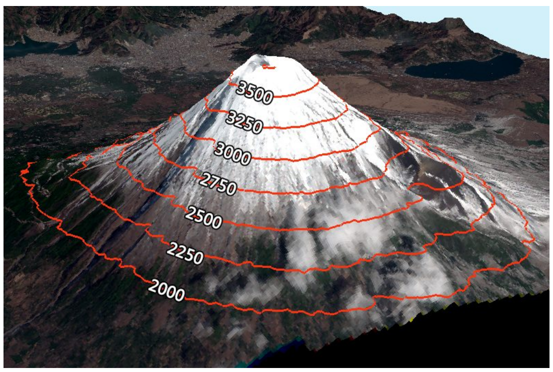
Identifying Plate Boundaries, by Alyssa Abbey, Mike Phillips, Liang Zeng. *In Development from EER2020 "Creating Inquiry Labs" Workshop, August 2020* (Group 15 PlateTectsF2F).

Topography

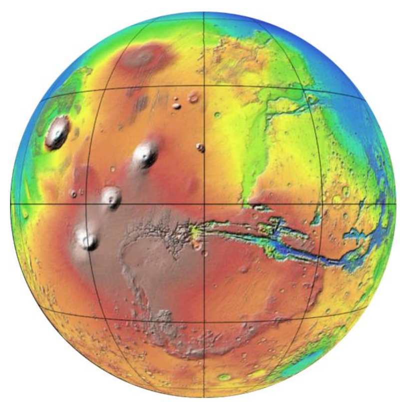
Topography and slope describe the shape and relief of the landscape. For example, topography refers to mountains, valleys, rivers or craters on the surface. The word origin for topography comes from "topo" for "place" and "graphia" for "writing" and represents a measurement of elevation while slope refers to the percent change in that elevation over a certain distance. For example, to calculate slope we take the difference in elevation from one point to another and divide by the lateral distance between those two points. Understanding topography and slope in a region is important to minimize risks from natural hazards such as flooding and landslides, reduce construction costs, and determine the impact of development on natural resources like soils, vegetation, and water systems. [1,2]



Contour lines (isolines) connect points of equal elevation. By reading contours, we interpret height, slope and shape in topographic maps. If contours are close together, the slope is steep. But when contours are spread apart, the slope is more gradual. We use contours for mountains, valleys and bathymetry. For example, Mount Fuji stands at 3,776 meters above sea level. At 250-meter spacing, each contour line represents equal elevations. Almost at the peak of Mount Fuji, it's a 3,750 meter contour line.

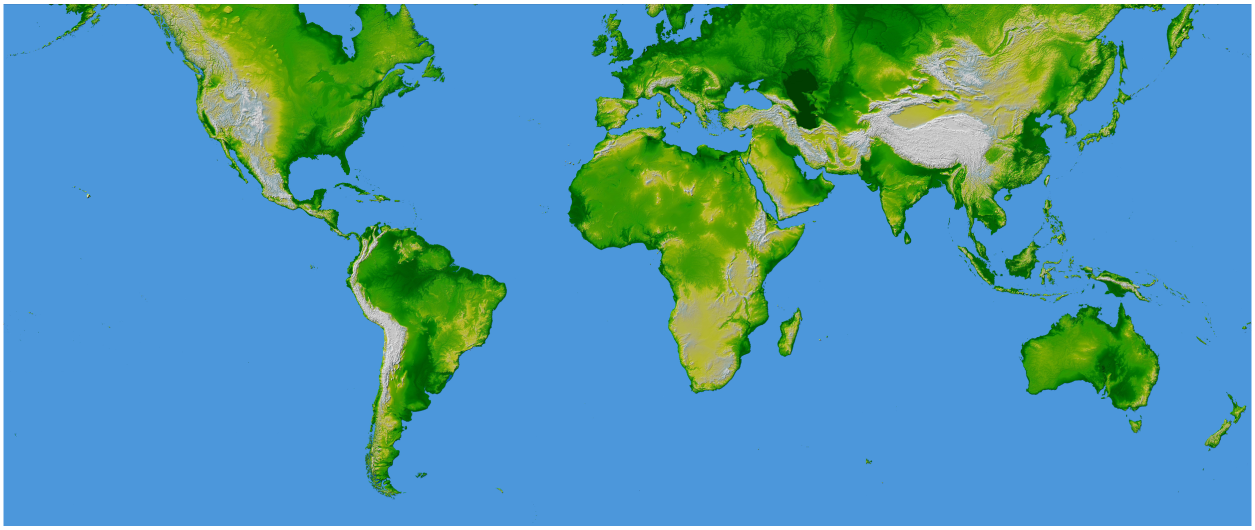
Topographic maps show how rivers flow, how high mountains rise and how steep valleys descend.

- Engineers use topographic maps to plan roads, construct cell towers or plan hydroelectric dams.
- Geologists use topography to understand tectonic activity, landforms, and where to dig mines.
- Hikers use topographic maps to find trails and steepness of slope to plan their ascent.
- Astronomers study the topography outside Earth like on the moon, Mars (topography of mars in image to the right), or an asteroid.
- Climate scientists tie topography into climate models to recognize air and water flow. [2]



Continental Topography

In 1596, Flemish mapmaker Abraham Ortelius noted that the coastlines of the continents appear to fit together. He suggested that the continents were once joined and that the Americas were "torn away" from Europe and Africa. Over 300 years later this idea was picked up again by German meteorologist and geophysicist Alfred Wegener who proposed in 1912 that the continents were once joined in a supercontinent called Pangea. Wegener believed that Pangea's constituent portions moved thousands of miles apart over long periods of geologic time, a phenomenon he called "continental displacement" (now known as continental drift). Until the 1950s and '60s, however, his idea was rejected by most geologists because he could not describe the driving forces behind continental drift. It wasn't until we were able to study the topography of the ocean floor (bathymetry) that we began to accept this idea of continental movement.



Elevation scale moves from dark green to yellow to white: Low elevations are the darkest greens and high elevation are white.
This image of the world was generated with data from the Shuttle Radar Topography Mission (SRTM). This image was created from that data set and shows the world between 60 degrees south and 60 degrees north latitude, covering 80% of the Earth's land mass. [3]

Ocean Floor Topography

Shortly after the conclusion of World War II, sonar-equipped vessels crisscrossed the oceans collecting ocean-depth profiles of the seafloor beneath them. The survey data was used to create three-dimensional relief maps of the ocean floor, and, by 1953, American oceanic cartographer Marie Tharp had created the first of several maps that revealed the presence of an underwater mountain range more than 16,000 km (10,000 miles) long in the Atlantic—the Mid-Atlantic Ridge.

In 1960, American geophysicist Harry H. Hess used Tharp's maps to develop the idea that that molten material from Earth's mantle continuously wells up along the crests of the mid-ocean ridges, which then cools, forming oceanic-crust that spreads out laterally away from the ridges. This spreading creates a successively younger ocean floor, and the flow of material is thought to bring about the migration, or drifting apart, of the continents. The following year, geophysicist Robert S. Dietz named the phenomenon seafloor spreading.

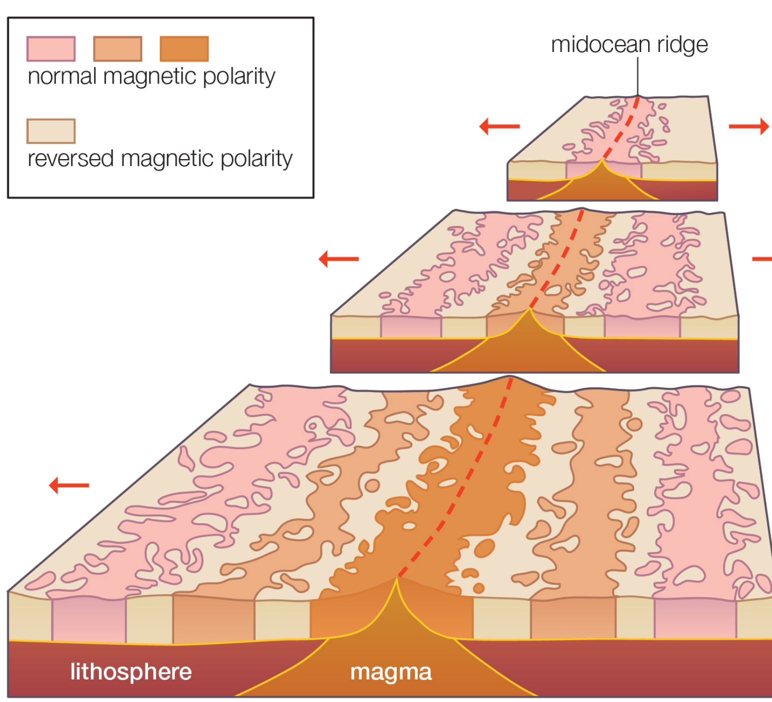
Continued survey and probe studies of the ocean floor provided more evidence supporting the seafloor spreading hypothesis. Studies conducted with thermal probes, for example, indicate that the heat flow through bottom sediments is generally comparable to that through the continents except over the mid-ocean ridges, where at some sites the heat flow measures three to four times the normal value. The anomalously high values are considered to reflect the intrusion of molten material near the crests of the ridges. Research has also revealed that the ridge crests are characterized by anomalously low seismic wave velocities, which can be attributed to thermal expansion and microfracturing associated with the upwelling magma.[4]

The age of the Ocean Floor

In 1968, The vessel Glomar Challenger set sail on an exploration of the mid-ocean ridge between South America and Africa. Core samples obtained from drilling revealed that rocks close to the mid-ocean-ridges are younger than rocks that are farther away from the ridges. Measurements of the thickness of marine sediments and absolute age determinations of such bottom material have provided additional evidence for seafloor spreading. The oldest sediments so far recovered by a variety of methods—including coring, dredging, and deep-sea drilling—date only to the Jurassic Period, not exceeding about 200 million years in age. Such findings are incompatible with the doctrine of the permanency of the ocean basins that had prevailed among Earth scientists for so many years.

Magnetic Anomalies

1963 British geologists Frederick J. Vine and Drummond H. Matthews—as well as Canadian geophysicist Laurence W. Morley, who worked independently of the others—postulated that new crust formed at mid-ocean-ridges would have a magnetization aligned with Earth's geomagnetic field. They noted that this would appear over geologic time as bands of crust that exhibit alternating patterns of magnetic polarity. The idea was that rising magma assumes the polarity of Earth's geomagnetic field before it solidifies into oceanic crust. At spreading centres, this crust is separated into parallel bands of rock by successive waves of emergent magma. When Earth's geomagnetic field undergoes a reversal, the change in polarity is recorded in the magma, which contributes to the alternating pattern of magnetic striping on the seafloor. Investigations of oceanic magnetic anomalies have further corroborated the seafloor spreading hypothesis. Such studies have shown that the strength of the geomagnetic field is alternately anomalously high and low with increasing distance away from the axis of the mid-ocean ridge system. The anomalous features are nearly symmetrically arranged on both sides of the axis and parallel the axis, creating bands of parallel anomalies.



References

[1] https://tompkinscountyny.gov/files2/planning/nri/land_resources.pdf accessed August 2, 2020
[2] https://gisgeography.com/what-is-topography/ accessed August 2, 2020
[3] https://earthobservatory.nasa.gov/images/3741/topography-of-the-world accessed August 2, 2020
[4] https://www.britannica.com/science/seafloor-spreading accessed July 20, 2020