UNIT 4: NAZARÉ

Ocean Literacy **Essential Principle of #2:**

"The ocean and life in the ocean shape the features of the Earth"

5 Fundamental Concepts that explain **Principle #2:**

A. Many earth materials and biogeochemical cycles originate in the ocean. Many of the **sedimentary rocks** now exposed on land were formed in the ocean. Ocean life laid down the vast volume of siliceous and carbonate rocks.

B. Sea level changes over time have expanded and contracted continental shelves, created and destroyed inland seas, and **shaped the surface of land**.

C. Erosion—the wearing away of rock, soil and other biotic and abiotic earth materials—occurs in coastal areas as wind, waves, and currents in rivers and the ocean, and the processes associated with plate tectonics move sediments. Most beach sand (tiny bits of animals, plants, rocks, and minerals) is eroded from land sources and carried to the coast by rivers; sand is also eroded from coastal sources by surf. Sand is redistributed seasonally by waves and coastal currents.

D. The ocean is the largest reservoir of rapidly cycling **carbon** on Earth. Many organisms use carbon dissolved in the ocean to form shells, other skeletal parts, and coral reefs.

E. Tectonic activity, sea level changes, and the force of waves influence the physical structure and **landforms of the coast**.

Scope & Sequence: Adjust for your Grade Level—

K - 2	3 - 5	6 - 8	9 - 12

SUGGESTED ACTIVITIES

ACTIVITY 4.1— "Ten-Story Waves"

According to the Second Principle of Ocean Literacy: ***The ocean shapes the features of the Earth.***

Review Fundamental Concepts 2A-2E, listed above. Define terms and concepts.

Focus in on 2E: how the force of waves and the violent nature of the ocean itself has altered and shaped the land in so many visible ways:

> **2E.** Tectonic activity, sea level changes, and the force of waves influence the physical structure and **landforms of the coast**.

To see how the force of waves landforms of the sea coast, visit Sunset Cliffs, Torrey Pines, or the tide pools off of Bird Rock. If you do not live near San Diego, visit any sea coast and look for examples of how the ocean has carved, smoothed, chopped and/or displaced the rocks, cliffs and shorelines.

Watch:

Ever since the HBO series *"100 Foot Wave"* was filmed in Nazaré, Portugal, many tourists have flocked to this old fishing village. In the 17-minute trailer below, we see an integration of many themes: eco-tourism, extreme sports, the blue economy, sustainability, how the weather and geography form the biggest waves in the world-- and then how those waves, in turn, shape the land and the culture.

Watch: The World's Biggest Waves

• How is the influx of tourists from around the world good for Nazaré? What's the downside?
• What are the issues of sustainability that local residents have to contend with now?
• What are signs from this short video that Nazaré is an integral part of the blue economy or Portugal and the world?
• What geographical features explain the enormous waves that come to Nazaré?

Teacher Note: Remember, you don't need to consume valuable class time with a 17-minutee video. Give the link to your students and ask them to watch it at their convenience-- some time over a weekend-- and be prepared to discuss it when they return to class. That's the concept of the *Flipped Classroom*.

Simulation: To feel what it's like on top of a wave that is 100' tall, find a 10-story hotel downtown and take the elevator to the top floor. Look over the edge!

ACTIVITY 4.2— The Carbon Cycle

> 2D. The ocean is the largest reservoir of rapidly cycling **carbon** on Earth. Many organisms use carbon dissolved in the ocean to form shells, other skeletal parts, and coral reefs.

When is too much carbon a bad thing?

The ocean absorbs some 30% of the excess carbon produced by humans *burning fossil fuels*. This overload is leading to ocean warming, acidification, rising sea temperatures, and loss of biodiversity.

Dive in:

If our students are ever going to address global warming, they must thoroughly understand the **carbon cycle.**

Resource:

- You can find good explanations of it here on the National Ocean Service site;
- Or in this brief video produced by the Economist
- Or on the United Nation's website;
- Or the National Geographic Resource Library;
- Or NASA.

Cite the evidence and how it all works. Bring in experts. *Make your students experts*. Have them visit the middle school and explain it to younger students. Don't move any further until every student gets it! Carbon is the key to understanding global warming.

ACTIVITY 4.3— Erosion

> 4C. **Erosion**—the wearing away of rock, soil and other biotic and abiotic earth materials—occurs in coastal areas as wind, waves, and currents in rivers and the ocean, and the processes associated with plate tectonics move sediments. Most beach sand (tiny bits of animals, plants, rocks, and minerals) is eroded from land sources and carried to the coast by rivers; sand is also eroded from coastal sources by surf. Sand is redistributed seasonally by waves and coastal currents.

Read through some recent studies on Erosion. For example:

- Scripps study of erosion in San Diego.
- Beach Preservation Efforts by the Surfrider Organization
- Where California Beaches are Collapsing the Fastest

Discuss:

- Is erosion a natural phenomenon?
- Is human activity contributing to it…and how do we know?
- How do beach communities manage erosion and the effects of violent storms.

View this brief video by Adam Young, a scientist at Scripps Institute: 99 Seconds

Discuss:
- What effect is erosion having on San Diego's Coast line?
- How is erosion being measured?
- What evidence do scientists have that it is getting better or worse?
- To what extent are these scientists interpreting data to warn the public about trends in erosion?
- What's the worst that could happen if the public doesn't pay attention to their warnings?

ACTIVITY 4.4— "Seabed 2030"

"Yet for all of our reliance on the ocean, more than eighty percent of this vast, underwater realm remains unmapped, unobserved, and unexplored."

--National Oceanographic and Atmospheric Administration

"We have better maps of the moon and Mars than we do of our own planet."
-Dr. Gene Feldman, oceanographer emeritus, NASA

RESEARCH: "The Seabed 2030 Project"

"There are many benefits to having a complete map of our ocean. Knowing the seafloor's shape is fundamental for understanding ocean circulation and climate models, resource management, tsunami forecasting and public safety, sediment transportation, environmental change, cable and pipeline routing, and much more.

It is also vital information which will enable the realization of the societal outcomes outlined by the UN Decade of Ocean Science for Sustainable Development (2021-2030), and the **UN's Sustainable Development Goal 14:** 'to conserve and sustainably use the ocean, seas and marine resources for sustainable.'
--Seabed 2030

View: the Ocean Floor Features Presented by NOAA:

"Beneath the smooth ocean surface extends an underwater landscape as complex as anything you might find on land. While the ocean has an average depth of 2.3 miles, the shape and depth of the seafloor is complex. Some features, like canyons and seamounts, might look familiar, while others, such as hydrothermal vents and methane seeps, are unique to the deep."

• **Identify and define** all the different land features.

Your thoughts:

• How important is it to map the ocean floor?
• How might an accurate map of the ocean floor benefit the Blue Economy?

📖 **Resource:**

• **Smithsonian Magazine:** Can Scientists Map the Entire Seafloor by 2030?
• **Video: Nautilus Live:** Mapping the Ocean Floor

ACTIVITY 4.5— The 8 Scientific Practices: *Models*

In Scientific Practice #2—**Developing and Using Models—** we can *use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, recreations, computer simulations and more!*

Review Fundamental Concept 1B ***(Activity1.1):***

> 1B. Ocean basins are composed of the seafloor and all of its **geological features** (such as islands, trenches, mid-ocean ridges, and rift valleys) and vary in size, shape and features due to the movement of Earth's crust (lithosphere). Earth's highest peaks, deepest valleys and flattest plains are all in the ocean.

Activity: Construct a 3-D model of the ocean floor that depicts basins, high peaks, canyons, and other geological features.

- Research ocean maps and identify some prominent "ocean basins."
- Identify examples of each of the geological features that are listed in 1B.
- Select a medium that will be easy to mold into geographical shapes (e.g., clay)
- Can you verify that last sentence in Fundamental Concept 1B: *"the Earth's highest peaks, deepest valleys and flattest plains are all in the ocean."*

Compare the size of the Earth's highest land-based mountains, and deepest valleys, with features in the sea—for example: the Grand Canyon compared to the Marianas Trench; or compare Hawaii's Mauna Kea to the size of Mt. Everest.

📖 **Resource:**

- **Woods Hole:** The Seafloor and Below
- **Ocean Explorer**: Sea Floor Mapping
- **Scripps Institute of Oceanography:** Draining the Ocean Basins

ACTIVITY 4.6— Seamounts

One particularly interesting topographical feature on the ocean floor is called a seamount.

Research the exact definition and description of Seamounts HERE.

Select from 5-10 video clips presented on NOAA's "Ocean Exploration Page"

Create a 6-slide, Powerpoint presentation which you will use to convince a room full of prospective investors to support NOAA's continuing exploration of the seafloor. The investors will be listening for:

- Where NOAA intends to explore next?
- Why it is important to the world to fully explore the ocean floor?
- Why seamounts are particularly critical to map and explore?
- What we have already gained from oceanographic exploration?
- What more we have to learn about underwater topography?
- What are the most innovative, state-of-the-art methods for seabed mapping?

📖 **Resource:**

- **Nautilus Live:** Underwater Exploration

ACTIVITY 4.7— Mauna Kea & The Hawaiian Islands

The highest mountain on Earth is actually a seamount—Hawaii's **Mauna Kea**, a dormant volcano that is more than 30,000 feet tall measured from its base on the seafloor 18,000 feet beneath the surface.

Research:

- How did volcanoes shape the Hawaiian Islands?
- Are there other volcanoes in the oceans? And if so, are they active?
- How are they formed?
- How do volcanoes influence the development of geographical features on land?
- How can submarine volcanoes create smoke and fire under water?

- Are there ecosystems of living creatures that thrive by volcanoes?

Watch: 10 Unbelievable Animals That Live Inside Volcanoes

Read: "Life in the Smoke of Underwater Volcanoes."

Critical Thinking:

Hawaiians share a connection to Mauna Kea that is both sacred and genealogically tied to the land. And it is because of this connection that they and others feel a sense of responsibility to care for and protect Mauna Kea from repeated desecration and encroachment by the settler state.

Mauna Kea continues to be the site of seemingly never-ending battles to protect the Hawaiian homeland and what natives continue to be a sacred place.

Research the controversial "Thirty Meter Telescope"- why scientists want to build it on top of the mountain, and why so many native Hawaiians have resisted.

- What are the "prose and cons" of building the telescope on Mauna Kea?
- How is the issue being debated… are all sides being heard?
- What do you think should be done?

ACTIVITY 4.8— Rose Canyon

> **2E. Tectonic activity**, **sea level changes**, and the force of waves influence the physical structure and **landforms of the coast**.

There is a reason why we practice earthquake drills every year in California schools. The California Earthquake Authority released an assessment in 2020 that stated: *"The Rose Canyon Fault is the biggest Earthquake threat to San Diego, capable of earthquake magnitude of 6.9."*

But Rose Canyon is not the only fault line running through the heart of San Diego. It's just one small part of numerous fault systems. The 800-mile long San Andreus fault is another. That's the one that Hollywood makes earthquake movies about.

Nor are fault lines unique to Southern California. In fact, we live in a zone called the **Pacific Ring of Fire,** which wraps around the entire Pacific Ocean and explains how earthquake, tsunami, and volcanic activity is all related-- from La Jolla, to Mt. St. Helens, the Aleutian Islands, Japan, Hawaii, and Mount Ruapehu in New Zealand.

Explain "Plate Tectonics." It sounds complicated, but this lesson provided by National Geographic is an excellent resource:

Plate Tectonics and the Ring of Fire

Learn These Concepts:

geology, geography, seismic, plate tectonics, magma, earth's crust, lava, convergent plate boundary, divergent boundary, transform boundary, subduction zones, volcanic arc, trench, seafloor spreading, rift valley, East Pacific Rise, hot spots, triple junction, cooling ring, submarine volcanoes, hydrothermal vents, seamounts

Research:
- **USGS:** Seafloor Faults off Southern California
- **Mira Costa Community College:** Rose Canyon Fault
- **San Diego County** Video Tour of the Rose Canyon Fault

Take a San Diego Field Trip:

There are numerous locations where students can see the actual evidence of fault lines in San Diego: La Jolla Bay, Tecolote Canyon Park, Torrey Pines State Park, Mt. Soledad, and Faultline Park in East Village, Downtown.

To plan your trip, use this guide by Mira Costa Community College or this Video Tour of the Rose Canyon Fault Line.

Invite a local geologist from UCSD, San Diego State, Scripps, or any number of our community colleges to help explain some of these concepts.

Research the Earthquake Preparedness Plan for your school. Research the Plan for the City.

- Does the plan take the fault zones into account?

ACTIVITY 4.9— Eleven San Diego Watersheds

Definition: A *watershed* is an area of land that drains rainfall and snowmelt into streams and rivers.

While some watersheds are relatively small, others encompass thousands of square

miles and may contain streams, rivers, lakes, reservoirs, and underlying groundwater that are hundreds of miles inland.

• San Diego features 11 watersheds. You can find them on this map.
• Look at the watershed where you live. Can you identify major bodies of water within that watershed?
• Pick out a few more watersheds and identify the bodies of water within each.
• The southernmost watershed in San Diego County is the Tijuana Watershed which actually includes some land within Mexico.

Critical Thinking: Why is it important to keep plastic, poisons and litter out of our watersheds?

ACTIVITY 4.10— Toxic Water: The Tijuana River Crisis

"90% of all pollution is discharged by industry and municipal wastewater treatment systems. Very few effluent treatment systems have the systems to remove micro-plastics and most of the toxic chemicals such as organic tin, PCBs, PBDE, mercury and oxybenzone. The plastic and associate toxins are killing the oceans." – Global Oceanic Environmental Survey (GOES)

The Tijuana River flows intermittently for some 120 miles on both sides of the border. It winds through the easternmost regions of San Diego County, down through the city of Tijuana, then turns up through the Tijuana River Valley just south of Imperial Beach and flows into the Pacific Ocean. The movement of water across an international border is referred to as a *transboundary flow*.

Locate the Tijuana River on this map.

The problem is, the Tijuana River carries raw sewage and waste from Tijuana into the US, where it is then discharged into American waters. According to the *Environmental Protection Agency*, contaminated flows from Mexico enter the U.S. and create significant negative impacts to water quality, public health, and the environment.

Surfrider Video: Tijuana River: The Largest Sewage Spill We Have Ever Seen