Build Your Own AR Sandbox!

Use an Augmented Reality sandbox to help students understand a gamut of earth science processes.

This lesson was developed for Ocean Exploration Trust in collaboration with [Dieuwertje 'DJ' Kast](#).

THE BASICS

The augmented reality (AR) sandbox project combines 3D visualization applications with a hands-on sandbox exhibit to teach earth science concepts. Simply mold the sand by hand and the landscape comes to life! The sand is augmented in real-time with an elevation color map, topographic contour lines, and simulated water. Designed by researchers at UC Davis, the hands-on exhibit allows learners to physically explore topographic and bathymetric concepts, relationships, and visualize the processes that result from manipulating the sand.

Build your own 3D Sandbox using these instructions: https://arsandbox.ucdavis.edu/instructions/.

At a deep sea science workshop, students learned about topography and geological formations above sea level, as well as how sonar reveals seafloor bathymetry. Image and workshop by USC Young Scientists Program led by Science Communication Fellow Dieuwertje Kast.

Learn more about the AR Sandbox teaching tool's development: https://arsandbox.ucdavis.edu/.

<u>What is AR?</u>

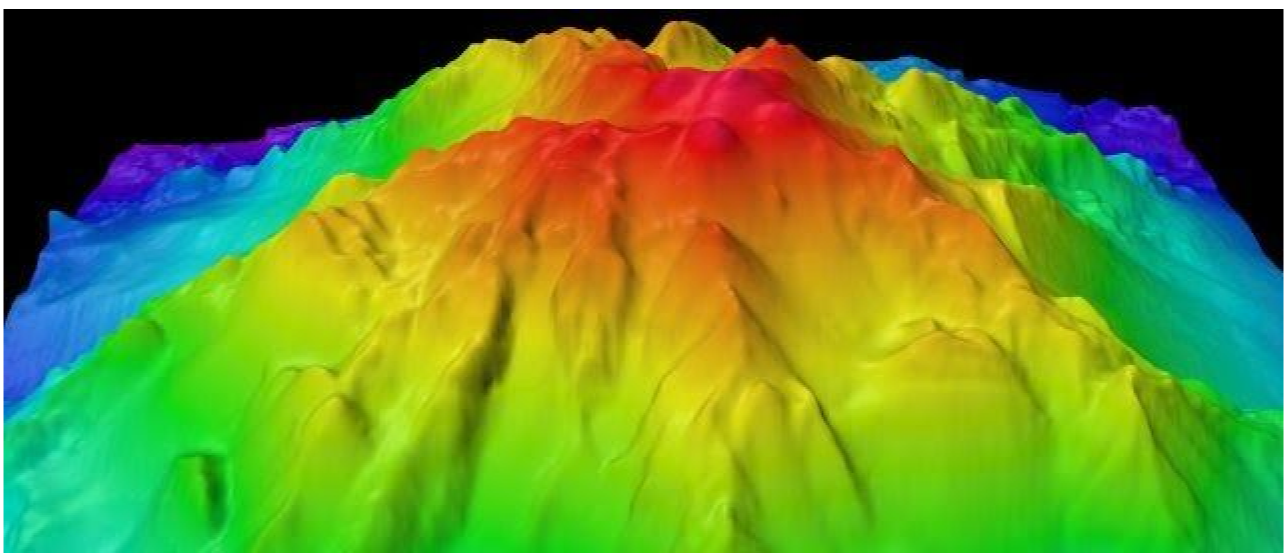
“Augmented reality (AR) is a live direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data. With the help of advanced AR technology the information about the surrounding real world of the user becomes interactive and digitally manipulable” (source: Graham, M., Zook, M., and Boulton, A. "*Augmented reality in urban places: contested content and the duplicity of code.*" Transactions of the Institute of British Geographers).

USC Young Scientists Program Intern Bob Steenhuis teaches high school students using the model in Los Angeles. Deezmakers AR Sandbox built with a Xbox-360™ Kinect and projector. Photo courtesy of Dieuwertje Kast.

SEAFLOOR MAPPING & BATHYMETRY CONNECTIONS

How are bathymetry and topography similar and different?

Topography is the arrangement of the natural and artificial physical features of an area of land. It is the sum shape of the slopes, dips, and plains that make up a landscape. Bathymetry is determined from data derived from the measurement of ocean depths. Beneath the surface of the ocean, the seafloor is not flat. The largest mountains on Earth are found underwater, along with trenches, abyssal hills, and vast basins. Bathymetry is both the measurement of these landscapes and the compiled topographic shape resulting from depth data collected by mapping systems mounted to the hulls of ships and specially outfitted vehicles. Exploration Vessel (E/V) *Nautilus* utilizes a state-of-the-art multibeam sonar mapping system to collect data of the seafloor.



Bathymetry image processed with QPS Maritime Solutions software. This image of a seamount off the coast of Mexico is a composite of thousands of individual depth measurements from E/V Nautilus. The spectrum of colors represents variation in ocean depth. This underwater mountain is artificially colored so red represents the shallow peak and purple represents the deepest depths.

How is bathymetry collected?

Mounted on the hull of *Nautilus,* the multibeam echosounder transducer emits two pulses of sound (or "pings") that travel to the seafloor. As the pulses bounce off the seafloor and travel back up to the receiving array, the distance from the hull to the seafloor can be calculated from the sound's travel time and the speed of sound through water. Unlike early acoustic mapping systems that emitted a single beam of sound to the seafloor and only returned one sounding (e.g. one depth measurement per ping), the multibeam sonar emits two fans of beams, resulting in a wider "swath width" with up to 864 soundings per ping!

Learn more about using multibeam sonar as a tool for exploration:
https://nautiluslive.org/blog/2016/09/08/more-just-bathymetry-seafloor-mapping-tool-exploration

Learn more about mapping technology and terms:
https://nautiluslive.org/blog/2017/10/12/read-rainbow-seafloor-mapping-glossary.

BUILD THESE SEAFLOOR SCENES

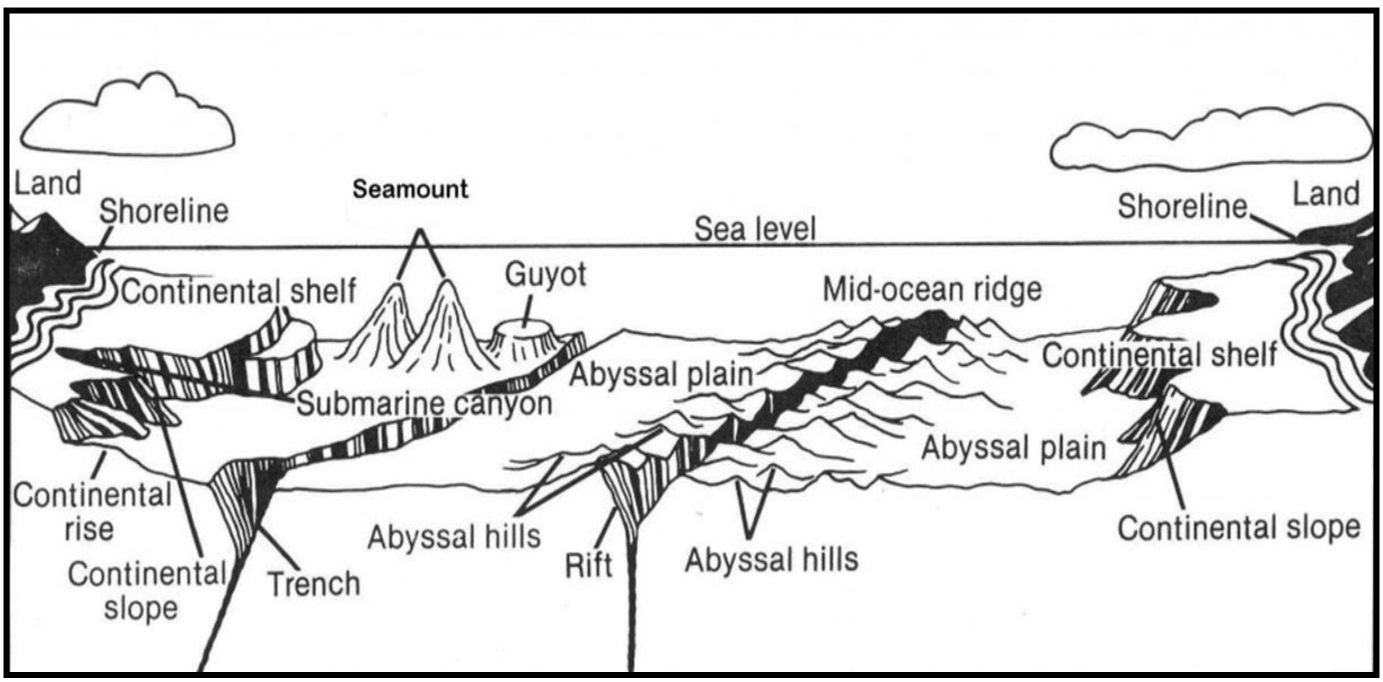


Image courtesy of slideplayer.com

Use the image as a guideline for modeling these features in your AR sandbox.

Research the seafloor structures below. Use this space to describe how each feature forms and its unique characteristics:

Continental shelf:

Abyssal hills:

Seamount chain:

Continental slope:

Submarine canyon:

Guyot**:**

Mid-ocean ridge:

Rift valley:

Abyssal plain:

NGSS Lesson Standards:

- 4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. [Clarification Statement: Examples of evidence from patterns could include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and, a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.]
    - [Assessment Boundary: Assessment does not include specific knowledge of the mechanism of a rock formation or memorization of specific rock formations and layers. Assessment is limited to relative time.]
- 4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. [Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.]
    - [Assessment Boundary: Assessment is limited to a single form of weathering or erosion.]
- 4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features.
    - [Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.]
- 4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.* [Clarification Statement: Examples of solutions could include designing an earthquake-resistant building and improving monitoring of volcanic activity.]
    - [Assessment Boundary: Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.]

Share your mapping sandbox activities and feedback with Ocean Exploration Trust at education@oet.org!