Navigating with Map & Compass

Nevada County Sheriff's Search & Rescue

Objectives

- Very Practical
- Teach you how to go from point A to point B
- Go from the wilderness (real world) to a map and visa versa

Agenda

Cover the basics of land navigation for search & rescue using maps & compass

- **Topographic maps**
- **Map reading**
- **Coordinate systems**
- **Compass**

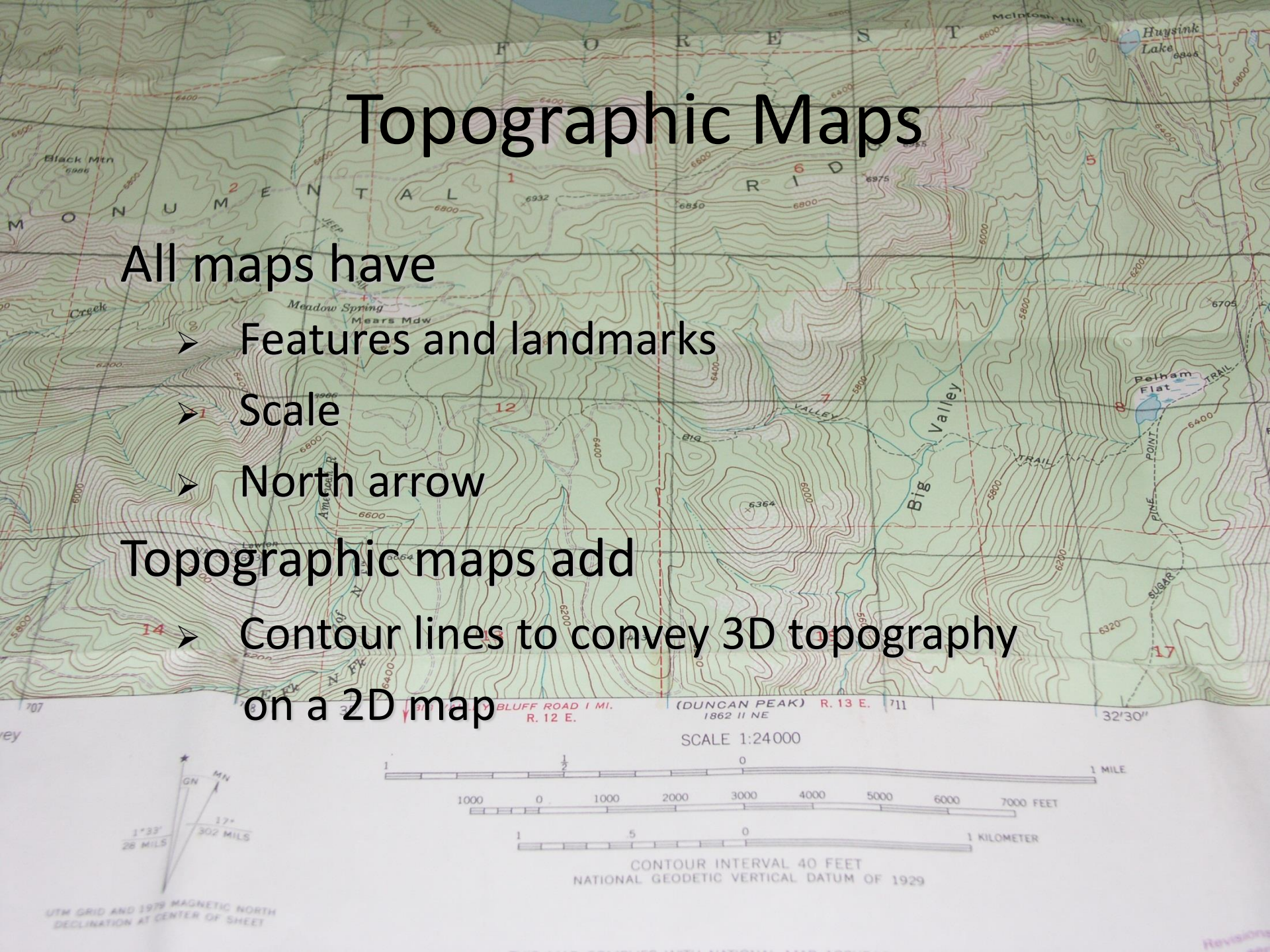
Topographic Maps

All maps have

- Features and landmarks
- Scale
- North arrow

Topographic maps add

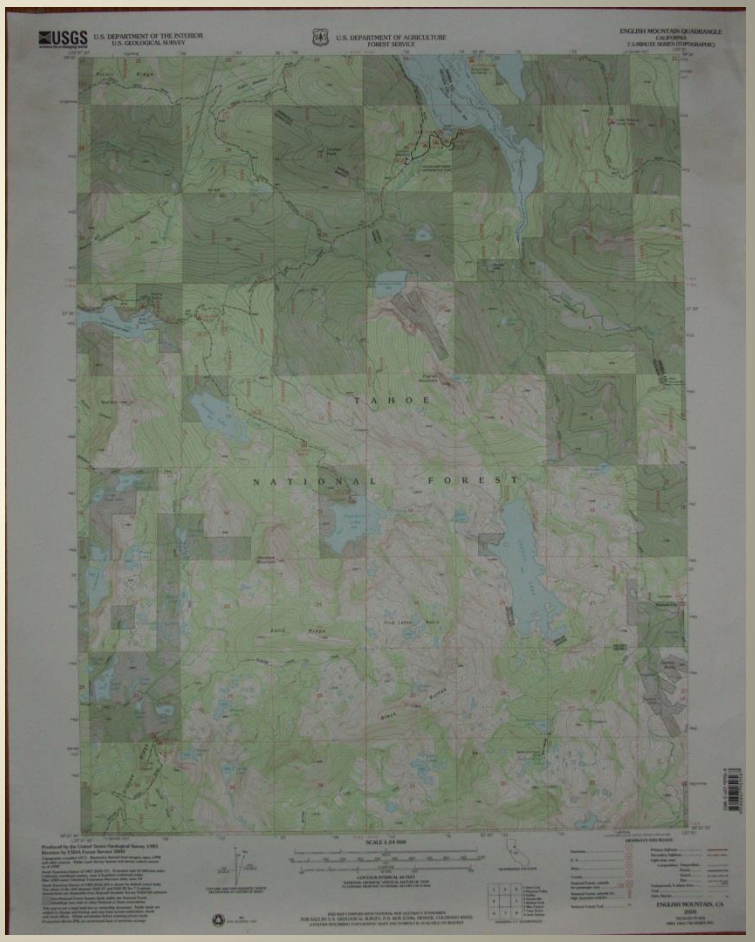
- Contour lines to convey 3D topography on a 2D map



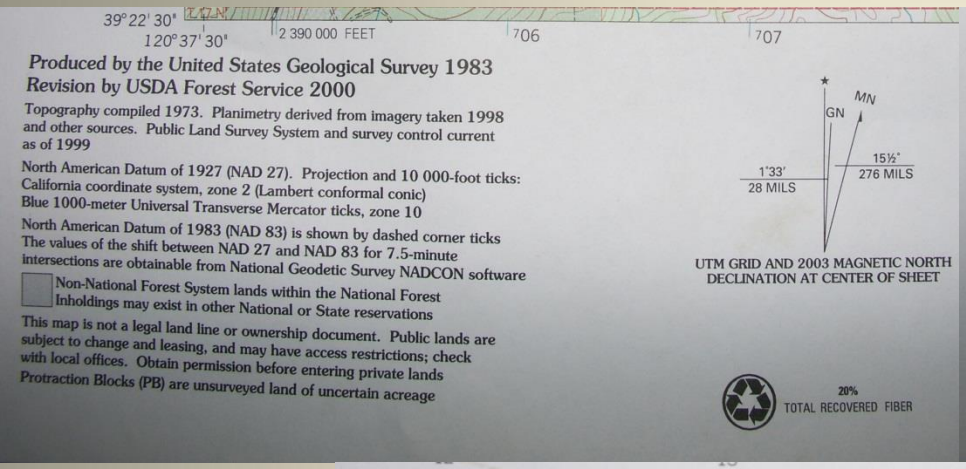
Topographic Maps

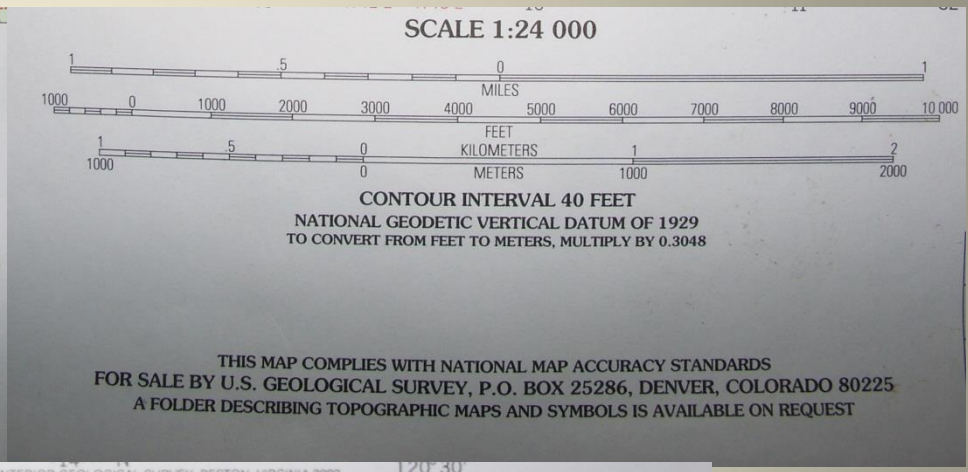
Typical map is USGS 7.5 minute quadrangle

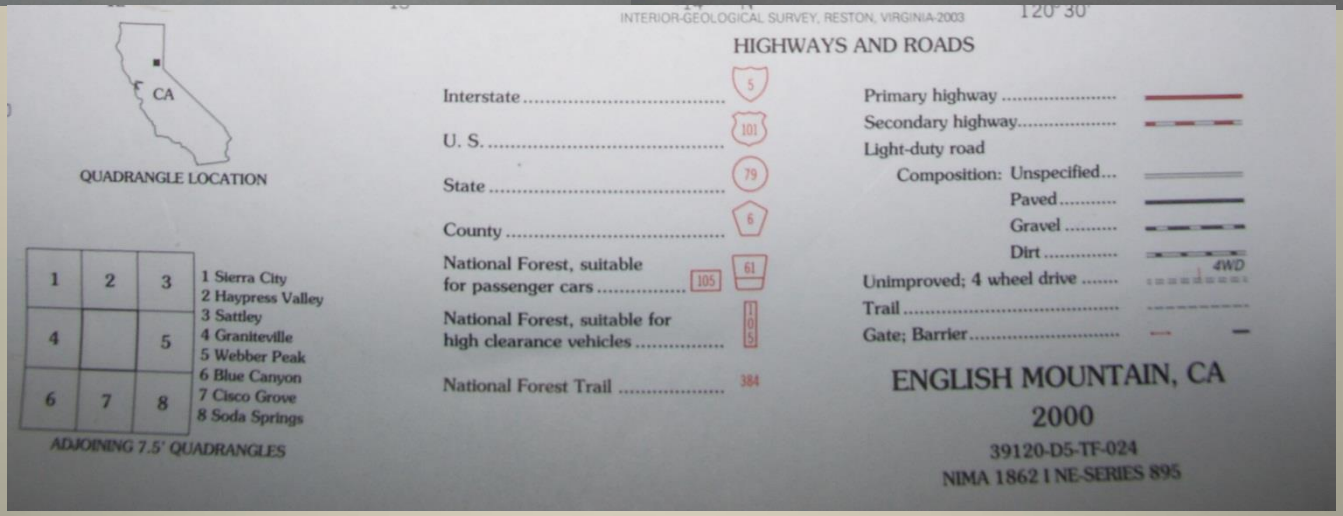
- Map represents 7.5 minutes of latitude and 7.5 minutes of longitude
- Much info at borders
  - Scale, coordinates, declination



Topographic Maps



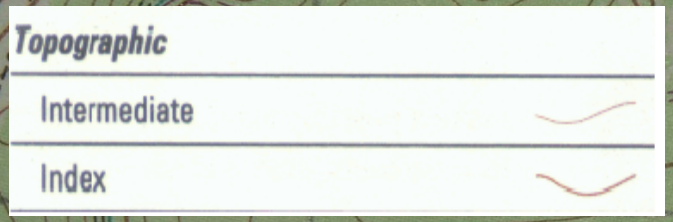




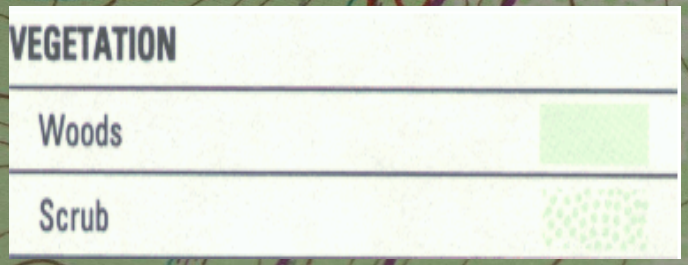
- Scale
- North Arrow
- Roads

Topographic Map Symbols

- Topo info in brown



  - Every 5th line is an index with printed elevation
- Vegetation in green



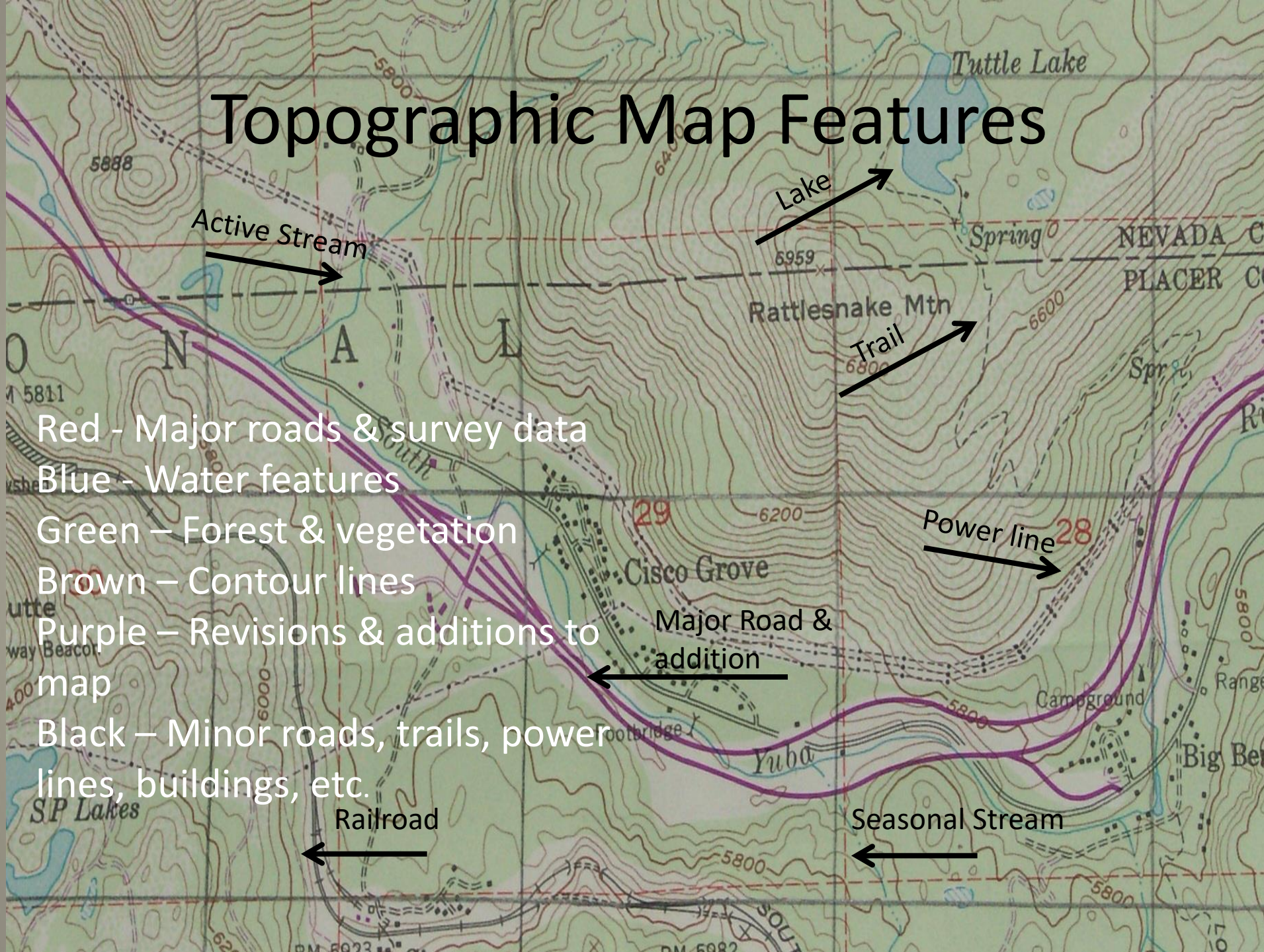
Index

Woods

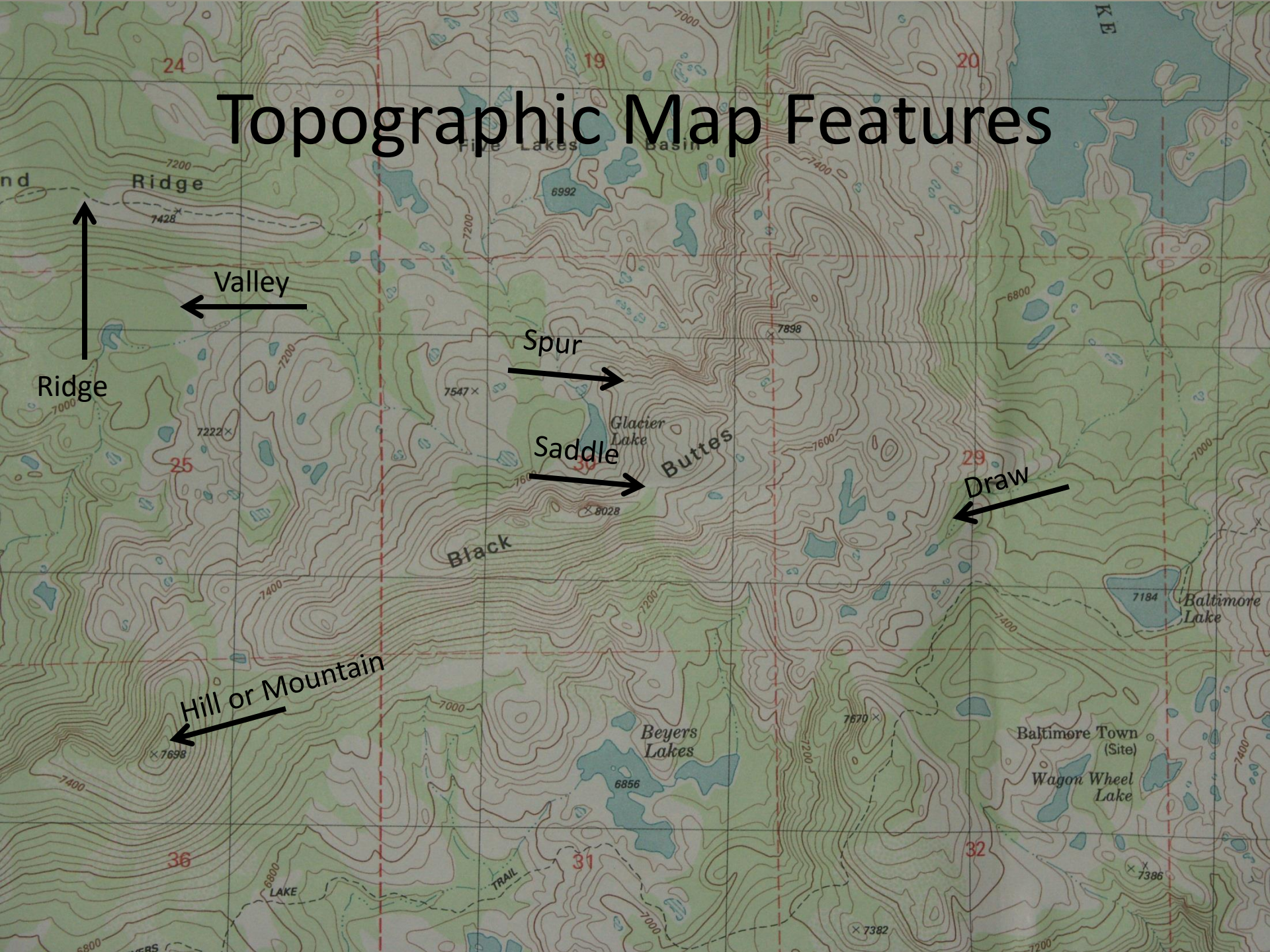
Scrub

Intermediate

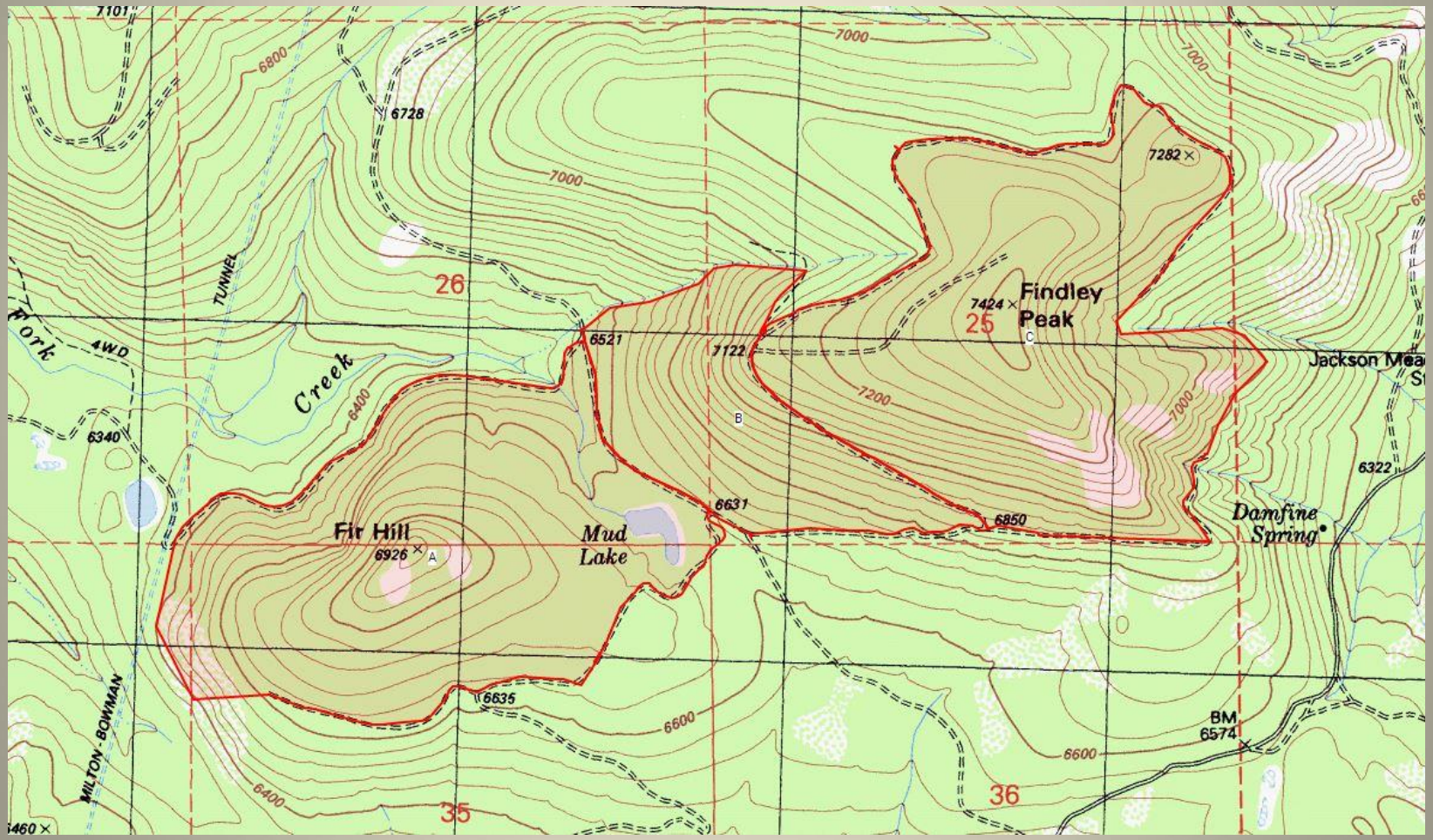
Topographic Map Features



Topographic Map Features



Map Reading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Damfine
Spring
Fir Hill
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A
Mud
Lake
6635
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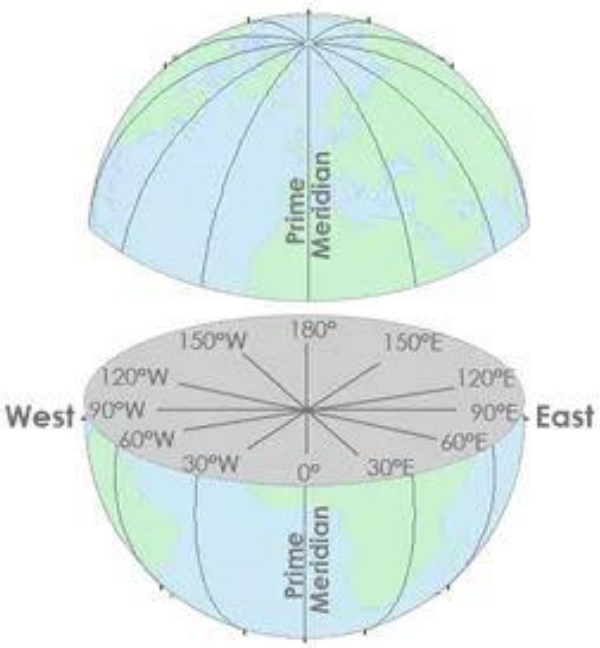
BM
6574
MILTON - BOWMAN
6400
35
36
6460

Coordinate Systems

- Most common are Latitude and Longitude (lat-long) and Universal Transverse Mercator (UTM)
  - Most SAR teams now use UTM
  - Many pilots just speak lat-long

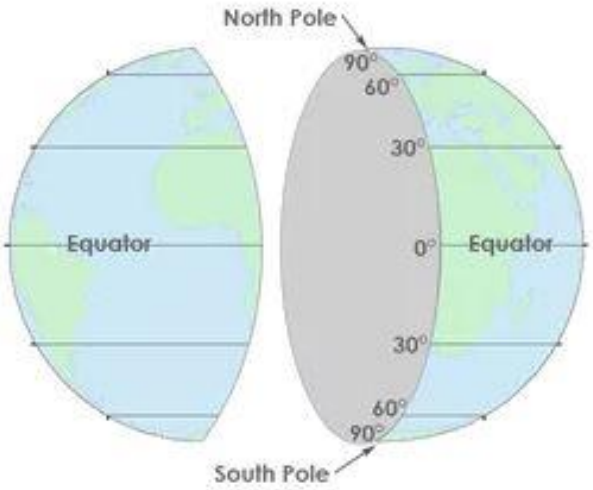
Latitude & Longitude

As shown in the image below, **lines of longitude** have X-coordinates between -180 and +180 degrees.



Longitude Coordinates

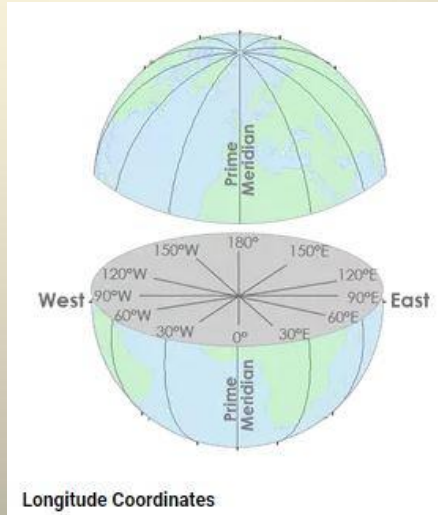
And on the other hand, **lines of latitudes** have Y-values that are between -90 and +90 degrees.



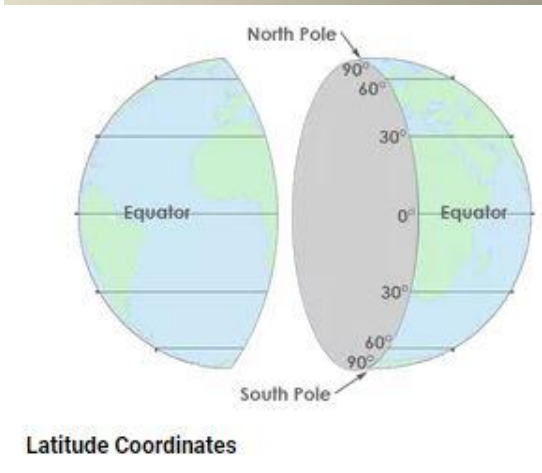
Latitude Coordinates

Latitude & Longitude

- Disadvantages
  - Longitude lines converge, so one minute at 60° is less distance than one minute at 30°
    - Can see this convergence on a 7.5” map
  - Latitude increases from right to left in western hemisphere
  - Hard to estimate 1/60ths on a map
  - Multiple formats
    - ddd°mm’ss”
    - ddd°mm.mm’
    - ddd.dd°



Longitude Coordinates



Latitude Coordinates

UTM

- Metric system developed by military
  - Divides earth into 60 north-south zones, measures distance by meters within each zone
- Uniform, a UTM grid is always 1 square kilometer
- Numbers increase left to right and bottom to top
- Easy to estimate 1/10ths on a map

UTM

- World is divided into 60 zones. Northern California is in Zone 10.

- The earth is divided into 60 zones, each 6° wide in longitude (with the exception of a few non-standard-width zones for Svalbard and southwest Norway). See Figure 1.

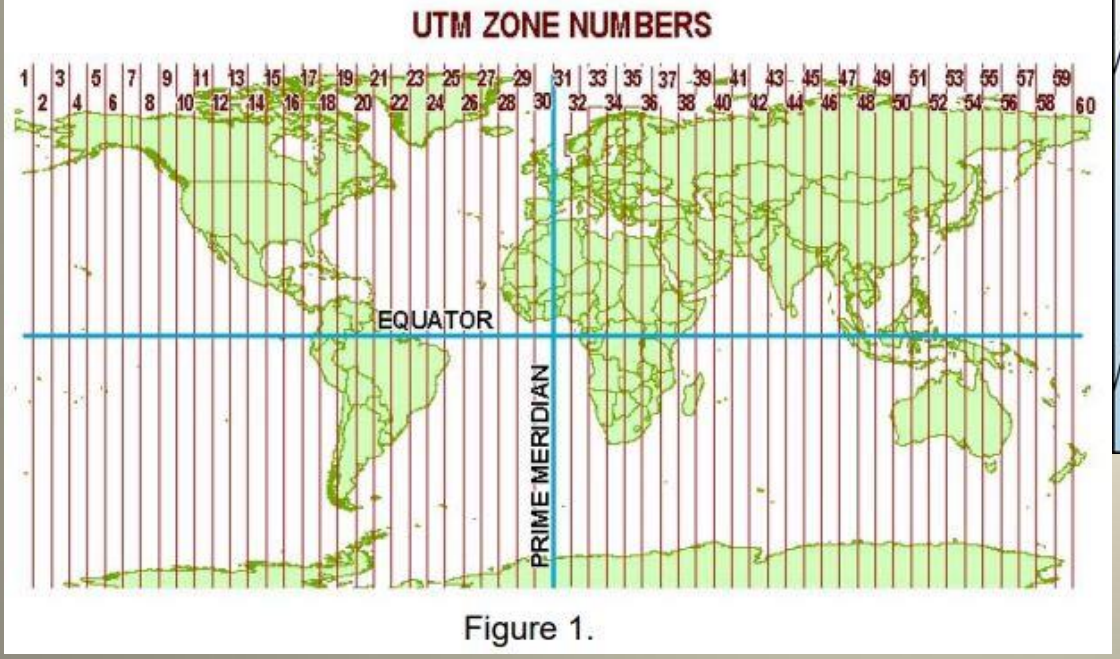
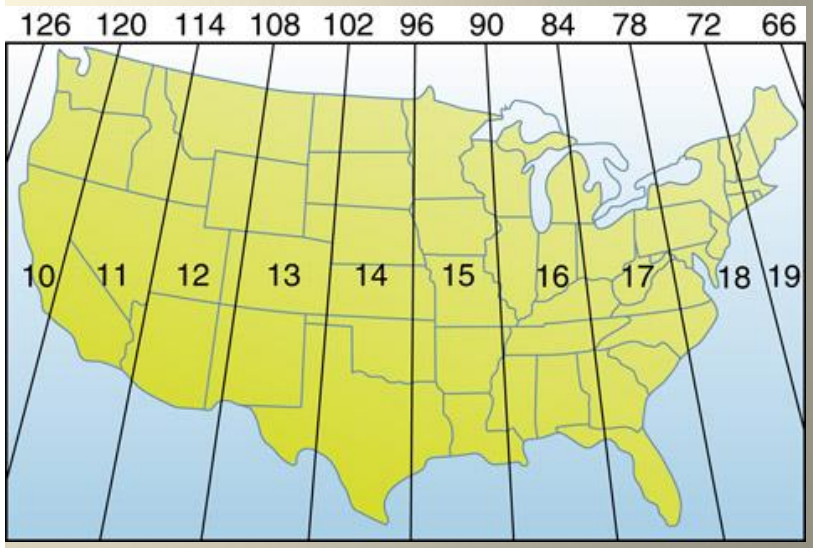


Figure 1.



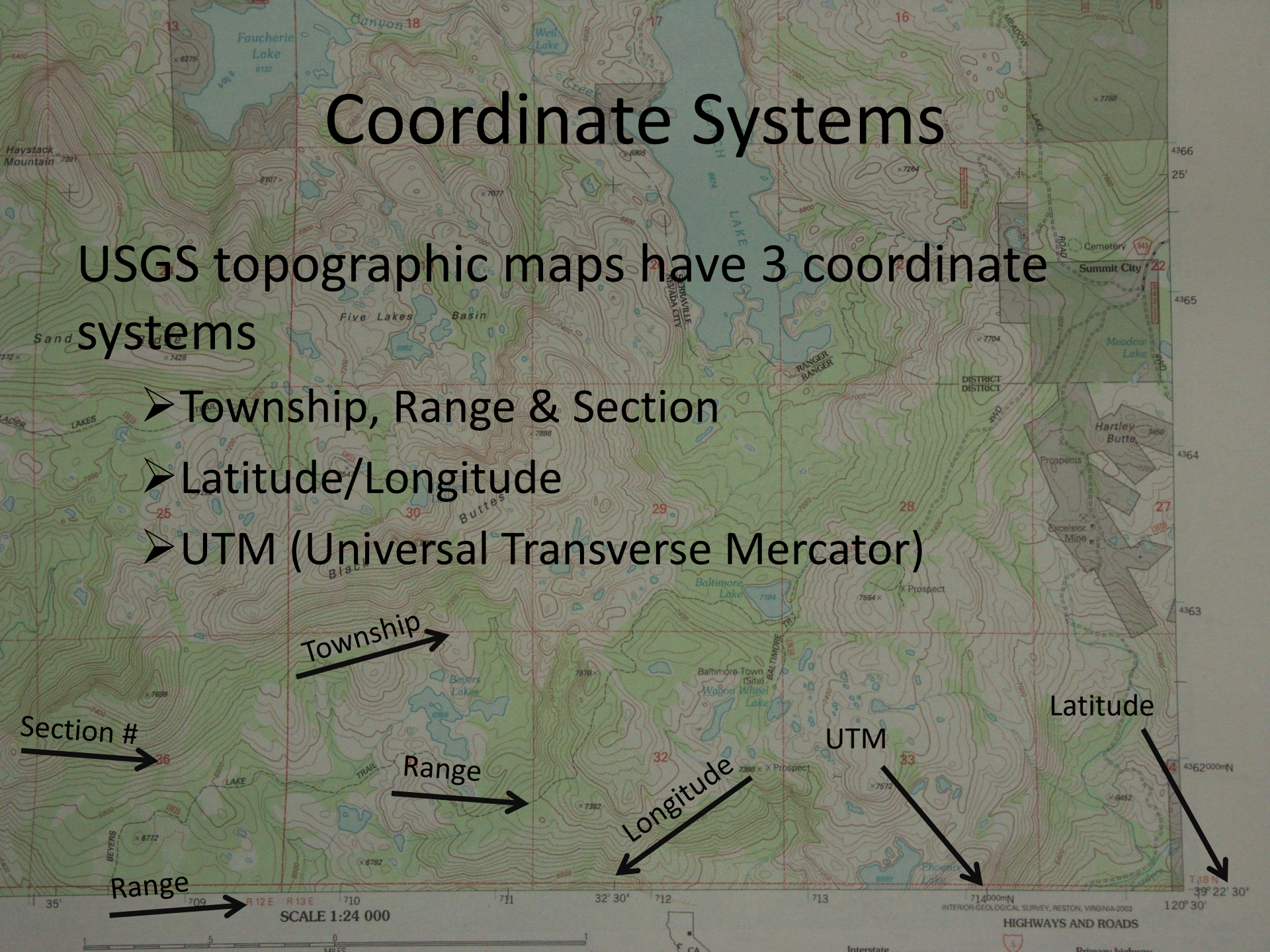
UTM

- UTM grids lines
  - Shown on all USGS quadrangle maps
  - Indicated at intervals of 1,000-meters
  - Indicated by either blue ticks in the margins of the map or with full grid lines
- The 1,000-meter value of the ticks is shown for every tick or grid line.

Coordinate Systems

USGS topographic maps have 3 coordinate systems

- Township, Range & Section
- Latitude/Longitude
- UTM (Universal Transverse Mercator)

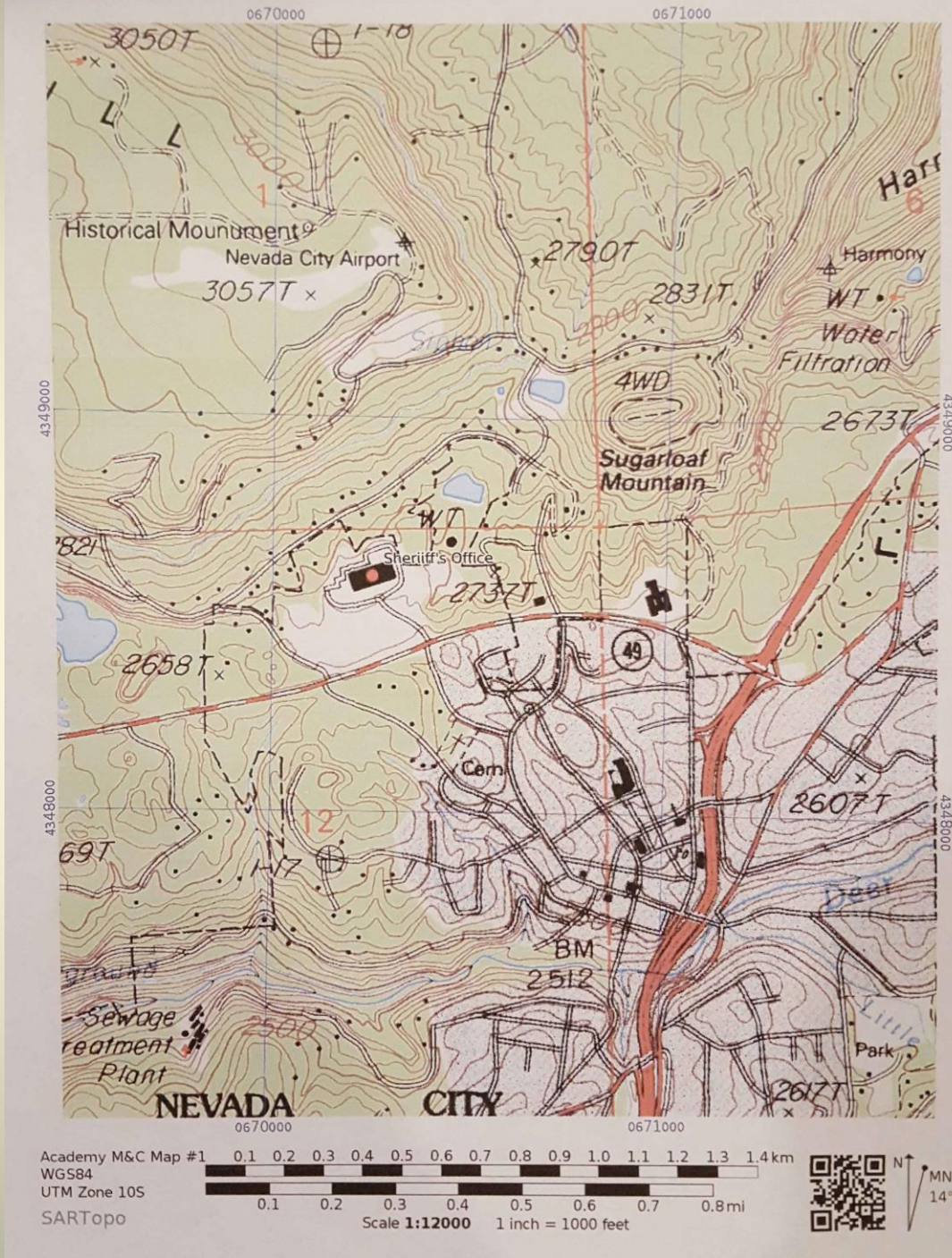


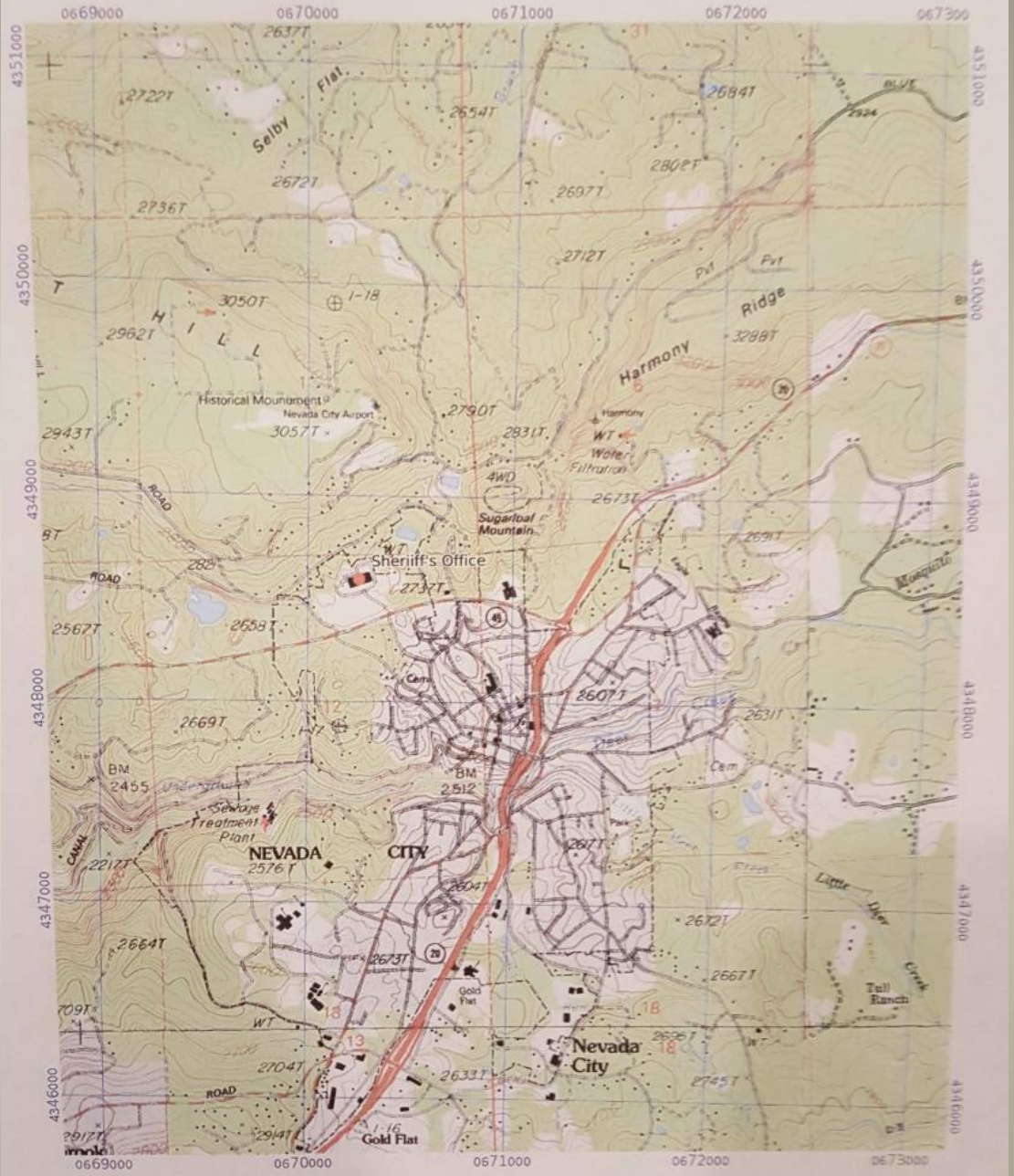
UTM

- The Sheriff's office is at:

  10S 06**70**215E & 43 **48**598N
- First number is easting (left to right), second is northing (bottom to top)

  "Read right up"
- Full coordinate gives 1 meter accuracy
- One UTM Grid is
  - 1 km on each side
  - about 250 acres in area

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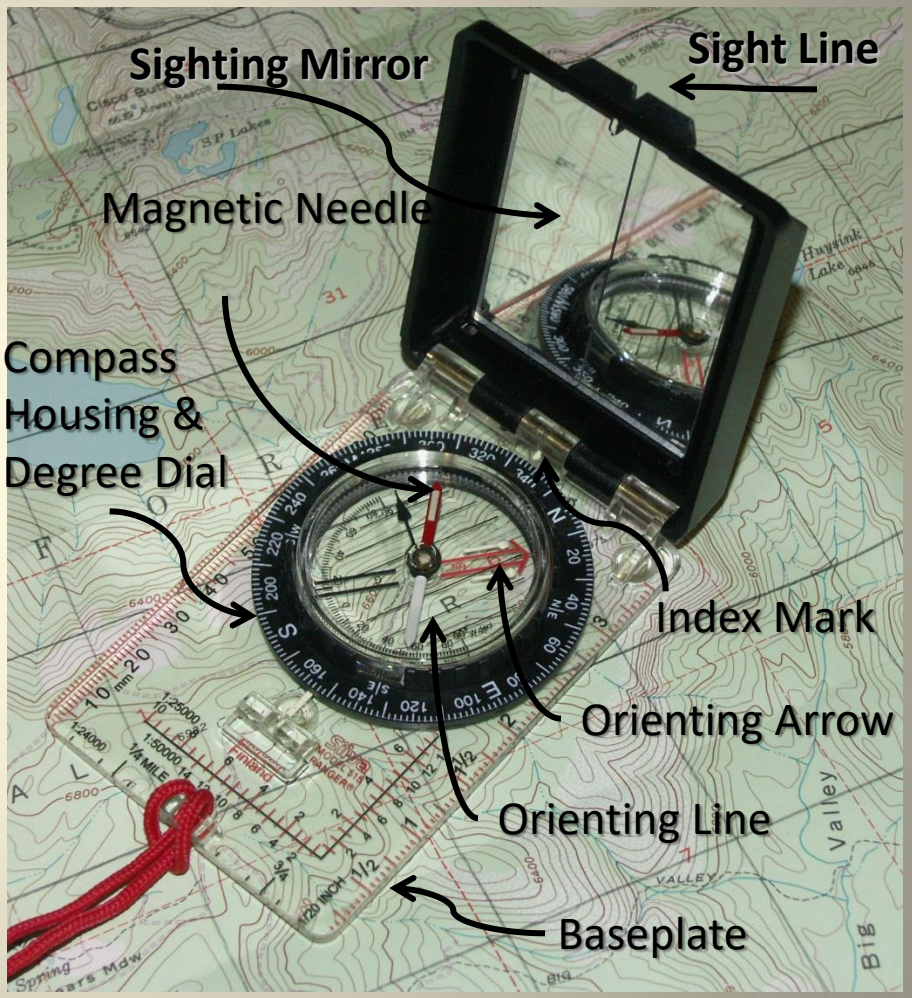
Selby Flat
Ridge
Harmony
Historical Monument
Nevada City Airport
Sheriff's Office
Sugarloaf Mountain
Water Filtration
4WD
Sewage Treatment Plant
NEVADA CITY
2576 T
BM 2455
BM 2512
Gold Flat
Nevada City
Tail Ranch
Little Deer Creek
CANAL
ROAD
I-16
I-18
Academy M&C Map #2
WGS84
UTM Zone 10S
SARTopo
0.5
1.0
1.5
2.0
2.5 km
0.5
1.0
1.5 mi
Scale 1:24000
1 inch = 2000 feet
MN
14°

The Compass

- Magnetic needle: North is usually red
- Rotating bezel with orienteering arrow/lines and degree markings
  - “Boxing the needle”
- Sight line and index mark
- Baseplate with inches and mm

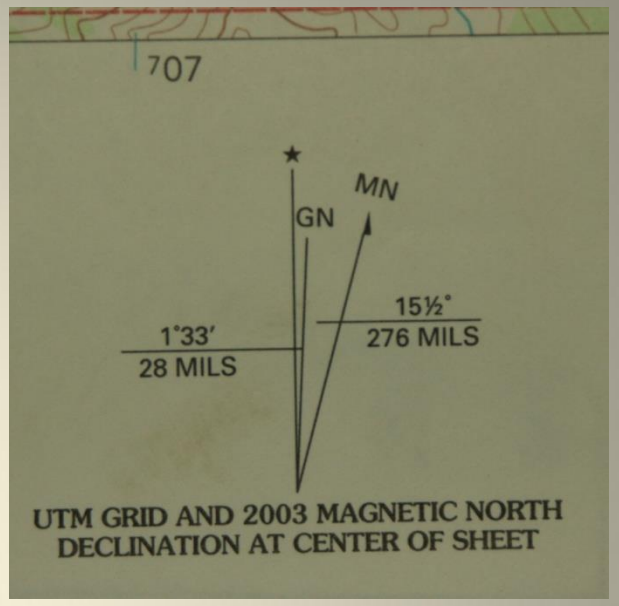


The Compass

- The magnetic needle aligns itself with the strongest magnetic field
  - Usually points to magnetic north
  - Can be thrown off by metal, electrical fields (radios!), and local magnetic anomalies
  - Be careful not to hold your compass too close to your radio!!

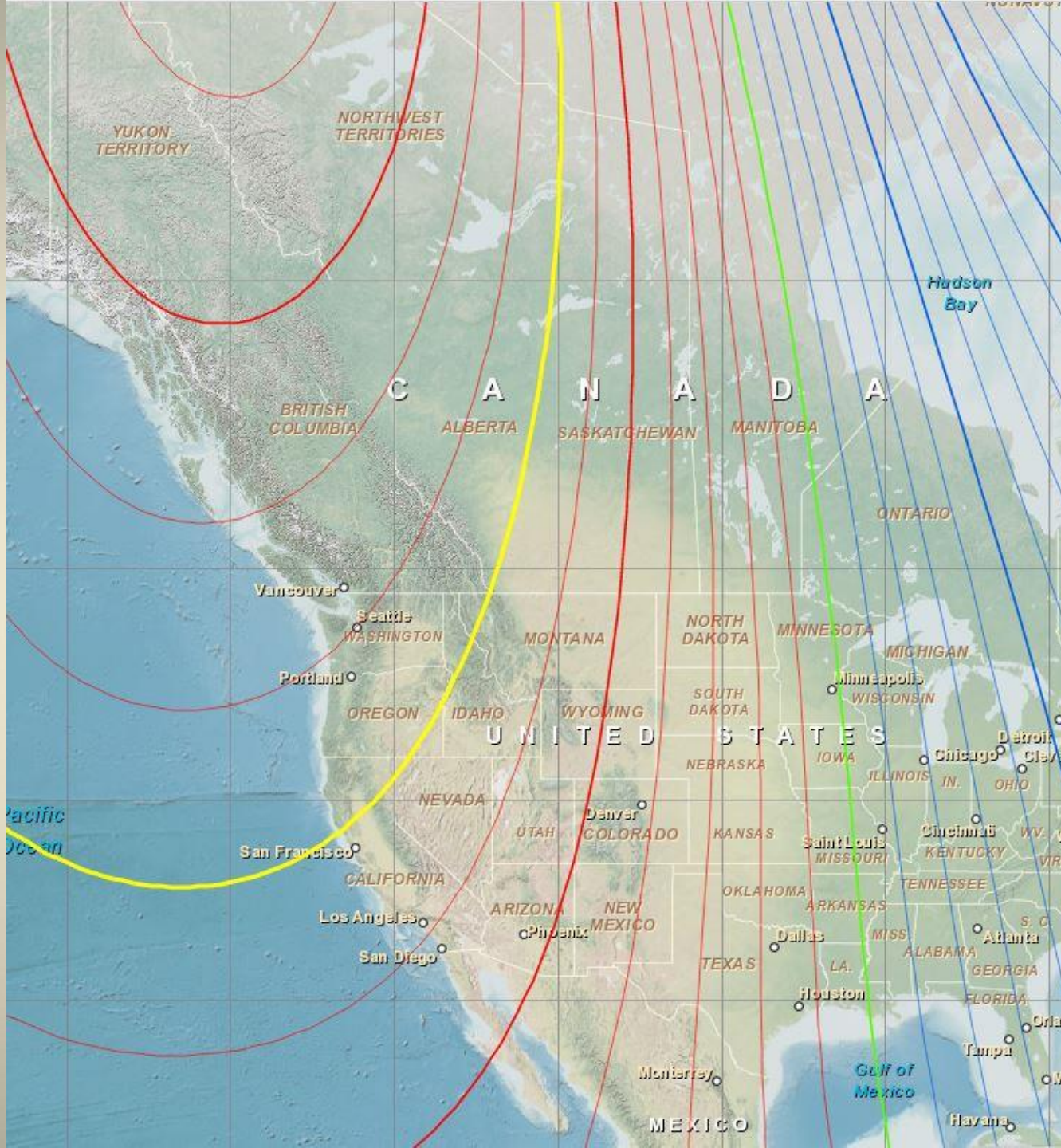
North?

- True North
  - Geographic north pole
- Magnetic North
  - Referenced to local magnetic field
  - Magnetic pole is near Hudson Bay
  - Changes over time
- Difference between true north and magnetic north is declination



Declination

- Declination in Nevada City is about 13.5° east
- (map is NOAA 2015 data)

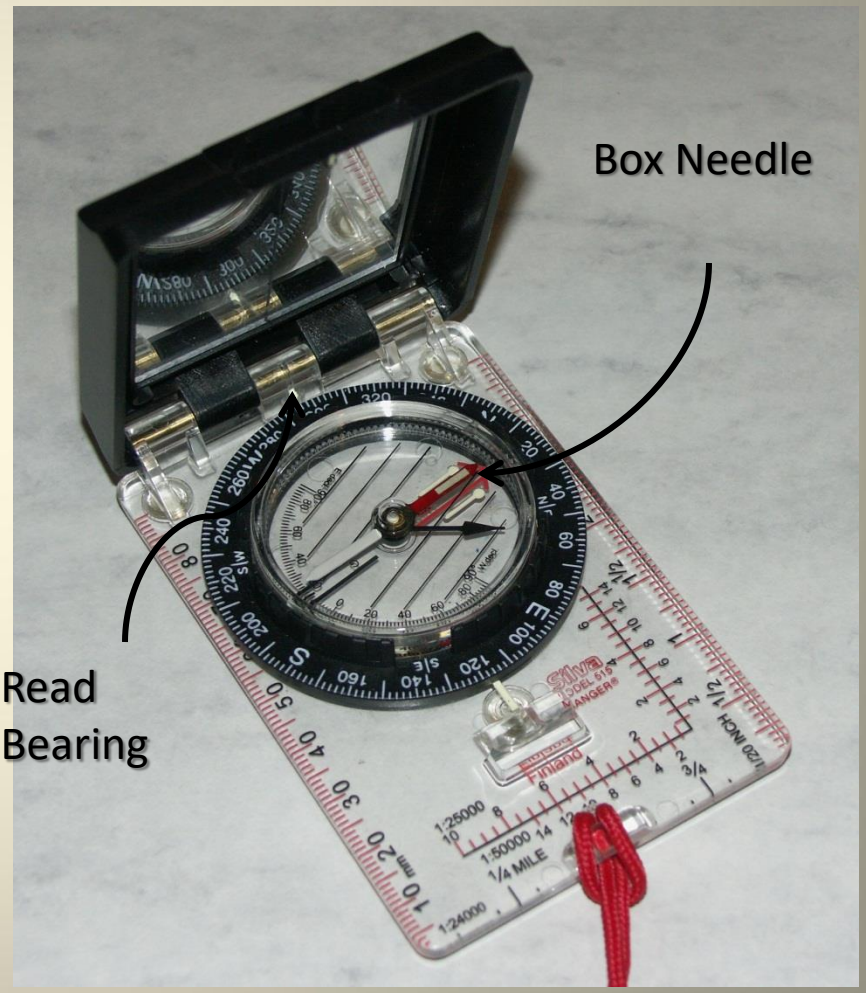


Orienting a Map

- Turn bezel to set North at index mark
- Align baseplate of compass to edge of map
- Box needle
- Map oriented to True North

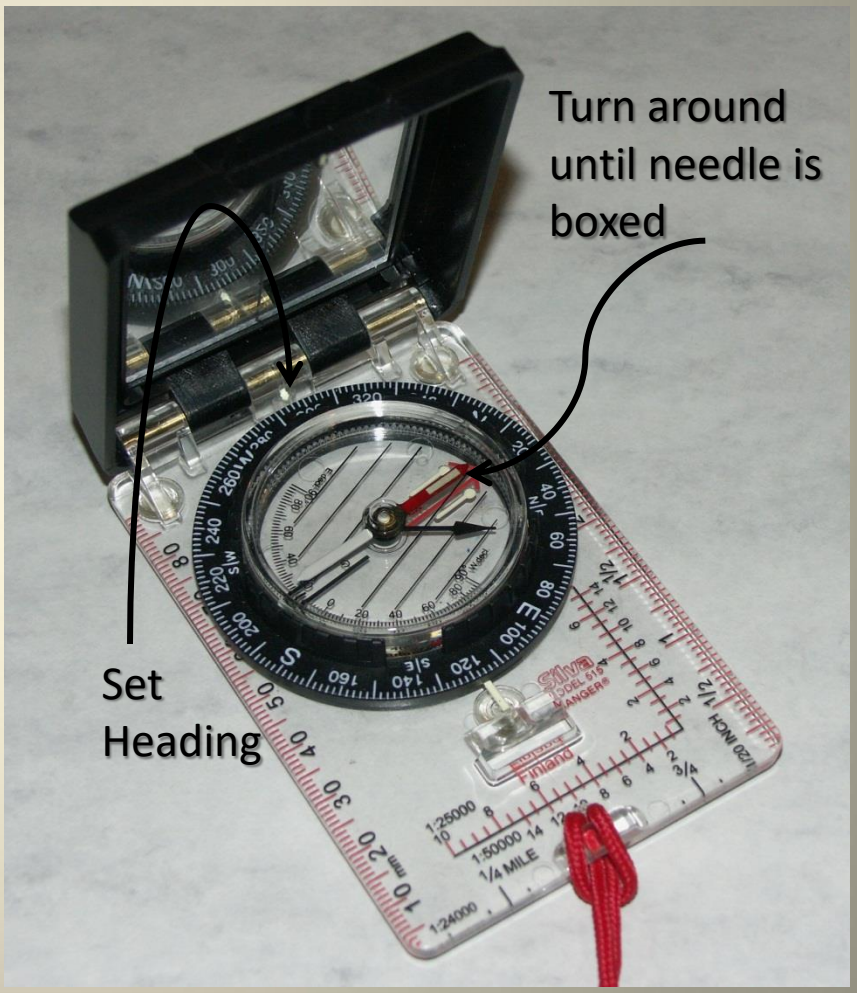
Take a Bearing

- Hold the compass out in front & level
- With mirror, hold at eye level, sight target in notch keeping black index line in center of compass
- Turn bezel to “box the needle”
- Read bearing at index mark



Following a Heading

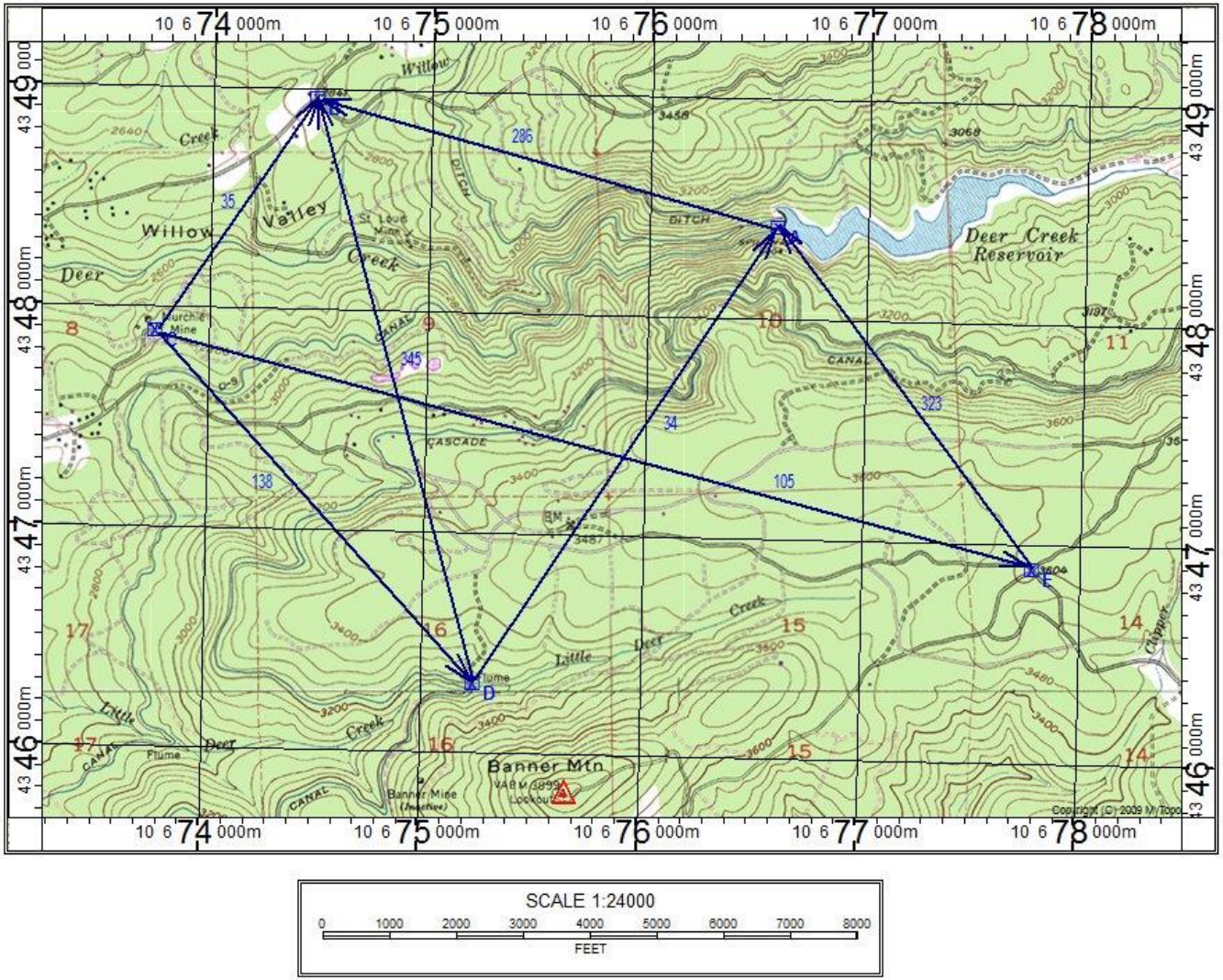
- Turn bezel to set desired heading at index mark
- Raise compass and turn yourself around until the needle is boxed
- Pick object on line, move ahead to object, repeat
- Can expect a 5-10% drift when following a heading



Read Bearing from Map

- Lay baseplate along line from start (X) to destination (Y)
  - Direction of travel towards destination
- Rotate bezel until orienteering lines and arrow point true north
- Ignore the needle!!
- Read bearing at index mark (true bearing from X to Y)

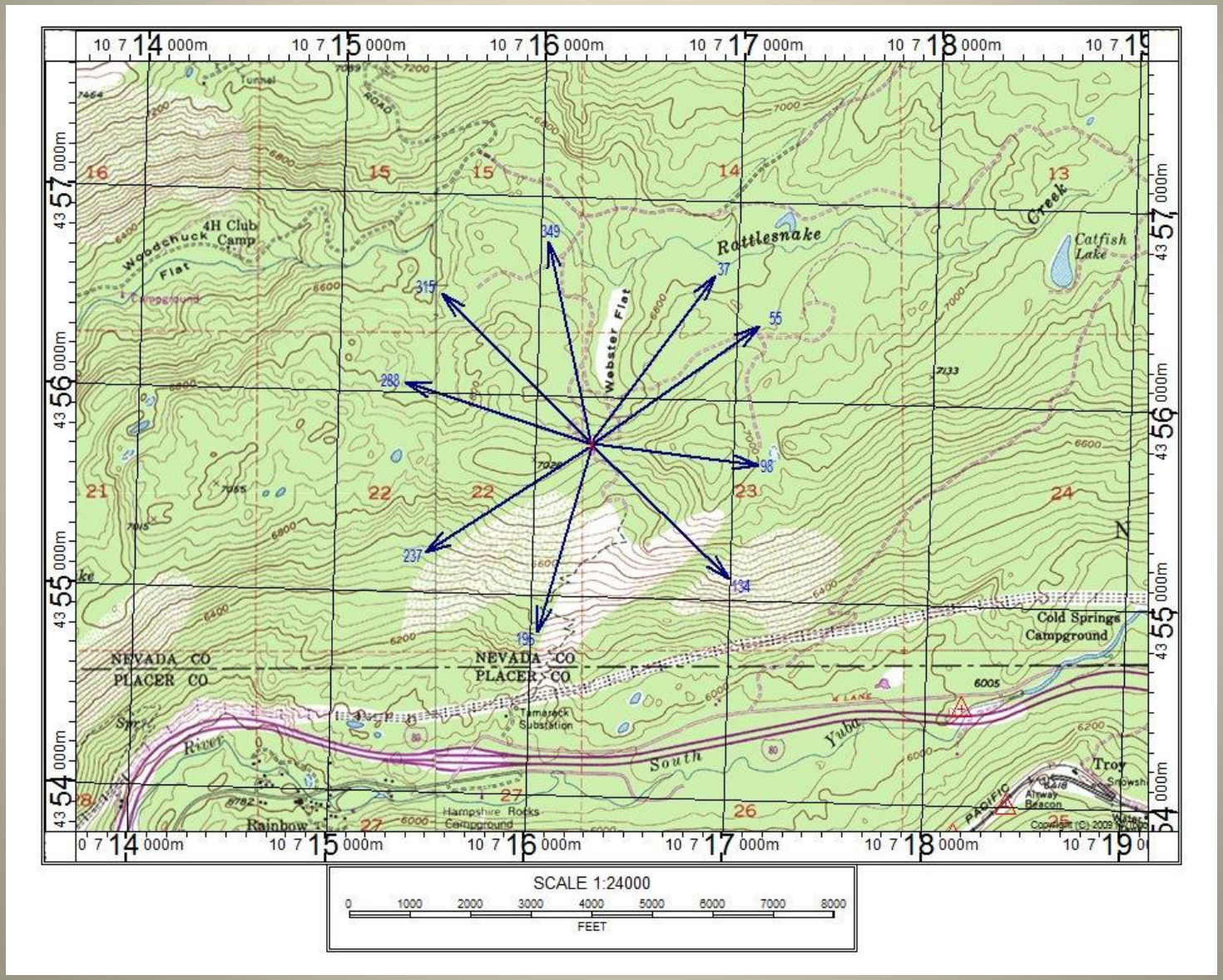
Read Bearing from Map



Plotting Bearing on Map

- Rotate bezel so that bearing is at index mark
- Lay baseplate on map with “heel” at starting point (X)
- Rotate entire compass until orienteering lines/arrow point true north
- Draw bearing line on map

Plotting Bearing on Map

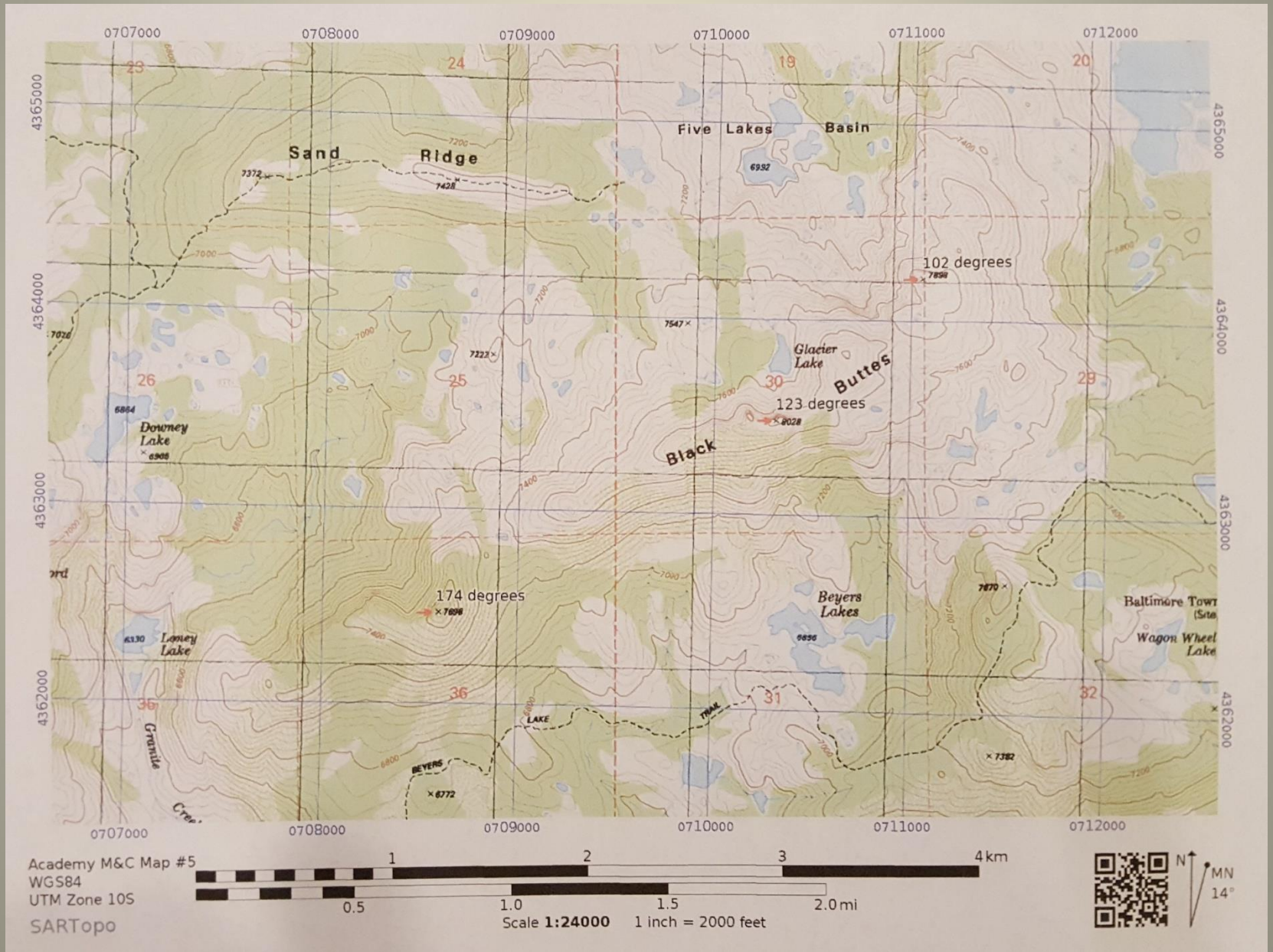


Triangulation

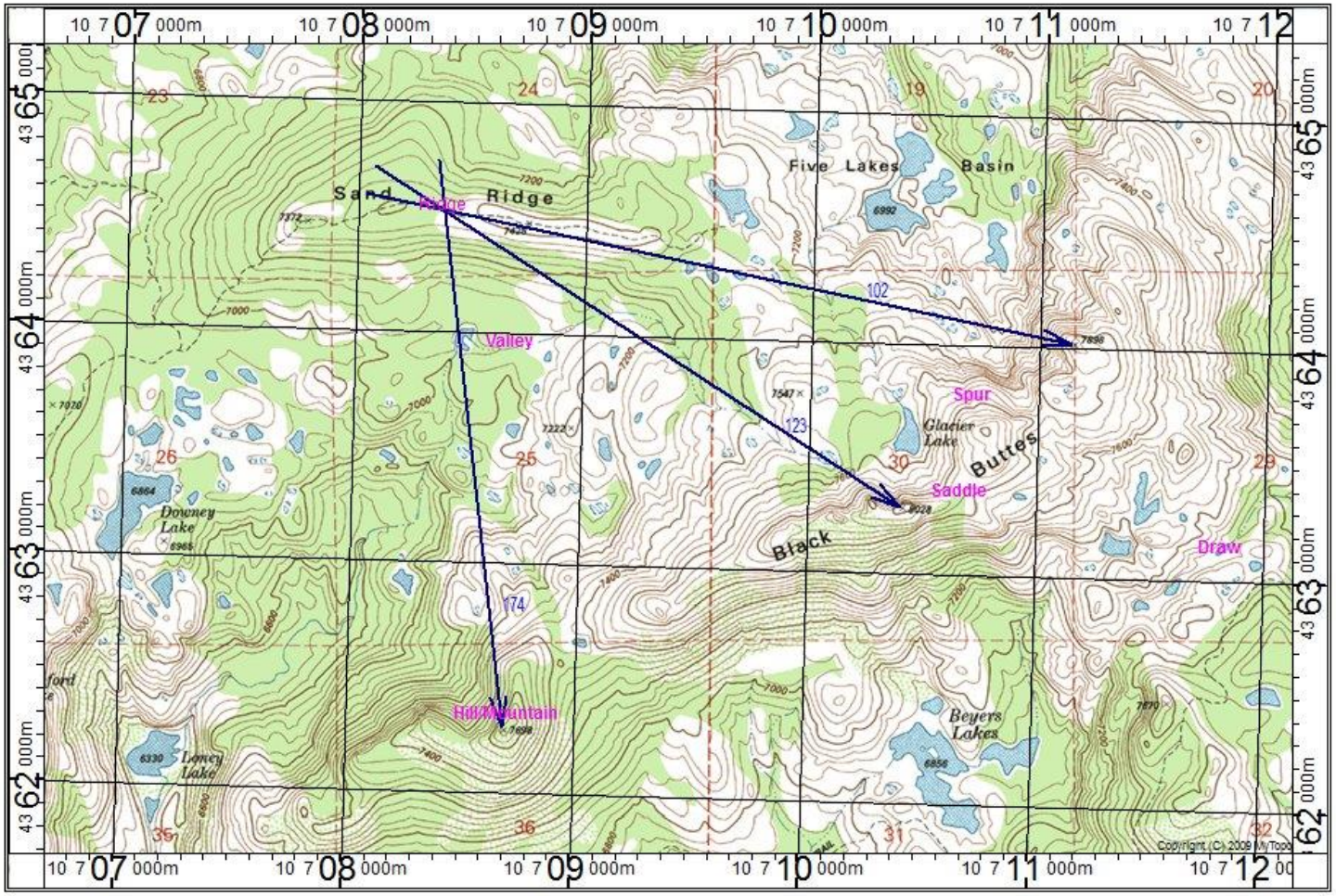
- Find prominent landmarks in real world and on map
- Determine bearing to one landmark
- Lay baseplate on map with direction of travel end on landmark
- Rotate entire compass until orienteering lines/arrow point true north
  - Ignore the needle!!
- Draw line along baseplate
- Repeat for next landmark
- Location is roughly where lines intersect

Triangulation

Triangulation



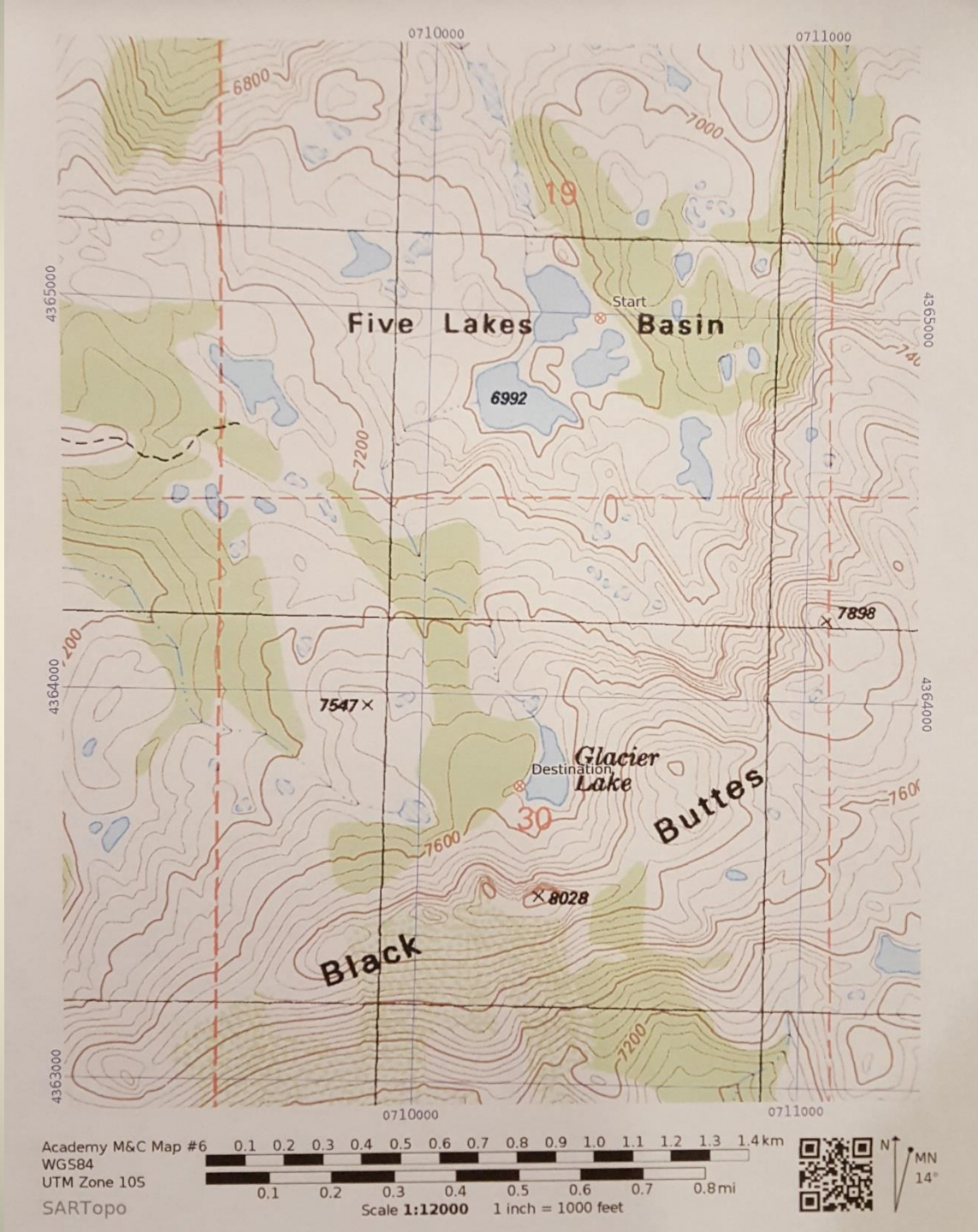
Triangulation



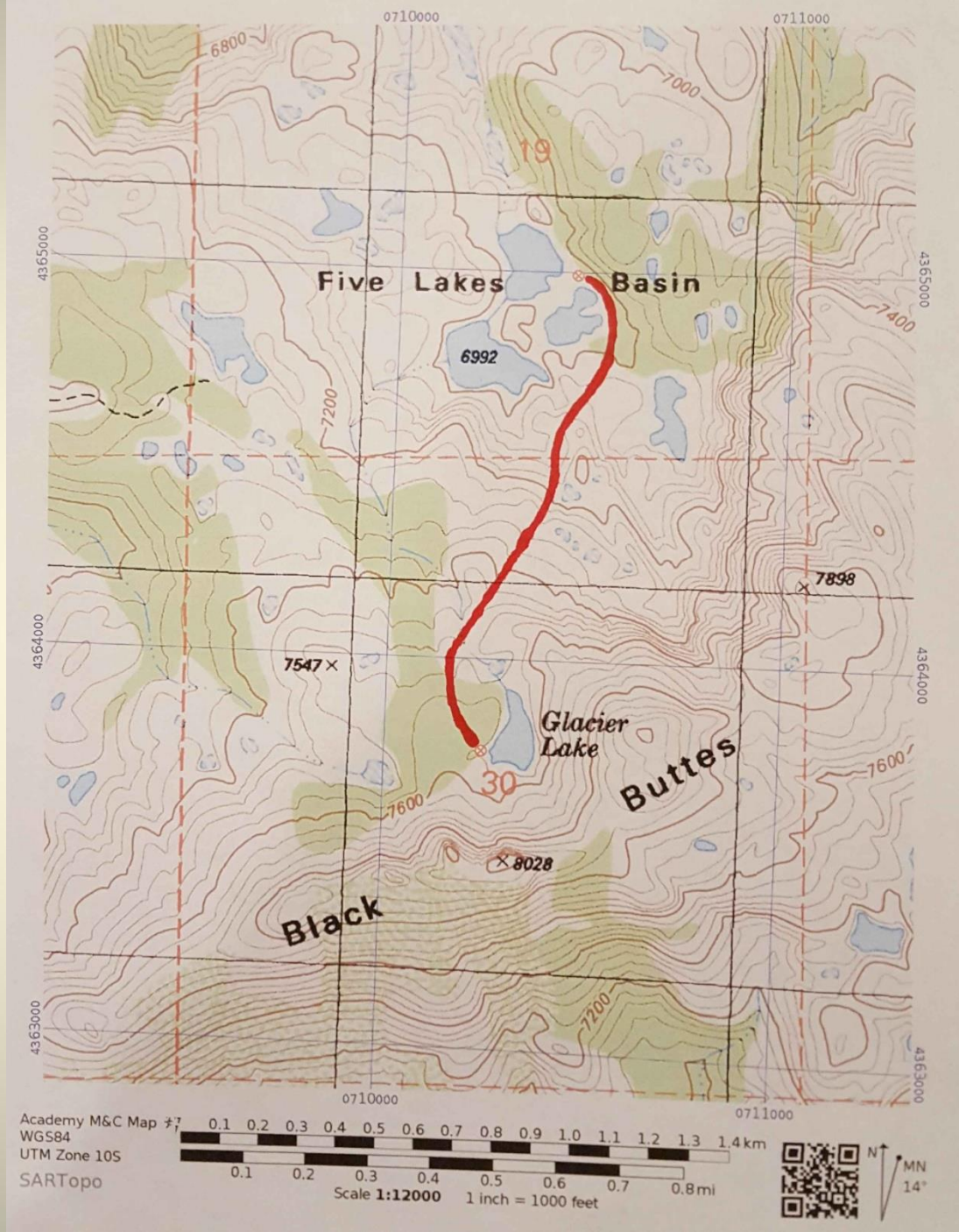
Route Finding

- Determining to safest way from one point on a map to another point on a map
- Used to get team from where you are to where you want to go
- Used to plan out how your going to search your area
- Being able to read a map is essential

Route Finding



Route Finding



Classroom Exercises

- Orienting maps
- Taking a bearing
- Following a heading
- Reading a bearing
- Plotting a bearing
- Triangulation
- Route Finding