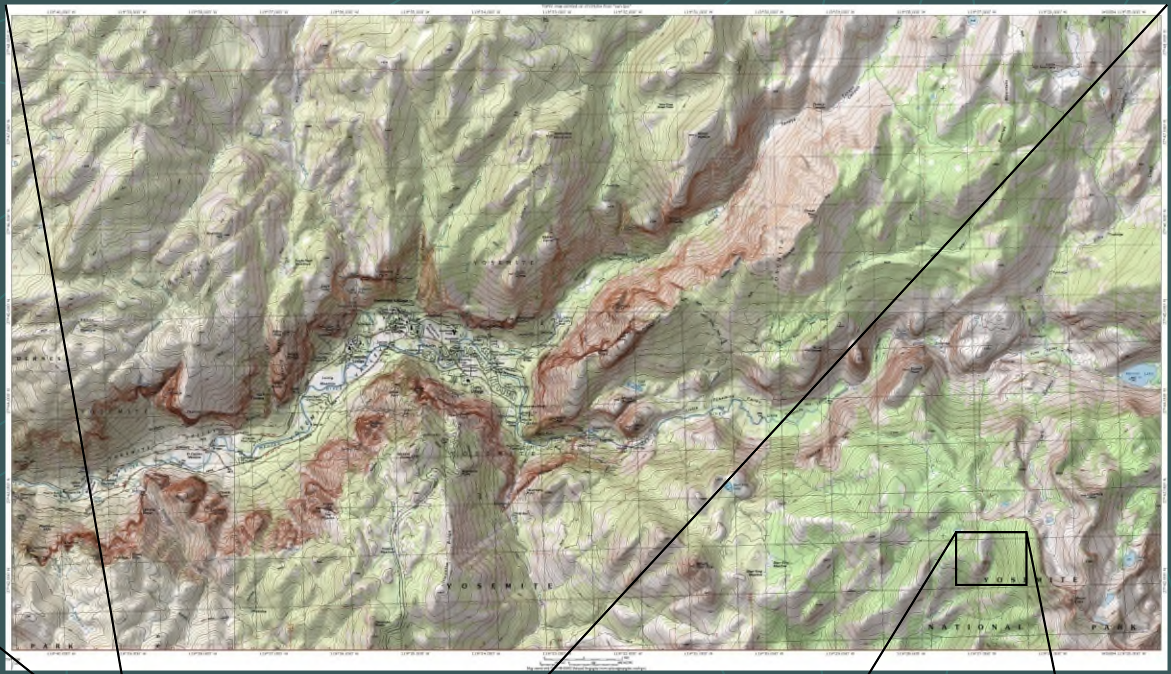
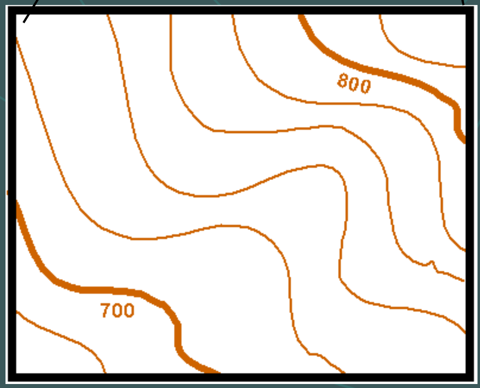
Topographic Maps





EOSC 110 –
Intro to Geosciences
Ray Rector: Instructor

Today's Lab Activities

1) Discussion of Last Week's Units Measure and Geo-timescale Lab
2) Lab lecture on Topographic Map Concepts
3) Topographic Maps, Gradients and Profiles
4) Analyses of Select Topographic Maps
   - Trout Run
   - Math State Park
   - Sweeney Pass
   - Yosemite Valley
5) Prepare for Next Week's Plate Tectonics Lab

Purpose of Today's Lab

1) Learn the fundamentals of topographic maps in order to be able to read a topographic map and recognize landforms from contour patterns

Learning Outcomes

When you are finished today, you should be able to:

1) Become familiar the concepts of scale, location (latitude and longitude), elevations, depths and contour lines.

2) Identify the type, shape, and steepness of landforms

3) Calculate slope gradient from a topo map

Many Types of Maps

1) Topographic Maps
2) Bathymetry Maps
3) Nautical Charts

(1–3: Surface Height Maps)

4) Geology Maps
5) Road Maps
6) Political Maps
7) Climate Maps
8) Ecosystem Maps

What is a Topographic Map?

1) An abstract, 2-dimensional, scaled-down graphic representation of the shape of the land.

2) “Topo” maps illustrate location, scale, width, length, and height of land surfaces.

3) Elevations of land surface are symbolized by contour lines which signify lines of equal elevation (termed isopleths).

4) Topo maps also show other features like rivers, streams, trails, roads, and buildings.

Next:

Let’s compare a “Topo” map to a Bathymetric Chart ?

Map Series Examples

USGS Topographic Maps

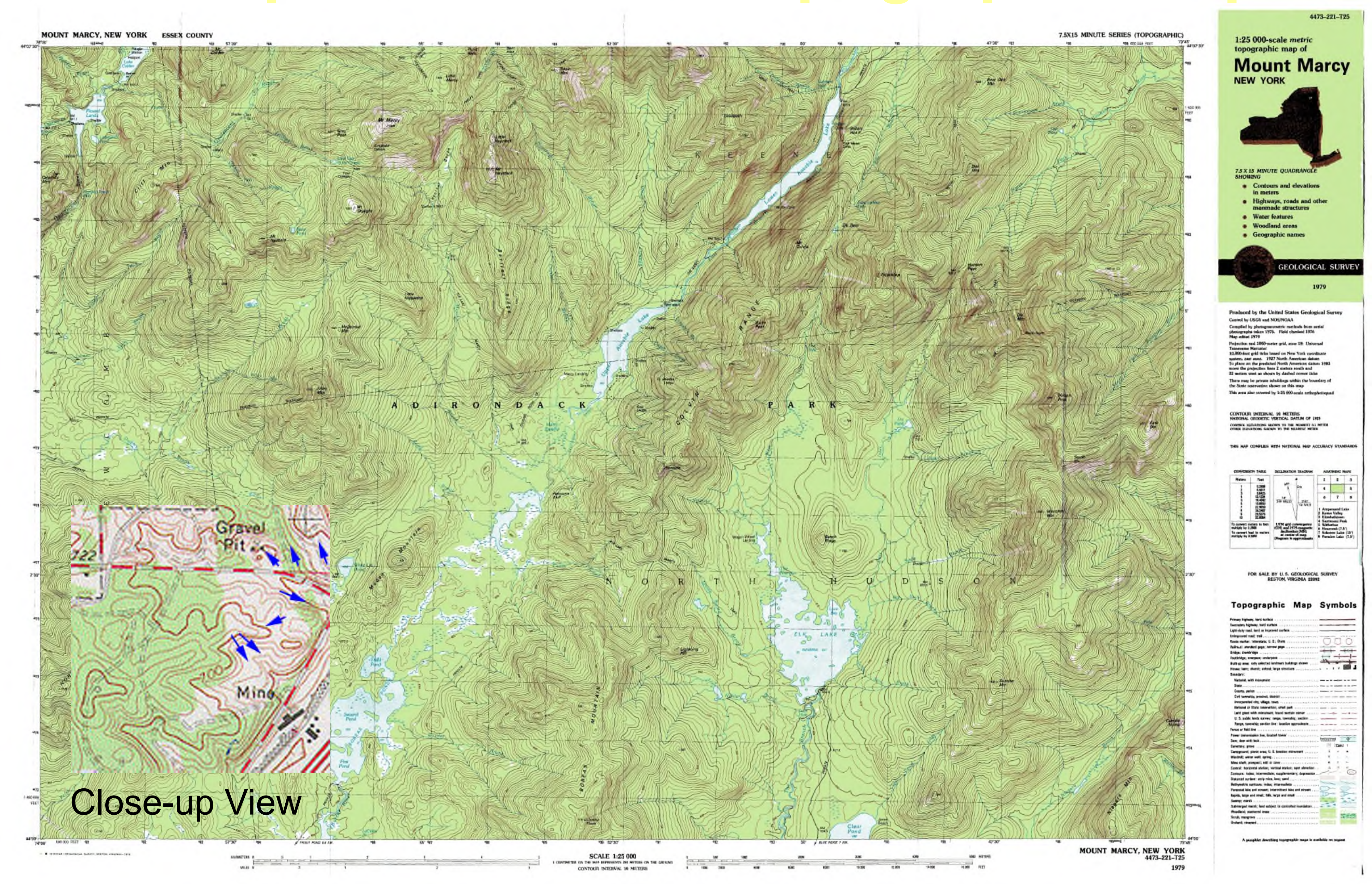
|| 7.5-minute maps || 15-minute maps || 1:100,000-scale series
|| County map series || 1:250,000-scale series
|| State map series || National park map series
|| Shaded-relief maps || Topographic-bathymetric maps
|| Antarctic maps ||

NOAA Bathymetry Maps

Coastal || Fishing || Global || Lakes || Multibeam
NOS surveys || Trackline

A Topographic Map Images the Ground

Example of a USGS Topographic Map



Example of a Orthoquad Map

Importance of Topographic Maps to Earth Scientists and Others

1) Navigation and Orienteering
2) Geologic Studies – Geologic Mapping and Sampling
3) Geographic Studies
4) Engineering Projects

Key Concepts of Topographic Maps

1) Map Projection

2) Compass Directions – N-S, E-W

3) Location – Longitude-Latitude and UTM

4) Map Scale – Fractional, Verbal and Bar

5) Magnetic Declination

7) Map Symbols

8) Elevation Contour Line Rules and Patterns

9) Slope gradient

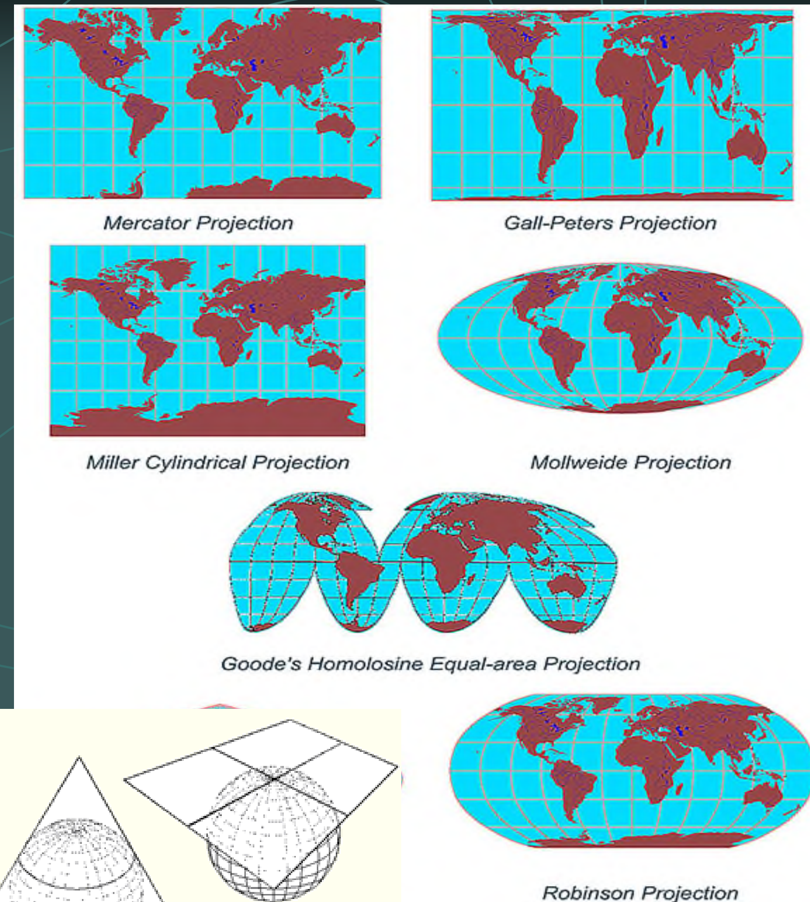
10) Profile Construction

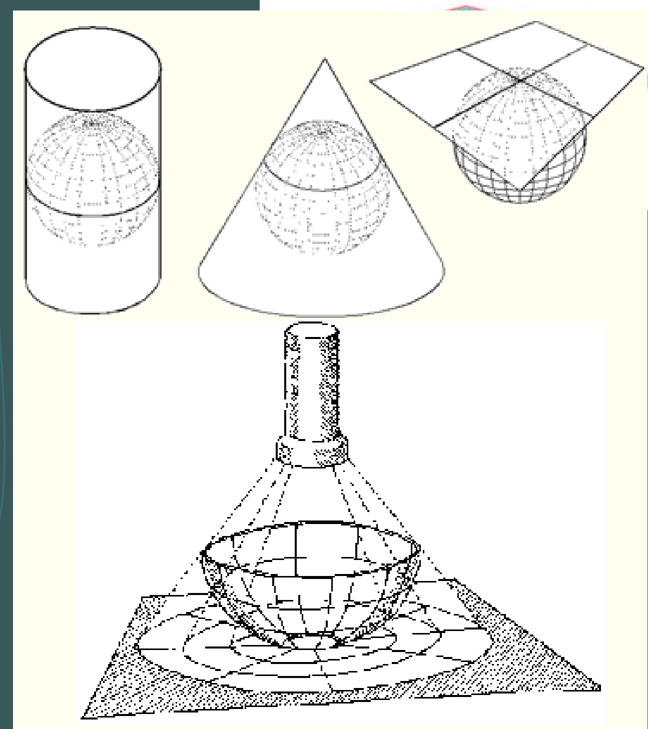
11) Interpreting a Topographic Map

Map Projections

1) Transferring a Curved Surface to a Flat Surface

- Cannot avoid distortion
- Numerous methods
- Each method has a specific type of distortion
- Each method preserves a correct aspect of the earth's surface

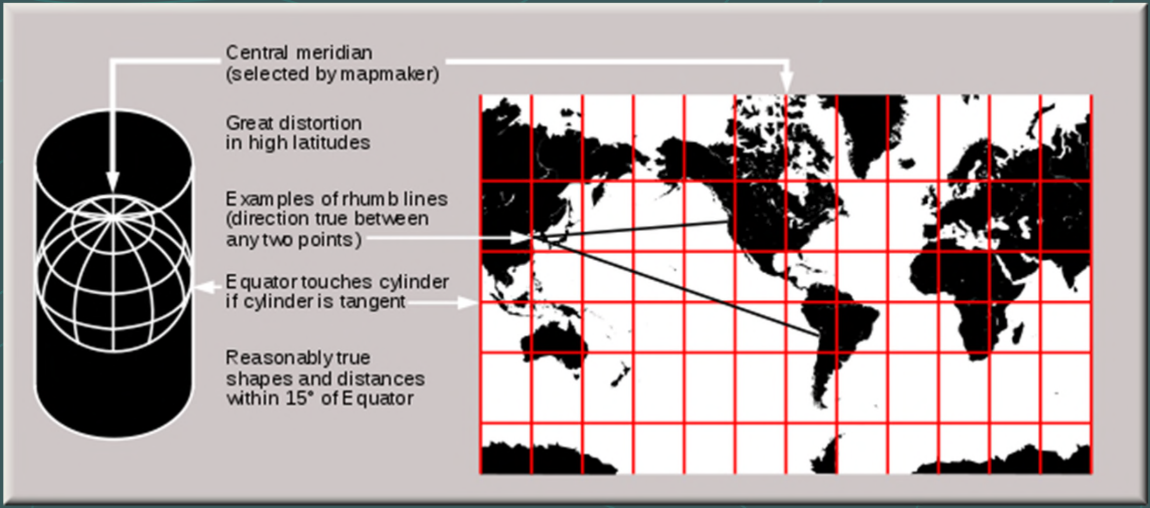




Various Map Projections

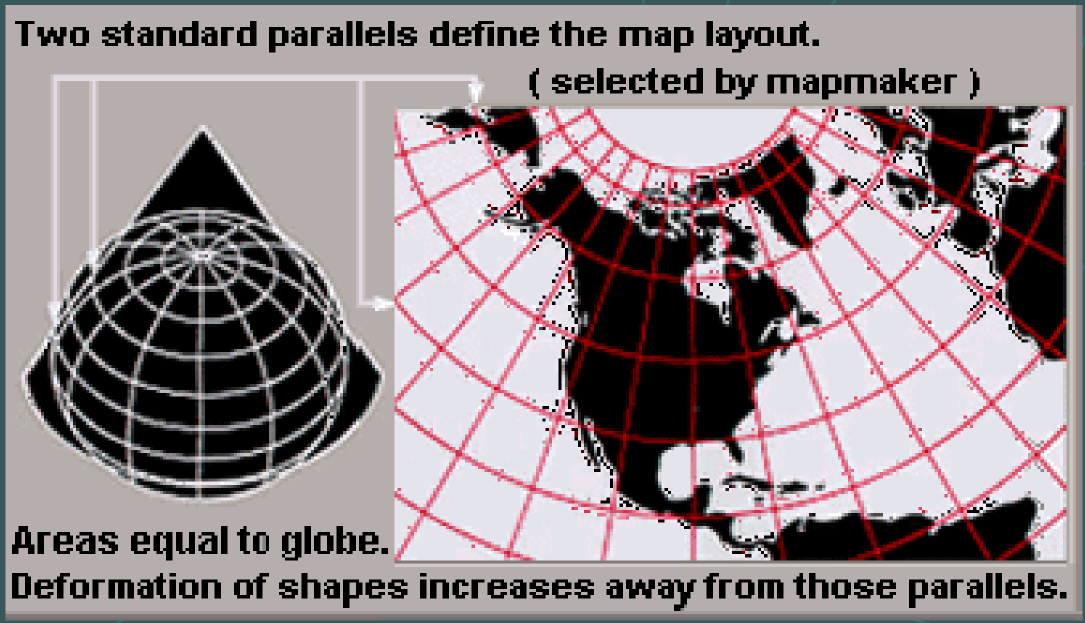
1) Preserve Direction/Angle

- Directions preserved
- Area is distorted
- Example is Mercator
- Popular projection



2) Preserve Area-Shape

- Preserves area size and shape
- Direction/angle is distorted
- Example is Albers
- Less popular projection



Map Scale

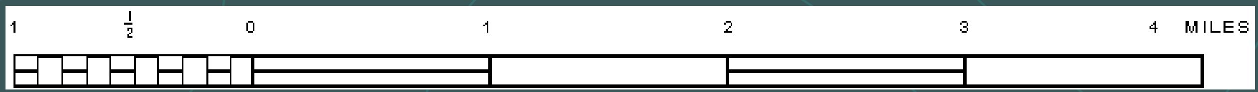
1) All maps are drawn to a specific scale

2) Distances on the map are proportional to distances on the ground

3) For example, 1 inch distance on a map with a 1:62,500 scale will represent 62,5000 inches of real ground distance, which translate to about 1 inch to 1 mile.

4) There are three ways to express map scale:

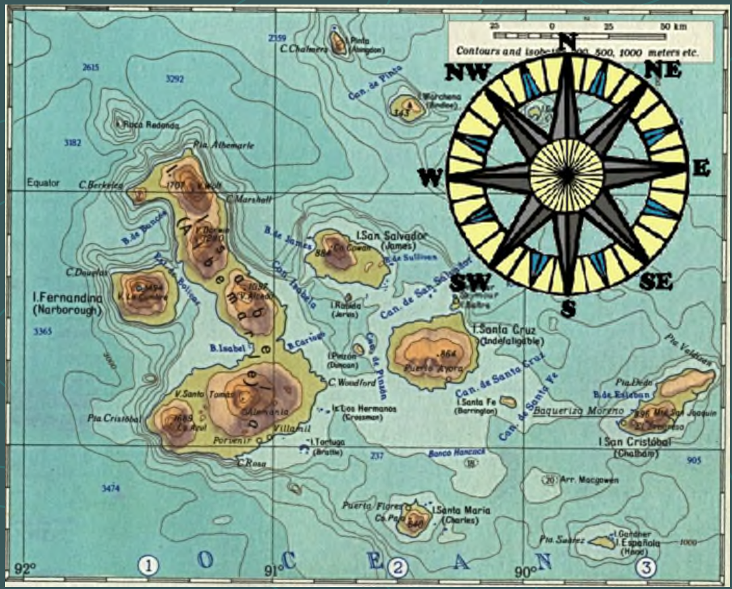
- Fractional scale: 1:62,500
- Verbal scale: 1 inch (map) equals 1 mile (ground)
- Bar scale:



5) Only bar scale stays accurate if the map shrunk or enlarged

Geographic Orientation of Maps

1) Compass direction of maps:
- ➢ True North points toward Top
- ➢ Due South points toward Bottom
- ➢ Due East points to the Right
- ➢ Due West points to the Left

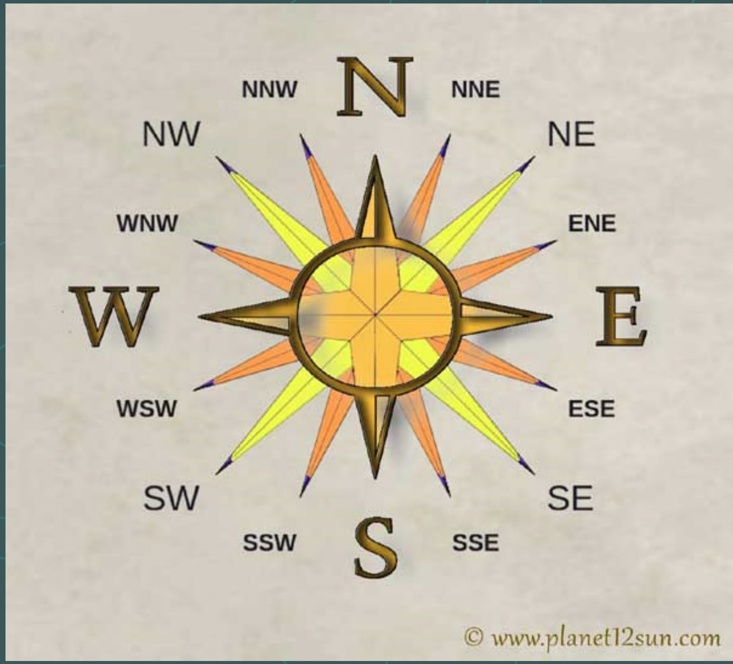


2) Note that a compass points to Magnetic North

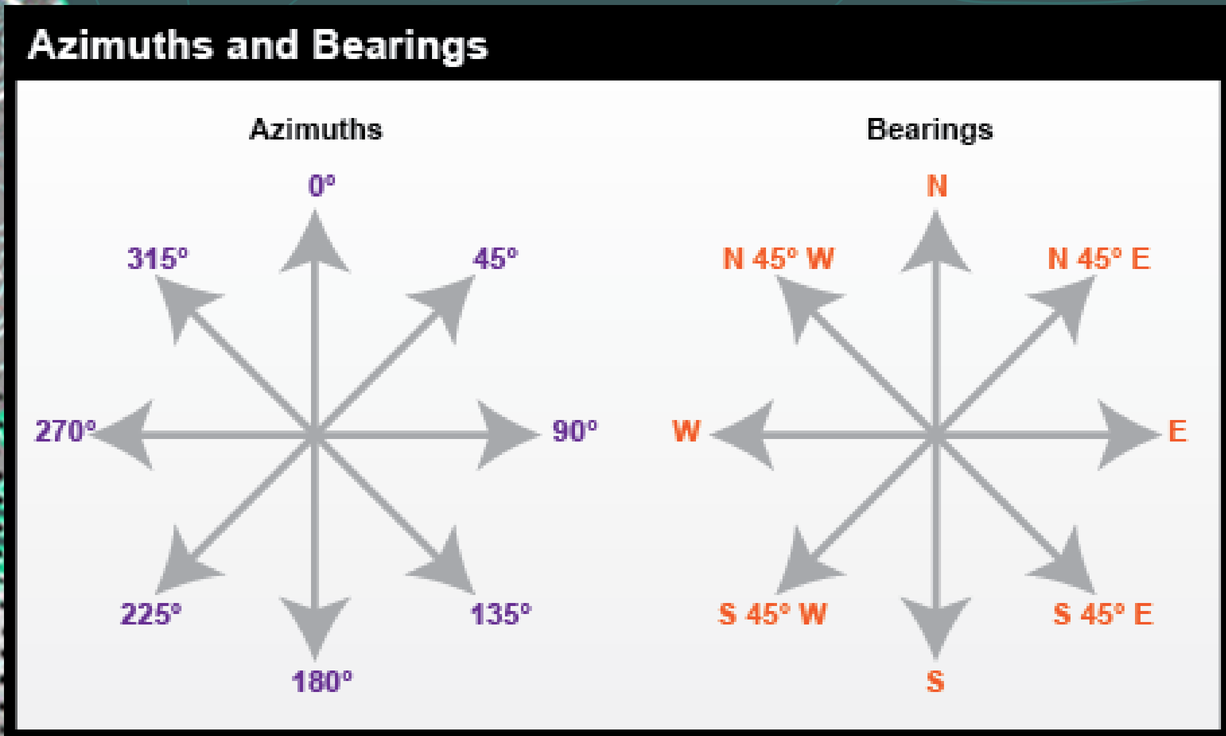
➢ Magnetic declination information should be found in the map legend

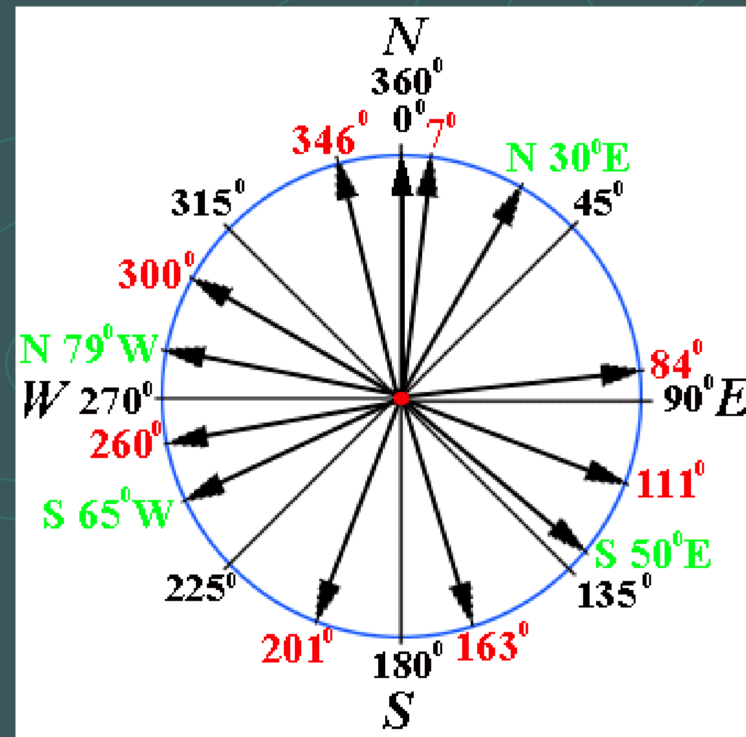
The Four Directional Quadrants

1) Compass direction of maps:
   - True North points toward Top
   - Due South points toward Bottom
   - Due East points to the Right
   - Due West points to the Left



Map Direction – Azimuth and Quadrant



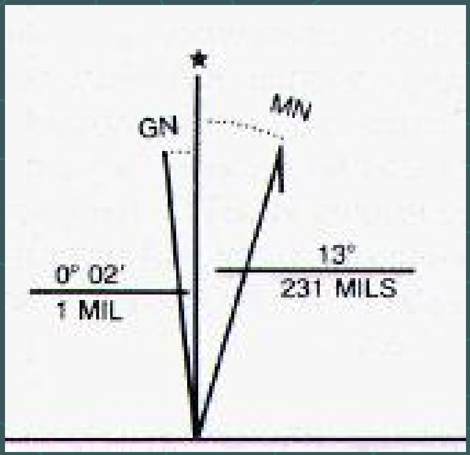


1) Azimuth measures direction from north (zero) 360 degrees clockwise around compass (E=90 – 180=S – 270=W)

2) Quadrant measures direction: either North or South; then so many degree off of N or S; then either toward West or East

3) Difference between True Bearing *Versus* Magnetic Bearing

Magnetic Declination on Topo Map

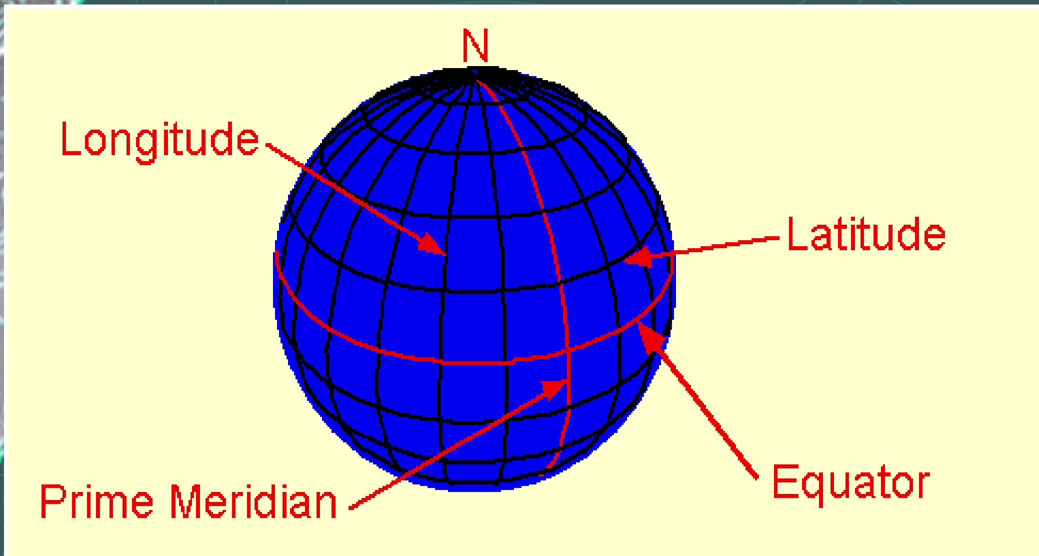


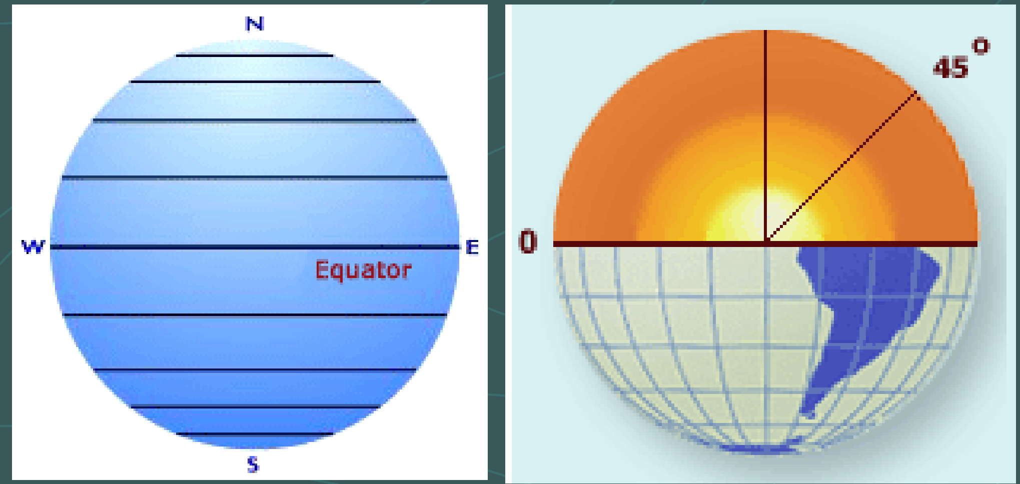
- Magnetic declination information should be found in the map legend
  - ✓ ★ = true north
  - ✓ MN = magnetic north
  - ✓ GN = grid north

- Magnetic declination has a magnitude and direction

Finding One's Position on the Earth's Surface

Latitude and Longitude: A Global Coordinate System





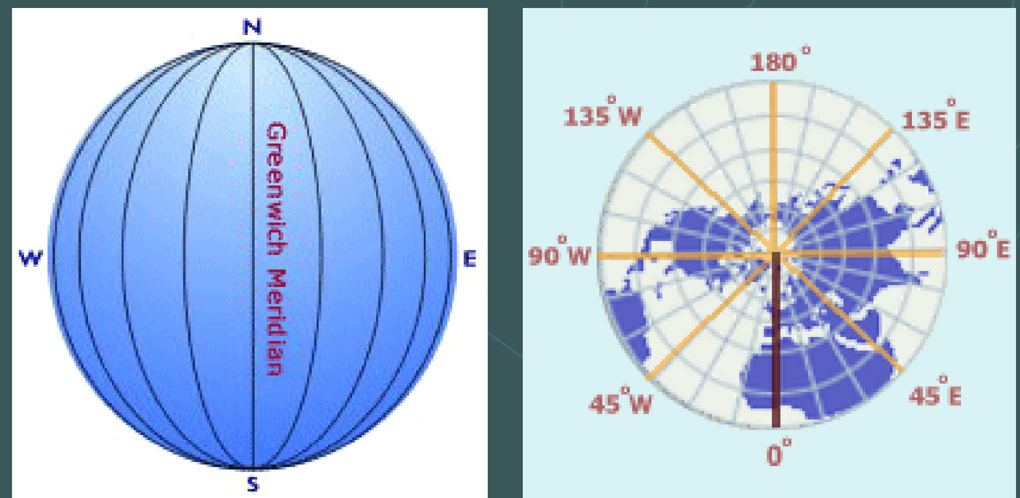
Lines of Latitude: N – S Position

Latitude:

- ✓ Equator = 0°
- ✓ Poles = 90° N and S

Longitude:

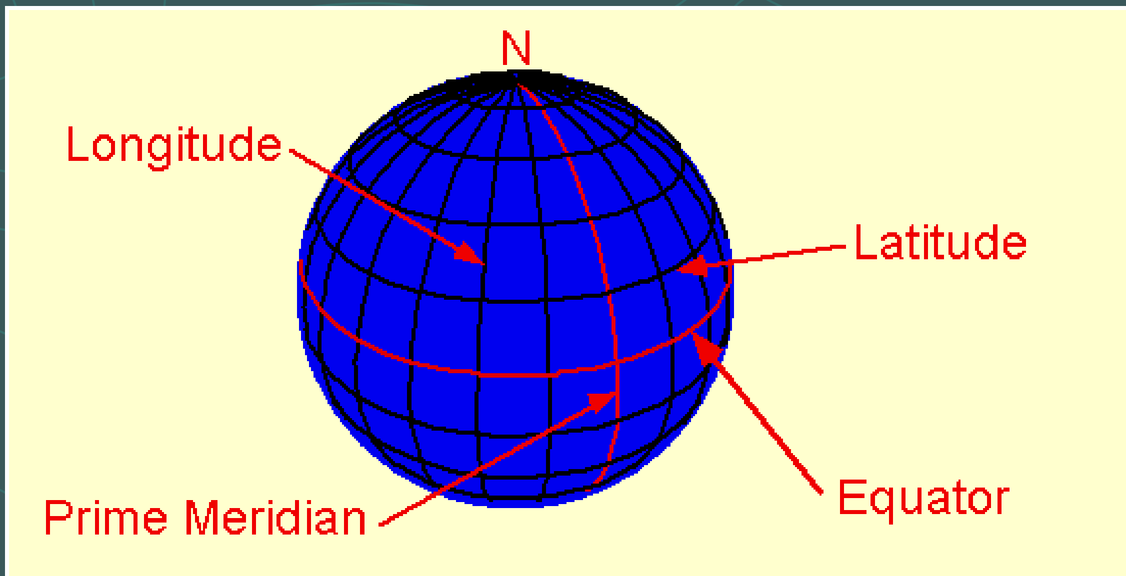
- ✓ Prime Meridian = 0°
- ✓ IDL = 180° W and E

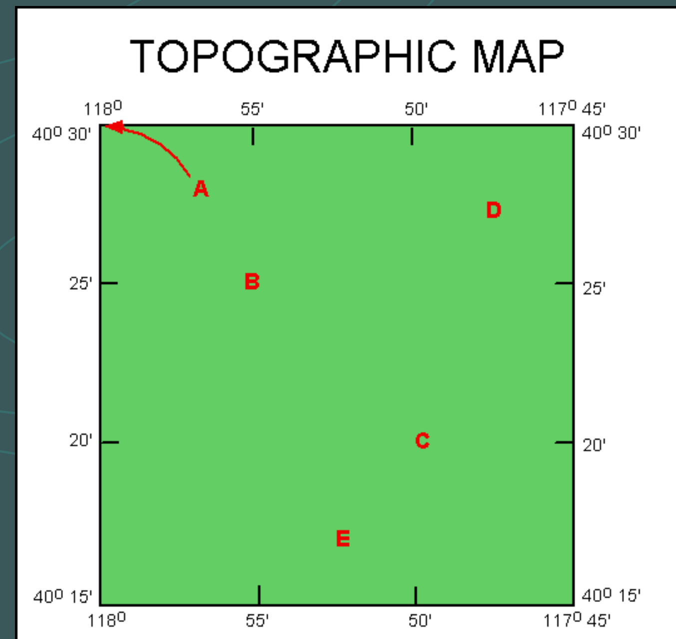


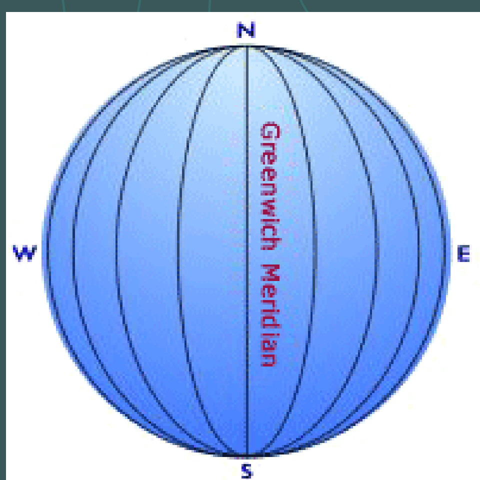
Lines of Longitude: W – E Position

Finding One's Position on the Earth's Surface

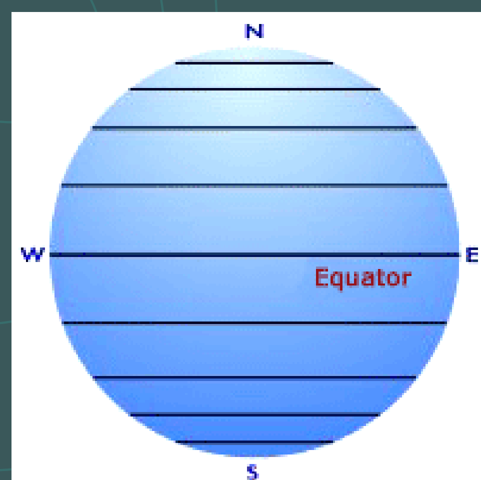
Latitude and Longitude: A Global Coordinate System



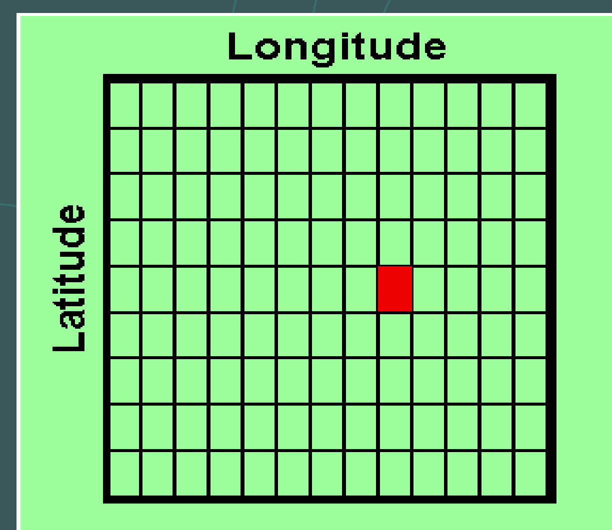




Lines of Longitude



Lines of Latitude

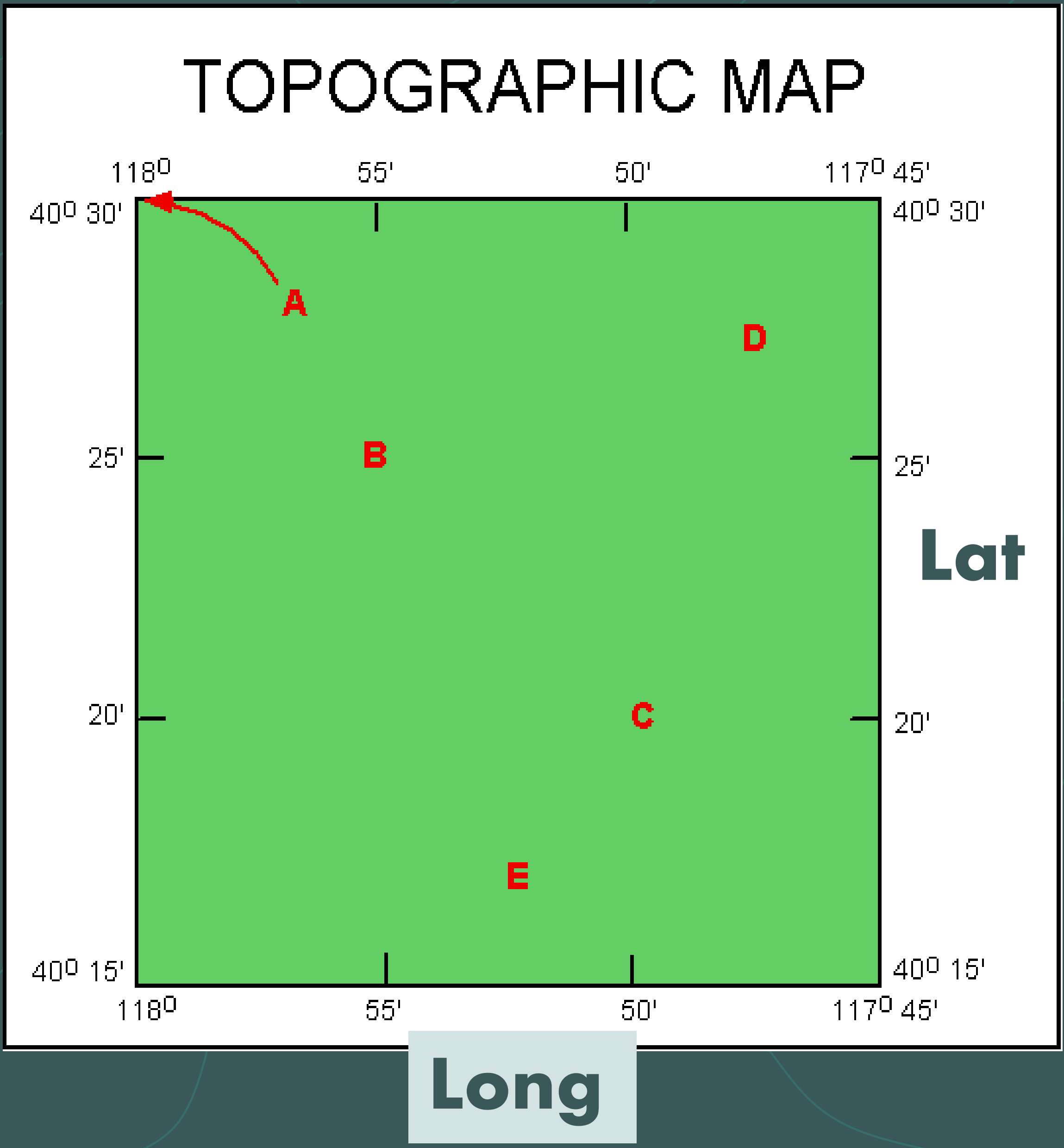


Finding Position on the Earth's Surface

Latitude and Longitude: Global Coordinate System

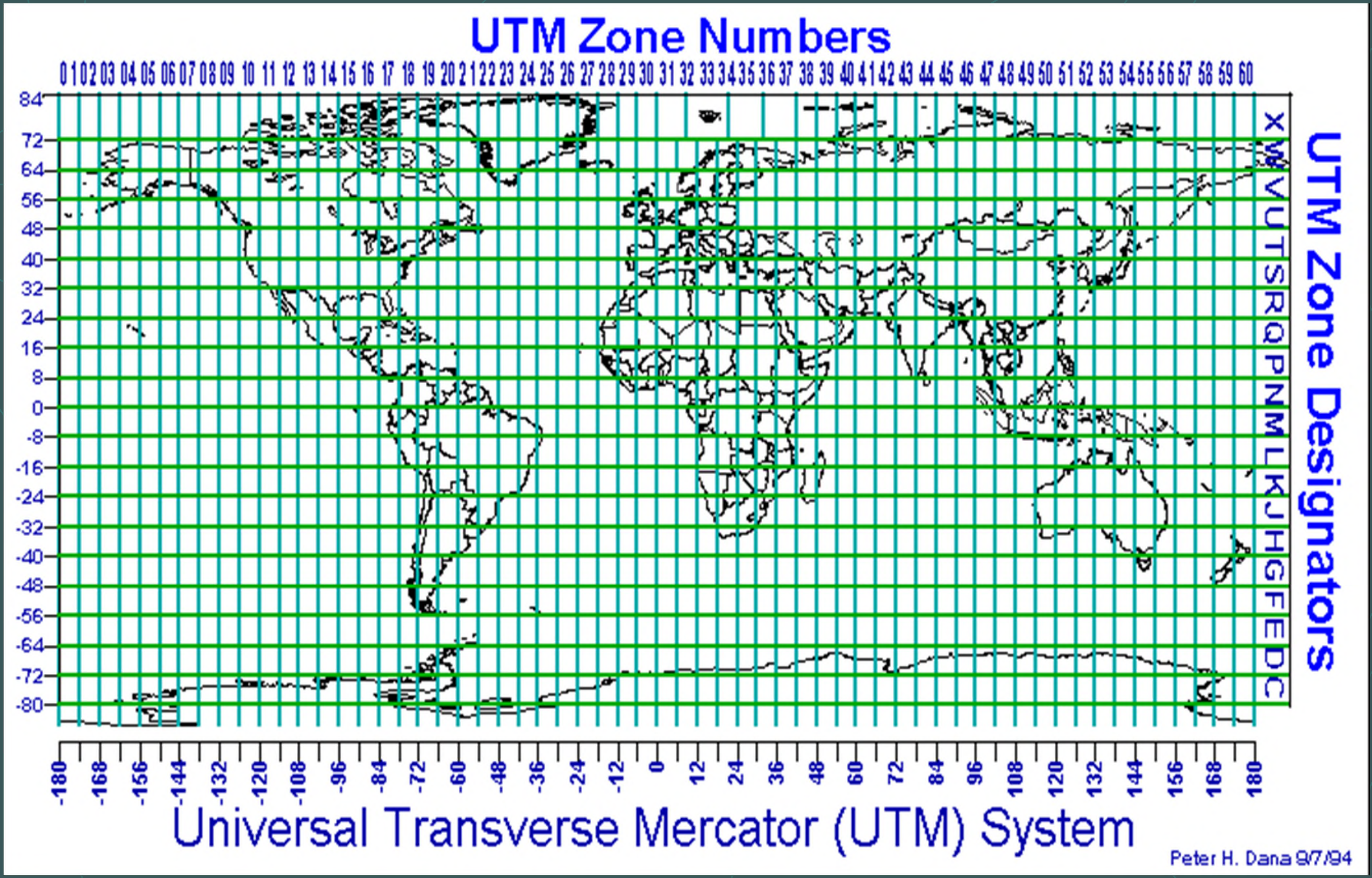
1) Given a specific location on map – Need to determine Latitude/Longitude coordinates

2) Given a specific set of Lat-Long coordinates – Need to determine the location on the map



Universal Transverse Mercator (UTM):

Another Global Coordinate System



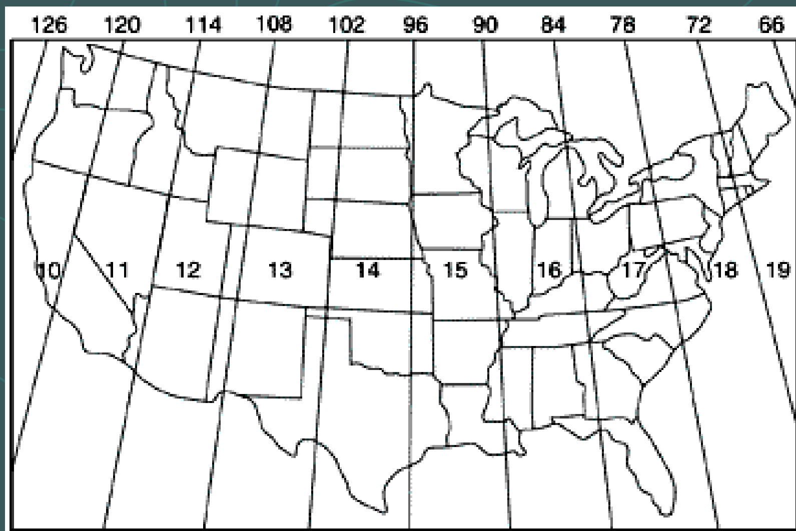
Earth Divided into 60 *6º degree* Longitudinal UTM Zones

Finding One's Position on the Earth's Surface

Universal Transverse Mercator (UTM):

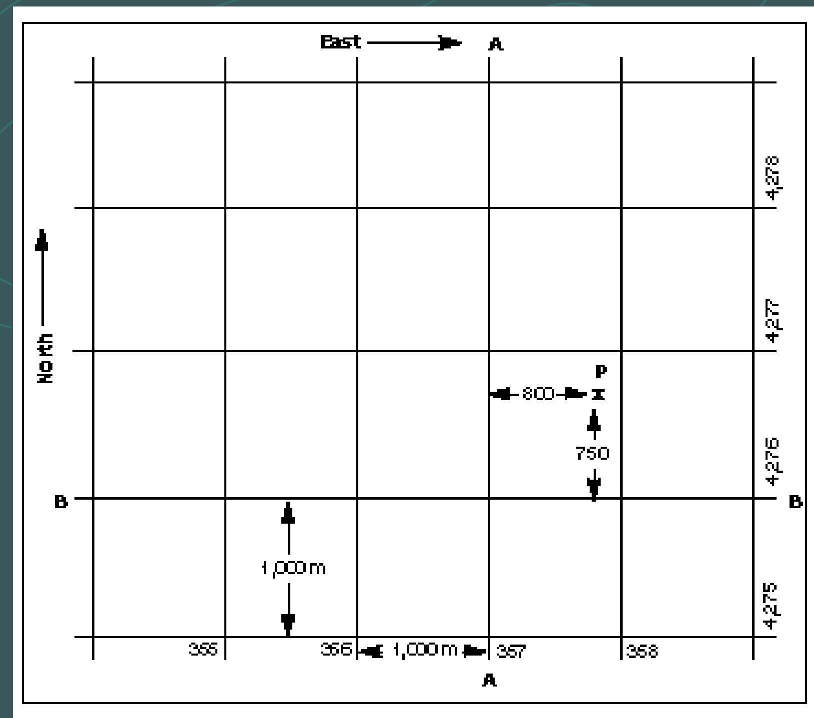
Another Global Coordinate System

UTM Zones



Easting →

Northing ↑



Northing: The number of meters north of the equator the location lies

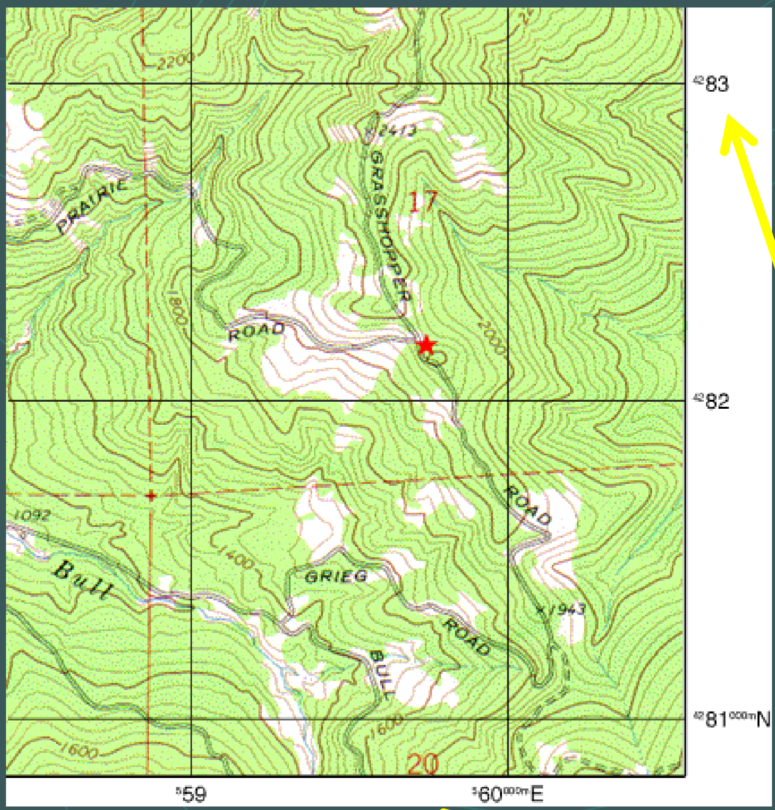
Easting: The number of meters east from the west side of the local zone the location lies

UTM map grid is divided into 1000 meter squares. This may be printed or not printed over the map

Universal Transverse Mercator (UTM):

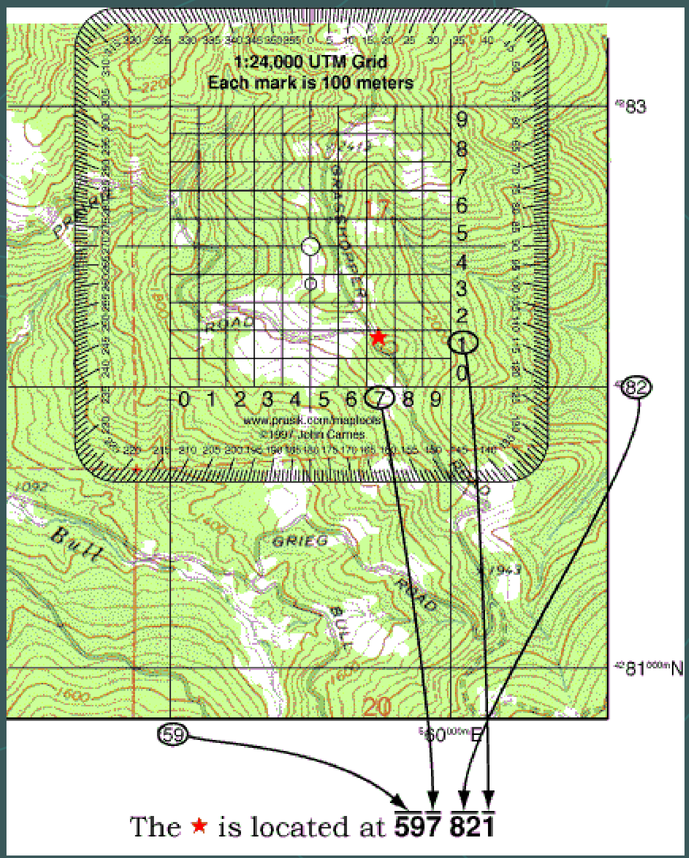
Another Global Coordinate System

UTM Zones, Northing and Easting on a Topo Map



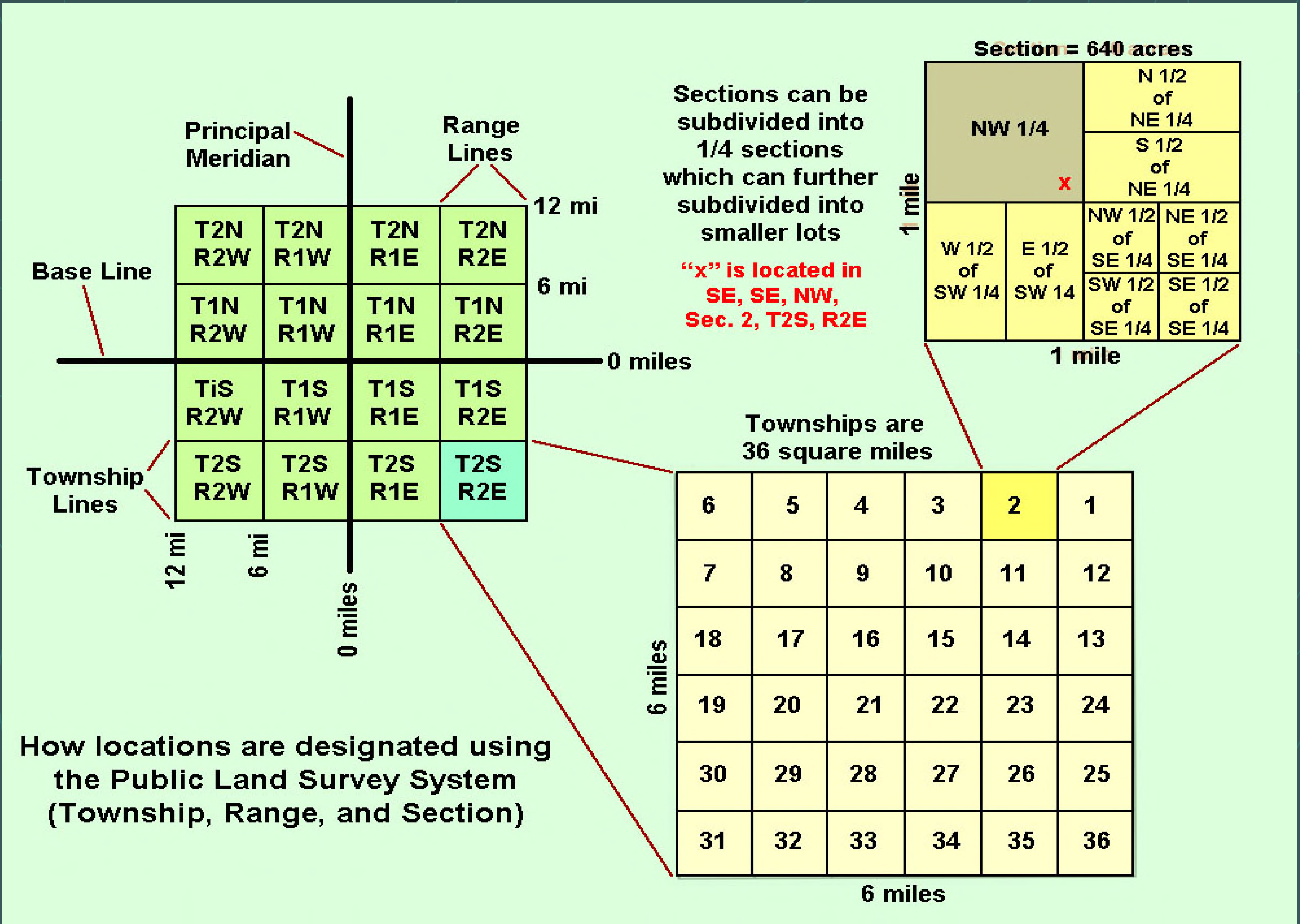
Northing values on the sides of the map

Easting values on the top and bottom of the map

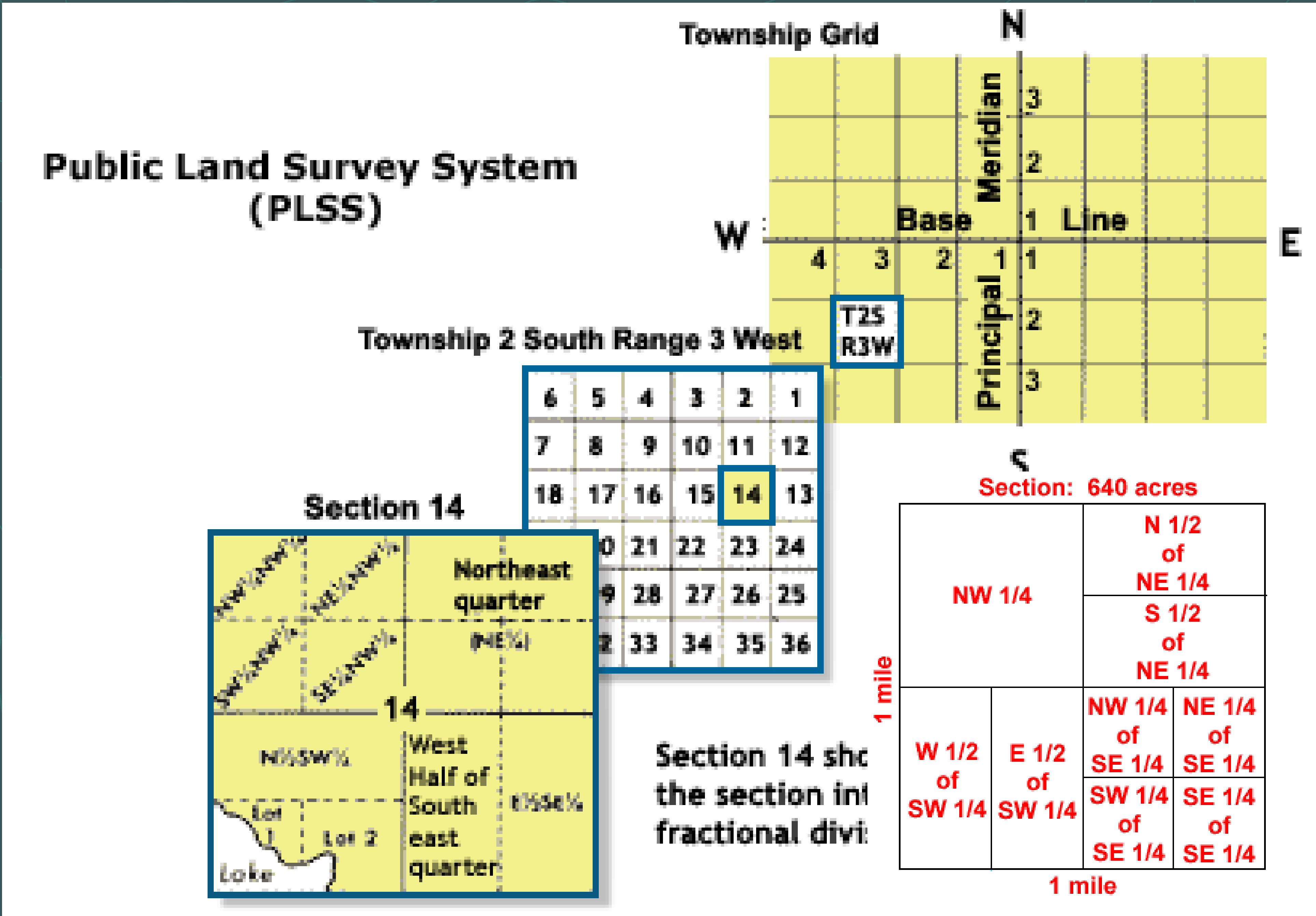


Using a UTM Grid template overlay on a Topo Map

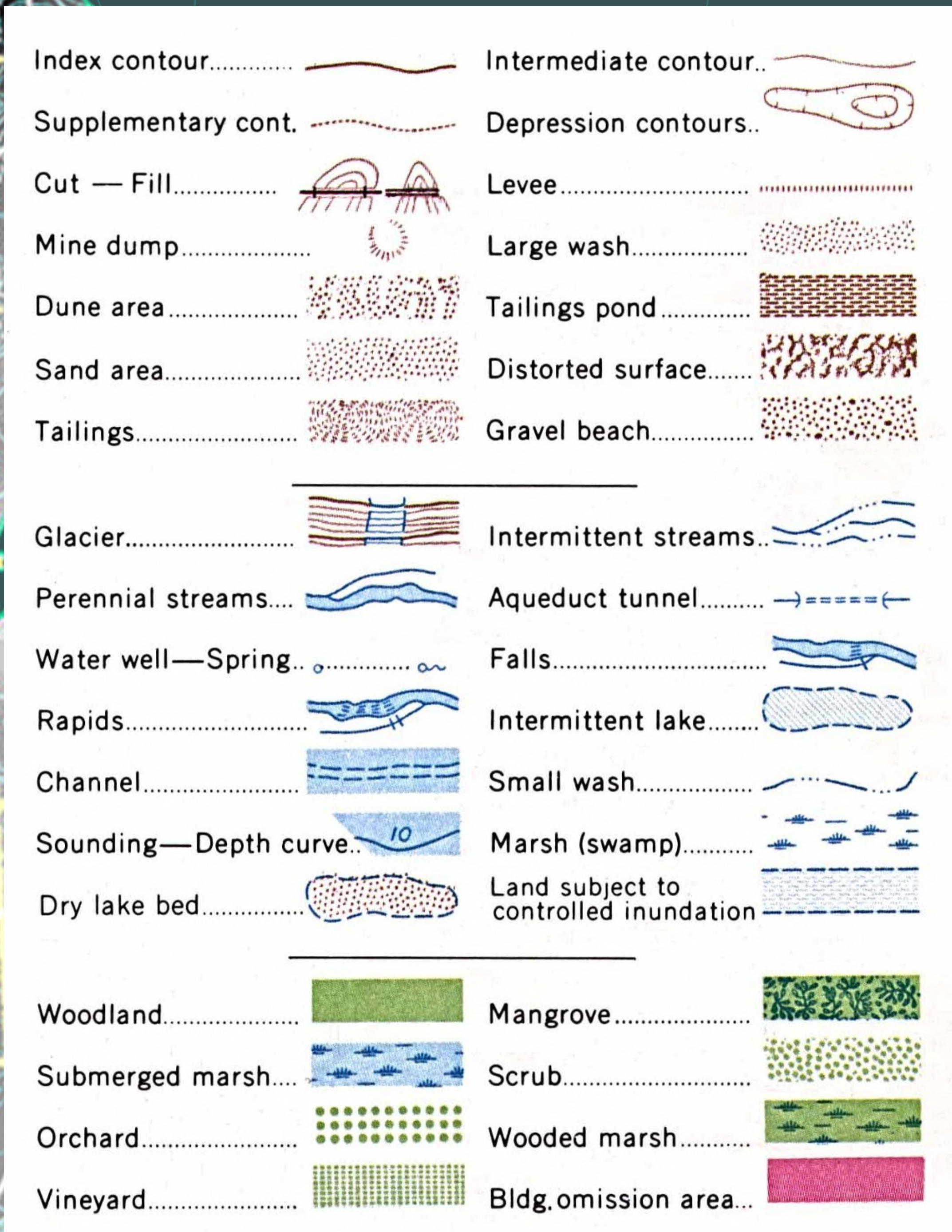
Township Range Land Survey

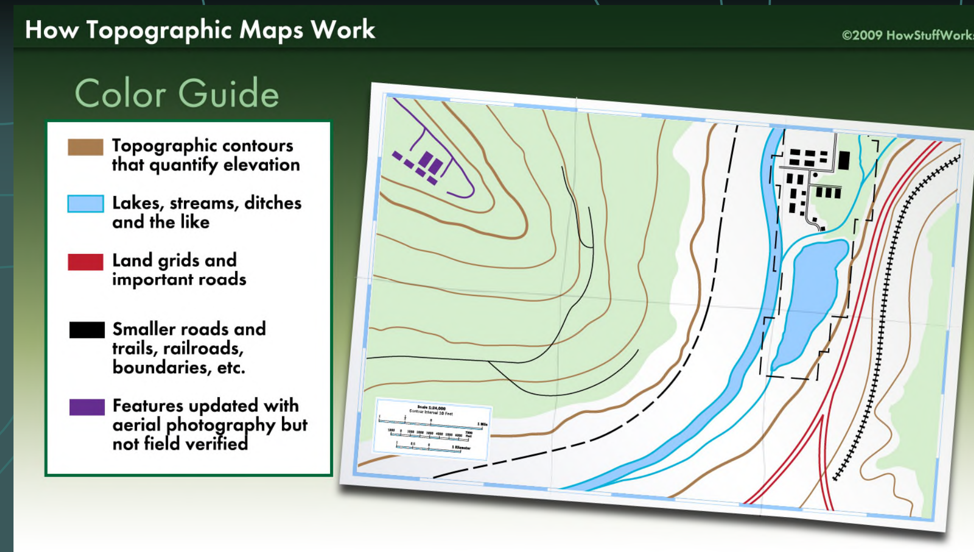


Township Range Land Survey



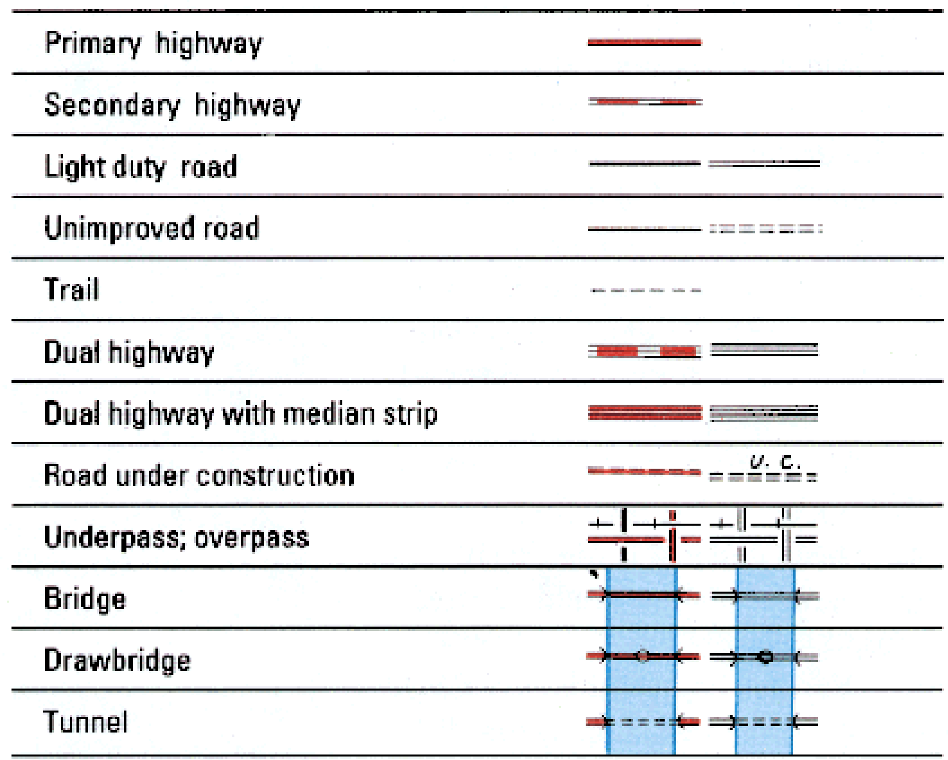
Topo Map Symbols





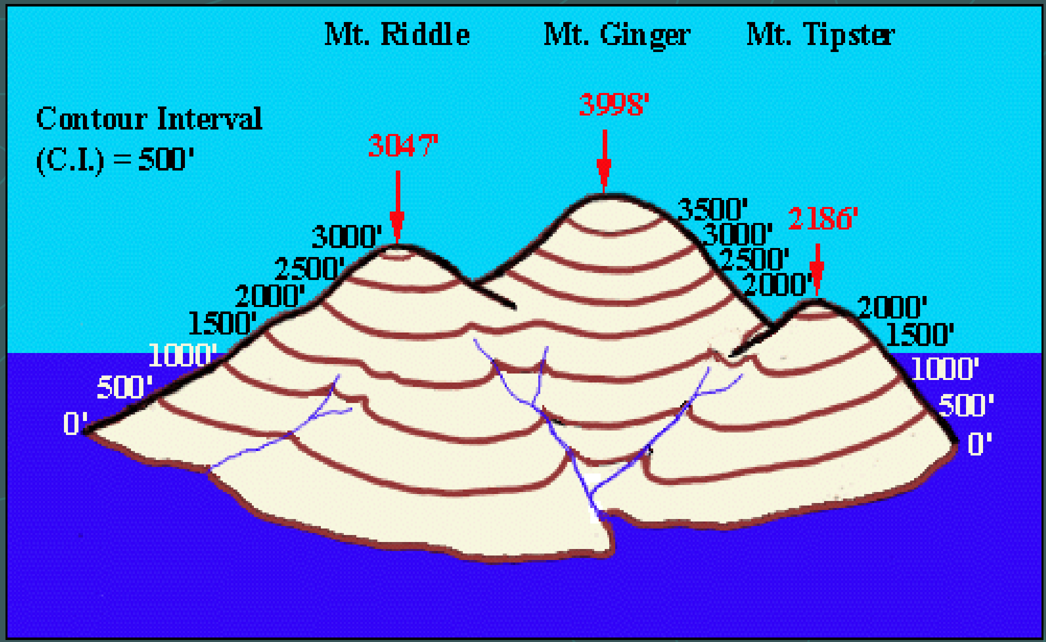
ROADS AND RELATED FEATURES

Roads on Provisional edition maps are not classified as primary, secondary, or light duty. They are all symbolized as light duty roads.



Understanding Elevation Contour Lines

1) Elevation contours are imaginary lines that join points of equal elevation on a topo map with a reference surface level - such as sea level - equal to zero.

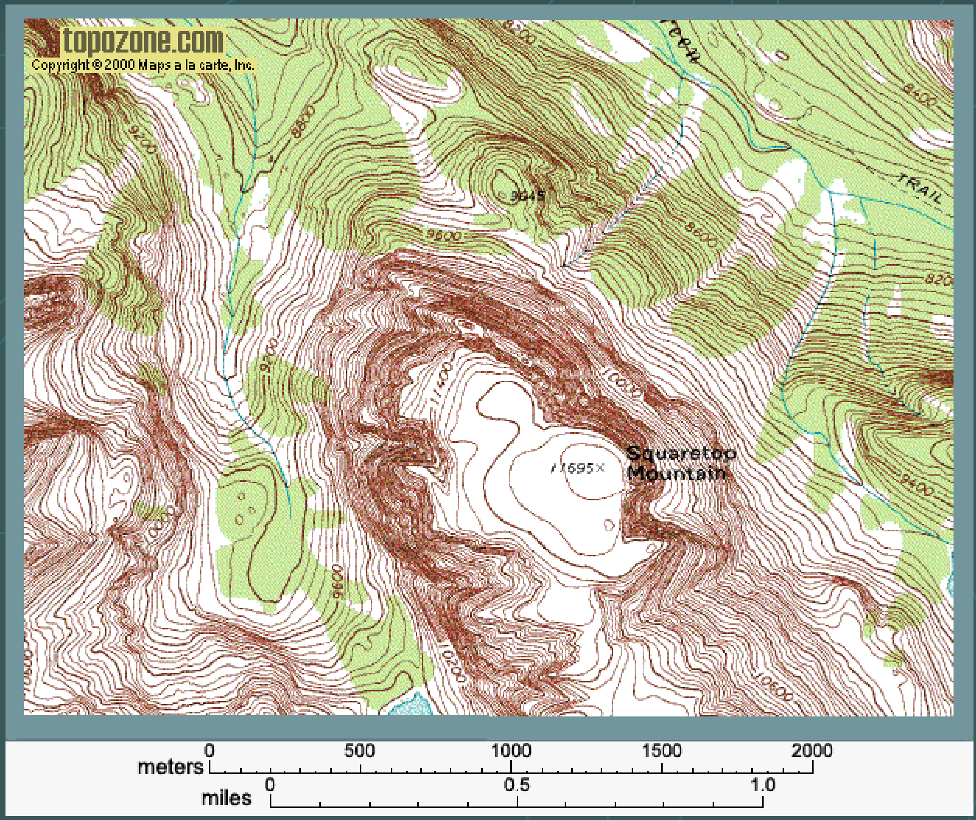


2) Contours make it possible to measure the height of mountains, depths of the ocean bottom, and steepness of slopes.

3) Contour line patterns also make it possible to decipher slope gradients, landform type and arrangement on a topo map

Rules of Contour Line

1) Contour lines never cross
2) Widely spaced contours indicate a gradual slope
3) Tightly-spaced lines indicate a steep slope
4) "V"-shaped contour pattern indicate either a valley or ridge line



- ✓ The "V" points toward higher area = valley
- ✓ The "V" points toward lower area = ridge

5) "Bull's Eye" contour pattern indicate a peak or basin

- ✓ Center of "bull's eye" is highest point = peak
- ✓ Center of "bull's eye" is lowest point = basin

RULES FOR CONTOUR LINES

Every point on a contour line is of the exact same elevation; that is, contour lines connect points of equal elevation.

Contour lines always separate points of higher elevation (uphill) from points of lower elevation (downhill). You must determine which direction on the map is higher and which is lower, relative to the contour line in question, by checking adjacent elevations.

Contour lines always close to form an irregular circle. But sometimes part of a contour line extends beyond the mapped area so that you cannot see the entire circle formed.

The elevation between any two adjacent contour lines of different elevation on a topographic map is the *contour interval*. Often every fifth contour line is heavier so that you can count by five times the contour interval. These heavier contour lines are known as *index contours*, because they generally have elevations printed on them.

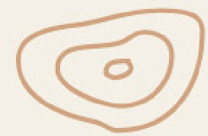
Contour lines never cross one another except for one rare case: where an overhanging cliff is present. In such a case, the hidden contours are dashed.

Contour lines can merge to form a single contour line only where there is a vertical cliff.

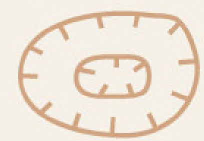
Evenly spaced contour lines of different elevation represent a uniform slope.

8. The closer the contour lines are to one another the steep the slope. In other words, the steeper the slope the close the contour lines.

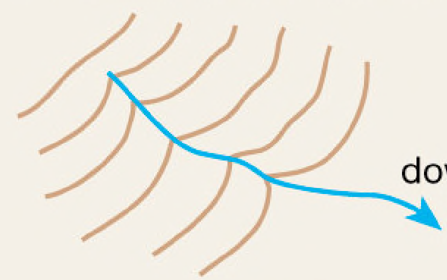
9. A concentric series of closed contours represents a hill:



10. *Depression contours* have hachure marks on the downhi side and represent a closed depression:



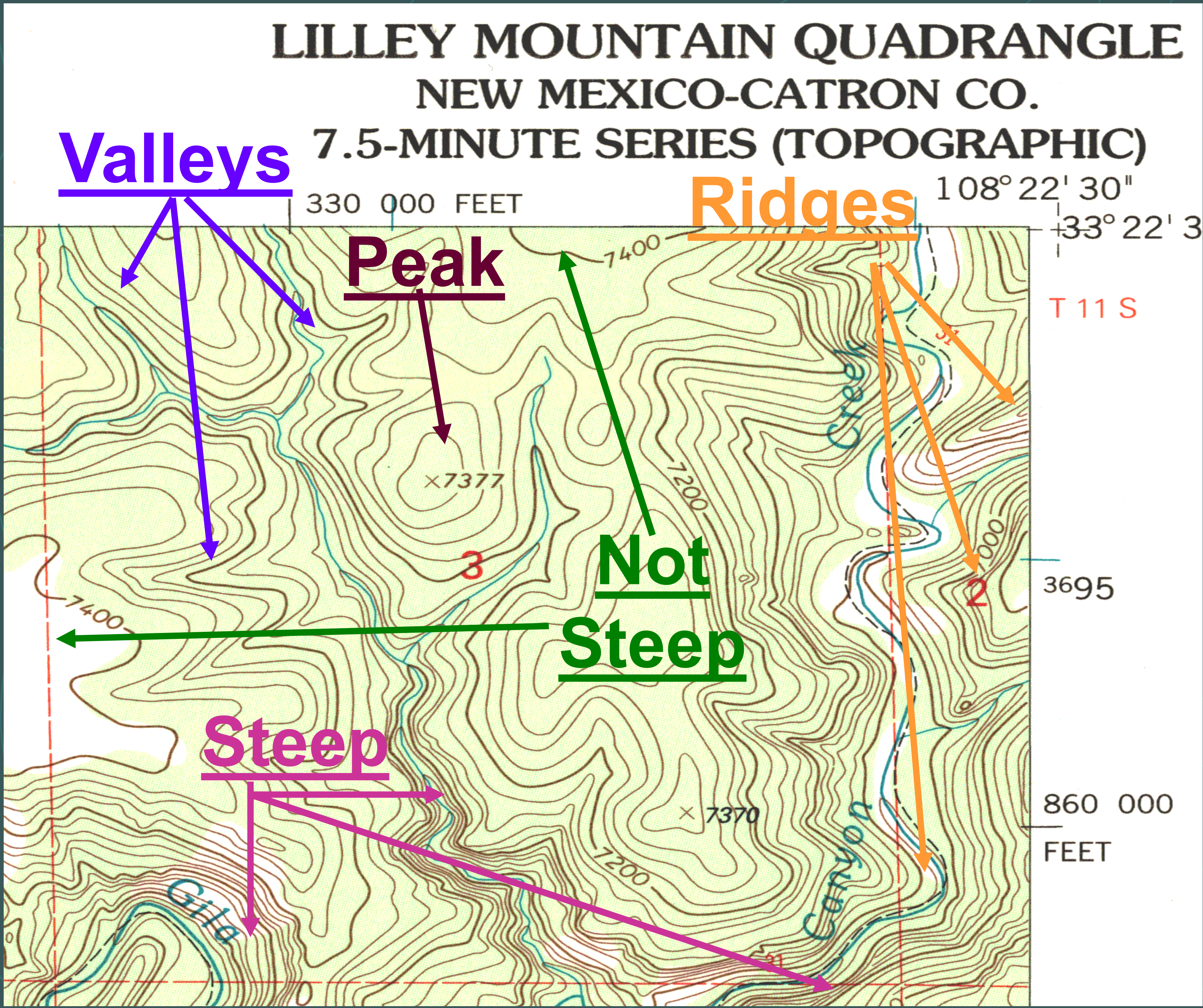
11. Contour lines form a V pattern when crossing streams. The apex of the V always points upstream (uphill):



12. Contour lines that occur on opposite sides of a valley always occur in pairs.

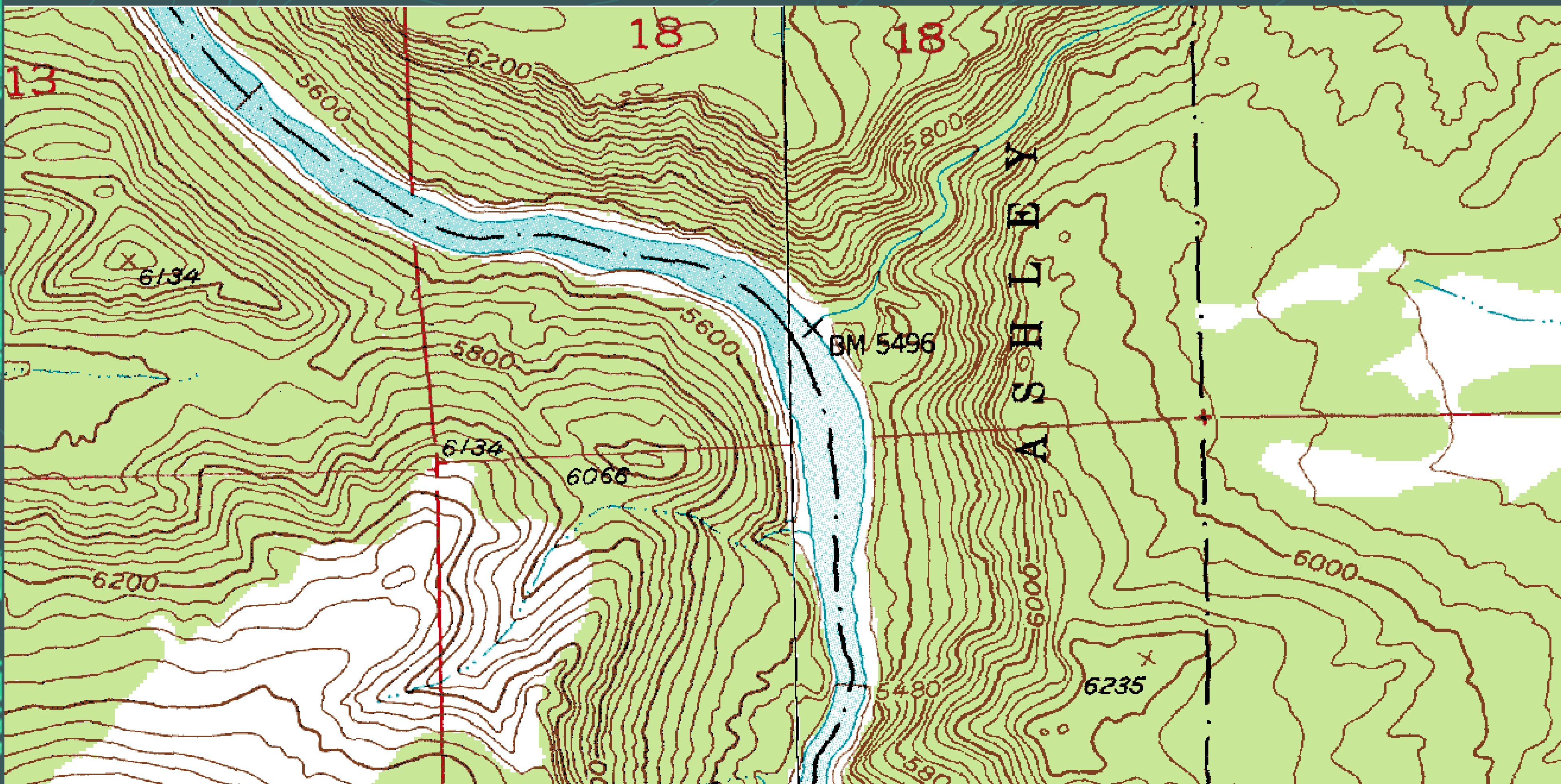
13. Topographic maps published by the U.S. Geological Survey are contoured in feet or meters referenced to sea level.

Example for Understanding Contour Rules



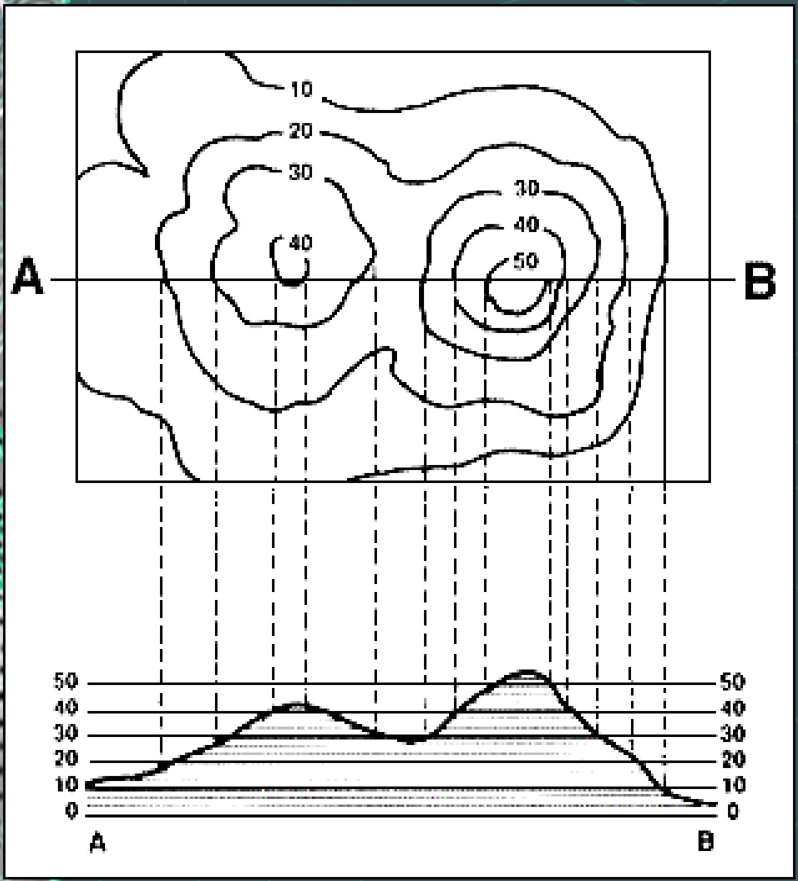
Can You Point Out These Features?

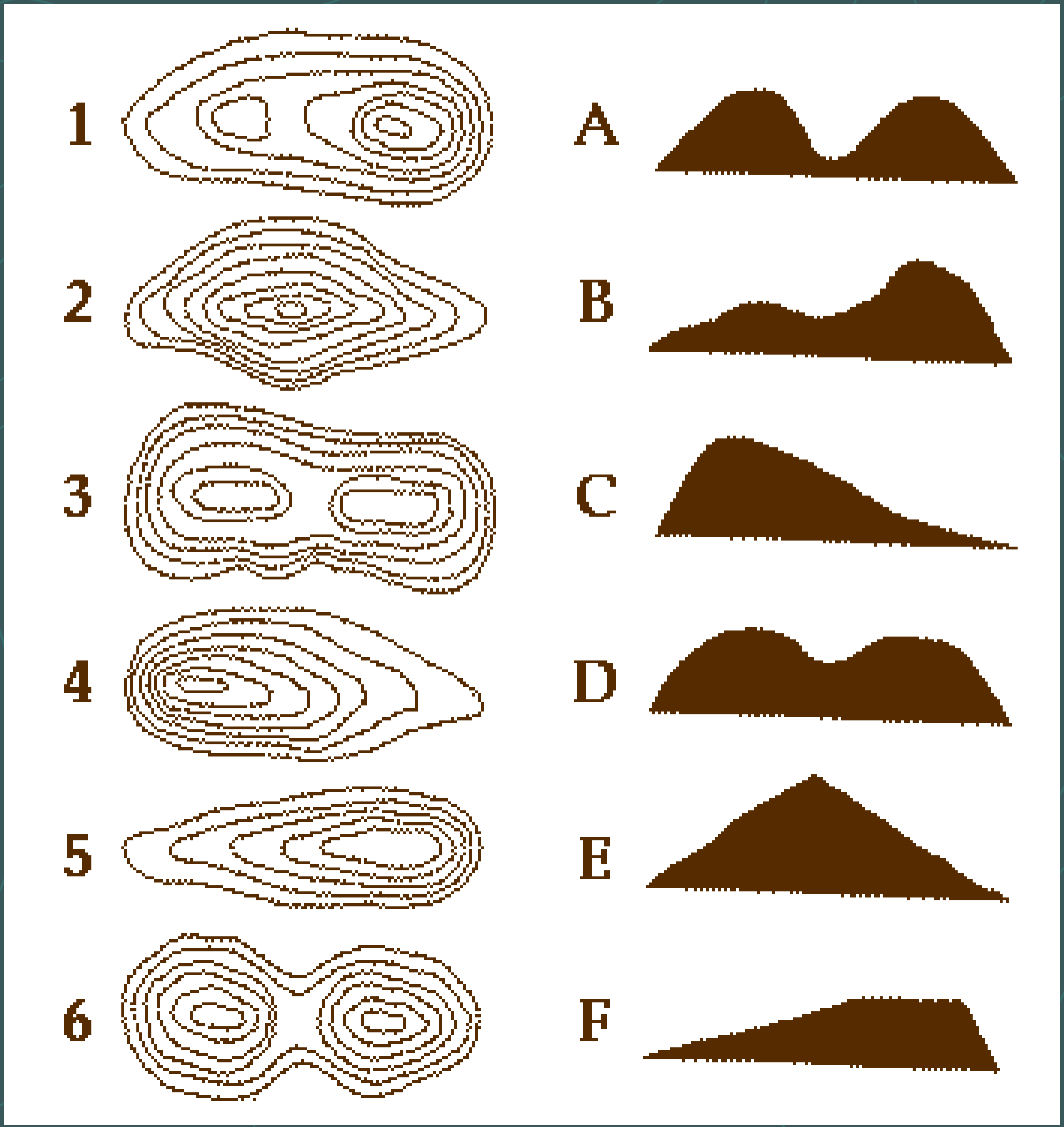
1) Valleys
2) Ridges
3) Steep terrain
4) Not Steep terrain
5) Peak tops
6) Total relief of map



Question: Which way does the river flow? North or South?

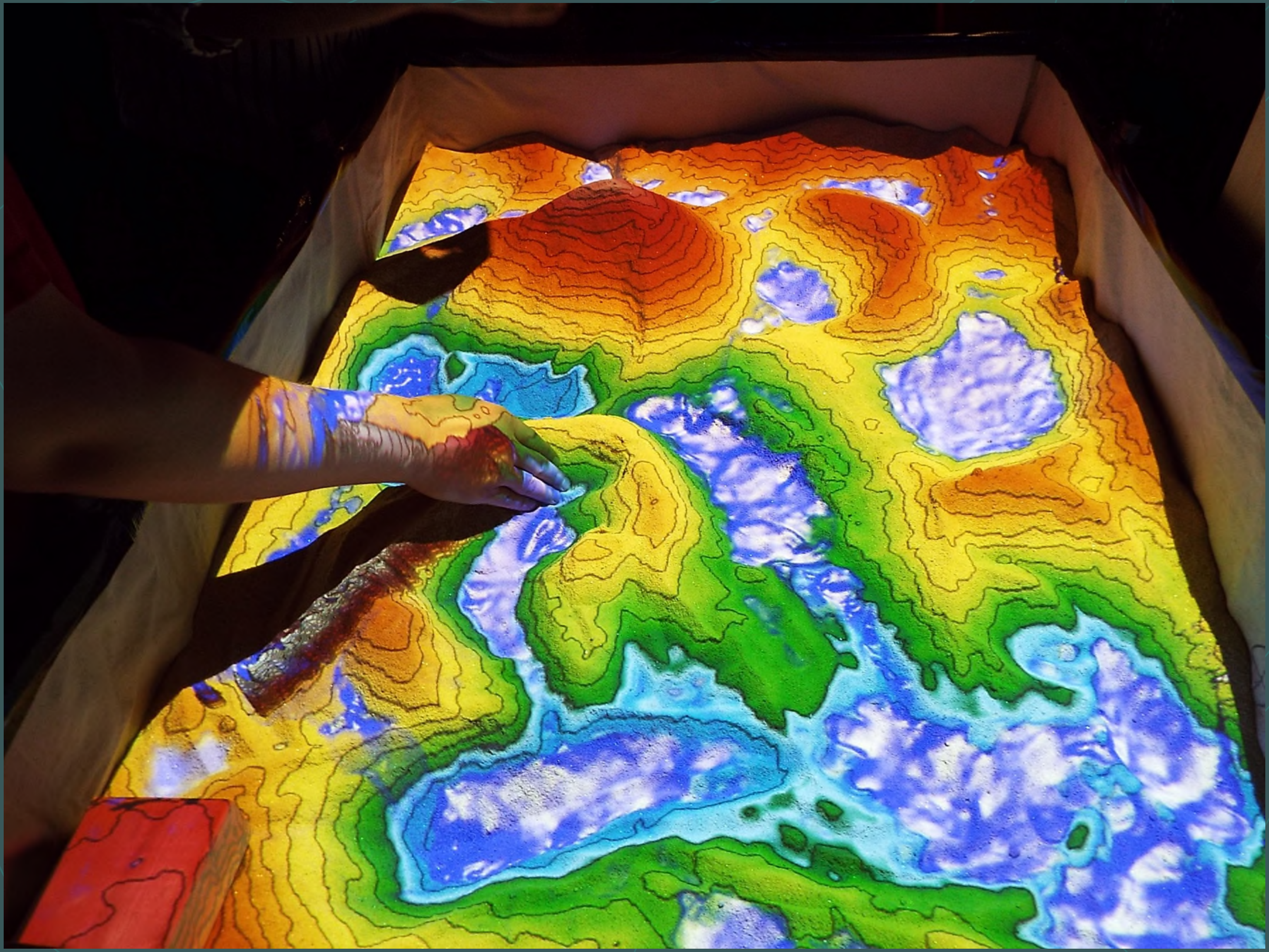
Contours Line Patterns and Landforms



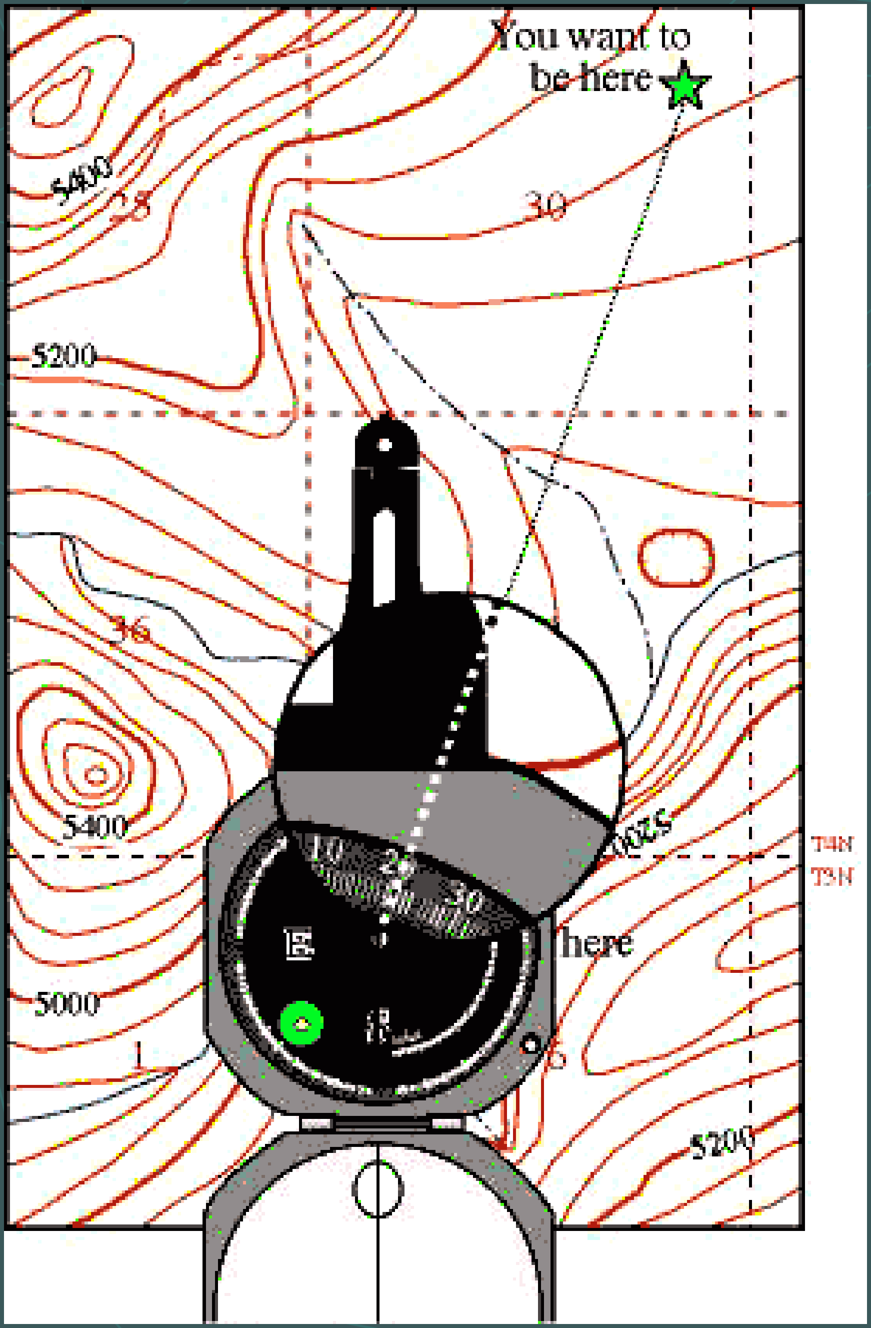


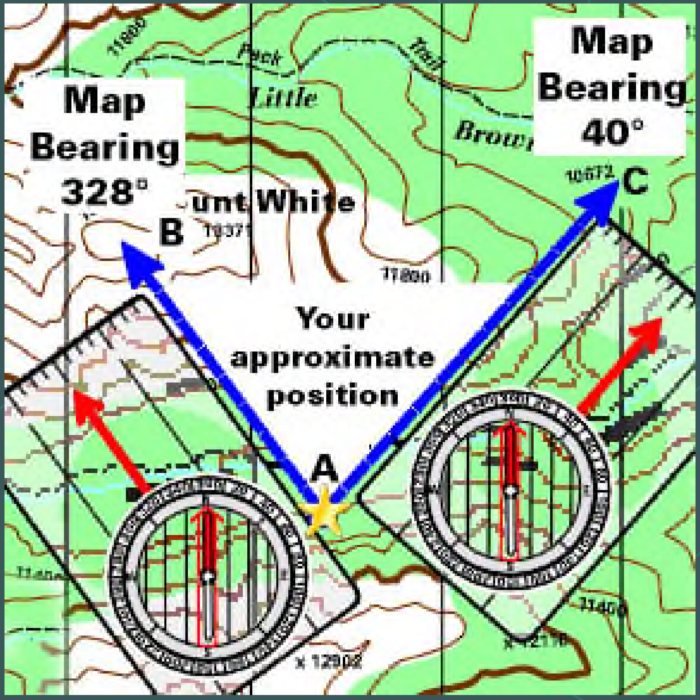
Match the Contours Line Patterns with the Hill Shape

Topo Sandbox Activity



Determining Compass Bearing on a Map





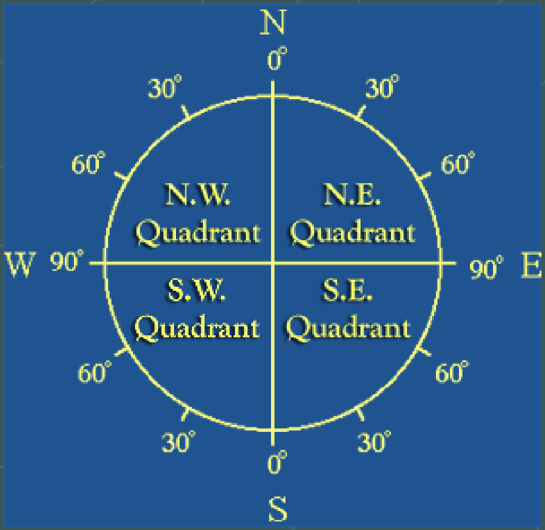
Determining Map Bearing and Distance

Understand Map Direction

1) Cardinal Directions

2) Azimuth versus Quadrant Notation

3) Difference between True Bearing *Versus* Magnetic Bearing

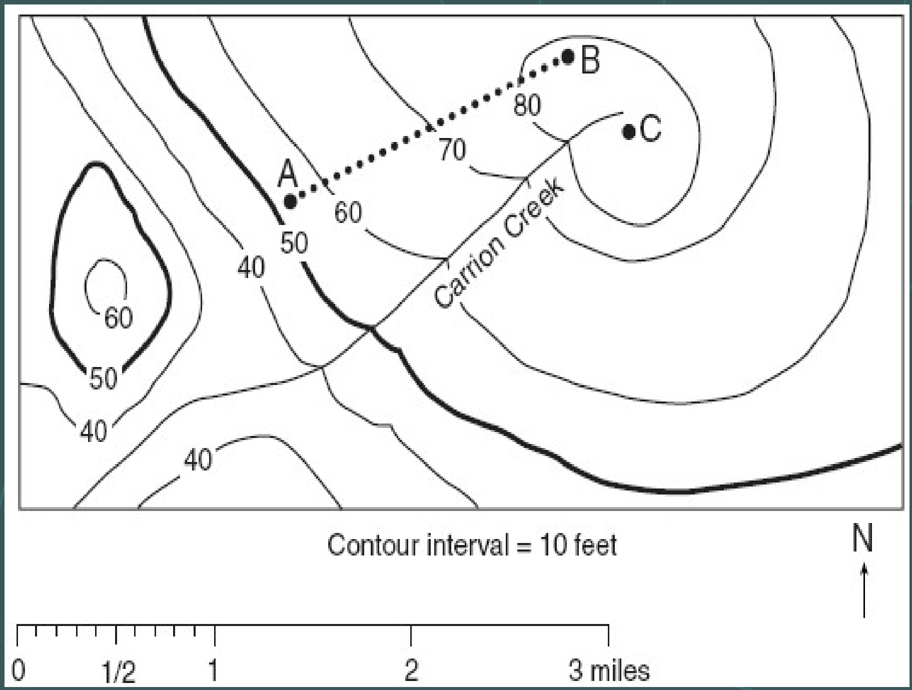


Understand Map Distance

1) Distance from One Point to Another along a Straight Line

2) Converting from Map Distance to Real Ground Distance

Going From Point "A" to "B"

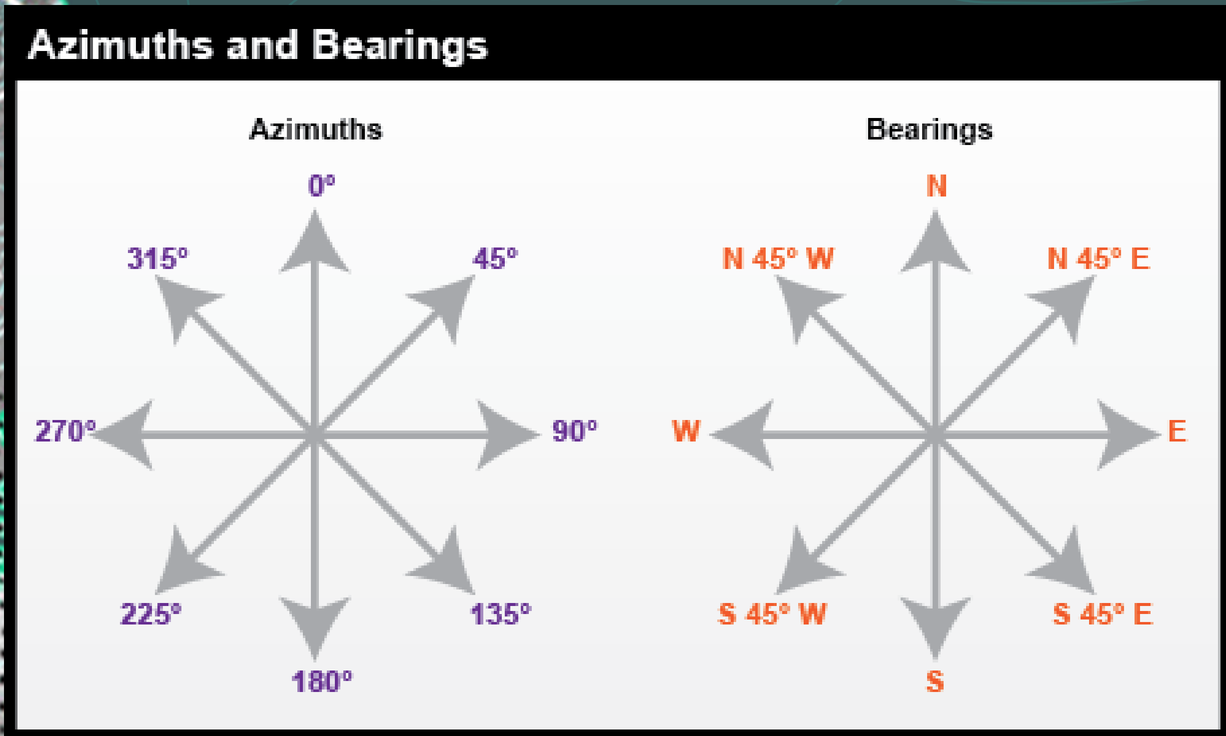


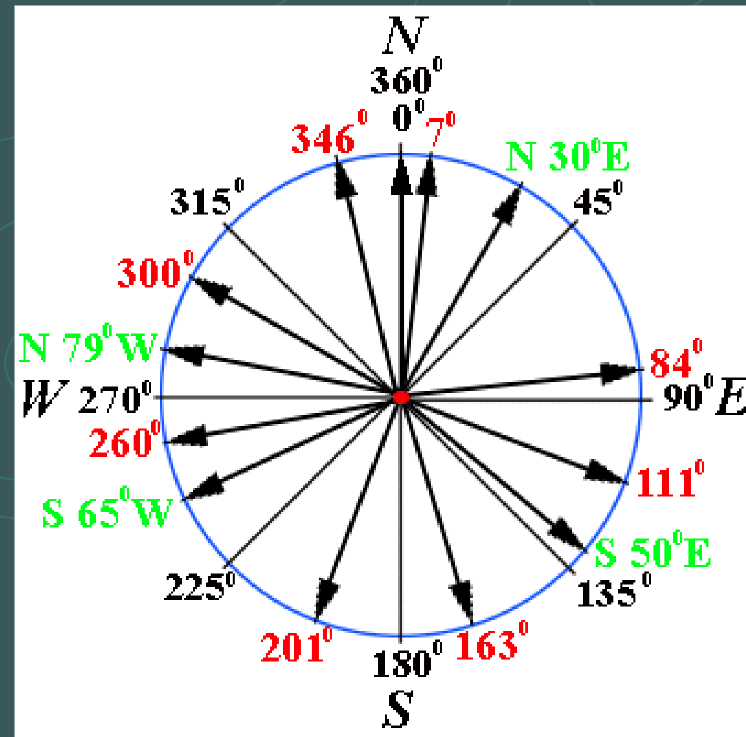
Map Direction as a Compass Bearing

Compass Bearing

- A bearing is the ***direction*** from one point to another
- If direction is expressed in degrees east or west of north, it is called a "***quadrant bearing***."
- If direction is expressed in degrees between 0 and 360, it is called "***azimuth bearing***."

Map Direction – Azimuth and Quadrant



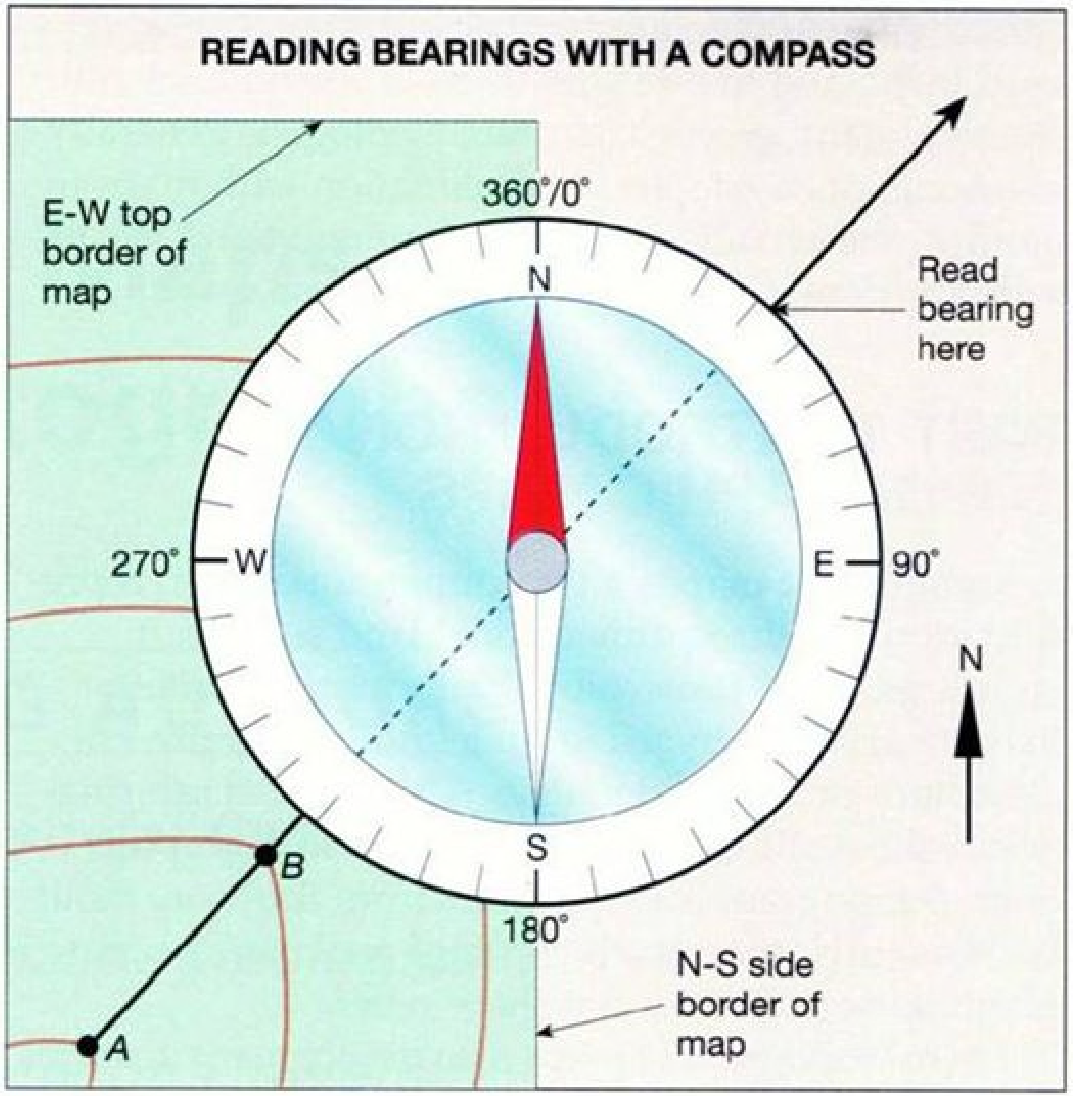


1) Azimuth measures direction from north (zero) 360 degrees clockwise around compass (E=90 – 180=S – 270=W)

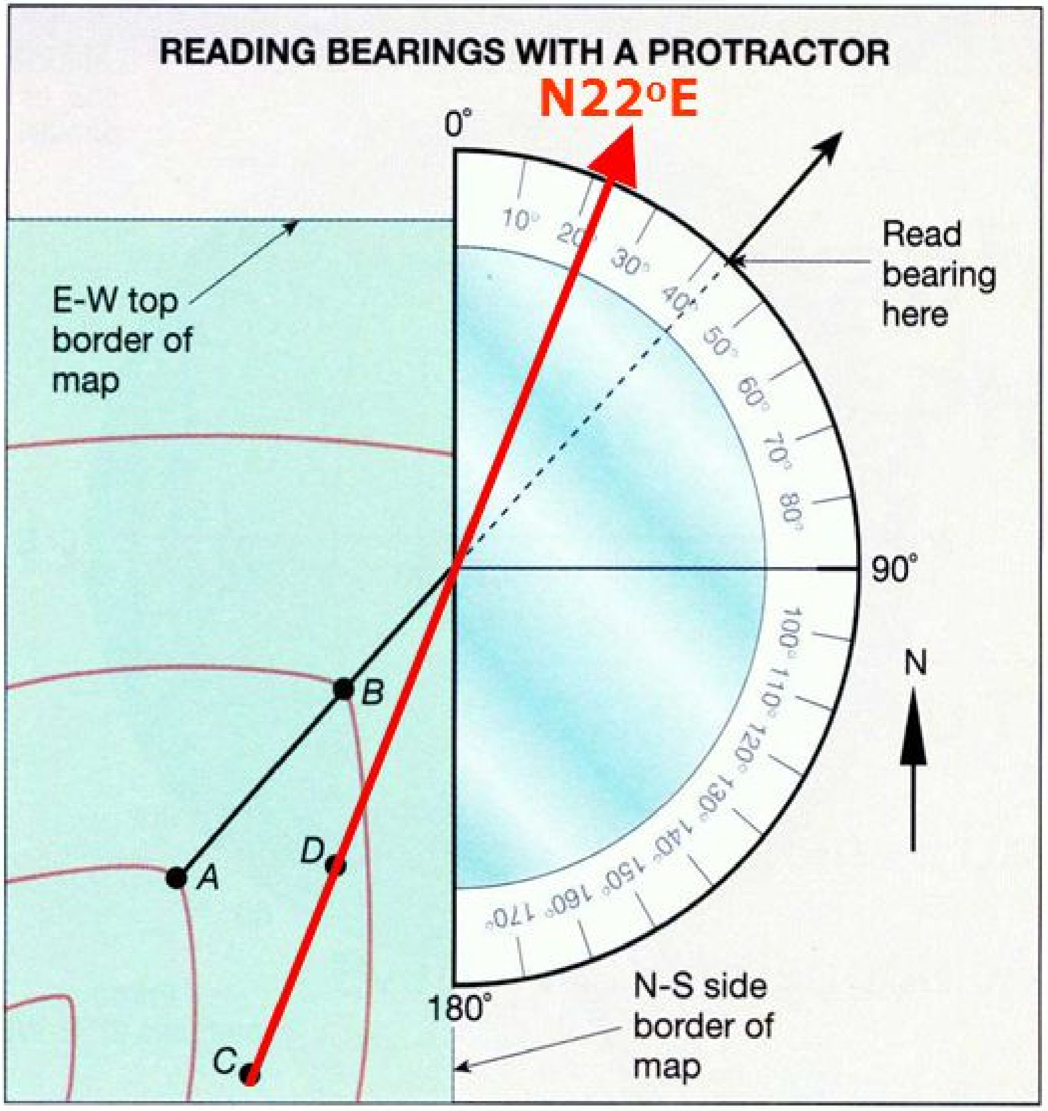
2) Quadrant measures direction: either North or South; then so many degree off of N or S; then either toward West or East

3) Difference between True Bearing *Versus* Magnetic Bearing

Azimuth Bearing



Quadrant Bearing



What is the bearing from C to D?

Determining Map Bearing with Protractor

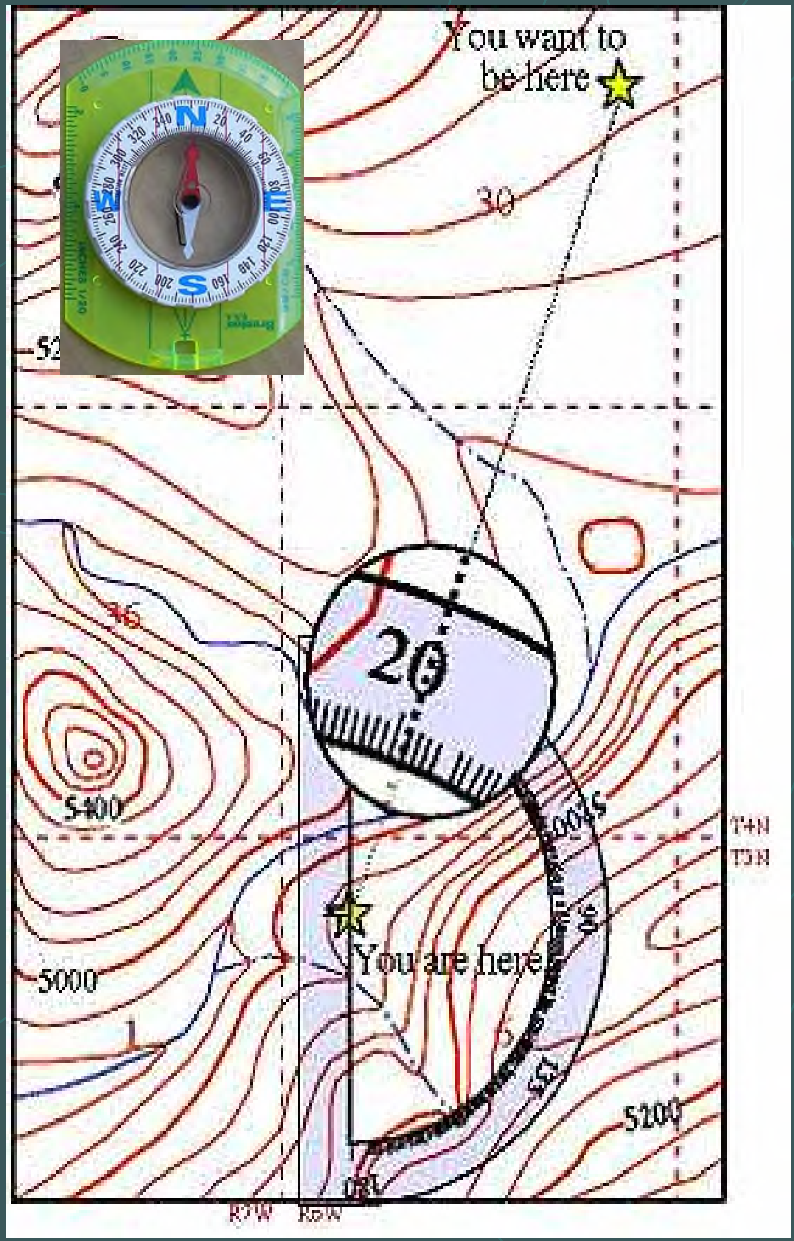
Three Basic Steps

1) Locate your present position

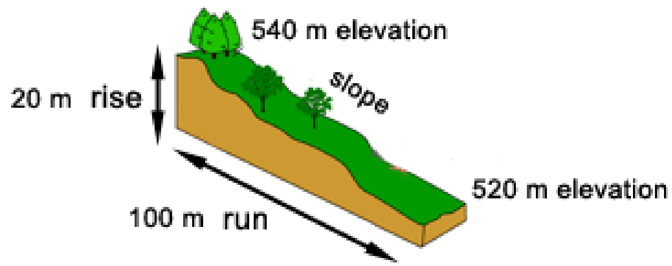
2) Locate the position you want to establish a bearing to

3) Use a properly positioned protractor to determine the true bearing from your location to the other position

4) Measure the bearing as either an azimuth or a quadrant bearing

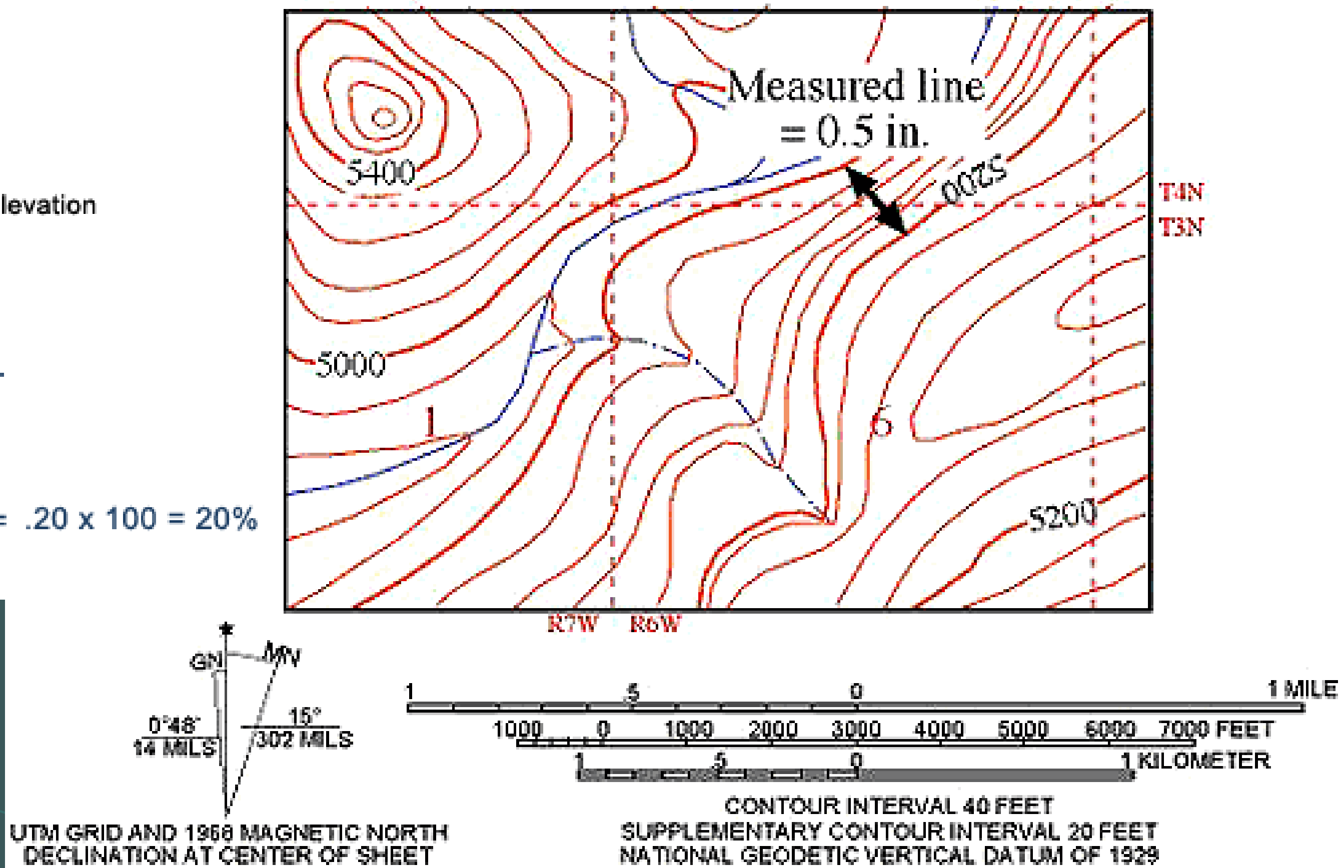


Topographic Slope Gradient / Slope Angle



$$\text{Slope} = \frac{\text{height difference (m)}}{\text{horizontal difference (m)}}$$

$$\text{Slope} = \frac{540\text{ m} - 520\text{ m}}{100\text{ m}} = \frac{20\text{ m}}{100\text{ m}} = .20 \times 100 = 20\%$$



Determining hillslope from a topographic map

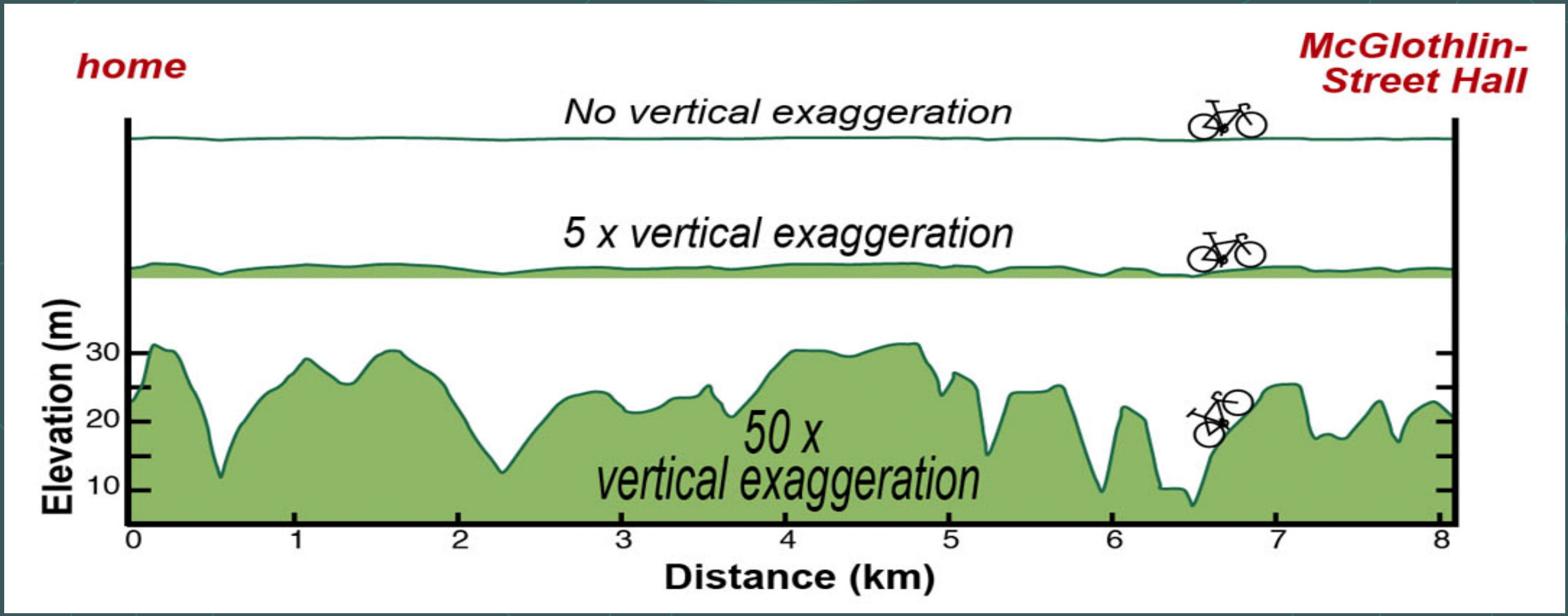
Length of measured line = 0.5 in, 0.5 in x $\frac{2000\text{ ft}}{1\text{ in}}$ = 1000 ft (.19 mi)= horizontal distance

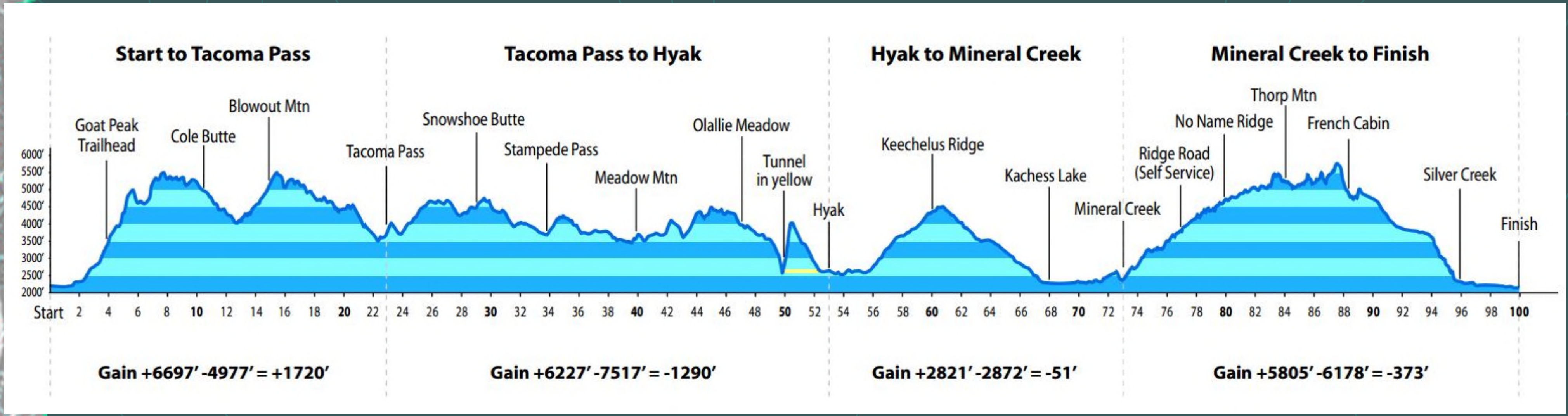
Elevation change = 200 ft. (read off of contour lines)

Percent slope = $\frac{200\text{ ft.}}{1000\text{ ft.}}$ x 100 = 20% slope

Slope angle = arctan $\left(\frac{200\text{ ft.}}{1000\text{ ft.}}\right)$ = 11.3° slope

Topographic Profile – Vertical Exaggeration





Map Activity #1 – Trout Run Topo Map

1) What is the distance across the bottom of the map (miles)**?**

Answer: The above map is roughly _____ miles across (from left side to right the side).

2) What is the magnetic declination? (See symbol In the upper left hand corner of map).

Answer: ______ (# of degrees) _____ (E or W)

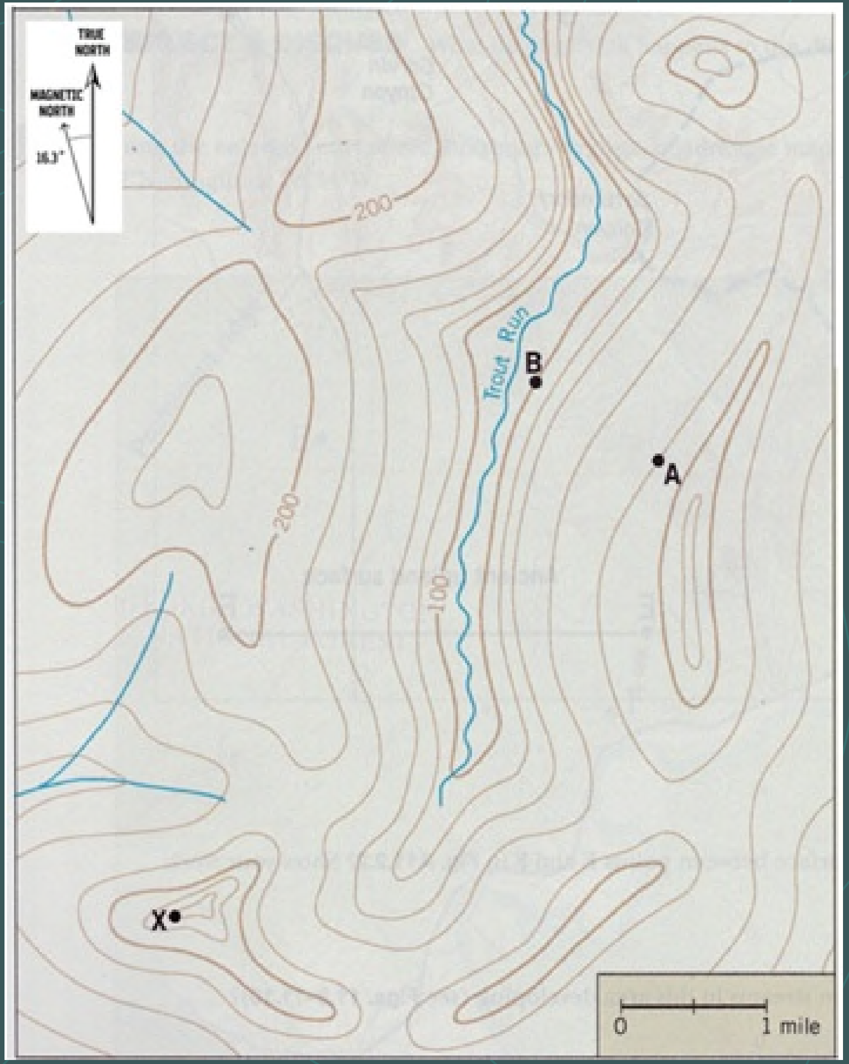
3) What is the contour interval? (Difference in elevation from one line to the next) ______feet

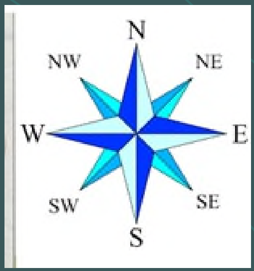
4) What's the **index** contour interval? (Difference in elev. from one thick line to the next) _____ feet

5) What is the elevation of Point "A"? (Hint: elevation of the thin index contour line at "A") ______ feet

6) What is the elevation of Point "B"? (Hint: elevation of the thick index contour line at "B") ______ feet

7) What is the elevation of Point "X"? (Hint: elevation of the thin index contour line at "X") ______ feet





Map Activity #2 – Math Park Topo Map

1) What is the distance across the map - West to East (from A-A’) (in miles)? ________ miles

2) Contour interval? ______feet

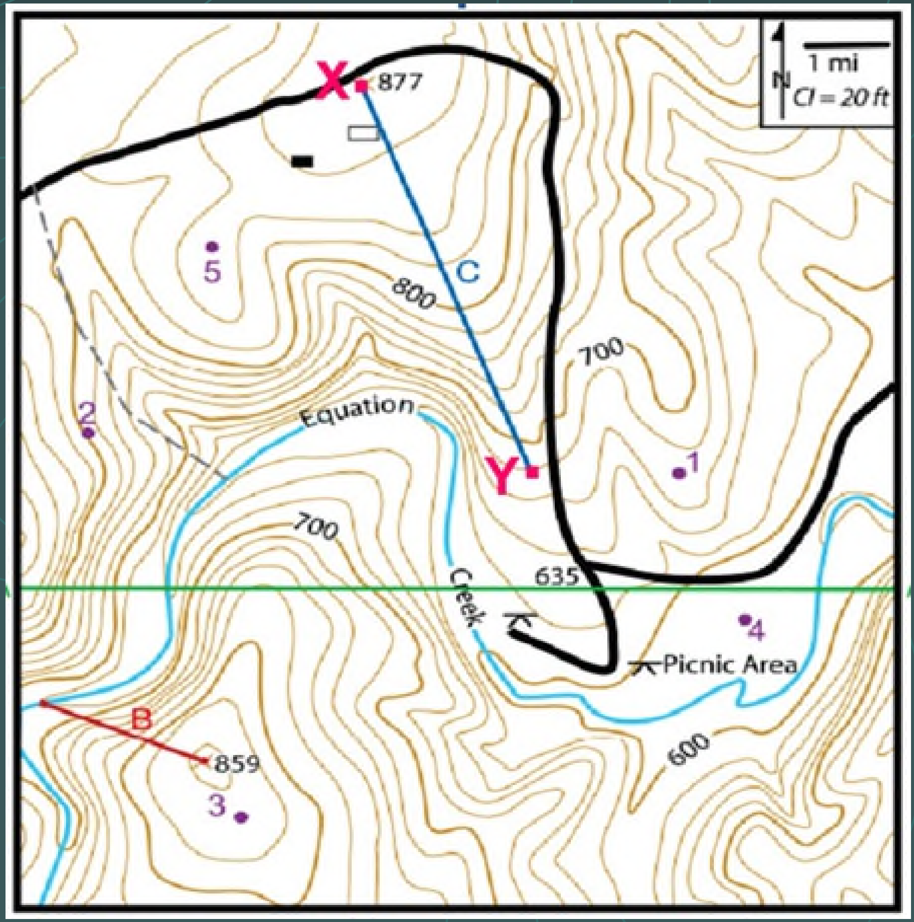
3) Index contour interval? ____ feet

4) Location with **lowest** elevation? (Points 1, 2, 3, 4, or ________

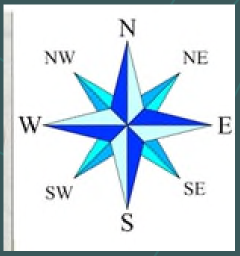
5) Location with **highest** elevation? (Points 1, 2, 3, 4, or ________

6) Elevation of the Picnic Area? _______ feet

7) Estimated elevation of Point 5? _____ feet



8) Ground distance from Point “X” to Point “Y” (in miles)? ________ miles.



9) Bearing (direction) from Point “X” to Point “Y”?
North; Northeast; East; Southeast; South; Southwest; West; Northwest

10) Direction Equation Creek flow? East? or West? _______________

11) Location with more <u>steeper</u> slope? Location “X” or “Y”? __________

Sweeney Pass, CA Topographic Map

SWEENEY PASS QUADRANGLE
CALIFORNIA–SAN DIEGO CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

Mapped, edited, and published by the Geological Survey

Control by USGS, USC&GS, USCE, and State of California

Topography from aerial photographs by photogrammetric methods
Aerial photographs taken 1957. Field check 1959

Polyconic projection. 1927 North American datum
10,000-foot grid based on California coordinate system, zone 6
1000-meter Universal Transverse Mercator grid ticks, zone 11, shown in blue

To place on the predicted North American Datum 1983 move the projection lines 4 meters south and 78 meters east as shown by dashed corner ticks
Dashed land lines indicate approximate locations
Unchecked elevations are shown in brown
There may be private inholdings within the boundaries of the National or State reservations shown on this map

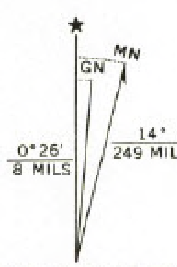
SCALE 1:24 000

1 ½ 0 1 MILE

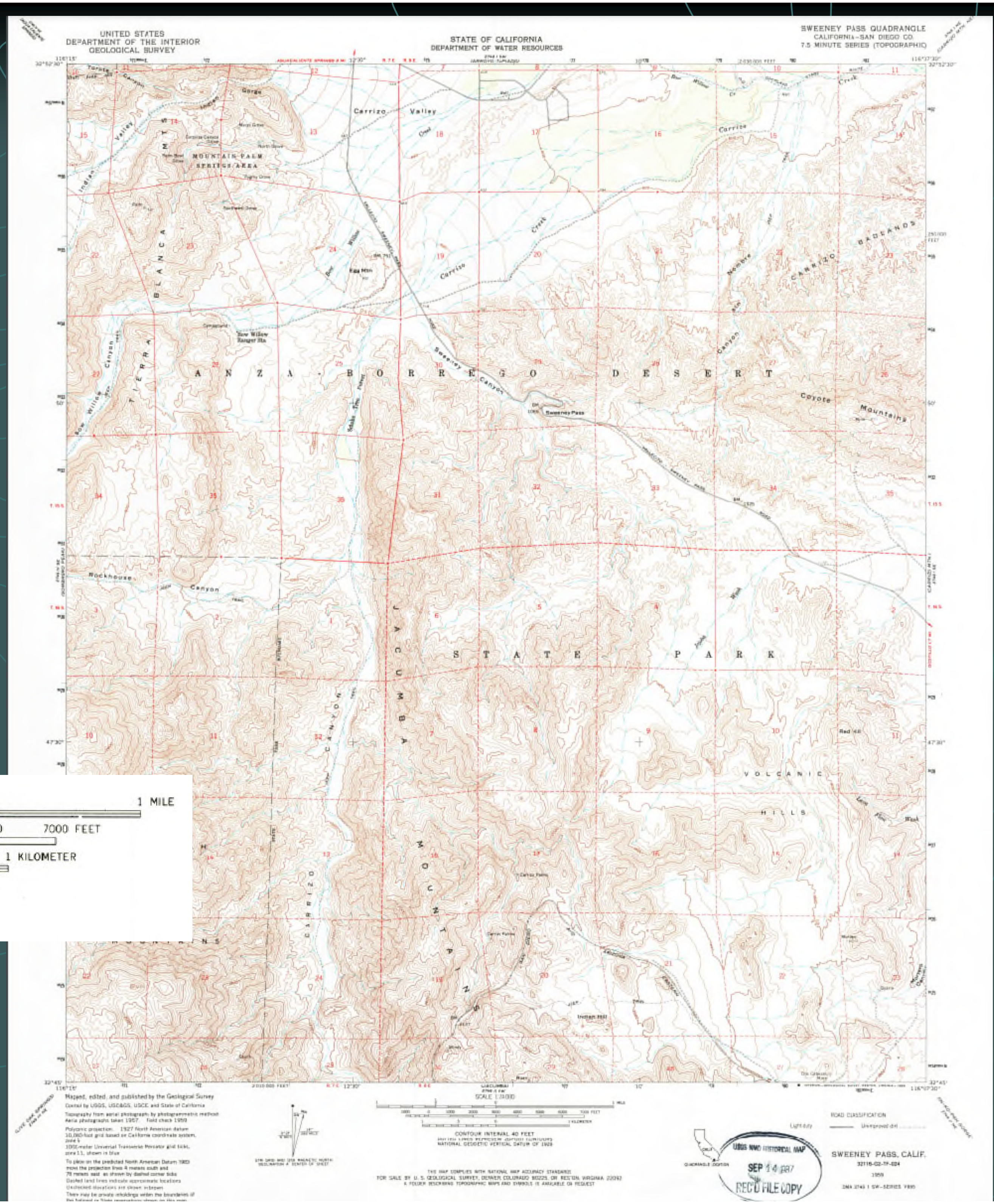
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

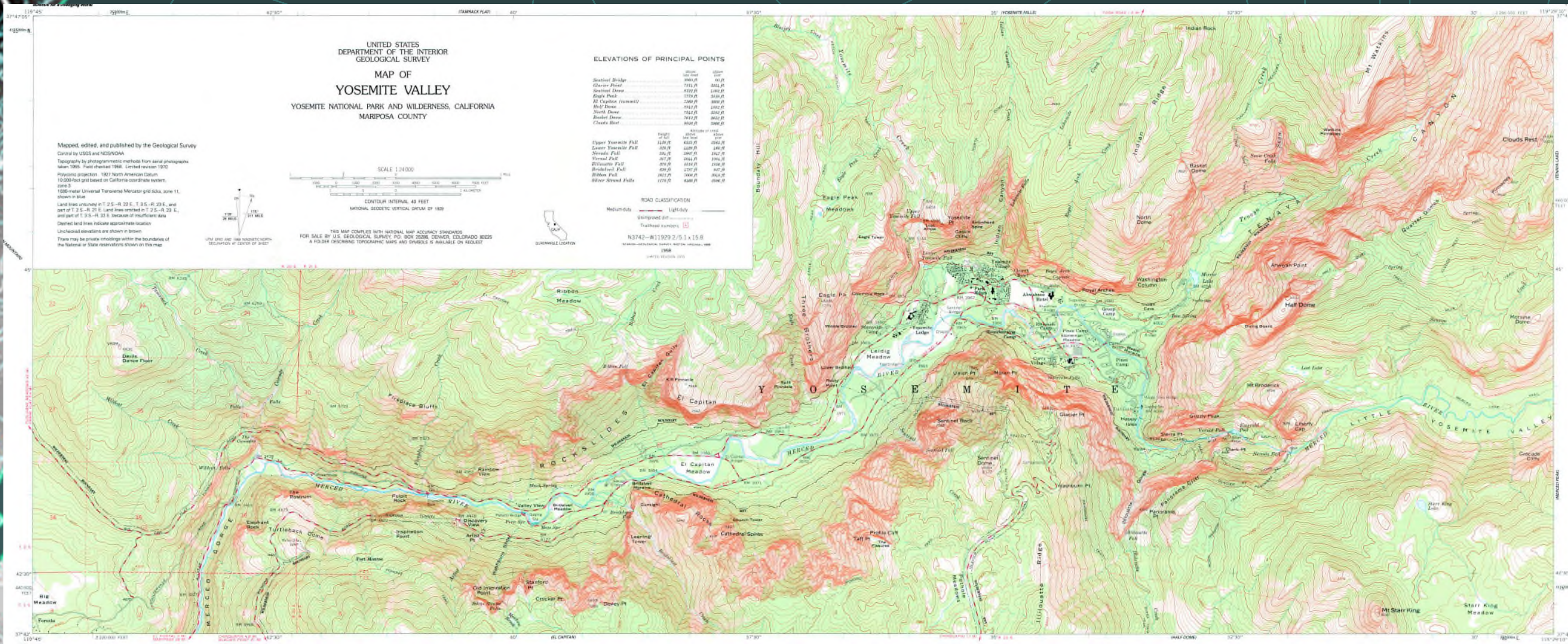
CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929



UTM GRID AND 1959 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

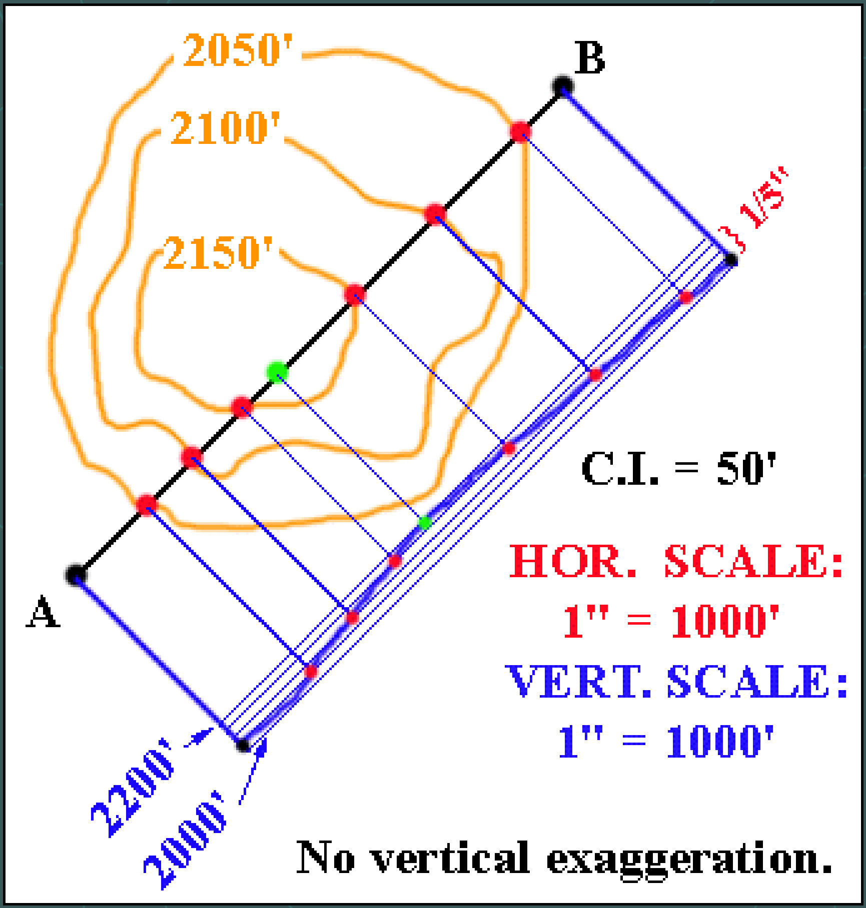


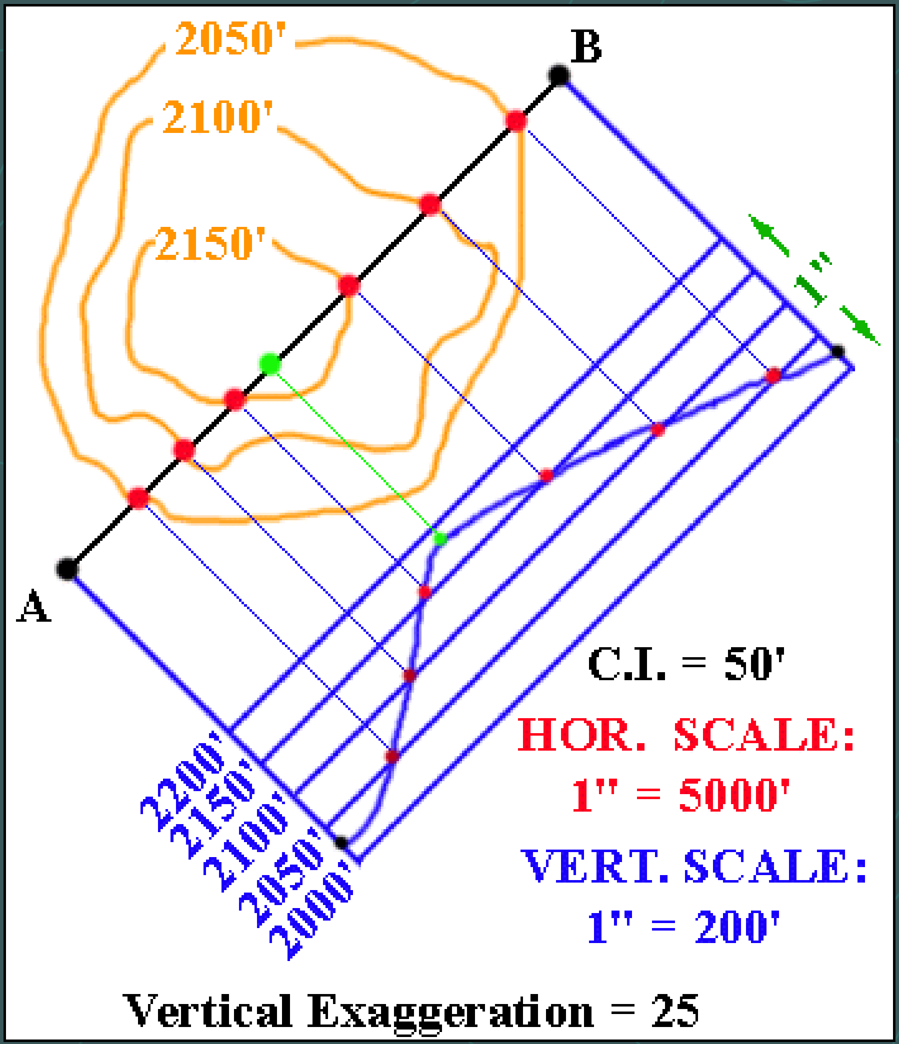
Yosemite Valley Topographic Map



1) Map scale
2) Map distances
3) Magnetic declination
4) Contour interval
5) Elevations
6) Latitude and Longitude
7) Bearings
8) Landform features
9) Slope gradient
10) Topographic profile
11) Drainage patterns

Topographic Profile – Vertical Exaggeration

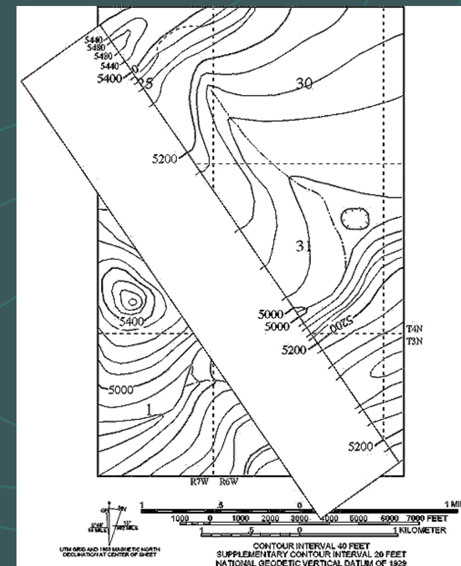




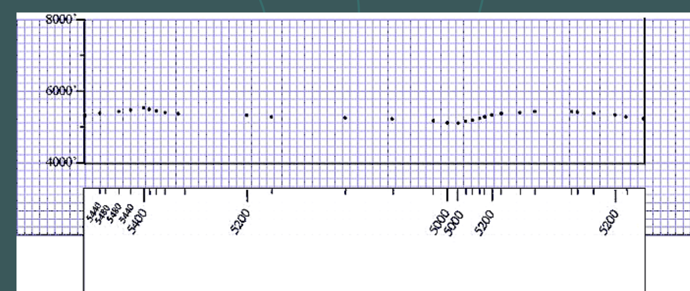
Creating Topographic Profiles

Three Basic Steps

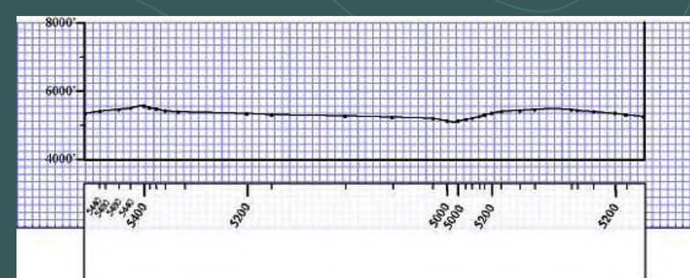
1) Copying contour map data onto paper strip



2) Transferring paper strip contour data onto labeled profile graph as a set of dots



3) Connecting the dots together as a smooth line

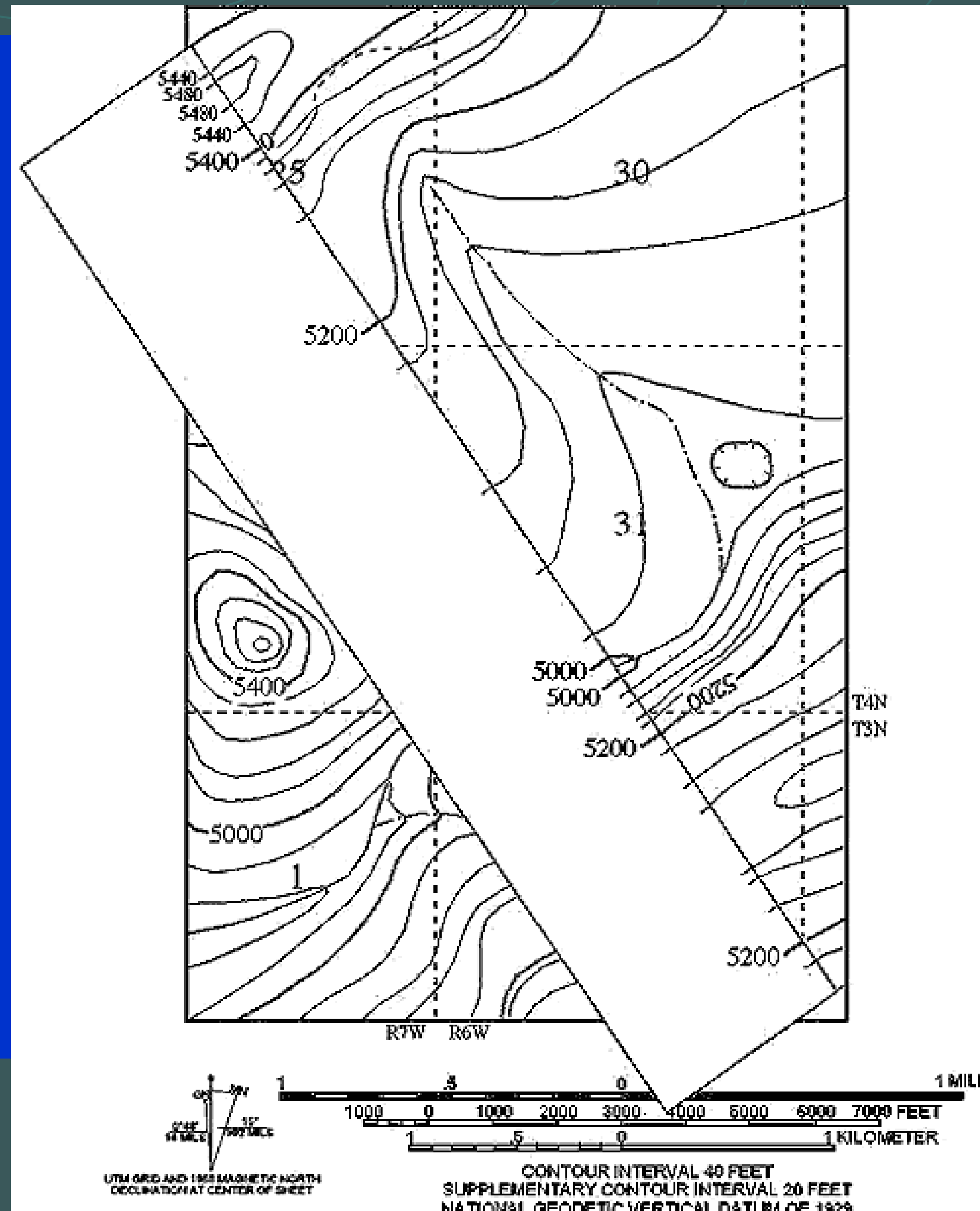


Creating a Topographic Profile

Step 1 –

Mark and label a continuous set of elevation/depth contour points along a predetermined transverse across the map onto a strip of paper

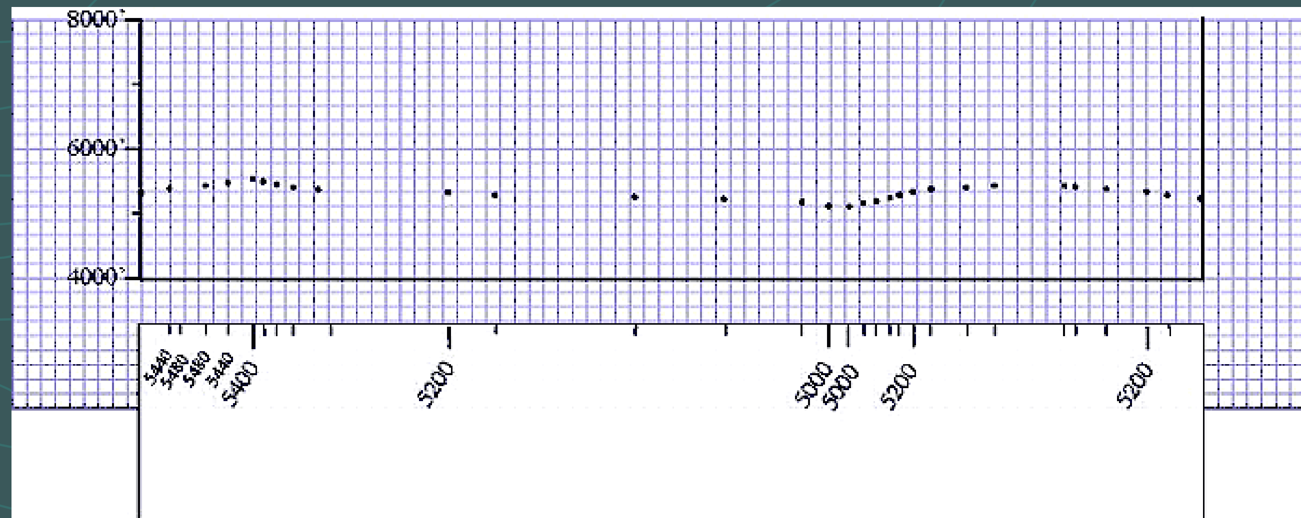
You will then use the strip of paper with the contour information to create a cross-section profile of the map transverse on a piece of graph paper



Creating a Topographic Profile

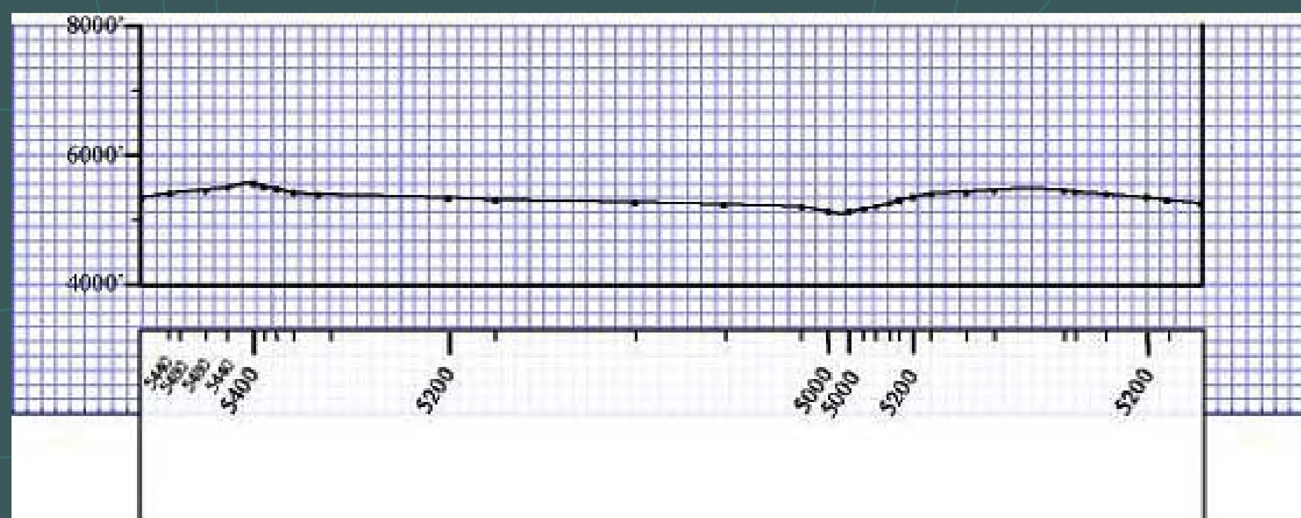
Step 2 -

Transfer contour info from strip of paper onto properly labeled graph paper as a set of dots that mark elevation or depth

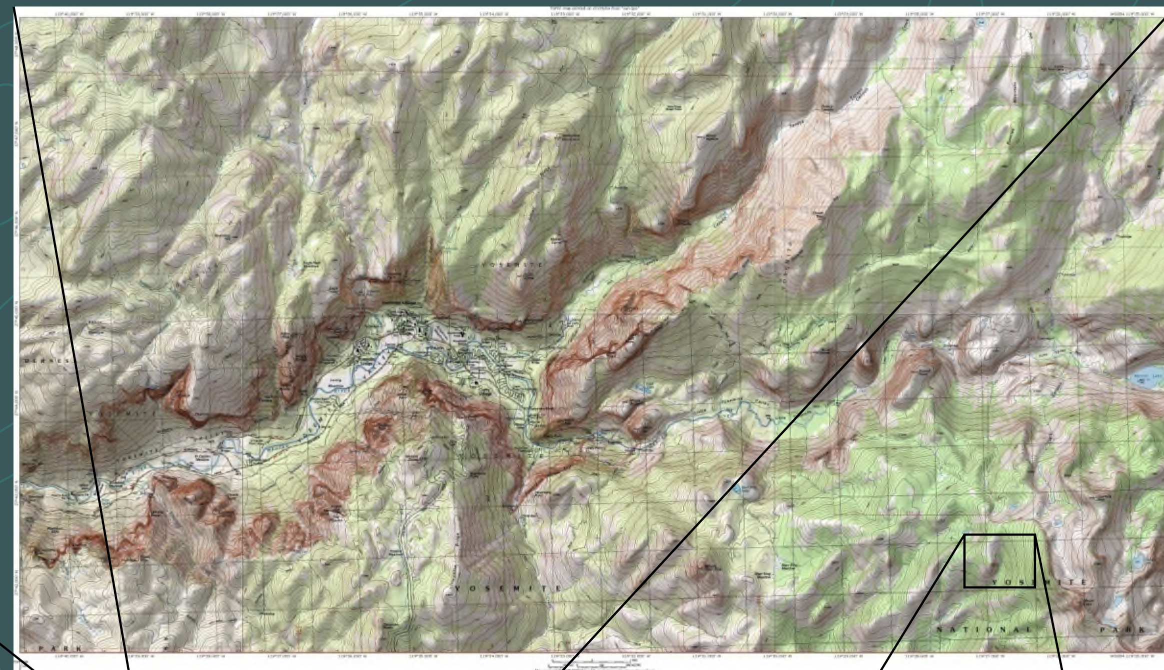


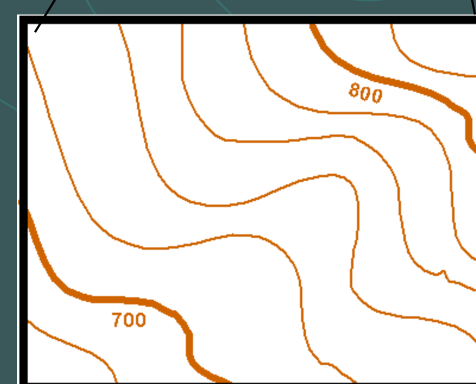
Step 3 –

Connect profile elevation or depth dots with a smooth line – this is your profile

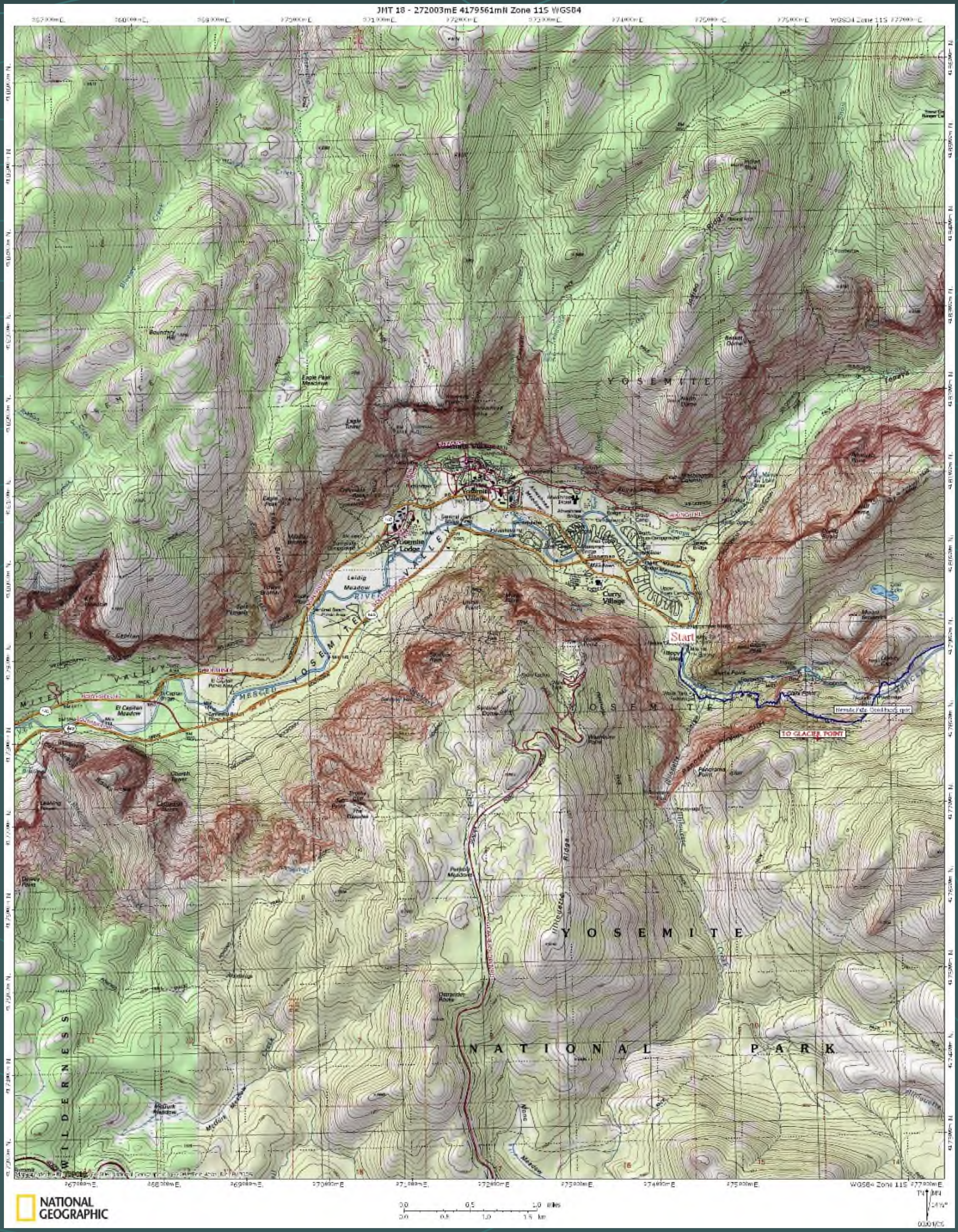


Yosemite Valley Topography

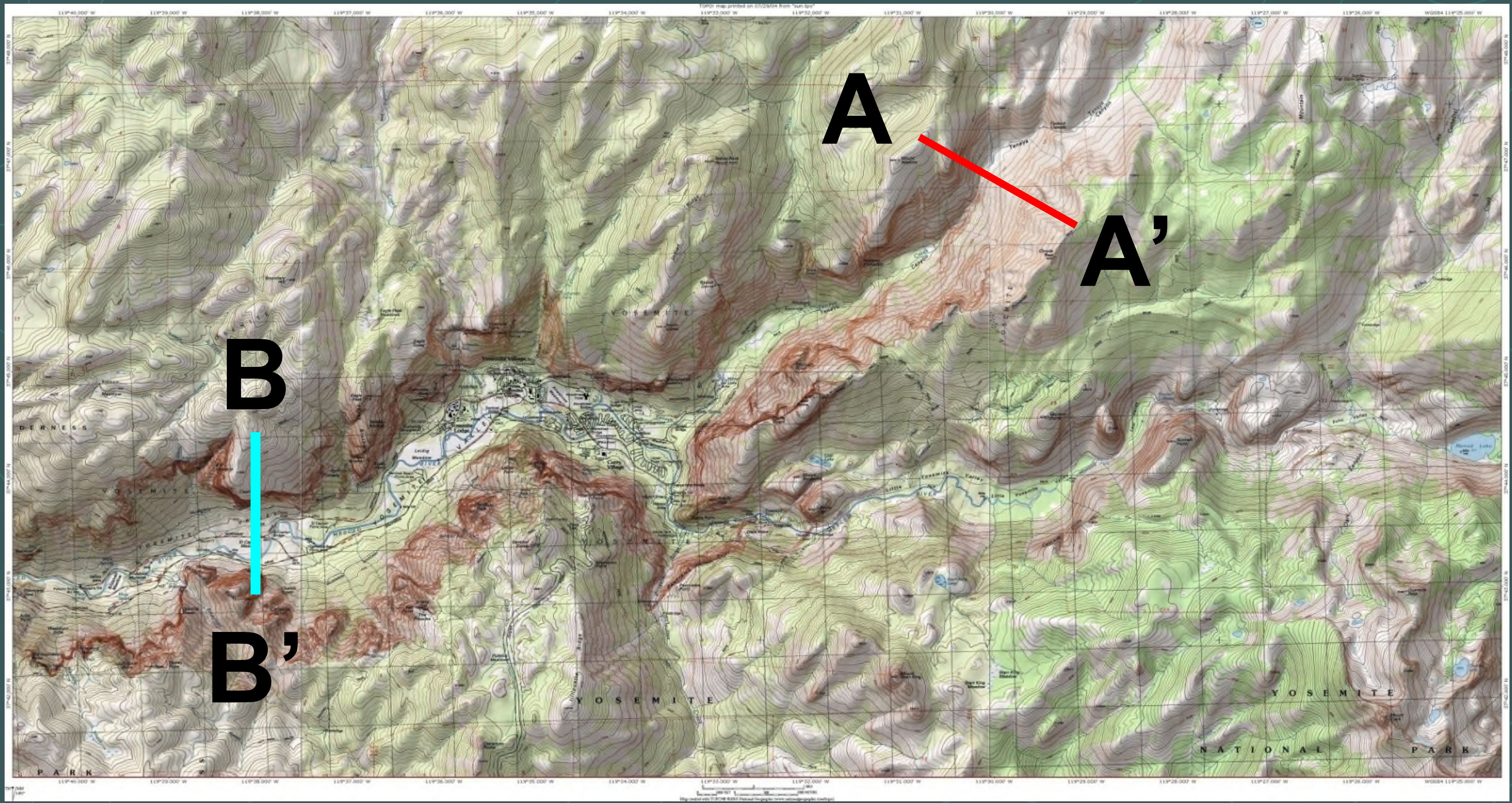




Yosemite Valley Topo Map



Yosemite Valley Topographic Map



Cross-Section Profiles

1) Mount Watkins to Clouds Rest
2) El Capitan to Cathedral Rocks

Views of Yosemite Valley

Views of Yosemite Valley

Extra Credit: Find Exact Location of Where Photo was Taken

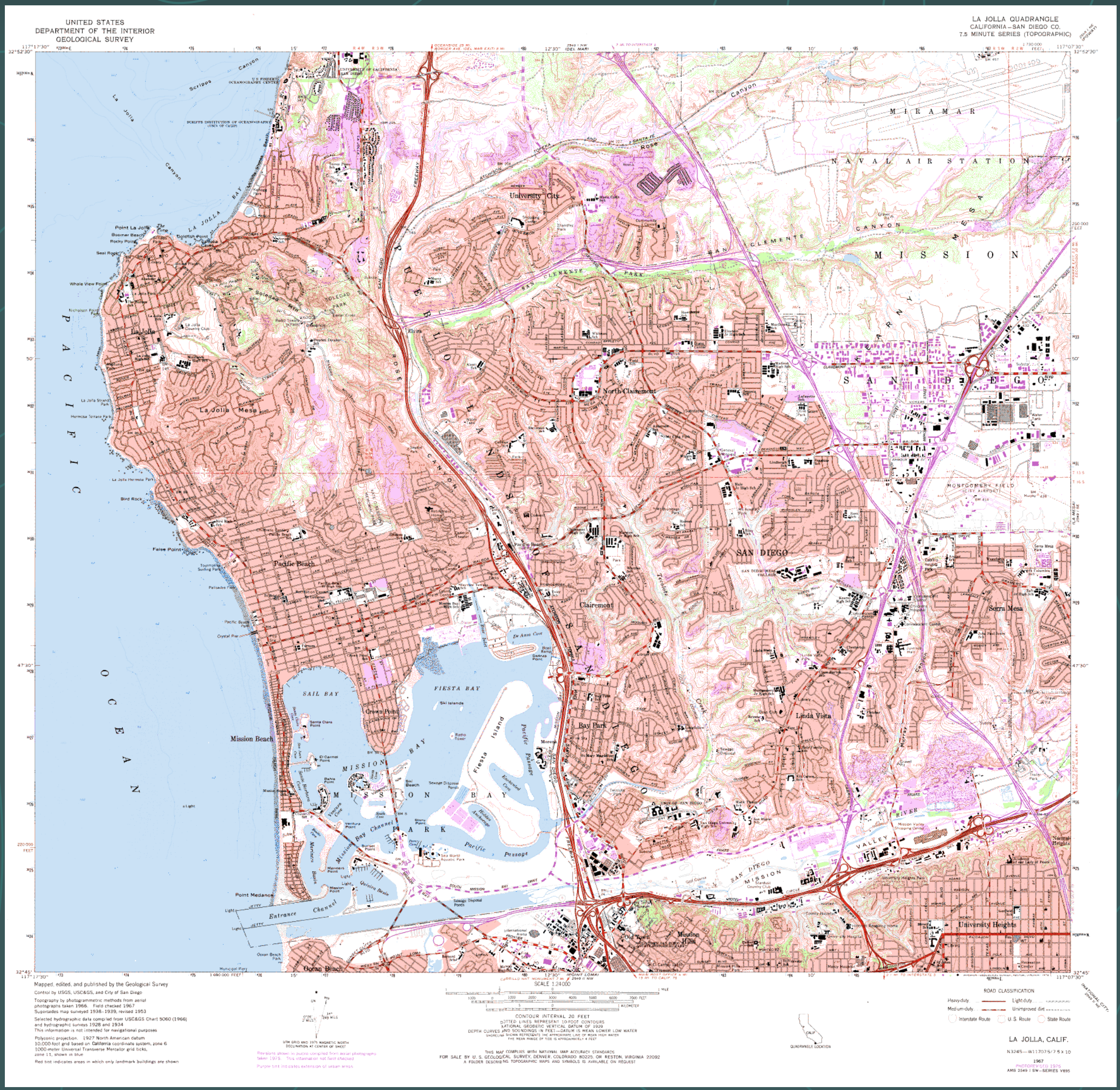
Views of Yosemite Valley

Views of Yosemite Valley

Views of Yosemite Valley

La Jolla 7 1/2 Minute Topo Map

1) Location?
2) Map scale?
3) Verbal scale?
4) Magnetic declination?
5) Contour interval?
6) Map relief? Total?
7) Distance/direction?
7) Latitude/Longitude?
8) Drainage direction?



Sweeny Pass
7 ½ Minute Topo Map

1) Location?
2) Map scale?
3) Verbal scale?
4) Magnetic declination?
5) Contour interval?
6) Map relief? Total?
7) Distance/direction?
7) Latitude/Longitude?
8) Drainage direction?