

STAAR Science Tutorial 34 TEK 8.9C: Topographic Maps & Erosional Landforms

TEK 8.9C: Interpret topographic maps and satellite views to identify land and erosional features and predict how these features may be reshaped by weathering.

Topography and Landforms

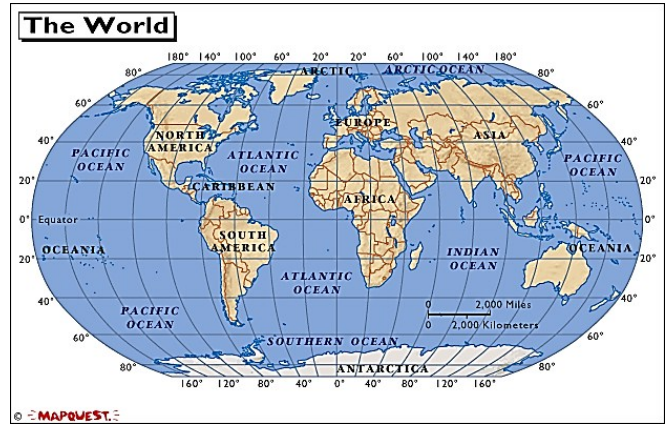
- **Topography** is a description of all of the physical features (landforms) of a particular area of land, such as mountains, hills, canyons and valleys. It is also the name given to the scientific study of these landforms.
- A **mountain** is a steep-sided landform rising above the surrounding land, usually forming a peak at its highest point. In the U.S., landforms called "mountains" usually rise over 1000 ft. (300 m) the surrounding land, and **hills** rise less than 1000 ft. A large, flat-topped area rising above the surrounding region is called a **plateau**. A smaller flat-topped mountain or hill is called a **mesa**.
- A **valley** is long depressed area through which a river flows. The upper end of long river valleys often form **V-shaped canyons** with steep sides. The middle section of a valley is generally wider and less deep, and may have **step-like terraces** parallel to the river. The lower end of river valleys are very flat and wide, with **natural levees**, **meander bends** and **oxbow lakes**. When a river flows into a large lake or ocean, it forms a **delta**.

Maps

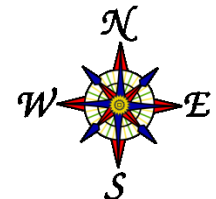
- A **map** is a flat model of all or part of the Earth's three-dimensional surface, scaled-down (made smaller than reality) and flattened (made two-dimensional or flat) to fit on a conveniently-sized page. To make a flat representation, the map maker usually starts with a photograph looking straight down from a satellite or airplane. Shown below is a satellite image and map of Washington, DC.



- If the map is of a small area, very little distortion of land shape and size occurs when the actual landforms are “flattened” for the map. In maps covering large areas, such as maps of whole countries or continents, or even of the entire surface of Earth, significant distortions of shape and size are created by the “projection” method, when the spherical surface of earth is stretched or cut apart and flattened. Many global projections make areas close to the North and South Pole (e.g., Alaska or Antarctica) seem much bigger than they actually are. For example, compare the map of Antarctica with a “polar projection” (on the left) and a world map centered on the equator with polar areas stretched (on the right, below). The polar projection of Antarctica is more accurate in shape and size than the equatorial projection of the world map.



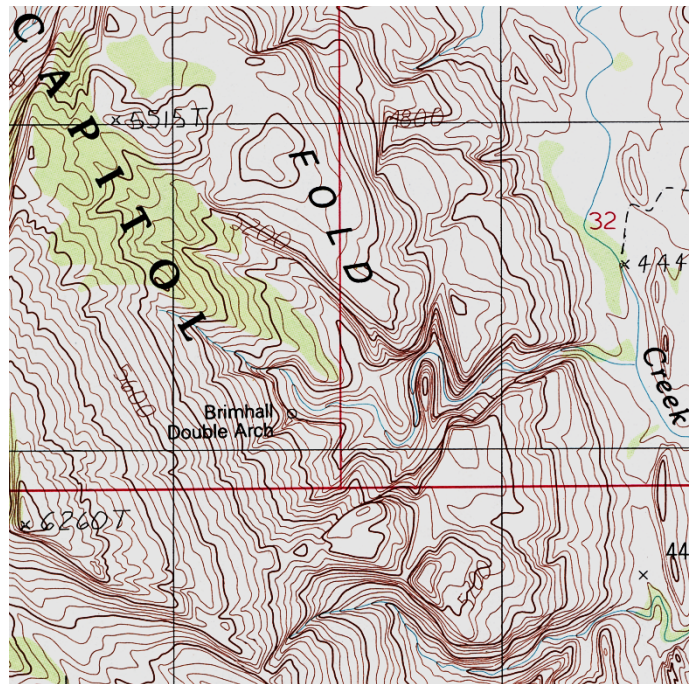
- All maps, including topographic maps, should include a **scale**, while gives the actual horizontal distance on the ground that is represented by a unit of distance on the map. Scales are usually stated in two ways: as a ratio between the size on the map and size in reality (e.g., 1:62,500), meaning that one unit on the map equals 62,500 units on the ground; and as a map unit to ground unit conversion factor (e.g., 1" = 1 mile), meaning that one inch on the map equals one mile on the ground.
- All maps include a compass rose, indicating the orientation of the map to actual directions on Earth. Most maps have north at the top of the page and south at the bottom, with east on the right and west on the left.
- All maps use **symbols** or color shading to show various natural or human-created features, such as rivers, lakes, roads and cities. A key to the symbols used on a map is usually included in or near the map’s title block. Small-scale maps showing large areas typically show only major features, such as the largest cities or biggest lakes. Large-scale maps showing small areas include more features. On color maps, water features are typically blue. On non-topographic maps, major mountains may be indicated only with a “X” labeled with name and the peak elevation.
- Locations on maps are usually identified by a grid of latitude and longitude lines. **Latitude** lines run from west to east, each parallel to the equator (which is 0 degrees latitude), and each representing a certain number of degrees north or



south of the equator in degrees of arc. The North Pole is found at 90 degrees north latitude and the South Pole at 90 degrees south latitude. **Longitude** lines run from north to south, pole to pole, and are not parallel to one another, because they converge at the poles, and are farthest apart at the equator. Again, they are numbered in degrees of arc, starting with the Prime Meridian (0 degrees longitude, which passes near London, England in Europe), numbered both in degrees east and west from the prime meridian. The lines are both measured in degrees of angle, with 90 degrees representing one quarter of a circle. Parts of a degree are represented in "minutes" and "seconds", here not units of time, but parts of a degree: there are 60 minutes in one degree of arc, and 60 seconds in one minute of arc.

Topographic Maps

- A **topographic map** is a map on which information about vertical elevation above sea level is represented, either by color shading to represent approximate elevation, or by use of contour lines. Color coding is usually only found on maps of large areas such as countries or continents, while contour lines are used on detailed maps of smaller areas. An example of a topographic map is shown to the right



- **Elevation**, as shown on a topographic map, is the actual vertical distance from average (mean) sea level to a particular point on land represented on the map. On maps made in the United States, elevation is usually stated in feet above (or below) mean sea level. Elevation is stated in meters above or below mean sea level in all other countries. The elevation of Carrollton, Texas is about 700 feet (220 meters above sea level)
- A **contour line** is a line on a topographic map connecting all points with the same elevation. For example, the line on a map representing the water's edge of a lake would be a contour line, because all points along the lake shore would have the same elevation. While a contour line can be drawn at any elevation, most contour lines on topographic maps are spaced at equal intervals of elevation, called the contour interval.
- The **contour interval** of a topographic map is the change in elevation represented by each successive contour line. In areas with little elevation change, the contour interval might be as small as one or two meters (or five feet in the U.S.). In mountainous areas, the contour interval might be as large as 10 or 20 meters (or 50 feet in the U.S.). The contour interval of a topographic map is usually stated in

the title and scale block on the map, or it can be determined from the index contours.

- On maps where the contours are crowded close together, not every contour line will be labeled with its elevation. It is typical for every fifth contour, called the **index contour**, to be labeled with the elevation that the contour line represents, and to be drawn with a heavier line. If every fifth contour is labeled, the contour interval can be found by dividing the difference between two adjacent index contours by five.
- Topographic maps typically come in three standard **scales**, each with a different amount of detail and scale. In the United States, the three scales are a: (1) 1:250,000 ratio, covering 1 degree of latitude by 2 degrees of longitude, with a scale of one inch equaling 4 miles; (2) a 1:62,500 ratio, covering a "15-minute" square (1/4 degree x 1/4 degree) area, with a scale of one inch on the map equaling one mile on the ground, and a (3) 1:24,000 ratio, covering a "7.5 minute" (1/8 degree x 1/8 degree) area with a scale of 2.4 inches on the map for every mile on the ground.
- A **ridge** on a topographic map is represented by a series of v-shaped contour lines pointing towards lower elevations. A **valley** on a topographic map is represented by a series of v-shaped contour lines pointing towards higher elevations. The closer the contour lines on the map are to one another, the steeper the slope of the ridge or valley. When the slope of a mountain or valley is completely vertical (straight up-and-down), forming a cliff, the contour lines are crowded together to form a single line.

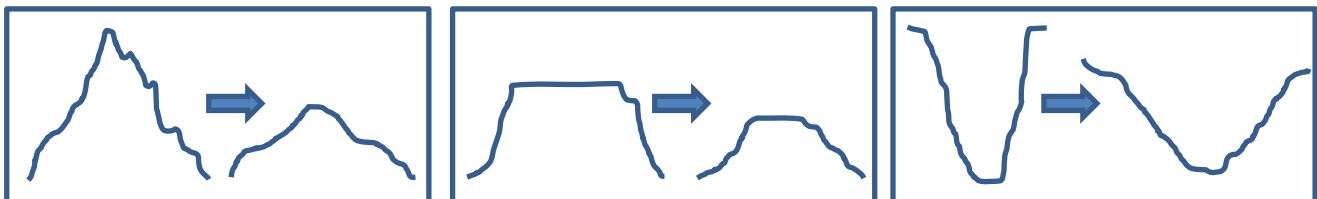
Weathering, Erosion and Deposition

- **Weathering** is the process that breaks down solid rock into smaller pieces of rock such as gravel, and eventually into even smaller particles such as sand, silt and clay. The product of the weathering process is called **sediment**. The weathering process can either occur **mechanically** or **chemically**. The mechanical weathering processes include abrasion, freeze-thaw wedging, pressure release, plant growth and animal actions. Abrasion is aided by the force of moving water in a river or a blowing wind, carrying small sharp sediment particles that wear down the solid rock it flows over. The chemical weathering agents include oxygen (oxidation reactions), acid rain caused by human-created pollution, naturally acidic rain caused by carbon dioxide dissolving in rainwater, acids secreted by plants, and water (dissolving minerals in the rock).
- Weathering is usually a slow process, but whole mountains can be reduced to hills and even level plains by weathering and erosion occurring over millions of years.
- Erosion is the process of moving sediment from one location to another. Erosional agents include moving water, wind, gravity, and glacial action. Moving water, as in streams, rivers and ocean waves, is by far the strongest agent of erosion. The wind is generally the weakest agent of erosion, except in desert areas with little plant cover to hold the soil. In all cases, solid rock high on a mountain becomes sediment at the bottom of the mountain or at the end of a river.

- Deposition is the placement of the sediment created by weathering and moved by erosion. The present deposition of sediment is often temporary—future erosion is likely to move the sediment again and deposit it in another location. The bottom of valleys are filled by erosion and deposition, and where a river enters a large body of water, the sediment is deposited into a delta.

Predicting Future Landforms

- Over time, landforms such as mountains can be built up by tectonic or volcanic forces, or worn down by weathering and erosional forces. If a question on the STAAR test asks for a prediction about the shape of future landforms, it must first give you clues about which processes (tectonic or erosional) are active in the area.
- The phrases “geologically active”, “volcanically active”, “uplift”, “compressive forces”, “convergent boundary”, “folding”, “fault-block mountains” and “upwarping” all suggest that mountain building processes are at work, and that over long spans of time the present elevations of mountains are likely to grow higher. The Himalaya Mountains in Asia, and the San Gabriel Mountains in California are both examples of mountains that are still growing because of compressional forces created by convergent plate boundaries.
- If the description suggests that a divergent boundary on land is active, or that the question concerns a “rift valley,” you should expect the valley to widen and eventually fill with water.
- The phrases “geologically stable,” “weathered,” “landslide,” “slump”, “creep”, “ice-wedging”, “freeze-thaw,” “abrasion”, and “eroded” all suggest that the primary forces at work are weathering and erosion, and that over time elevations of mountain peaks are likely to lower, valleys are likely to fill in with sediment, raising their bottom elevations, canyons are likely to widen, and the shape of mountains generally will become lower and smoother. Before and after profiles of mountain, mesa and canyon landforms are shown below, assuming only weathering and erosional forces over long time periods.



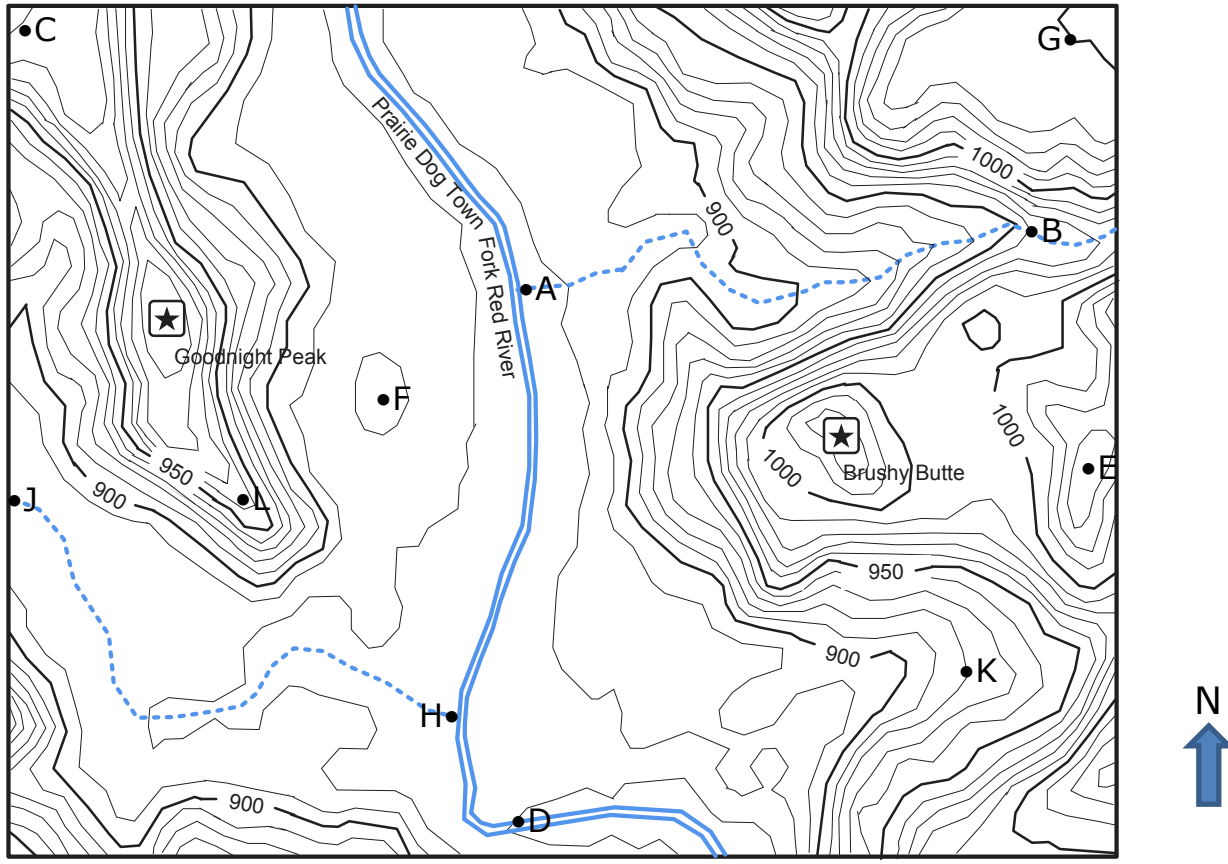
- One exception where weathering and erosional forces make a mountain have a sharper or more angular profile is glacial carving, which makes the mountain peaks very pointed (a “horn”), a ridge between two valley knife-edged and sharp (an “arête”), and a valley on the side of a peak very steep sided (a “cirque”).
- In an area that is being uplifted by tectonic forces, river valleys tend to become deeper. The Grand Canyon was created because the Colorado River cut down into the rock as the rock (the Colorado Plateau) was being uplifted. The canyon also grew wider over time, due to the erosional forces working on the canyon edges.

Practice Questions

1. What information is included on topographic maps that is not included on other maps? _____
2. A _____ is a line on a topographic map connecting all points with the same elevation.
3. The _____ of a topographic map is the change in elevation represented by each successive contour line.
4. An _____ is a thicker contour line labeled with the elevation of that line, usually placed at every fifth contour for reference.
5. To find the contour interval of a topographic map, assuming that every fifth contour line is an index contour, divide the difference between adjacent index contours by _____.
6. On a topographic map, when the contour lines form a "V" pointing uphill, usually with a line representing a creek or river at the center of the "V", it indicates a _____.
7. On a topographic map, when the contour lines form a "V" pointing downhill, it indicates a _____.
8. A _____ is indicated by an "x" labeled with an elevation, surrounded by a series of circular contour lines forming a "bulls-eye" pattern.
9. Draw a before and after profile of a mountain, showing erosion over a long period of time.

10. Draw a before and after profile of a canyon or deep valley, showing erosion over a long period of time.

Use the following topographic map from Palo Duro Canyon State Park in west Texas to answer questions 11 - 35.



Contour Interval = 10 meters 

11. What is the elevation of Goodnight Peak? _____
12. What is the elevation of Brushy Butte? _____
13. What is the elevation of point A? _____
14. What is the elevation of point B? _____
15. If you walked along the creek from point A to point B, what would be the total change in elevation? _____ In what direction would you be walking? _____
16. What is the elevation of point C? _____
17. What is the elevation of point D? _____
18. What is the elevation of point E? _____
19. What is the elevation of point F? _____

20. What is the elevation of point G? _____
21. What is the elevation of point H? _____
22. What is the elevation of point J? _____
23. If you walked along the creek from point H to point J, what would be the total change in elevation? _____ In what direction would you be walking? _____
24. What is the lowest labeled point on the map? _____
25. What is the highest labeled point on the map? _____
26. In what direction is the river at the center of the map flowing? _____
27. Put a small star on the map where the slope is the steepest.
28. Put a small triangle on the map where the slope is the flattest.
29. Is point K in a valley or a ridge? _____
30. Is point L in a valley or a ridge? _____
31. What is the distance from point A to point F, to the nearest tenth of a kilometer?

32. What is the distance from point H to point D, to the nearest tenth of a kilometer? _____
33. What is the distance from point B to point E, to the nearest tenth of a kilometer? _____
34. What is the distance from Goodnight Peak to point L, to the nearest tenth of a kilometer? _____
35. If you could travel in time and visit the park shown on the map 100,000 years in the future, what changes do you think will have taken place to the elevations of Goodnight Peak and Brushy Butte? Explain your answer. _____

