PART 1

BASIC LAND NAVIGATION

USING THE MILITARY LENSATIC COMPASS

WARNING

This presentation is intended as a quick summary, and not a comprehensive resource. If you want to learn Land Navigation in detail, either buy a book; or get someone, who has the knowledge and skills, to teach you in person.

NOTE

To get the ideas across presented on these slides, many figures, pictures, and calculations may not be to scale and may be exaggerated for clarity.

Note:

Prior to being issued any training *equipment, you will be required to sign a "statement of liability" agreeing to pay for anything you damage or lose.

All items will be inspected and inventoried prior to your signature and at the end of the training day too.

If you do not intend to sign this statement, then you may be denied training.

* **You may use your own equipment.**

Any Questions?

LAND NAVIGATION WITH MAP AND LENSATIC COMPASS

LAND NAVIGATION

Why Learn **Land Navigation**? *Training and practicing land navigation on foot provides the following everyday navigation (how not to get lost) benefits;*

- *Tracking present location (Where am **I** ?)*
- *Determining Distance (How far is it and am **I** there yet ?)*
- *Sense of direction (Where do **I** want to go and where am **I** actually going ?)*
- *How to read a topographic map (Do **I** understand the map ?)*
- *Terrain and map association (What hill or river am **I** looking at ?)*
- *Spatial skills (Can **I** mentally visualize the landscape in 3D ?)*
- *Planning safe, practical routes (Take a long safe route or a short risky route ?)*
- *And more Navigational skills*

The best way to learn **LAND NAVIGATION** is to get "dirt time", that is, get out there with a map and compass!

Navigation is not about finding yourself after you are lost (although that's what happens sometimes); it's about keeping track of your position as you move away from a known point. As you move you have to remain cognizant of the terrain you are leaving, of the terrain you are passing, and of the terrain that is ahead.

Navigation in the wilderness means knowing your starting point, your destination, and your route to get there.

These skills will allow you to venture farther off the beaten path than you ever thought before.

THIS PRESENTATION IS DIVIDED INTO FOUR PARTS

PART 1 Basic Land Navigation

- The Lensatic Compass
- The Topographic Map
- The Land and Map Association

PART 2 Intermediate Land Navigation

- Making Sense of Direction
- Tracking Present Location
- Determining Travel Distance

PART 3 Advance Land Navigation

- Planning to Navigate
- Navigation Methods to Stay On Course
- Additional Skills of Land Navigation

PART 4 Expert Land Navigation

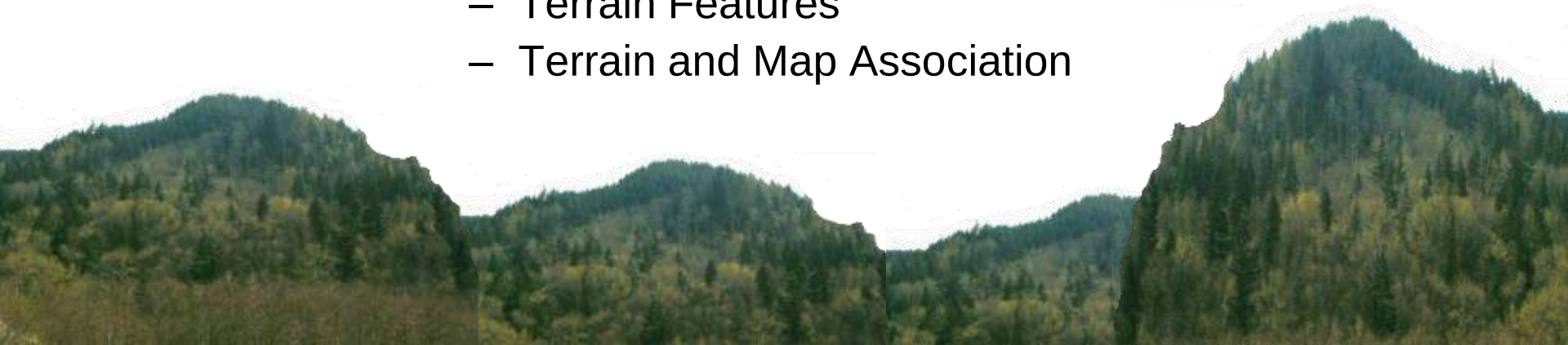
- Navigation in different types of Terrain
- Night Navigation
- Sustainment

Any Questions?

PART 1

BASIC LAND NAVIGATION

- **The Lensatic Compass**
  - Description
  - Parts and Features
- **The Topographic Map**
  - Description
  - How to Read
- **The Land**
  - Terrain Features
  - Terrain and Map Association



THE LENSATIC COMPASS

The genuine Lensatic compass differs from the type most hikers are familiar with, the traditional "orienteering" compasses. The Lensatic, a design preferred by military forces for its precision and durability, is designed to take hyper-accurate bearings for land navigation and directing artillery fire!

LENSATIC COMPASS DESCRIPTION

- Preferred by military for its precision and durability, and its hyper-accuracy in land navigation and combat.
- Battle tested - shock, water, sand proof, and functional from -50ºF to +150ºF.
- Uses a retractable lens to read the bearing while simultaneously sighting an object.
- With the Lensatic you just point and shoot one target and immediately move on to the next.
- Luminous Lights allow for navigation in low-light conditions and night navigation.
- Equipped with a magnifying lens, sight wire, and dial graduations in both degrees and mils to ensure accurate readings.
- Copper induction dampening system slows the rotation of the magnet without the use of liquids. Retractable lens locks the dial jewel bearing when stowed to lessen wear and tear.
- Employs a "Card" type compass Dial, and this makes for single handed operation. (Most magnetic "needle" type, always requires 2 hands.)
- A 'deep-well' design is used to allow the compass to be used globally with little or no effect in accuracy caused by a tilting compass dial.
- Lensatic sighting compasses are so simple and rugged and incredibly easy to use that it is no wonder they are the standard type used for navigation by the U. S. Military.

LENSATIC COMPASS GENUINE or IMITATION

Cheap Lensatic Copies

When someone tried to buy a genuine **CAMMENGA LENSATIC COMPASS** from websites, they came across a whole raft of cheap imitations. Most outlets tell you they are selling ***'Military Style'*** Lensatic compasses (fake, inaccurate, missing features) – but some claim to offer U.S. Government Military Lensatic compasses for just $14.95, which are also fake cheap imitations.

Cheap copies break easily, are not accurate, have false features displayed on the compass glass face and will mislead you.

The genuine lensatic compass used by the military is very durable, accurate, and easy to use. It can survive rough handling and harsh environments.

Buy the Genuine Article
Purchasing a genuine **CAMMENGA LENSATIC COMPASS** is easy, go to www.cammenga.com

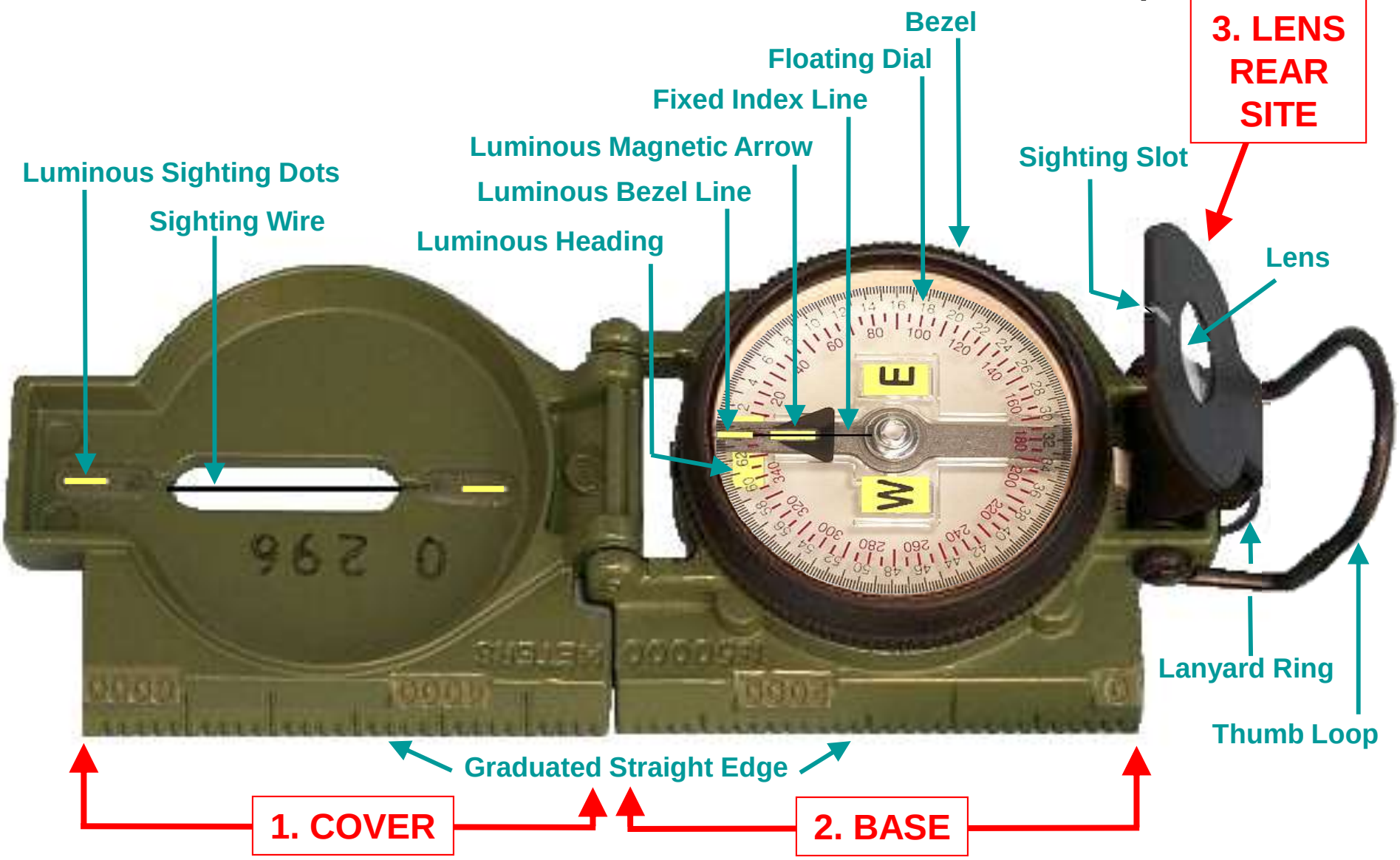
Click below
Lensatic Compass Evaluation.pdf
to read about the comparison of compasses…

"orienteering compass vs. lensatic compass".

Any Questions?

LENSATIC COMPASS

PARTS and **Features** of a Lensatic compass



LENSATIC COMPASS

Cover - **Protects the floating dial and other parts of the compass when closed.**

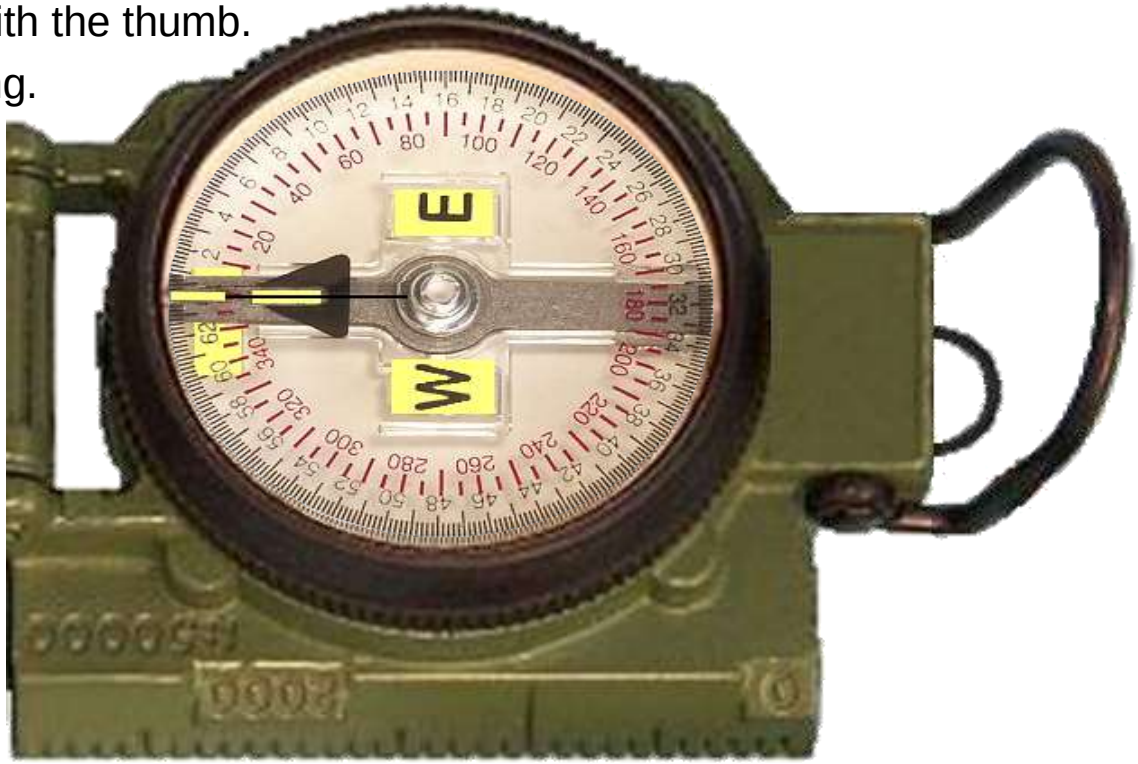
- Sighting Wire - front sight used with rear sight, for sighting landmarks for azimuth headings.
- Luminous Sighting Dots – used in low-light condition and night navigation. Also a visual queue on aligning your body with the compass during night navigation.
- Graduated Straight Edge - upper half of a standard 1:50,000 scale map ruler, for measuring distances on a map.

LENSATIC COMPASS

Base - **The main body of the compass. If, for any reason, the lensatic compass were to malfunction, the base would be the piece that you would want to still work.**

- Bezel Ring – device clicks when turned; full 360° rotation is 120 clicks; each click equals 3°.
- Luminous Bezel Line – Used to mark a course direction during day or night navigation.
- Floating Dial – black scale (mils), red scale (degrees), set in a deep tub for global use.
- Luminous Heading – to read azimuth heading in low-light or night conditions.
- Luminous Magnetic Arrow – always points to magnetic north.
- Thumb Loop – to hold compass with the thumb.
- Fixed Index Line – azimuth heading.
- Lanyard Ring – for string or rope.

NOTE:
The only way for the compass to malfunction is for the user to misuse and abuse the compass.



FLOATING DIAL SCALE

BLACK RING

Mils - is used mainly in artillery, tank, and mortar gunnery. AND is also used for very accurate azimuth land navigation.

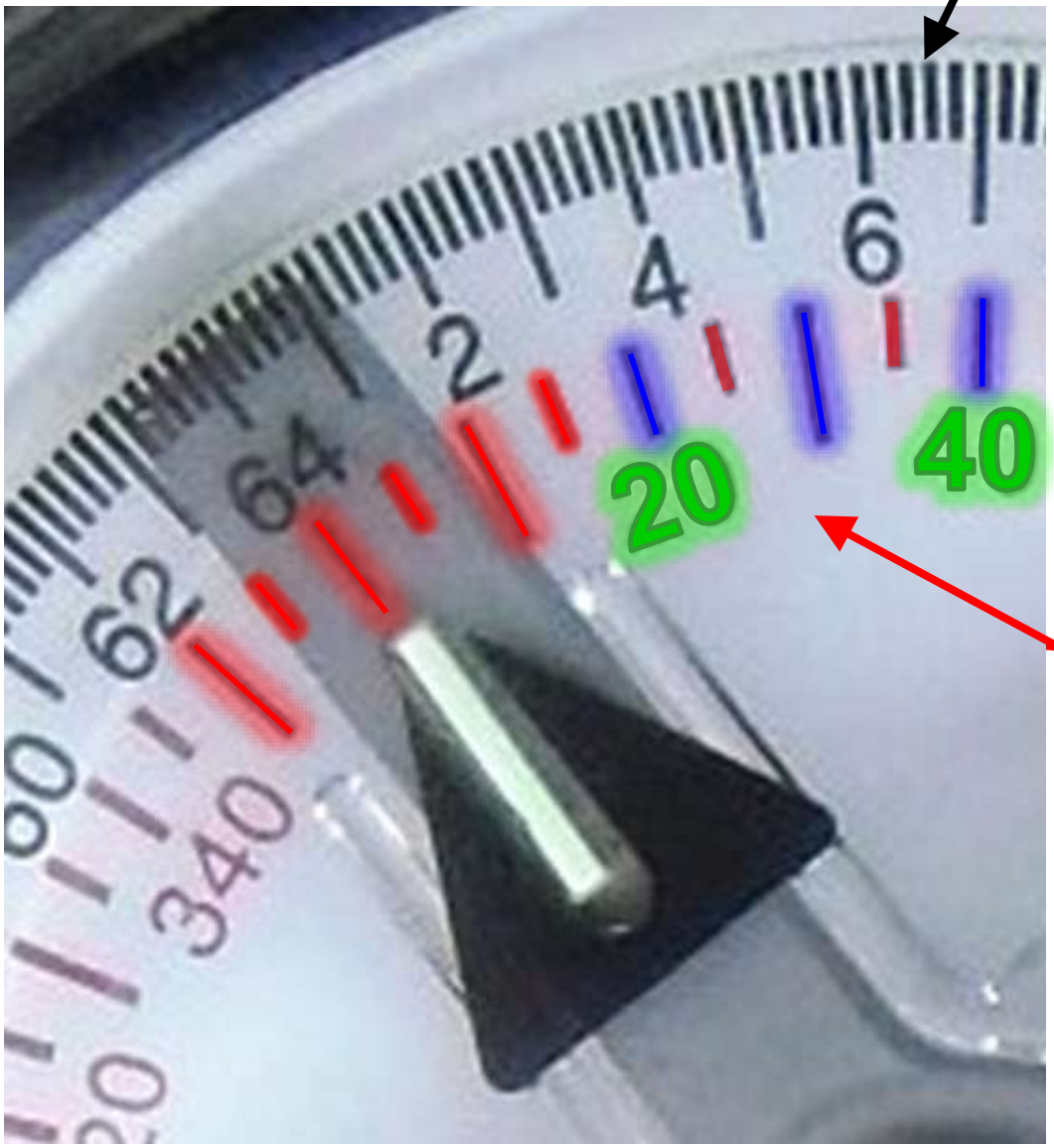
- **6400** Mils to a Circle
- Distance Between **Small** Marks = 20 Mils
- Distance Between **Big** Marks = 100 Mils
- Distance Between **Numbers** = 200 Mils

N = 64 (6400)
E = 16 (1600)
S = 32 (3200)
W = 48 (4800)

8.89 Mils = ½ Degree
17.78 Mils = 1 Degree

LENSATIC COMPASS

FLOATING DIAL SCALE



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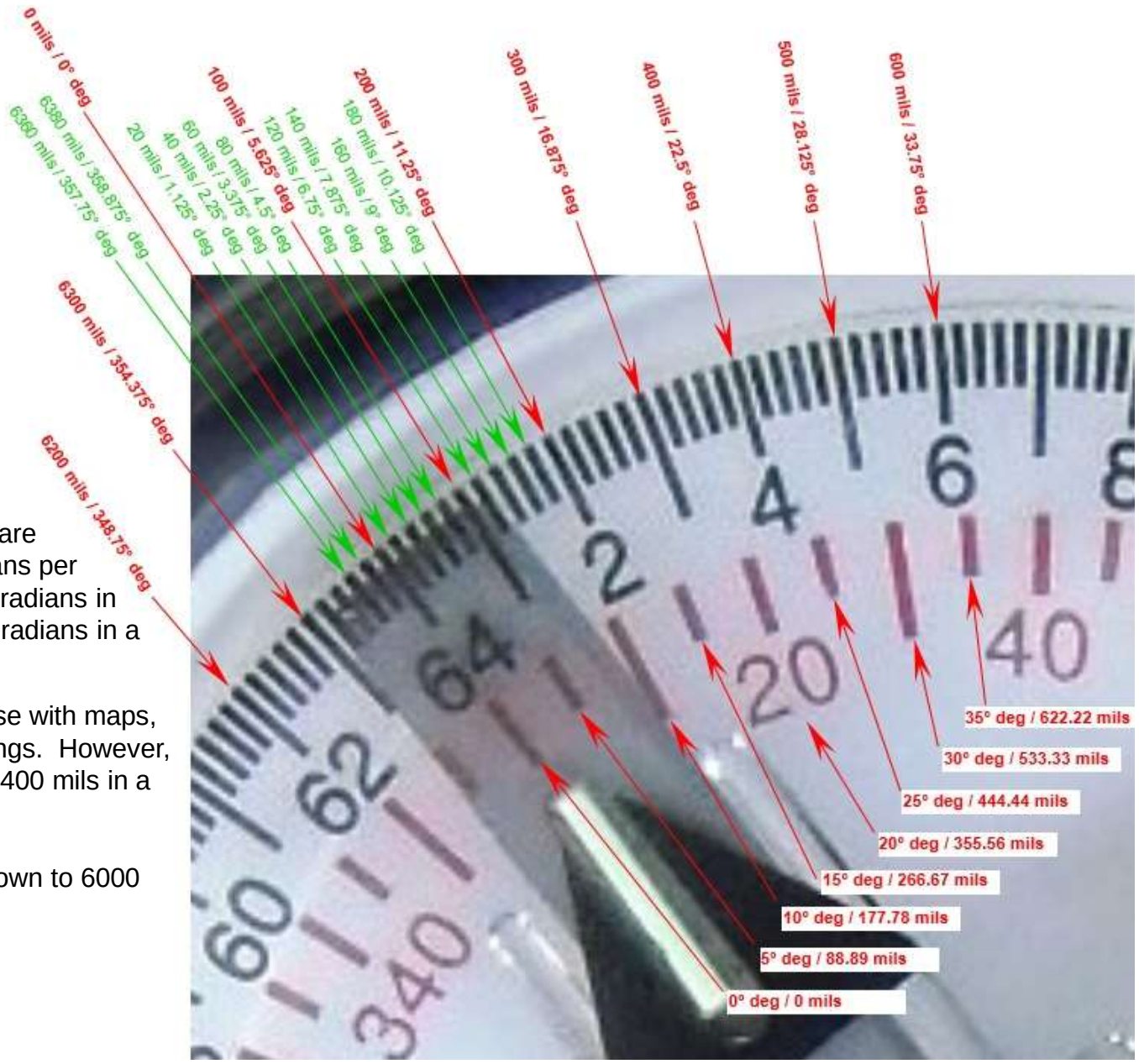
RED RING

Degrees – common unit of measure is the degree (º).

- 360 Degrees to a Circle
- Distance Between **Red** Marks = 5º
- Distance Between **Big** Marks = 10º
- Distance Between **Numbers** = 20º

N = 0º
E = 90º
S = 180º
W = 270º

FLOATING DIAL SCALE



In a complete 360 circle, there are 2 pi radians. This is 6.283 radians per circle. Since there is 1000 milli-radians in one radian, there are 6283 milli-radians in a circle.

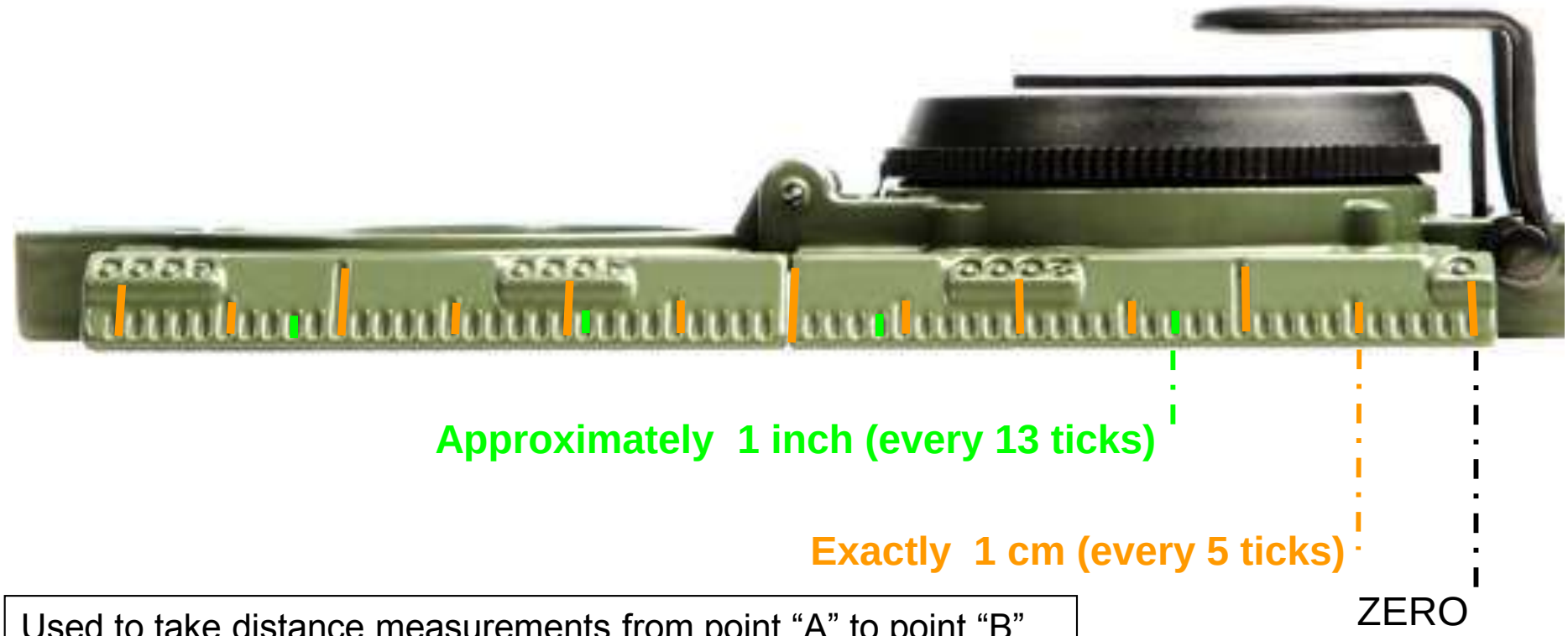
The US military adapted it for use with maps, artillery and numerous other things. However, the US military 'simplified' it to 6400 mils in a circle.

The Russian military rounded down to 6000 mils in a circle.

Any Questions?

LENSATIC COMPASS

GRADUATED STRAIGHT EDGE



Used to take distance measurements from point “A” to point “B” on maps; in conjunction with the distance bar scales on the map.

NOTE

When used on a 1:50,000 map, each tick mark on the edge represents 100 meters (107 yards) of ground distance.

LENSATIC COMPASS

Lens Rear Site - Sighting device.

- Lens - used to read the dial.
- Rear Site - used in conjunction with the front site wire for sighting on objects.

NOTE:

The Lens Rear Sight also serves as a locking device and locks the dial jewel bearing to protect from wear and tear when closed. Also the rear sight must be opened more than 45° to allow dial to float freely.

When traveling make sure that the rear sight is totally folded down as this will lock the floating dial and prevent vibration, as well as protect the crystal and rear sight from being damaged.

Any Questions?

LENSATIC COMPASS
HANDLING A COMPASS

When buying a new compass check . . .

- That the dial does not stick
- Sighting wire is not bent
- Glass and other parts are not broken
- Numbers on the dial are legible
- Check for accuracy along a known line of direction
  - — Discard any type of compass with more than a 3° +/- variation.
  - — Lensatic compass is accurate to a ½° degree (better when using the mils scale).
- ***When traveling make sure that the rear sight is totally folded down as this will lock the floating dial and prevent vibration, as well as protect the crystal and rear sight from being damaged.***

EFFECTS OF METAL AND ELECTRICITY – these sources affect the performance of a compass during use.

• 180 feet / 55 meters	*High tension power lines*
• 33 feet / 10 meters	*Truck, car, Barbed wires*
• 6 feet / 2 meter	*Hunting rifle*
• 1 feet / ½ meter	*Knife, flashlight, binoculars, camera*
• Inches / centimeters	*Belt buckle, paper clip, jewelry, etc.*
• Misc distances	*any local geological magnetic rocks.*

LENSATIC COMPASS
INSPECTING A COMPASS

Compasses are delicate instruments and should be cared for accordingly. A detailed inspection is required when first obtaining and using a compass. Important serviceability checks are outlined below:

VISUAL INSPECTION

- Your compass should be opened to see that the cover glass is not broken, clouded, or cracked and that the compass dial does not stick.
- The front cover should be inspected to see if the cover sighting wire is missing or bent. If it is, use the center of the opening for sighting purposes, not the wire.
- The eyepiece should be placed flat against the cover glass. The index line on the cover glass should bisect the sight slot. Then, with the compass closed, it should be noted that the sighting wire also bisects the sight slot.
  - ✓ This procedure will ensure that the eyepiece is not bent. Gently bend the eyepiece back into proper alignment, if necessary.
- Check the bezel ring around the face of the compass; it should make a distinct click as it is rotated. If it does not click, you will have to use an alternate method for night azimuth settings.

MAINTENANCE

- The lensatic compass is built to detailed specifications that were developed in an attempt to increase its serviceable life. Adherence to very simple maintenance procedures will significantly increase the life of the lensatic compass. Maintenance procedures are outlined below:
- Rinse in fresh water. This is extremely important, especially after exposure to salt water.
- Brush off dirt and grime. Ensure the "ridges" on the bezel ring are free of dirt. Check movement of the rear sight to ensure it is free moving.

LENSATIC COMPASS CALIBRATION

A compass in good working condition is very accurate, but it should be checked periodically on a known line of direction. This process is called compass calibration.

CALIBRATION

- Note the calibration point azimuth. This is the known magnetic azimuth from the calibration point to a designated point.
- Shoot an azimuth from the calibration point to the designated point utilizing the compass-to-cheek technique (described in detail later in this handout).
- Ensure you check for effects on your compass from your eyeglasses, watches, rings, etc. If you wear these items in the field, ensure you wear them when calibrating your compass.

Compare azimuths (LENSATIC COMPASS ERROR – if there is any error.)

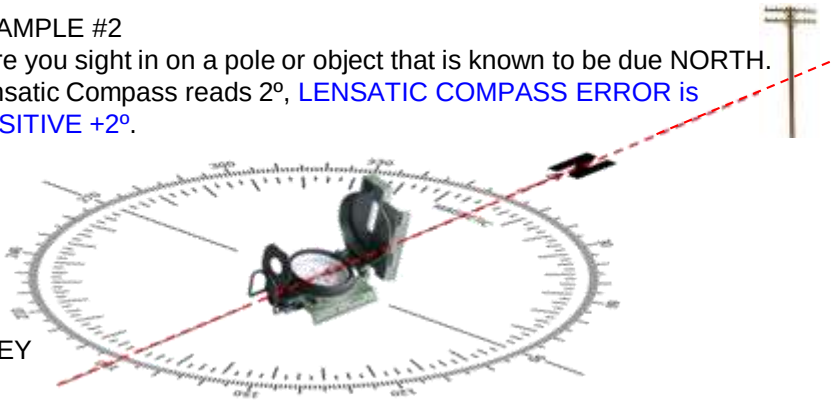
- If your compass shot an azimuth greater than the calibration point azimuth, then you must add the difference between the two azimuths (the calibration point value) to your computed magnetic azimuth.
  - ✓ Conversely, you must also ensure you subtract this value when converting from an actual compass (magnetic) azimuth to a grid azimuth.
- If your compass shot an azimuth less than the calibration point azimuth, then you must subtract the difference between the two azimuths (the calibration point value) from your computed magnetic azimuth.
  - ✓ Conversely, you must also ensure you add this value when converting from an actual compass (magnetic) azimuth to a grid azimuth.

NOTE: Any bearing / azimuth heading can be used, when checking your Lensatic Compass for any errors. Also, the farther the object, the more accurate is the reading.

NOTE: If lensatic compass reads the same as a known pole or object bearing / azimuth heading, then there is NO ERROR.

EXAMPLE #1
Here you sight in on a pole or object that is known to be 270º degrees. Lensatic Compass reads 269º, LENSATIC COMPASS ERROR is NEGATIVE -1º.

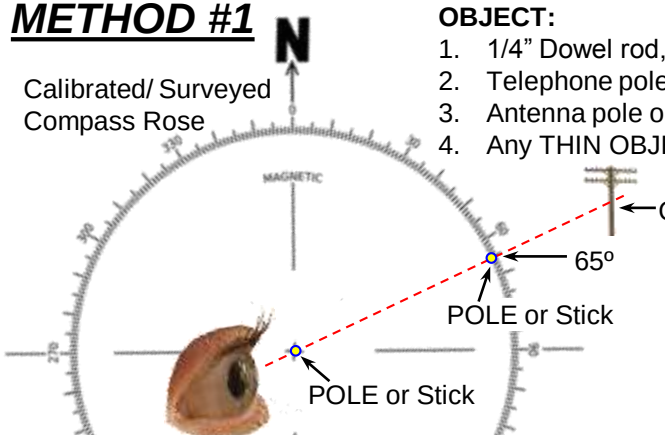
EXAMPLE #2
Here you sight in on a pole or object that is known to be due NORTH. Lensatic Compass reads 2º, LENSATIC COMPASS ERROR is POSITIVE +2º.



CALIBRATED / SURVEY COMPASS ROSE

LENSATIC COMPASS CALIBRATION

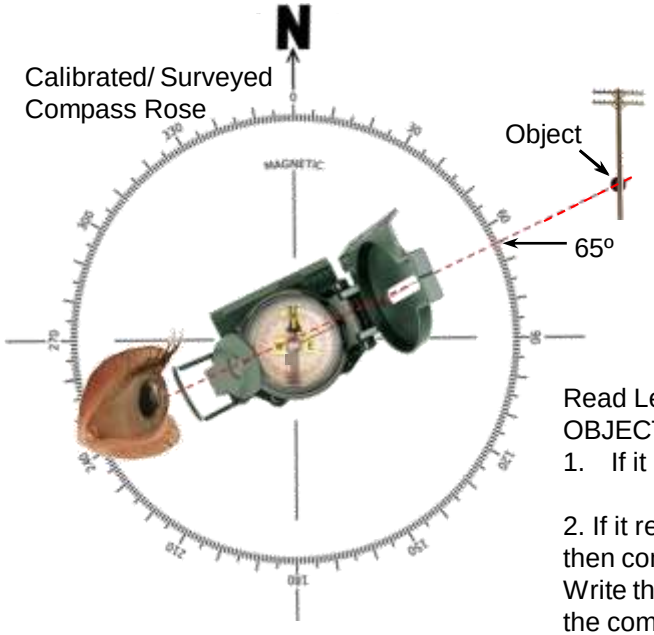
METHOD #1



OBJECT:

1. 1/4" Dowel rod, stick, or thin pole stuck in ground @ 50 feet
2. Telephone pole @ 100 yards to 1/4 mile
3. Antenna pole on top of building @ 1/4 mile
4. Any THIN OBJECT that is far away.

1. Stand in center of Compass Rose and visually align both sticks to desired heading (here it is 65º Degrees).
2. Select object aligned with sticks in distance on desired heading (here it is telephone pole at 65º Degrees).
3. Standing in center of Compass Rose, check heading to object with Lensatic Compass. (see below)



Read Lensatic Compass heading to OBJECT.

1. If it reads 65º Heading, NO ERROR.

2. If it reads different from 65º Heading, then compass has a - /+ ERROR. Write this - /+ ERROR on the back of the compass for reference.

LENSATIC COMPASS CALIBRATION

METHOD #2

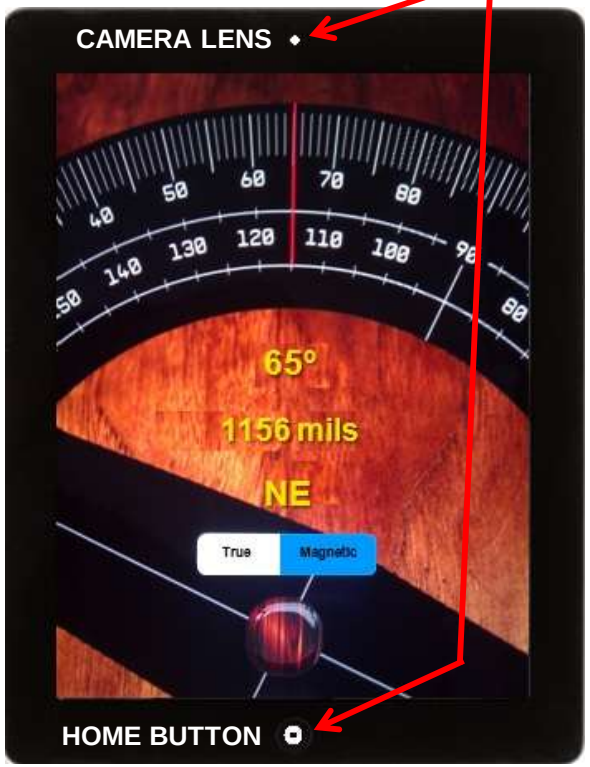
NOTE: This can be done in your backyard or local park.

OBJECT:
See METHOD #1, any THIN OBJECT that is far away.

← Object known to be 65º heading in distance.

1. Visually align both IPAD DOTS to OBJECT in distance (here it is a Telephone Pole).
2. Read IPAD compass Degrees and Mils.
3. Staying in same position, check heading to object with Lensatic Compass.

IPAD DOTS



Read Lensatic Compass heading to OBJECT.

1. If it reads 65º Heading, NO ERROR.
2. If it reads different from 65º Heading, then compass has a - /+ ERROR.
3. Write this - /+ ERROR on the back of compass for reference.

IPADs have gyros, accelerometers, magnetometers, sensors, and GPS, etc. This means IPAD compass apps are very accurate and easy to use. There are FREE apps out there that work. Find one that has;

1. Both True & Magnetic readings.
2. Mils reading.
3. High accuracy, less than 1º.
4. No jittering, erratic, or lagging.

NOTE: you may have to try several different apps to see which one works for you. The one displayed above worked great for me. No error to known object heading, with either IPAD or LENSATIC COMPASS

LENSATIC COMPASS CALIBRATION

METHOD #3

NOTE: This IPAD app (Theodolite) allows you to use the camera and compass together, so you can visually see the object and compass together. However, this IPAD app cost money.

1. Visually align Crosshairs to OBJECT in distance. Here it is a Streetlight Pole.
2. Read IPAD compass Degrees and Mils.
3. Staying in same position, check heading to object with Lensatic Compass.

Read Lensatic Compass heading to OBJECT.

1. If it reads 65º Heading, NO ERROR.

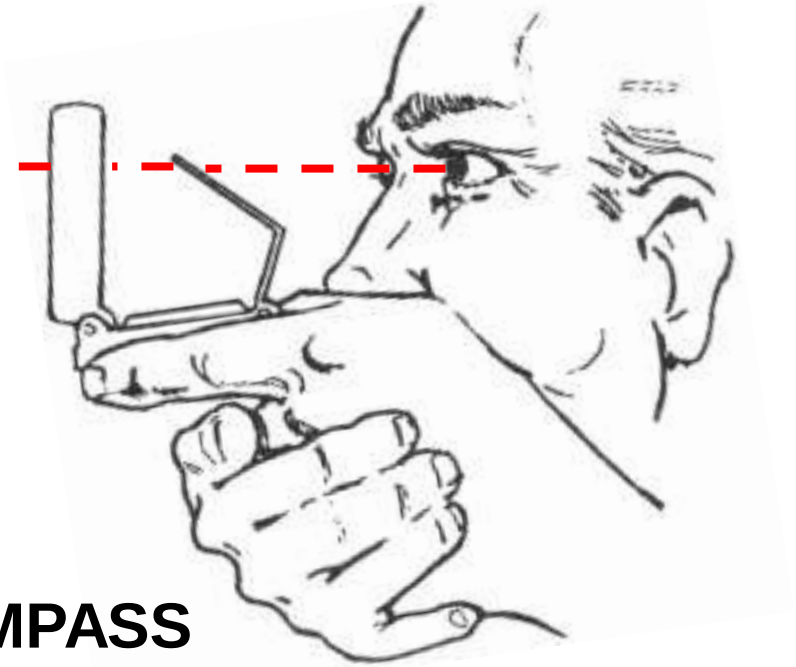
2. If it reads different from 65º Heading, then compass has a - /+ ERROR. Write this - /+ ERROR on the back of compass for reference.

Any Questions?

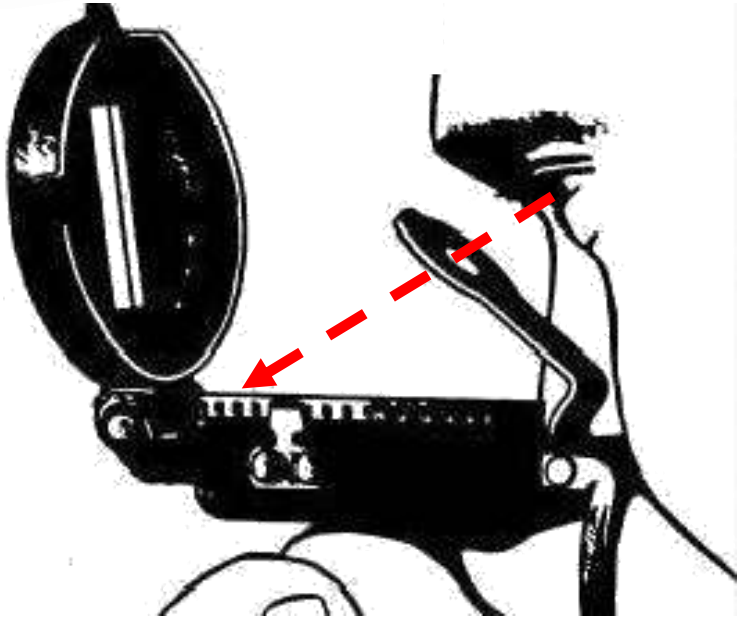
HOW TO SIGHT A LENSATIC COMPASS

SIGHTING A LENSATIC COMPASS
Compass-to-Cheek method for taking a target azimuth bearing

- The compass-to-cheek technique is used almost exclusively for **sighting**, and it is the best technique for this purpose.
- It is the most efficient technique for taking an accurate azimuth bearing.



SIGHTING A LENSATIC COMPASS



SIGHTING A LENSATIC COMPASS

SIGHTING A LENSATIC COMPASS

Any Questions?

SIGHTING A LENSATIC COMPASS

SIGHTING A LENSATIC COMPASS

R I G H T

SIGHTING LENSATIC COMPASS

SIGHTING LENSATIC COMPASS

R I G H T

PART 1
Basic Land Navigation

SIGHTING LENSATIC COMPASS

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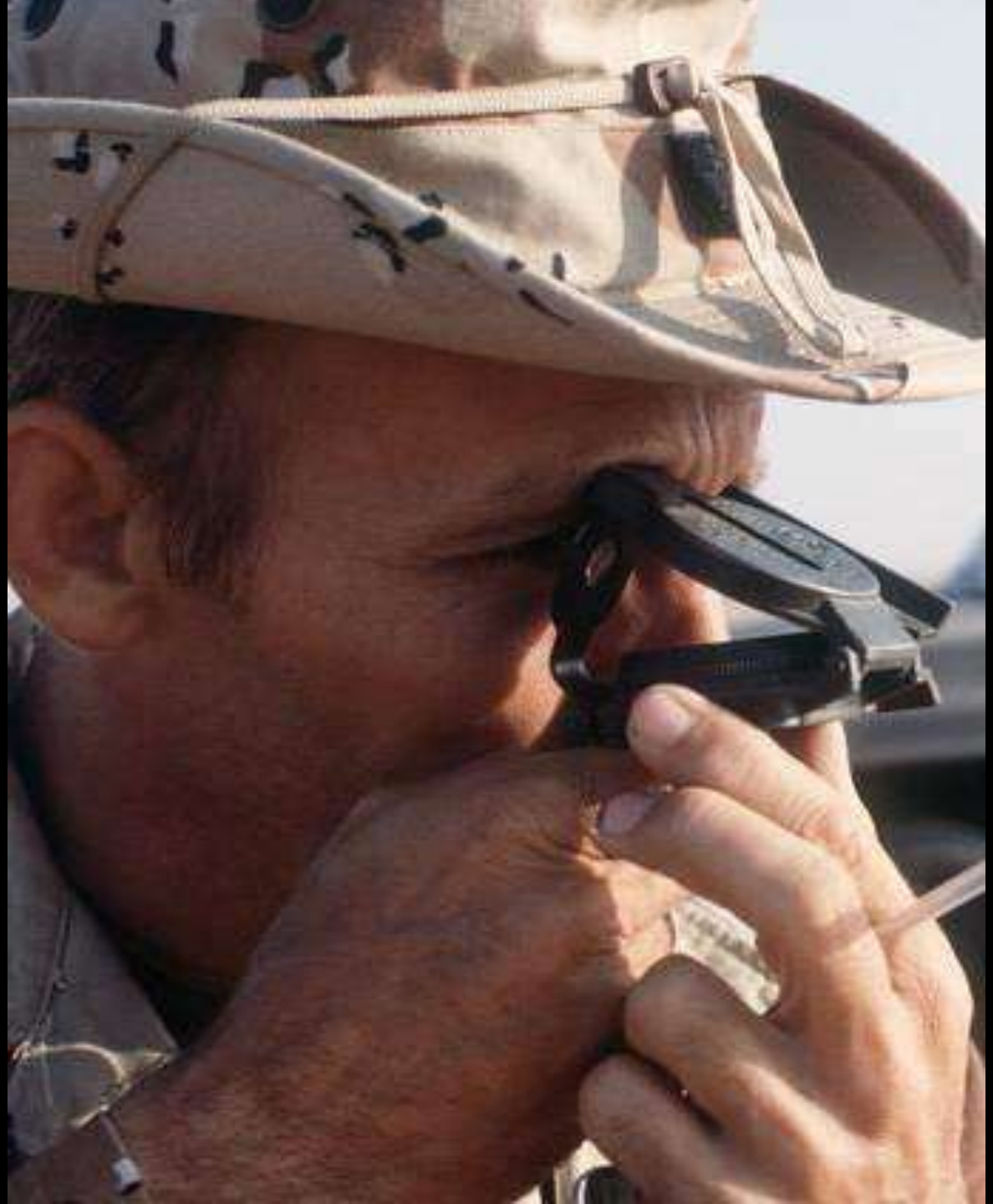
PART 1
Basic Land Navigation

SIGHTING LENSATIC COMPASS

R I G H T



PART 1
Basic Land Navigation

SIGHTING LENSATIC COMPASS

PART 1
Basic Land Navigation

SIGHTING LENSATIC COMPASS

R I G H T

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SIGHTING LENSATIC COMPASS

WRONG
SIGHTING
LENSATIC
COMPASS

Any Questions?

LENSATIC COMPASS

Center-Hold method for taking a target azimuth bearing

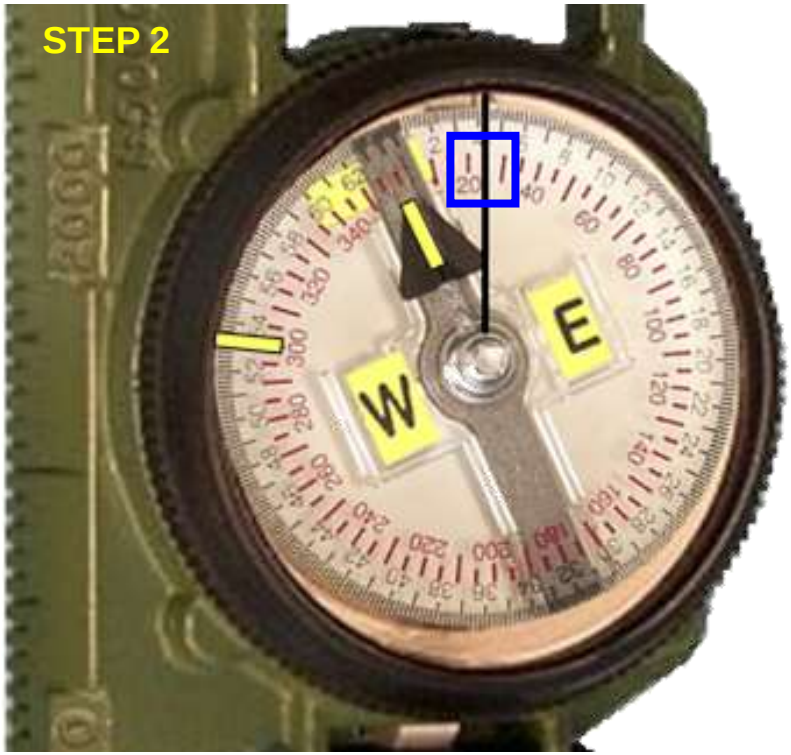
The center-hold technique is less precise, but is faster to use and can be used under all conditions of visibility.

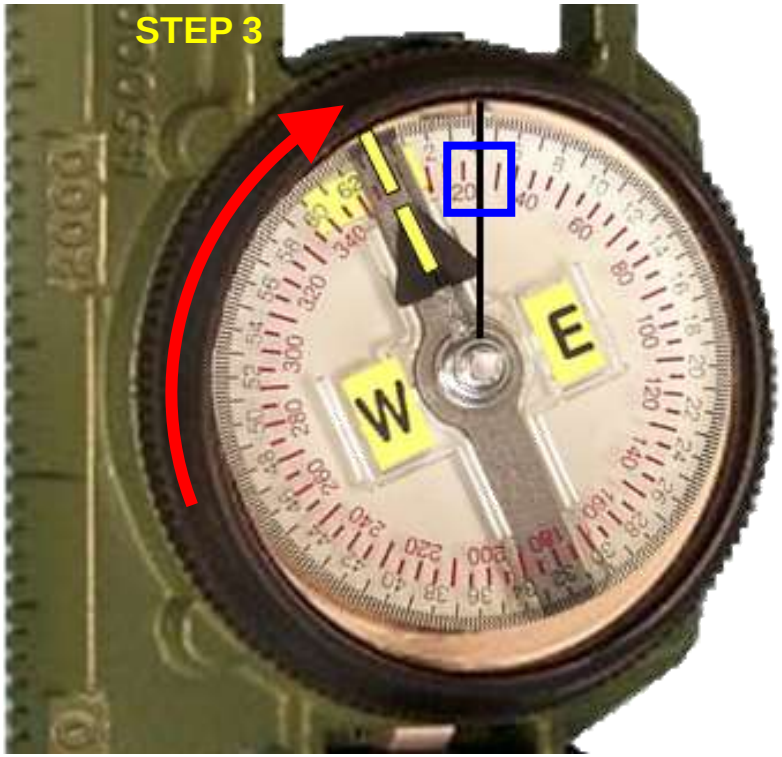
1. Open the cover until it forms a straight edge with the base.
2. Pull the rear sight to the rear most position, allowing the dial to float freely.
3. Next, place your thumb through the thumb loop, form a steady base with your third and fourth fingers, and extend your index finger along the side of the compass.
4. Place the thumb of the other hand between the rear sight and the bezel ring; extend the index finger along the remaining side of the compass, and the remaining fingers around the fingers of the other hand.
5. Pull your elbows firmly into your sides; this will place the compass between your chin and your belt.
6. To measure azimuth, turn entire body toward the object, pointing the compass cover directly at the object.
7. Once you are pointing at the object, look down and read the azimuth from the fixed black index line.

LENSATIC COMPASS

Center-Hold method for following an azimuth bearing

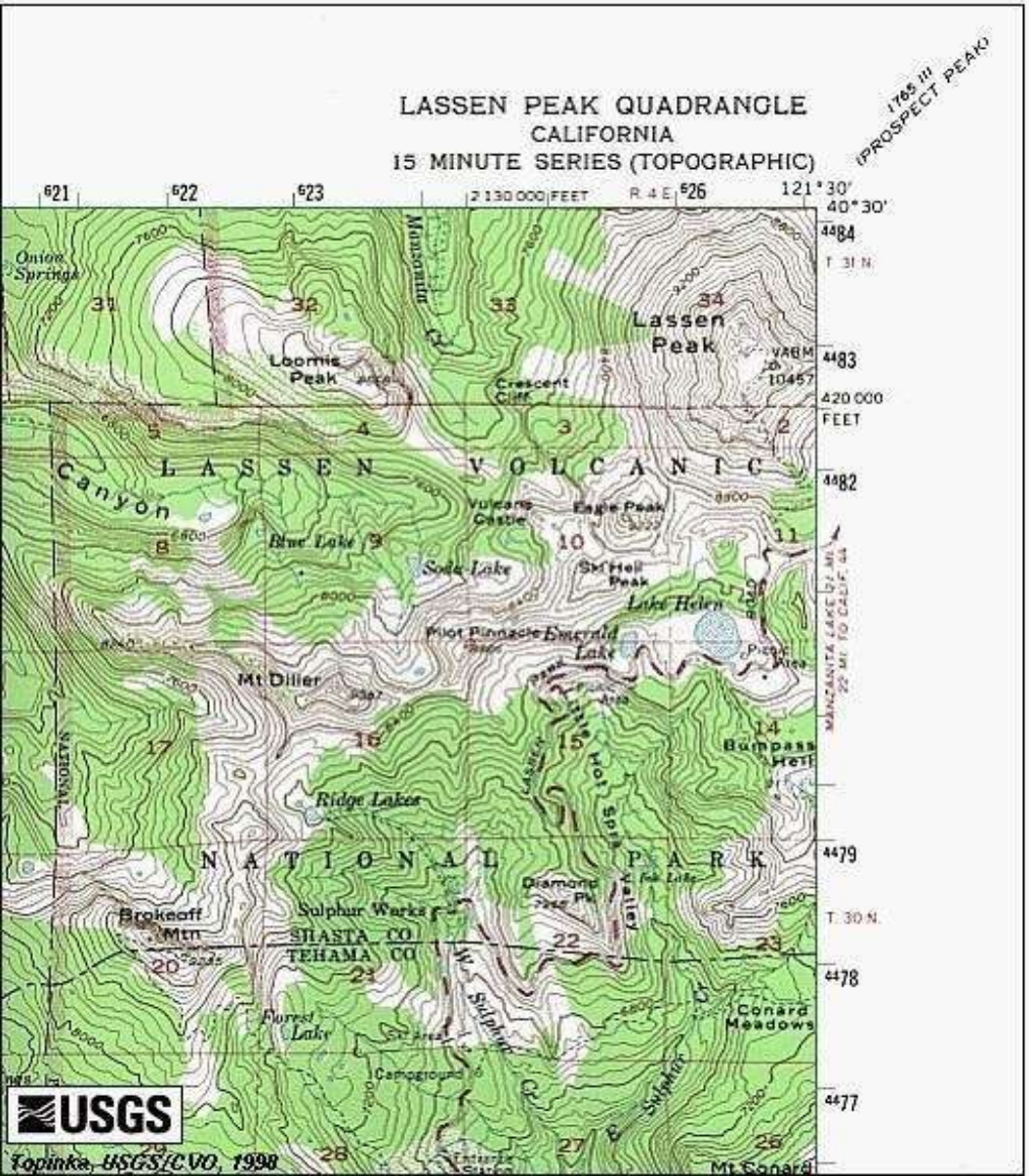
1. Using the Center-Hold method to hold the compass to your body.
2. Turn **your body** till desired azimuth is aligned with **Black Index Line**, hold this azimuth. Example **25º**.
3. Without turning compass, **rotate Bezel Ring** till **Luminous Bezel Line** is aligned with **North Arrow**.
4. Once bezel is set leave it there. (Till you are ready to change heading, then start the process over again.)
5. Keeping the **North Arrow** aligned with the **Luminous Bezel Line**, proceed forward in the direction of the desired azimuth **25º** on the **Black Index Line**.





Any Questions?

THE TOPOGRAPHIC MAP



Without ever having been to a particular place, and with out talking to someone who has been there, you can already know quite a lot about it with a map. A map is a graphic representation of the earth's surface drawn to scale, as seen from above. It uses colors, lines, symbols, and labels to represent features found on the ground.

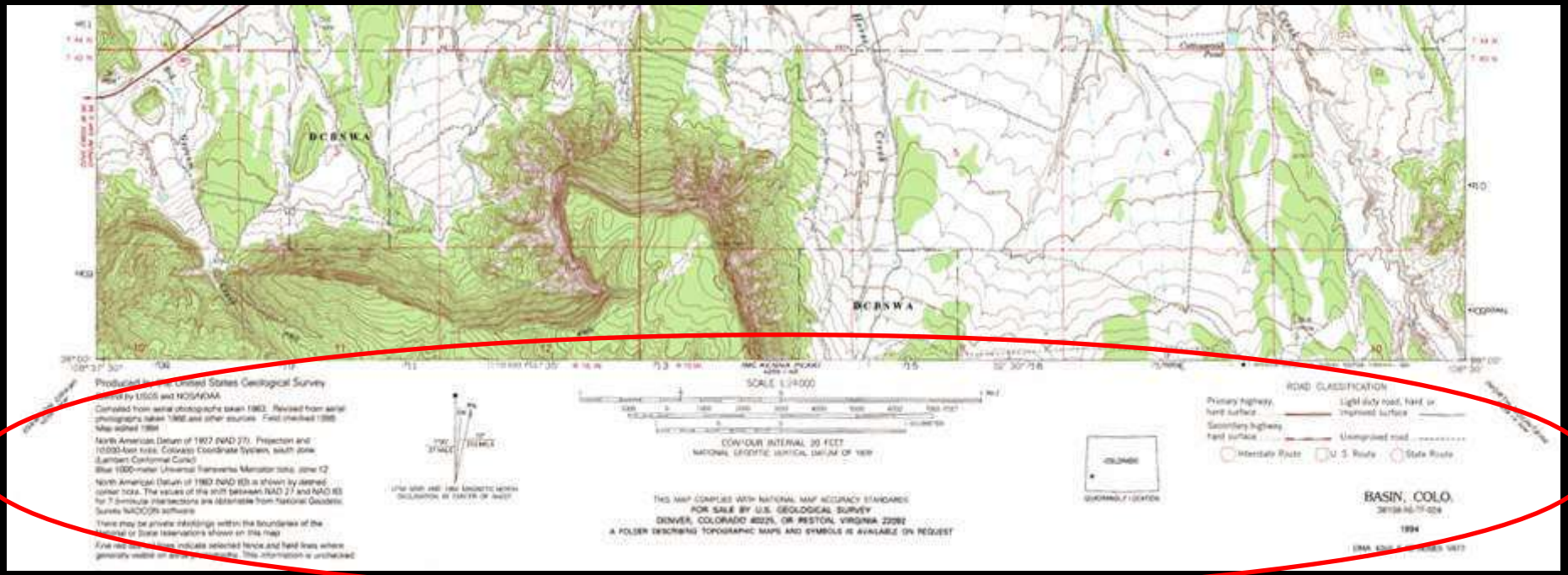
However, the finest maps available are worthless unless the map user knows how to read them.

TOPOGRAPHIC MAP DESCRIPTION

- Reading a map is a language composed of lines, colors, and symbols.
- Five basic colors are used for Topographic Maps.
  - **Brown (Contour Lines)**
  - **Black (Man Made Features, Roads, Trails)**
  - **Blue (Water Features)**
  - **Green (Vegetation)**
  - **Red (Highway and Land Grids)**
  - Two minor colors
    - **Pink (Built up area, civilization)**
    - **Purple (Updated Map Information)**
- Symbols are used to represent the natural and man-made features of the earth.
- Lines show relief and elevation; it indicates variations in terrain features and heights of natural features.
- Every map has Margin Information about the map.
- Maps come in three scale sizes; SMALL, MEDIUM, and LARGE. Which affects the amount of area covered and detail that will be shown.
- A map is read for four basic kinds of information.
  - Direction
  - Distance
  - Position
  - Identification
- Maps must be taken care of and properly folded for field use.

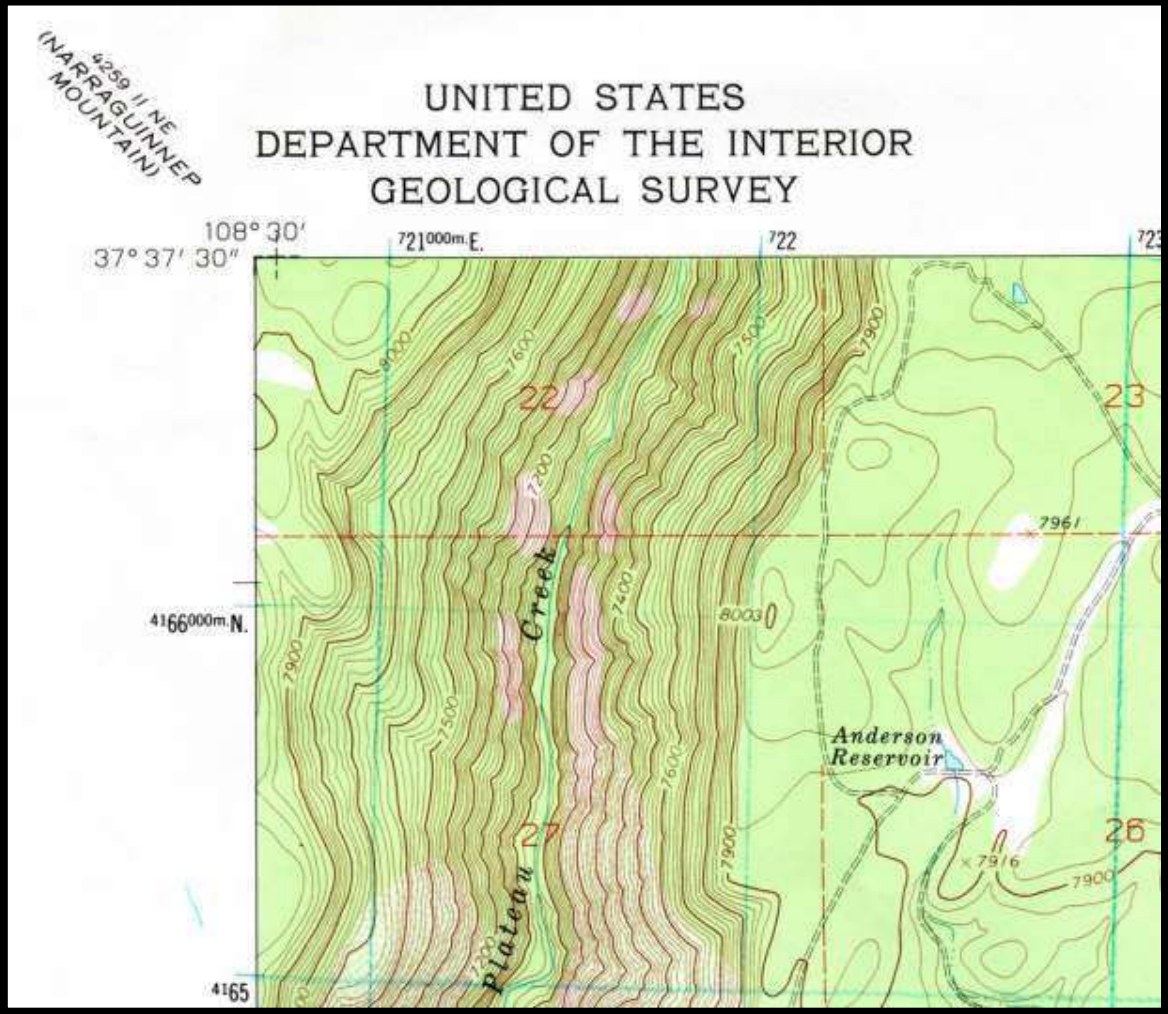
Map Margin Information

- A map could be compared to any piece of equipment, in that before it is placed into operation the user must read the instructions.
- It is important that you know how to read these instructions.
- The most logical place to begin is the marginal information and symbols, where useful information telling about the map is located and explained.
- All maps are not the same, so it becomes necessary every time a different map is used to examine the marginal information carefully.



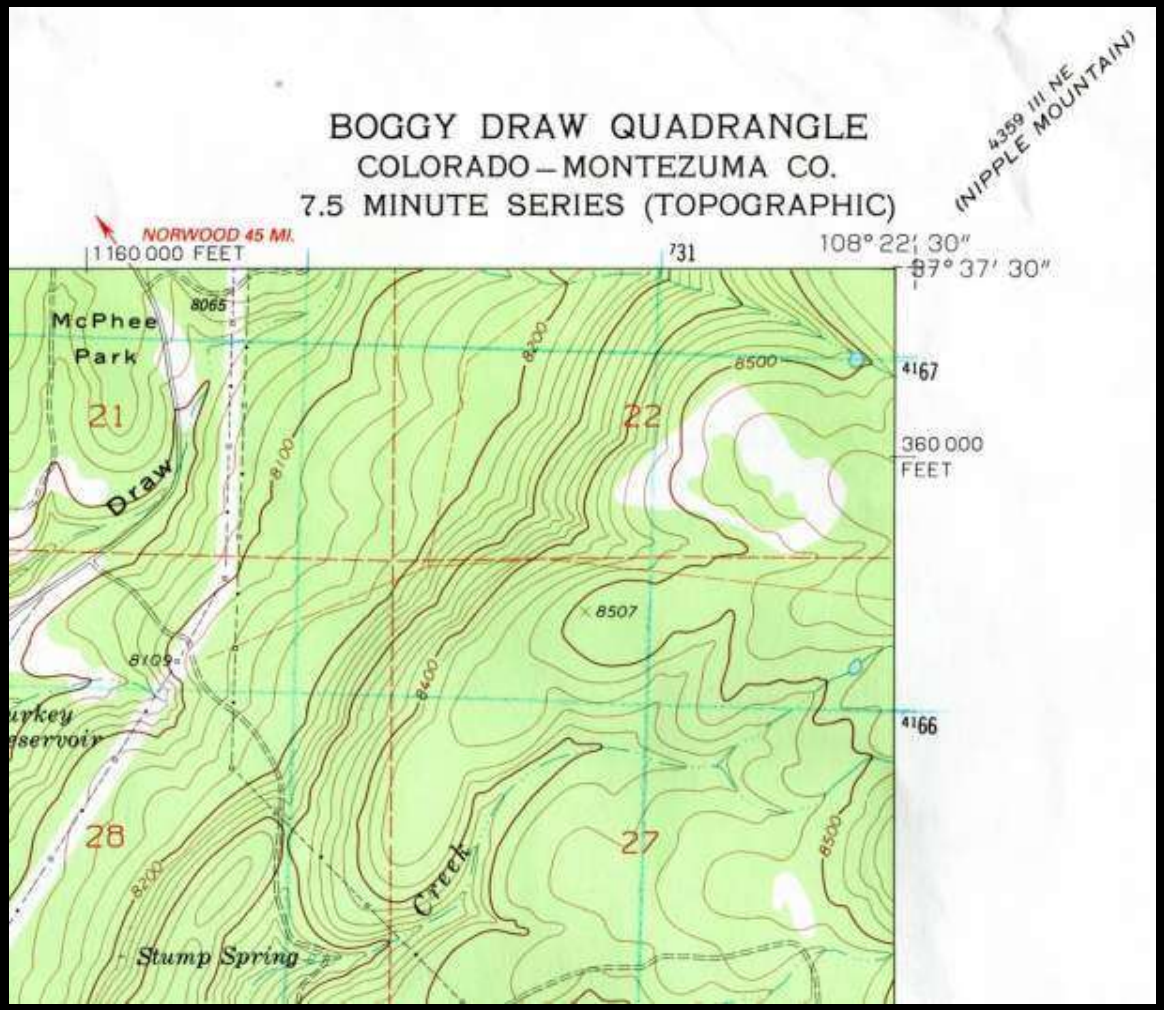
Map Margin Information

The top left corner of all USGS topographic maps carries the imprint of the authority responsible for the mapping .



Map Margin Information

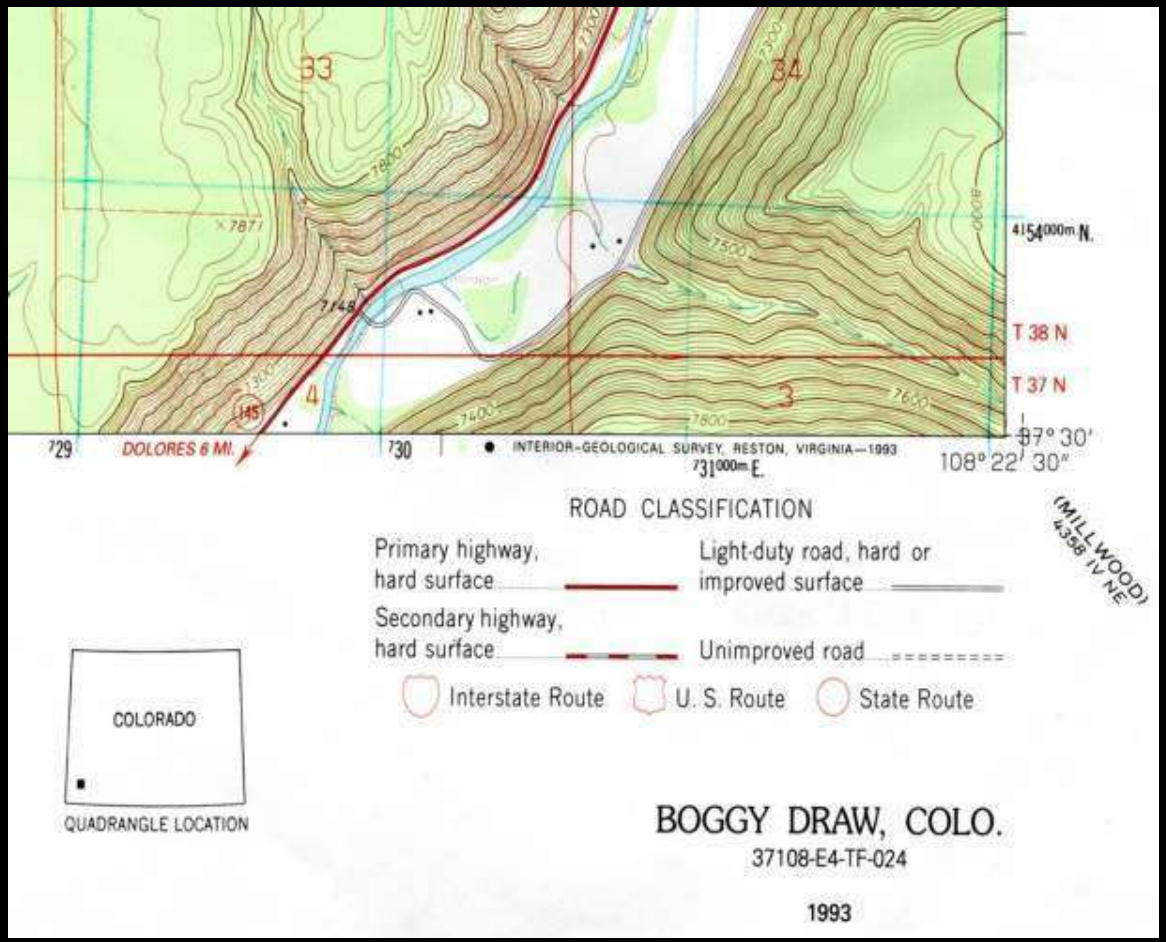
In the upper right corner is the complete quadrangle name. The state is also given, as may be the county. Also included is the area covered and the type of map.



Map Margin Information

In the bottom right corner of the map is a

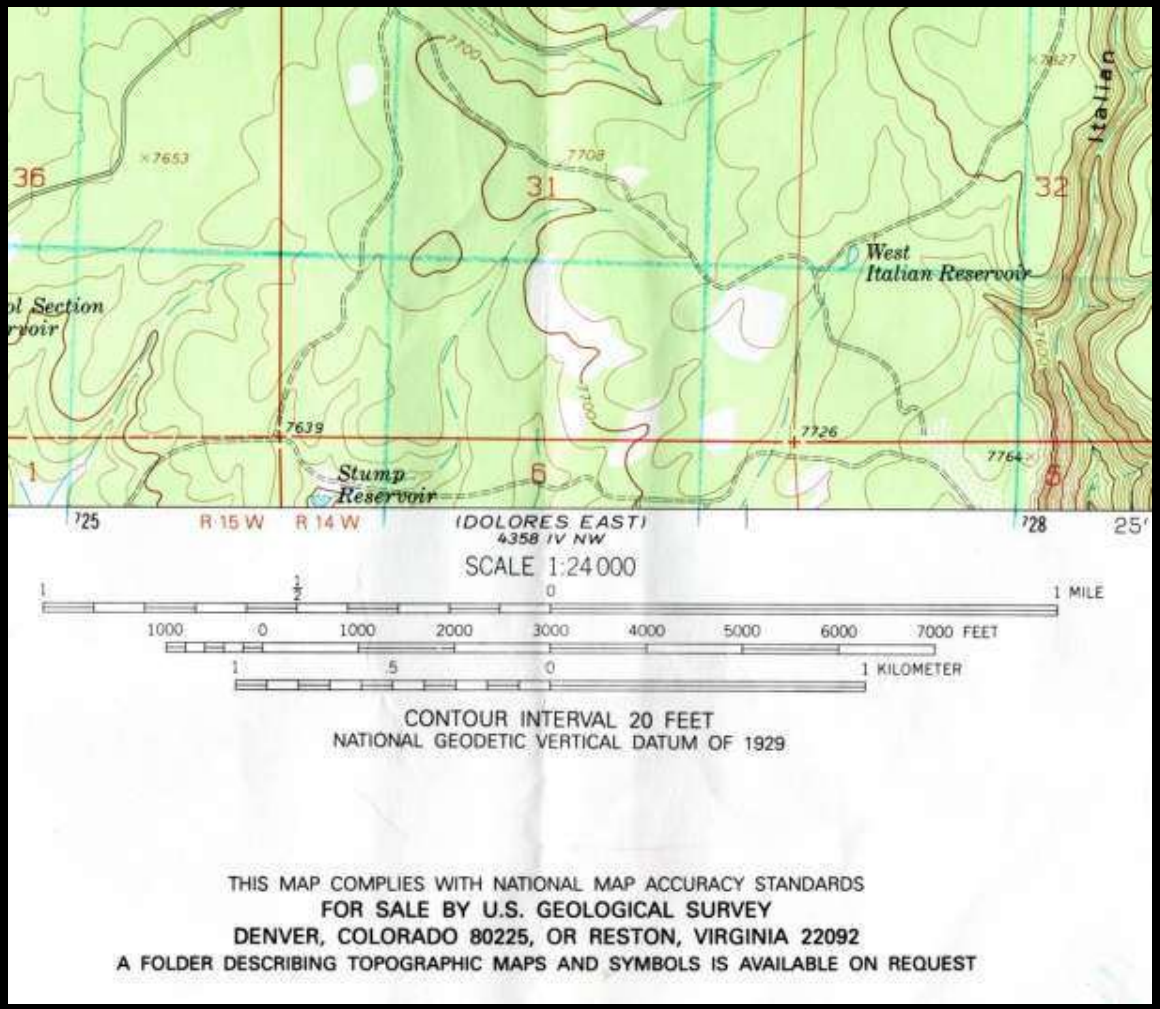
- key to roads on the map.
- Map name and state.
- date of the map - one of the most significant pieces of information available.
- quadrangle location shown as a black square superimposed on a state map.



Map Margin Information

At bottom center is the

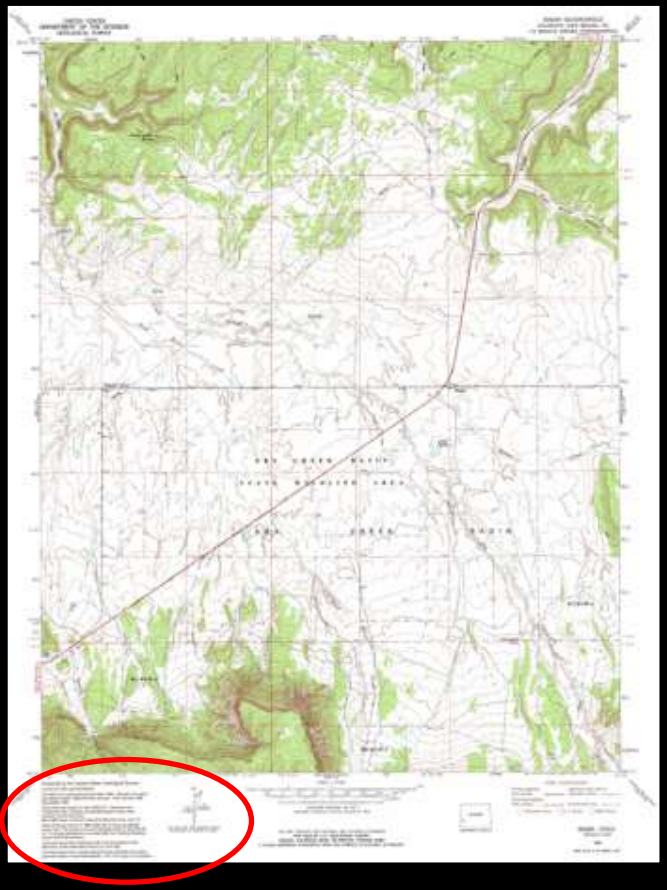
- map scale ratio – size of area covered and terrain detail.
- Distance bar scales show several alternative units for the measurement of distance.
- the contour interval. The contours are the brown lines.

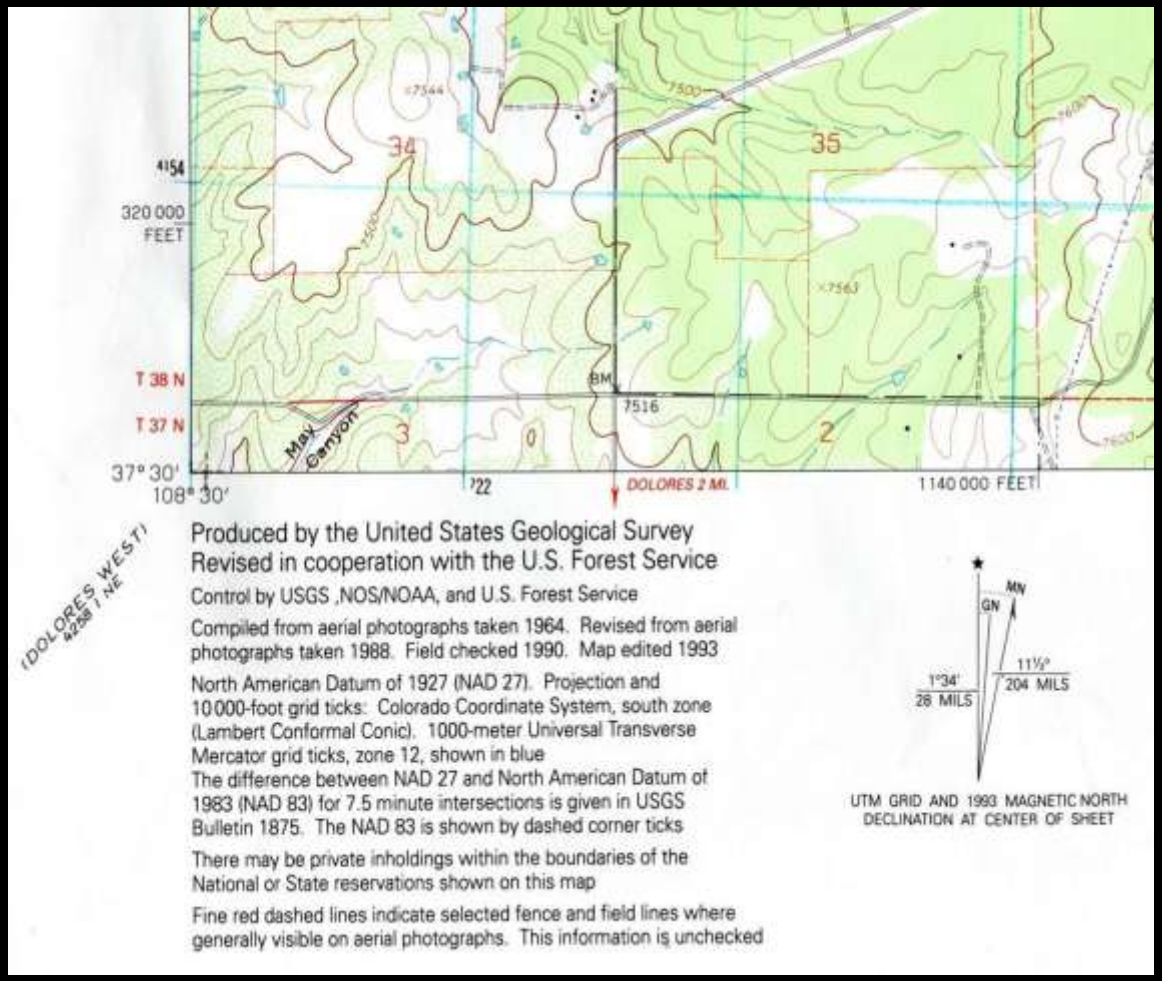


Map Margin Information

In the lower left corner is the credit legend, a complex of information. And the following

- the magnetic declination.
  - The star indicates true north: the direction of the North (rotational) Pole
  - "MN" indicates the direction of the North Magnetic Pole
  - "GN" (Grid North), the Universal Transverse Mercator (UTM) grid.

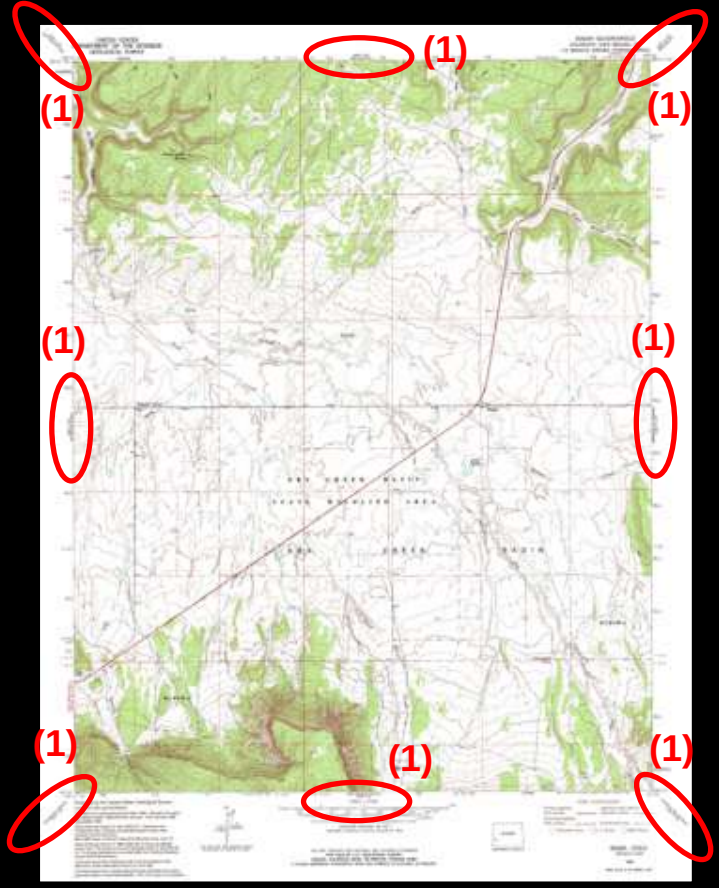


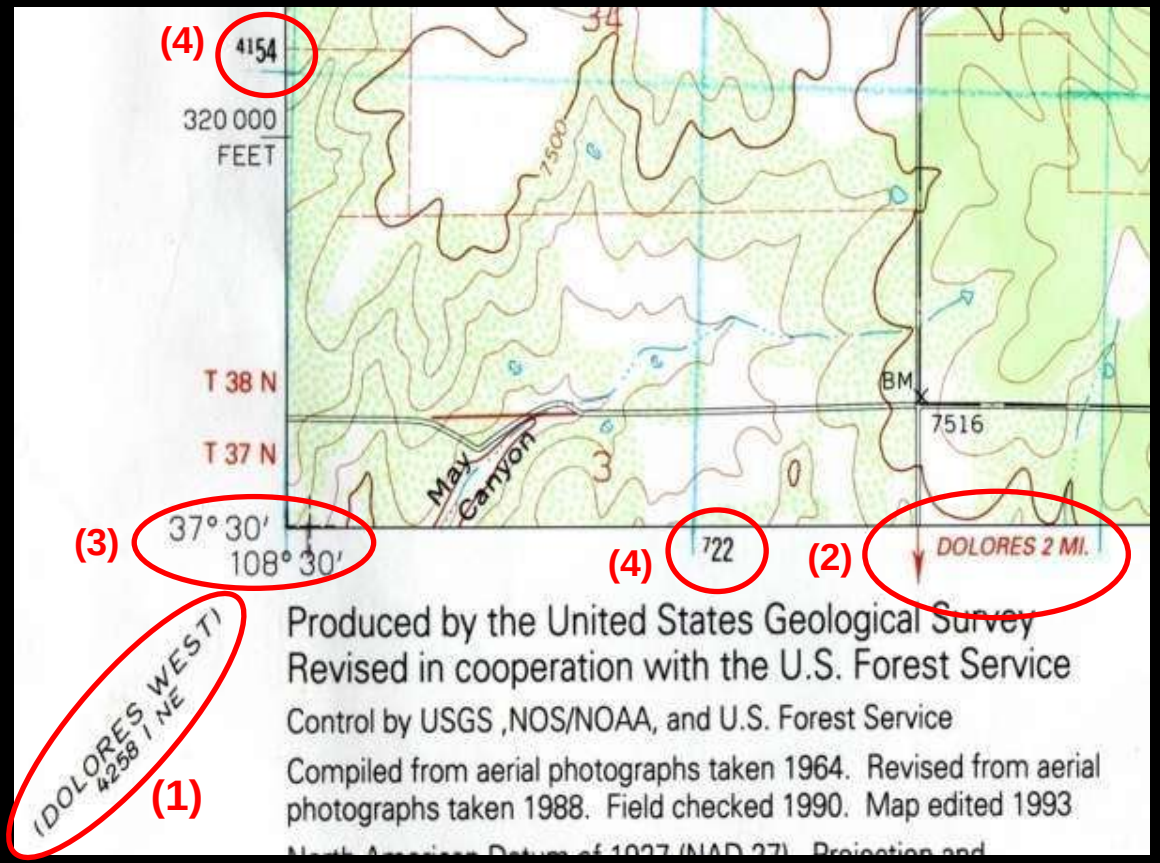


Map Margin Information

Additional information is distributed around the entire map margin. (only "need to know" items are circled)

- (1) names for adjoining quadrangle maps (in black). Adjacent to corners and centers of the map sides.
- (2) In red are the distances by road to the nearest towns.
- (3) The spherical grid, latitude and longitude, complete coordinates are given at each corner of the map.
- (4) the UTM (in black lettering with blue tics) and the UTM grid is in kilometers.



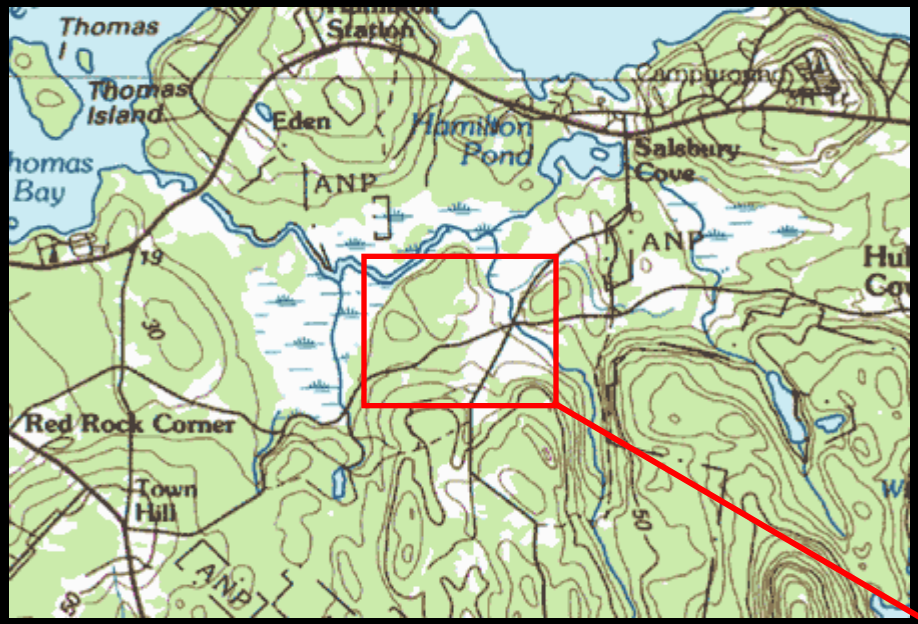


Any Questions?

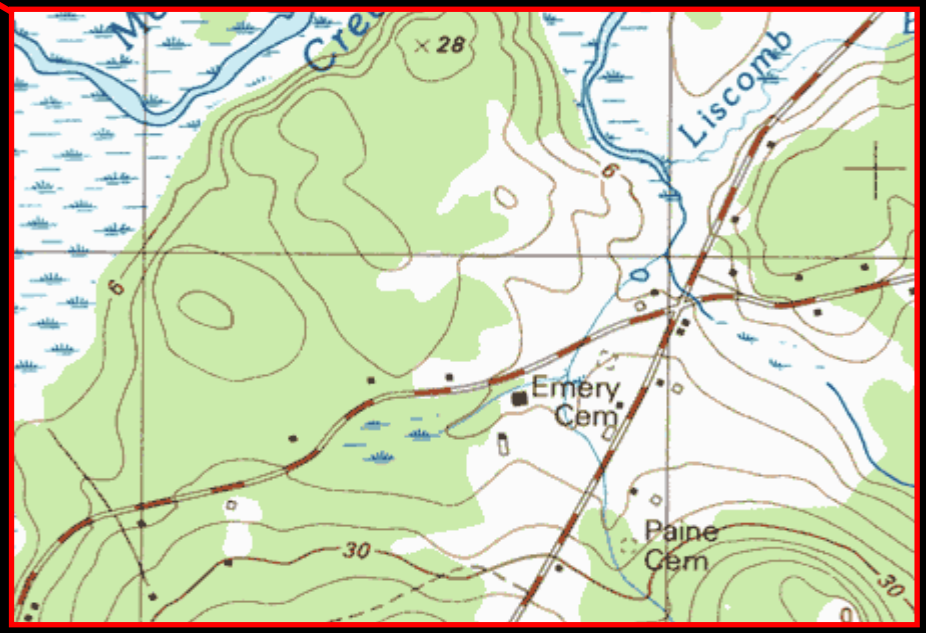
Map Scale

- Map scale is the relationship between distance on a map and the corresponding distance on the ground. Scale is expressed as a ratio, such as 1:24,000, and shown graphically by bar scales marked in feet and miles, or in meters and kilometers. Maps with a small scale for example, 7.5-minute maps, are often called large-scale maps because they show more detail (by covering less area) than a large bar-scale (30- x 60-minute) map.
- You must know the scale to determine ground distances between objects or locations on the map, the size of the area covered, and how the scale may affect the amount of detail being shown.
- The terms "*small scale*," "*medium scale*," and "*large scale*" may be confusing when read in conjunction with the number.
- However, if the number is viewed as a fraction, it quickly becomes apparent that 1:600,000 of something is smaller than 1:75,000 of the same thing. Therefore, the larger the number after 1:, the smaller the scale of the map.
- (1) ***Small***. Maps with scales of 1:1,000,000 and smaller are used for general planning and for strategic studies. The standard small-scale map is **1:1,000,000 (1 inch = 16 miles).** This map covers a very large land area at the expense of less detail.
- (2) ***Medium***. Maps with scales larger than 1:1,000,000 but smaller than 1:75,000 are used for operational planning. They contain a moderate amount of detail, but terrain analysis is best done with the large-scale maps. The standard medium-scale map is **1:250,000 (1 inch = 4 miles).** Medium-scale maps of 1:100,000 are also frequently encountered.
- (3) ***Large***. Maps with scales of 1:75,000 and larger are used for tactical, administrative, and logistical planning. These are the maps that you as a Soldier or junior leader are most likely to encounter. The standard large-scale map is 1:50,000; however, many areas have been mapped at a scale of **1:25,000 (1 inch = 2,000 feet).** Lots of detail is shown on this type of map.

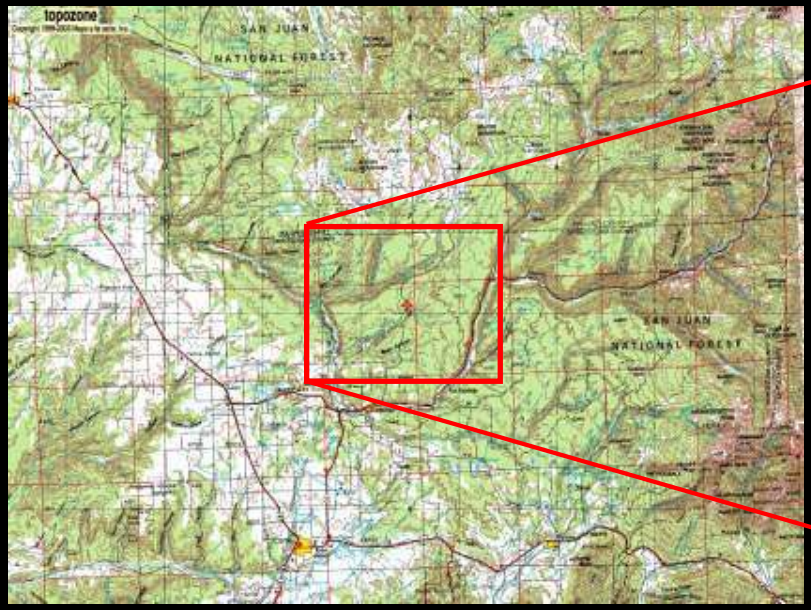
Map Scale



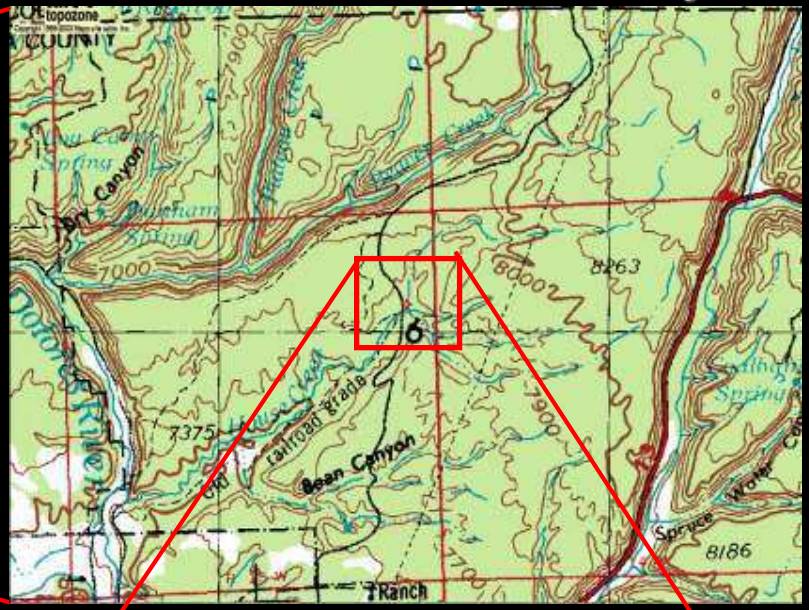
Medium-scale topo map (1:150,000)
SOME DETAIL



Large-scale topo map (1:24,000)
LOTS OF DETAIL

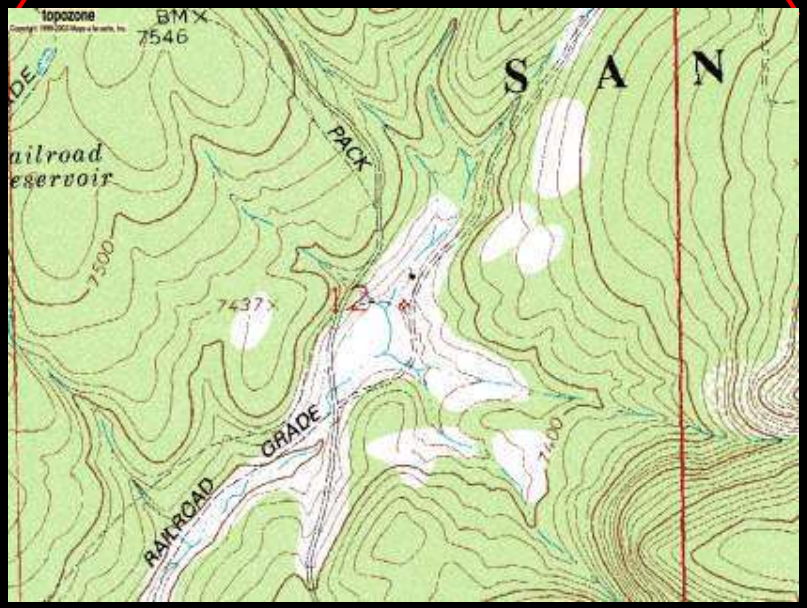


Small-scale map (1:100,000,000)
VERY LITTLE DETAIL



Medium-scale map (1:250,000)
MORE DETAIL

Map Scale



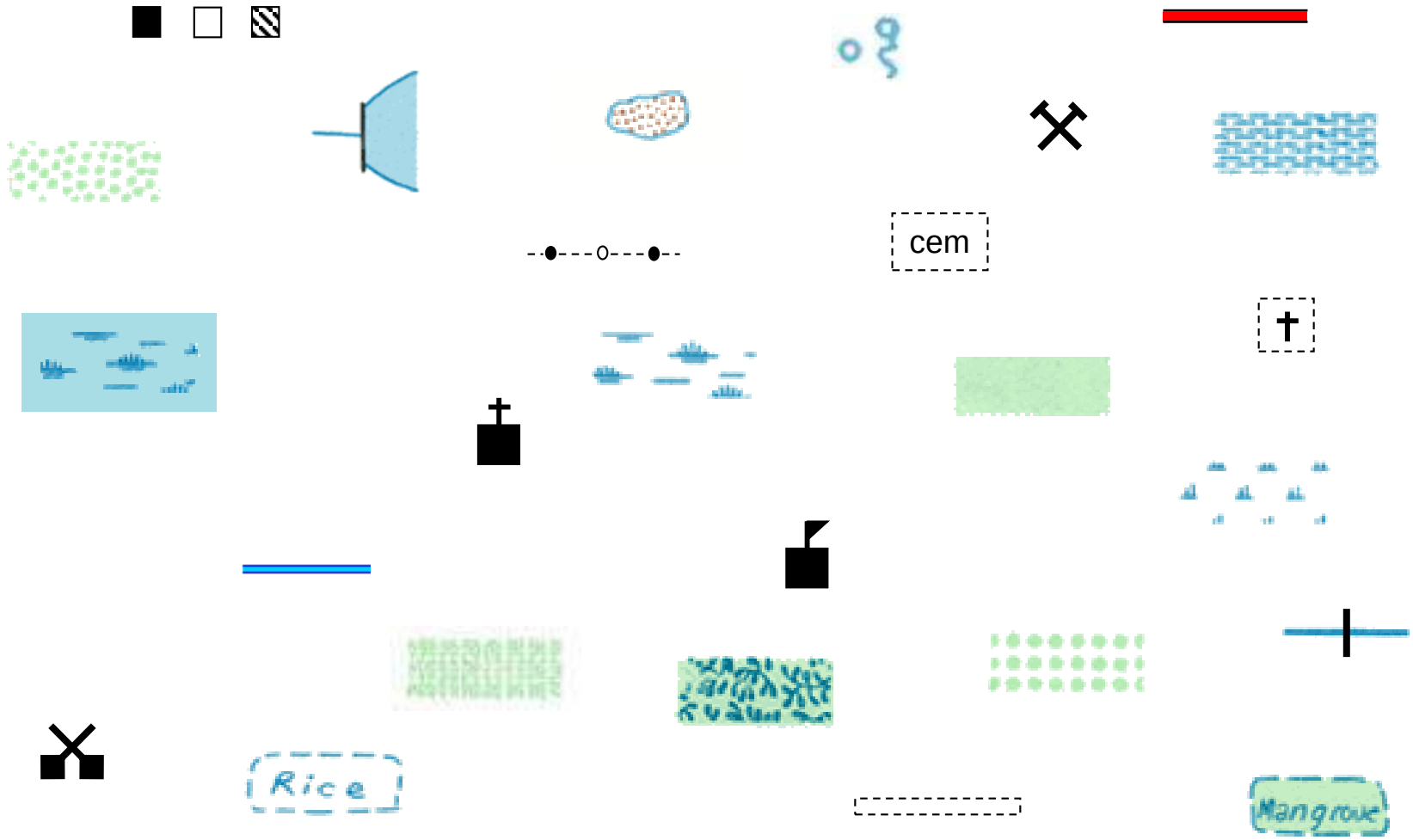
Large-scale map (1:24,000)
LOTS OF DETAIL

Any Questions?

Map Symbols

Symbols are used to represent the natural and man-made features of the earth.

It is a map language that is simple to read and understand. BUT you must first know what the map symbols represent, in order to understand, read and speak map language to others.



Map Symbols

VEGETATION

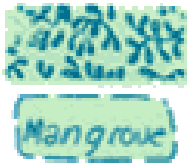
Woods

Shrub

Orchard

Vineyard

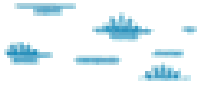
Mangrove



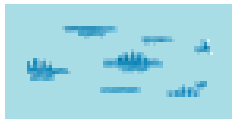
Map Symbols

SUBMERGED AREAS AND BOGS

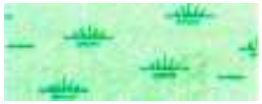
Marsh or swamp



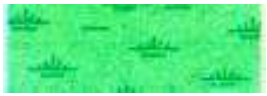
Submerge marsh or swamp



Wood marsh or swamp

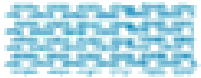


Submerge wood marsh or swamp



Rice field

Land subject to inundation



Map Symbols

RIVERS, LAKES, AND CANALS

Intermittent stream

Perennial stream

Intermittent river

Perennial river

Small falls; small rapids

Large falls; large rapids

Perennial lake or pond

Intermittent lake or pond

Dry lake

Well or spring

Dam

Canal

Map Symbols

MAN-MADE FEATURES and HIGHWAY & LAND GRIDS

Built-up Areas

Buildings

School

Church

Airports

Landing Strip

Cemetery cem

Mine

Gravel Pit

Highway

Road

Dirt Road

Bridge

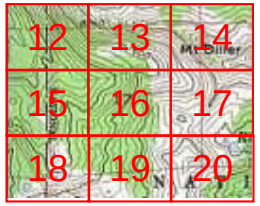
Foot Bridge

Trail

Power Lines

Railroad

Land Grids



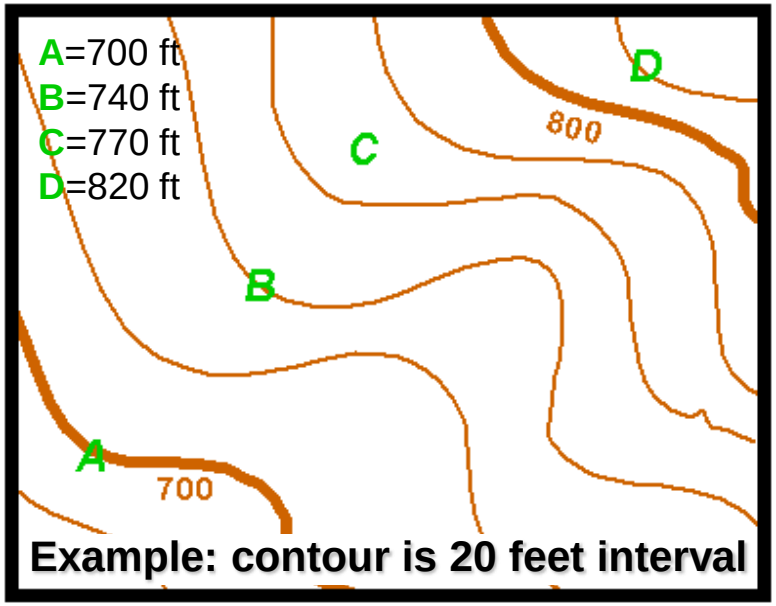
Any Questions?

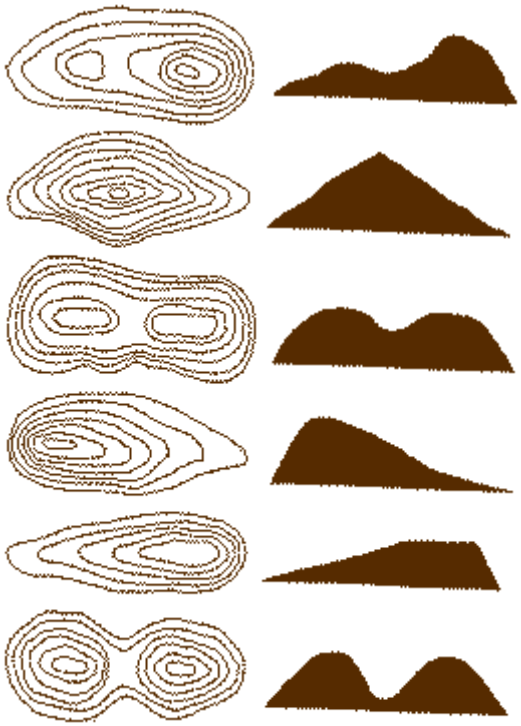
CONTOUR LINES

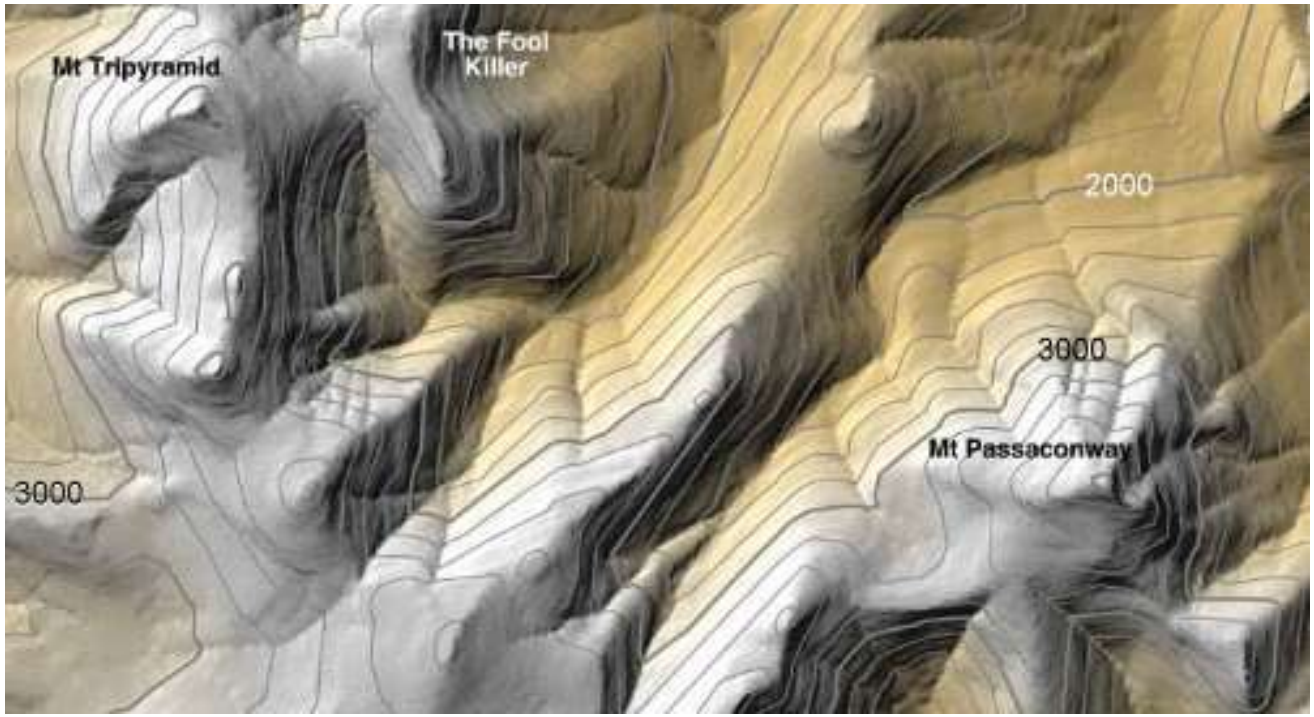
Contour Interval ~ The contour interval is the distance between each contour line. The contour interval is found along the bottom edge, center of the map.

Intermediate Contour ~ a brown line on a topographic map and represents a line of equal elevation.

Index Contour ~ a bolder/wider brown line that has the elevation value marked at various intervals as a part of the line.

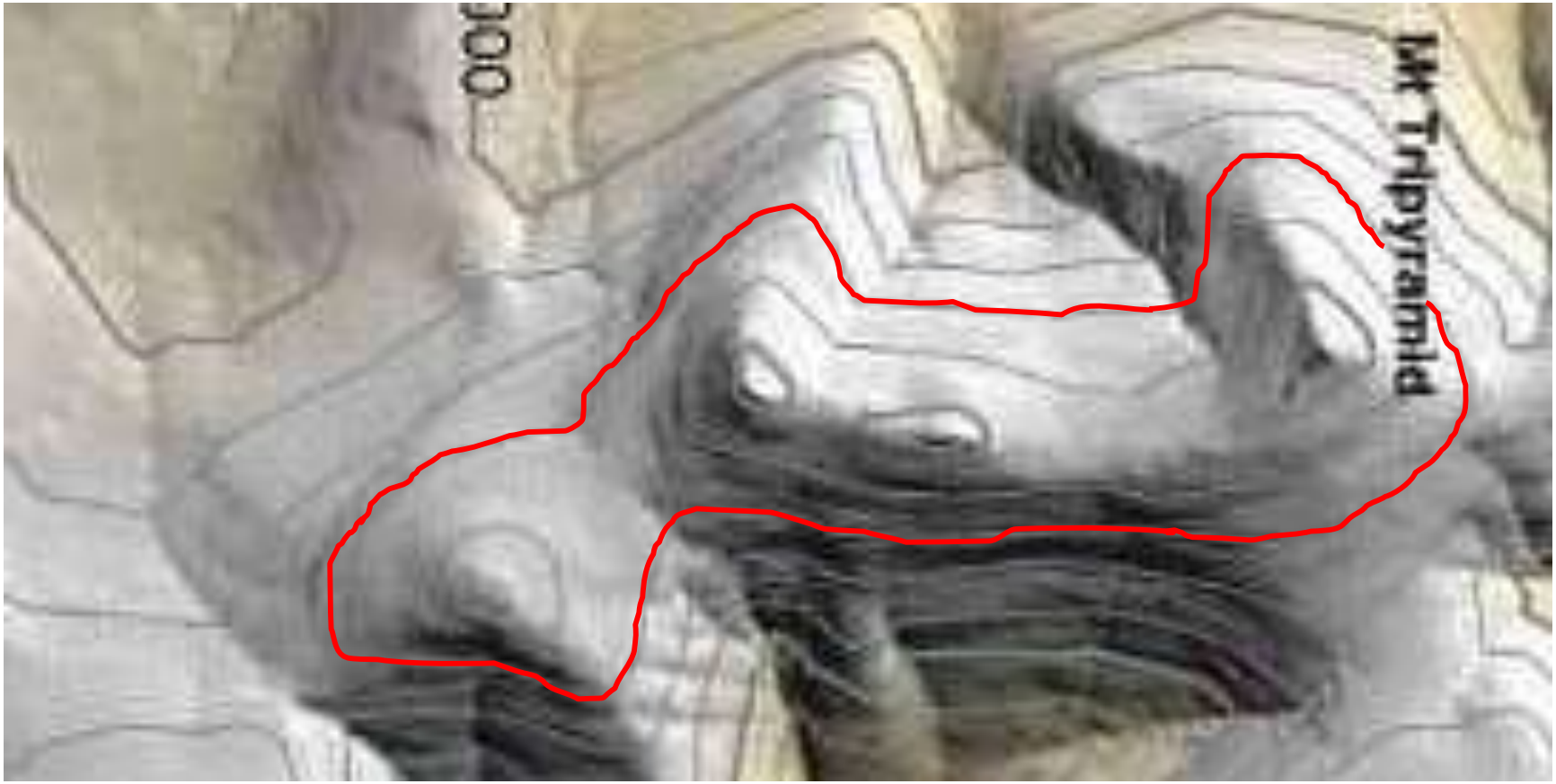






CONTOUR LINES

- There is a dimension to establishing position which does depend on map reading skills.
- This is the vertical dimension. On a map it is referred to as “relief”.
  - Knowledge of the relief of an area is extremely important to a wilderness navigator.
- The most graphic technique ever devised to show relief information is the contour line.
  - If you were to walk a contour line you would never go down hill and never up hill, and eventually you would arrive back where you started.



Any Questions?

Terrain Relief Features

Five Major

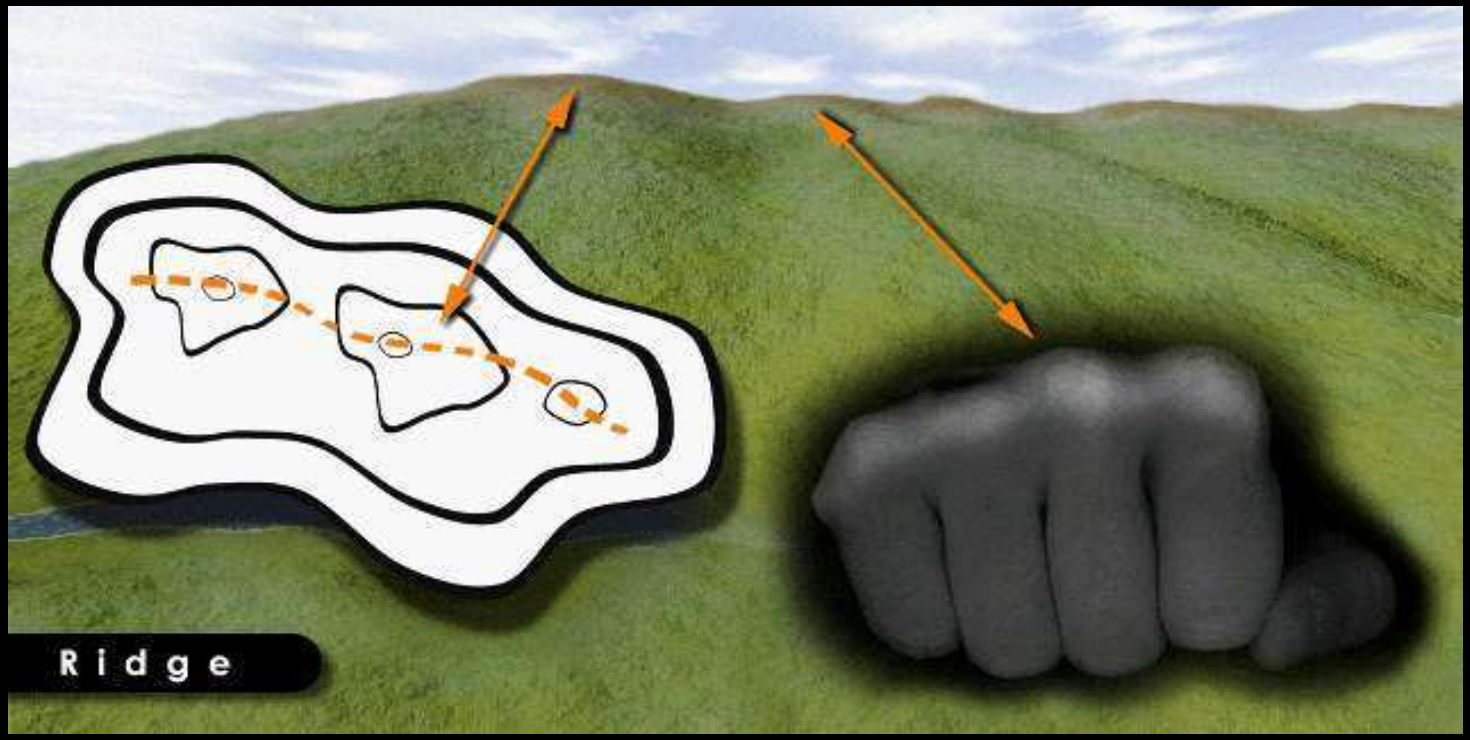
- Ridge
- Hill
- Saddle
- Valley
- Depression

Three Minor

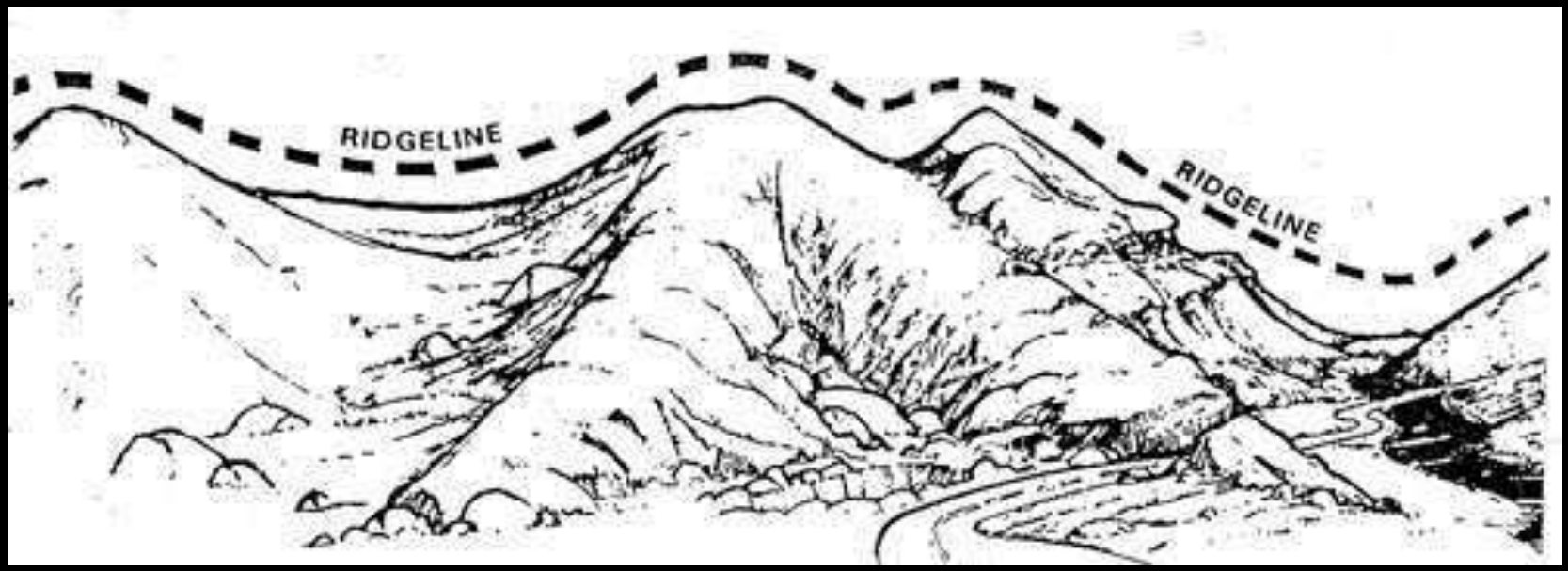
- Spur
- Draw
- Cliff

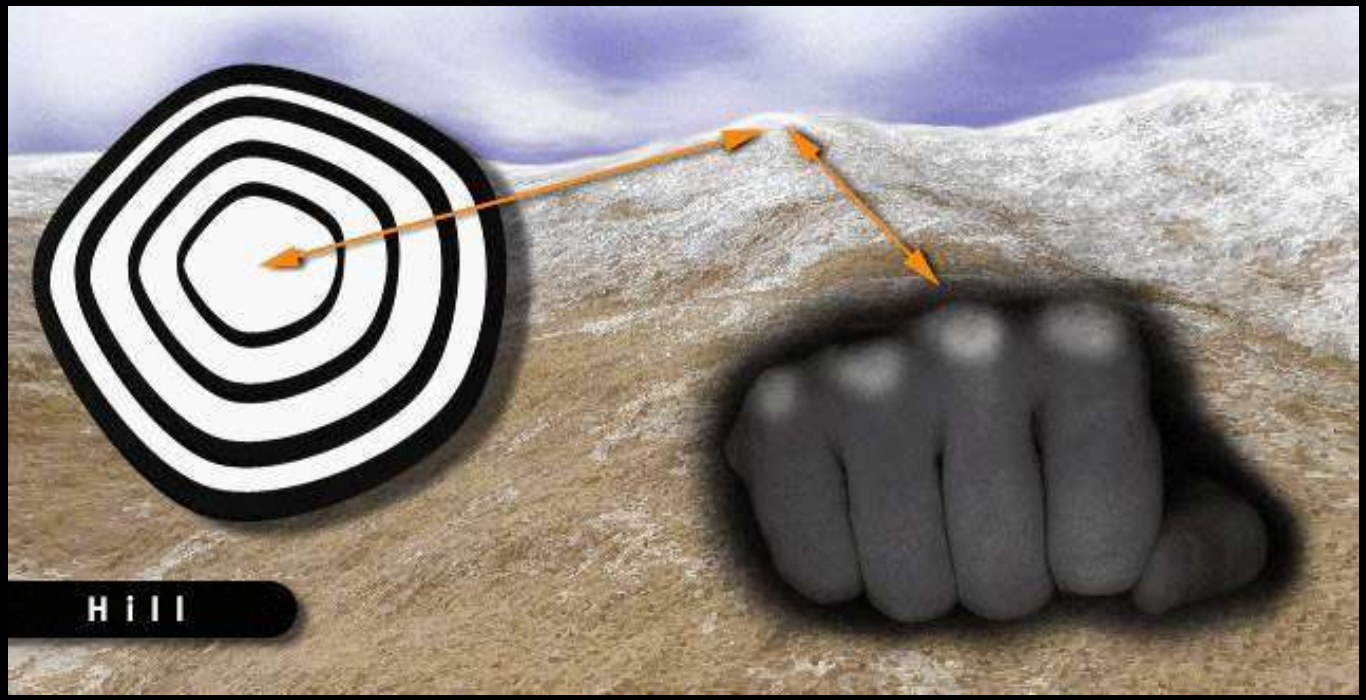
Two Supplemental

- Cut
- Fill

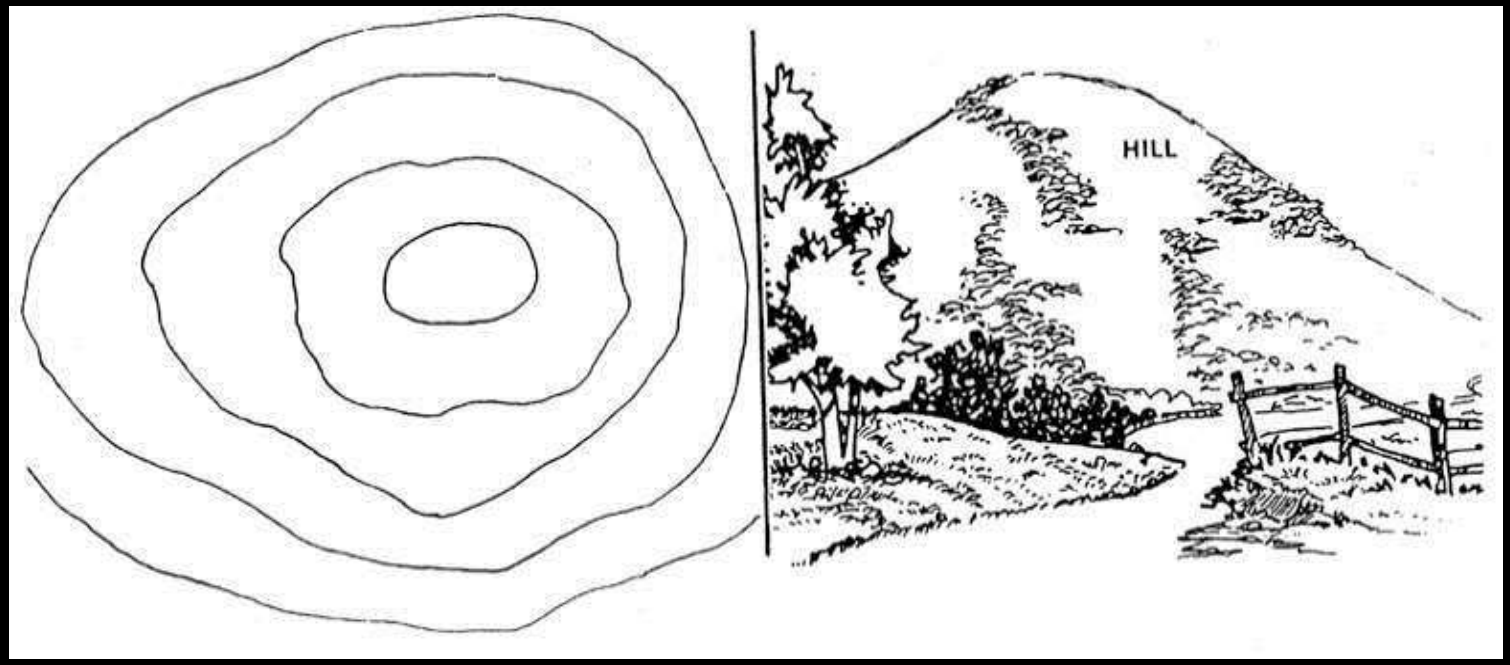


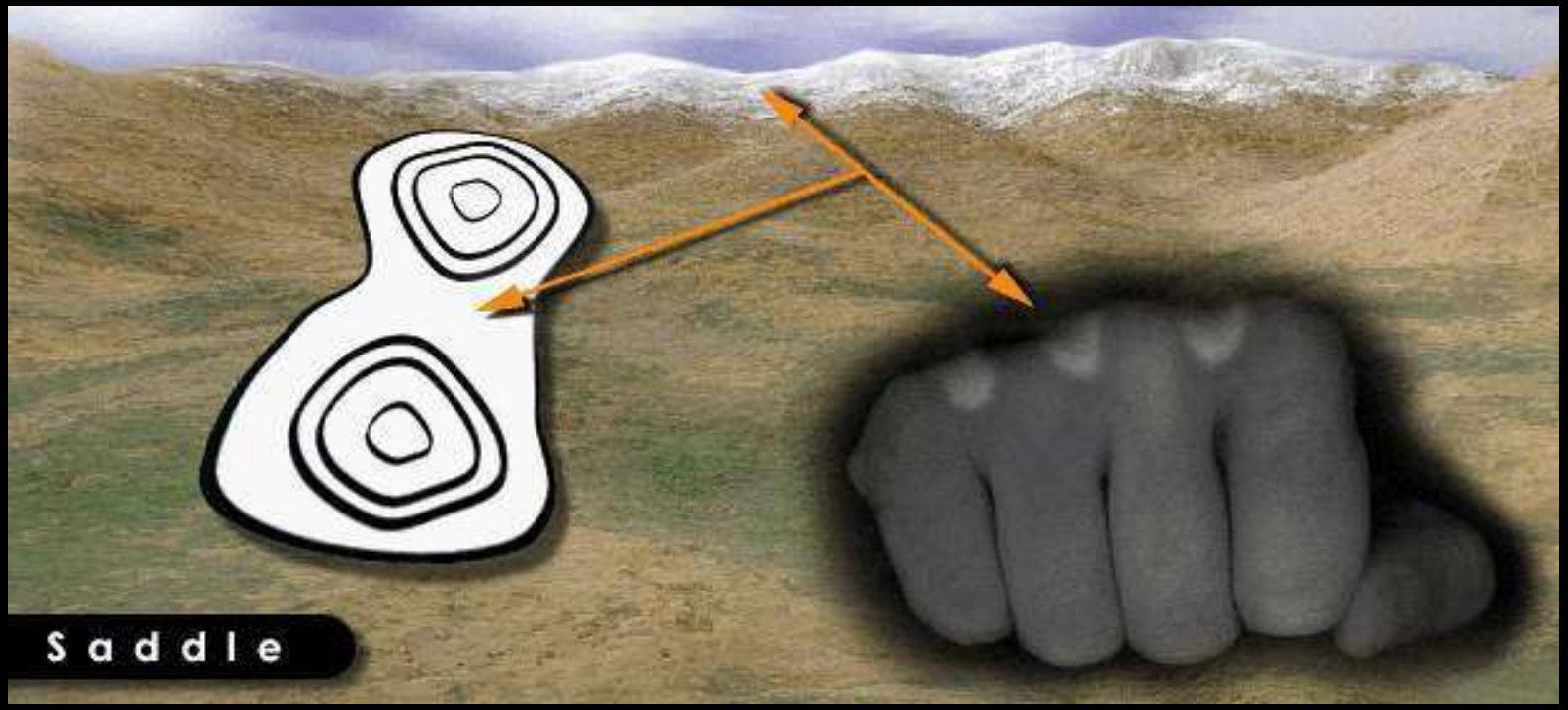
RIDGE



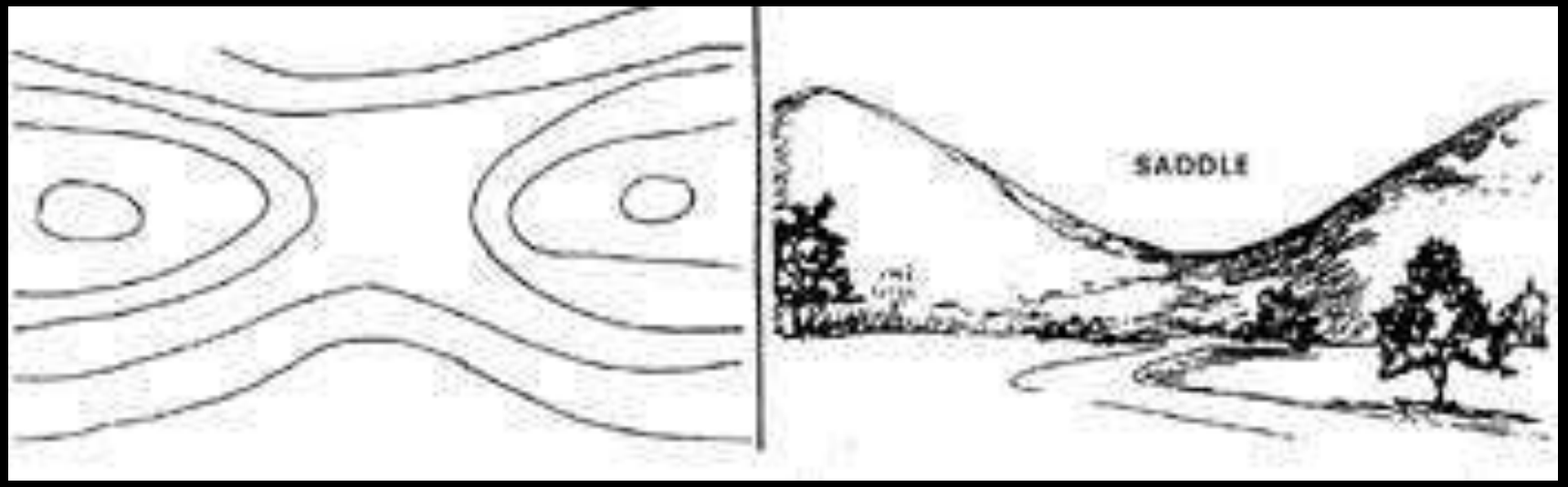


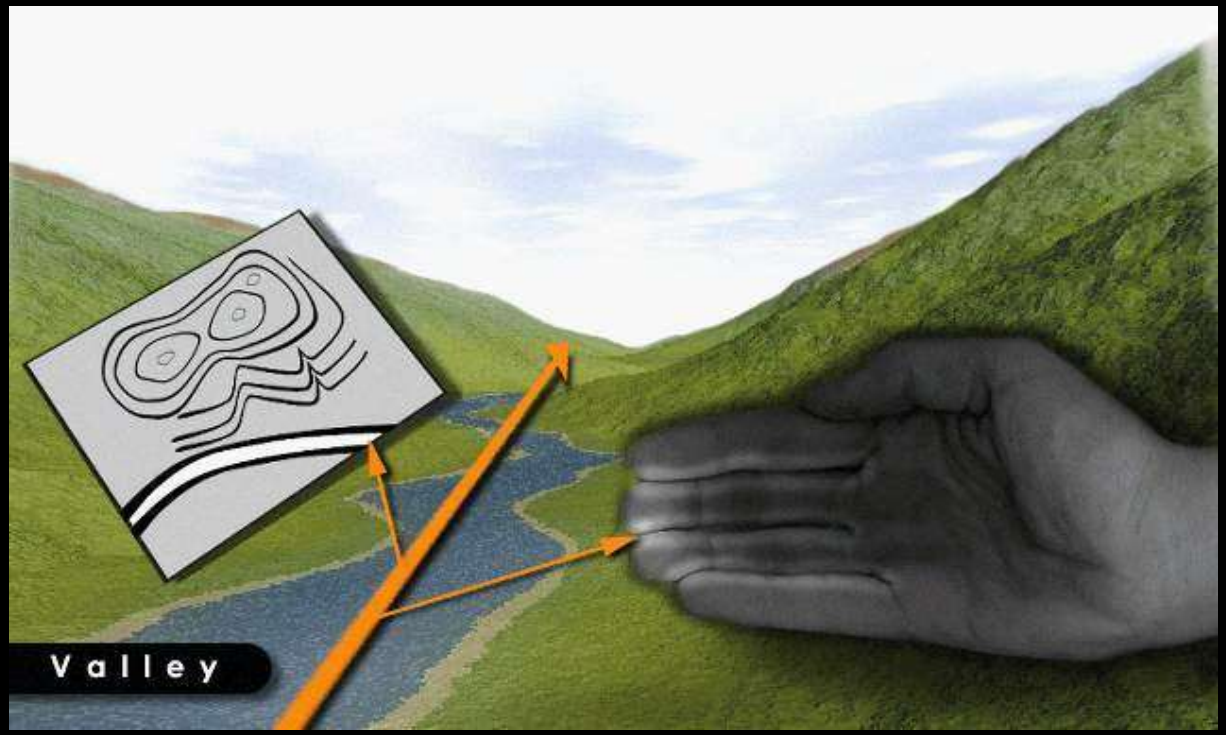
HILL



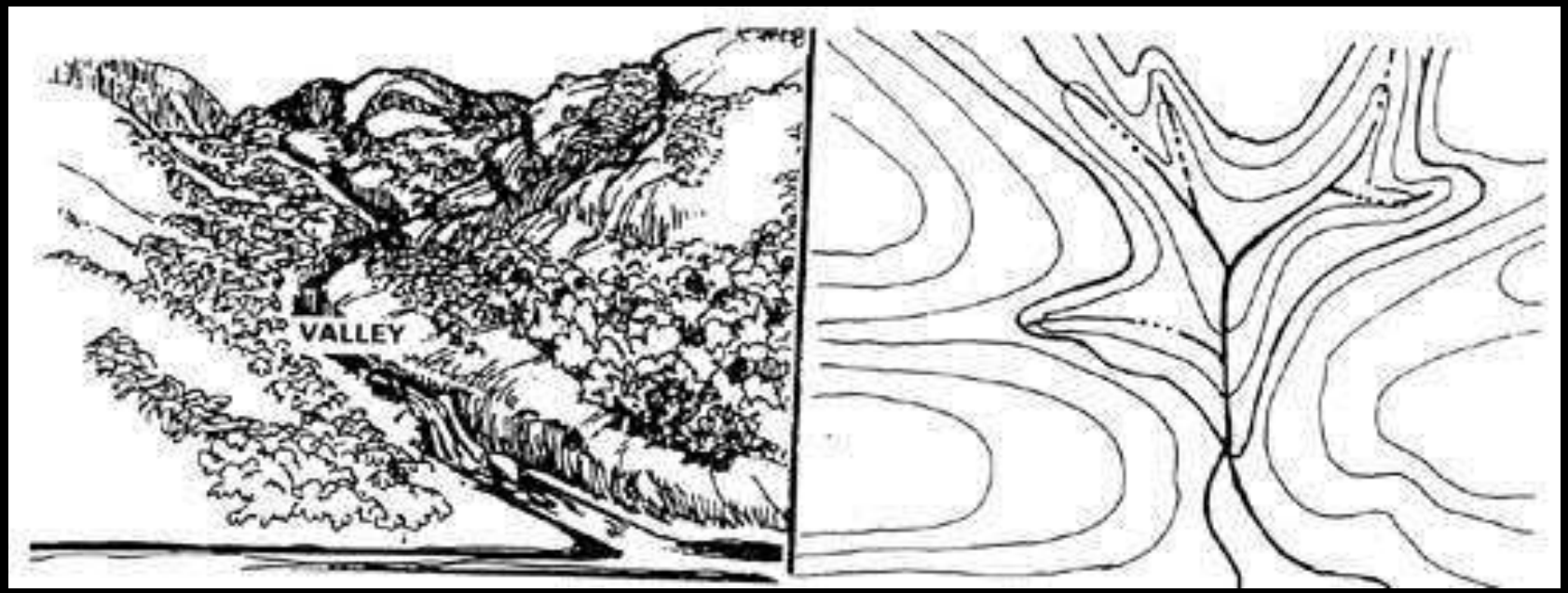


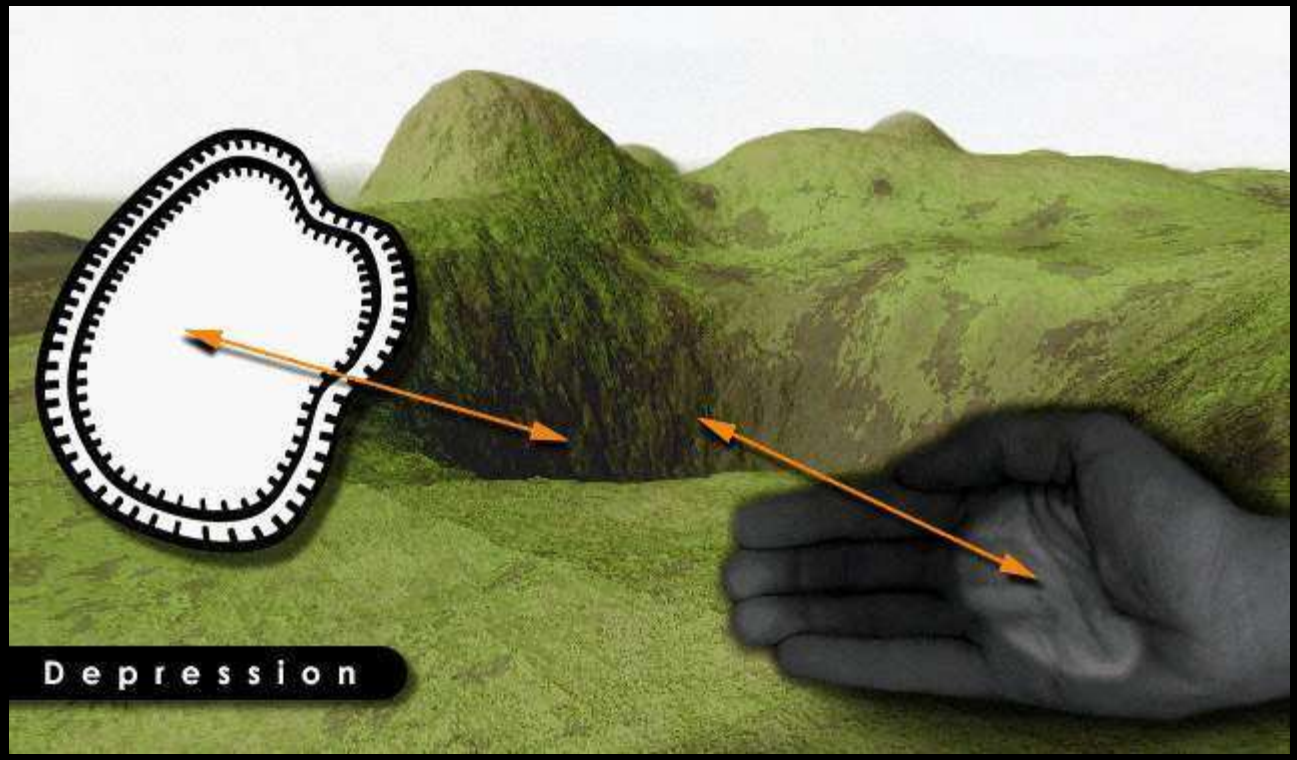
SADDLE



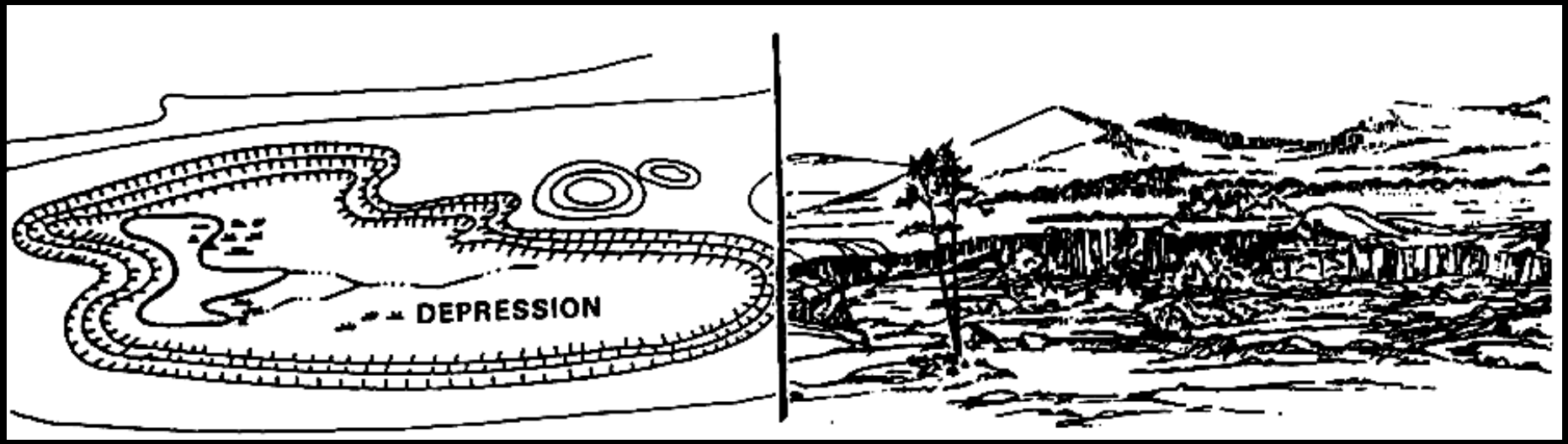


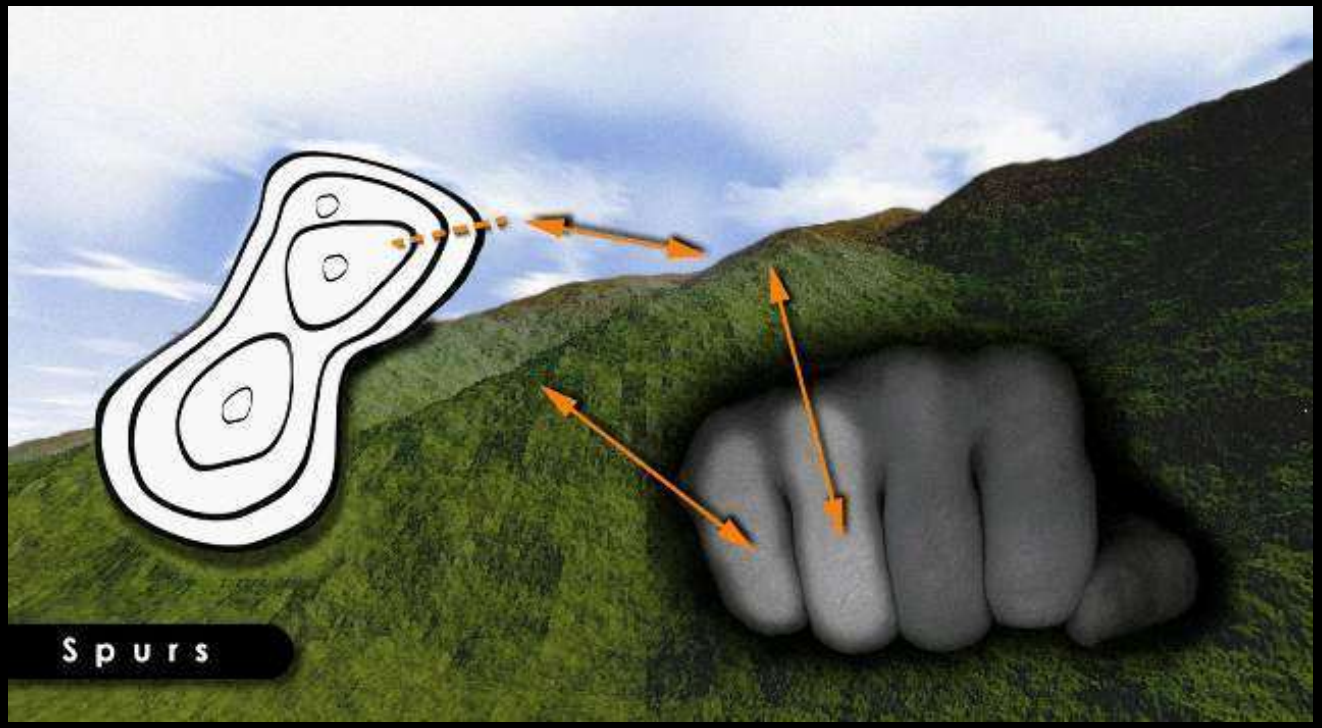
VALLEY



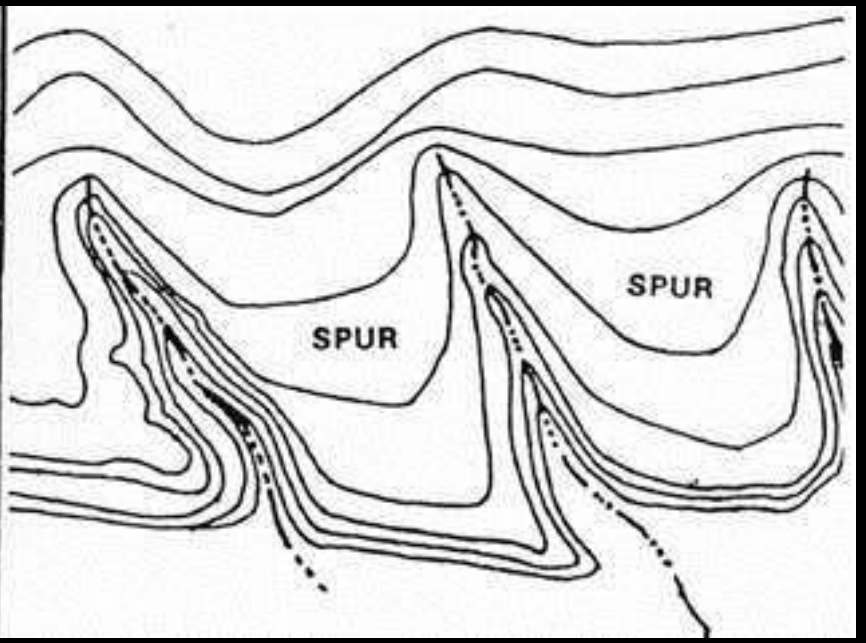


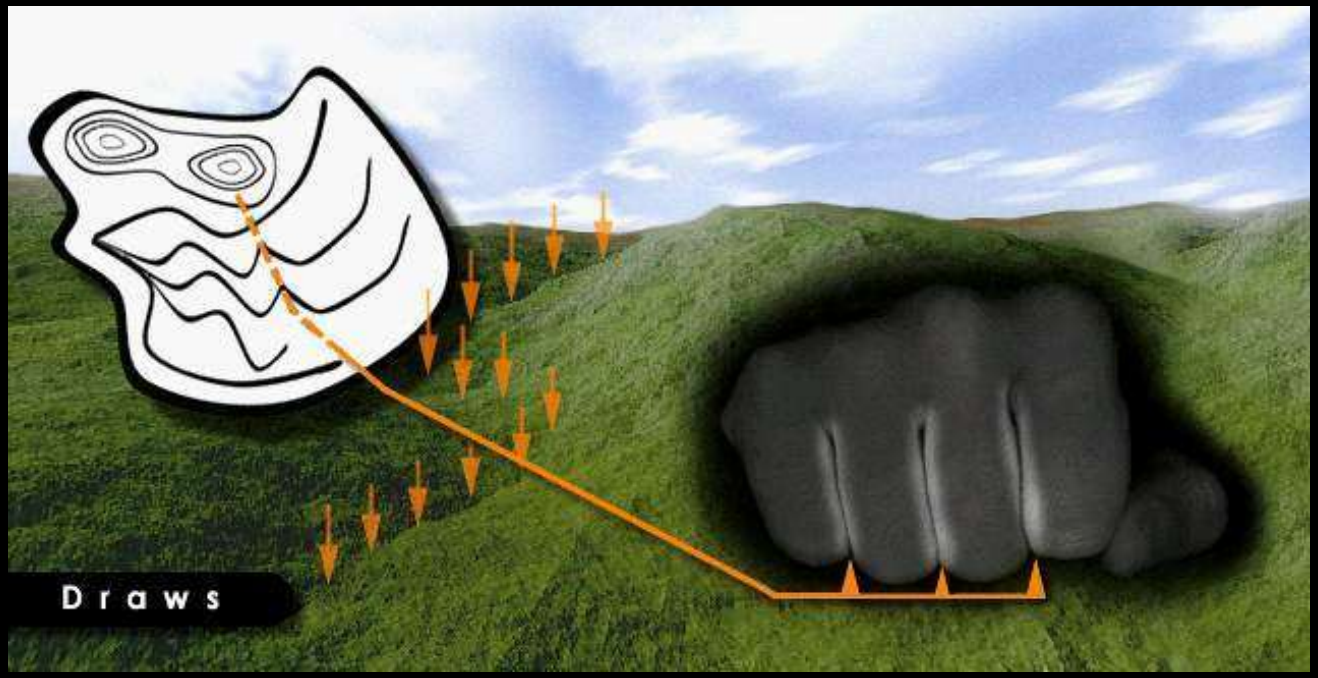
DEPRESSION



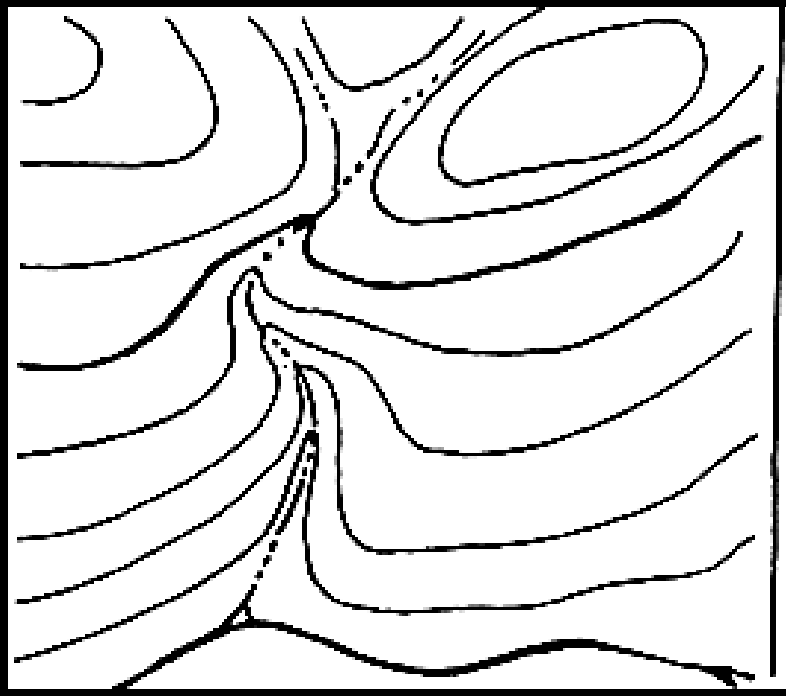


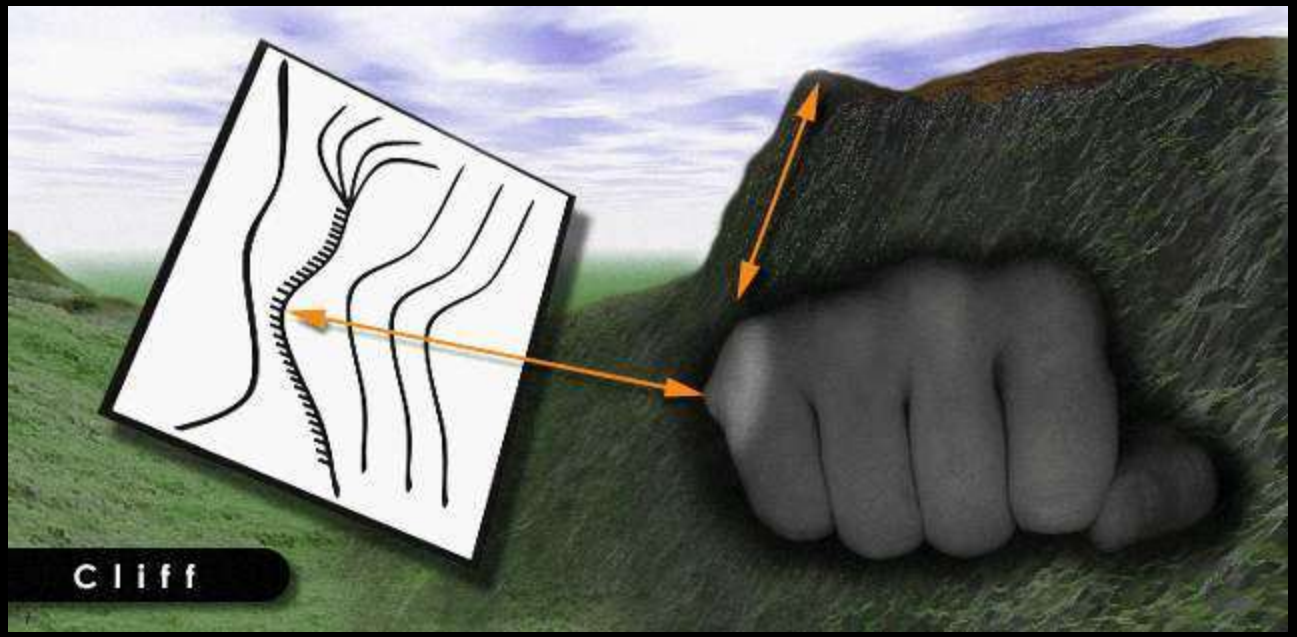
SPURS



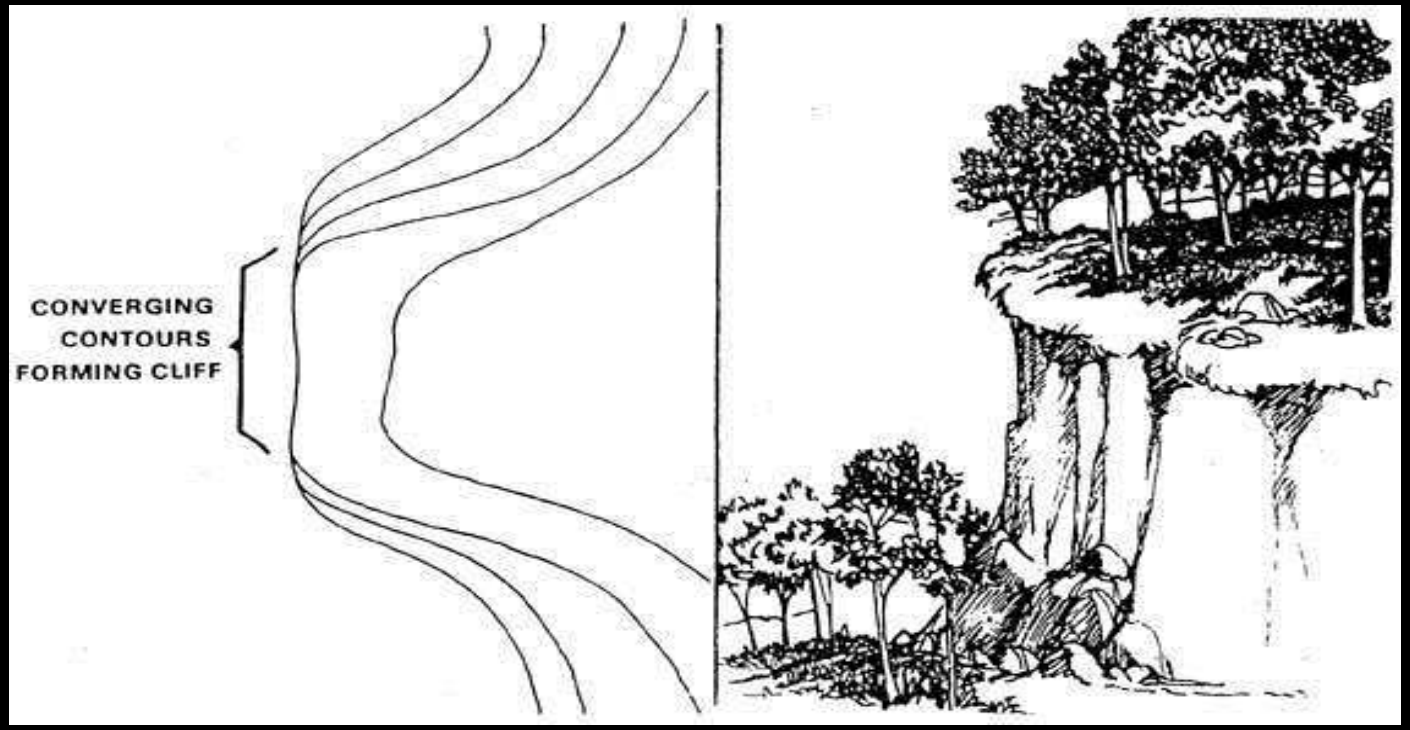


DRAWS

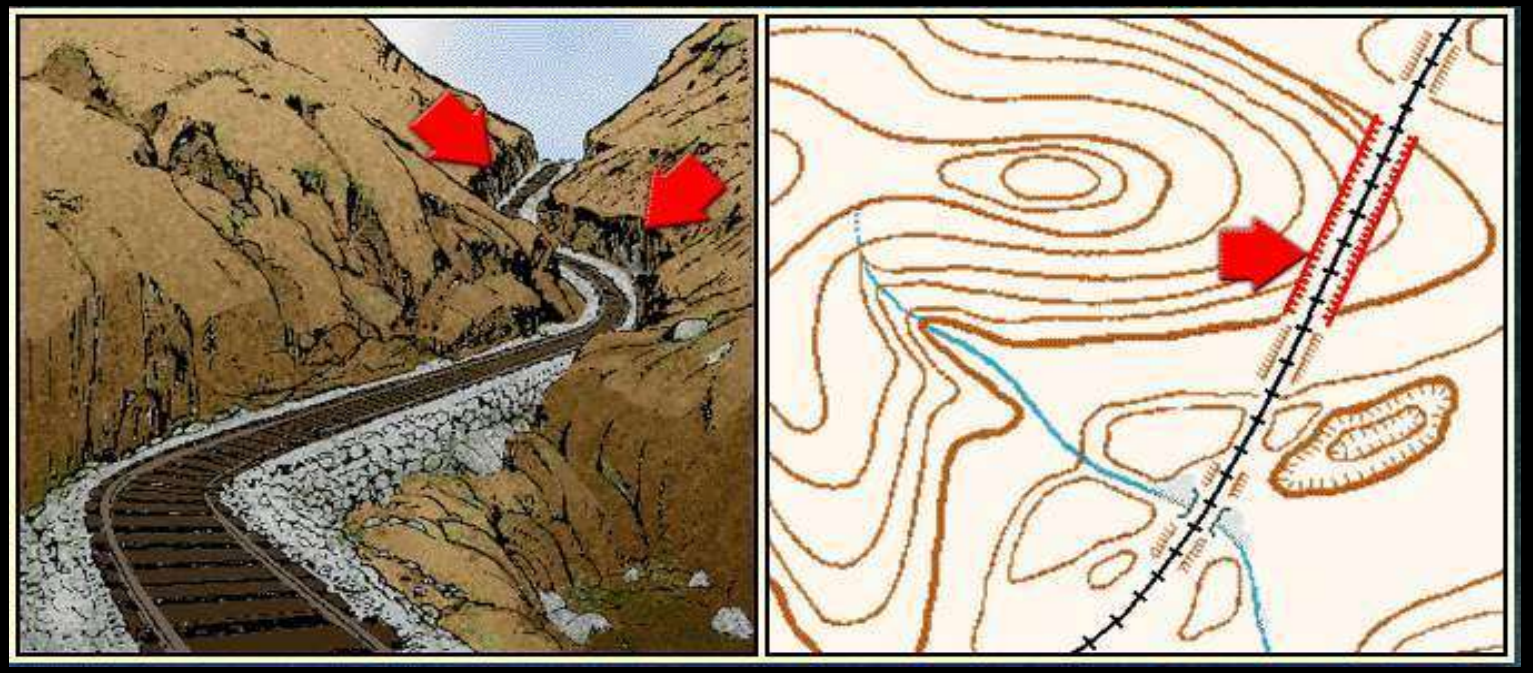




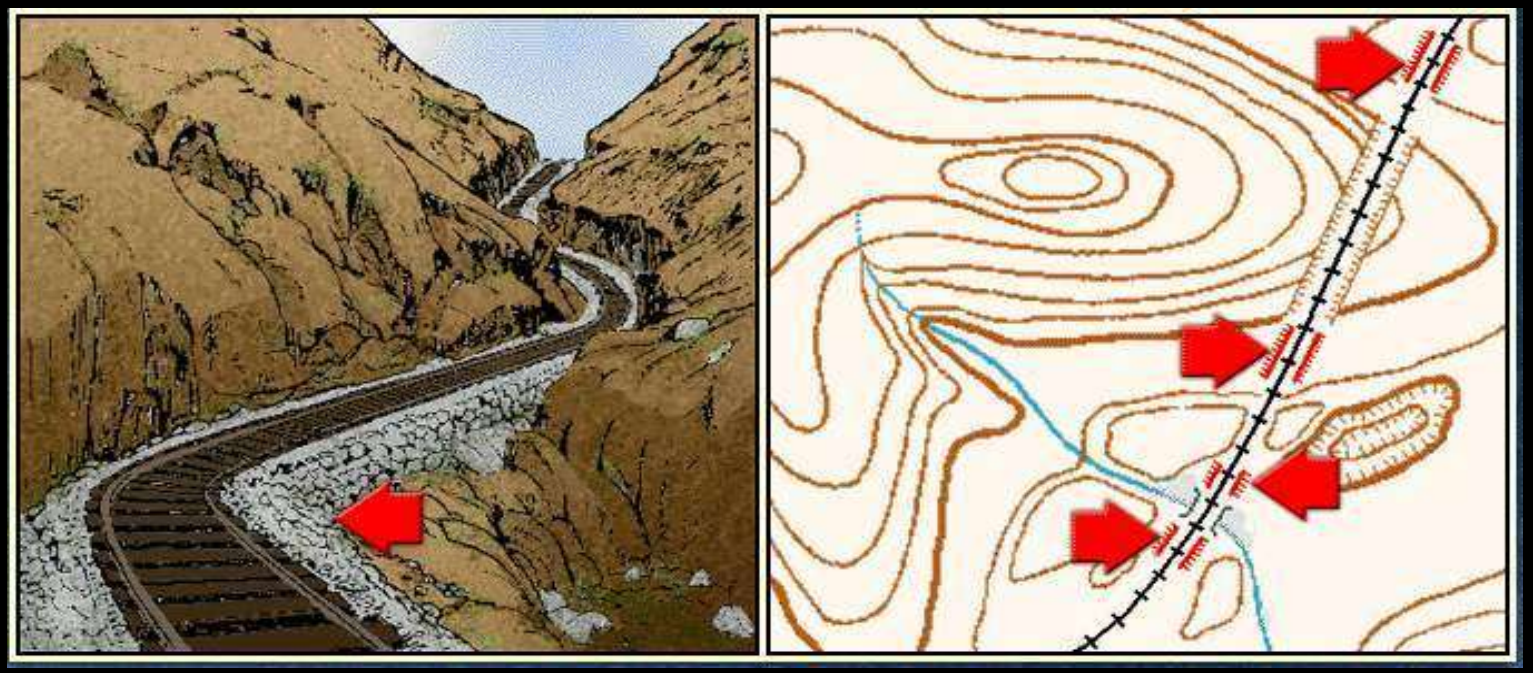
CLIFF



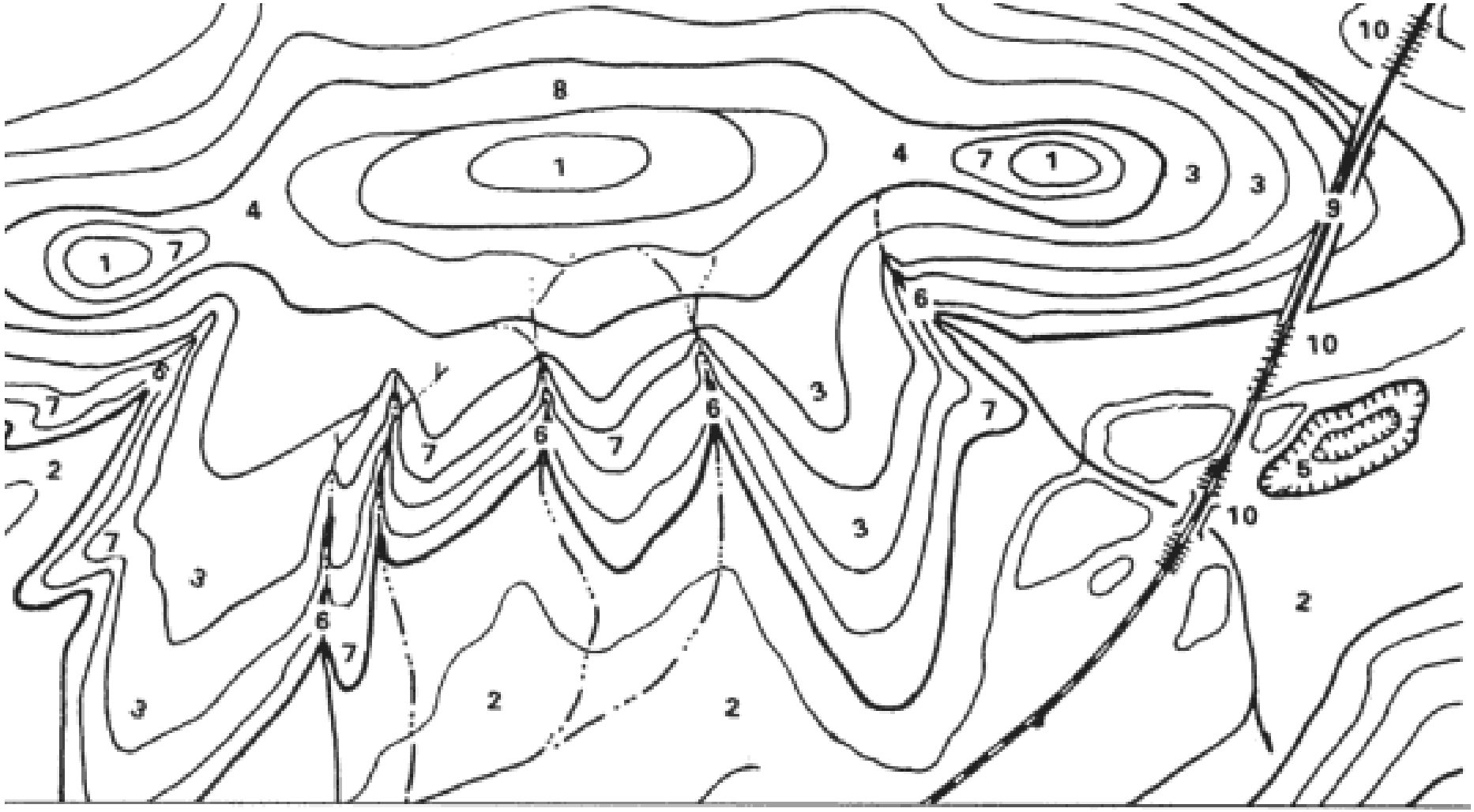
CUT



FILL



Terrain Features



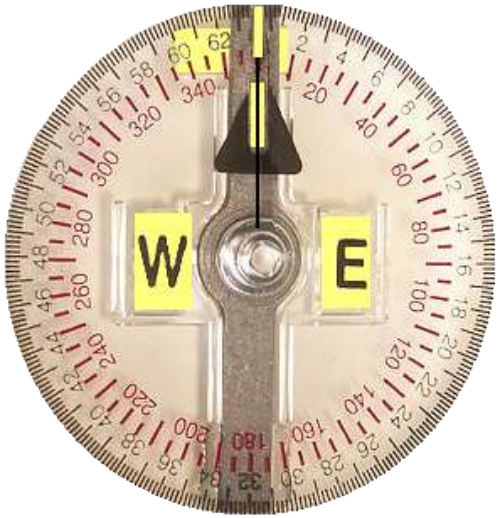
1. HILL
2. VALLEY
3. RIDGE
4. SADDLE
5. DEPRESSION
6. DRAW
7. SPUR
8. CLIFF
9. CUT
10. FILL

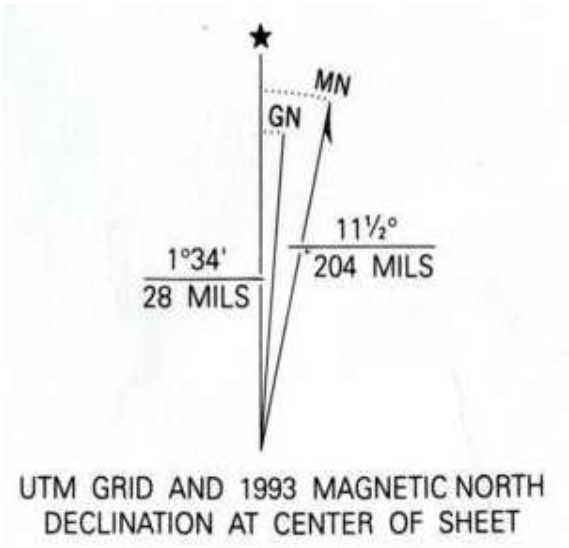
Any Questions?

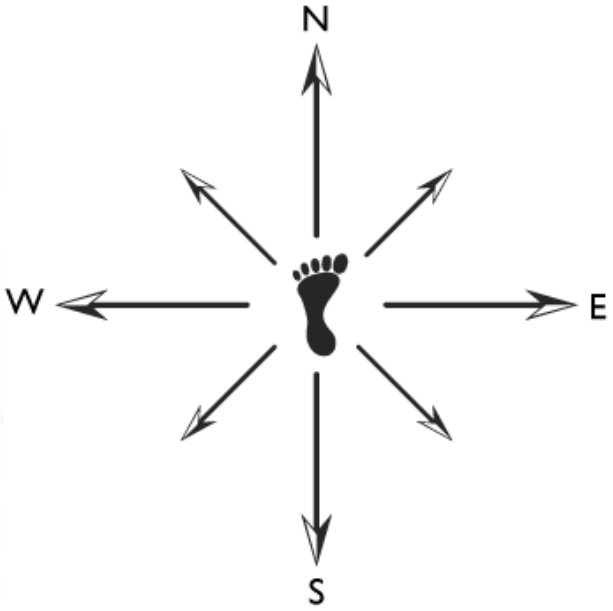
Map Information – Direction

EXPRESSING DIRECTION

- You need a way of expressing direction that is accurate, is adaptable to any part of the world, and has a common unit of measure. Directions are expressed as units of angular measure and direction implies a reference point.
- The common reference point for maps is True North, and map direction is figured in degrees from that point.
- Azimuths - The direction from one point to another point (either on the map or on the ground) is called an azimuth.
  - Azimuths are given in degrees in a clockwise direction. Since there are 360° in a circle, an azimuth can be any number up to 360°. East is 90°, South is 180°, West is 270°, and North is 360°.
- Maps are laid out with the top toward the top of the earth – True North (geographic north) and map north. The side edges of the map are the only lines on the map guaranteed to run true north-south.
- The many north-south lines on a map give grid north. The compass needle points to magnetic north. Grid north and magnetic north usually have a few degrees difference. Neither points straight at the North Pole; that is called “true north.”
- With compass and map you can know what direction you are heading.







Map Information – Direction

THREE TYPES OF DIRECTION

- **True North.** A line from any point on the earth's surface to the north pole. Is represented by a star.
- **Magnetic North**. The direction to the north magnetic pole, as indicated by the north-seeking needle of a magnetic compass. The magnetic north is usually symbolized by a line ending with half of an arrowhead.
- **Grid North.** The north that is established by using the vertical grid lines on the map. Symbolized by the letters GN. Used for UTM grid by military and rescue teams for its accuracy and simplicity.

G-M ANGLE. The angular difference between GN and MN.

<u>Why do we need to know all this?</u>
So that we can navigate using a **map**, the **ground** (we often forget the ground is important) and **compass**.

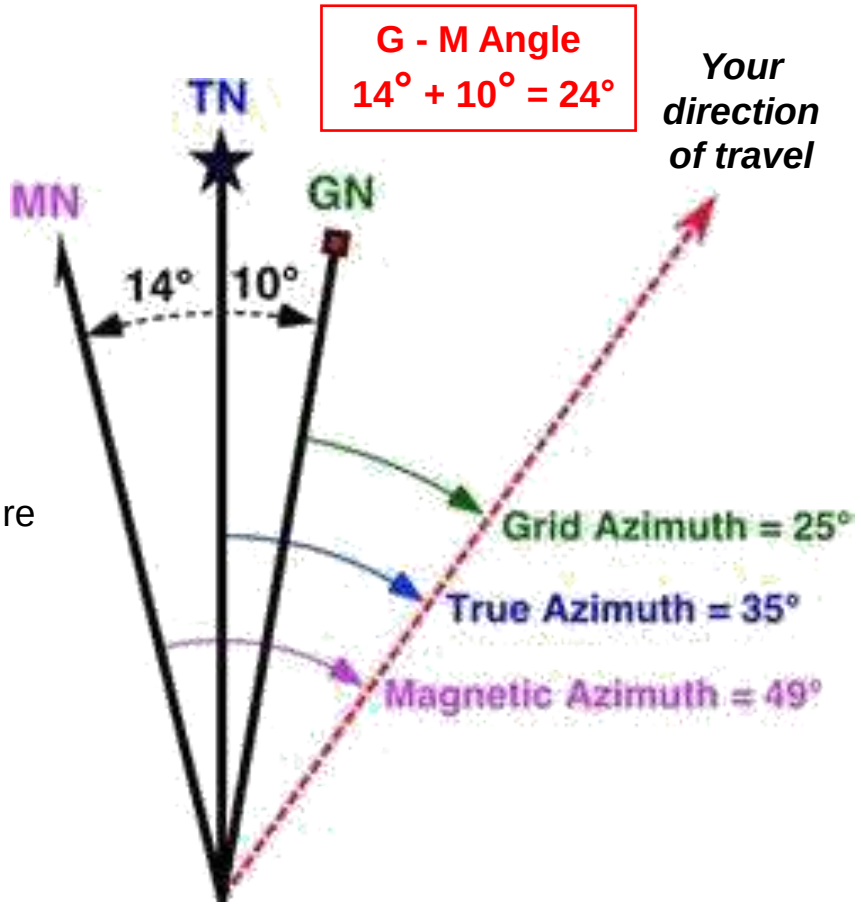
You cannot follow a GN with a compass; nor can you plot a MN with a protractor. To assist you in making the conversion from MN to GN, and vice versa, a declination diagram is placed on the map margin.

<u>Remember the following.</u>
When using a **map** - use a protractor (next slides) to measure **GRID** Bearings. Do not use the compass magnetic needle.
(*unless map has MN Lines – see Part 2 Intermediate Land Nav*)

When using the **ground** – use a **Compass** to Measure **MAGNETIC** Bearings.

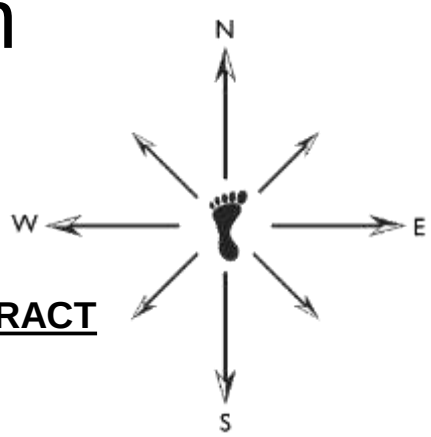
With GN and G-M ANGLE you can find the MN.

With MN and G-M ANGLE you can find the GN.



Map Information – Direction

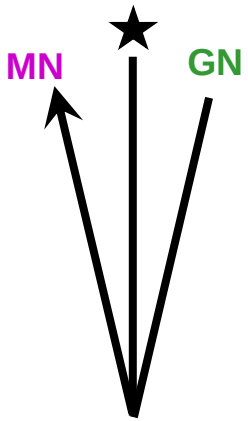
CONVERSION (three ways to remember)

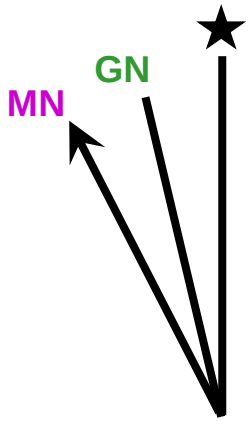


Left to Right → **SUBTRACT**
Right to Left ← **ADD**

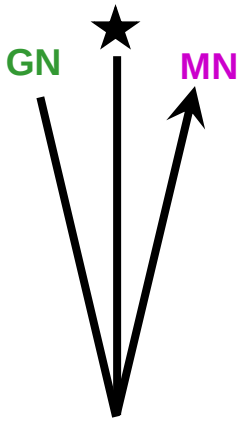
WEST to EAST is least (-) **SUBTRACT**
EAST to WEST is best (+) **ADD**

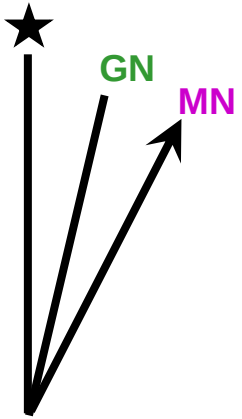
When **MN** is to the west (left) of **GN**
MN to GN **subtract** G-M ANGLE
GN to MN **add** G-M ANGLE





When **MN** is to the east (right) of **GN**
MN to GN **add** G-M ANGLE
GN to MN **subtract** G-M ANGLE



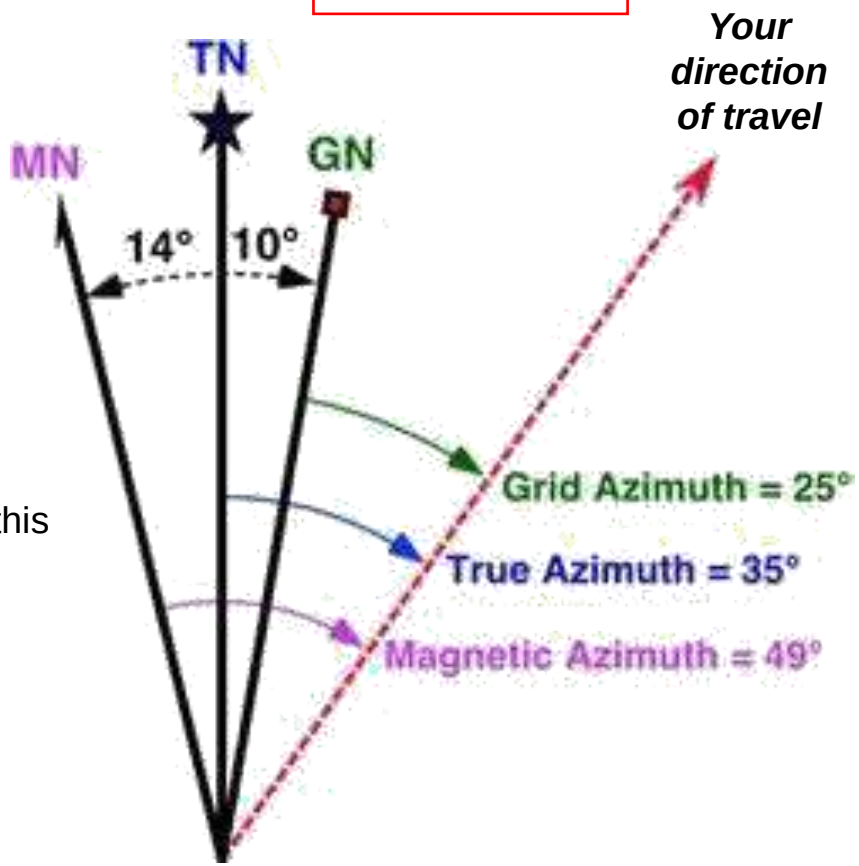


Map Information – Direction

CONVERSION
(example 1)

G - M Angle
14° + 10° = 24°

Left to Right → **SUBTRACT**
Right to Left ← **ADD**



HOW?

*From **ground** to **map**.*

1. You measure the bearing of a landmark on the ground with a compass. It is **49°** MN.
2. The G-M ANGLE on the Map is **24°**
3. So MN to GN **SUBTRACT** **49°** - **24°** = **25°** GN (Draw this on your map)

*From **map** to **ground**.*

1. You measure the bearing of a point on the map with a protractor (next slides). It is **25°** GN.
2. The G-M ANGLE on the Map is **24°**
3. So GN to MN **ADD** **25°** + **24°** = **49°** MN (Put this on your compass)

Map Information – Direction

CONVERSION
(example 2)

Left to Right → **SUBTRACT**
Right to Left ← **ADD**

G - M Angle
14° - 5° = 9°

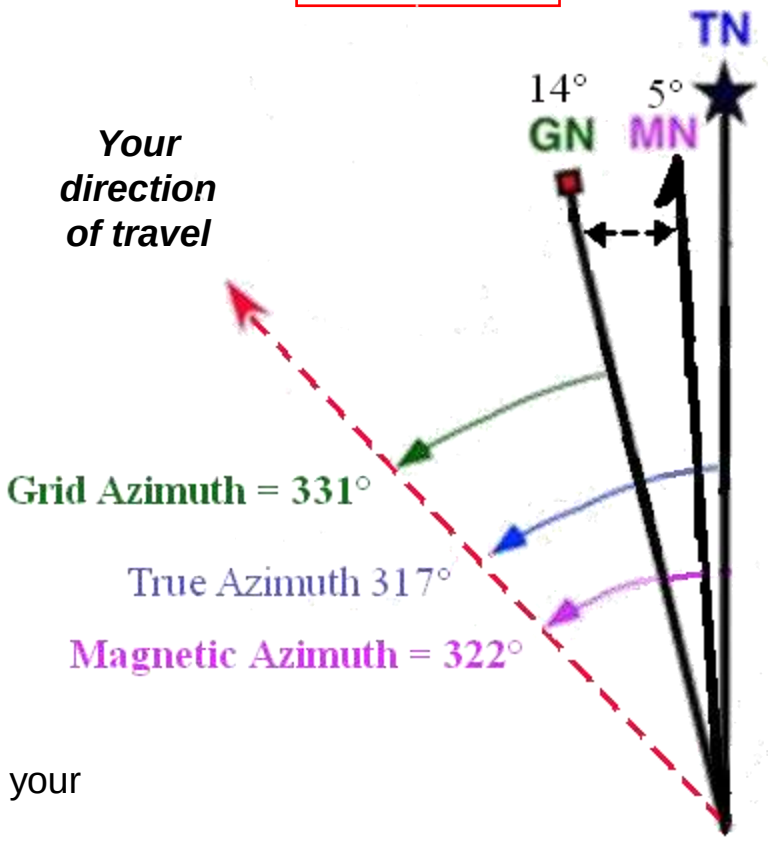
HOW?

*From **ground** to **map**.*

1. You measure the bearing of a landmark on the ground with a compass. It is **322°** MN.
2. The G-M ANGLE on the Map is **9°**
3. So MN to GN **ADD** **322°** + **9°** = **331°** GN (Draw this on your map)

*From **map** to **ground**.*

1. You measure the bearing of a point on the map with a protractor (next slides). It is **331°** GN.
2. The G-M ANGLE on the Map is **9°**
3. So GN to MN **SUBTRACT** **331°** - **9°** = **322°** MN (Put this on your compass)



Any Questions?

Map Information – Direction

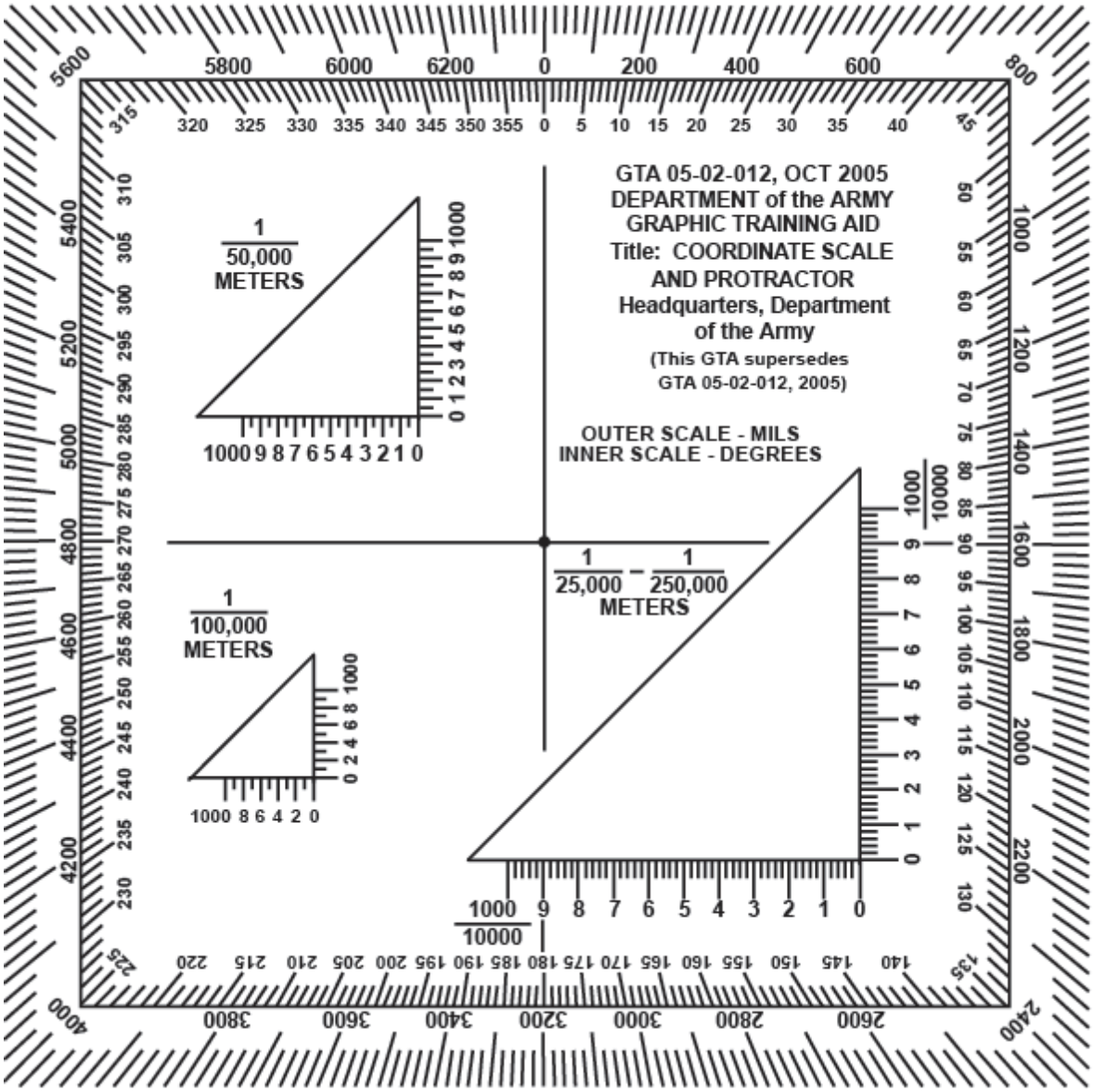
PROTRACTOR

1. With a protractor the map does NOT have to be oriented.
2. It is used to calculate direction from **map** to **ground** (**compass**) by converting the protractor GN to a MN for the compass.
3. It is used for –
   - Plotting azimuths
   - Plotting position
   - Plotting UTM coordinates

NOTE

If you have MN LINES drawn on the map, you can align the protractor to a MN LINE, get the MN azimuth on the protractor and you DO NOT have to do any MN conversions.

(see Part 2 Intermediate Land Nav)



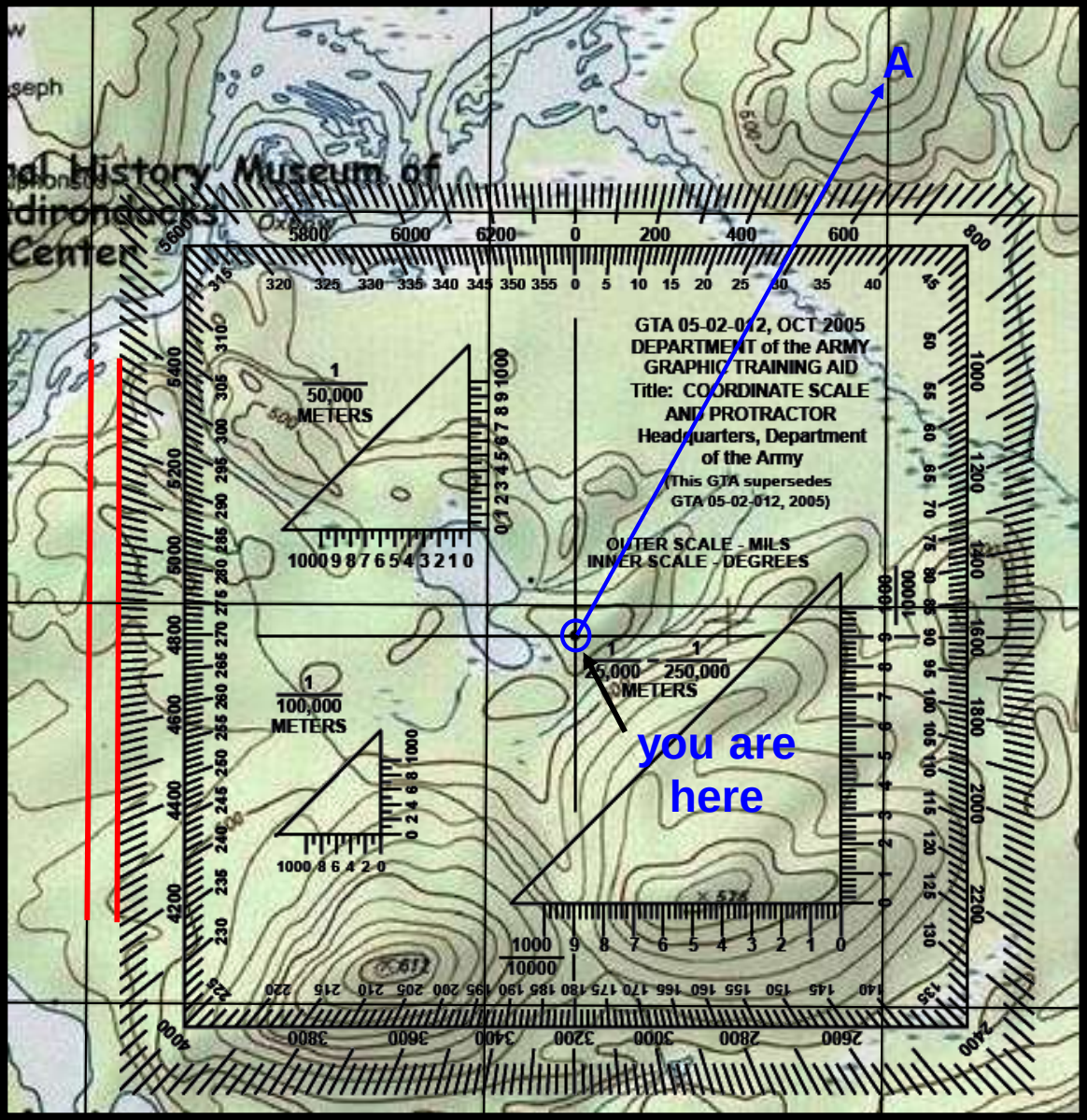
Map Information – Direction

PROTRACTOR (with a protractor the map does NOT have to be oriented)

From **map** to **ground**.

1. You are in thick woods and cannot see any landmarks. But you decide to go to a hill (**A**) on the map.
2. With protractor aligned with GRID LINES drawn on the map and the center of the protractor aligned on your map position (**you are here**).
3. You see that the azimuth is **29°** or **520** MILS. *Next page for closer view*
4. Convert this to MN azimuth and put this on your compass.

NOTE
If you have MN LINES drawn on the map, align the protractor to a MN LINE, get the MN azimuth and you DON'T have to do MN conversions. *(See PART 2 Intermediate Land Navigation)*



Map Information – Direction

PROTRACTOR (with a protractor the map does NOT have to be oriented)

From **map** to **ground**.

1. You are in thick woods and cannot see any landmarks. But you decide to go to a hill (**A**) on the map.
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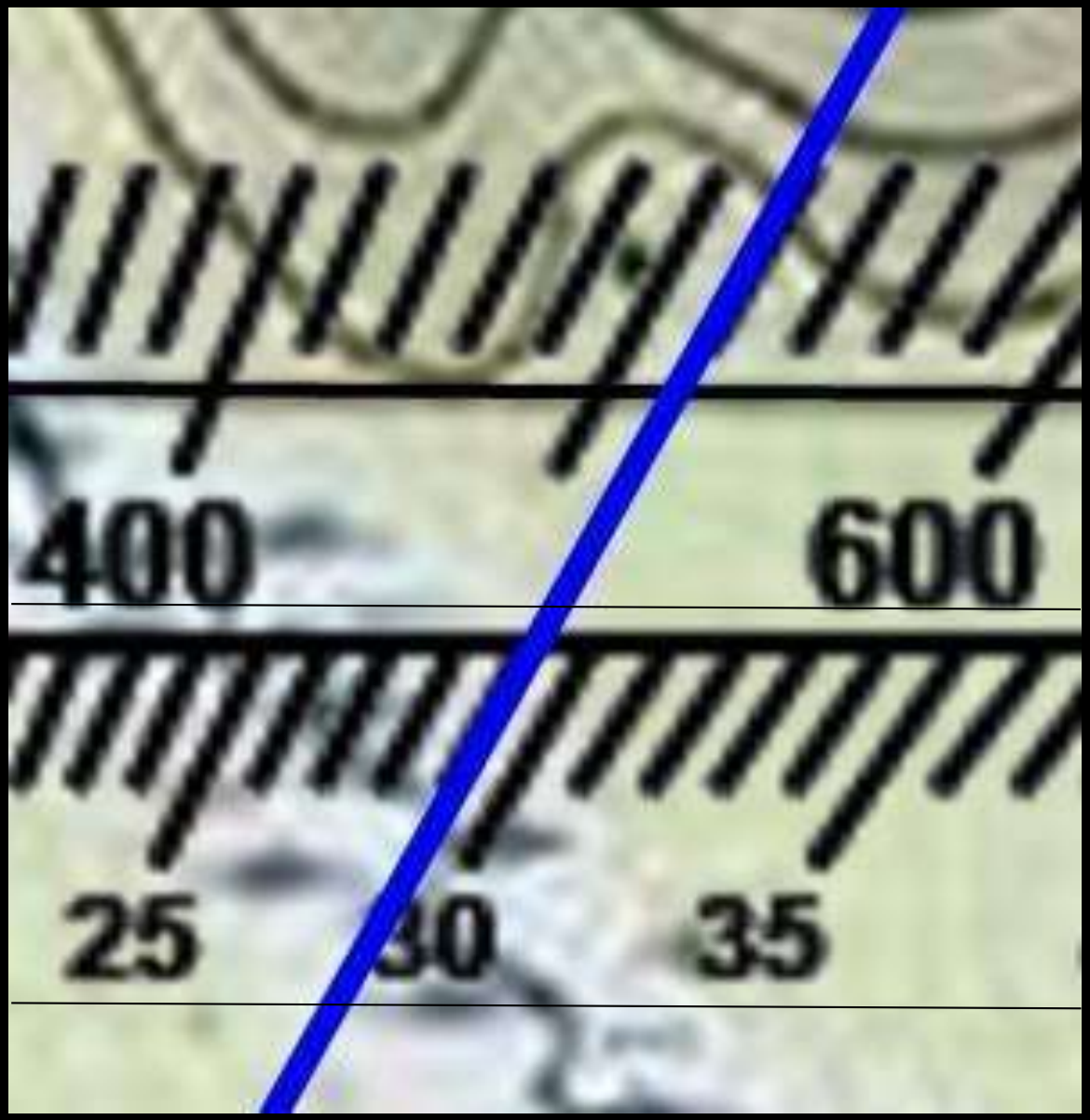
3. You see that the azimuth is **29°** or **520** MILS. *See previous page*
4. Convert this to MN azimuth and put this on your compass.

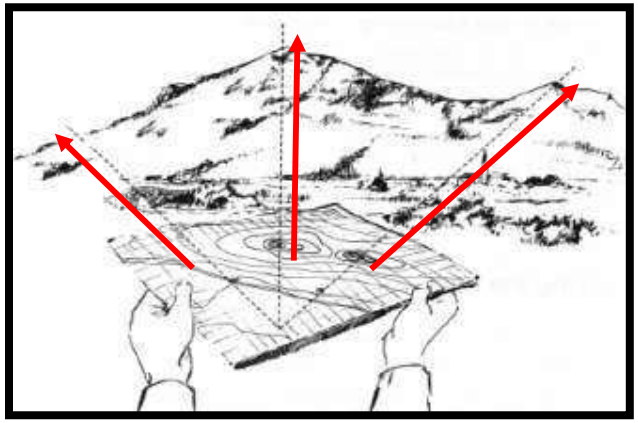
NOTE
If you have MN LINES drawn on the map, align the protractor to a MN LINE, get the MN azimuth and you DON'T have to do MN conversions. *(See PART 2 Intermediate Land Navigation)*



Any Questions?

Map Information - Direction

Orienting the Map with the Landscape (MN and True North)



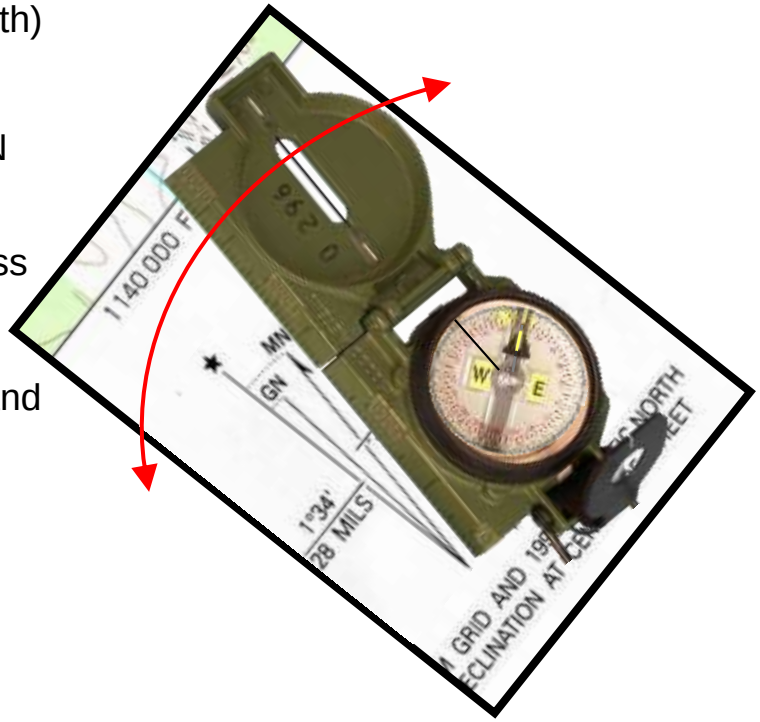
TECHNIQUE # 1 (True North)

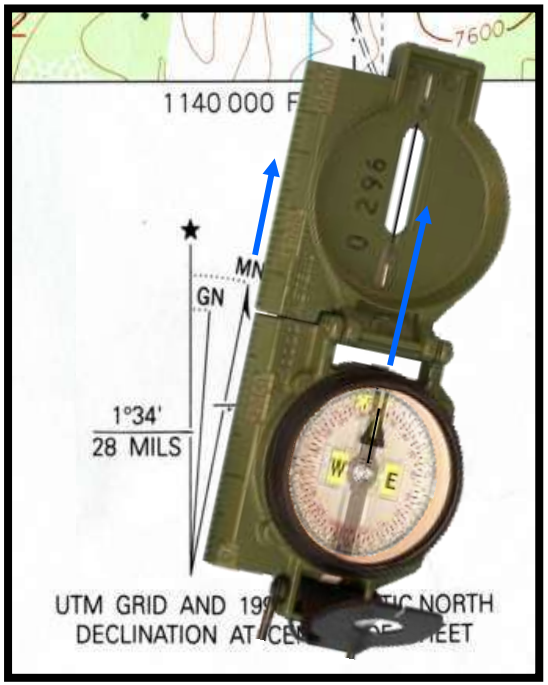
1. Identify several landmarks on the map and on the terrain.
2. Visually orient the map landmarks with the terrain landmarks.
3. The map is oriented to True North.

TECHNIQUE # 2 (Magnetic North)

With compass & map:

1. Lay the compass on the MN line on the map.
2. **Rotate** the map and compass together until the compass bearing reads 0° degrees Magnetic North (compass and MN line on the map are **aligned** / **parallel**).
3. The map is oriented to MN.





Map Information - Direction

Orienting the Map with the Landscape (True North)

TECHNIQUE # 3

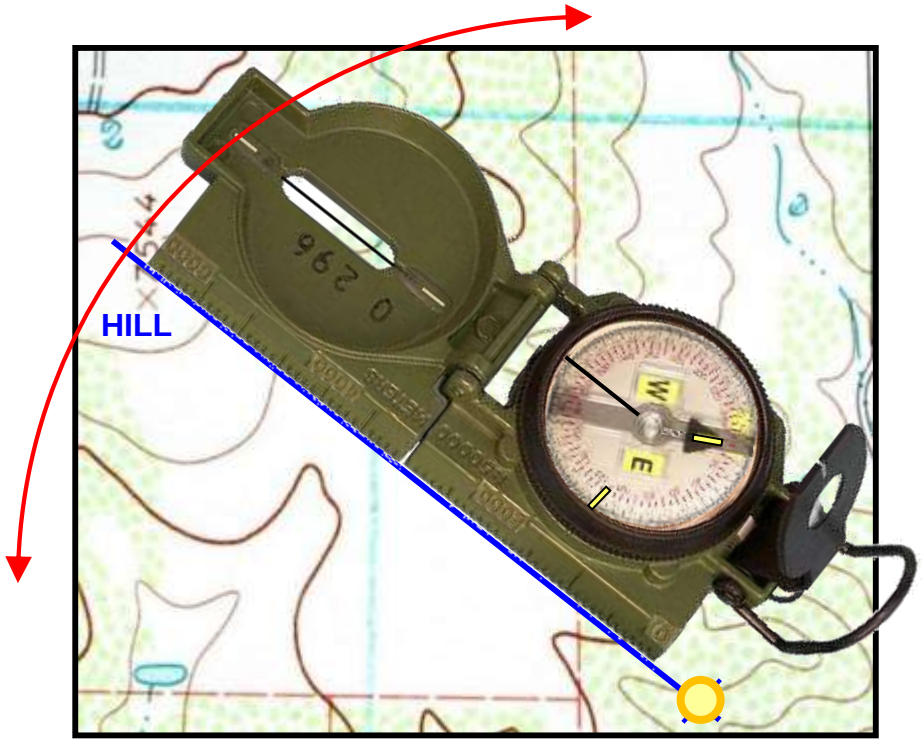
1. Find Magnetic Declination value in the map margin (bottom left corner), example **East 11.5°**.
2. Place compass edge on edge of map North/South line with front of compass facing top of map.
3. **Rotate** map and compass together until **North Arrow** is **11.5° east** of **Black Index Line**.
   Note: **Black Index Line** is aligned with **348.5°**(360° – 11.5° = 348.5°), map is oriented to TRUE NORTH.

Map Information - Direction

Orienting the Map with the Landscape (Magnetic North)

TECHNIQUE # 4 – ***when your position on the map is known***.

1. Select a terrain feature on the ground that you can find on the map, example the **HILL**.
2. With the compass, sight the azimuth to the **HILL(295 °)** from your **position** ( ).
3. Align the compass edge through the **HILL** and your **position** ( ).
4. **Rotate** map and compass together until **295°** is aligned with the **Black Index Line**. Map is oriented MN.



Any Questions?

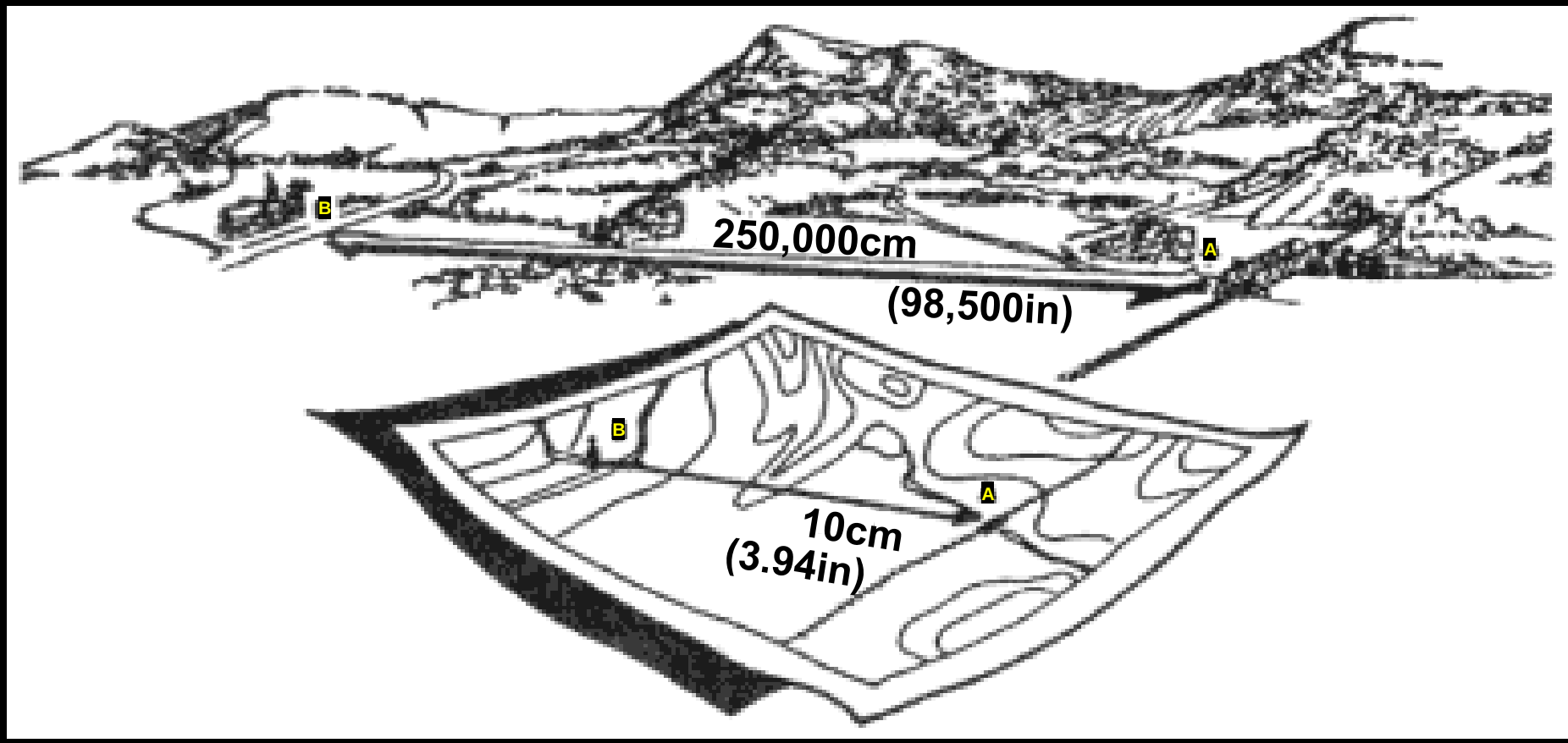
Map Information - Distance

- The relationship between map and ground distance is the function of the bar scale.
- The bar scale looks like a small ruler and usually has 3 to 4 bar scales; feet, miles, meters, and kilometers.
- The ability to determine distance on a map, as well as on the earth's surface, is an important factor in planning and executing safe, practical routes.
- The map scale of 1:xx,xxx means that one unit of measure on the map is equal to xx,xxx units of the same measure on the ground.
  - Example
    - A map scale of 1:25,000 means that one unit of measure on the map is equal to 25,000 units of the same measure on the ground.
      - On map 1 inch = 25,000 inches (2083 feet, 694 yards) on the ground.
      - On map 1 cm = 25,000 cm (250 meters, ¼ kilometer) on the ground.
    - A map scale of 1:100,000 means that one unit of measure on the map is equal to 100,000 units of the same measure on the ground.
      - On map 1 inch = 100,000 inches (8333 feet, 2778 yards, 1¾ miles) on the ground.
      - On map 1 cm = 100,000 cm (1000 meters, 1 kilometer) on the ground.
    - A map scale of 1:500,000 means that one unit of measure on the map is equal to 500,000 units of the same measure on the ground.
      - On map 1 inch = 500,000 inches (41667 feet, 13889 yards, 8 miles) on the ground.
      - On map 1 cm = 500,000 cm (5000 meters, 5 kilometer) on the ground.

Map Information - Distance

- EXAMPLE - a map scale of 1:25,000 means that one unit of measure on the map is equal to 25,000 units of the same measure on the ground.
  - On map 1 inch = 25,000 inches (2083 feet, 694 yards) on the ground.
  - On map 1 cm = 25,000 cm (250 meters, ¼ kilometer) on the ground.
- Example below shows the navigator using centimeters (cm) as a measurement, therefore the map 10cm measurement is equal to 250,000cm on the ground. (3.94 inches map = 98,500 inches ground)

10cm x 25,000 = 250,000cm (2.5 Km) 3.94in x 25,000 = 98,500in (1.55 miles)



Map Information - Position

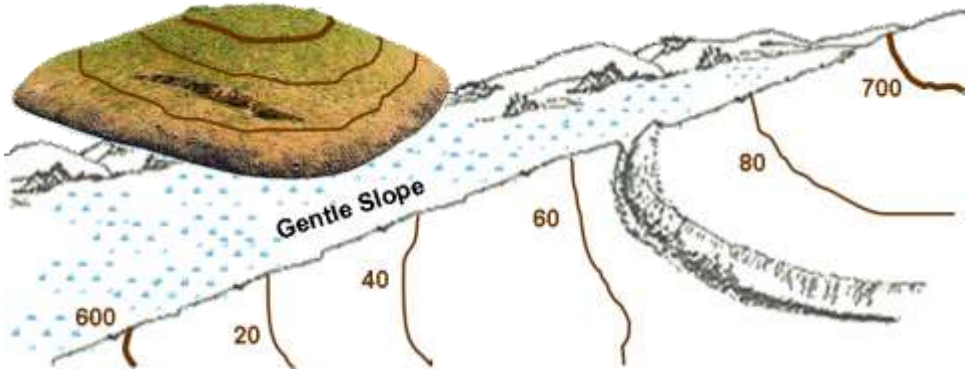
- Finding one's position on a map in the usual sense, such as at the intersection of two compass bearings, is more a matter of compass technique than of map reading skills. . . BUT . . .
- It is possible to locate your **POSITION** on a map without a compass, by land feature and map association.
- It is **IMPOSSIBLE TO BE TOTALLY LOST**. Finding your location is a process of narrowing down the options until you can determine a point on a map.
  - By determining the lay of the land and finding prominent features, then relating them to your map, the narrowing-down process will not take long.
  - Landmarks can be anything that you recognize as being on the map. Classically these are hill tops, but you can use the intersection of two roads, a building such as a power grid sub-station, the abrupt edge of a ridge, the edge of an island, the bend in a trail, anything that you can recognize as being on the map and that you can see.
- There is a second dimension to establishing position which does depend on map reading skills. This is the vertical dimension. On a map it is referred to as "relief".
  - Knowledge of the relief of an area is extremely important to a wilderness navigator.
  - The most graphic technique ever devised to show relief information is the contour line.
  - If you were to walk a contour line you would never go down hill and never up hill, and eventually you would arrive back where you started.
- **Navigation is not about finding yourself after you are lost (although that's what happens sometimes); navigation is about keeping track of your POSITION as you move away from a known point. As you move you have to remain cognizant of the terrain you are leaving, of the terrain you are passing, and of the terrain that is coming up.**

Map Information - Identification

- The identification of significant features, both natural and man-made, is partly a matter of knowing the language of maps.
  - One category of map language is lines. In addition to showing contour relief, lines are used to portray roads, trails, railroads, power lines, and drainage features.
  - Another category of map language is composed of various picture symbols.
  - A third part of map language is color.

- If part of identification is in knowing the language of maps, the rest is a problem of interpretation. What is the relationship among certain lines, symbols, and colors?

- Reading contour lines is literally reading between the lines. ***Contour lines represent the shape of the terrain only at specified intervals***. The user must be aware that what lies between may be quite different. There could be rugged terrain, vertical bluffs, or deep ravines that might not be shown.



- A river may be drawn some what straight on a map, but the terrains actual river meanders, with many curves, turns, and with wide and narrow banks.

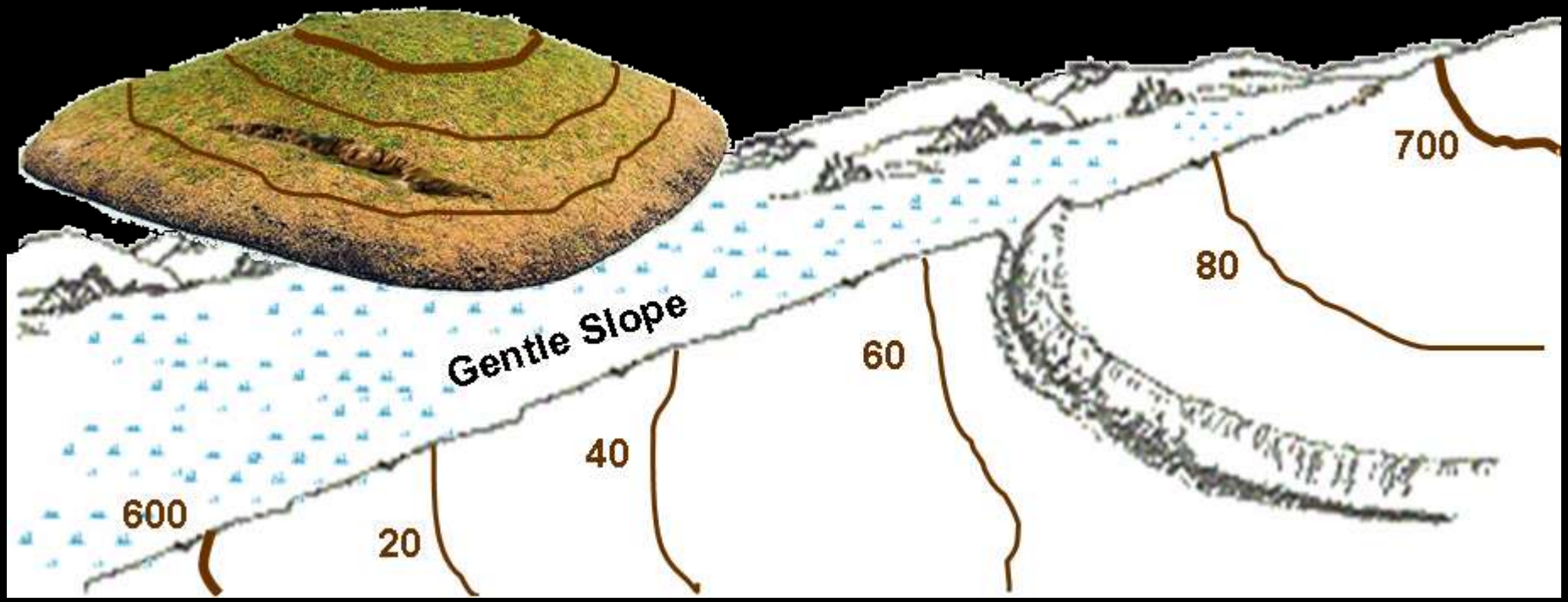
- What a topographic map shows is as accurate as possible, BUT can give you a false sense of what you might mentally think what is ahead of you and what actually is shown on an aerial photo map and actual land features. (see next slides)

Map Information - Identification

CONTOUR LINES

Contour Lines on a map
Do not show everything.

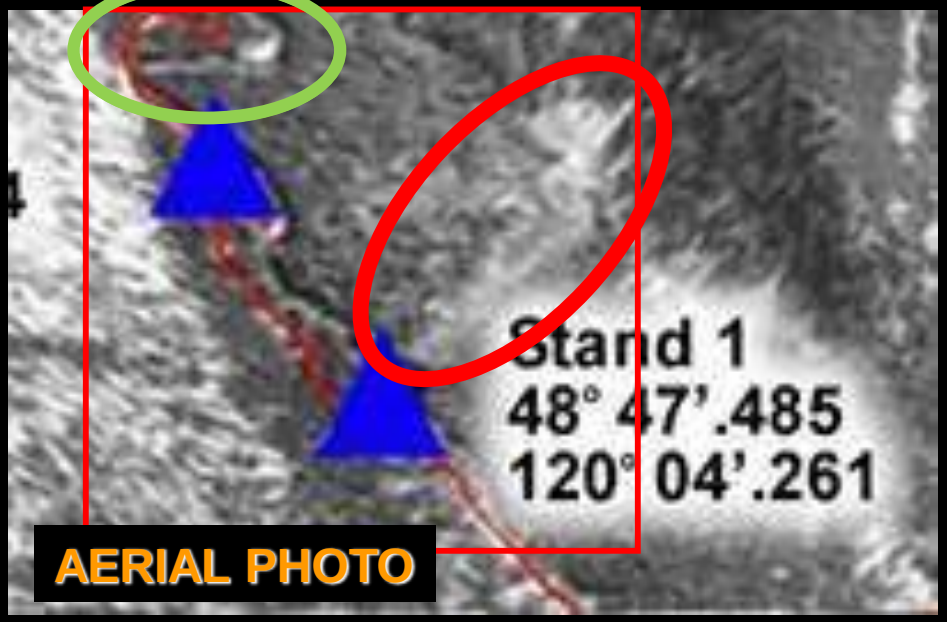
Scan the Landscape,
read between the lines.

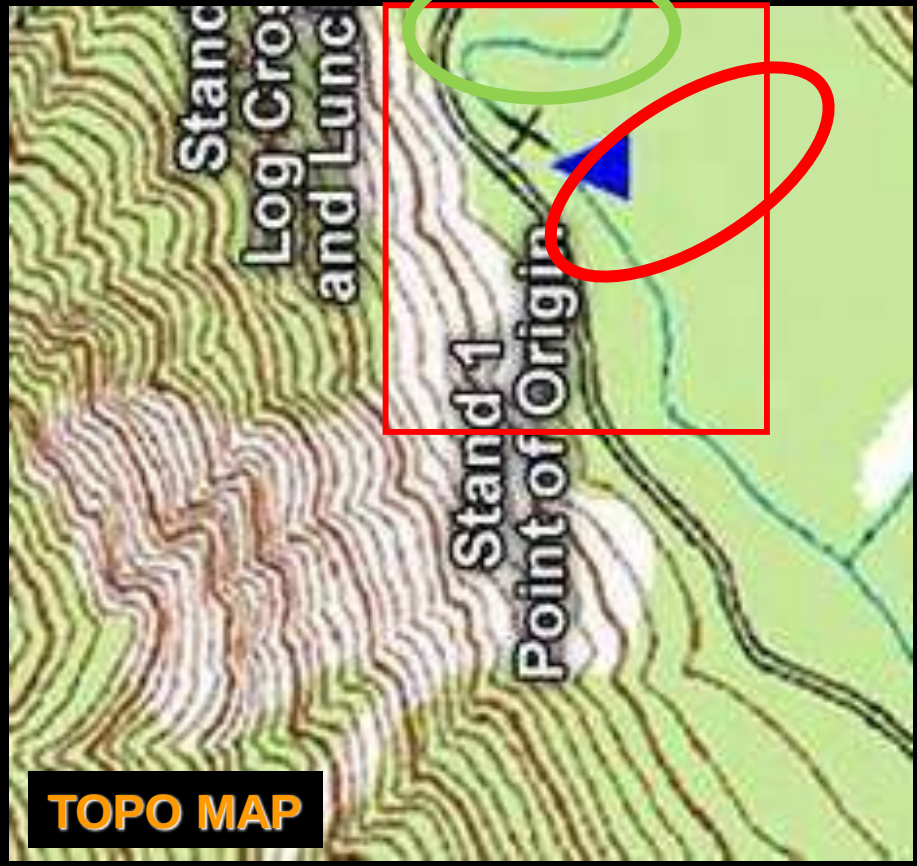


Any Questions?

Map Information – Identification

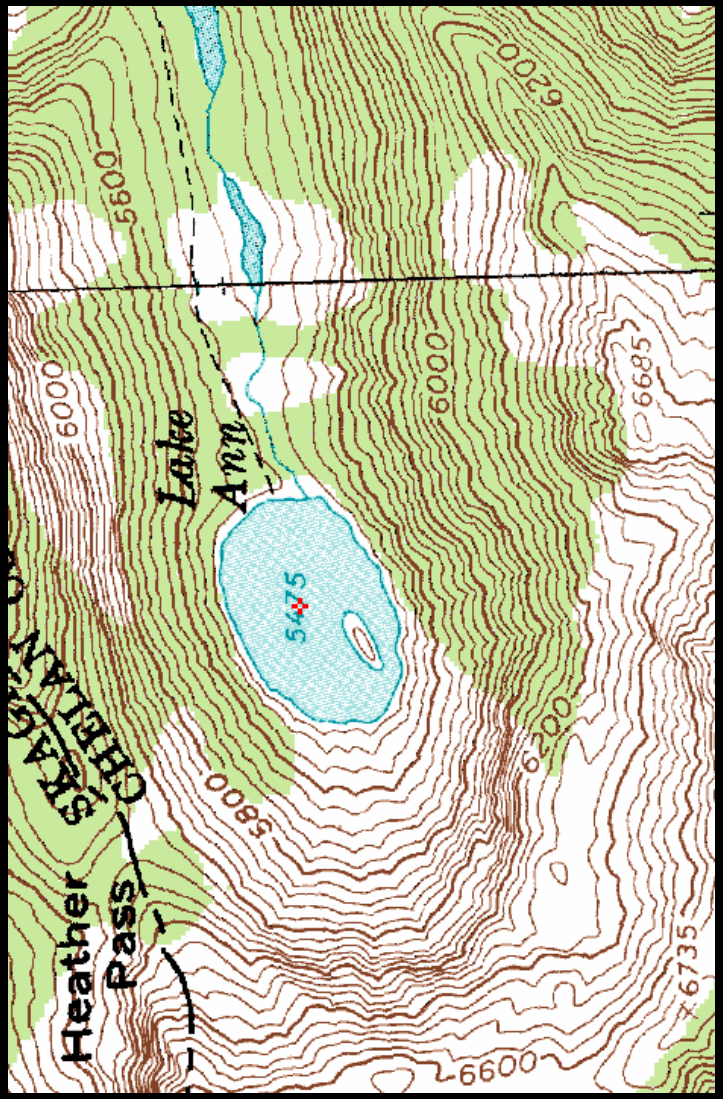
What a Topo map,
Aerophoto map,
And actual Land features show





Map Information – Identification

What a Topo map
and actual Land features show



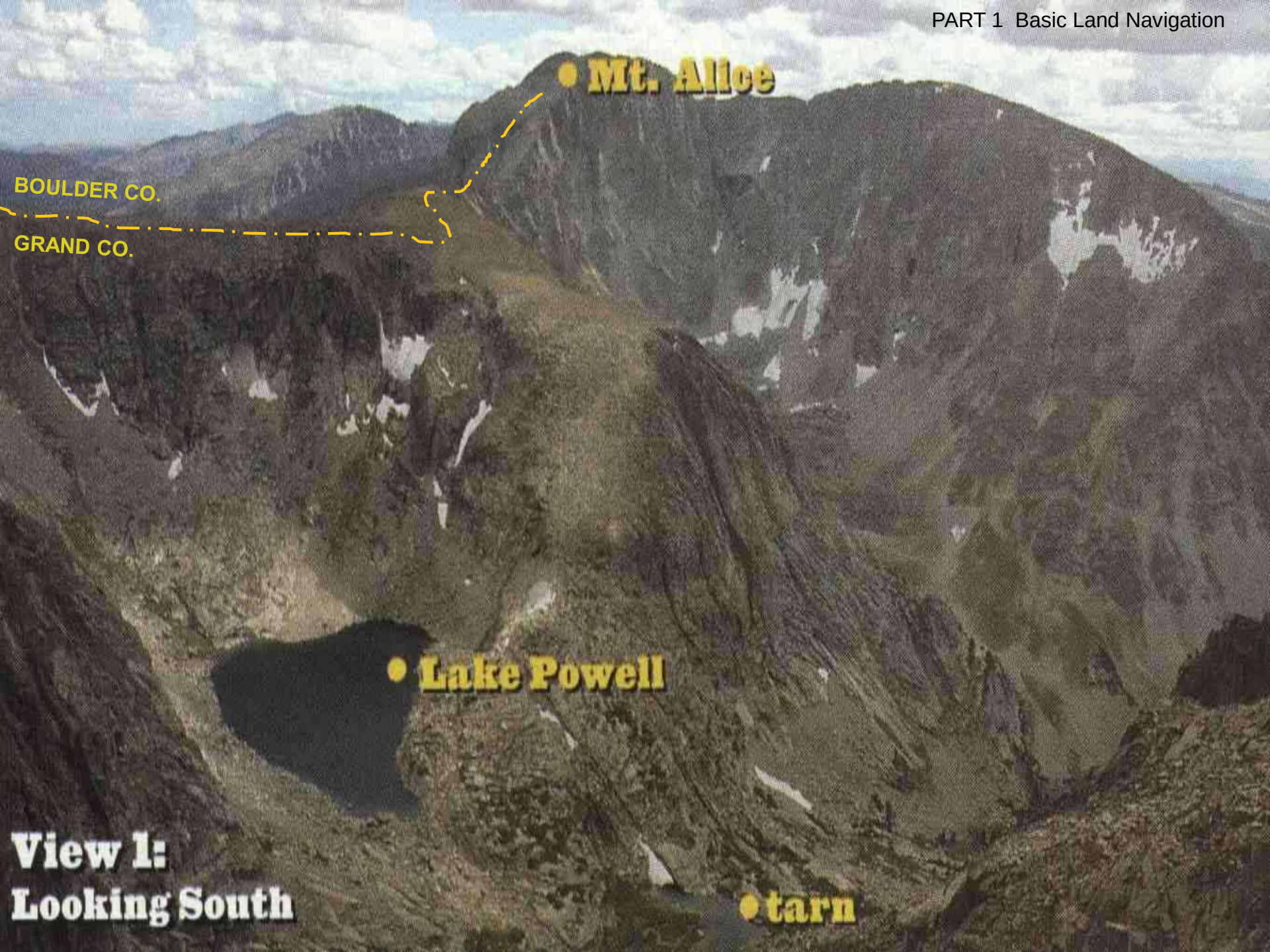
Map Information – Identification

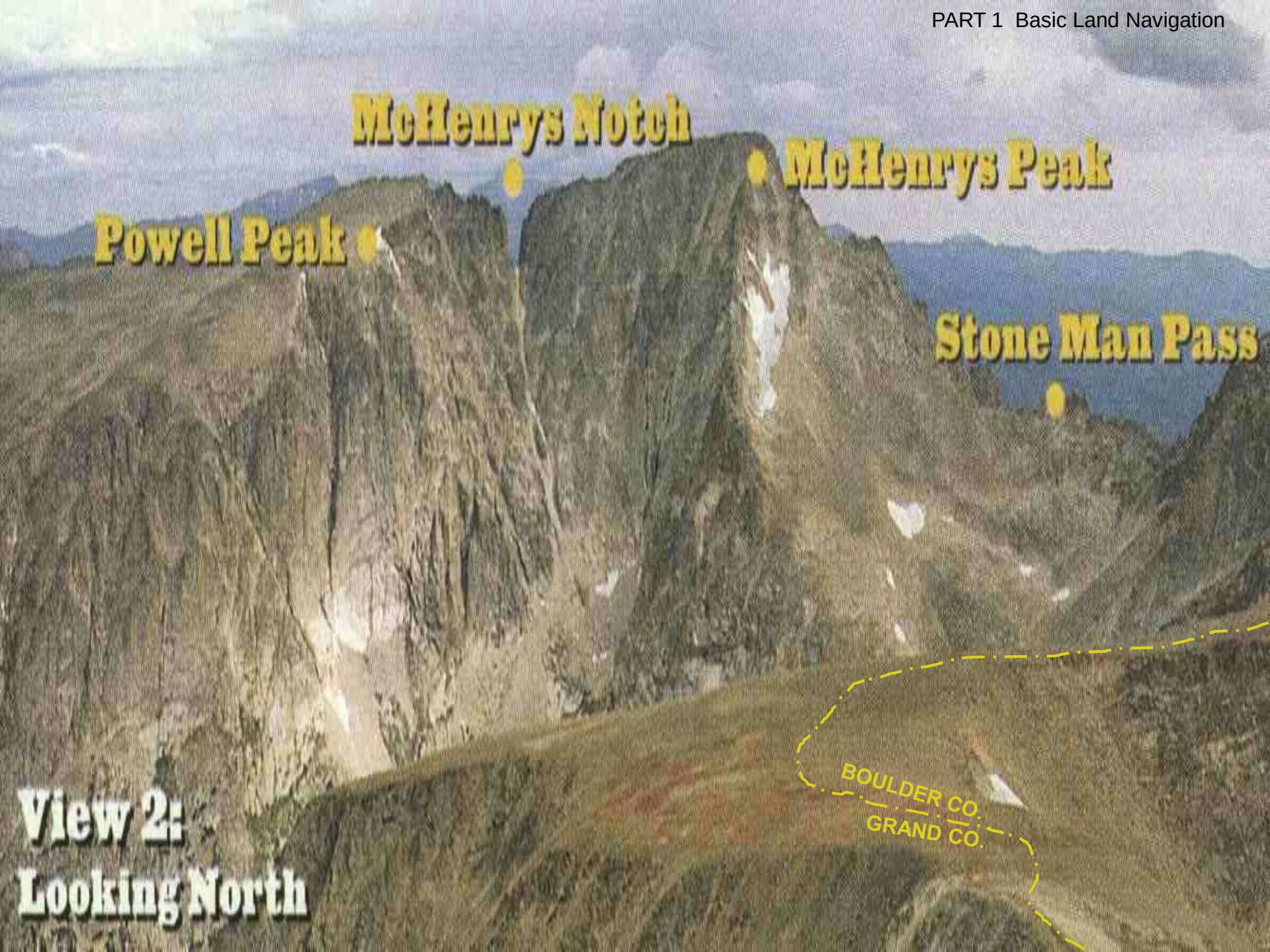
What a Topo map
and actual Land features show

Map Information – Identification

What a Topo map
and actual Land features show

Compare the next five slides with this map, to get view point perspective of what you see on this map and what you see on the landscape in front of you.


Mt. Alice
BOULDER CO.
GRAND CO.
Lake Powell
tarn
View 1:
Looking South

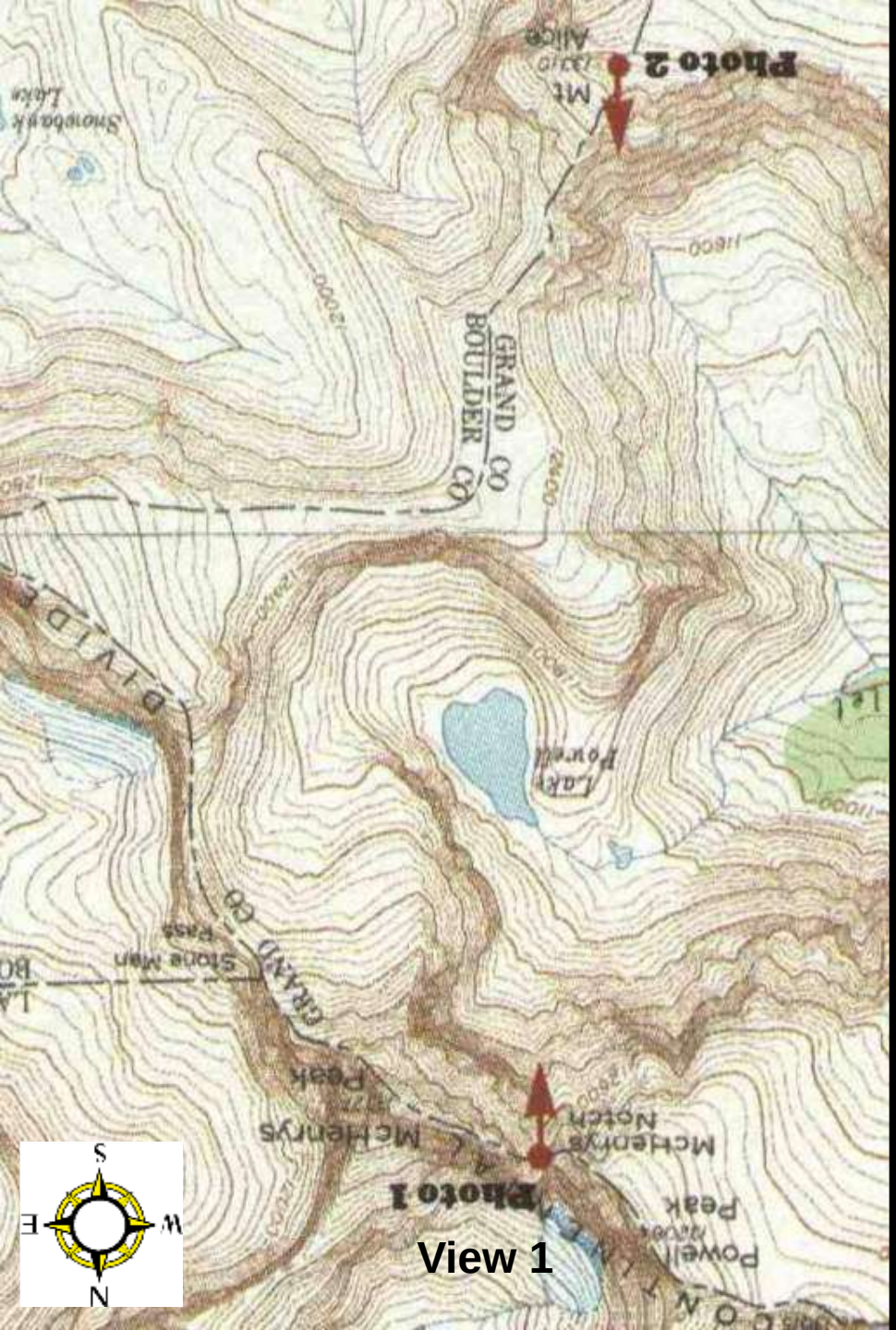

McHenrys Notch
McHenrys Peak
Powell Peak
Stone Man Pass
BOULDER CO.
GRAND CO.
View 2:
Looking North

Map Information – Identification

What a Topo map
and actual Land features show

Note: here the map is turned upside down so you can get a better perspective

View 1

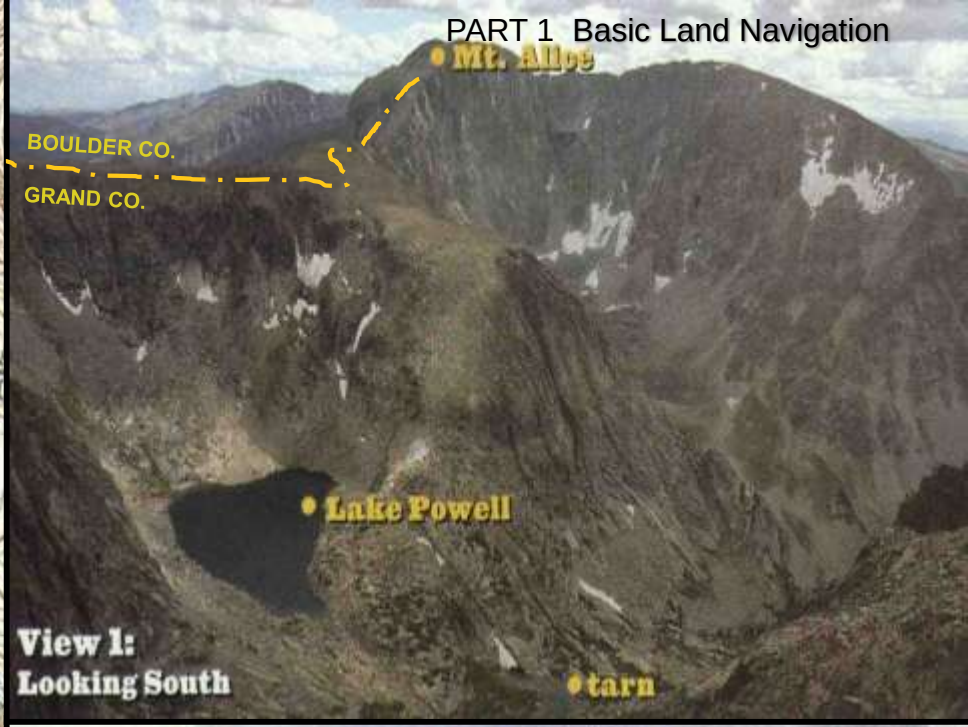


Map Information – Identification

What a Topo map
and actual Land features show

View 2

View 1
Photo 1
View 2
Photo 2
N
W
E
S
Powell Peak
McHenrys Notch
McHenrys Peak
Stone Man Pass
GRAND CO
BOULDER CO
Lake Powell
DIVIDE
Mt Alice
Snowbank Lake


Mt. Alice
BOULDER CO.
GRAND CO.
Lake Powell
tarn
View 1:
Looking South

McHenrys Notch
McHenrys Peak
Powell Peak
Stone Man Pass
BOULDER CO.
GRAND CO.
View 2:
Looking North

Any Questions?

Map Folding and Map Care

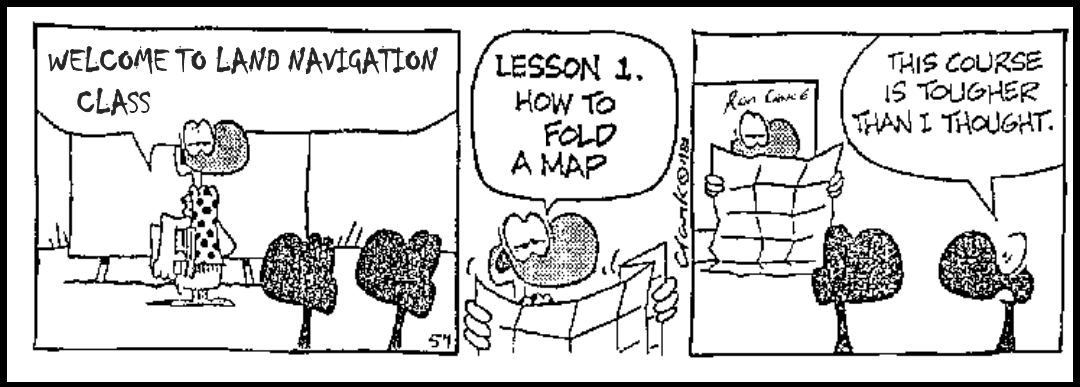
- Maps should be correctly folded.
  - Maps should be folded to make them small enough to be carried and still be available for use without having to unfold them entirely.
  - After a map has been folded it should be placed in a folder for protection. This will prevent the corners and edges of the map from wearing out and tearing easily when opened.

- It is hard to navigate accurately with a dirty, grimy, wet or damaged map. Take care of your map and it will take care of you.
  - Most maps are printed on paper and require protection from water, mud, weather, and tearing.
  - Whenever possible, a map should be carried in a waterproof packet to prolong its life.
  - Waterproofing maps.

All members of the group should know the map's location at all times.

- Marking a map.
  - If it is necessary to mark a map, use light lines so that they may be erased without smearing or smudging. If the margins of the map must be trimmed note any marginal information which may be needed, such as grid data or magnetic declination data, on the back of the map.

- Special care should be taken of a map that is being used in any situation, especially in a small group; the mission may depend on that map.



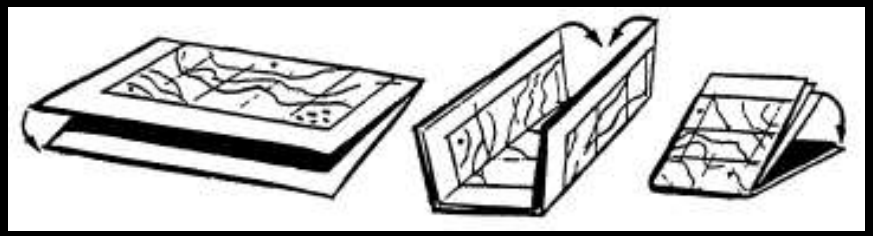
Map Folding

Technique # 3

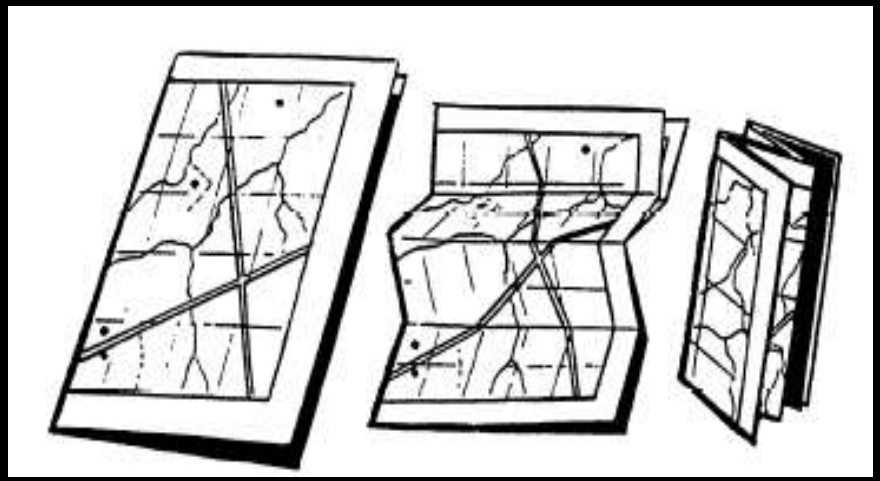
After a map has been folded, it should be pasted in a folder for protection. Apply adhesive to the back of the segments corresponding to A, F, L, and Q

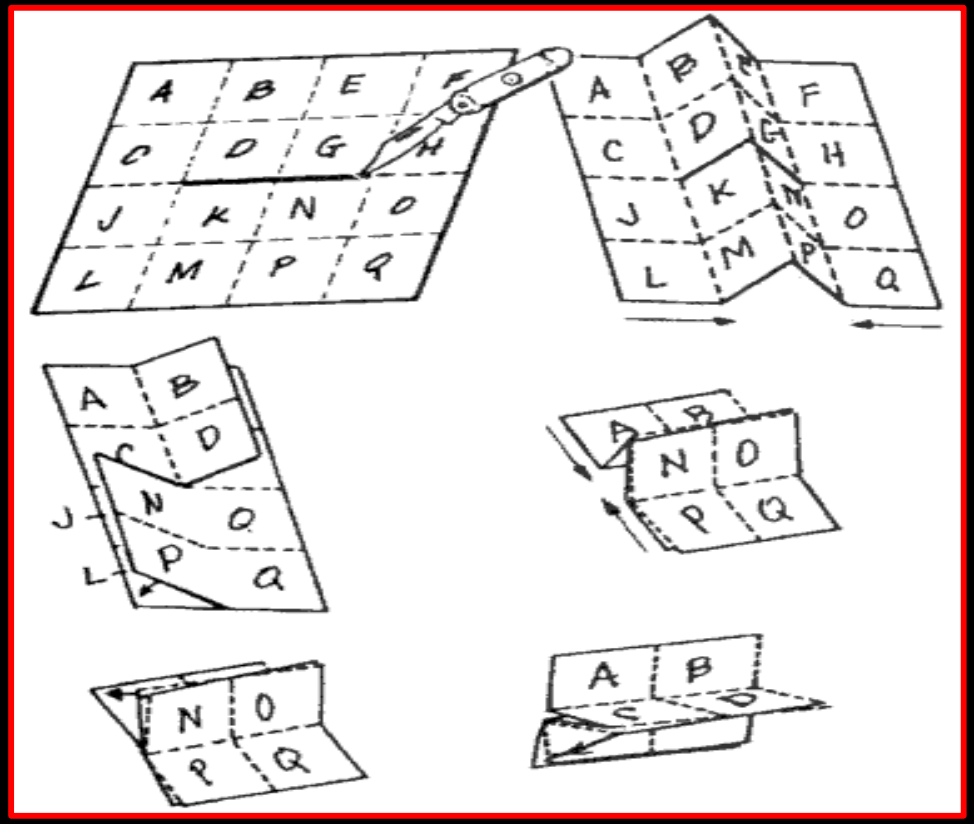
NOTE: It is suggested that before attempting to cut and fold a map in the manner illustrated below (Technique #3), make a practice cut and fold with a piece of paper.

Technique # 1



Technique # 2





Any Questions?

Note:

Prior to being issued any training *equipment, you will be required to sign a "statement of liability" agreeing to pay for anything you damage or lose.

All items will be inspected and inventoried prior to your signature and at the end of the training day too.

If you do not intend to sign this statement, then you may be denied training.

* **You may use your own equipment.**

TESTING

Now it is time for the following . . .

- Written exam
- Hands-on / Outdoors exam

THE END OF
LAND NAVIGATION
PRESENTATION
PART 1