

## Photo Description



Ocean waves crash powerfully against dark rocks along a shoreline, creating white foam and spray that shoots high into the air. The rocky coastline shows how moving water can hit solid surfaces with great force, while pebbles and sand cover the beach area.

## Scientific Phenomena

This image captures the Anchoring Phenomenon of wave energy transfer and erosion. Ocean waves carry kinetic energy from wind across vast distances of water. When these moving waves encounter the solid rocky shore, they transfer their energy through collision, creating the dramatic splash and spray visible in the photo. Over time, this constant pounding breaks down rock particles through mechanical weathering, gradually reshaping coastlines through the process of erosion.

## Core Science Concepts

1. Energy Transfer: Waves carry kinetic energy from one place to another, transferring it when they hit obstacles like rocks or shorelines.
2. Forces and Motion: The moving water exerts force on stationary rocks, demonstrating Newton's laws of motion in action.
3. Weathering and Erosion: Repeated wave action mechanically breaks down rock surfaces, carrying away small particles and gradually changing the landscape.
4. States of Matter: Water demonstrates fluid properties as it moves, splashes, and flows around solid rock formations.

### Pedagogical Tip:

Use this image to help students make the connection between energy they can see (the dramatic splash) and energy they cannot see (the sound waves, vibrations in the ground, and the slow process of rock breakdown happening over time).

### UDL Suggestions:

Provide multiple ways for students to experience wave energy: play audio recordings of crashing waves, let them feel vibrations by tapping on their desks, and use slow-motion videos to help students see the details of energy transfer that happen too quickly to observe in real-time.

## Zoom In / Zoom Out

1. Zoom In: At the molecular level, water molecules are constantly moving and colliding with each other and the rock surface. When waves hit rocks, the impact creates compression forces that work into tiny cracks in the rock, eventually causing pieces to break away grain by grain.

2. Zoom Out: This coastal erosion is part of the larger rock cycle and Earth's surface processes. Material eroded from these rocks will be transported by ocean currents, potentially forming new sedimentary deposits elsewhere, while tectonic forces may eventually create new mountains from ocean floor sediments.

### Discussion Questions

1. What evidence do you see that energy is being transferred from the water to the rocks? (Bloom's: Analyze | DOK: 2)
2. How might this coastline look different after 100 years of wave action, and what processes would cause those changes? (Bloom's: Evaluate | DOK: 3)
3. Where do you think the energy in these waves originally came from? (Bloom's: Apply | DOK: 2)
4. What would happen if we built a wall to block these waves, and how might that affect the energy transfer? (Bloom's: Create | DOK: 3)

### Potential Student Misconceptions

1. Misconception: "Rocks are too hard for water to break them down."

Clarification: While individual water drops are weak, the repeated force of millions of water molecules hitting rocks over long periods creates enough energy to break even the hardest stones.

2. Misconception: "Waves only move water up and down."

Clarification: Waves actually move energy across the water surface, while water particles move in circular motions, allowing energy to travel great distances.

3. Misconception: "Erosion happens quickly like in the picture."

Clarification: The splash happens instantly, but the actual erosion process takes thousands of years of repeated wave action to create significant changes.

### Cross-Curricular Ideas

1. Math - Measuring and Graphing: Have students research wave heights and frequencies, then create bar graphs comparing wave sizes during different seasons or weather conditions. Students could also calculate how many years it takes to erode a certain amount of rock if given the erosion rate per year.
2. ELA - Descriptive Writing: Ask students to write detailed narratives describing what they see, hear, and feel while standing on this rocky beach during a storm. They could use sensory language and metaphors to bring the scene to life, then share their writing with the class.
3. Social Studies - Human Geography: Explore how coastal communities adapt to wave erosion and design protective structures. Students could research famous eroded coastlines around the world (like the cliffs of Dover or the California coast) and learn how people live safely in these dynamic environments.
4. Art - Movement and Motion: Have students create mixed-media artwork or sculptures inspired by the energy and motion in waves. They could use water, paint, sand, and rocks to recreate the crashing wave effect, exploring how artists represent dynamic forces in their work.

## STEM Career Connection

1. Coastal Engineer: Coastal engineers design and build structures like seawalls, breakwaters, and dams to protect beaches and communities from erosion and flooding caused by waves and storms. They study how water moves and how rocks break down to create solutions that keep people safe. Average Salary: \$92,000/year
2. Geologist: Geologists study rocks, minerals, and Earth's processes like erosion and weathering. They examine coastlines to understand how landscapes change over time and predict future changes. Some geologists help protect important historical sites or predict natural disasters. Average Salary: \$95,000/year
3. Ocean Scientist (Oceanographer): Ocean scientists study waves, currents, and how water interacts with land. They use equipment to measure wave energy and understand how oceans shape our planet. Some work to protect marine environments and predict storms. Average Salary: \$88,000/year

## NGSS Connections

- Performance Expectation: 5-ESS1-2: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and atmosphere interact.
- Disciplinary Core Ideas: 5-PS1.A, 5-ESS2.A, 2-ESS1.C
- Crosscutting Concepts: Energy and Matter, Stability and Change

## Science Vocabulary

- \* Kinetic Energy: The energy that moving objects have because they are in motion.
- \* Erosion: The process where wind, water, or ice wears away rocks and soil and moves them to new places.
- \* Mechanical Weathering: The physical breaking apart of rocks without changing what they are made of.
- \* Energy Transfer: When energy moves from one object or place to another object or place.
- \* Force: A push or pull that can change how objects move or their shape.

## External Resources

### Children's Books:

- Waves by Patricia Whitehouse
- Seashore by Steve Parker
- The Magic School Bus on the Ocean Floor by Joanna Cole