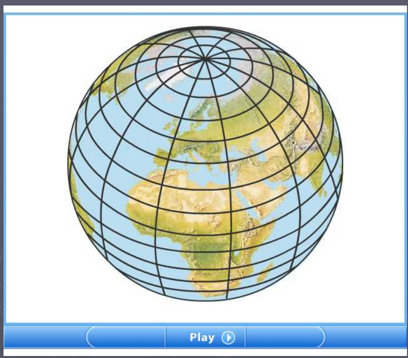
Chapter 3
Models of the Earth

3.1 Finding Locations on the Earth

3.1 Objectives

- Explain latitude and longitude.
- How can latitude and longitude be used to find locations on Earth?
- How can a magnetic compass be used to find directions on Earth.

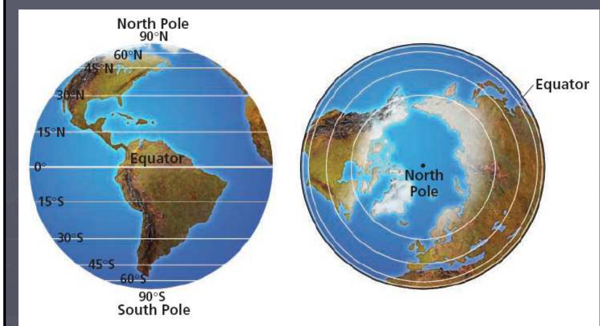
Latitude & Longitude



Latitude

- One set of circles describes positions north and south of the equator. These circles are known as parallels, and they express latitude.
- **parallel** any circle that runs east and west around Earth and that is parallel to the equator; a line of latitude
- **latitude** the angular distance north or south from the equator; expressed in degrees

The diagram below shows Earth's parallels.



Measuring Latitude

Degrees of Latitude

- Latitude is measured in degrees, and the equator is 0° latitude. The latitude of both the North Pole and the South Pole is 90°.
- In actual distance, 1° latitude equals about 111 km.

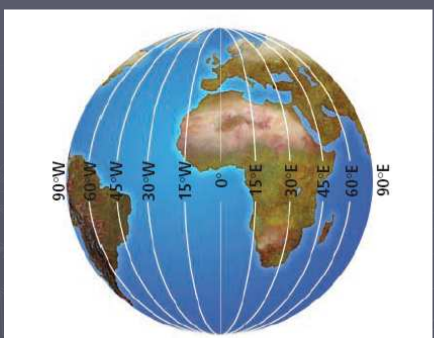
Minutes and Seconds

- Each degree of latitude consists of 60 equal parts, called *minutes*. One minute (symbol: °) of latitude equals 1.85 km.
- In turn, each minute is divided into 60 equal parts, called *seconds* (symbol: °).

Longitude

- East-west locations are established by using meridians.
- **meridian** any semicircle that runs north and south around Earth from the geographic North Pole to the geographic South Pole; a line of longitude
- **longitude** the angular distance east or west from the prime meridian; expressed in degrees

The diagram below shows Earth's meridians.



Measuring Longitude

Degrees of Longitude

- The meridian that passes through Greenwich, England is called the *prime meridian*. This meridian represents 0° longitude.
- The meridian opposite the prime meridian, halfway around the world, is labeled 180°, and is called the *International Date Line*.

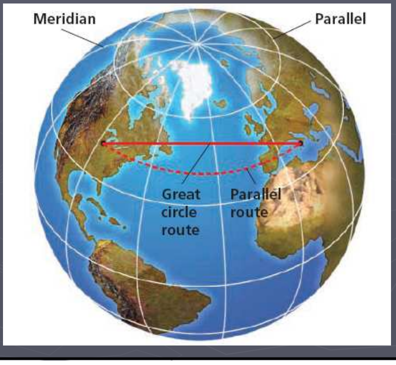
Distance Between Meridians

- The distance covered by a degree of longitude depends on where the degree is measured. The distance measured by a degree of longitude decreases as you move from the equator toward the poles.

Great Circles

- A great circle is any circle that divides the globe into halves, or marks the circumference of the globe.
- Any circle formed by two meridians of longitude that are directly across the globe from each other is a great circle.
- The equator is the only line of latitude that is a great circle.
- The route along a great circle is the shortest distance between two points on a sphere. As a result, great circles are commonly used in navigation, such as for air and sea routes.

The diagram below shows what a great circle is.



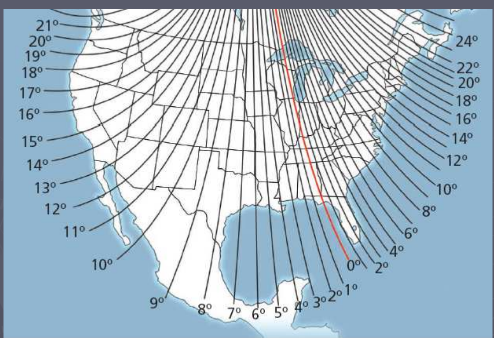
Finding Direction

- One way to find direction on Earth is to use a magnetic compass.
- A magnetic compass can indicate direction because Earth has magnetic properties as if a powerful bar-shaped magnet were buried at Earth's center at an angle to Earth's axis of rotation.
- The areas on Earth's surface just above where the poles of the imaginary magnet would be are called the *geomagnetic poles.*
- The geomagnetic poles and the geographic poles are located in different places.

Magnetic Declination

- The angle between the direction of the geographic pole and the direction in which the compass needle points is called **magnetic declination**.
- In the Northern Hemisphere, magnetic declination is measured in degrees east or west of the geographic North Pole.
- By using magnetic declination, a person can use a compass to determine geographic north for any place on Earth.
- **true north** is the direction of the geographic North Pole.

Magnetic Declination



Global Positioning System

- Another way people can find their location on Earth is by using the global positioning system, or GPS.
- GPS is a satellite navigation system that is based on a global network of 24 satellites that transmit radio signals to Earth's surface.
- A GPS receiver held by a person on the ground receives signals from three satellites to calculate the latitude, longitude, and altitude of the receiver on Earth.

3.2 Mapping the Earth's Surface

3.2 Objectives

- What are the characteristics AND uses of 3 types of map projections?
- What is scale, and how can scale be used to find distance on a map?

Maps

- Globes are too small to show details of Earth's surface, such as streams and highways, so a great variety of maps have been developed for studying and displaying detailed information about Earth.
- The science of making maps is called **cartography**. Scientists who make maps are called *cartographers*.
- Because a map is a flat representation of a globe, flat maps have distortion.
- Distortion = errors in size, distance, and/or direction.

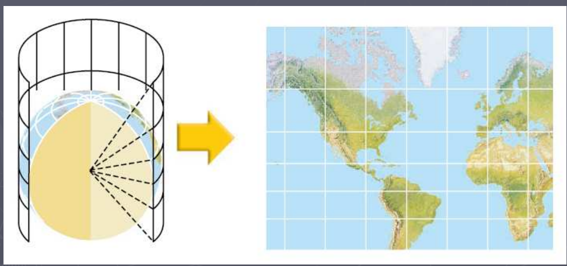
Map Projections

- A map is a flat representation of Earth's curved surface.
- Transferring a curved surface to a flat map results in a distorted image of the curved surface. An area shown on a map may be distorted in size, shape, distance, or direction.
- Over the years, cartographers have developed several ways to transfer the curved surface of Earth onto flat maps. These methods are called *map projections*.
- **map projection** a flat map that represents a spherical surface
- No map projection is entirely accurate, but each kind of projection has advantages and disadvantages.

Mercator Projection

- If you wrapped a cylinder of paper around a lighted globe and traced the outlines of continents, oceans, parallels, and meridians, a **Mercator projection** would result.
- A Mercator projection is accurate near the equator but distorts distances and sizes near the poles.
- One advantage to Mercator projections is that parallels and meridians form a grid, which makes locating positions easier.
- On a cylindrical projection, shapes of small areas are usually well preserved.

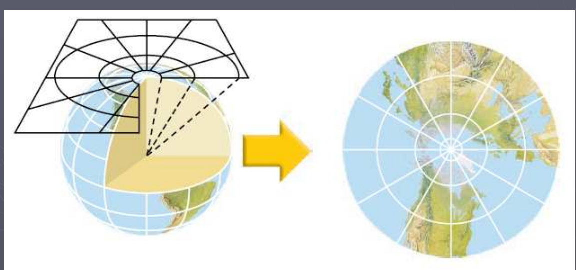
Mercator Projection



Gnomonic Projection

- A projection made by placing a sheet of paper against a globe such that the paper touches the globe at only one point is called an **Gnomonic projection**.
- On an Gnomonic projection, little distortion occurs at a the point of contact, but the unequal spacing between parallels causes a distortion in both direction and distance that increases as distance from the point of contact increases.
- One advantage of Gnomonic projections is that on these maps, great circles appear as straight lines. Thus, Gnomonic projections are useful for plotting navigational paths.

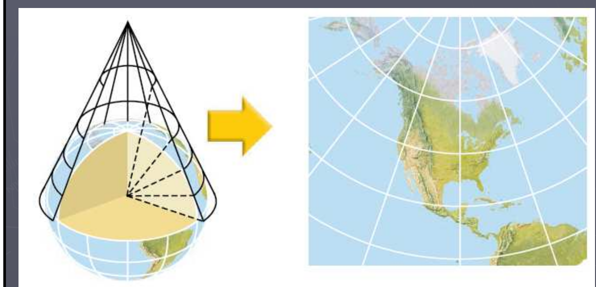
Gnomonic Projection



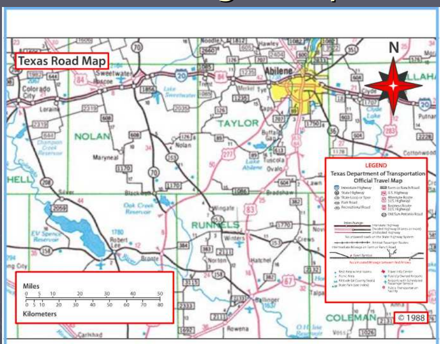
Conic Projection

- A projection made by placing a paper cone over a lighted globe so that the axis of the cone aligns with the axis of the globe is known as a **conic projection**.
- Areas near the parallel where the cone and the globe are in contact are distorted least.
- A series of conic projections can be used to increase accuracy by mapping a number of neighboring areas and fitting the adjoining areas together to make a **polyconic projection**.
- On a polyconic projection, the relative sizes and shapes of small areas on the map are nearly the same as those on the globe.

Conic Projection



Reading a Map



Rollover the image to learn more.

Reading a Map - Symbols

- Symbols are commonly used on maps to represent features such as cities, highways, rivers, and other points of interest.
- Symbols may resemble the features that they represent, or they may be more abstract.
- Symbols are commonly explained in a legend.
- **legend** a list of map symbols and their meanings

Reading a Map - Direction

- Maps are commonly drawn with north at the top, east at the right, west at the left, and south at the bottom.
- Some maps use parallels of latitude and meridians of longitude to indicate direction and location.
- Many maps also include a compass rose, which is a symbol that indicates the cardinal directions (north, east, south, and west), or an arrow that indicates north.

Map Scale

- **scale** the relationship between the distance shown on a map and the actual distance
- Map scales are commonly expressed as graphic scales, fractional scales, or verbal scales.
- A graphic scale is a printed line that has markings that represent units of measure, such as meters or kilometers.
- A fractional scale is a ratio that indicates how distance on Earth relates to distance on the map.
- A verbal scale expresses scale in sentence form.

3.3 Topographic Maps

3.3 Objectives

- How can elevation and topography be shown on a map?
- How do you interpret (read) a topographic map?

Topographic Maps

- One of the most widely used maps is called a topographic map, which shows the surface features of Earth.
- **topography** the size and shape of the land surface features of a region
- **elevation** the height of an object above sea level

Advantages of Topographic Maps

- Topographic maps provide more detailed information about the surface of Earth than either drawings or political maps.

Interpreting a Topographic Map

- Symbols are used to show certain features on topographic maps.
- Symbol color indicates the type of feature. Constructed features, such as buildings, are shown in black. Highways are shown in red. Bodies of water are colored blue, and forested areas are colored green.
- Contour lines are brown or black.

Elevation on Topographic Maps

- On topographic maps, elevation is shown by using contour lines.
- **contour line** a line that connects points of equal elevation on a map
- The difference in elevation between one contour line and the next is called the **contour interval.** The contour interval is selected based on the relief of the area being mapped.
- **relief** the difference between the highest and lowest elevations in a given area
- Every fifth contour line is darker than the four lines one either side of it. This **index contour** makes reading elevation easier.

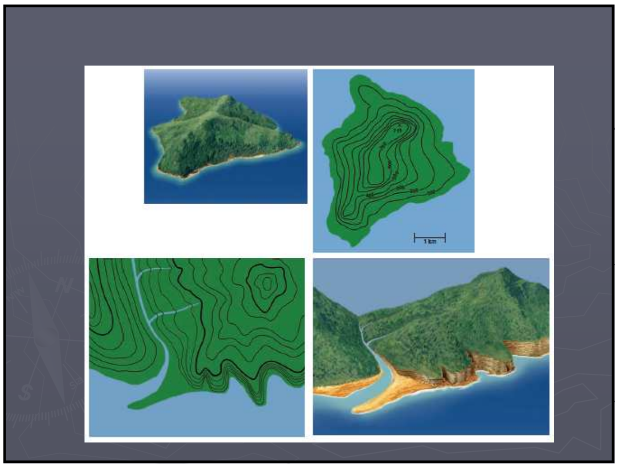
Index Contour, Contour Interval, and Relief

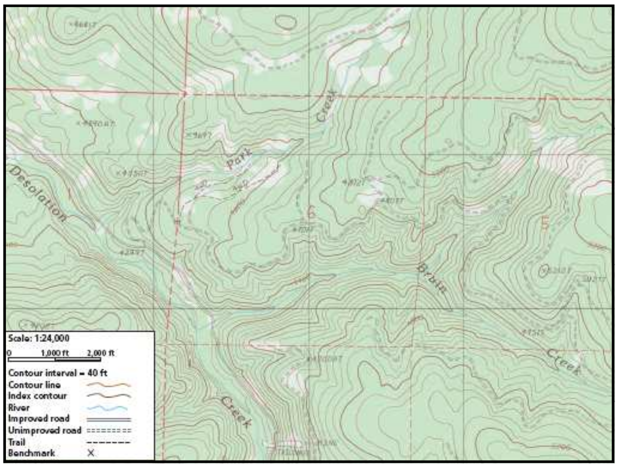
Landforms on Topographic Maps

- The spacing and direction of contour lines indicate the shapes of the landforms represented on a topographic map.
- Closely spaced contour lines indicate that the slope is steep.
- Widely spaced contour lines indicate that the land is relatively level.

Landforms on Topographic Maps

- A contour line that bends to form a V shape indicates a valley. The bend in the V points toward the higher end of the valley; this V points upstream, or in the direction from which the water flows, if there is a stream.
- Contour lines that form closed loops indicate a hilltop or a depression. Closed loops that have short straight lines perpendicular to the inside of the loop indicate a depression.




Desolation
Park
Creek
Bruin
Creek
Creek
Scale: 1:24,000
0 1,000 ft 2,000 ft
Contour interval = 40 ft
Contour line
Index contour
River
Improved road
Unimproved road
Trail
Benchmark