# Island Formation

## *Constructing a Coral Island*

Heather Austin and Amelia Edd

**Abstract.** The process of coral island formation is often difficult for middle school students to comprehend. Coral island formation is a dynamic process, and students should have the opportunity to experience this process in a synergistic context. The authors provide instructional guidelines for constructing a coral island. Students play an interactive role in this activity, which gives them both visual and tactile experiences. The activity was designed for 6th-grade students. After completing the activity, the students could accurately describe the significant components and process of coral island formation. Additionally, students understood that this is an ongoing geologic process.

**Keywords:** atoll, coral island, island formation, lagoon

*Inquiry into authentic questions generated from student experiences is the central strategy for teaching science.*
—National Science Education Standards *(National Research Council 1996)*

"Coral islands are formed from large white mountains that lie beneath the ocean," yelled one sixth-grade student when asked how coral islands are formed. The various kinds of coral skeletons on the sixth-grade students' table, as well as pictures of coral islands from all over the world, had immediately captivated the students. Questions such as "What is coral made of?" and "How can coral be part of an island?" circulated through the classroom. The students' comments and questions included several misconceptions, such as one student's theory that "coral islands are formed from white meteors that fall out of the sky and into the ocean."

The coral's beautiful yet alien quality already had students mesmerized. The idea that these alien objects could form an island further piqued their curiosity. The formation of a coral island is the result of a dynamic but slow process that involves the growth of coral on an oceanic volcano and the subsequent subsidence of the volcano and creation of a coral atoll (Grigg 1982). Illustrating this process in the classroom is a way to cover the second ocean literacy essential principle by investigating how subsidence and erosive processes can help shape Earth's features (National Geographic Society et al. 2006).

Coral island formation is a process that takes millions of years. It begins with a newly formed volcanic island that rises above the surface of the ocean. As the island stabilizes and magma stops flowing into the ocean, coral starts to grow in the shallow water around the volcanic island. This new *fringing coral reef* contains many tiny animals, called *coral polyps*, that create limestone shells. The polyps grow and develop on any solid surface, building on the skeletal remains of other polyps. Consequently, a coral reef is composed of a thin layer of living coral on top of the limestone remains of dead coral (Darwin 1842; Grigg 1982).

Over millions of years, the volcanic island undergoes significant changes. First, the island moves away from the magma hot spot that originally caused it to grow, so no new material is added to the island. As the magma cools, the rock's density increases, resulting in subsidence (sinking)

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of the island. Second, the erosive processes of wind, rain, and waves slowly disintegrate the island's surface, making it smaller. Finally, rising sea levels resulting from global climate change cause the island to sink below the surface. The fringing coral reef gradually sinks (or subsides) with its island. However, new coral polyps continue to grow on top of the limestone skeletons, developing fast enough to keep the surface of the coral reef at sea level. A *lagoon* starts to form between the island and the reef. This lagoon eventually surrounds the sinking volcanic island, and the coral reef continues to grow up around the island, becoming a *barrier reef*. Over time, the entire volcanic island sinks below the surface of the ocean, leaving an *atoll*, a ring of growing coral with an open lagoon in its center (Darwin 1842; Grigg 1982).

Because the process of coral island formation encompasses abstract geologic processes like erosion and subsidence, it can be hard to comprehend. Combining both visual and tactile experiences as students construct their own coral island is an effective way to help middle school students learn about coral island formation. As students become involved in the formation process, they synthesize different components and stages of coral island formation and see how each stage contributes to the overall process. Ultimately, this activity increases the students' scientific literacy, enabling them to describe, explain, and teach this process to others (National Research Council 1996).

## Background

*Lesson Context*

Sixth-grade students participated in the following introductory lesson to gain some background on coral island formation before beginning the hands-on activity. To help them begin thinking about islands, students worked in groups of three to observe various objects typically found on islands, such as fish bones, shells, sand, and coral, as well as pictures of different types of islands. After this observation, each student wrote his or her own definition of an island and shared it with the class. The teacher led a discussion of these ideas, and students voted on the best definition. After the discussion, the teacher gave students a formal definition of an island (a land mass, smaller than a continent, entirely surrounded by water). Students wrote this definition next to their own.

The teacher then used pictures and overheads to introduce volcanic, barrier, and continental islands. Students asked questions and recorded basic definitive features of each type of island, including the material from which the island is composed, how the island forms, and where islands of this type are found. Each group of students then picked one of the three island types to research in greater detail. Over the next few days, students created posters listing their island type's specific characteristics, details about its process of formation, and descriptions of where it can be found. Each group had 5 min to present its finished island poster to the class.

*Preactivity Assessment*

Before the coral island formation activity, students answered questions that assessed their understanding of island formation and connected their previous knowledge of islands with the activity. Questions included the following: What geologic processes are responsible for the formation of islands? What materials compose coral islands? How do you think coral islands form? Typical student responses involved concepts such as the tectonic shifting of plates, the rising of sea levels, the rise of volcanoes, and the amalgamation of skeletons of small animals called *polyps*. Students also made connections between the rise of volcanic islands and the formation of coral reefs.

## Objectives of Coral Island Formation Activity

1. Students can distinguish between different island types.
2. Students can describe how a coral island forms and what creates the atoll using vocabulary such as *barrier reef*, *fringing reef*, *subsidence*, *atoll*, and *lagoon*.
3. Students can explain how the formation of their island models that of an actual coral island.

## Materials

- Coral skeleton set (can be purchased from Carolina Biological Supply)
- Five pictures of coral islands or atolls from around the world (e.g., Tuamotu Islands, Caroline Islands, Maldives, Laccadive Islands, Chagos Archipelago); images can be found online or in old calendars such as the National Geographic *Islands* calendar
- Schematic for the initial setup of the coral island activity (for the teacher; see Figure 1)
- Three Coral Island Formation worksheets for each student (see Figures 2–4)
- Overhead on coral island formation (see Figure 5)
- One can of white shaving cream, labeled "coral reef mix," for each group
- One empty soda can for each group
- One 7.6 × 12.7 cm (3 × 5 in.) index card per group; fold each card into the shape of a cone and tape to top of can
- One tub of water for each group (water level should be 2.5–5.0 cm from the top, so the water will not overflow when the can displaces water)
- One blue paper plate for each group with a hole cut from the center (the hole should be the exact diameter of the soda can, so the can barely fits through), and labeled "ocean" in large letters with a permanent marker
- 60 marbles for each group
- Paper towels (for cleaning up spilled water)

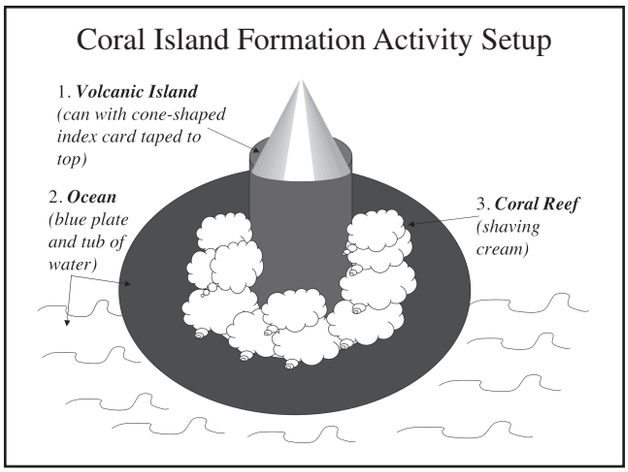



*FIGURE 1. Initial setup for coral island formation activity.*

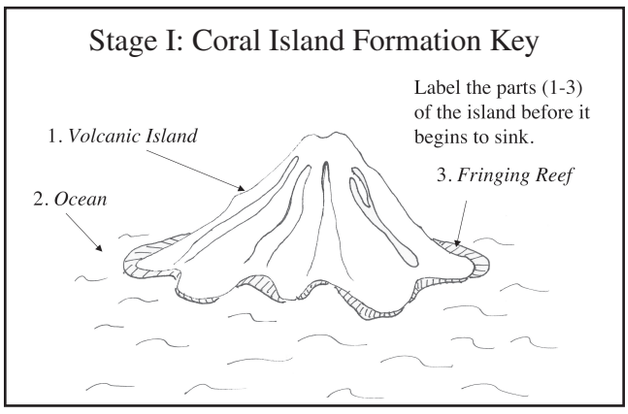



*FIGURE 2. Stage I: Coral Island Formation worksheet key.*

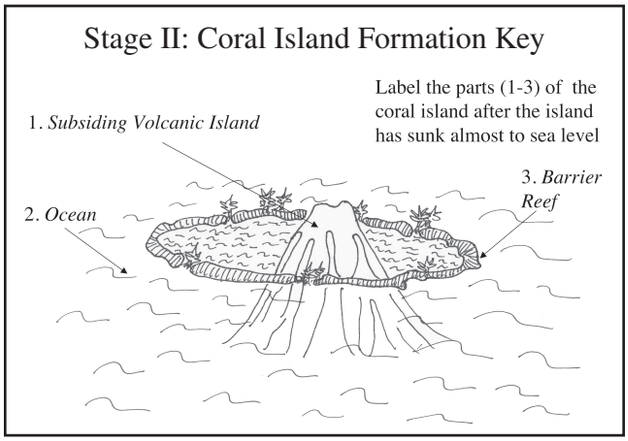



*FIGURE 3. Stage II: Coral Island Formation worksheet key.*

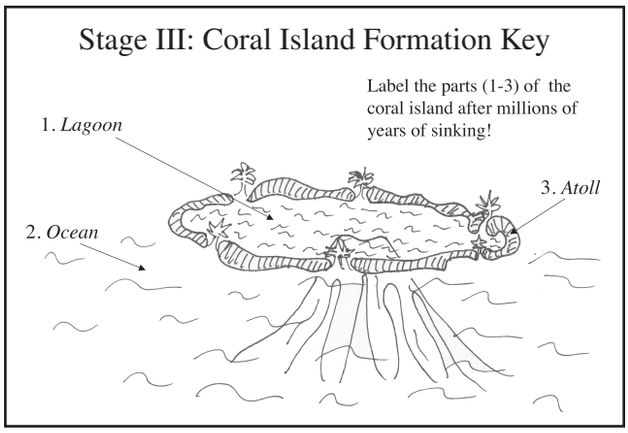



*FIGURE 4. Stage III: Coral Island Formation worksheet key.*

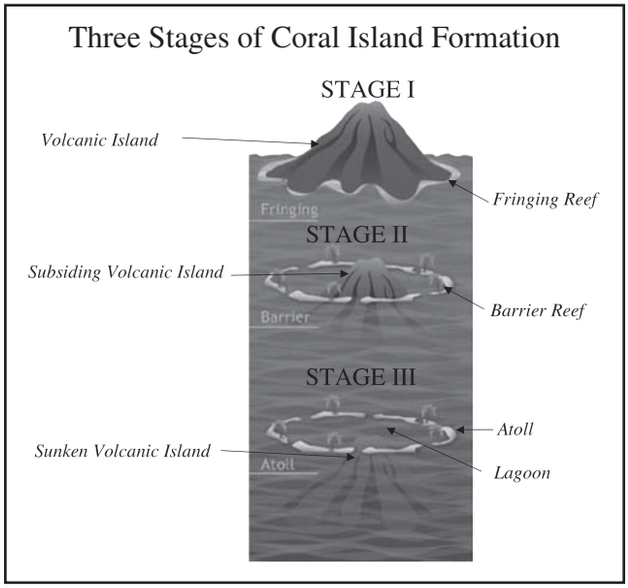



*FIGURE 5. Coral Island Formation overhead, which shows the three different stages and components of the island formation process. Figure modified from http://www.coris.noaa.gov/about/what_are/atoll_dev_186.jpg.*

## Procedure

The activity takes approximately 45 min. A classroom with an overhead projector, tables, and sink is ideal for this activity.

1. Place students in groups of three and assign each student a letter for the activity: student A, student B, and student C.

2. Hang pictures of different coral islands from around the world on the blackboard and walls of the classroom. Ask each group to discuss the pictures and predict how they think a coral island is formed based on their observation

of the coral at their table and the pictures of coral islands. Tell students to save their predictions for the discussion after the activity.

3. Place two different types of coral, one tub of water, one paper plate with a hole cut out, one soda can with attached cone-shaped index card, 60 marbles, and one shaving cream can labeled "coral reef mix" at each table. Figure 1 shows a schematic for the initial setup of the activity.

4. Give each student a copy of the Coral Island Formation worksheets (Figures 2–4), and tell the students that they will actively go through the coral island formation process to make their own coral island. Remind students that, in reality, this process takes millions of years. For example, in Hawaii the process has been going on for the past 30 million years.

5. Tell student A in each group to place the blue plate (with the hole in the center) on top of the water in the tub. Student B places the soda can in the hole so the can and the plate are floating together on top of the water. Student C slowly sprays a thin layer of shaving cream around the base of the can (see Figure 1).

6. Ask students what they think the can, the shaving cream, and the tub of water represent. After discussing their ideas, confirm that the tub of water represents the ocean and that the can represents the newly formed volcanic island protruding from the depths of the ocean. The shaving cream represents the new fringing reef forming along the shore of the volcanic island. It is important to note that the actual volcanic island does not float like the can but is connected to the bottom of the ocean. Make sure each student understands this so it does not become a lasting misconception.

7. Instruct students to label the parts of their island on the Stage I: Coral Island Formation worksheet (see Figure 2).

8. After students complete their worksheet, student A drops 60 marbles into the can. As the can begins to sink through the hole in the plate, student C sprays three more layers of shaving cream around the can while student B simultaneously pushes the can down through the hole until only the cone taped to the top is visible on the plate.

9. Ask students how their island has changed. What has happened to the island? How did this happen? What has happened to the coral reef? What do the can, shaving cream, and tub of water represent now?

10. Confirm that the can represents the subsiding (sinking) volcanic island, that the newly applied shaving cream represents the growth of new coral on top of the limestone remnants of dead coral, and that the reef at this stage is now considered a barrier reef, as it continues to grow upward around the sinking volcanic island. The tub of water represents the ocean. Ask students what processes have caused the change in the island. This allows for a discussion of subsidence and erosion, if time permits.

11. Instruct students to label the parts of their island on the Stage II: Coral Island Formation worksheet (Figure 3).

12. To model the ultimate stage in coral island formation, student C sprays another layer or so of shaving cream on top of the existing layers. If the can has not sunk to the bottom already, student B can push the can (and the paper cone taped to its top) all the way through the hole and into the water. The paper cone is now saturated with water and will slowly start to come apart in the tub. (If the tub is too small, have students remove the can and the cone from the tub completely, but remind them that the island has sunk beneath the surface of the ocean.) Students should see a ring of coral (shaving cream) with a large hole in the center that is filled by the surrounding water.

13. Ask the students how their island has changed. What happened to the volcanic island? Where did it go? How did this happen? What happened to the coral reef? Why? What is this coral reef called now? What is the water in the center called?

14. Ask students to explain what has happened to their model island. During the discussion, introduce the concept that what is left of the island is a ring of growing coral, called an *atoll*, with water in the center, a *lagoon.* The ring of shaving cream at the water's surface represents the atoll, the water within the hole in the center of the shaving cream is the lagoon, and the can (the former island) is now under the water.

15. Ask the students how long this activity took. Depending on the size of the class, answers will vary from 20 min to 25 min. Tell students that each minute that they were forming their coral island represented roughly 1.5 million years of actual coral island formation. Have them work out how many millions of years their 20–25 min time period represents. Emphasize how slow this process is.

16. Have students label the parts of their new coral island on the Stage III: Coral Island Formation worksheet (see Figure 4). This is a good time for a teacher to use paper towels to mop up any spilled water from the tables.

17. To solidify learning and assess understanding, ask students to explain the three different stages of coral island formation in their own words.

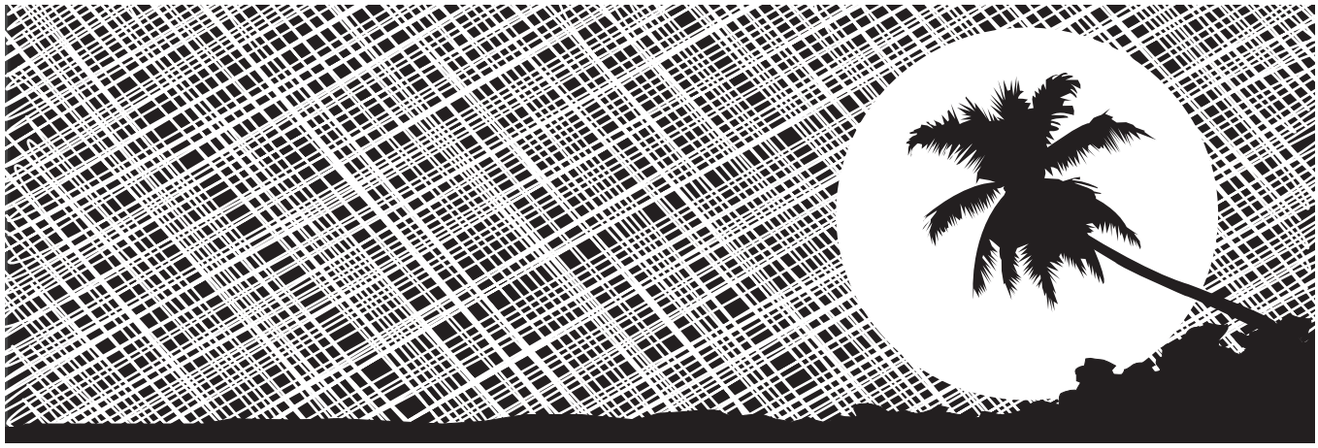
18. Review coral island formation using the overhead (see Figure 5) and pictures of the coral islands.

19. For a final assessment, have students write their own description of coral island formation using pertinent vocabulary.

## Evaluation

After completing the activity, assess students on the basis of the following criteria:

1. participation in the activity;
2. completion of the three coral island formation worksheets;



3. overall comprehension of coral island formation and its process, assessed by participation in the discussions during the activity; and
4. their written description of the three different stages in coral island formation, using correct vocabulary words (i.e., atoll, lagoon, barrier reef, fringing reef, subsidence).

## Conclusion

Overall, this lesson went very well. Students' previous misconceptions concerning coral island formation appeared to dissolve as they completed the activity. Students were able to (1) identify different types of islands, (2) use relevant vocabulary to describe how the coral island forms, and (3) describe how the formation of their island modeled that of a real coral island. Students explored this process through tactile and visual perspectives that helped them forge connections between the process and components of coral island formation. Through active learning, students discovered aspects of the process on their own by asking questions and working together to figure out the answers, rather than by receiving information solely from the teacher. Consequently, at the end of the lesson many students wanted to expand their knowledge by investigating processes that help shape other features on Earth, such as sand dunes, sand bars, canyons, and mountain ranges. Helping students make these connections helped them appreciate the ubiquitous nature of geologic processes and better understand the mechanisms leading to the creation of Earth's features.

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