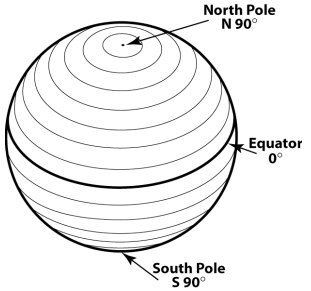
Introductions

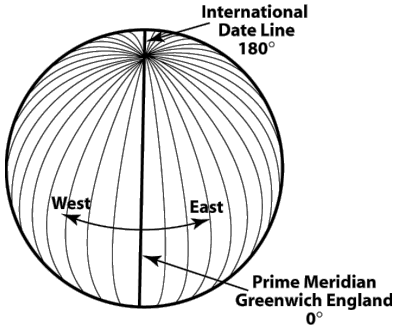
- What is your name?
- What activities do you do (or plan to do) that involve wilderness navigation?
- What do you do (did, plan to do) professionally?
- How did you hear about this class?

Latitude / Longitude

The Equator and Parallels of Latitude



Longitude



The Prime Meridian

- Today the world has agreed the the Prime Meridian or 0° line of longitude runs through the Royal Observatory at Greenwich, England.
- Prior to the 1884 International Meridian Conference, most countries defined their own prime meridian running through their own capital city.
- The French did not abandon use of their prime meridian, which ran through the Paris Observatory, until 1911.

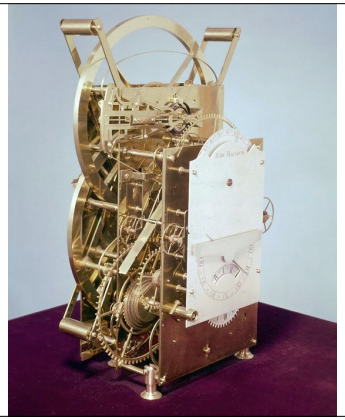
Longitude was difficult to measure at sea

- Your longitude is the time difference between high noon at a known longitude (A ship's home port for example.) and high noon at your current location.
- How many degrees does a one hour time difference represent?

No Clock

No Longitude

H3
John Harrison
1740-1757



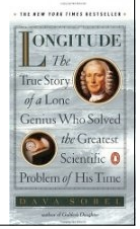
National Maritime Museum, Greenwich, London, Ministry of Defence Art Collection

H4
John Harrison
1755-1759

National Maritime Museum, Greenwich, London, Ministry of Defence Art Collection

If the history of navigation intrigues you, I'd suggest you read…

- Longitude: The true story of a lone genius who solved the greatest scientific problem of his time.
- By Dava Sobel
- Also as a PBS Nova show.
  - On DVD, Netflix has it.



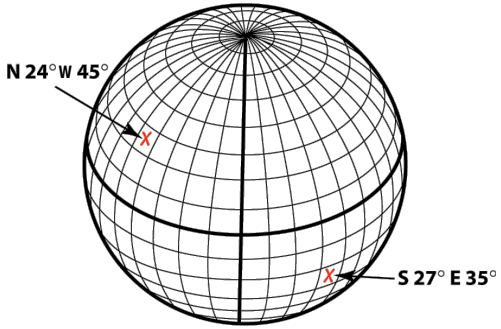
Degrees, Minutes, and Seconds

- Because measurement of latitude & longitude were so closely tied to time, it made sense to subdivide degrees into minutes and seconds.
- A degree is made up of 60 minutes
- A minute is made up of 60 seconds

DDD° MM' SS"

- A latitude / longitude coordinate would be written like…

N 37° 22' 30"
W 122° 15' 45"



DDD° MM' SS"

- A latitude / longitude coordinate would be written like…

N 37° 22' 30"
W 122° 15' 45"

DDD° MM.MMM'

- It is now common place to write lat / lon coordinates in a "decimal minutes" format.

N 37° 22.5'
W 122° 15.75'

DDD.DDDD°

- Many computer based systems report lat/lon in decimal degrees.

N 37.3750°
W 122.2625°

Units Matter

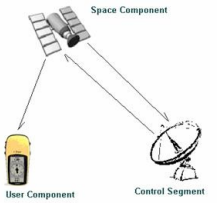
- It is important to include all of the units and notation.
- It's N 37° 22' 30" W 122° 15' 45"

  Not 372230 1221545

Where am I?

Using a GPS receiver
to determine your location.

Global Positioning System



Geographic Coordinates

A GPS receiver reports its position as numeric coordinate values.

There are several common formats for the coordinates.

Geographic Coordinate Systems

- Latitude / Longitude
- Universal Transverse Mercator (UTM)
- US National Grid (USNG)
- Others
  - State Plane
  - Military Grid Reference System
  - British Grid
  - Maidenhead
  - and many, many more.

UTM Reference Card
Lat/Lon Reference Card
Coordinate Formats

Communicating Geographic Coordinates

- You need to understand the most common coordinate formats.
- Units and symbols help. Don't just give sequences of numbers.
- Map datum matters if you need better than 2 football field accuracy.
- You can easily convert between formats with your GPS receiver.

Latitude / Longitude

DDD° MM' SS"

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N 37° 22' 30"
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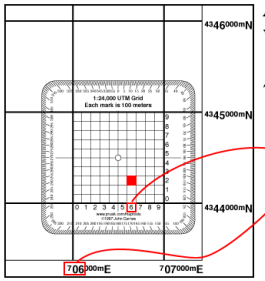
Not 372230 1221545

Universal Transverse Mercator
UTM



A simple UTM Grid tool will quickly locate a 100m square.

This 100m square is located at:

706.6km E 4344.2km N

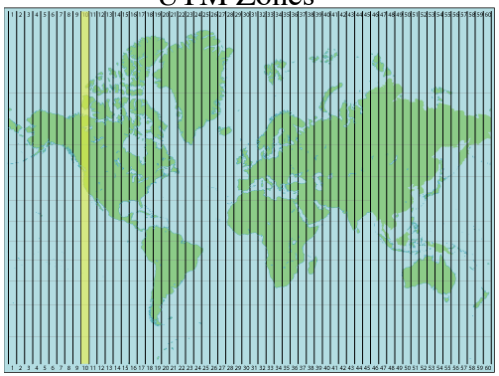
There are many ways to write the same position...

Precision ↓

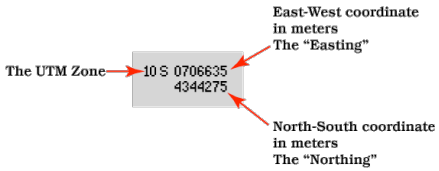
Kilometers	Meters
755km E 4255km N	755000m E 4255000m N
755.2km E 4255.4km N	755200m E 4255400m N
755.23km E 4255.48km N	755230m E 4255480m N
755.234km E 4255.483km N	755234m E 4255483m N

755.200km
755 200m

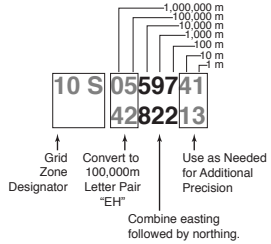
UTM Zones



UTM Display on a GPS Receiver

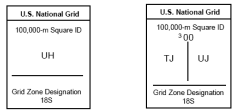


U.S. National Grid (USNG) Coordinates



Full MGRS Coordinate with 100m Precision: **10SEH597822**
Abreviated MGRS Coordinate with 100m Precision: **597822**

Printed Grid Reference Box

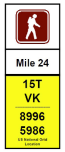


U.S. National Grid could make many location signs "GPS Compatible"

House Numbers

Rural Fire Numbers

Trail Markers



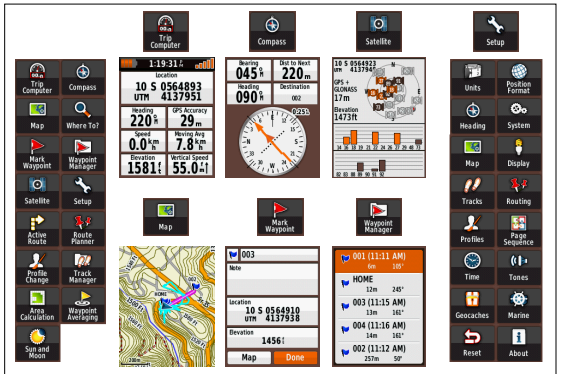
Upgraded Highway Mile Post

Basic GPS Operation

GPS Setup & Use

- Different GPSrs will be a bit different…
- The concepts are similar
- The buttons and menus will all be a bit different.

To turn the eTrex GPS on
press and hold the "light" button for several seconds.



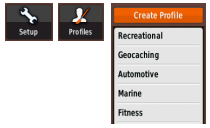
GPS setup can be stored in a "profile"

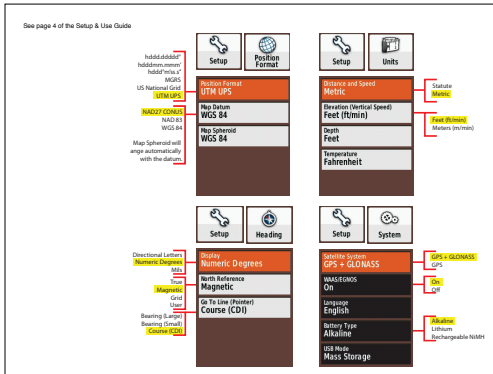
Classroom GPSrs are all set up.
Just change to the NavClass profile.

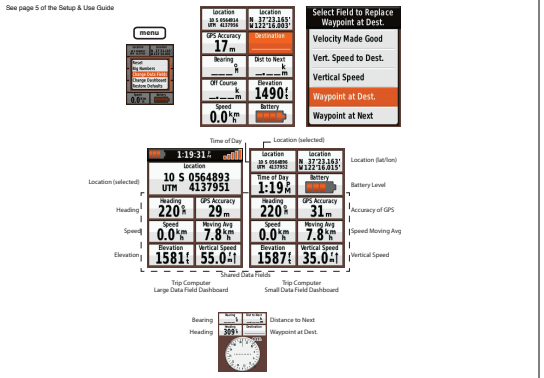
If you want to play with the settings, use the Studen Profile

On your own
GPSr, you will want to create a new profile.

Then set it up as shown on pages 4 and 5 of the Setup & Useg guide

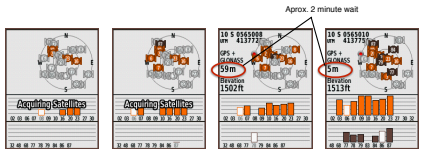






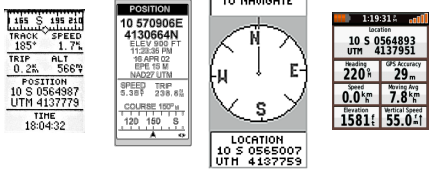
Acquiring satellite signals

- To accurately determine your position, your GPS must be able to receive a strong signal from at least 4 satellites.
- Typically the unit will display a "map" of visible satellites, indicating which are currently being received and their signal strength.



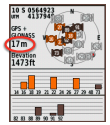
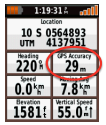
Current position display

- Once your GPS has acquired enough satellites to calculate your position, it will switch to a position display screen.

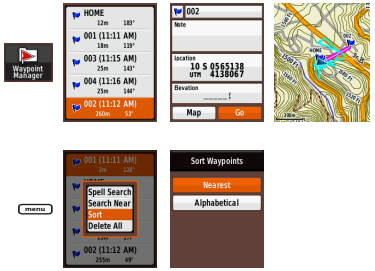


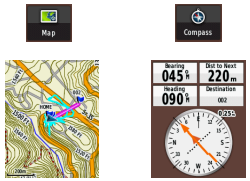
Checking Accuracy

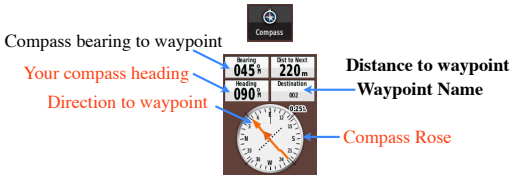
- Your GPS will calculate an Estimated Position Error (EPE). You should get in the habit of checking to see that it is reasonable.

Selecting and Navigating to an Existing Waypoint







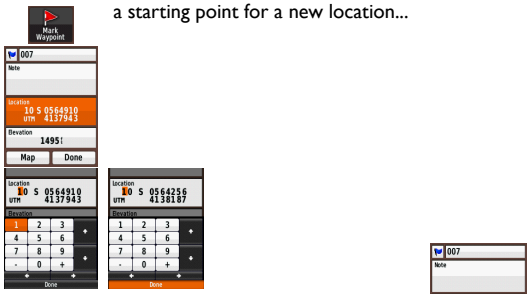
Data in red is only valid when you are moving!
Unless you GPS has an electronic compass.

Saving your position

- Most GPS units have a button or menu for saving your current position. (Often labeled Mark)
- Garmin calls these saved positions "waypoints", Magellan calls them "landmarks".
- Usually the GPS will assign the next number in a sequence as the default name.

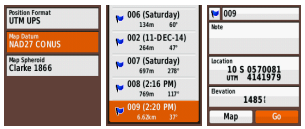
To save your current location in the GPS...

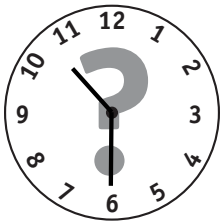
To use the location you just marked as a starting point for a new location...



To enter a waypoint with a different coordinate format or map datum…

N 37° 25.423' W 122° 12.541' WGS 84



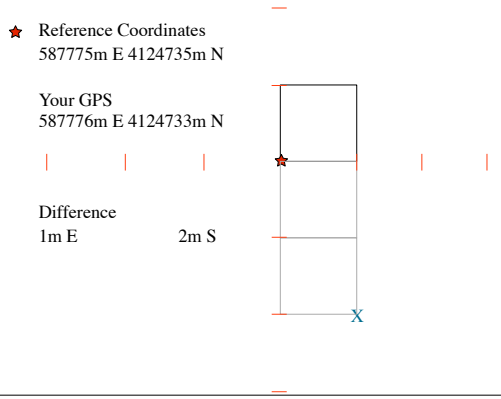


GPS Field Exercise

- GPS Set Up & Basic Operation
- GPS Accuracy Check
- Place a new flag, and exchange coordinates with another team.
- Use the GPS to find flags

–The waypoints are already stored in the GPS units. Labeled 100*

–If you are using your own GPS, I can load the waypoints using the computer.

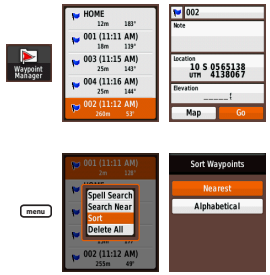


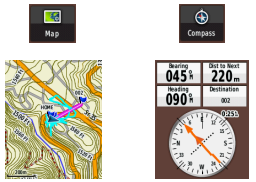
Coordinate Exchange Exercise

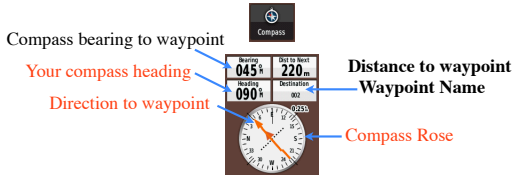
- Coordinate Card and Flagging Tape
- Exchange cell phone #'s with another group
- Place the flagging tape, get its coordinates
- Exchange coordinates and map datum
- Find the other group's flagging tape

Coordinate Format	GPS Format Name	Example Coordinate
UTM	UTM/UPS	10S 0587905m E 4124393m N
Latitude / Longitude Degrees, Minutes, Seconds	hddd° mm' ss.s"	N 37° 22' 30.0" W 122° 15' 45.0"
Latitude / Longitude Degrees, Decimal Minutes	hddd° mm.mmm'	N 37° 22.5000' W 122° 15.7500'
Latitude / Longitude Decimal Degrees	hddd.ddddd°	N 37.37400° W 122.26250°
United States National Grid USNG	US National Grid	10S ES 87040 24516
Military Grid Reference System MGRS	MGRS	10S ES 87040 24516

Selecting and Navigating to an Existing Waypoint







Data in red is only valid when you are moving!
Unless you GPS has an electronic compass.

Get your GPS set up correctly.
Load waypoints if needed.

Go out to the Accuracy Cross Hairs and check the accuracy of your GPS.

Place your flag and pass on it's coordinates

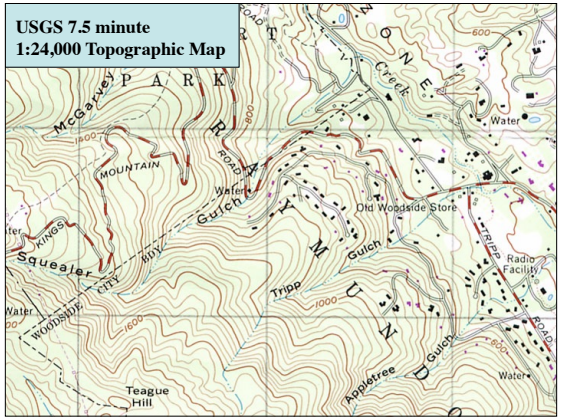
Find the six waypoint flags.

Return to the classroom by....

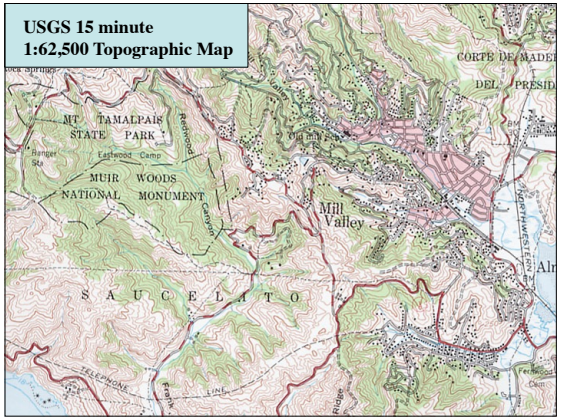
USGS Topographic Maps

The map series that covers
the entire United States

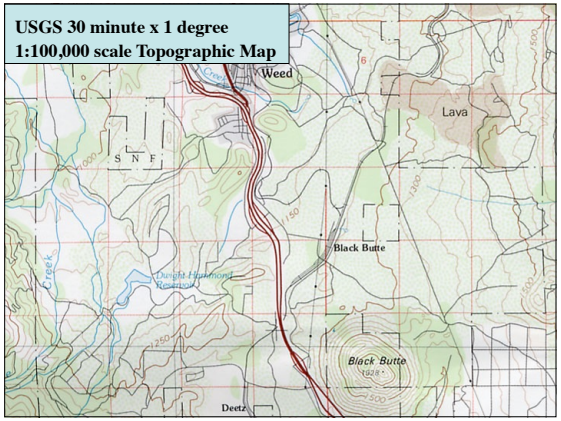
**USGS 7.5 minute
1:24,000 Topographic Map**



**USGS 15 minute
1:62,500 Topographic Map**

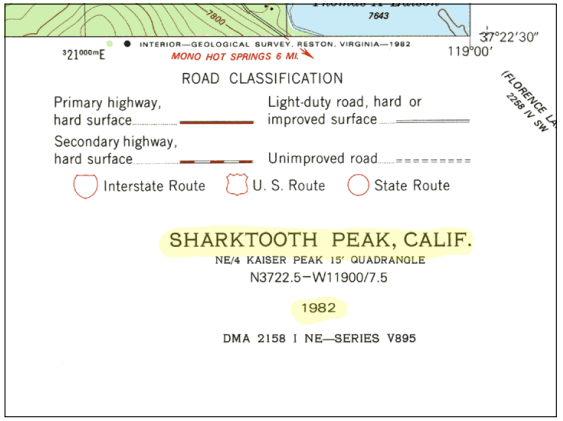


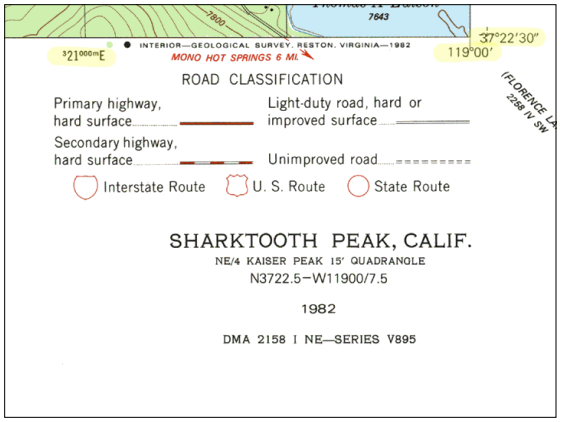
**USGS 30 minute x 1 degree
1:100,000 scale Topographic Map**

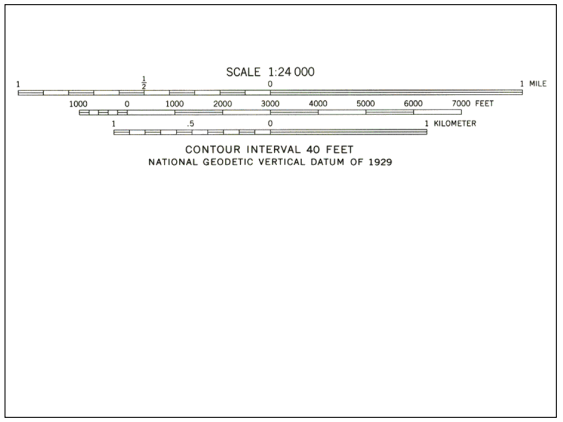


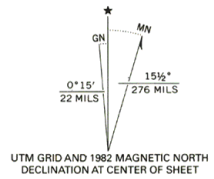
Around the edges of the map…

there is lots of useful information

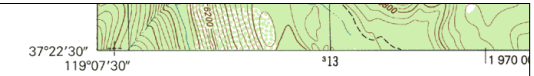








UTM GRID AND 1982 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET



Mapped, edited, and published by the Geological Survey

Control by USGS, NOS/NOAA, and U.S. Forest Service

Topography by photogrammetric methods from aerial photographs taken 1976. Field checked 1978. Map edited 1982
Underwater contours by Southern California Edison Co.

Projection and 10,000-foot grid ticks: California coordinate system, zone 4 (Lambert conformal conic)
1000-meter Universal Transverse Mercator grid, zone 11
1927 North American Datum
To place on the predicted North American Datum 1983 move the projection ines 10 meters north and 85 meters east as shown by dashed corner ticks

Land lines have not been established in this area

There may be private inholdings within the boundaries of the National or State reservations shown on this map

Mapped, edited, and published by the Geological Survey

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Topography by photogrammetric methods from aerial photographs taken 1976. Field checked 1978. Map edited 1982
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Produced by the United States Geological Survey 1982
Revision by USDA Forest Service 2004

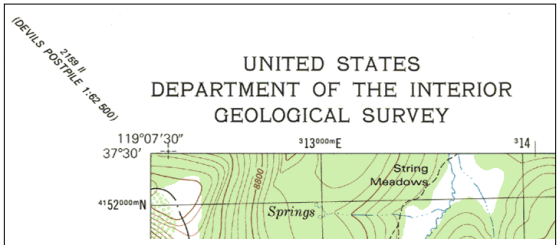
Topography compiled 1976. Planimetry derived from imagery taken 1998 and other sources. Public Land Survey System and survey control current as of 2005. Boundaries current as of 2005

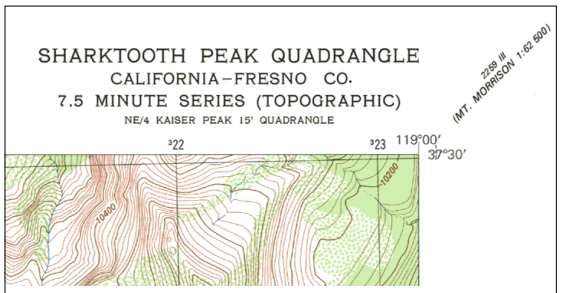
North American Datum of 1983 (NAD 83). Projection and 1 000-meter grid: Universal Transverse Mercator, zone 11
10 000-foot ticks: California Coordinate System (zone IV)

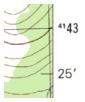
North American Datum of 1927 (NAD 27) is shown by dashed corner ticks
The values of the shift between NAD 83 and NAD 27 for 7.5-minute intersections are obtainable from National Geodetic Survey NADCON software

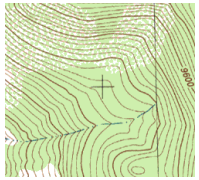
Non-National Forest System lands within the National Forest
Inholdings may exist in other National or State reservations

This map is not a legal document. Public lands are subject to change and leasing, and may have access restrictions; check with appropriate offices
Obtain permission before entering private lands









USGS Topographic Map Symbols

CONTOURS

Topographic

- Index
- Approximate or indefinite
- Intermediate
- Approximate or indefinite
- Supplementary
- Depression
- Cut
- Fill
- Continental divide

VEGETATION

- Woodland
- Shrubland
- Orchard
- Vineyard
- Mangrove

RIVERS, LAKES, AND CANALS

- Perennial stream
- Perennial river
- Intermittent stream
- Intermittent river
- Disappearing stream
- Falls, small
- Falls, large
- Rapids, small
- Rapids, large

RIVERS, LAKES, AND CANALS – *continued*

- Perennial lake/pond
- Intermittent lake/pond
- Dry lake/pond
- Narrow wash
- Wide wash
- Canal, flume, or aqueduct with lock
- Elevated aqueduct, flume, or conduit
- Aqueduct tunnel
- Water well, geyser, fumarole, or mud pot
- Spring or seep

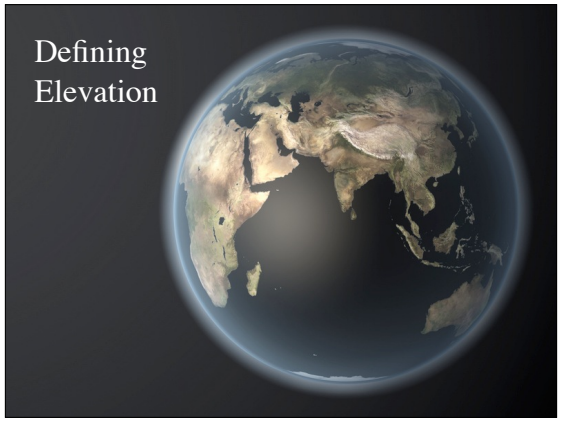
ROADS AND RELATED FEATURES

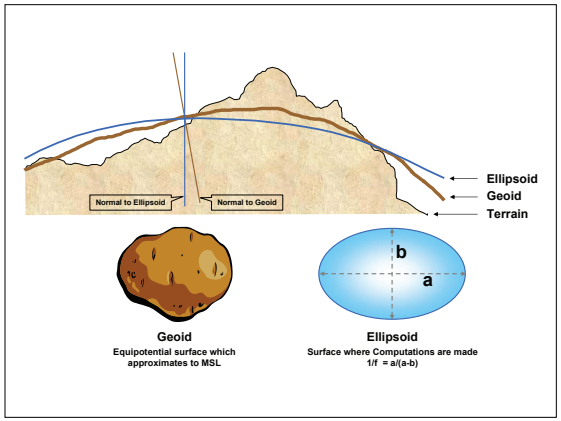
Please note: Roads on Provisional-edition maps are not classified as primary, secondary, or light duty. These roads are all classified as improved roads and are symbolized the same as light duty roads.

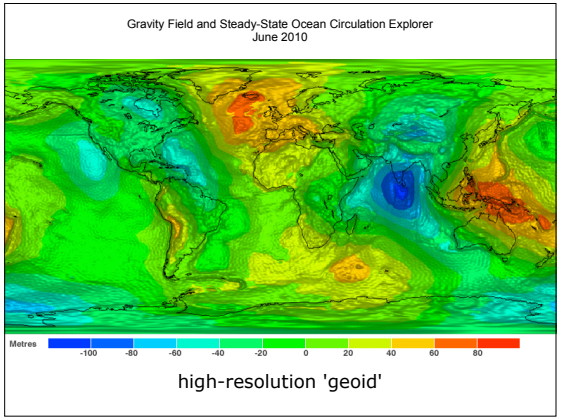
- Primary highway
- Secondary highway
- Light duty road
- Light duty road, paved*
- Light duty road, gravel*
- Light duty road, dirt*
- Light duty road, unspecified*
- Unimproved road
- Unimproved road*
- 4WD road
- 4WD road*
- Trail
- Highway or road with median strip
- Highway or road under construction
- Highway or road underpass; overpass
- Highway or road bridge; drawbridge
- Highway or road tunnel
- Road block, berm, or barrier*
- Gate on road*

Classroom Exercise

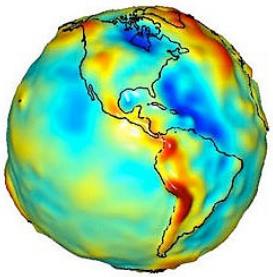
- Find and identify features on topographic maps.







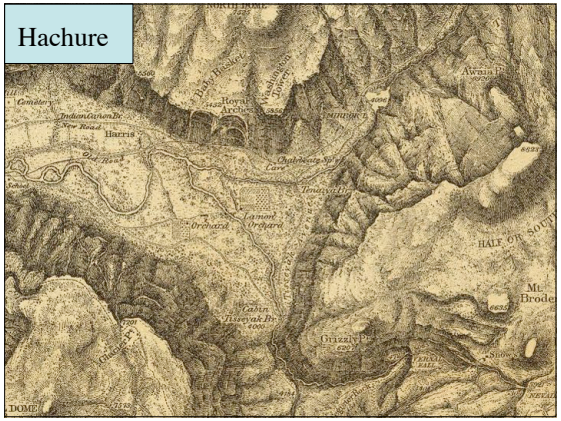
high-resolution 'geoid'

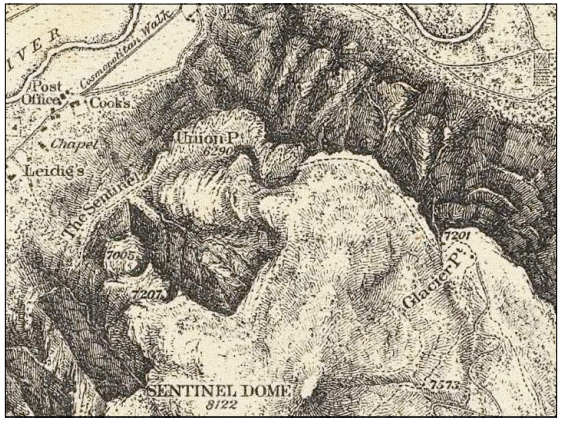


Topography

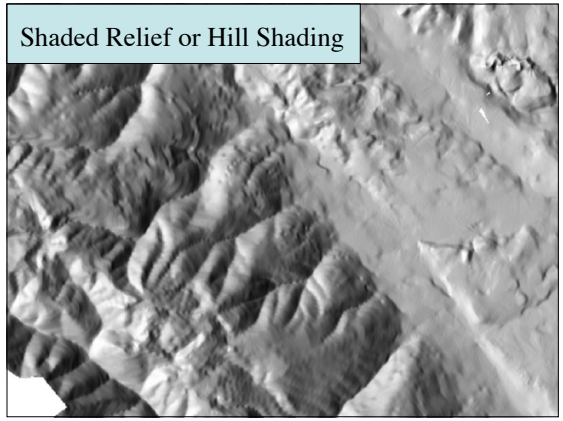
- How maps show topography
  - Hachure
  - Isopleths
  - Hypsography (water flows)
  - Shading
  - Contours

Hachure

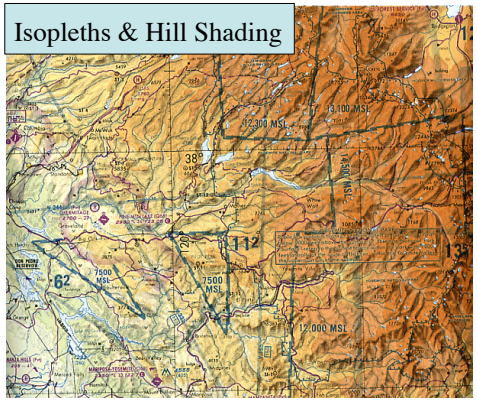




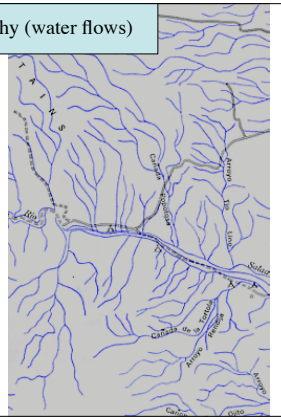
Shaded Relief or Hill Shading



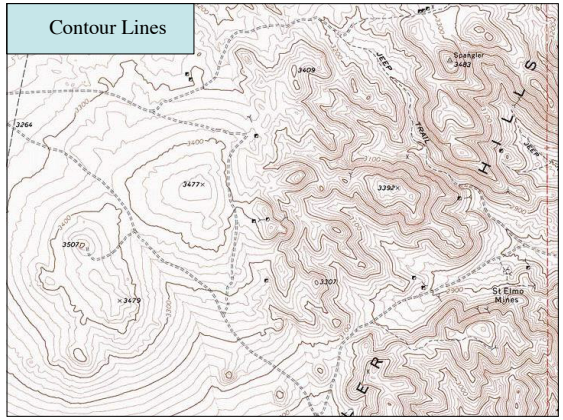
Isopleths & Hill Shading



Hypsography (water flows)



Contour Lines



Contour Lines

- All points along a contour line are the same elevation.
- *Contour Interval* is the elevation change between adjacent contour lines.
- Most maps have *major* contour lines at a regular interval that are labeled with their elevation.

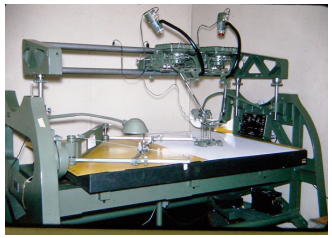
Contour Properties

- The closer together the contour lines, the steeper the slope.
- The *fall line*, or "straight down the hill" is perpendicular to the contour lines. This is the direction water would flow.
- Water flows downhill and is a major force in shaping the topography.

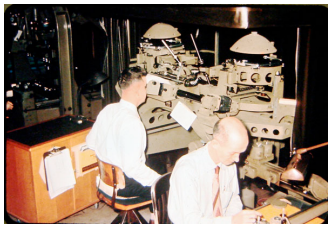
Understanding Contour Lines

- The key to making contour lines useful is learning how to translate from the "bird eye view" on the map, to what you see and experience as you hike through the terrain.
  - What will you see?
  - Will you be going uphill or down?
  - How steep will it be?
  - How will these things change as you move along your path?

the Kelsh stereoplotter, invented by Harry T. Kelsh of the USGS



The Wild A8, stereoplotter



The Kelsh stereoplotters were used in areas of moderate to high relief, but low relief areas, such as along the coasts and large parts of the Great Plains, required the capabilities of the "heavy" stereoplotters that used projection by mechanical rods.

These stereoplotters included the Wild A8, B8, the Kern PG-2, and others of German, Swiss, and Italian manufacture.

The Kelsh and the heavy plotters were used until completion of the 7.5-minute topographic map series in 1991.

A USGS topographer engraves topographic map information onto a copper plate for map reproduction.

Many names, similar feature

- How many names can we come up with for a natural water course?

There are distinctions but...

- Don't get hung up on exact definitions
- There are regional and cultural differences
- Usage differences abound
- And not just for water features

Using Contour Lines to Visualize Topography

The skills you need to know…

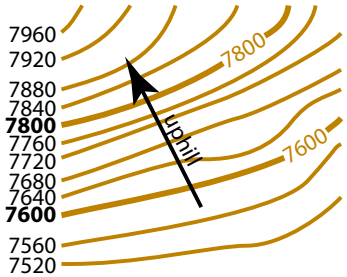
- Learn a few rules about contour lines.
- Learn to recognize a small set of "contour line signatures" and what they mean.
- Learn to visualize the cross section of a line or path across a short section of terrain.

Contour Lines

- A contour line joins points of equal elevation.
- Two adjacent contour lines represent a change in elevation.
  - The amount of change is called the "contour interval" and is usually the same across the whole map.
- Typically every fifth contour line is thicker and labeled with its elevation.
  - These are called "index lines."

Contour Lines

40 foot contour interval

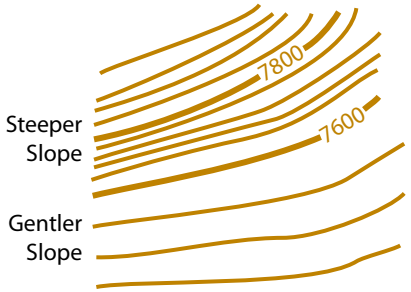


Contour Lines

A few rules…

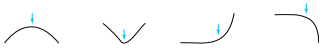
- Contour lines never cross each other.
- The closer the spacing between contour lines, the steeper the slope.
- When they touch it represents a vertical or nearly vertical slope. They do not have the ability to depict an overhang.

Contour Lines



Terrain Breaks

- Points or lines where *important* changes in slope occur.
  - changes between uphill and downhill travel.
  - changes between gentle and steep slopes
- Some examples: hilltops, ridge lines, spurs, drainages, valleys, cliffs,…



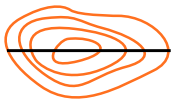
Terrain Break Cross Sections

Contour Line "Signatures"

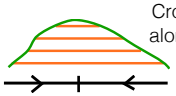
Hilltop

"from the top of a hill, there is no place to go but down"

Contour lines representing a hilltop



Cross Section along the path

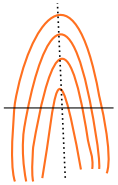


A path across the hilltop

Uphill arrows and a mark at the terrain break.

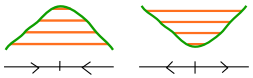
Contour Line "Signatures"

It's a Terrain Break, but what kind?



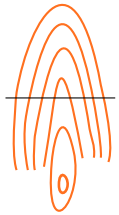
There will be an uphill/downhill terrain break, wherever you cross the dotted line

But the cross section could be either one of these…

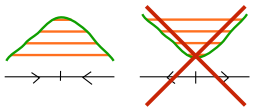


Contour Line "Signatures"

Spur from a hilltop

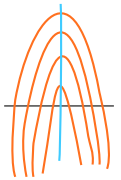


Now that we see a hilltop, we can say this is a spur coming off the hilltop.

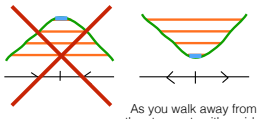


Contour Line "Signatures"

Drainage



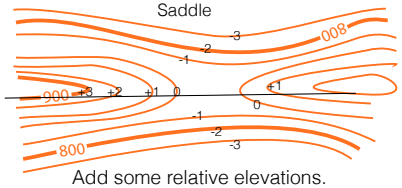
Streams don't run along the tops of spurs. This must be a drainage.



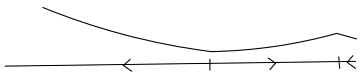
As you walk away from the stream, to either side, you will be going uphill.

Contour Line "Signatures"

Saddle

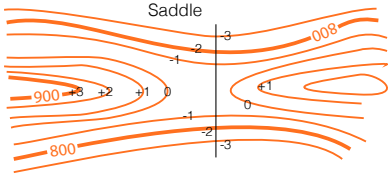


Add some relative elevations.

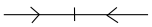


Contour Line "Signatures"

Saddle



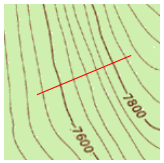
What about a cross section going this way?



Some examples

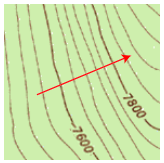
- Using your handout…
  - On each red line, add an **arrow pointing uphill**.
  - On each purple line, add **marks for terrain breaks**, and **uphill arrows for each segment**.

1



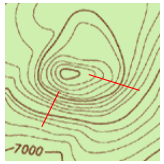
1

Labeled index contour lines allow us to determine elevations, and thus what is uphill.



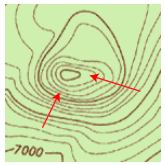
Contour Interval is 40ft
200 ft / 5 intervals = 40 ft/interval

2



2

Hilltop is highest point.
Arrows point up to the top.



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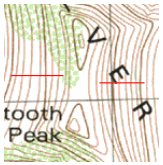
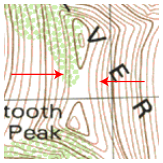


3

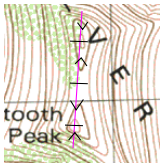
The twin peaks define the high points.

This would be a saddle between two peaks.

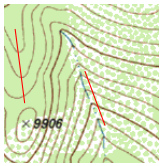


3

Terrain breaks at the two peaks
and the saddle.
Arrows point up to the peaks.



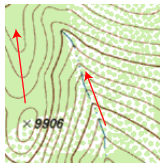
4



4

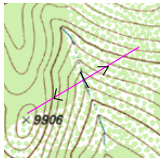
Just because you see a hilltop doesn't always make it the **highest** point.

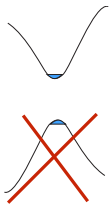
In this case, it is a bump on the side of a slope.



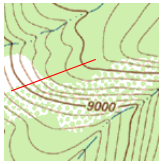
4

Terrain break is at the stream.
Arrows point up to either side of the stream.

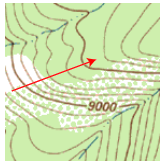




5

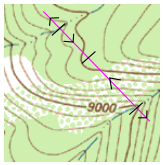


5

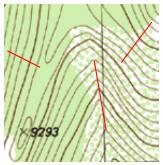


5

Terrain breaks at both creeks,
and the spur in between them.
Arrows point uphill from either side of the creek.

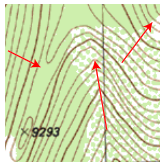


6



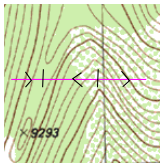
6

Use the hilltop at x9293 to
determine up from down.

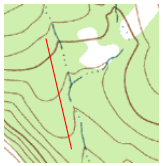


6

Terrain breaks on the spur and in the drainage.
Arrows point uphill from either side of the drainage.

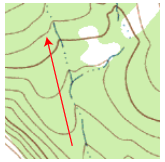


7

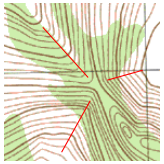


7

Usually streams of water merge to form larger stream.
When might a stream of water split into multiple
streams?



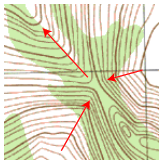
8



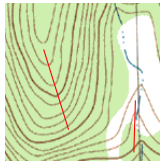
8

Use the high spots to
determine up from down.

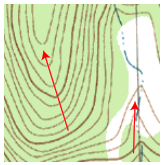
This is a saddle in a ridge
line that runs NW to SE



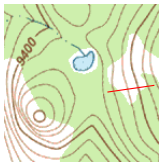
9



9

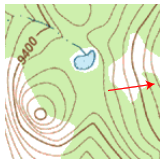


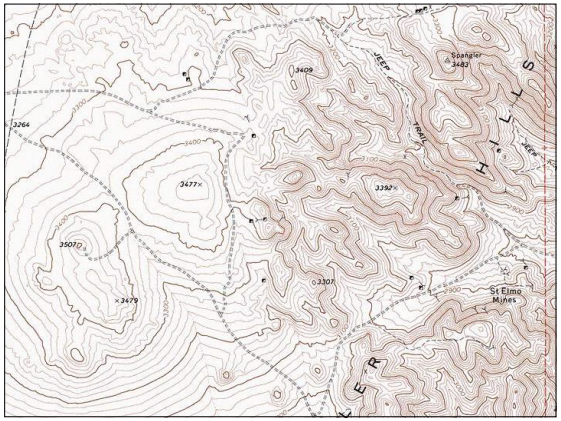
10



Use the high point to determine up from down. 10

Pay close attention to the contour lines in the SE corner. Use them to determine up and down east of the lake.





Let's take a virtual backpacking trip

Sharktooth Peak Map

Instructions

- We will be hiking on the Sharktooth Peak map
- Work with a partner
- I will come around and mark a start and end point on your map.
- You need to come up with a brief verbal route description. It can be on or off trail. Avoid hazards and unpleasant hiking.
- You will be describing your route to the class, as they follow along on their maps.
- The class will ask for clarification if we get lost.

- Use
  - The 16 cardinal directions N, NE, NNE
  - Linear and point topographic features
  - Uphill and downhill
  - Approximate distance in kilometers
  - Spot elevations
- Avoid
  - Travel along a contour line
  - GPS coordinates
  - Straight line bearing and distance directions
  - Vegetation boundaries
  - Lettering on the map
- Note: There are 2 different versions of the map
  - There are differences in the roads, trails, and camps

Field Exercise

Let's use the campus map and the GPS to locate some more flags.

Most of the points are loaded into the GPSrs already.

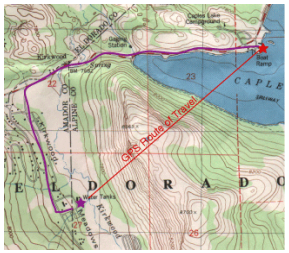
You will need to enter the first point.

Plot your destination on your map.

Use your map to determine the best route.

Don't let your GPS determine the route.
It will be a straight line from your current location to your destination.

Perils of straight line routes



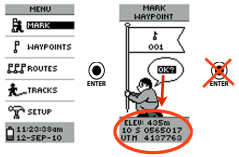
Straight Line
v.s.
Terrain Based Route

700+ ft Elevation Gain,
Rock Gear, & Boat
v.s.
80 ft Elevation Gain,
Paved Road

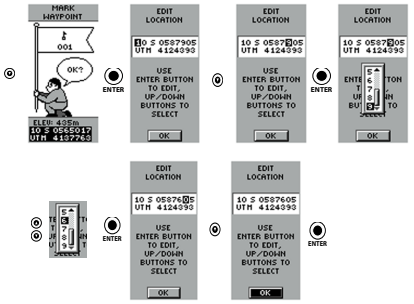
To store a location in your gps...

- Mark your current position
- Before you save it, change it to the desired coordinates.
- Now you can save it.

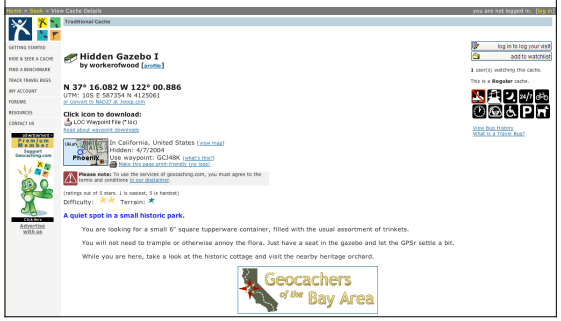
To save your current location in the GPS...



To use the location you just marked as a starting point for a new location...



Geocaching



Nav to Known Coordinates Geocaches

Let's try it!

10 Waypoints to find
You need to enter the first one (2001)
I'll load the rest with the computer.

Plot them on the map first!

Use the map to determine your route.

2 Geocaches to find

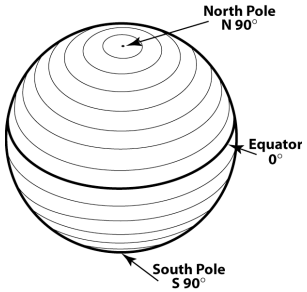
Return by....

Introductions

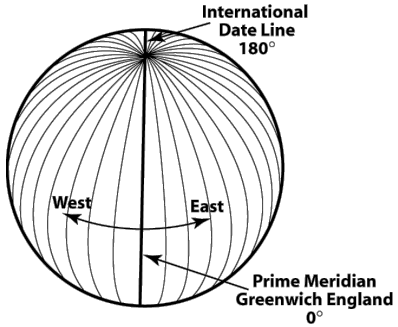
- What is your name?
- What activities do you do (or plan to do) that involve wilderness navigation?
- What do you do (did, plan to do) professionally?
- How did you hear about this class?

Latitude / Longitude

The Equator and Parallels of Latitude



Longitude



The Prime Meridian

- Today the world has agreed the the Prime Meridian or 0° line of longitude runs through the Royal Observatory at Greenwich, England.
- Prior to the 1884 International Meridian Conference, most countries defined their own prime meridian running through their own capital city.
- The French did not abandon use of their prime meridian, which ran through the Paris Observatory, until 1911.

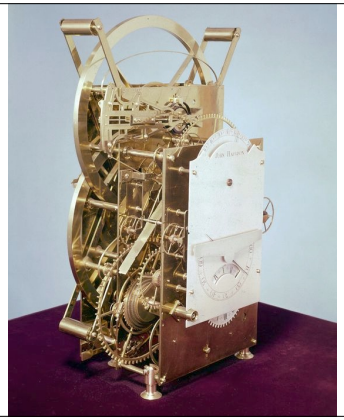
Longitude was difficult to measure at sea

- Your longitude is the time difference between high noon at a known longitude (A ship's home port for example.) and high noon at your current location.
- How many degrees does a one hour time difference represent?

No Clock

No Longitude

H3
John Harrison
1740-1757



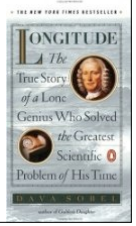
National Maritime Museum, Greenwich, London, Ministry of Defence Art Collection

H4
John Harrison
1755-1759

National Maritime Museum, Greenwich, London, Ministry of Defence Art Collection

If the history of navigation intrigues you, I'd suggest you read…

- Longitude: The true story of a lone genius who solved the greatest scientific problem of his time.
- By Dava Sobel
- Also as a PBS Nova show.
  - On DVD, Netflix has it.



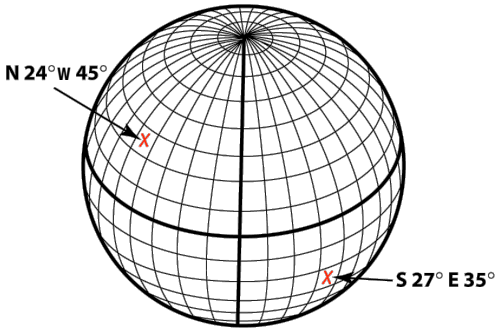
Degrees, Minutes, and Seconds

- Because measurement of latitude & longitude were so closely tied to time, it made sense to subdivide degrees into minutes and seconds.
- A degree is made up of 60 minutes
- A minute is made up of 60 seconds

DDD° MM' SS"

- A latitude / longitude coordinate would be written like…

N 37° 22' 30"
W 122° 15' 45"



DDD° MM' SS"

- A latitude / longitude coordinate would be written like…

N 37° 22' 30"
W 122° 15' 45"

DDD° MM.MMM'

- It is now common place to write lat / lon coordinates in a "decimal minutes" format.

N 37° 22.5'
W 122° 15.75'

DDD.DDDD°

- Many computer based systems report lat/lon in decimal degrees.

N 37.3750°
W 122.2625°

Units Matter

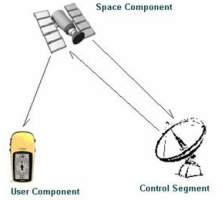
- It is important to include all of the units and notation.
- It's N 37° 22' 30" W 122° 15' 45"

Not 372230 1221545

Where am I?

Using a GPS receiver
to determine your location.

Global Positioning System



Geographic Coordinates

A GPS receiver reports its position as numeric coordinate values.

There are several common formats for the coordinates.

Geographic Coordinate Systems

- Latitude / Longitude
- Universal Transverse Mercator (UTM)
- US National Grid (USNG)
- Others
  - State Plane
  - Military Grid Reference System
  - British Grid
  - Maidenhead
  - and many, many more.

Communicating Geographic Coordinates

- You need to understand the most common coordinate formats.
- Units and symbols help. Don't just give sequences of numbers.
- Map datum matters if you need better than 2 football field accuracy.
- You can easily convert between formats with your GPS receiver.

Latitude / Longitude

DDD° MM' SS"

- A latitude / longitude coordinate would be written like…

N 37° 22' 30"
W 122° 15' 45"

DDD° MM.MMM'

- It is now common place to write lat / lon coordinates in a "decimal minutes" format.

N 37° 22.5'
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- Many computer based systems report lat/lon in decimal degrees.

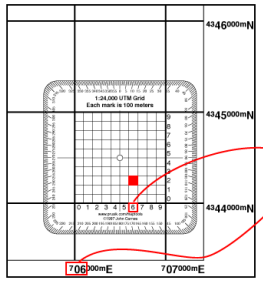
N 37.3750°
W 122.2625°

Units Matter

- It is important to include all of the units and notation.
- It's N 37° 22' 30" W 122° 15' 45"

Not 372230 1221545

Universal Transverse Mercator UTM



A simple UTM Grid tool will quickly locate a 100m square.

This 100m square is located at:

706.6km E 4344.2km N

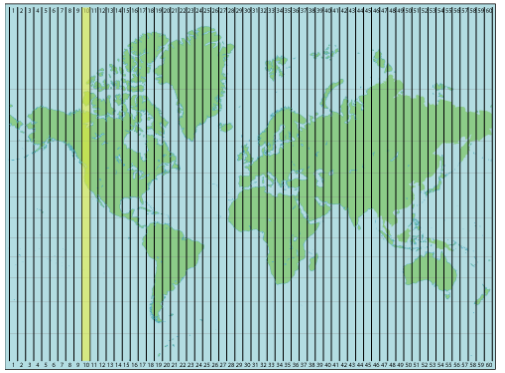
There are many ways to write the same position…

Precision ↓

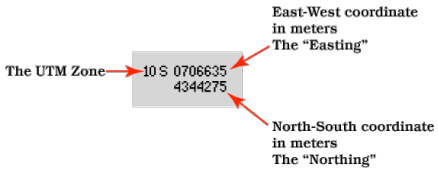
Kilometers	Meters
755km E 4255km N	755000m E 4255000m N
755.2km E 4255.4km N	755200m E 4255400m N
755.23km E 4255.48km N	755230m E 4255480m N
755.234km E 4255.483km N	755234m E 4255483m N

755.200km
755 200m

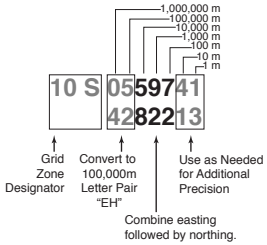
UTM Zones



UTM Display on a GPS Receiver

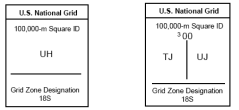


U.S. National Grid (USNG) Coordinates



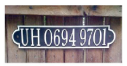
Full MGRS Coordinate with 100m Precision: **10SEH597822**
Abreviated MGRS Coordinate with 100m Precision: **597822**

Printed Grid Reference Box



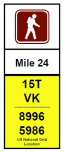
U.S. National Grid could make many location signs "GPS Compatible"

House Numbers



Rural Fire Numbers

Trail Markers



Upgraded Highway Mile Post

Basic GPS Operation

- Different GPSrs will be a bit different…
- The concepts are similar
- The buttons and menus will all be a bit different.

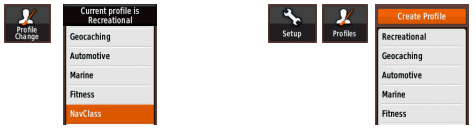
To turn the eTrex GPS on
press and hold the "light" button for several seconds.

GPS setup can be stored in a "profile"

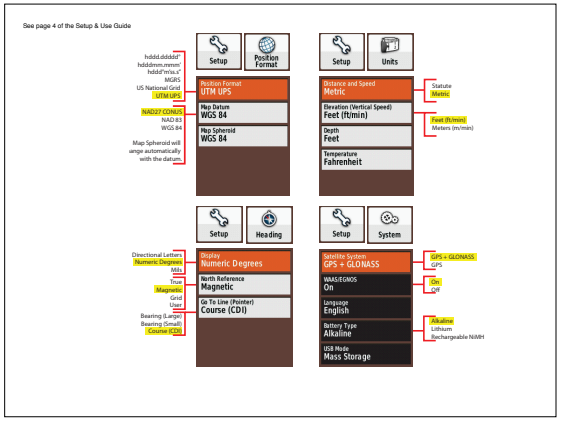
Classroom GPSrs are all set up.
Just change to the NavClass profile.

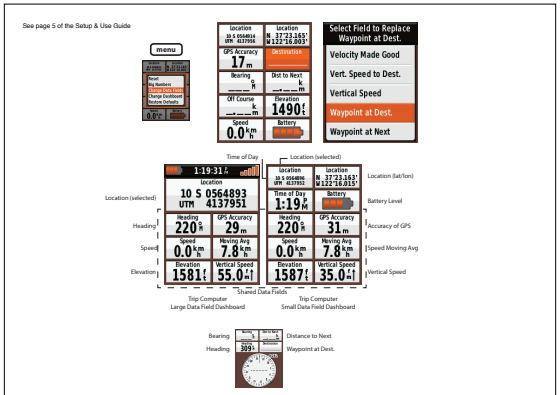
On your own
GPSr, you will want to create a new profile.

Then set it up as shown on pages 4 and 5
of the Setup & Useg guide



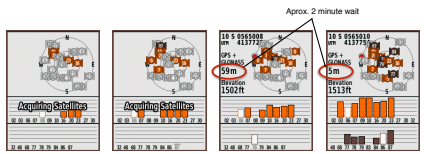
If you want to play with the settings,
use the Studen Profile





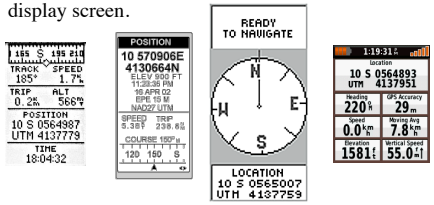
Acquiring satellite signals

- To accurately determine your position, your GPS must be able to receive a strong signal from at least 4 satellites.
- Typically the unit will display a "map" of visible satellites, indicating which are currently being received and their signal strength.



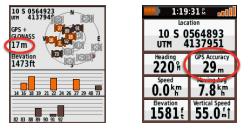
Current position display

- Once your GPS has acquired enough satellites to calculate your position, it will switch to a position display screen.

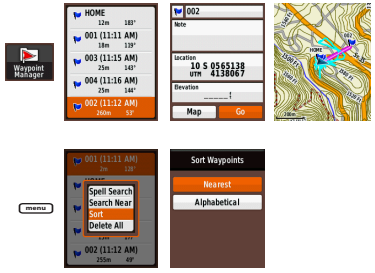


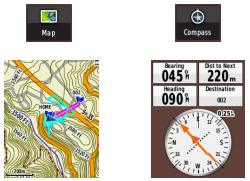
Checking Accuracy

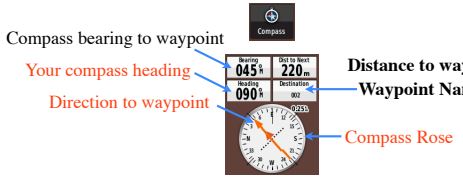
- Your GPS will calculate an Estimated Position Error (EPE). You should get in the habit of checking to see that it is reasonable.



Selecting and Navigating
to an
Existing Waypoint







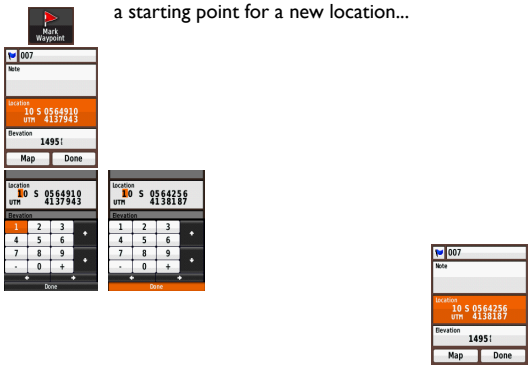
Data in red is only valid when you are moving!
Unless you GPS has an electronic compass.

Saving your position

- Most GPS units have a button or menu for saving your current position. (Often labeled Mark)
- Garmin calls these saved positions "waypoints", Magellan calls them "landmarks".
- Usually the GPS will assign the next number in a sequence as the default name.

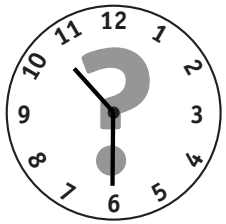
To save your current location in the GPS...

To use the location you just marked as a starting point for a new location...



To enter a waypoint with a different coordinate format or map datum…

N 37° 25.423' W 122° 12.541' WGS 84



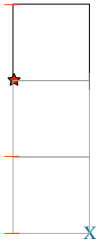
GPS Field Exercise

- GPS Set Up & Basic Operation
- GPS Accuracy Check
- Place a new flag, and exchange coordinates with another team.
- Use the GPS to find flags
  - –The waypoints are already stored in the GPS units. Labeled 100*
  - –If you are using your own GPS, I can load the waypoints using the computer.

★ Reference Coordinates
587775m E 4124735m N

Your GPS
587776m E 4124733m N

Difference
1m E 2m S

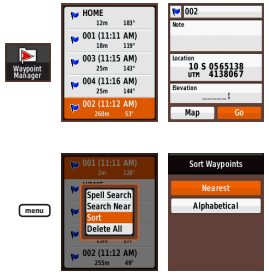


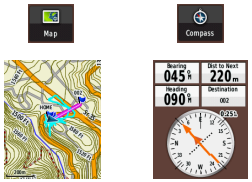
Coordinate Exchange Exercise

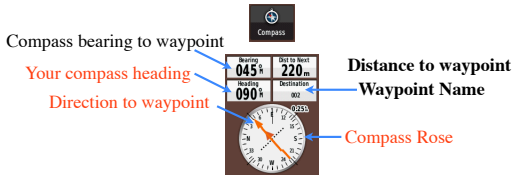
- Coordinate Card and Flagging Tape
- Exchange cell phone #'s with another group
- Place the flagging tape, get its coordinates
- Exchange coordinates and map datum
- Find the other group's flagging tape

Coordinate Format	GPS Format Name	Example Coordinate
UTM	UTM/UPS	10S 0587905m E 4124393m N
Latitude / Longitude Degrees, Minutes, Seconds	hddd° mm' ss.s"	N 37° 22' 30.0" W 122° 15' 45.0"
Latitude / Longitude Degrees, Decimal Minutes	hddd° mm.mmm'	N 37° 22.5000' W 122° 15.7500'
Latitude / Longitude Decimal Degrees	hddd.ddddd°	N 37.37400° W 122.26250°
United States National Grid USNG	US National Grid	10S ES 87040 24516
Military Grid Reference System MGRS	MGRS	10S ES 87040 24516

Selecting and Navigating to an Existing Waypoint







Data in red is only valid when you are moving!
Unless you GPS has an electronic compass.

Get your GPS set up correctly.
Load waypoints if needed.

Go out to the Accuracy Cross Hairs and check the accuracy of your GPS.

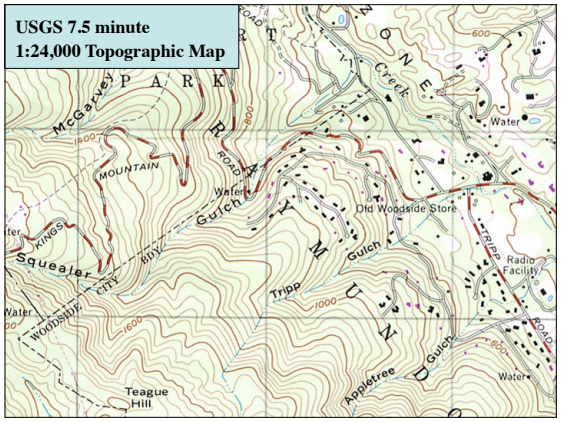
Place your flag and pass on it's coordinates

Find the six waypoint flags.

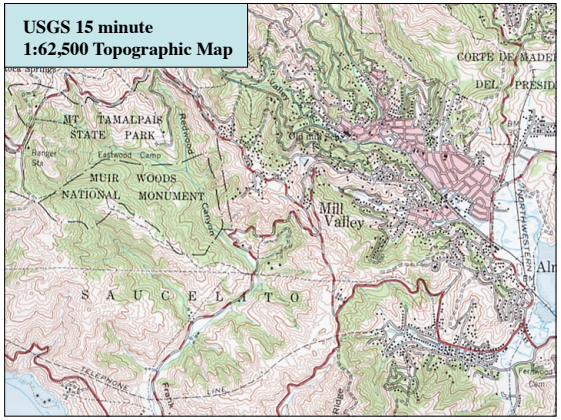
Return to the classroom by....

USGS Topographic Maps

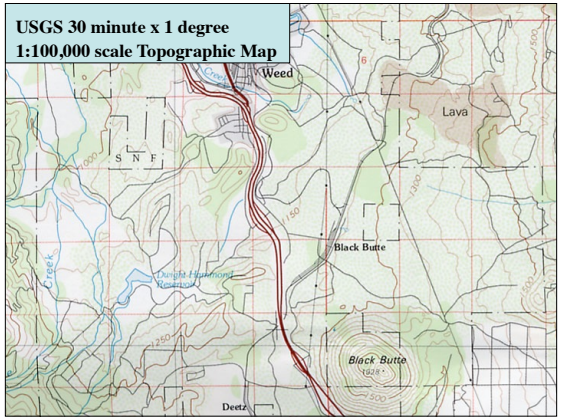
The map series that covers
the entire United States



USGS 15 minute
1:62,500 Topographic Map

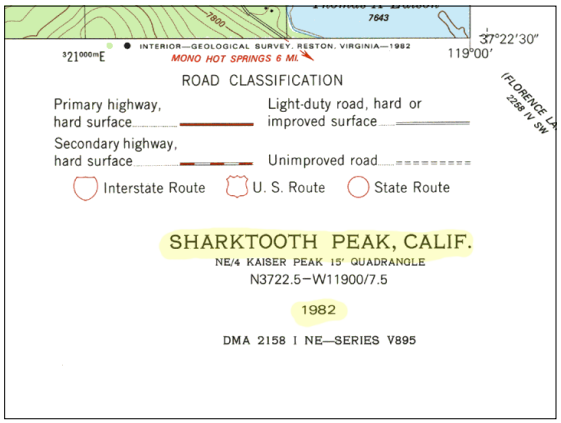


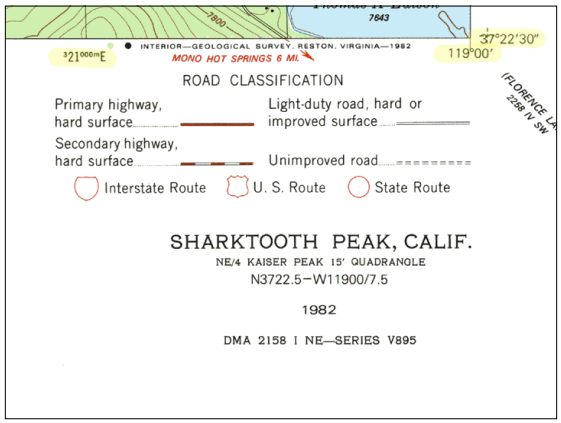
USGS 30 minute x 1 degree
1:100,000 scale Topographic Map

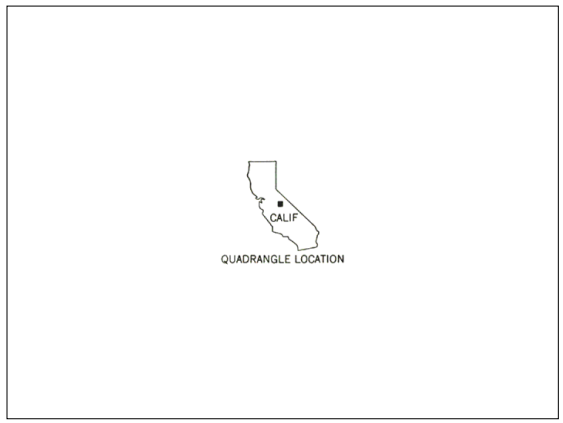


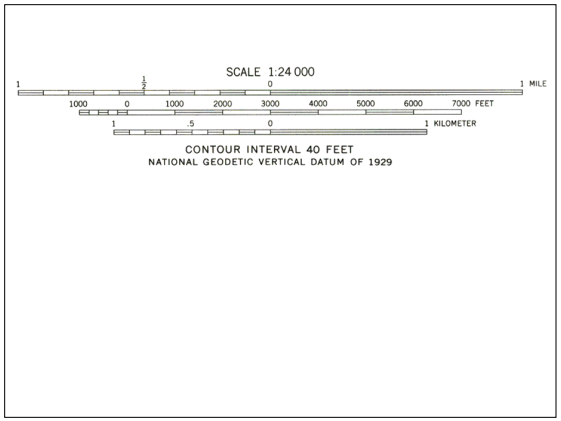
Around the edges of the map…

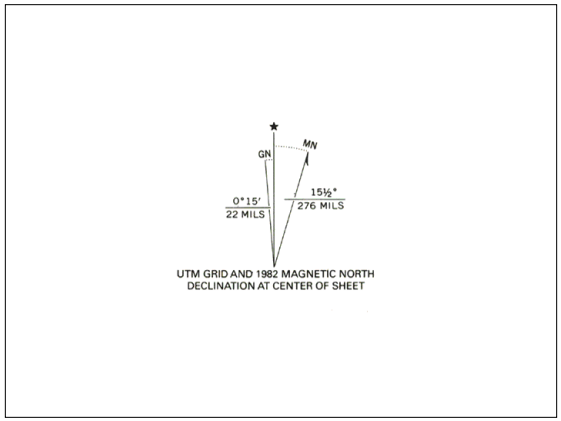
there is lots of useful information

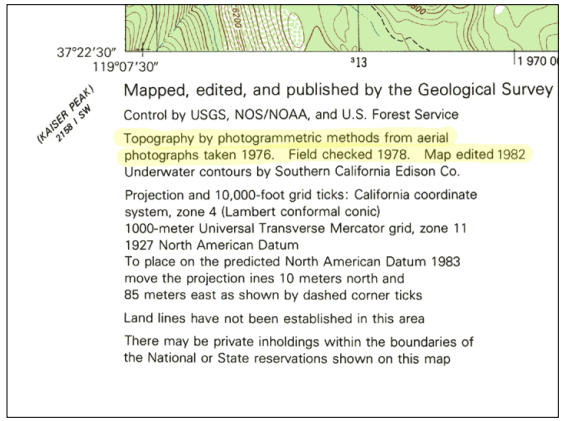


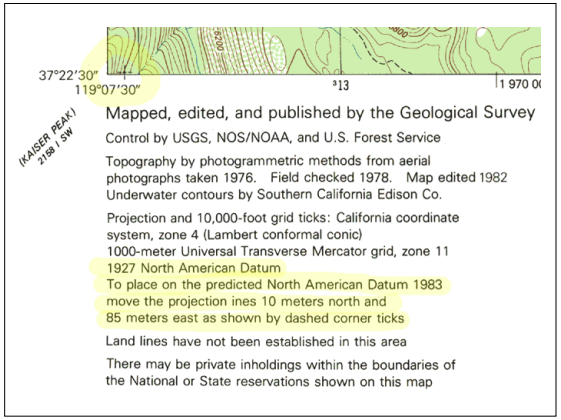


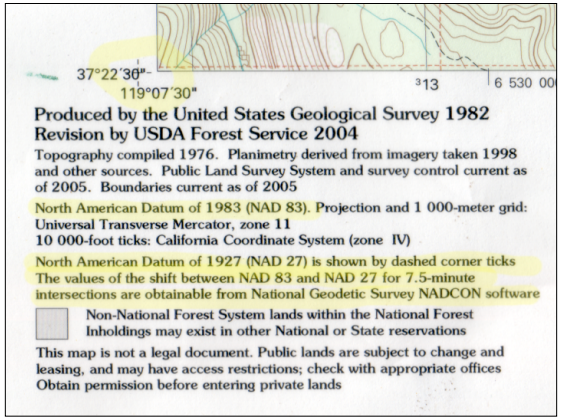


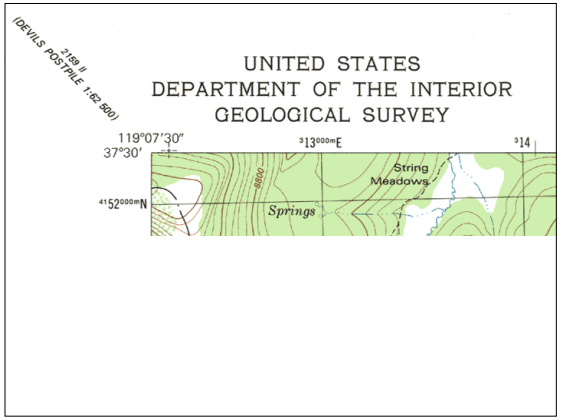


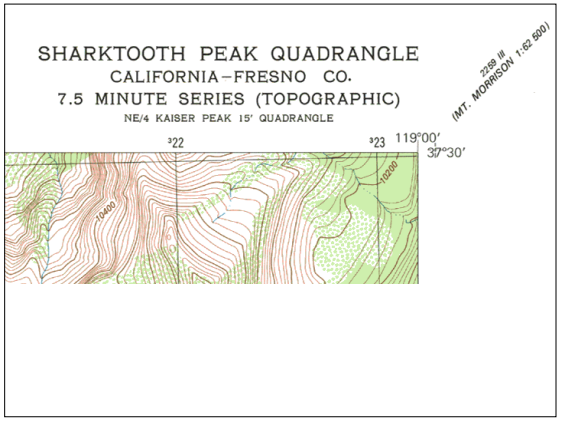


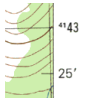


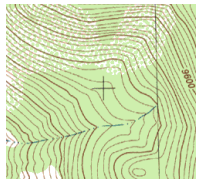




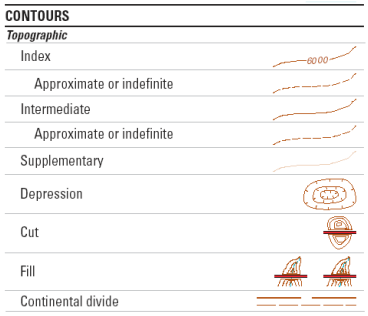


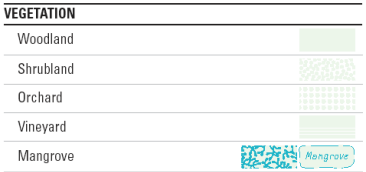






USGS Topographic Map Symbols





RIVERS, LAKES, AND CANALS

- Perennial stream
- Perennial river
- Intermittent stream
- Intermittent river
- Disappearing stream
- Falls, small
- Falls, large
- Rapids, small
- Rapids, large

RIVERS, LAKES, AND CANALS – *continued*

- Perennial lake/pond
- Intermittent lake/pond
- Dry lake/pond
- Narrow wash
- Wide wash
- Canal, flume, or aqueduct with lock
- Elevated aqueduct, flume, or conduit
- Aqueduct tunnel
- Water well, geyser, fumarole, or mud pot
- Spring or seep

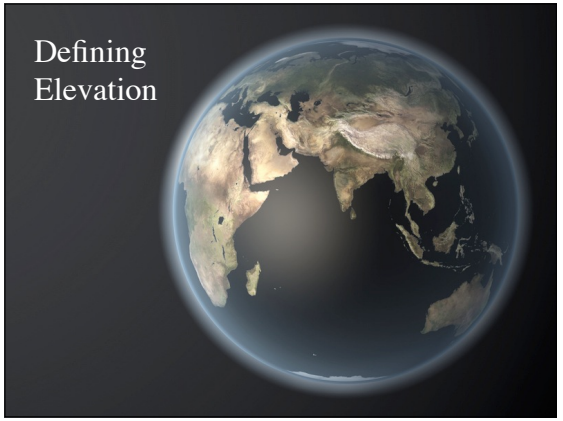
ROADS AND RELATED FEATURES

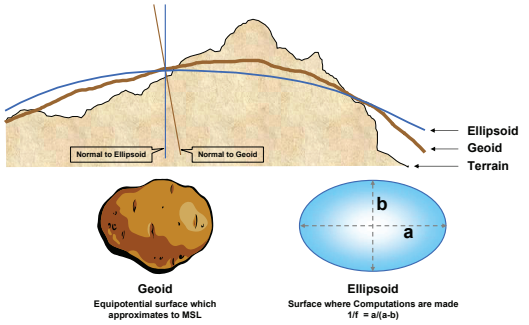
Please note: Roads on Provisional-edition maps are not classified as primary, secondary, or light duty. These roads are all classified as improved roads and are symbolized the same as light duty roads.

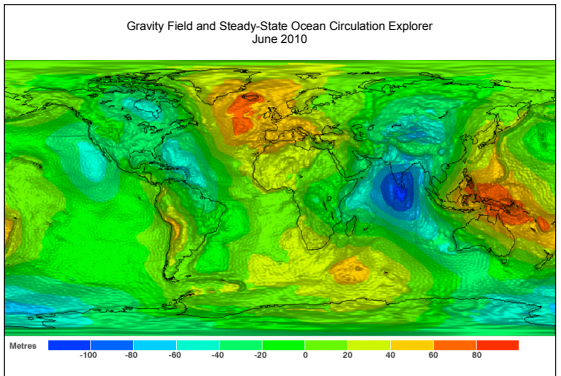
- Primary highway
- Secondary highway
- Light duty road
- Light duty road, paved*
- Light duty road, gravel*
- Light duty road, dirt*
- Light duty road, unspecified*
- Unimproved road
- Unimproved road*
- 4WD road
- 4WD road*
- Trail
- Highway or road with median strip
- Highway or road under construction
- Highway or road underpass; overpass
- Highway or road bridge; drawbridge
- Highway or road tunnel
- Road block, berm, or barrier*
- Gate on road*

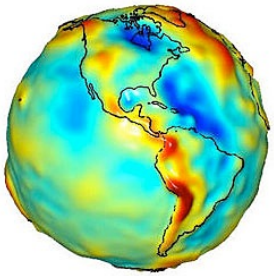
Classroom Exercise

- Find and identify features on topographic maps.





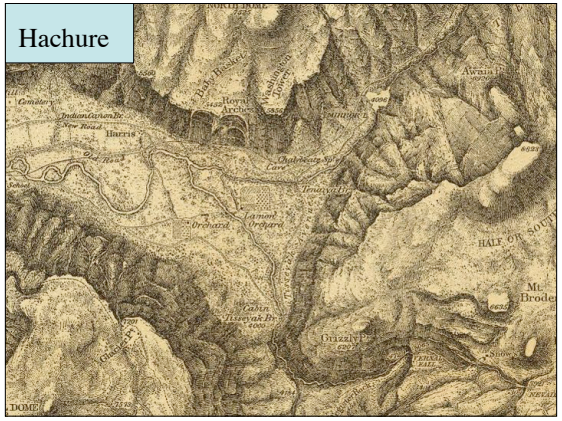


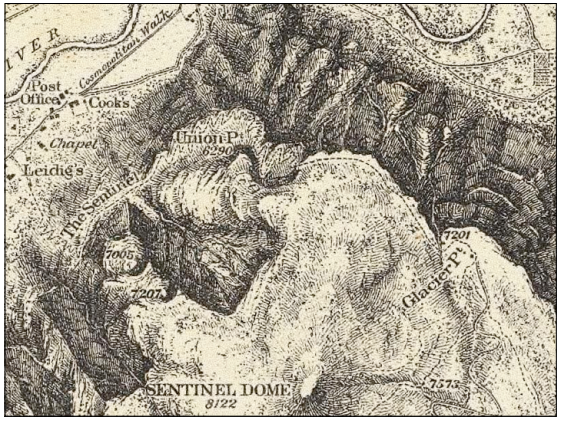


Topography

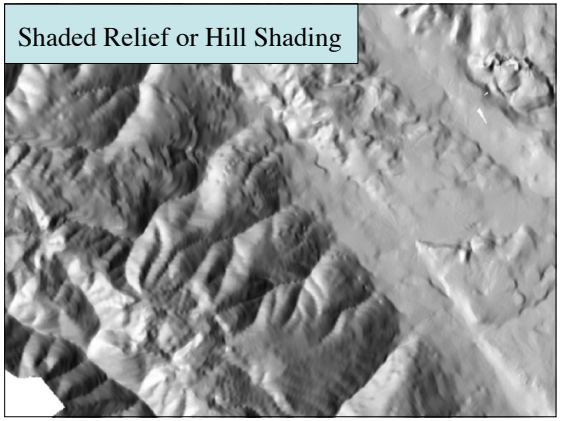
- How maps show topography
  - Hachure
  - Isopleths
  - Hypsography (water flows)
  - Shading
  - Contours

Hachure

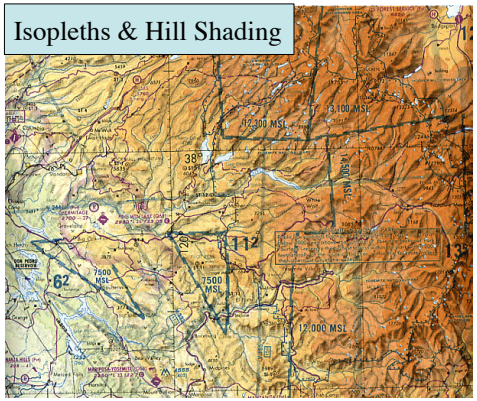




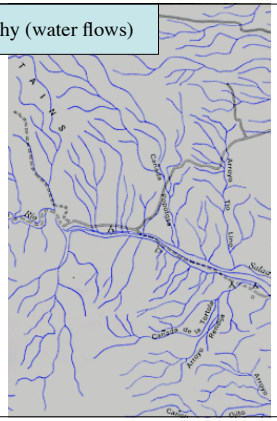
Shaded Relief or Hill Shading



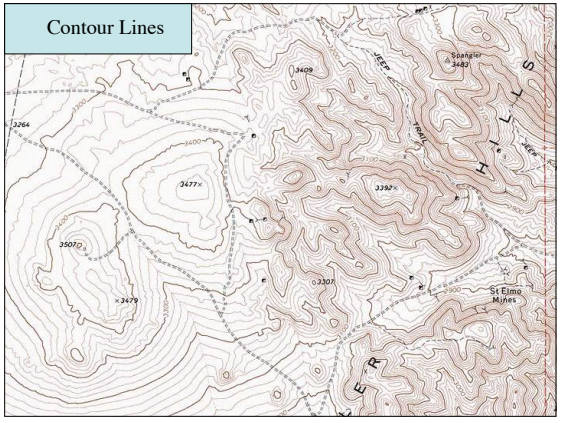
Isopleths & Hill Shading



Hypsography (water flows)



Contour Lines



Contour Lines

- All points along a contour line are the same elevation.
- *Contour Interval* is the elevation change between adjacent contour lines.
- Most maps have *major* contour lines at a regular interval that are labeled with their elevation.

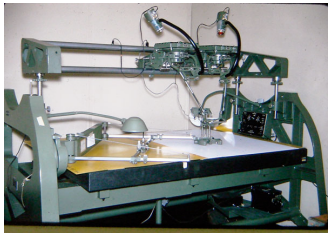
Contour Properties

- The closer together the contour lines, the steeper the slope.
- The *fall line*, or "straight down the hill" is perpendicular to the contour lines. This is the direction water would flow.
- Water flows downhill and is a major force in shaping the topography.

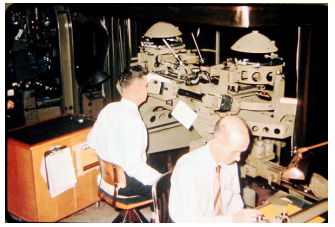
Understanding Contour Lines

- The key to making contour lines useful is learning how to translate from the "bird eye view" on the map, to what you see and experience as you hike through the terrain.
  - What will you see?
  - Will you be going uphill or down?
  - How steep will it be?
  - How will these things change as you move along your path?

the Kelsh stereoplotter, invented by Harry T. Kelsh of the USGS



The Wild A8, stereoplotter



The Kelsh stereoplotters were used in areas of moderate to high relief, but low relief areas, such as along the coasts and large parts of the Great Plains, required the capabilities of the "heavy" stereoplotters that used projection by mechanical rods.

These stereoplotters included the Wild A8, B8, the Kern PG-2, and others of German, Swiss, and Italian manufacture.

The Kelsh and the heavy plotters were used until completion of the 7.5-minute topographic map series in 1991.

A USGS topographer engraves topographic map information onto a copper plate for map reproduction.

Many names, similar feature

- How many names can we come up with for a natural water course?

stream course tributary run arroyo *firth* estuary *rill* swamp bayou *burn* gulch allt gully **river** brooklet falls seep kill arm fjord ***wadi*** crick inlet brook syke branch **spring** marsh tidewater *beck* **drainage** *runnel* *bourne* **creek** *rambla* **fork** watercourse ditch *rindle* prong coulee streamlet *nant* rivulet bog

There are distinctions but...

- Don't get hung up on exact definitions
- There are regional and cultural differences
- Usage differences abound
- And not just for water features

Using Contour Lines to Visualize Topography

The skills you need to know…

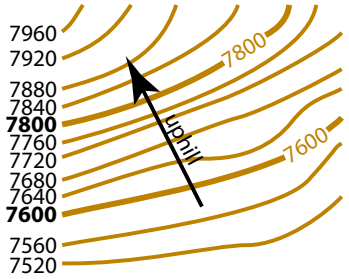
- Learn a few rules about contour lines.
- Learn to recognize a small set of "contour line signatures" and what they mean.
- Learn to visualize the cross section of a line or path across a short section of terrain.

Contour Lines

- A contour line joins points of equal elevation.
- Two adjacent contour lines represent a change in elevation.
  - The amount of change is called the "contour interval" and is usually the same across the whole map.
- Typically every fifth contour line is thicker and labeled with its elevation.
  - These are called "index lines."

Contour Lines

40 foot contour interval

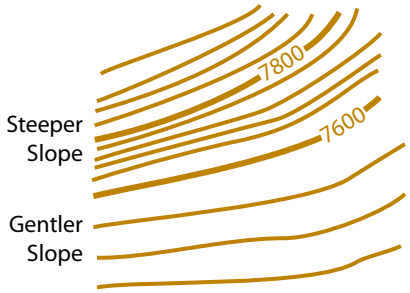


Contour Lines

A few rules…

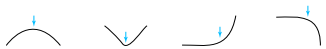
- Contour lines never cross each other.
- The closer the spacing between contour lines, the steeper the slope.
- When they touch it represents a vertical or nearly vertical slope. They do not have the ability to depict an overhang.

Contour Lines



Terrain Breaks

- Points or lines where *important* changes in slope occur.
  - changes between uphill and downhill travel.
  - changes between gentle and steep slopes
- Some examples: hilltops, ridge lines, spurs, drainages, valleys, cliffs,…



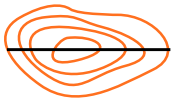
Terrain Break Cross Sections

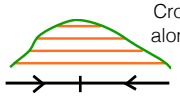
Contour Line "Signatures"

Hilltop

"from the top of a hill, there is no place to go but down"

Contour lines representing a hilltop





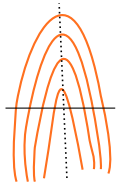
Cross Section along the path

A path across the hilltop

Uphill arrows and a mark at the terrain break.

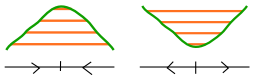
Contour Line "Signatures"

It's a Terrain Break, but what kind?



There will be an uphill/downhill terrain break, wherever you cross the dotted line

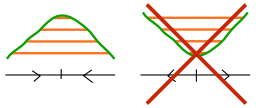
But the cross section could be either one of these…



Contour Line "Signatures"

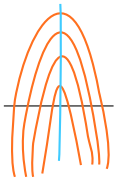
Spur from a hilltop

Now that we see a hilltop, we can say this is a spur coming off the hilltop.

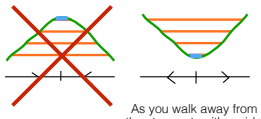


Contour Line “Signatures”

Drainage



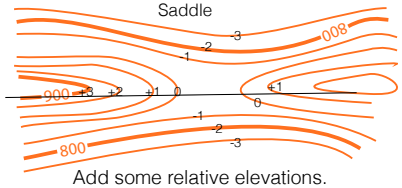
Streams don’t run
along the tops of spurs.
This must be a drainage.



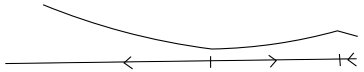
As you walk away from
the stream, to either side,
you will be going uphill.

Contour Line “Signatures”

Saddle

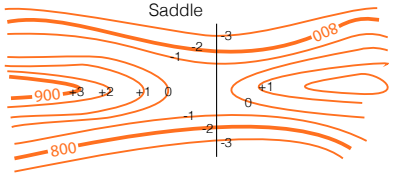


Add some relative elevations.

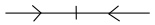


Contour Line “Signatures”

Saddle



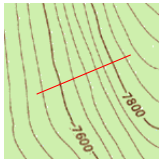
What about a cross section going this way?



Some examples

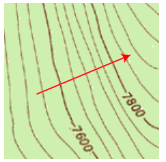
- Using your handout…
  - On each red line, add an **arrow pointing uphill**.
  - On each purple line, add **marks for terrain breaks**, and **uphill arrows for each segment**.

1



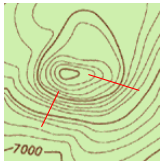
1

Labeled index contour lines allow us to
determine elevations, and thus what is uphill.



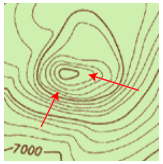
Contour Interval is 40ft
200 ft / 5 intervals = 40 ft/interval

2

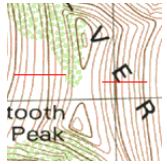


2

Hilltop is highest point.
Arrows point up to the top.



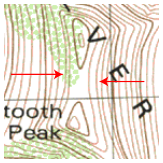
3



3

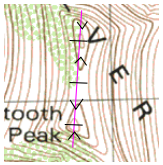
The twin peaks define the high points.

This would be a saddle between two peaks.



3

Terrain breaks at the two peaks
and the saddle.
Arrows point up to the peaks.



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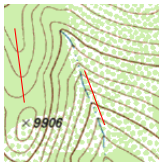
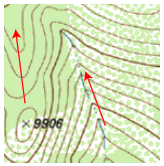


4

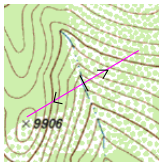
Just because you see a hilltop doesn't always make it the **highest** point.

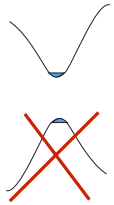
In this case, it is a bump on the side of a slope.



4

Terrain break is at the stream.
Arrows point up to either side of the stream.





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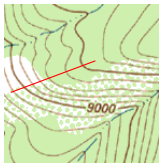

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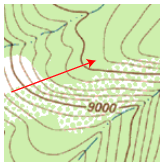
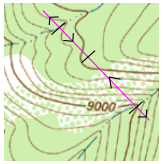


5

Terrain breaks at both creeks,
and the spur in between them.
Arrows point uphill from either side of the creek.



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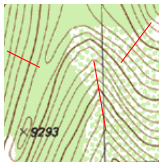
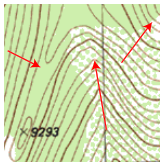


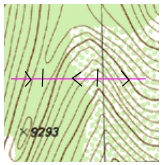
6

Use the hilltop at x9293 to determine up from down.

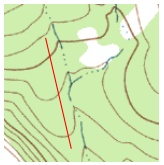


6

Terrain breaks on the spur and in the drainage. Arrows point uphill from either side of the drainage.

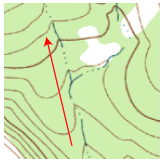


7

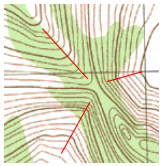


7

Usually streams of water merge to form larger stream. When might a stream of water split into multiple streams?



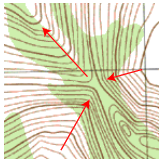
8



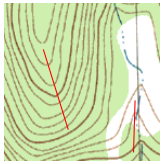
8

Use the high spots to determine up from down.

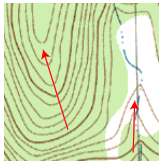
This is a saddle in a ridge line that runs NW to SE



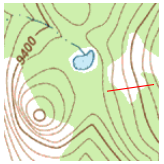
9



9

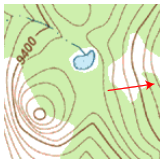


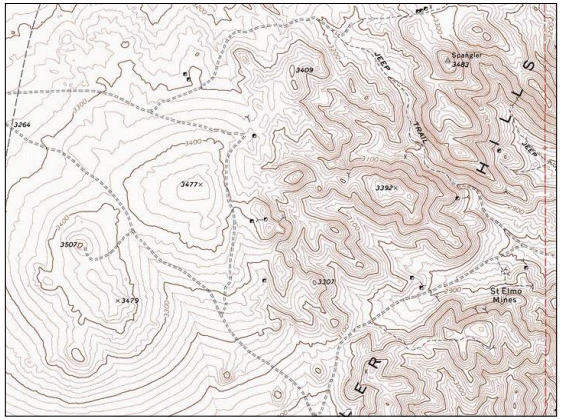
10



Use the high point to determine up from down. **10**

Pay close attention to the contour lines in the SE corner. Use them to determine up and down east of the lake.





Let's take a virtual backpacking trip

Sharktooth Peak Map

Instructions

- We will be hiking on the Sharktooth Peak map
- Work with a partner
- I will come around and mark a start and end point on your map.
- You need to come up with a brief verbal route description. It can be on or off trail. Avoid hazards and unpleasant hiking.
- You will be describing your route to the class, as they follow along on their maps.
- The class will ask for clarification if we get lost.

- Use
  - The 16 cardinal directions N, NE, NNE
  - Linear and point topographic features
  - Uphill and downhill
  - Approximate distance in kilometers
  - Spot elevations
- Avoid
  - Travel along a contour line
  - GPS coordinates
  - Straight line bearing and distance directions
  - Vegetation boundaries
  - Lettering on the map
- Note: There are 2 different versions of the map
  - There are differences in the roads, trails, and camps

Field Exercise

Let's use the campus map and the GPS to locate some more flags.

Most of the points are loaded into the GPSrs already.

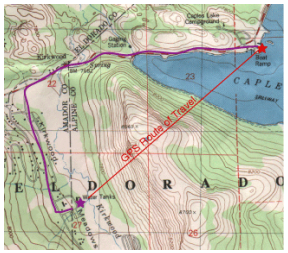
You will need to enter the first point.

Plot your destination on your map.

Use your map to determine the best route.

Don't let your GPS determine the route.
It will be a straight line from your current location to your destination.

Perils of straight line routes



Straight Line
v.s.
Terrain Based Route

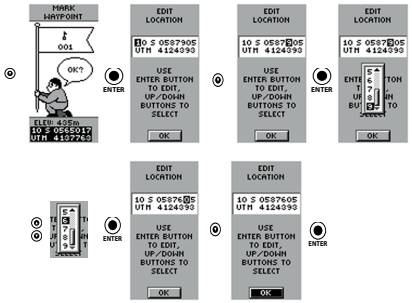
700+ ft Elevation Gain,
Rock Gear, & Boat
v.s.
80 ft Elevation Gain,
Paved Road

To store a location in your gps…

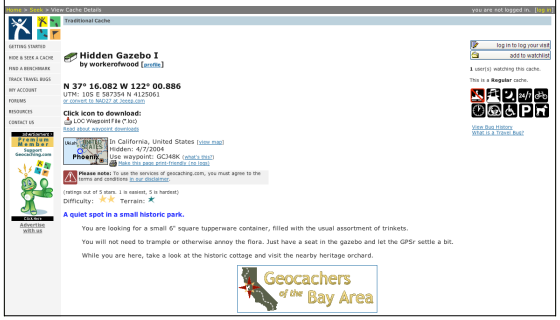
- Mark your current position
- Before you save it, change it to the desired coordinates.
- Now you can save it.

To save your current location in the GPS...

To use the location you just marked as a starting point for a new location...



Geocaching



Let's try it!

10 Waypoints to find
You need to enter the first one (2001)
I'll load the rest with the computer.

Plot them on the map first!

Use the map to determine your route.

2 Geocaches to find

Return by....