Topic 2: Measuring Earth

Topic 2 Section 1

Overview: consistent methods of locating positions on Earth (latitude, longitude, and more recently GPS) allow for accurate and reproducible boundaries for ownership and knowledge of landforms to help understand the best use of land resources

Size and Shape of Earth

The Earth is very close to a perfect sphere – too close for the human eye to detect deviation

Equatorial diameter = 12 756 km

Polar diameter = 12 714 km (a 0.3% deviation)

Earth is often represented by a globe (a globe is therefore a model of the Earth)

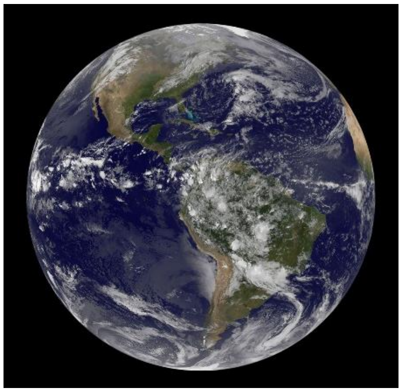
Model – a way to represent the properties of an object or system

Examples of models: globe, diagram, chart, table, or mathematical equation

Evidence of Earth's shape

Ships appear to be cut off as they sail over the horizon

Pictures of Earth taken from space



Acceleration of gravity is a constant at sea level all around the Earth (and varies only very slightly from sea level (9.8066 m/s^2) to the highest elevation (9.7795 m/s^2, −0.3% deviation)

Spheres of Earth

The Earth is composed of a series of spheres held together by gravity

- the lowest density sphere will the outer edge of Earth's atmosphere
- the highest density sphere will sink to the center (Earth's core)

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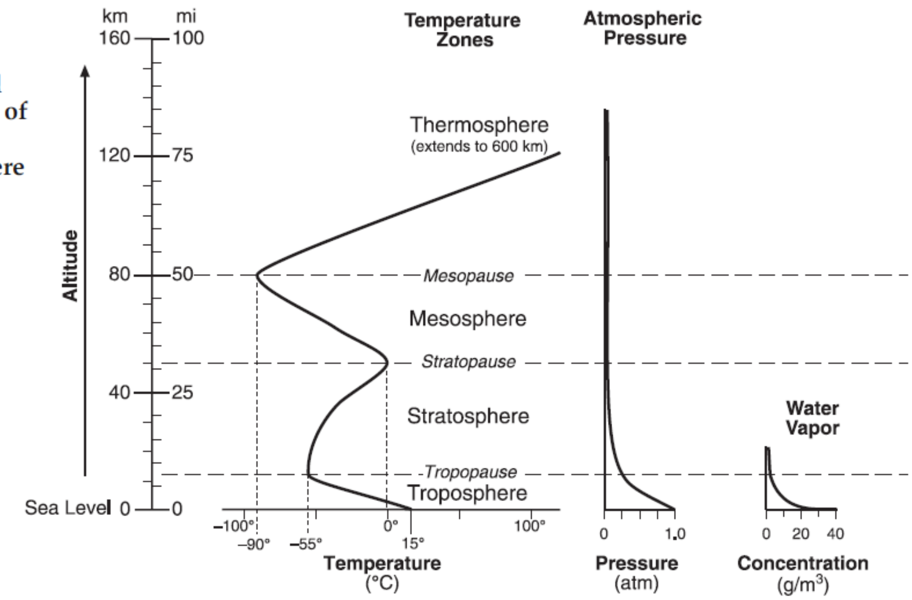
Outer spheres of the Earth (from outermost sphere to the center of the Earth)

Atmosphere

The atmosphere is the outermost sphere of the Earth because it has the lowest density

Thermosphere	outermost layer – 80 to 120 km
Mesopause	boundary between the mesosphere and the thermosphere
Mesosphere	about 50 to 80 km
Stratopause	boundary between the stratosphere and the mesosphere
Stratosphere	about 12 km to 50 km
Tropopause	boundary between the troposphere and the stratosphere
Troposphere	0 to about 12 km



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The dried and filtered atmosphere is composed of

78% nitrogen

21% oxygen

0.9% argon

0.04% carbon dioxide

Before drying and filtering, the air contains water vapor and suspended particles

Hydrosphere – Earth's liquid layer of water

About 70% of Earth's surface is covered by water which is mostly hydrogen and oxygen

Earth's Interior (from outermost sphere to the center of the Earth)

Lithosphere – Earth's rocky layer at the top of its interior

The lithosphere lies directly beneath the hydrosphere or the atmosphere

The lithosphere is approximately 100 km thick

The lithosphere is divided into sections called lithospheric plates

The upper portion of the lithosphere is the crust

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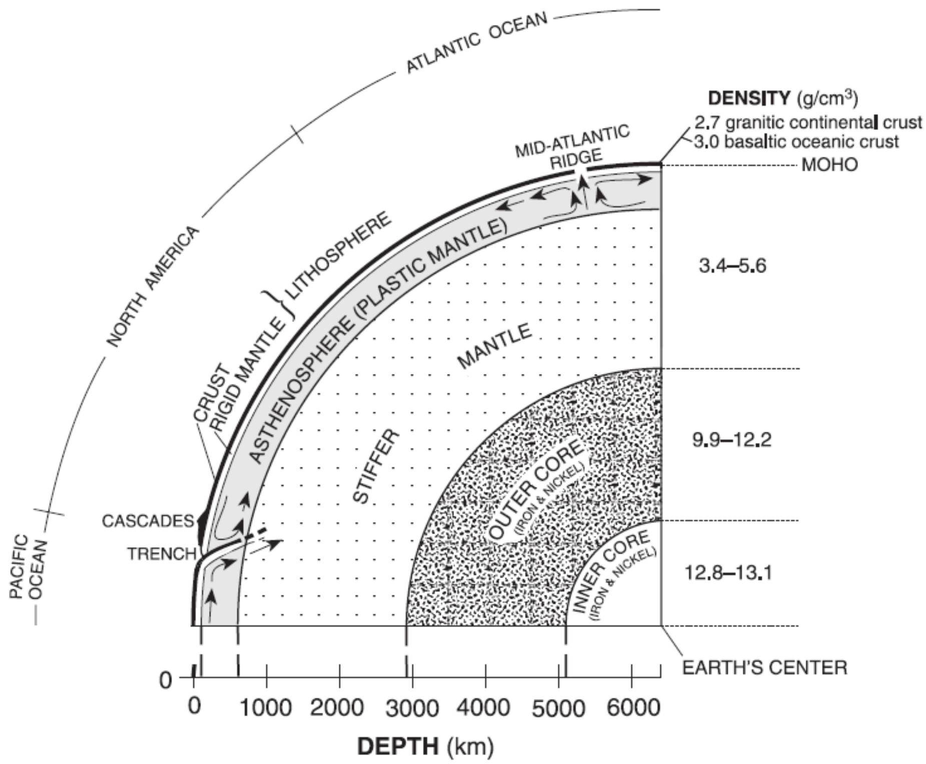
Geosphere – the region extending from Earth's rocky layer to the center of the Earth

Inferred Properties of Earth's Interior



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Topic 2 Section 2

Locating positions on Earth:

Coordinate system – a method used to determine a specific location using two numbers

On Earth, the latitude-longitude system is the coordinate system used to determine location

The angular units used are degrees (°), minutes (′), and seconds (″)

A circle = 360°   1° = 60′   1′ = 60″

Latitude – the angular distance north or south of the equator

Equator – marks the middle location exactly between the North and South Poles

Equator = 0°   North Pole = 90° N   South Pole = 90° S

The angle from a line drawn from the center of the Earth to any point on Earth and the plane of the equator will equal the latitude of that point

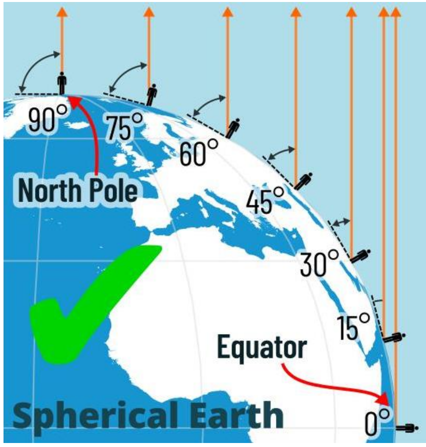
All points that have the same latitude lie on a circle that is parallel to the equator

These circles are called *parallels of latitude* or just *parallels*

Measuring latitude

In the Northern Hemisphere, the altitude of the North Star or Polaris at any position should be the same as the latitude of that position

A *sextant* is used to measure the altitude of an object (usually a star) in the sky



Longitude – the angular distance east or west of the prime meridian

A semi-circle on Earth's surface that connects the North and South Poles is called a *meridian of longitude* or *meridian*

The meridian that passes through Greenwich, England is the *prime meridian* or 0° longitude

Meridians measure from 0° to 180° either east or west

Meridians to the west of the prime meridian are measured as negative or written with a W (west) designation

The 180° meridian roughly follows the International Date Line

The position for Faith Heritage School is 42° 0′ 10″ N and −76° 8′ 52″ or 76° 8′ 52″ W

Measuring longitude

Longitude is measured by comparing the time local noon occurs (when the sun is directly overhead) to the time of local noon at the prime meridian

360° around the planet divided by 24 hours in a day works out to 15° per hour

Local noon in New York State (which is west of Greenwich) occurs at 5:00 p.m. in Greenwich, England

5 hr × 15°/hr = 75° W

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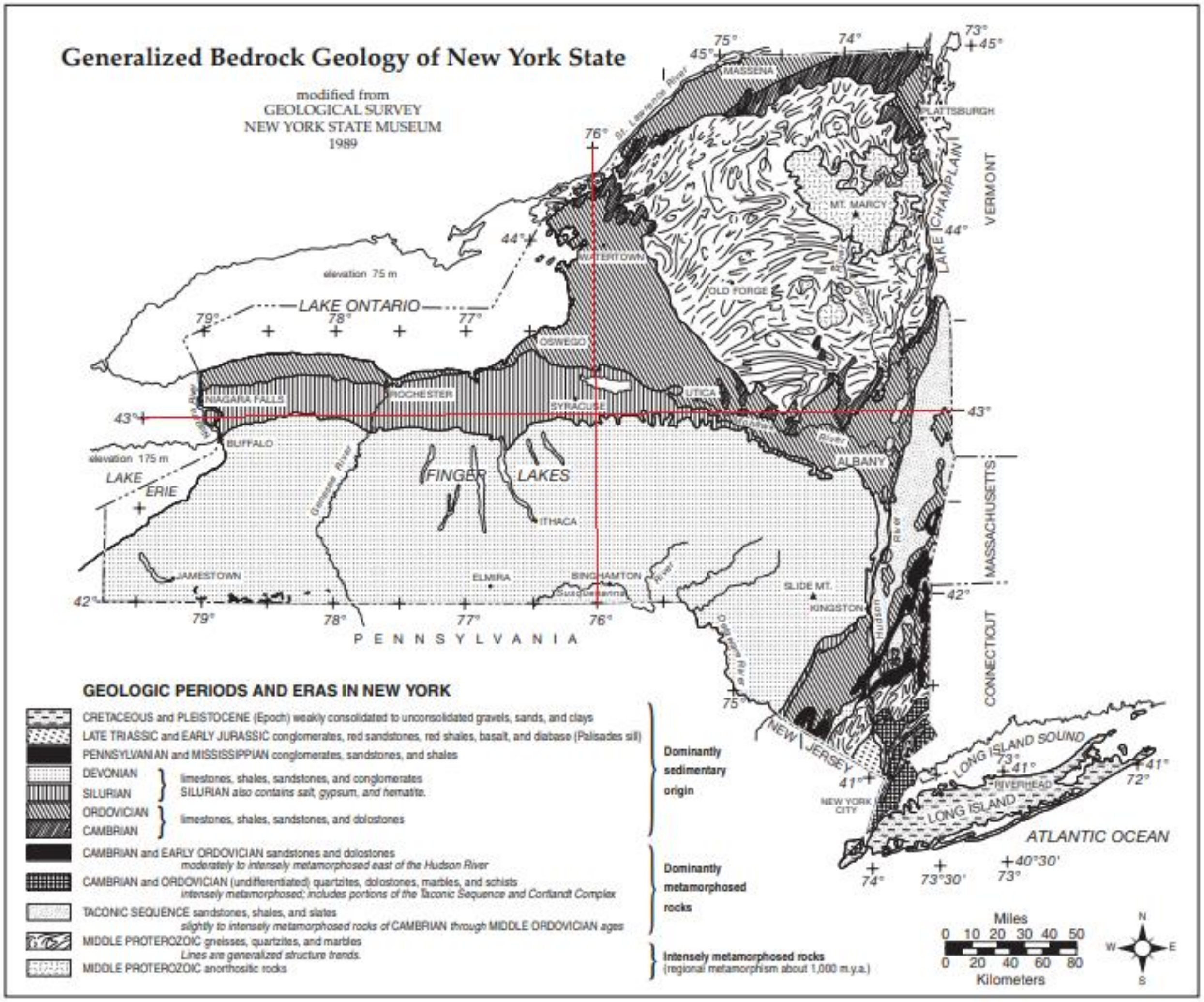
Find the position of Syracuse, NY



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By using a ruler and connecting the latitude and longitude crosses on the map in the ESRT, Syracuse, NY is at approximately 43° 8′ N and 76° 10′ W

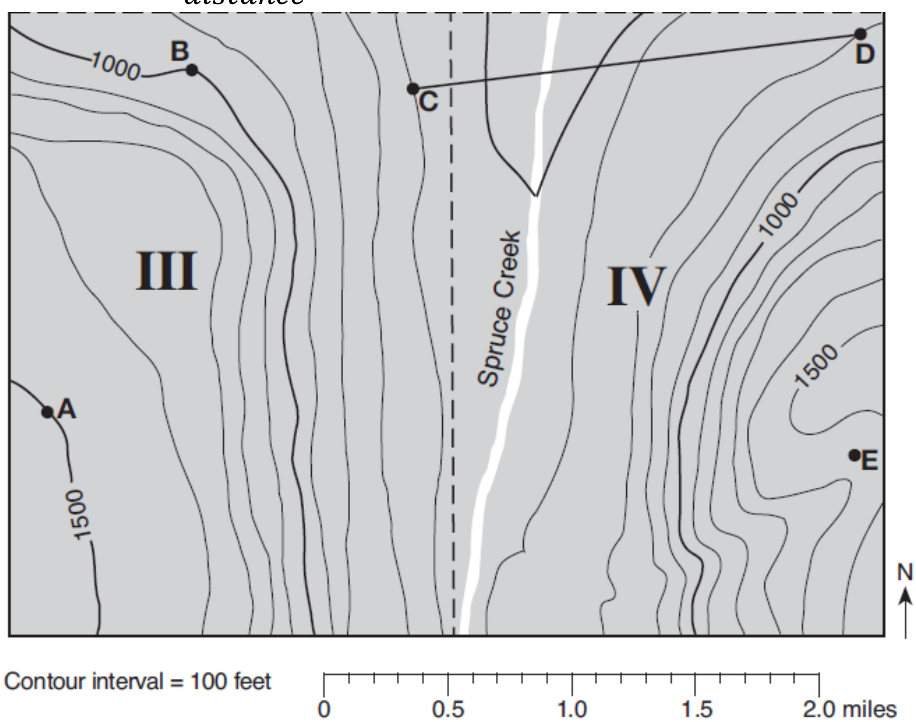
Topic 2 Section 3

Field – any region of space or the environment that has a measurable value at every point
Examples: wind speed, temperature, elevation, relative humidity, or atmospheric pressure

Isolines – points of equal field values connected by lines
Examples: isotherms (temperature), isobars (pressure), and contour lines (elevation)

Gradient – the rate of change in a measured value of a field from place to place

$$gradient = \frac{change\ in\ field\ value}{distance}$$



Example: Calculate the gradient between locations A and B

$$gradient = \frac{change\ in\ field\ value}{distance}$$

$$gradient = \frac{1500\ ft - 1000\ ft}{1.5\ mi} = \frac{500\ \text{ft}}{1.5\ \text{mi}} = 330\ ft/mi$$

Topic 2 Section 4

Mapping Earth's surface

Topographic maps – a model used to show elevation (sometimes called a *contour map*)
contour lines are isolines used to show elevation

Elevation – height above or below sea level

Contour interval – the difference in elevation between consecutive contour lines of differing elevation

- contour lines that cross a stream form an "arrow" that points upstream
- consecutive contour lines that form smaller and smaller ovals indicate a hilltop
- most contour maps show every fourth or fifth line thicker or bolder and show a number that gives the elevation for that line – *index contour*
- a BM × symbol on a contour map is a benchmark that shows the position of a metal marker with the exact elevation for that location
- depression contour lines would look like hilltop lines except they will have small lines along the contour that point toward the center of the depression – when going uphill, the very first depression contour line marks the same elevation as the last regular contour line

Symbols on topographic maps – there are hundreds of symbols used to show natural and man-made features on topographic maps but there is always a key to help you

Most government maps (especially US Geological Survey, USGS) use the following:

- brown – contour lines for natural landforms
- red and black – human made boundaries, roads, structures
- blue – water features
- green – wooded areas
- purple – places that have been updated using aerial photographs

Horizontal distance on maps

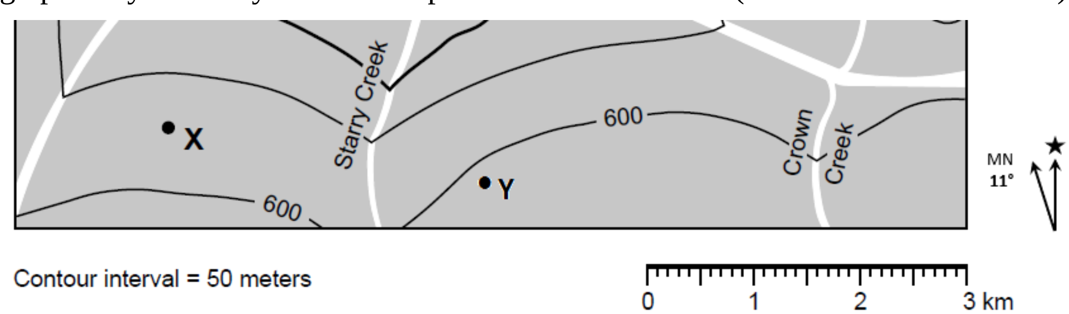
Contours show elevations and depressions

A map scale shows horizontal distances

The scale shows the ratio between distance on the map and the actual distance

Three methods to show scale:

- using words – one inch equals one mile
- using fractions – 1/500,000 or 1:500,000 (one inch on the map = 500,000 inches)
- graphically – usually a tick mark picture near the bottom (this is the most common)



Hold a piece of paper on line XY and mark it, then move to the scale

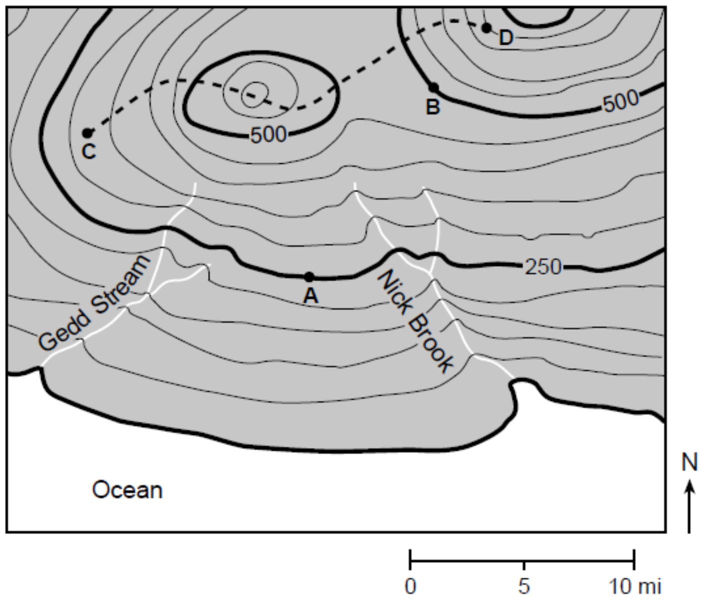
Topographic gradient

Use a piece of paper to determine the distance from the scale

Read the contours to determine the change in elevation

Use the gradient formula

Example: find the gradient between points A and B on the map below



AB is 10 miles using a piece of paper to mark AB then compare it to the scale

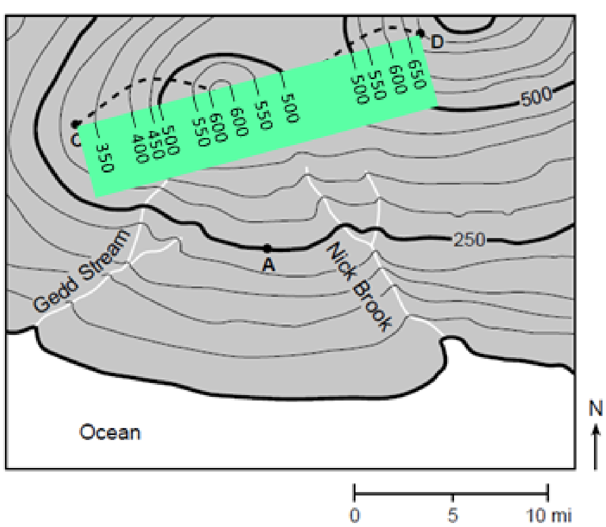
The index contours show A is 250 feet and B is 500 feet for a difference of 250 feet

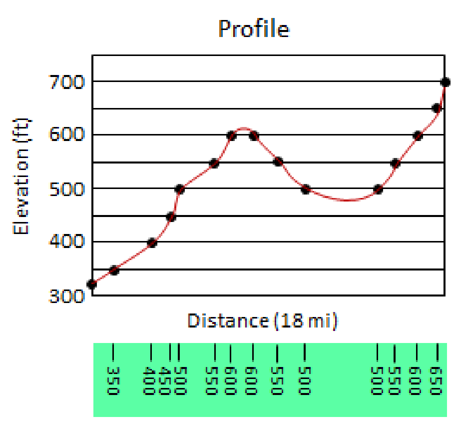
$$gradient = \frac{change\ in\ field\ value}{distance}$$

$$gradient = \frac{500\ ft - 250\ ft}{10\ mi} = \frac{250\text{ ft}}{10\text{ mi}} = 25\ ft/mi$$

Topographic profile

A profile shows a side or cut-away view of a landform (topo maps show the top view)





Mark elevations and distance on a strip of paper and then use the paper to fill the profile.