L.14
SC.K.L.14	SC.2.P.9	SC.4.P.8	SC.6.L.14	SC.912.L.15
SC.1.L.14	SC.3.L.14	SC.4.P.9	SC.6.L.15	SC.912.L.17
SC.1.L.17	SC.3.L.15	SC.5.L.14	SC.7.L.15	SC.912.L.18
SC.1.P.8	SC.3.L.17	SC.5.L.15	SC.7.L.17	SC.912.P.8
SC.2.L.14	SC.3.P.8	SC.5.L.17	SC.8.P.8	

Preliminary Phase

Find out what the students already know.

Teacher talk:

- *Where does coral reef rock come from?*

Teacher asks students if they have any ideas. Teacher writes what the students come up with on the board.

Teacher talk:

- *To talk about how coral polyps do this, we need to talk about the states of matter.*

On a separate part of the board, Teacher writes down "Solid, Liquid, Gas". At this point, depending on the age and background of the students, Teacher my want to go on to the extension activity States that Matter, if they do not understand the different states of matter. For more advanced students, Teacher simply asks for examples of solids, liquids, and gases, and writes them on the board.

Focus Phase

The students explore examples of the concept.

Teacher talk:

- *What about combinations of different states of matter? These we call **solutions**. We are most familiar with solutions of solids in liquids. What happens when you mix sugar in water? Or salt into soup? (Discuss.) Unless you put too much, the solids disappear. This is called **dissolving**. You know the sugar and the salt are still there in these liquids because we can taste them even though we can't see them anymore. But what about if you add flour to water? Or sand?*

Exploration Phase

The students exchange, debate, and test ideas.

Teacher talk:

- *It is only considered a solution if the substance truly dissolves. Which of these will become a solution?*

Teacher displays different substances, including sand, salt, sugar, baking soda, baby powder, and flour. Different substances can be added or subtracted to this group. Teacher makes a list on the board, and students guess which will become a solution and which will not.

Application Phase

The students apply their rules to new situations.

Place the teaspoon in each of the mason jars full of water. Then, Teacher gives the jars to students to shake up for one minute. Record the results on the board. Remember, a solution should be completely dissolved.

Challenge Phase

The students take their application to a real-world situation

Teacher talk:

- *Now, let's go back to the original question of how coral polyps build reef rock. Sea water is a solution. The liquid is water, but what is the solid? (discuss) Yes, salt. But that is not the only substance that is dissolved. Another substance that is dissolved in water is a type of rock called* ***limestone*** *made of a chemical called* ***calcium carbonate****.*
- *Inside* ***coral polyps*** *are algae known as* ***zooxanthellae****. Along with giving the coral extra food, the zooxanthellae also help build the coral's skeleton. Zooxanthellae can take the dissolved calcium carbonate and turn it back into a solid through a chemical reaction in their bodies. This limestone is secreted from the base of the polyp and grow vertically. They will do this throughout their life.*

Teacher begins the demonstration by breaking a piece of chalk piece of chalk into pieces. Teacher puts the pieces in the paper bag, and allows a student to use the hammer to turn the pieces into powder.

Teacher talk:

- *Chalk is made of limestone, also known as calcium carbonate. Unlike salt or sugar, it dissolves very slowly in water. So, to speed up the dissolving process, we are going to put the chalk into vinegar, which is a solution of water and* ***acetic acid****.*

Teacher pours 250 ml vinegar into a container and adds the chalk pieces. It will have a reaction. This reaction will be familiar to the students who have already done the activity, Sibilating Scleractinia.

Teacher talk:

- *We will leave the chalk vinegar preparation sit overnight.*

Teacher should stir the solution as often as possible. When Teacher returns to the demonstration, show students that much of the chalk has disappeared. It has dissolved in the liquid. Teacher can wait multiple days if time allows so that even more of the chalk dissolves.

Teacher talk:

- *Sea water acts much like this solution, except that saltwater has dozens of dissolved solids in it, including limestone, salt, and even gold.*

Into a separate container that is labelled "dissolved limestone", Teacher carefully pours off the clear liquid from the chalk/vinegar solution. Leave the leftover chalk at the bottom and discard.

Into an unlabeled container, fill 250 ml of water and add 6 teaspoons of baking soda. Teacher asks a student to stir the solution for 15 minutes or until no trace of a solid remains. Let any remaining solid settle for a few minutes, then pour the clear liquid into a different container labeled "dissolved baking soda".

Teacher asks for a volunteer to mix both liquids into the 500-ml container.

Teacher talk:

- *Watch closely. What you are about to see will be similar to what happens to seawater when it comes in contact with algae in coral polyps!*

For larger classes, Teacher may prepare enough so that each student or group of students can do this individually. The student should pour the baking soda solution into the limestone solution. Students will observe white particles of solid calcium carbonate appear in the liquid. Pass the container around so all students can see what was created.

Teacher talk:

- *Once the calcium carbonate is formed by algae within the coral polyp, the polyp transport it downwards and secretes it as a skeleton. However, within a coral, this is laid down as tight crystals rather than white powder like in this demonstration. Each different type of coral lays these down in a different pattern.*

Synthesis Phase

The students take their overall understanding to the next level.

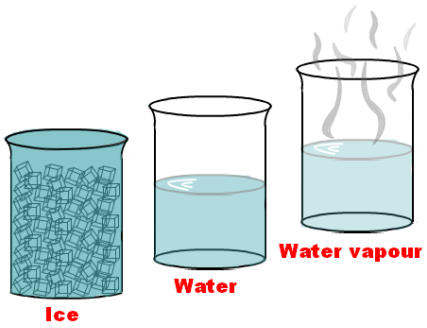
Teacher talk:

- *So, during bleaching events, would the coral be able to create new skeleton and grow? (discuss)*
- *The production rate of $CaCO_3$ must exceed that of the removal processes (dissolution, storm export, and bioerosion) in order for the reef to grow (termed **reef accretion**). Studies of $CaCO_3$ budgets on coral reefs suggest that these building and erosive processes are nearly balanced at most reefs, and net reef accretion is small.*
- *Most experiments now demonstrate a reduced rate of calcification as a consequence of **ocean acidification**. Laboratory studies have examined the effects on many types of corals and coralline algae, revealing a range of responses from a 3% to 60% decline in calcification rate for a doubling of atmospheric CO_2. Additionally, a recent study of Brain Corals in Bermuda found that calcification rates have declined by 25% over the past 50 years and ocean acidification is a likely contributing factor.*
- *Thus, a primary threat of ocean acidification is the potential to compromise the ability for reefs to maintain a positive net accretion, thereby resulting in the loss of critical habitat and coastal protection.*
- ***Effects beyond reduced calcification rates have also been observed**, such as reducing the abundance of crustose coralline algae and a reduced fertilization success in sea urchins, which would cause significant changes to the community structure of coral reefs.*
- *Other potential effects include an increased susceptibility to coral bleaching, a reduced capacity to tolerate ultraviolet radiation, and increased bioerosion rates.*

Extension 1 – States that Matter (SCIENCE)

Materials

- Station materials – for instance Ooblick, copper, hand cream, marshmallow, water, sand, Alka Seltzer, hair spray, Play-Dough, helium balloon, hand sanitizer, hair mousse, etc.
- 3 different color Post-Its



Instructions:

1. Teacher explains that scientists classify matter by listing their properties. Make a chart on the board, and have the students create their ideas of what a solid, liquid, and gas are, and the properties of each. At this point, the teacher should not correct them.
2. Make stations around the room in which there are solids, liquids, and gases. Some of these should be slightly tricky (such as how hand sanitizer starts as a liquid, and turns into a gas quickly when on your hands, or how hair mousse seems to be somewhere between a solid and a liquid). The list of materials is just an example of objects that can be used. Give each student 3 different color post it notes, or notecards with Solid, Liquid, and Gas on them. As they got to each station, they should anonymously vote if each are a solid, liquid, or gas.
3. At the end, calculate the voting and present the findings to the class. A follow-up activity can be creating a Venn Diagram and, after a discussion, adding the objects that have traits of multiple states in. It is probably a good idea to go over the actual definitions of solids, liquids, and gasses before starting this follow up activity.

Extension 2 – Coral Cannon (SCIENCE)

Materials

- Baking Soda
- Vinegar
- Flask
- Balloon
- Toilet Paper
- Film Canister

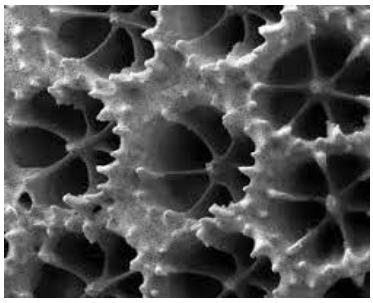
Instructions:

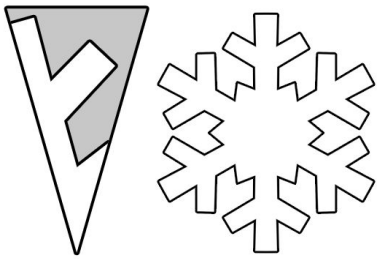
1. Explain to students that the states of matter can change. For example, when an ice cube gets warm, it melts into a liquid. That liquid, water, if heated again, will evaporate into a gas.
2. Put a teaspoon of baking soda inside the balloon and then place the tip of the balloon over the flask filled with vinegar. Do not spill any of the baking soda into the flask yet.
3. Have all students watch as you lift the balloon and allow the baking soda to mix with the vinegar. The balloon shall inflate. Make sure you do not put too much or the balloon will pop.
4. Teacher explains that when the vinegar and sodium bicarbonate mix, carbon dioxide is released.
5. Fill half of a film canister full of vinegar.
6. Within a single square of toilet paper, put a teaspoon of baking soda, and wrap the edges of the toilet paper around it
7. Drop the toilet paper ball into the film canister, and put on the cap. Within a few seconds, as long as there is a complete seal, the cap will pop off from the pressure of the carbon dioxide being created. If you have extra film canisters, you can have the students design paper rocketship coverings for them and fire them as a class. If you do not have vinegar and baking soda, this can also be done with Alka Setzer and water.

Extension 3 – Scleractinia Snowflake (ART)

Materials

- Paper
- Scissors
- Bulletin Board





Instructions:

1. Explain to students that different types of corals create different crystalized patterns as they excrete the limestone through their bodies, similar to the shapes of snowflakes
2. Have each student create their own "coral cup" snowflake, and put them all together on a bulletin board

Extension 3 – Saturated Scleractinia (MATH)

Teacher explains that a solution can become **saturated**. If more solute is added and it does not dissolve, then the original solution was saturated. If the added solute dissolves, then the original solution was **unsaturated**. A solution that has been allowed to reach equilibrium but which has undissolved solute at the bottom of the container must be saturated.

Teacher can use leftover supplies from this lab (baking soda, salt, sugar, etc.) to find the saturation levels, and see if different substances have different saturation levels or if the liquid makes the difference.

The students answer should be done by a ratio of the volume (or mass) of the liquid by the volume (or mass) of the solid. This can be then converted into percent.

Extension 4 – Limestone Lyric (LANGUAGE ARTS)

At the end of the activity, have the students write either a poem, song, music video. or other musical presentation to teach other people what happened in this activity, as well as how coral polyps grows reefs, their relationship with zooxanthellae, how it reactions to the solution of ocean water, and the effects of ocean acidification on the future of coral reefs.