Cold Weather and Mountain Land Navigation Techniques

Cold Weather and Mountain Land Navigation Techniques Terminal Learning Objective

Action: Navigate from one point on the ground to another in snow covered and/or mountainous terrain while dismounted

Condition: In a field environment, given a map, compass, protractor and altimeter

Standard: Soldier scored a 70% or better on the land navigation written practical exercise (BMC and CWLC). Soldier found 3 of 4 points within five hours (BMC) on the land navigation course.

Outline

- Module 1:
  - Maps and Properties of Maps
  - Map Sheet Marginal Information
  - Universal Transverse Mercator (UTM) and Military Grid Reference System (MGRS)
  - Determining Grid Coordinates on a Map

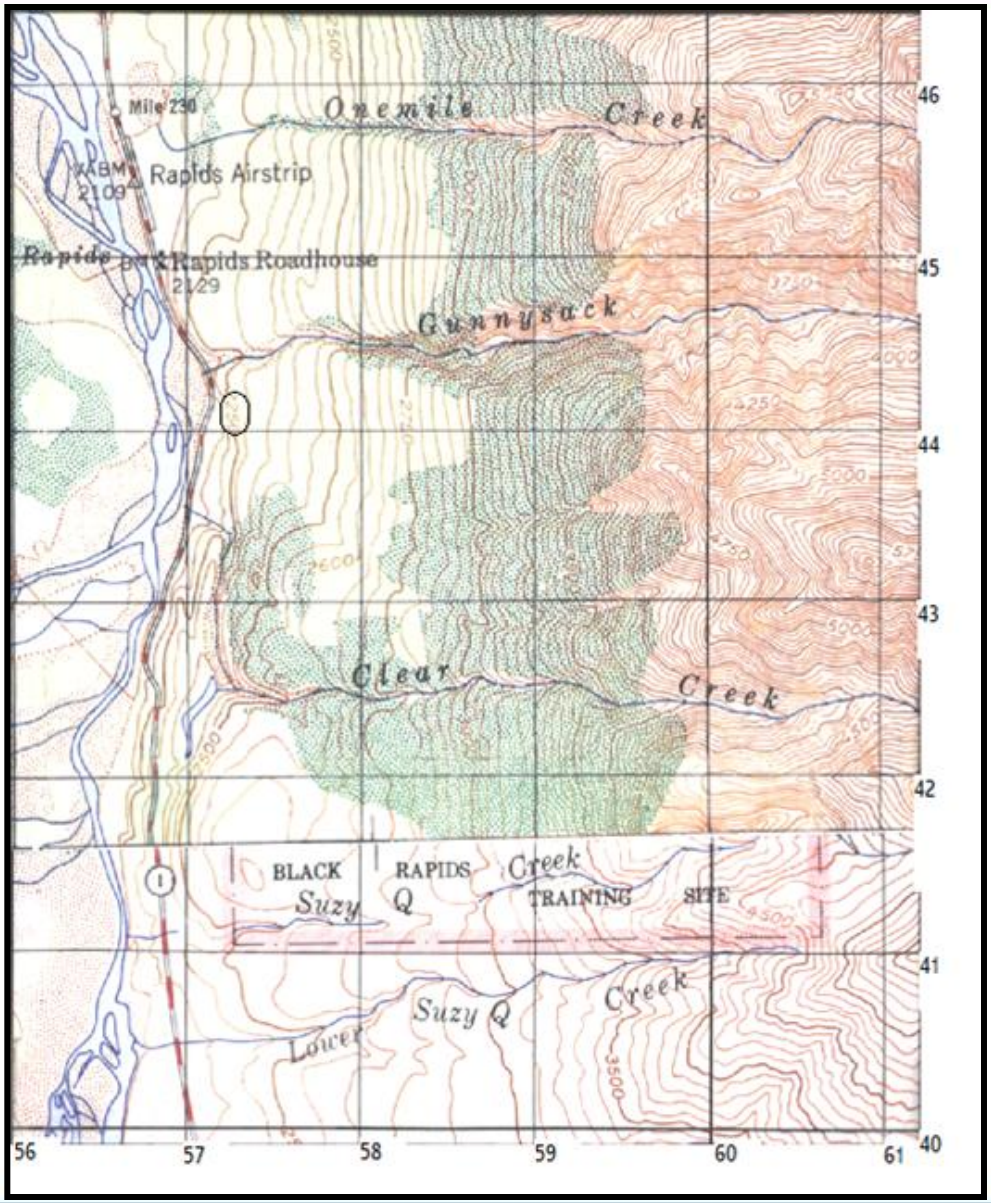
- Module 2:
  - Elevation and Relief
  - Terrain Features
  - Map Distance and Graphic Scale
  - Azimuth and Direction

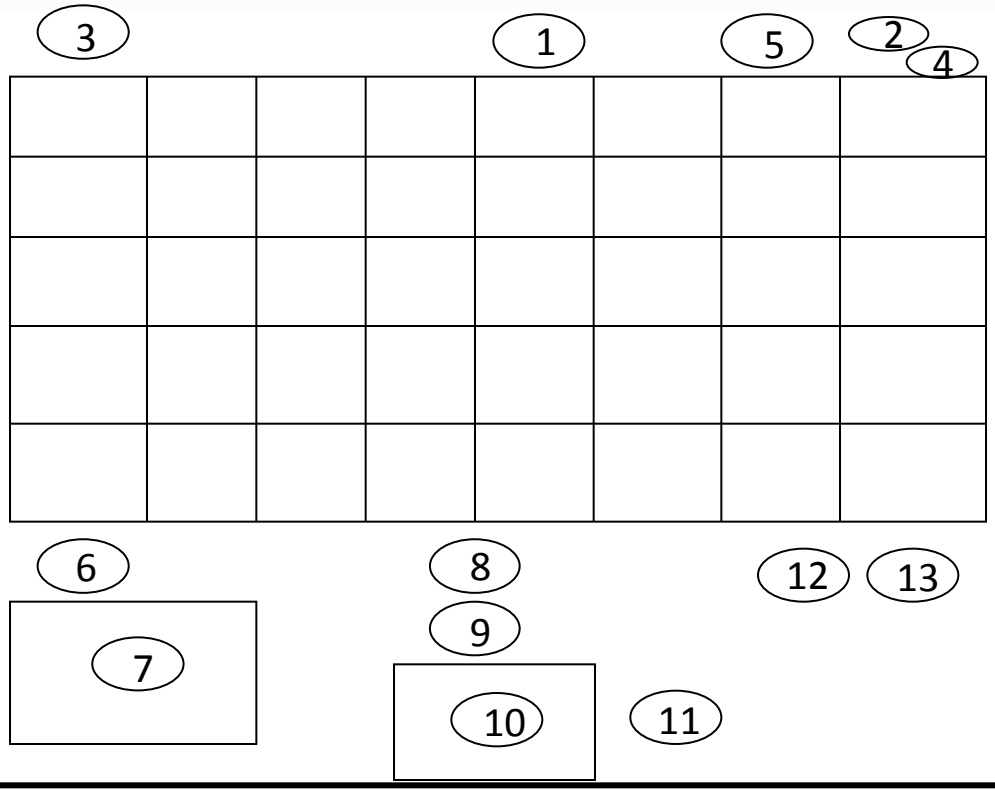
- Module 3:
  - Polar Coordinates
  - Intersection
  - Resection
  - Orient a Map
  - Use of Altimeter as an aid to navigation

Module 1

1. Maps and Properties of Maps
2. Map Sheet Marginal Information
3. Universal Transverse Mercator (UTM) and Military Grid Reference System (MGRS)
4. Determining Grid Coordinates on a Map

Properties of Maps





Marginal Information

1. Sheet Name
2. Sheet Number
3. Series Name and scale
4. Series Number
5. Edition
6. Credit Note
7. Legend
8. Bar Scales
9. Contour Interval
10. Grid Reference Box
11. Declination Diagram
12. Elevation Guide
13. Adjoining Sheets Diagram

The Five Basic Colors Used On A Map Sheet

Blue: water, streams, glaciers, lakes

Red: major/main roads and built up areas such as cities

Black: features which are man-made (to include some roads)

Green: vegetation

Brown: elevation and relief (contour lines and spot elevations)

Red Brown may also be used to indicate cultural features, all relief features, non-surveyed spot elevations and elevation such as contour lines on red-light readable maps.

Topographic Symbols
Man Made Objects

(RED/BROWN)

HEAVY DUTY

HARD SURFACE

(RED/BROWN)

MEDIUM DUTY

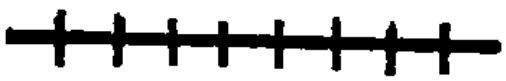
IMPROVED ROAD

UNIMPROVED ROAD

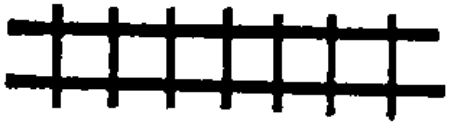
Topographic Symbols
Man Made Objects

TRAIL

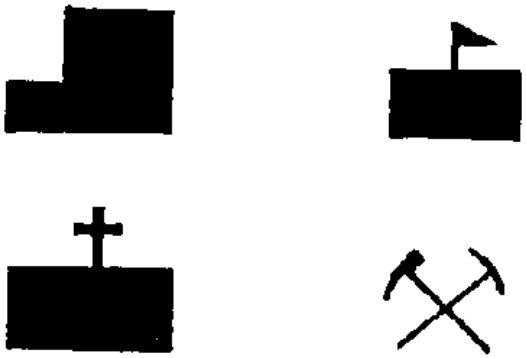
PROMINENT FENCE

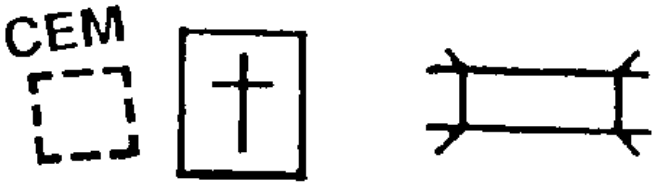


SINGLE TRACK RR



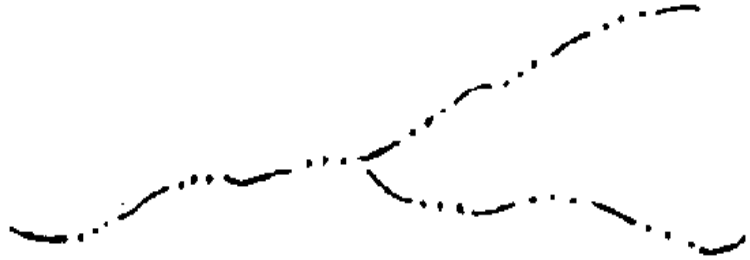
DOUBLE TRACK RR





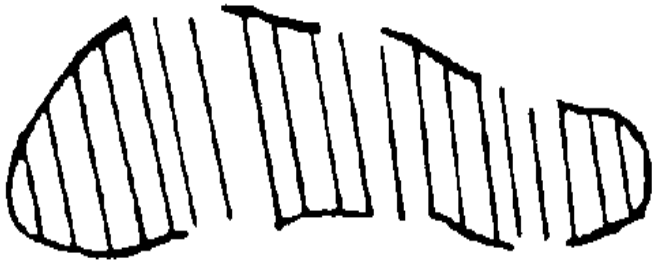
Topographic Symbols
Drainage and Vegetation

STREAM



INTERMITTENT STREAM

LAKE OR POND



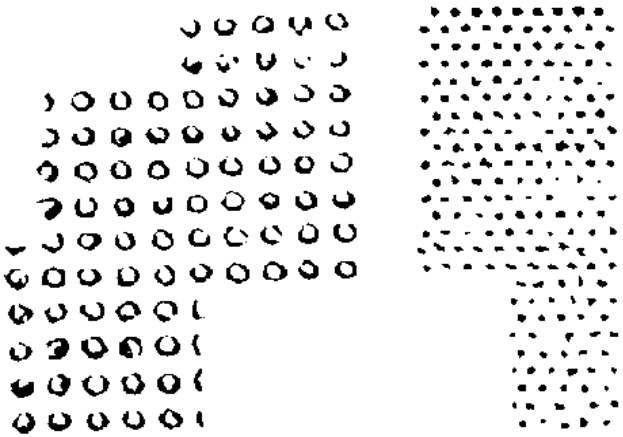
INTERMITTENT LAKE OR POND

Topographic Symbols
Drainage and Vegetation

MARSH OR SWAMP

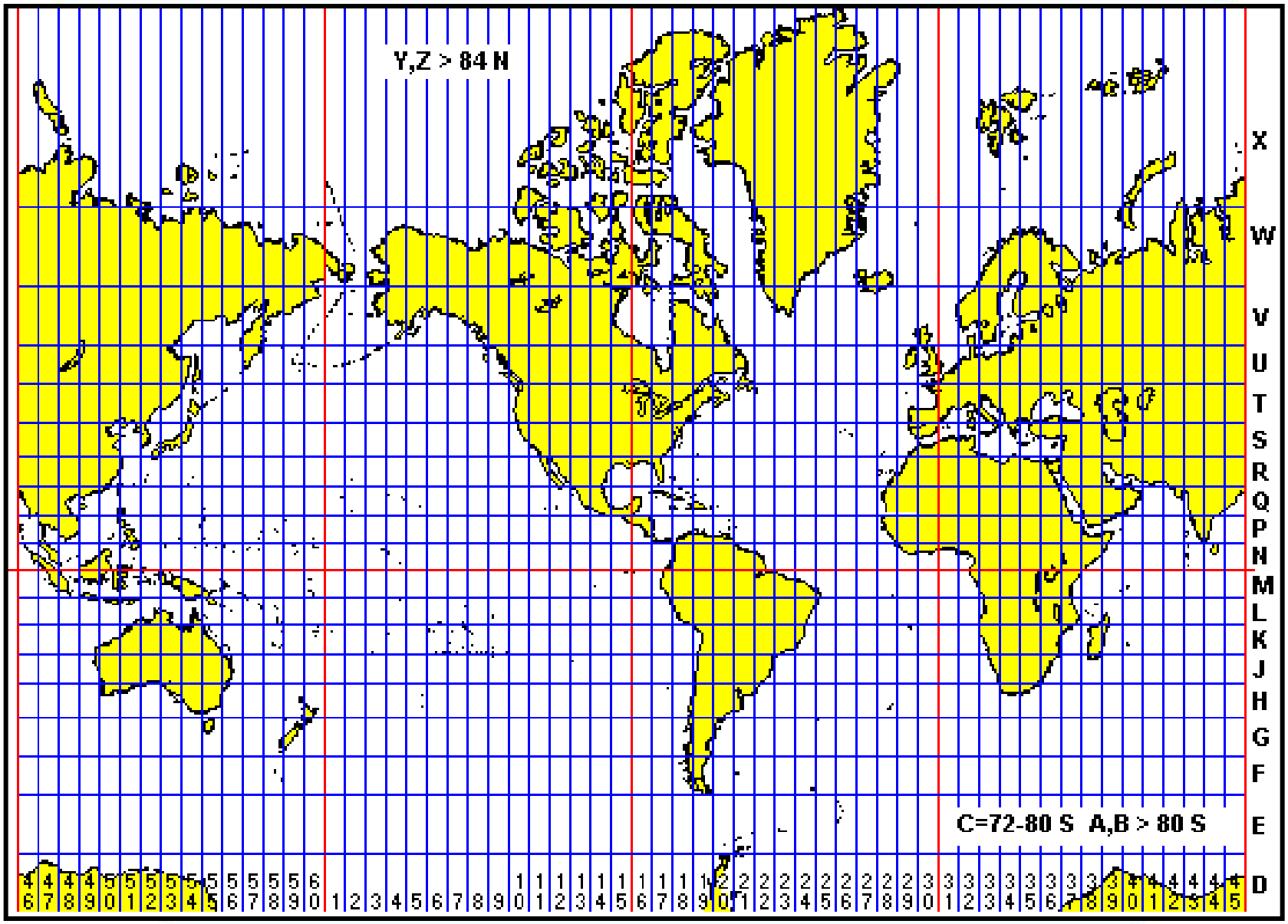
TROPICAL GRASS

WOODS

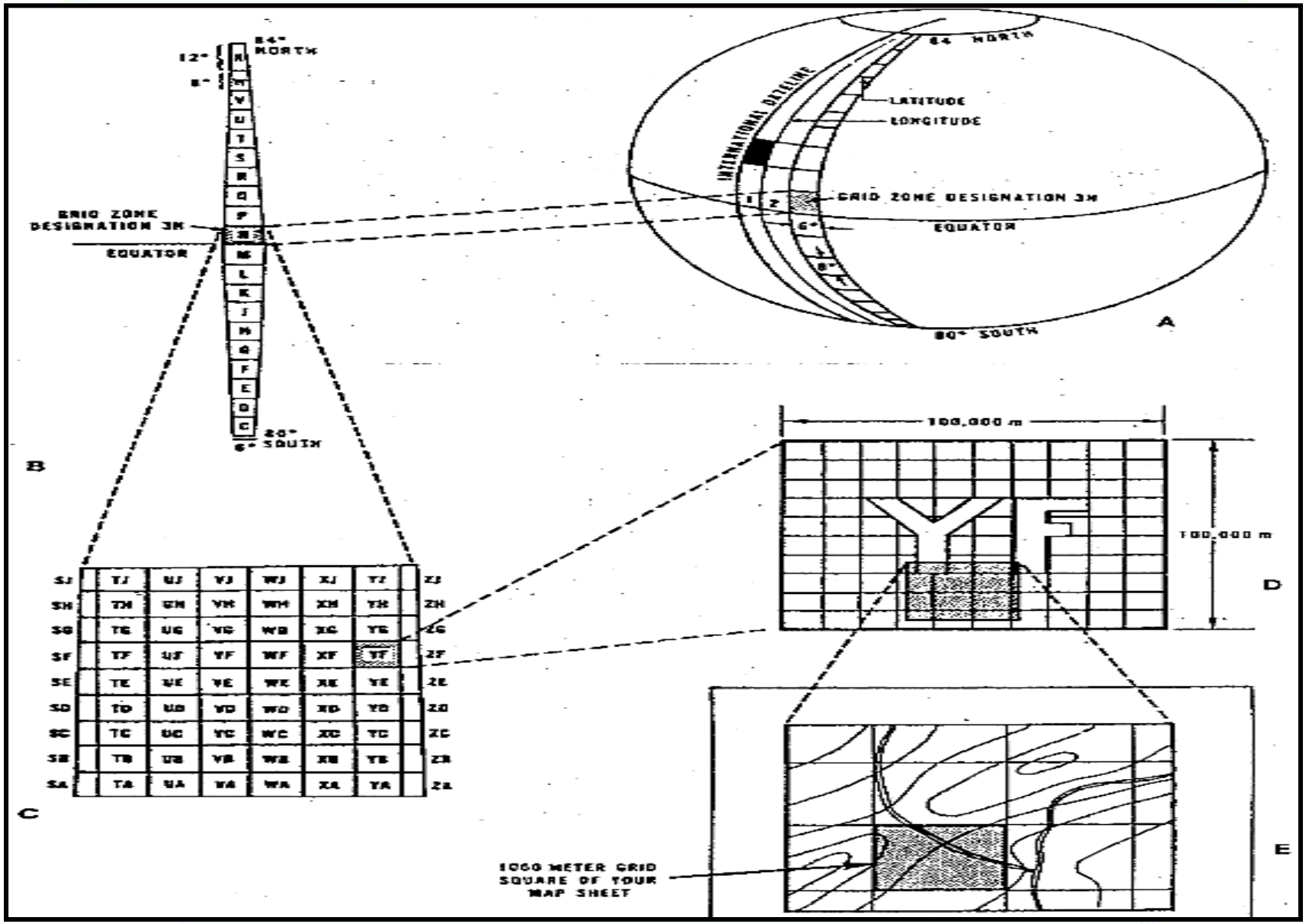


VINEYARD/ORCHARD

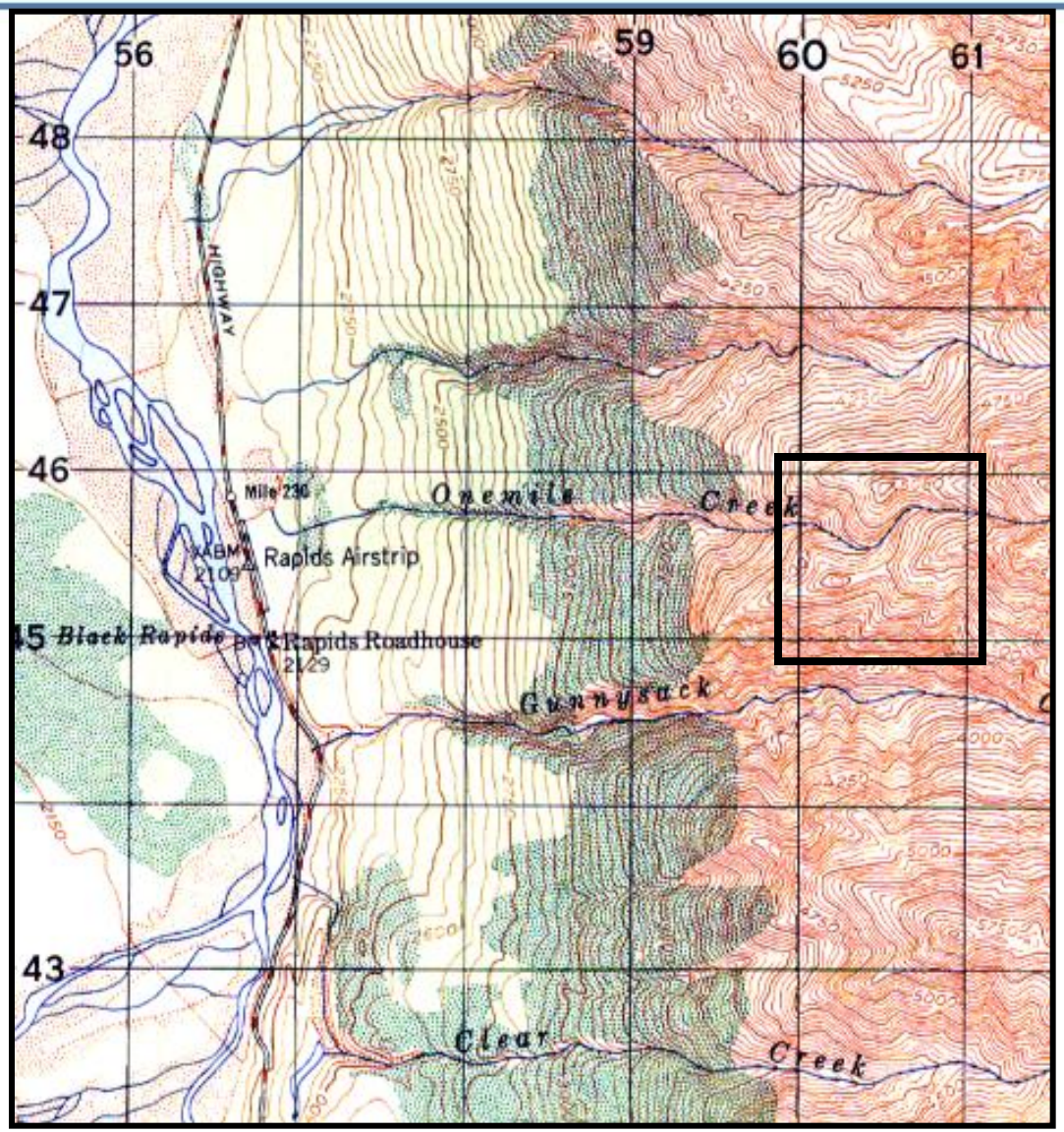
Universal Transverse Mercator (UTM)



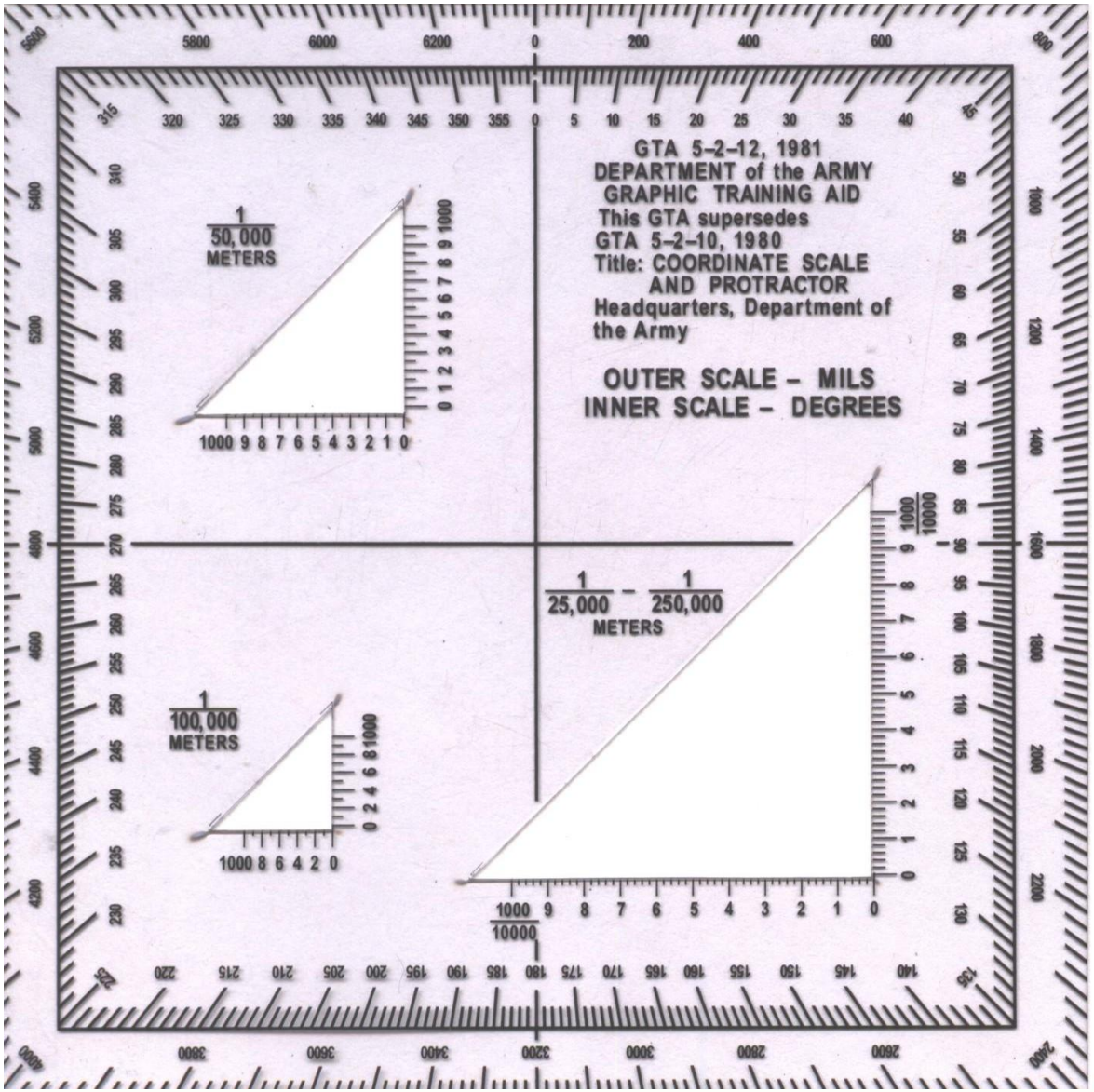
Universal Transverse Mercator (UTM)

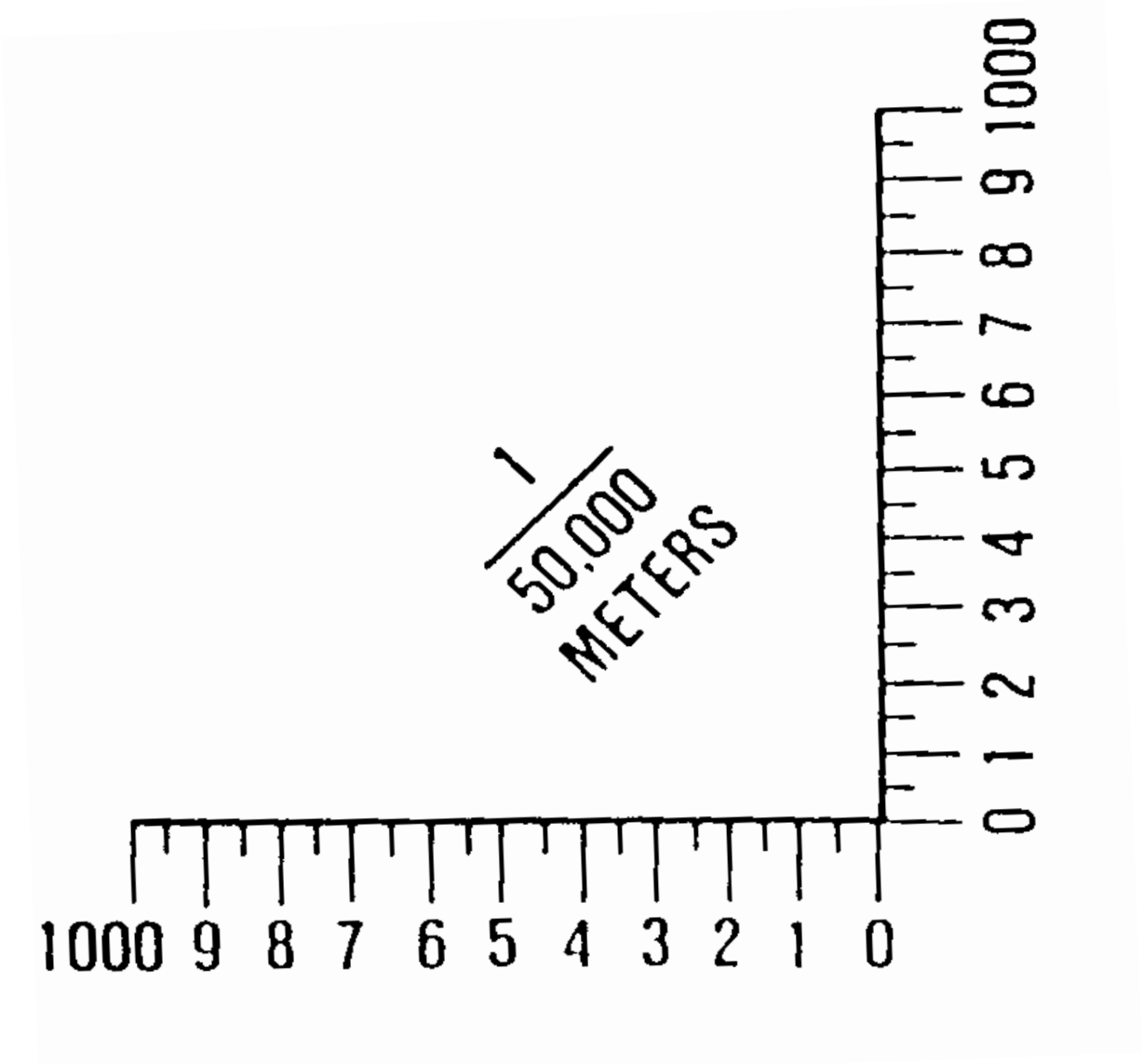


Determine a grid coordinate to within 1000 meters

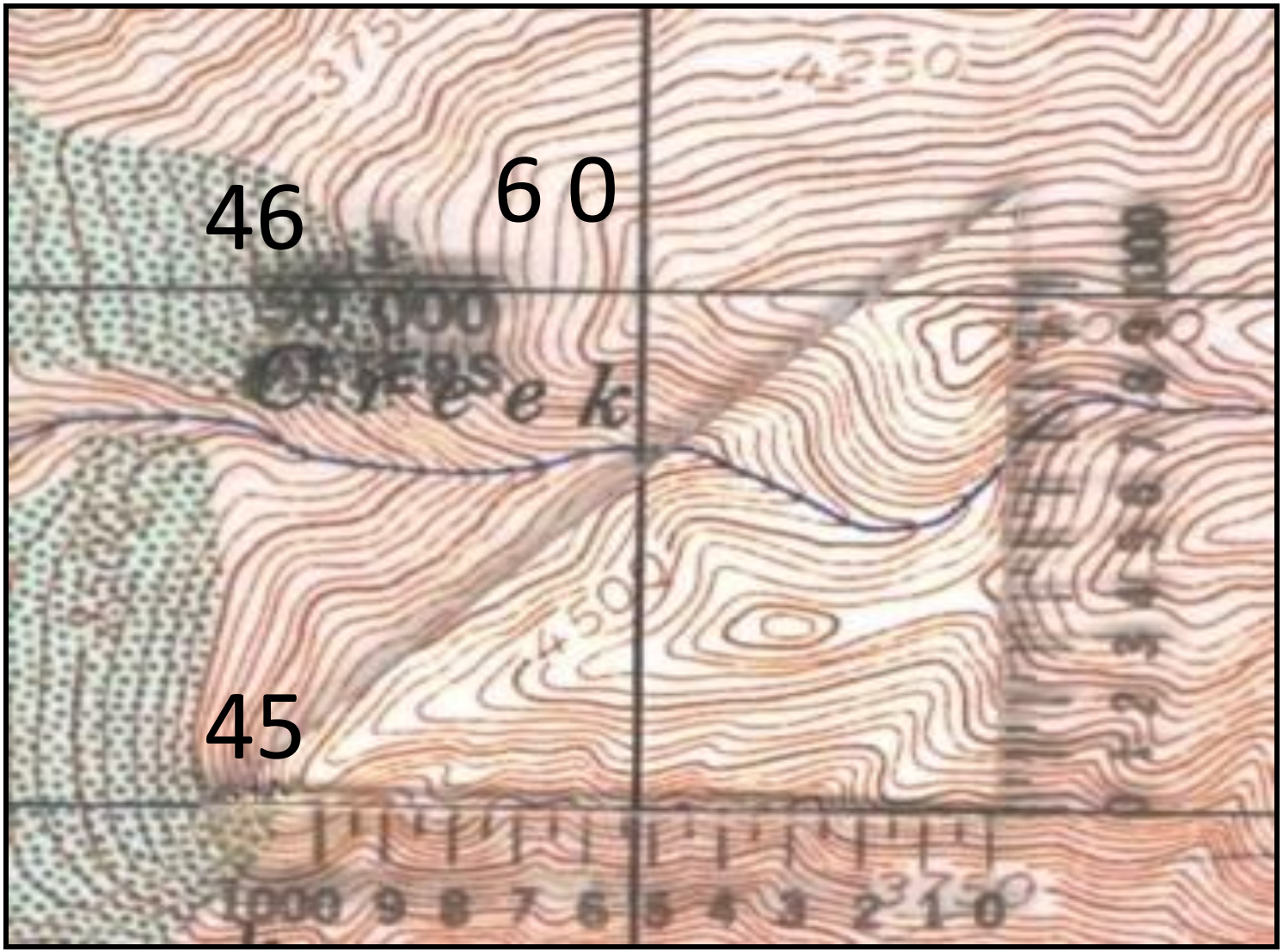


Grid Coordinate to within 1000 meters: WF60 45


GTA 5-2-12, 1981
DEPARTMENT of the ARMY
GRAPHIC TRAINING AID
This GTA supersedes
GTA 5-2-10, 1980
Title: COORDINATE SCALE
AND PROTRACTOR
Headquarters, Department of
the Army
OUTER SCALE – MILS
INNER SCALE – DEGREES
1/50,000 METERS
1/100,000 METERS
1/25,000 – 1/250,000 METERS

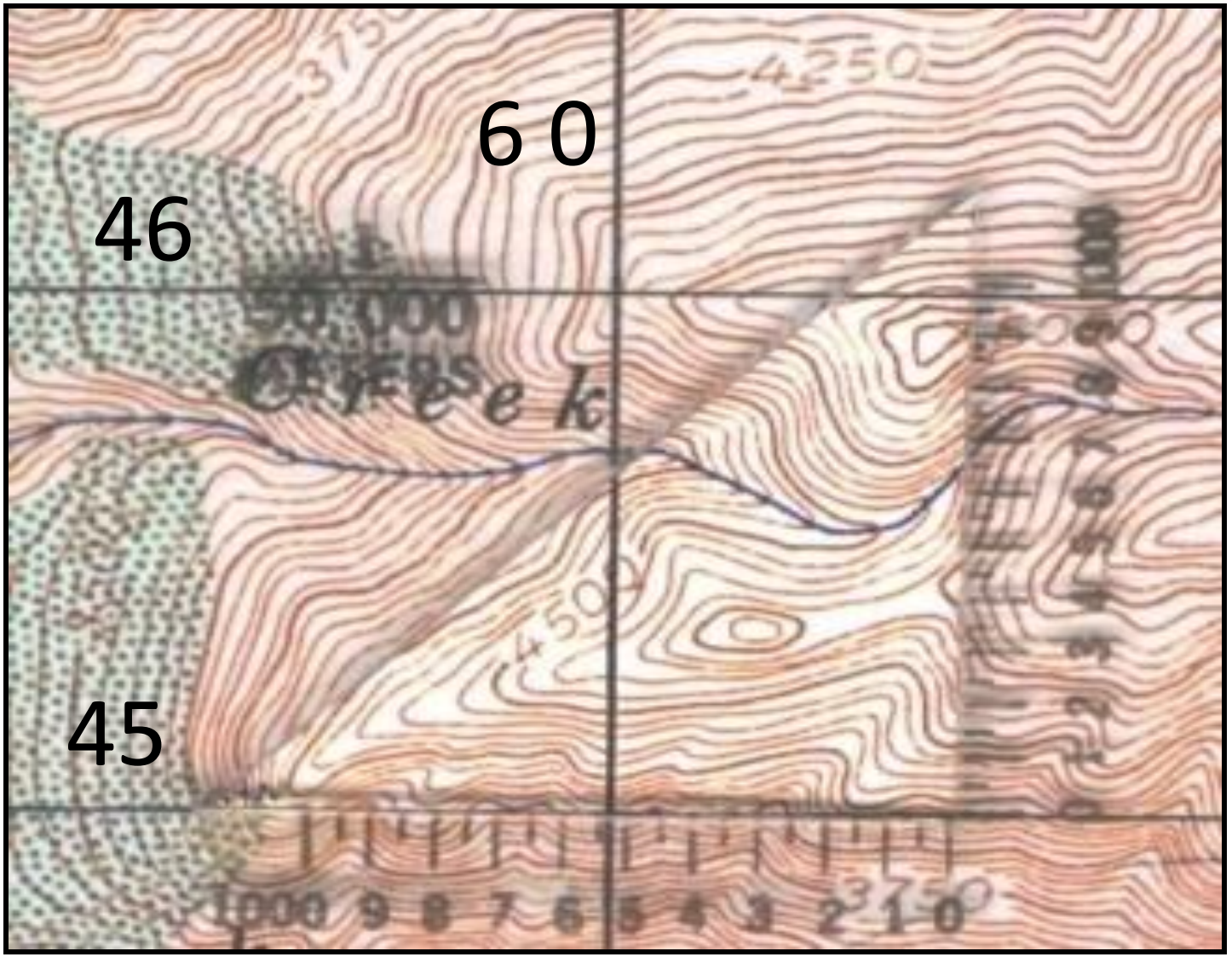

1
50,000
METERS
0 1 2 3 4 5 6 7 8 9 1000
1000 9 8 7 6 5 4 3 2 1 0

Determine a grid coordinate to within 100 meters



Grid Coordinate to within 100 meters: WF605 459

Determine a grid coordinate to within 10 meters



Grid Coordinate to within 10 meters: WF6054 4591

Incomplete Grid Squares: Determine a Grid Coordinate

Draw or complete the square. In this method, you will actually draw or complete the grid square on the map. This method is good in a classroom environment because of a stable platform and availability of sharp pencils. The grid square is complete and the coordinate is read from a complete grid square.

Practical Exercise
Determine a Grid Coordinate

1. Determine the location of the benchmark (VABM 2109), at the Rapids Airstrip to within 1000 meters, 100 meters and 10 meters.

2. Plot the following grid coordinate and identify the feature at these locations:

WF 67514230

WF 59554884

WF 55386128

Practical Exercise
Determine a Grid Coordinate

1. Determine the location of the benchmark (VABM 2109), at the Rapids Airstrip to within 1000 meters, 100 meters and 10 meters.

Within 1000 meters: WF 56 45
Within 100 meters: WF 567 454
Within 10 meters: WF 5670 4543

2. Plot the following grid coordinate and identify the feature at these locations:

WF 67514230 is a Hilltop

WF 59554884 is a Horizontal Control Point

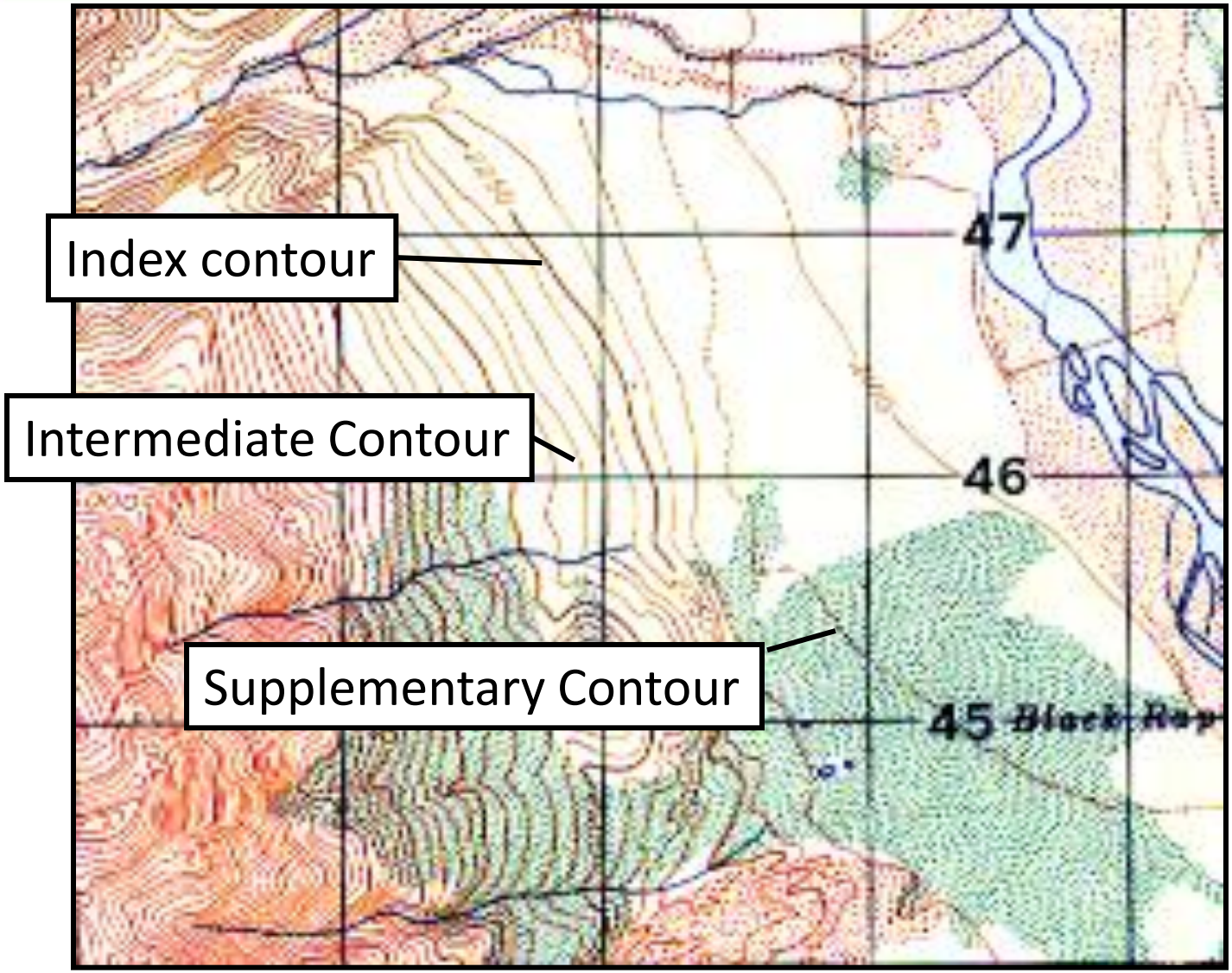
WF 55386128 is Mile Marker 240 for Rich Hwy.

Questions?

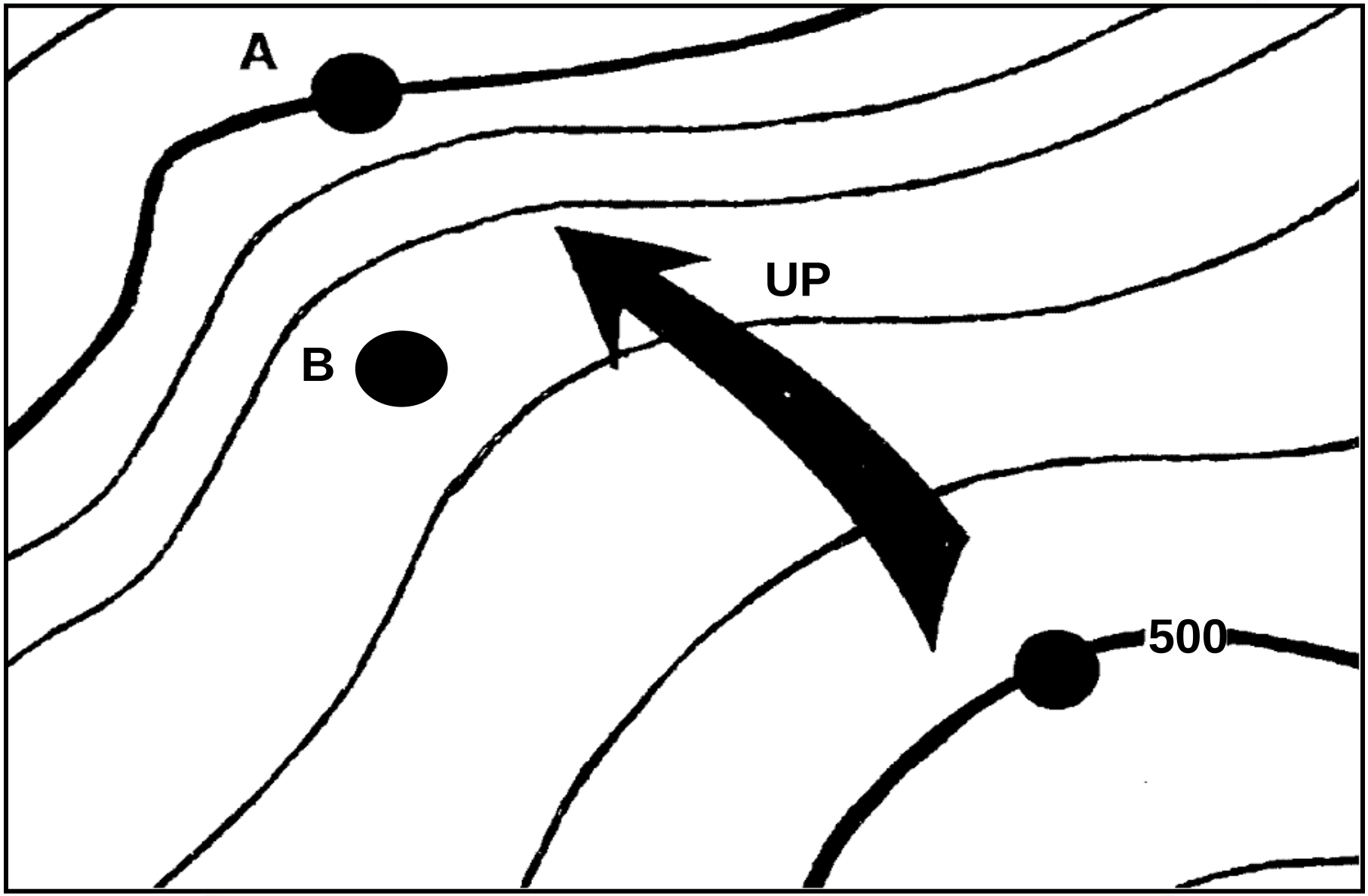
Module 2

1. Elevation and Relief
2. Terrain Features
3. Map Distance and Graphic Scale
4. Azimuth and Direction

Elevation and Relief

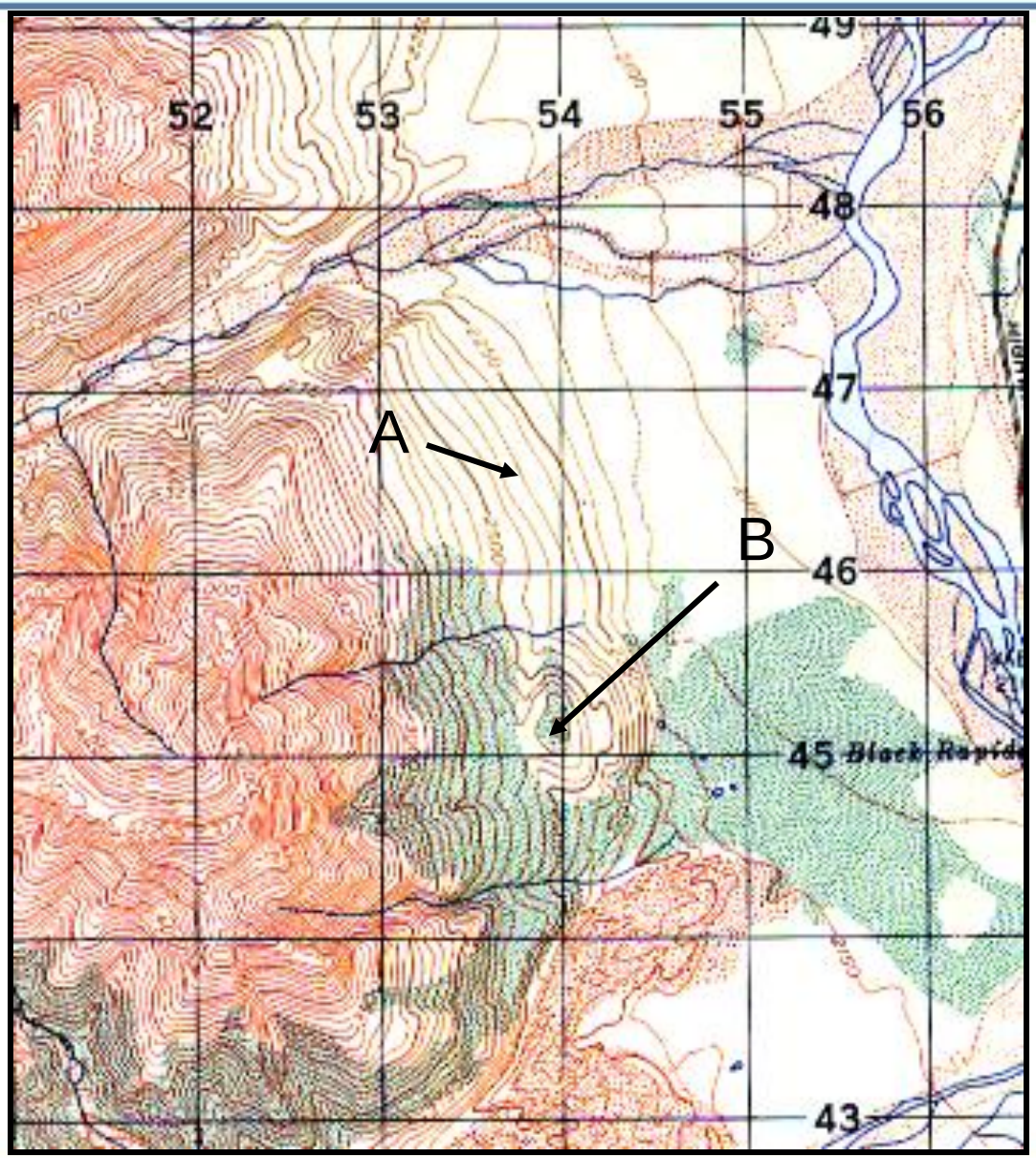


Elevation



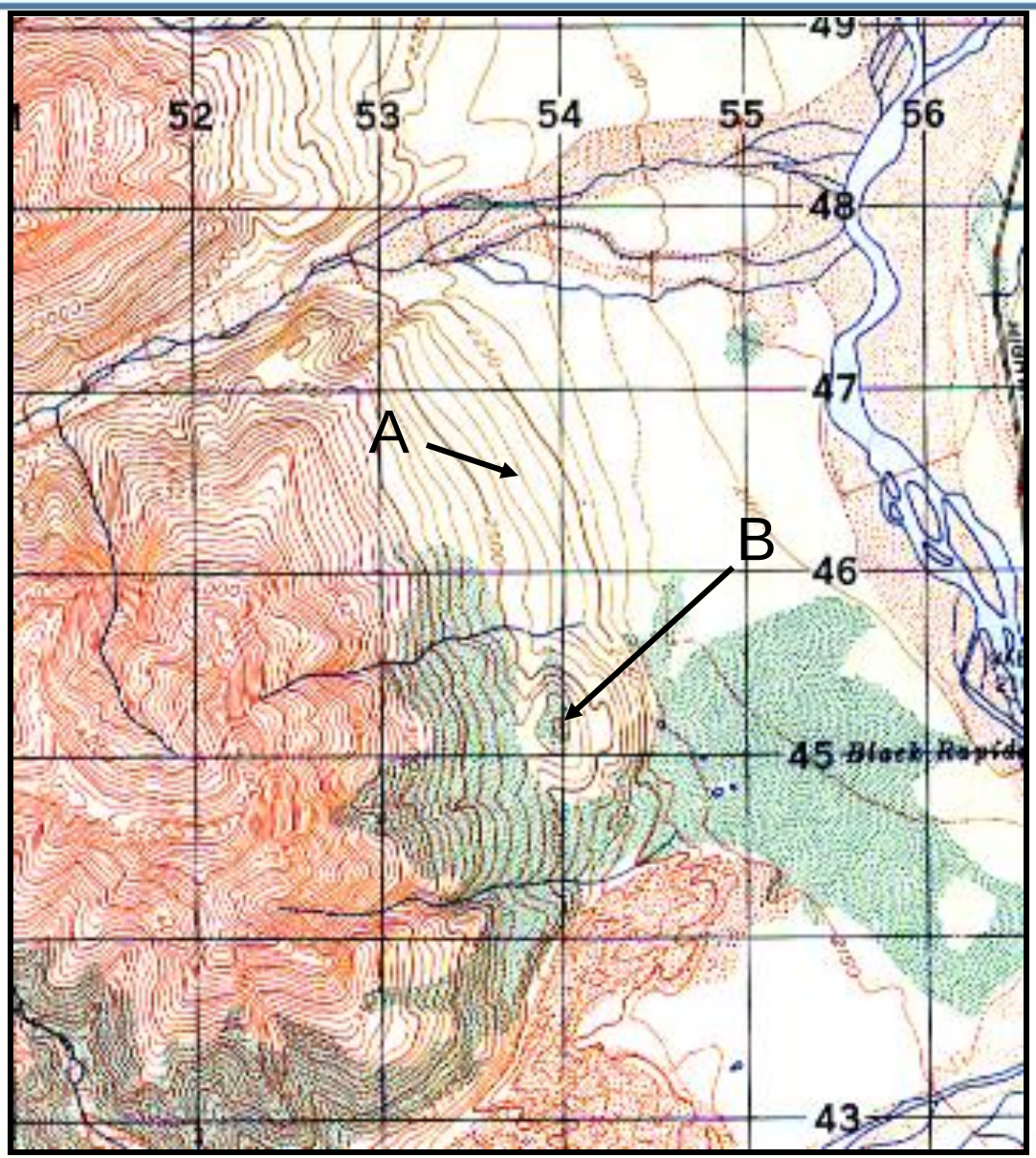
Practical Exercise: Determine Elevation

A. WF 5375 4655 B. WF 5395 4515

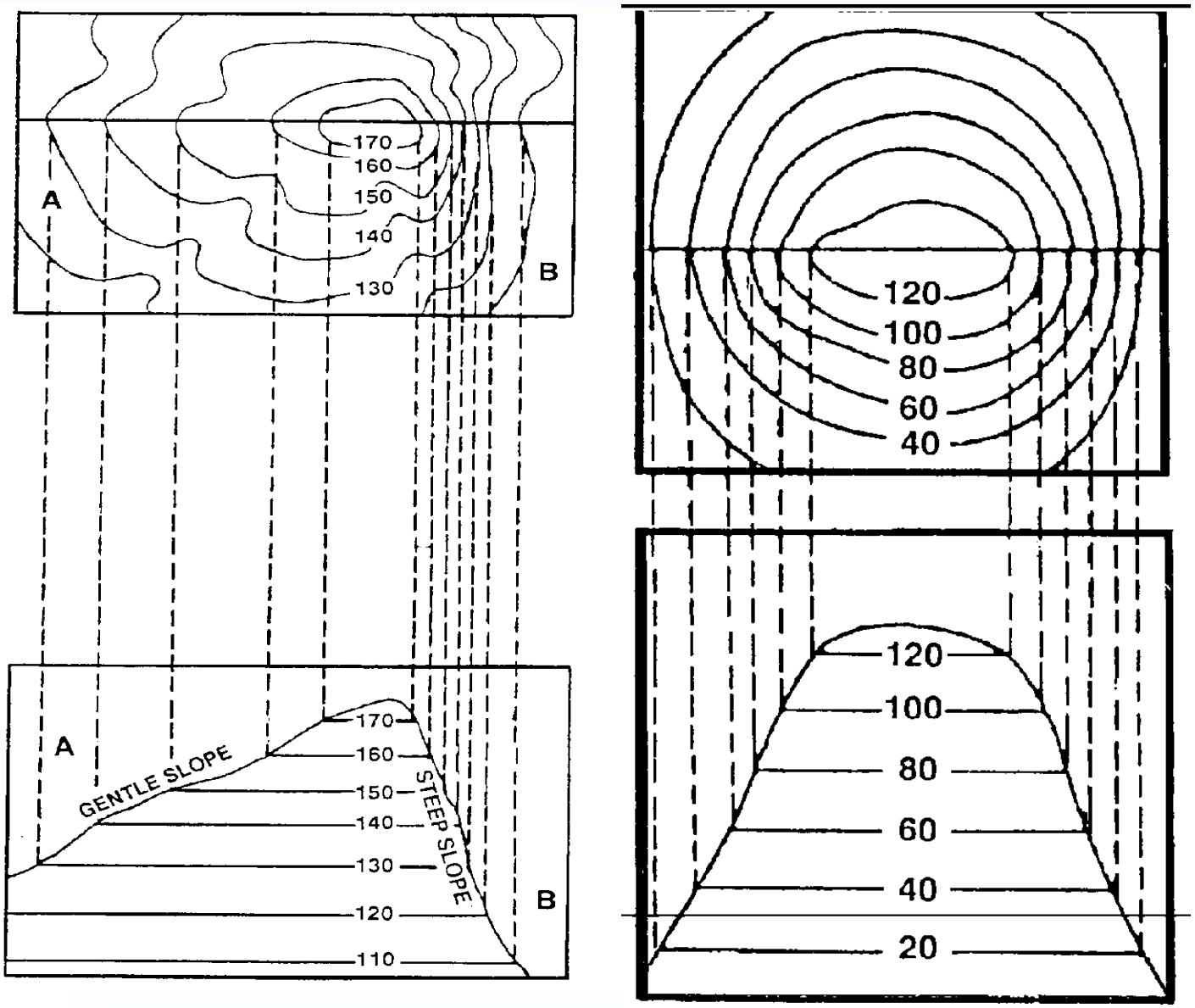


Practical Exercise: Determine Elevation

A. 2350 Feet B. 2725 Feet



Relief

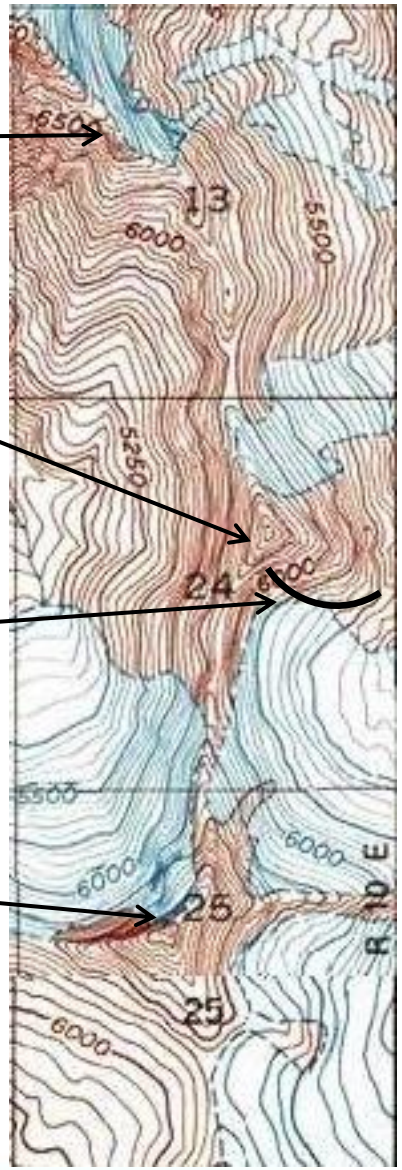

170
160
150
140
130
A
B
120
100
80
60
40
A
GENTLE SLOPE
STEEP SLOPE
170
160
150
140
130
120
110
B
120
100
80
60
40
20

Terrain Features

- Ridgeline – line of high ground, usually with changes in elevation along its top and low ground on all sides

- Ten terrain features
  - Major Terrain Features:
    - Hilltop
    - Saddle
    - Valley
    - Ridge
    - Depression
  - Minor Terrain Features
    - Draw
    - Spur
    - Cliff
  - Supplementary Terrain Features
    - Cut
    - Fill

Ridgeline



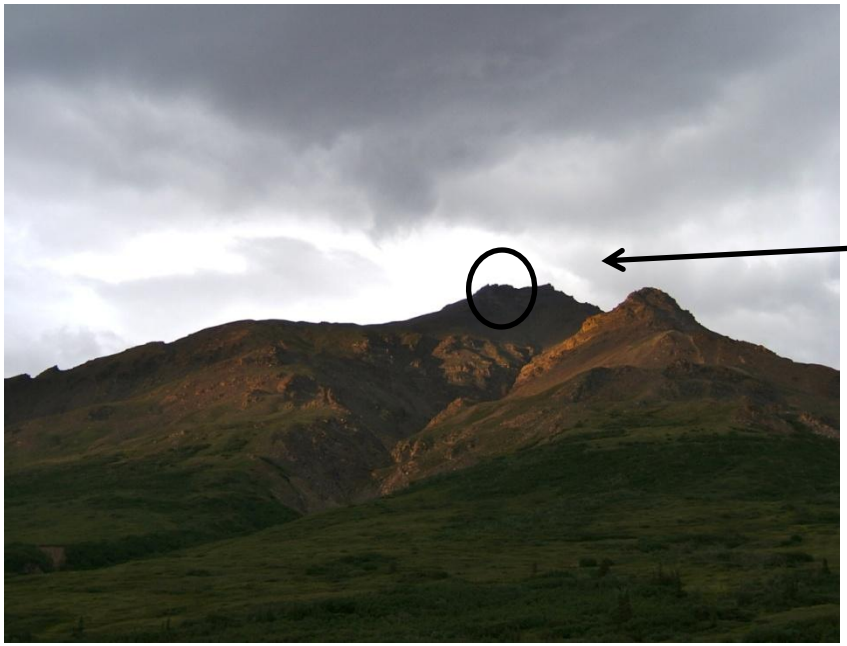
4

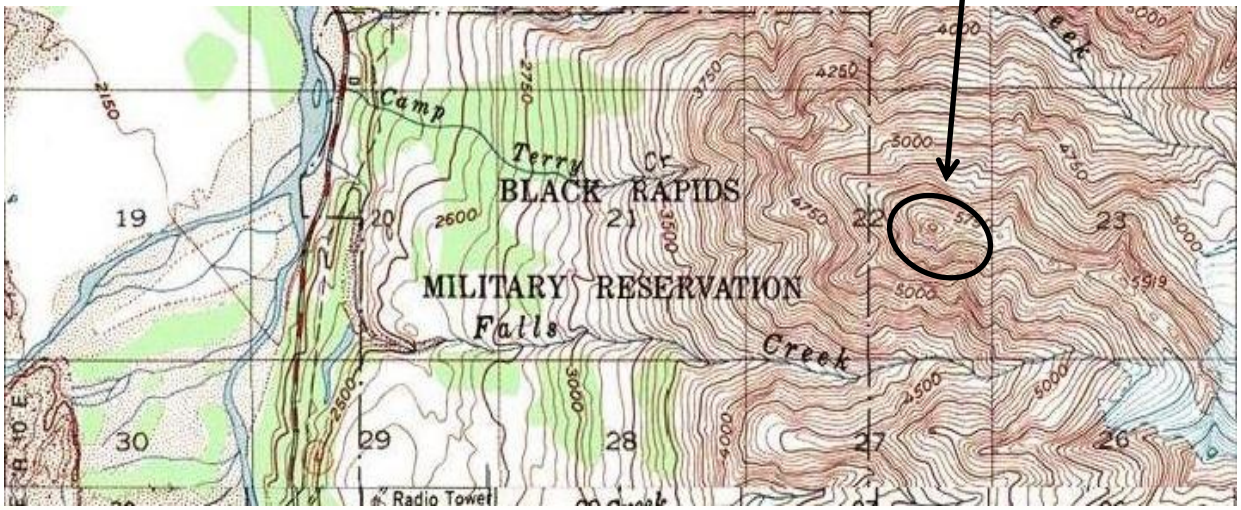
3

2

1

HILLTOP




Camp
Terry Cr
BLACK RAPIDS
MILITARY RESERVATION
Falls Creek
19
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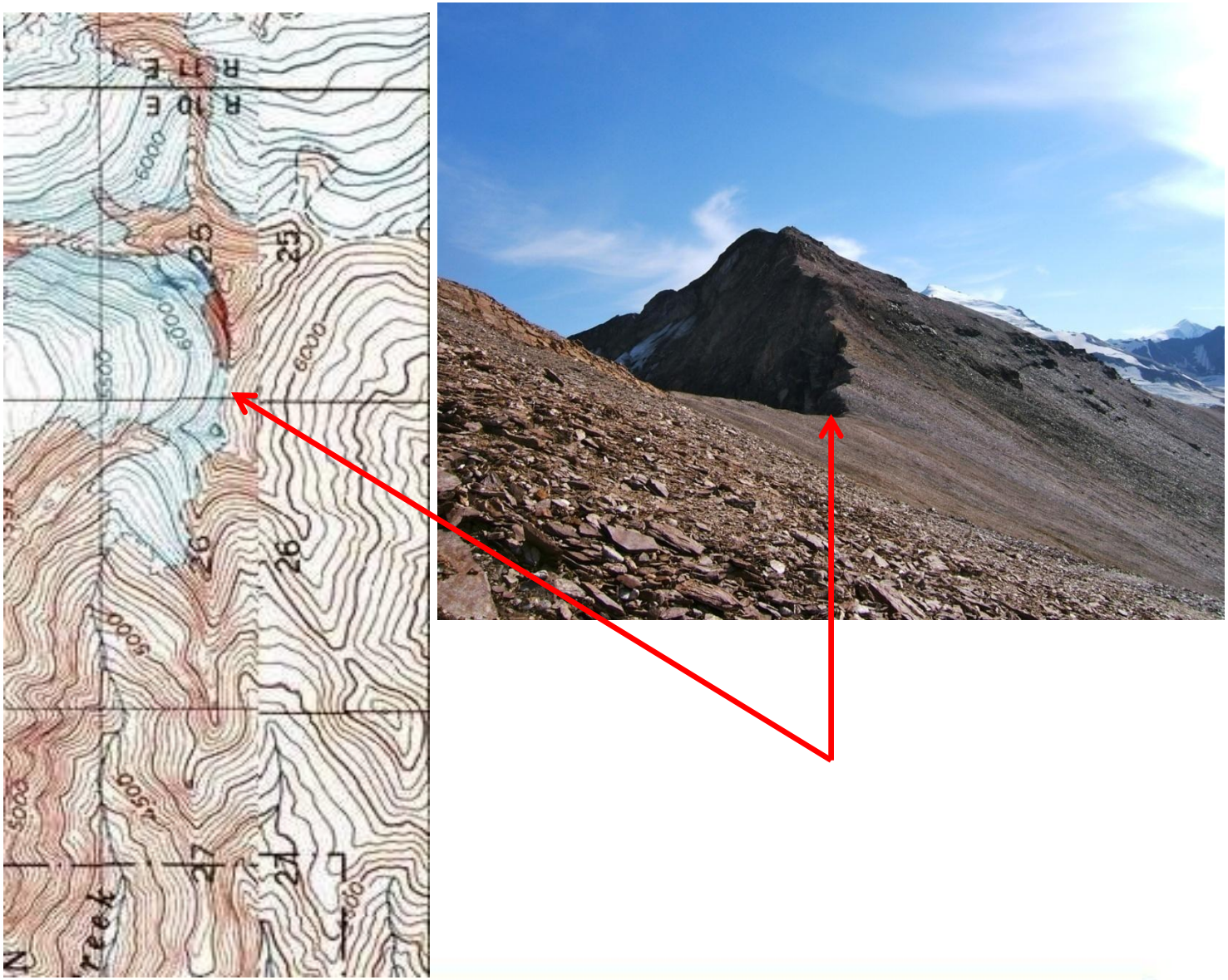
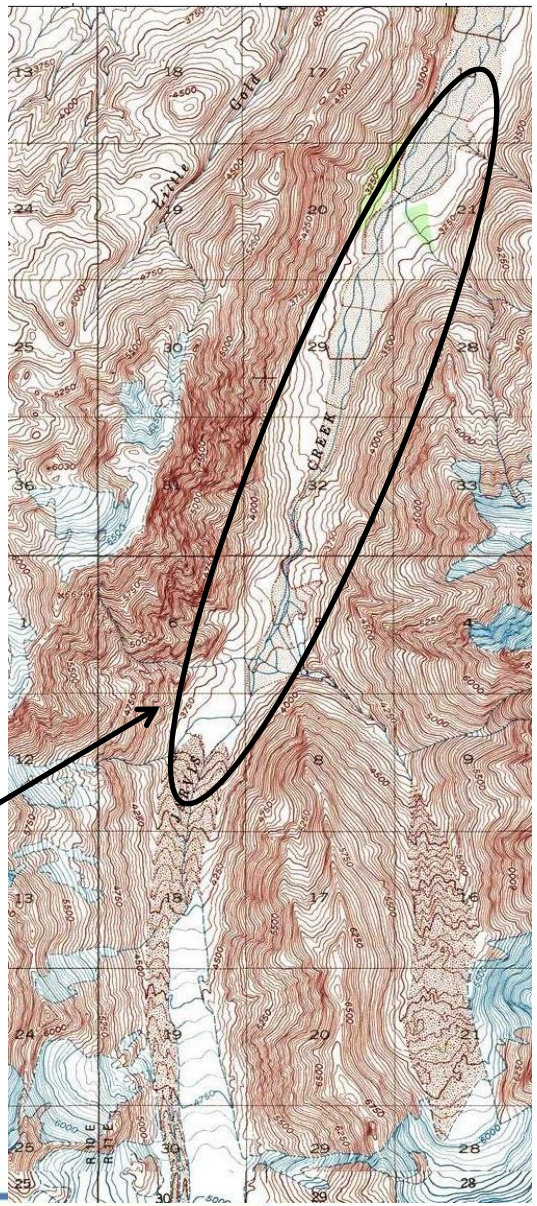
27
26
Radio Tower

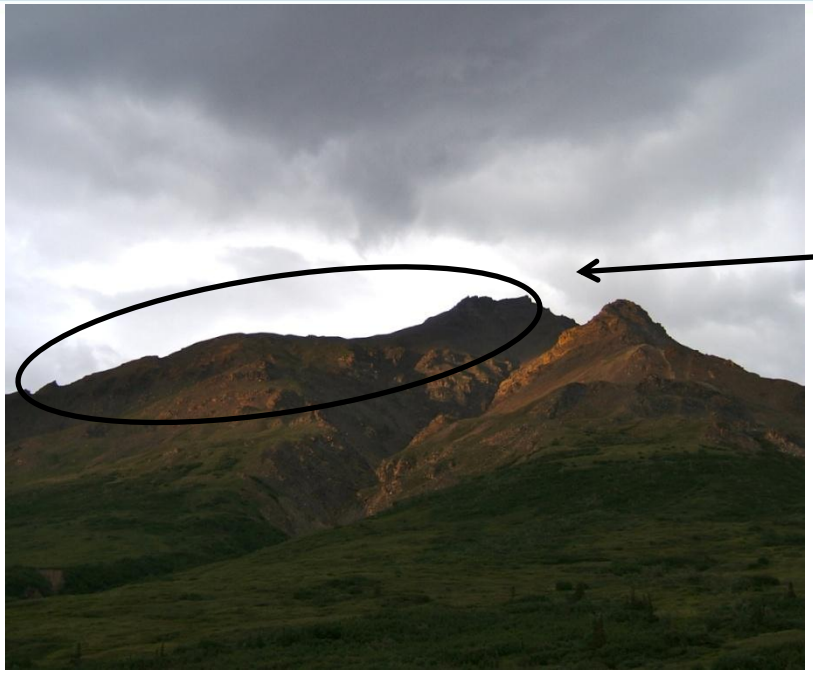
SADDLE

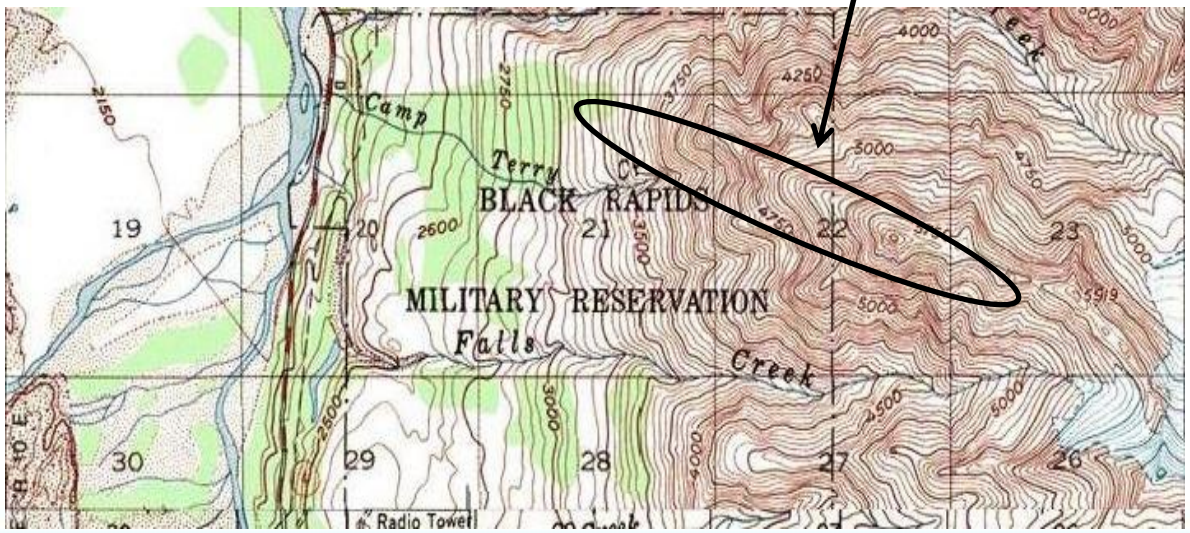


VALLEY



RIDGE




Camp
Terry
BLACK RAPIDS
MILITARY RESERVATION
Falls
Creek
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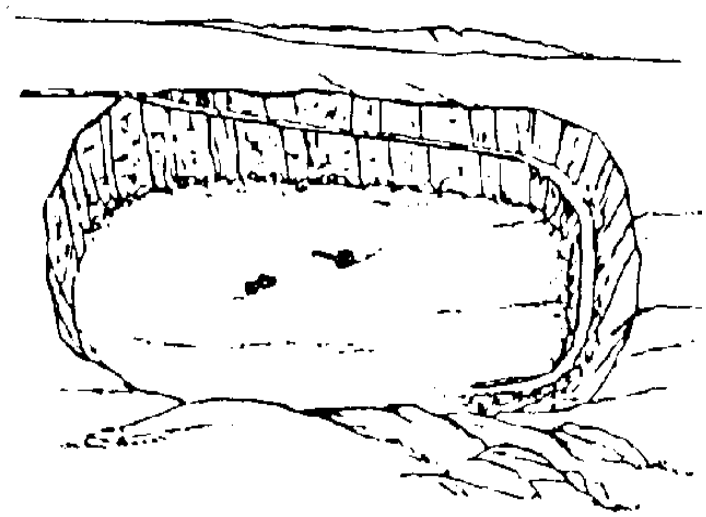
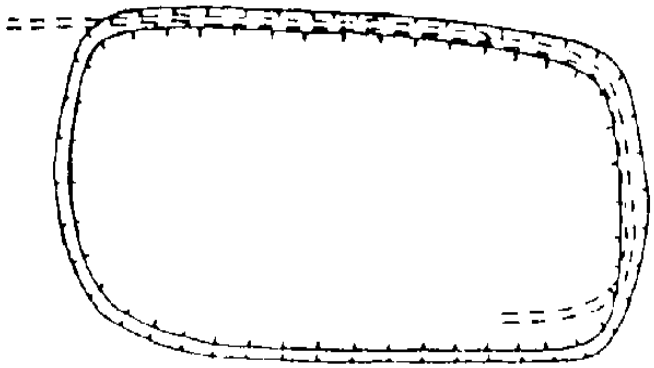
26
Radio Tower

Depression

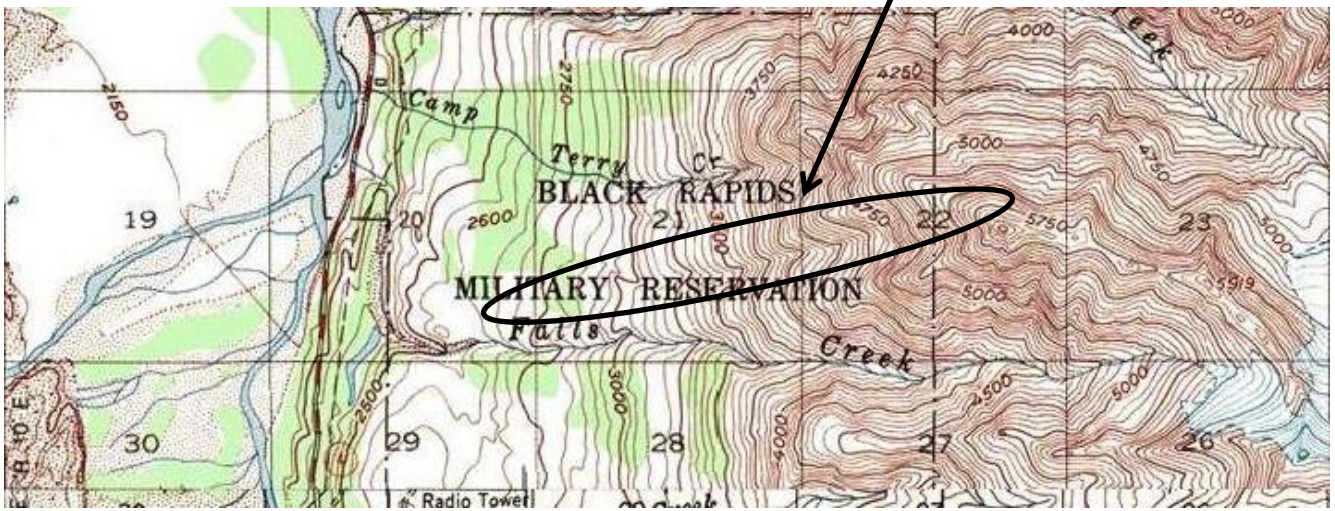
DEPRESSION ON THE GROUND



DEPRESSION ON THE MAP



DRAW


Camp
Terry Cr
BLACK RAPIDS
MILITARY RESERVATION
Falls
Creek
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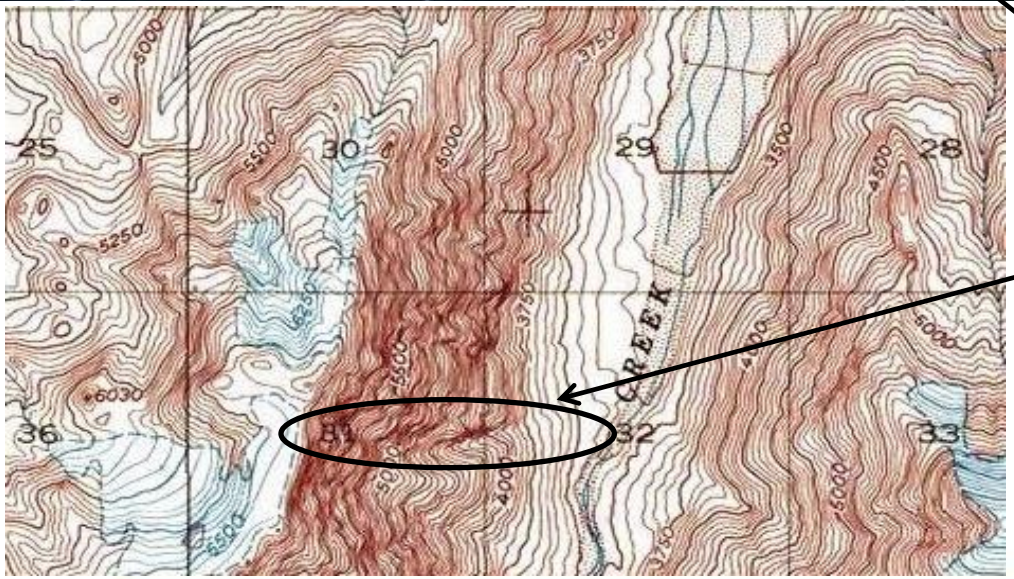
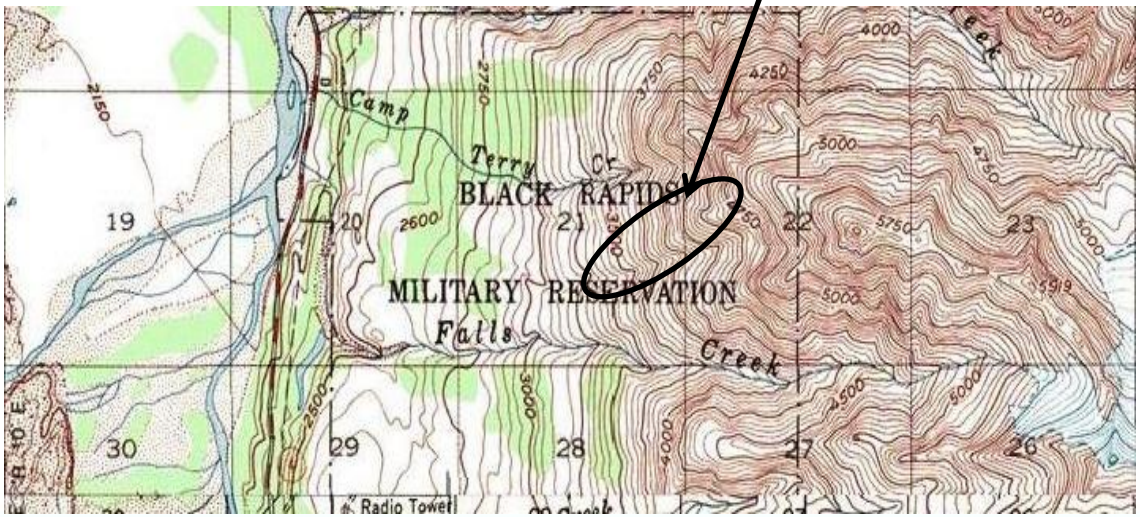
27
26
Radio Tower

CLIFF


25
30
29
28
36
31
32
33
CREEK
5000
5500
5250
6030
3750
3500
4500
4000

SPUR


Camp
Terry
Cr
BLACK RAPIDS
MILITARY RESERVATION
Falls
Creek
19
20
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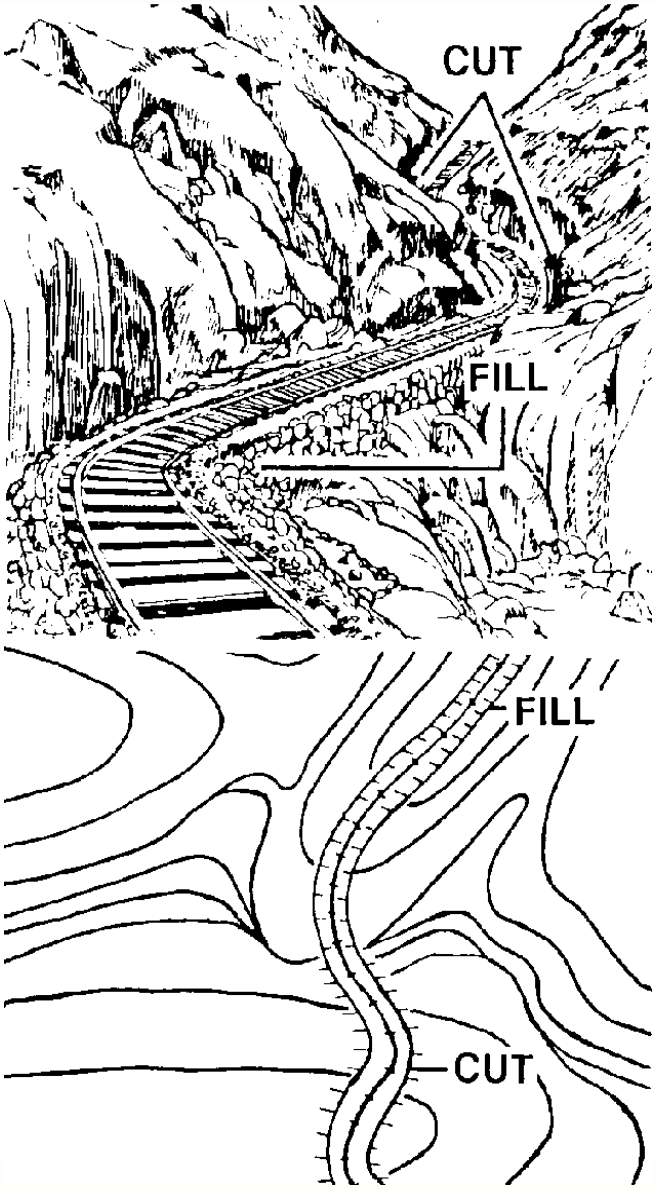
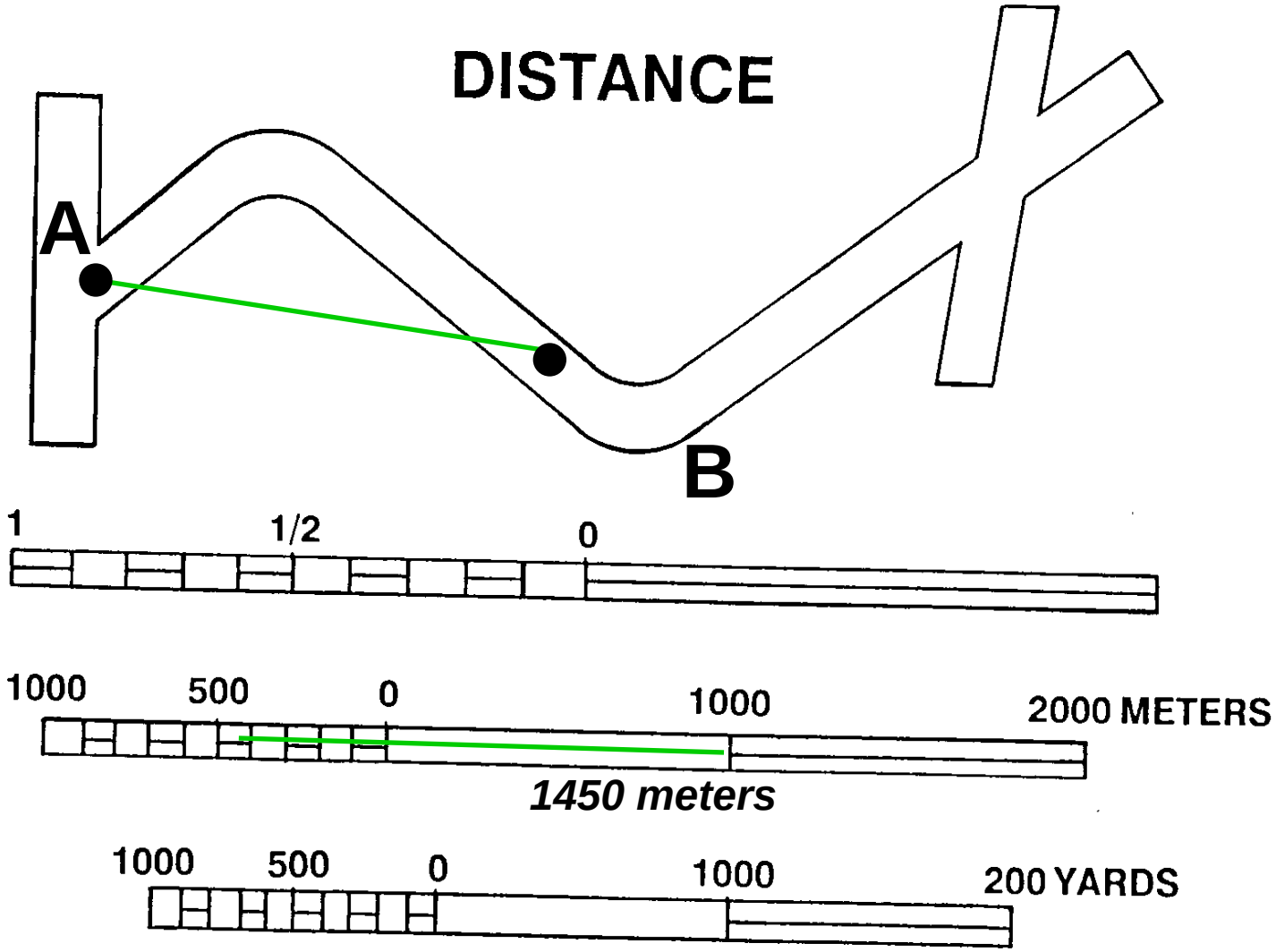
30
29
28
27
26
Radio Tower

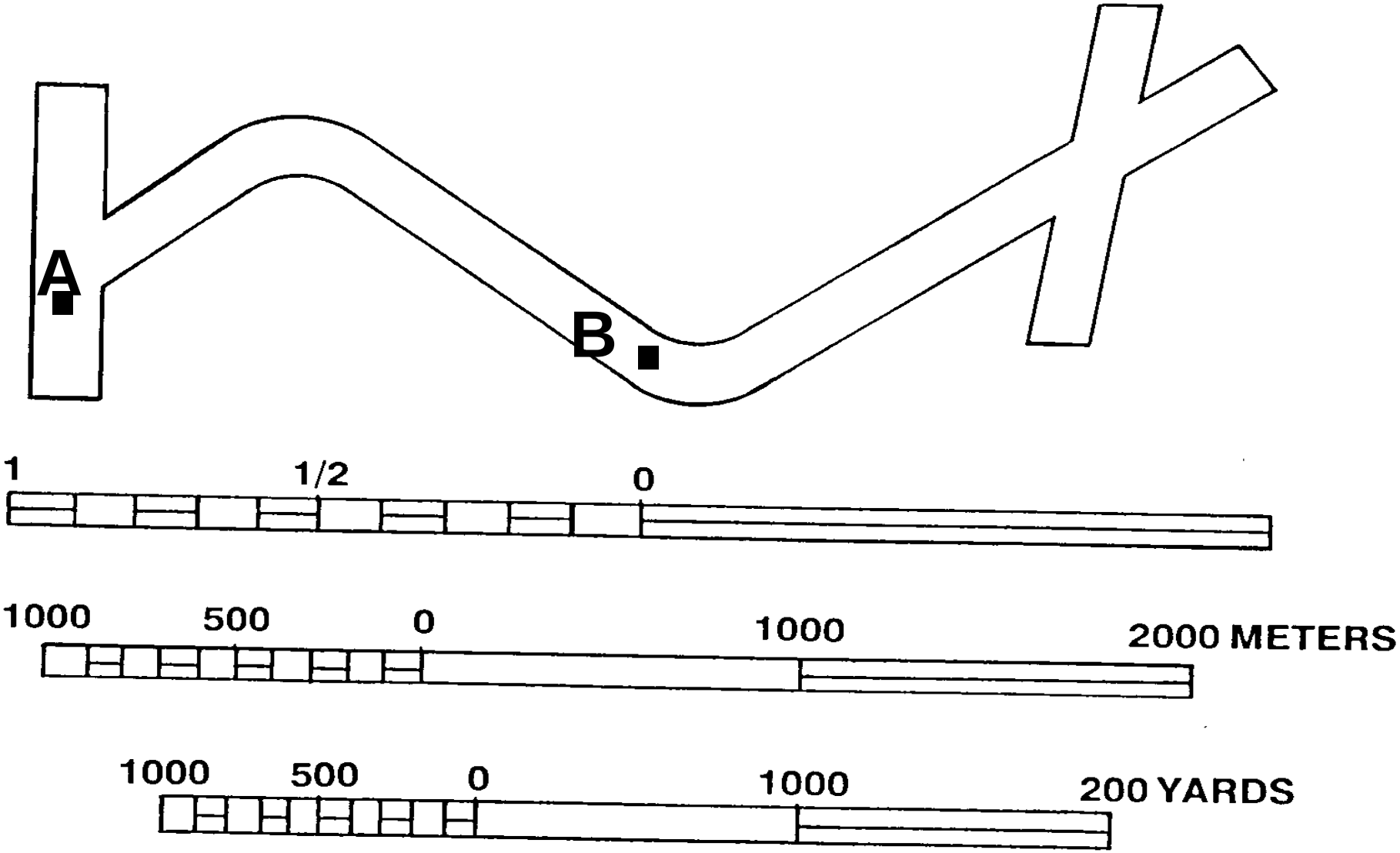
Cut and Fill

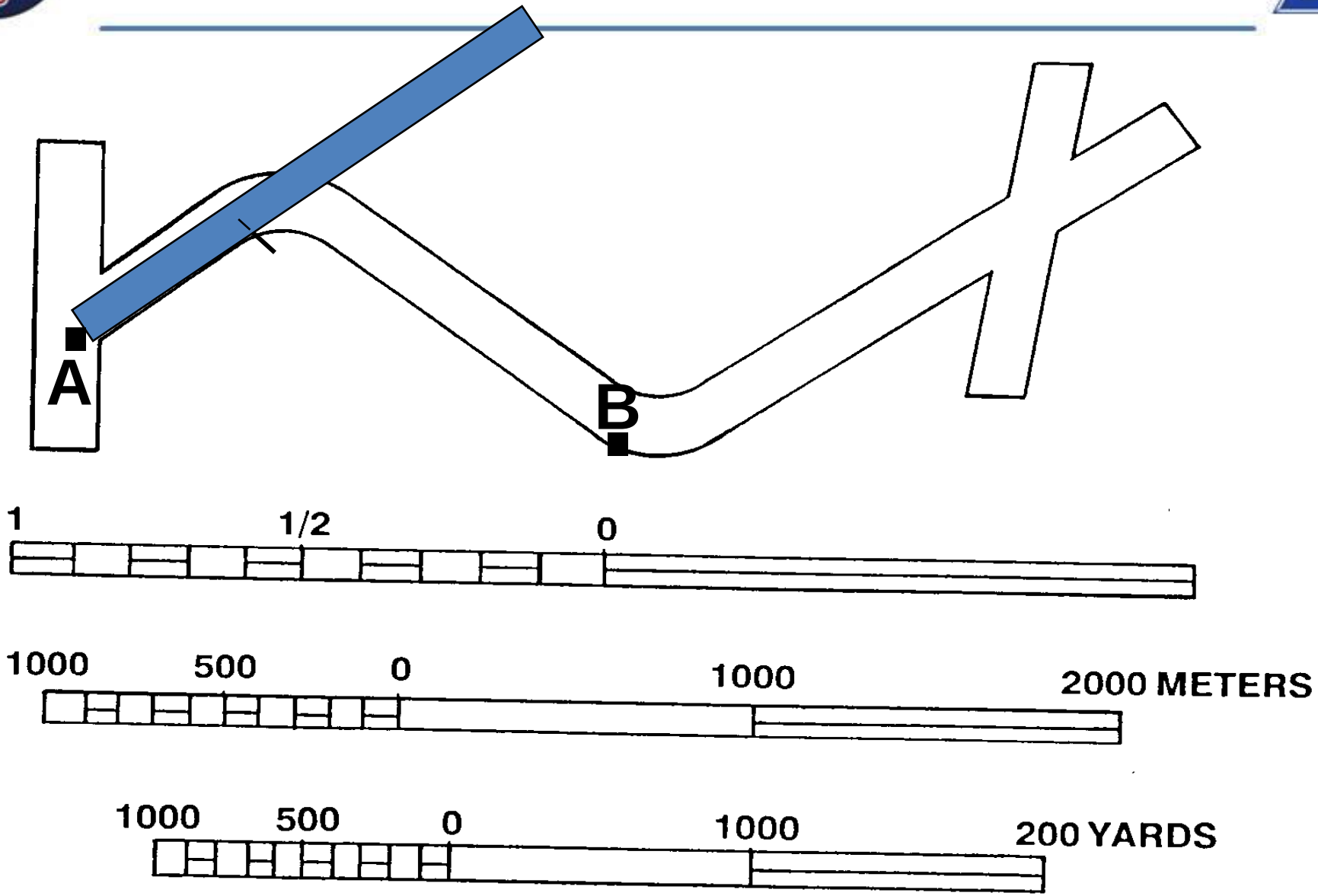


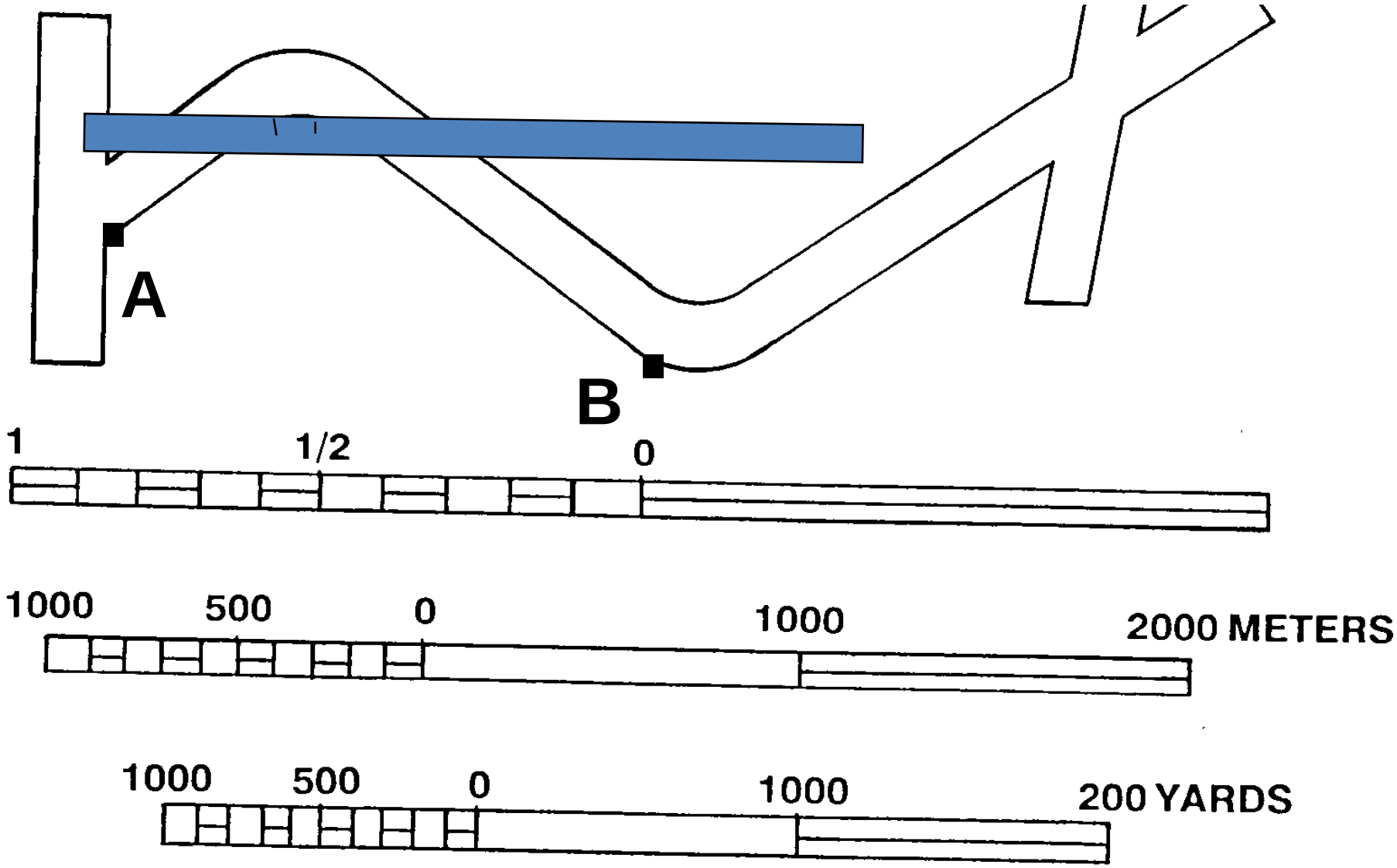
Determine the distance between two points



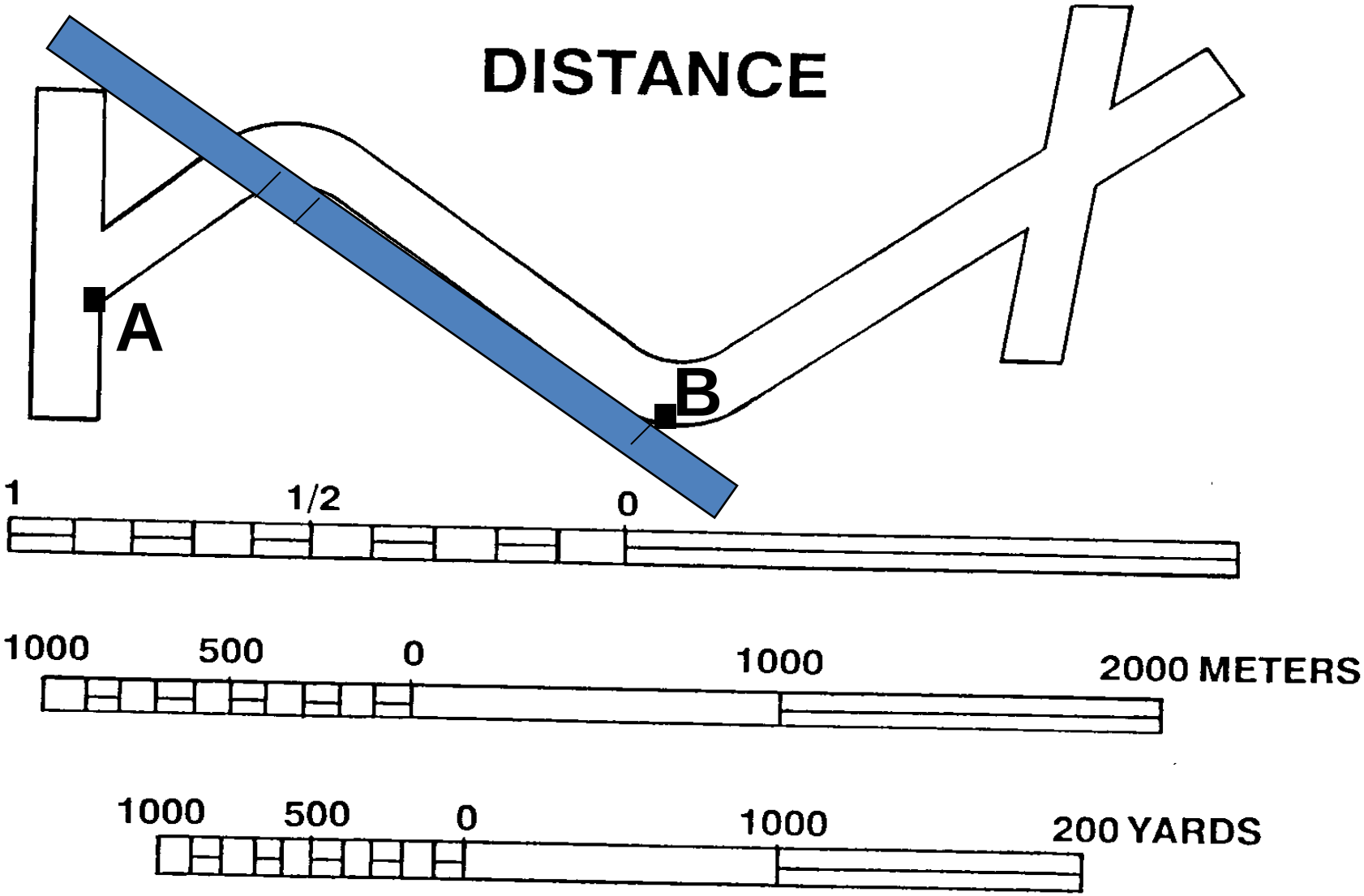
Determine the road or trail distance



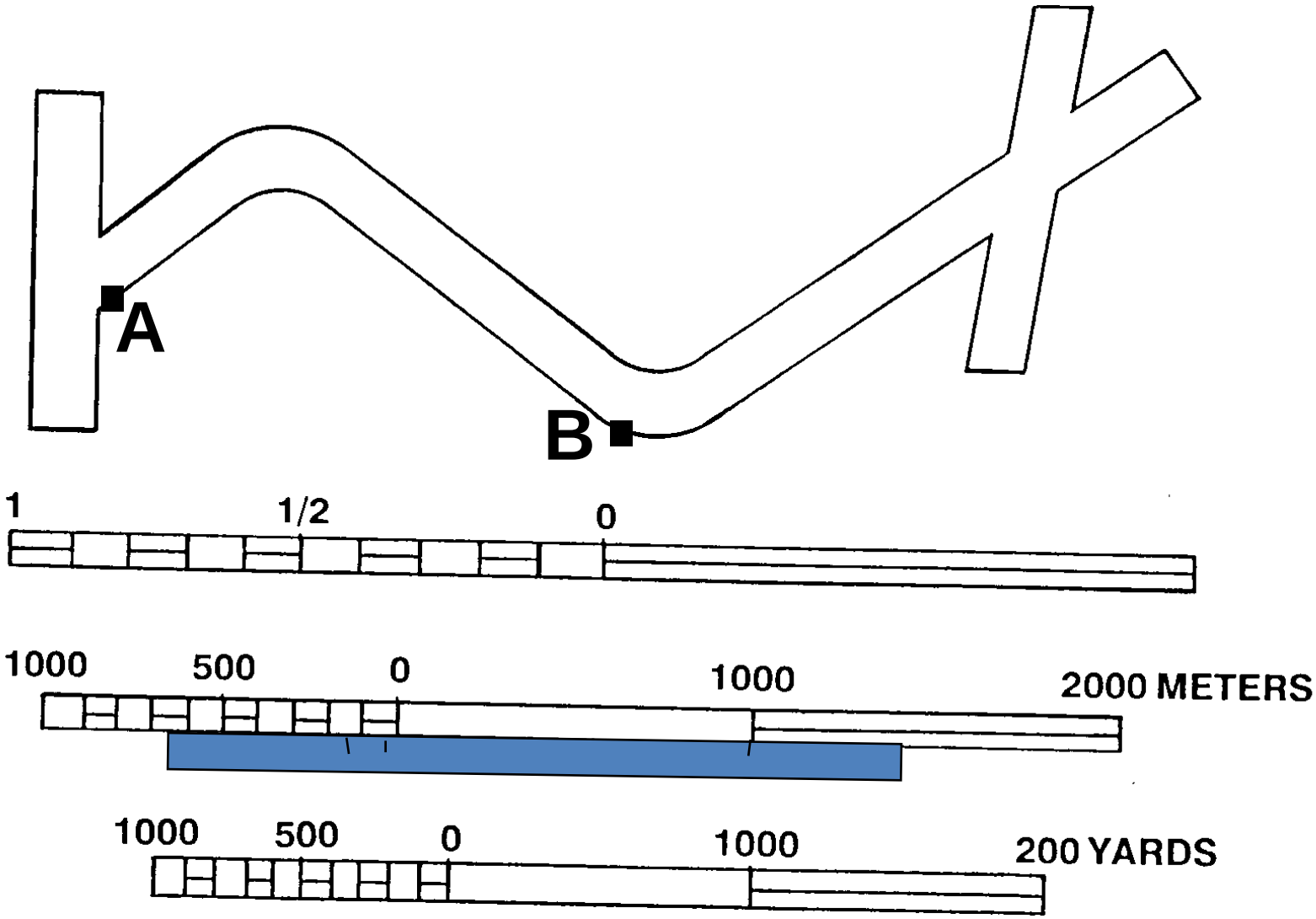

A
B
1
1/2
0
1000
500
0
1000
2000 METERS
1000
500
0
1000
200 YARDS


A
B
1
1/2
0
1000
500
0
1000
2000 METERS
1000
500
0
1000
200 YARDS

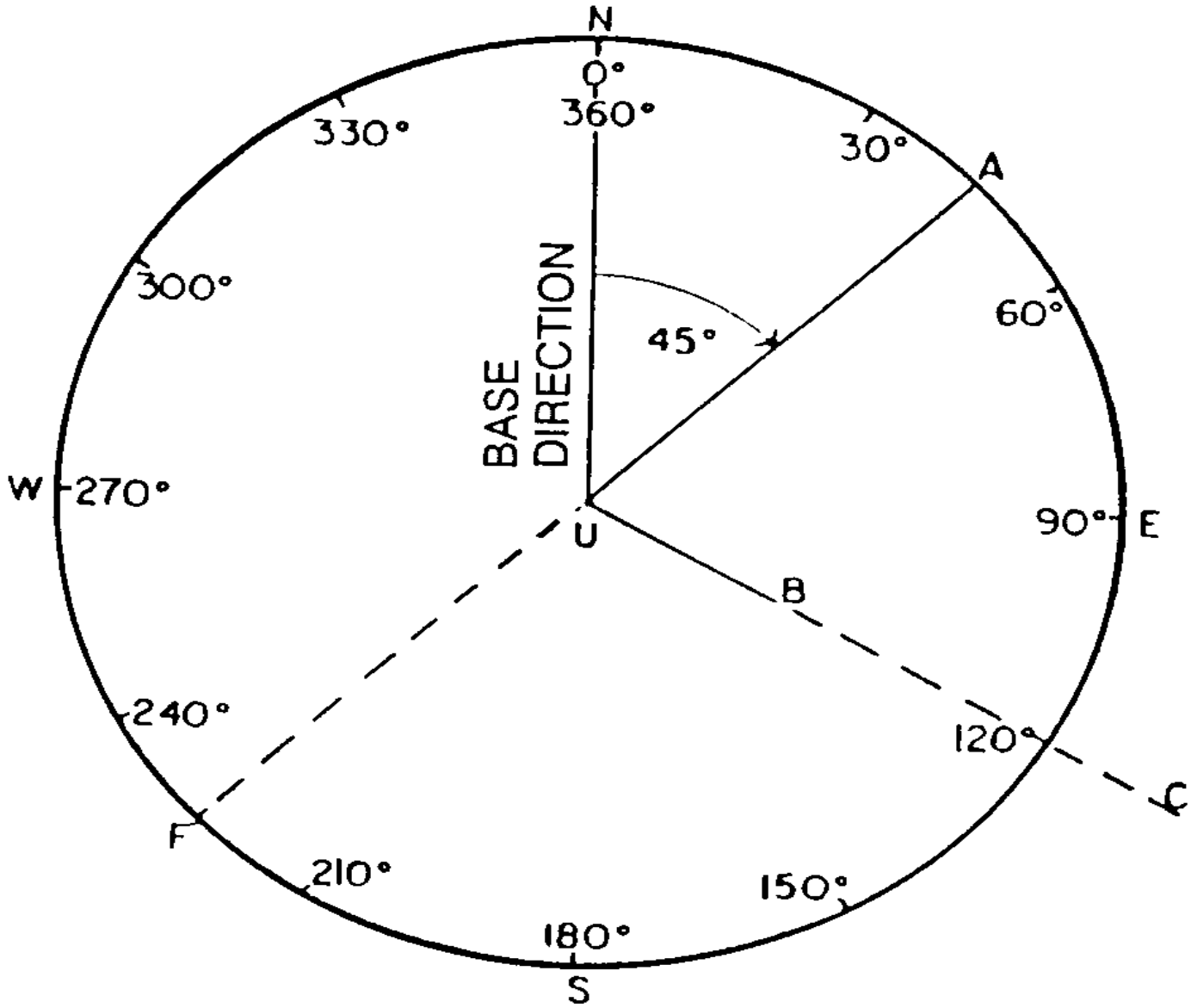
DISTANCE



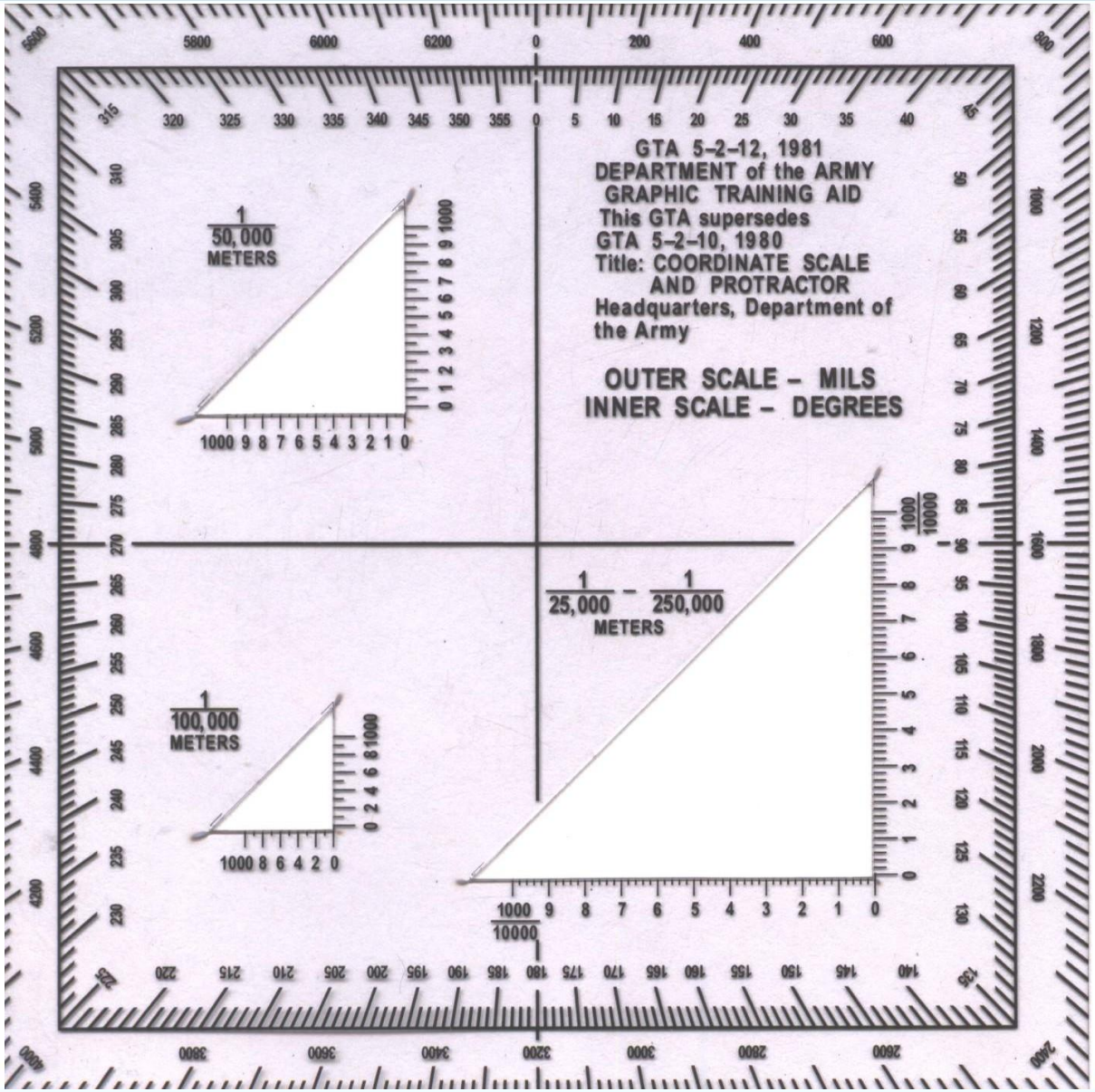
Road Distance is 1650 meters



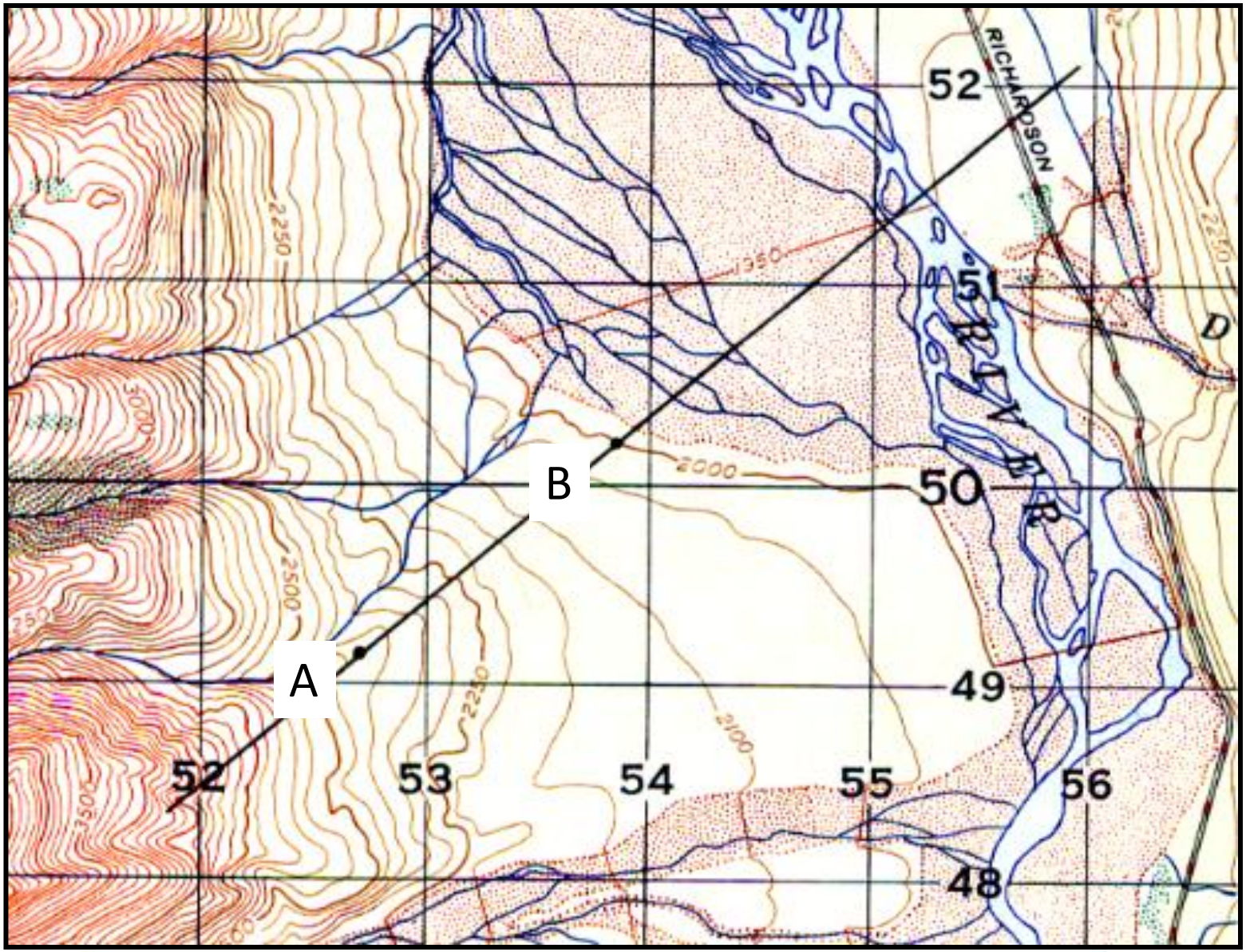
Azimuth and Direction



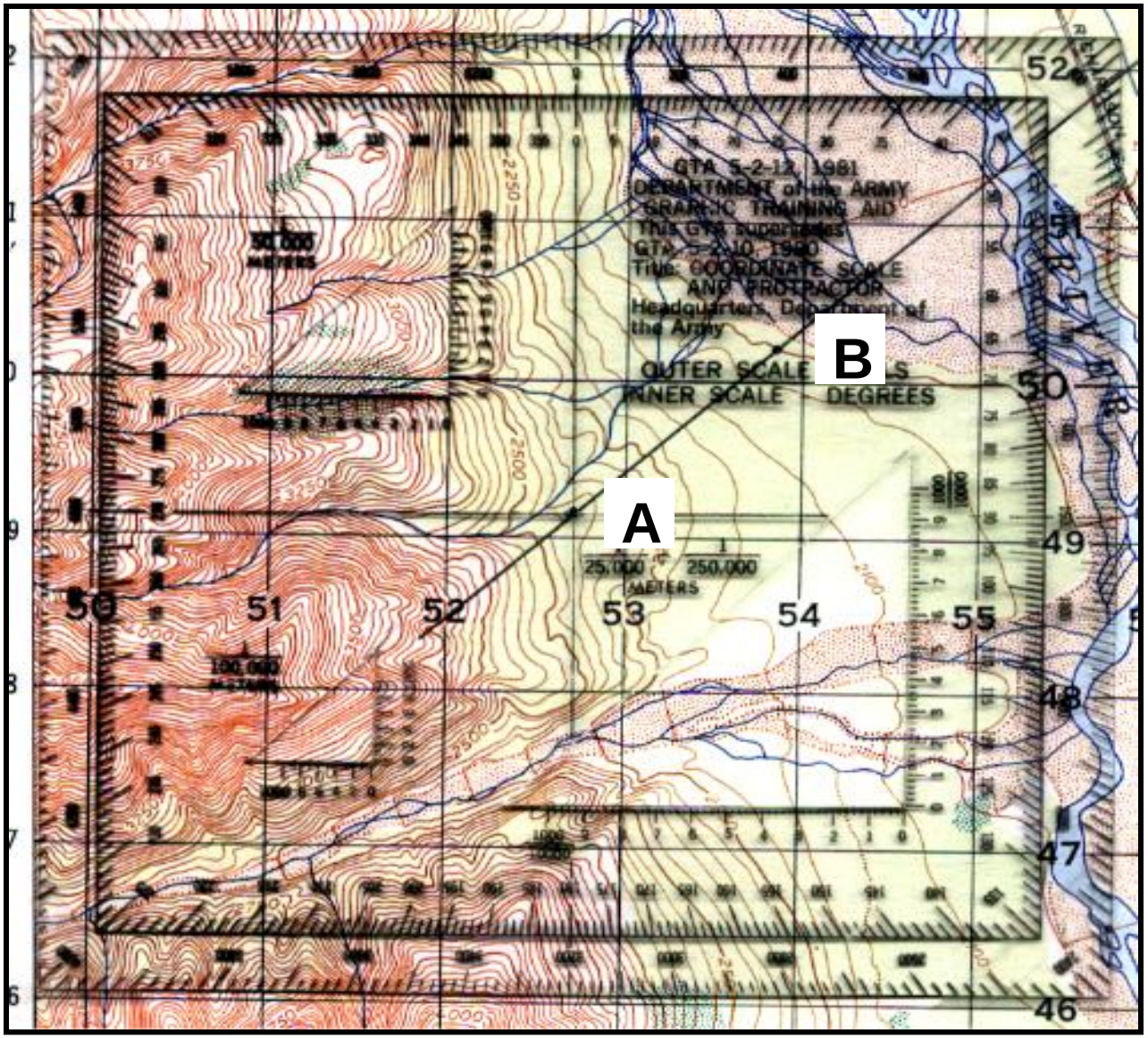
Grid Azimuths



Grid Azimuth



Grid Azimuth



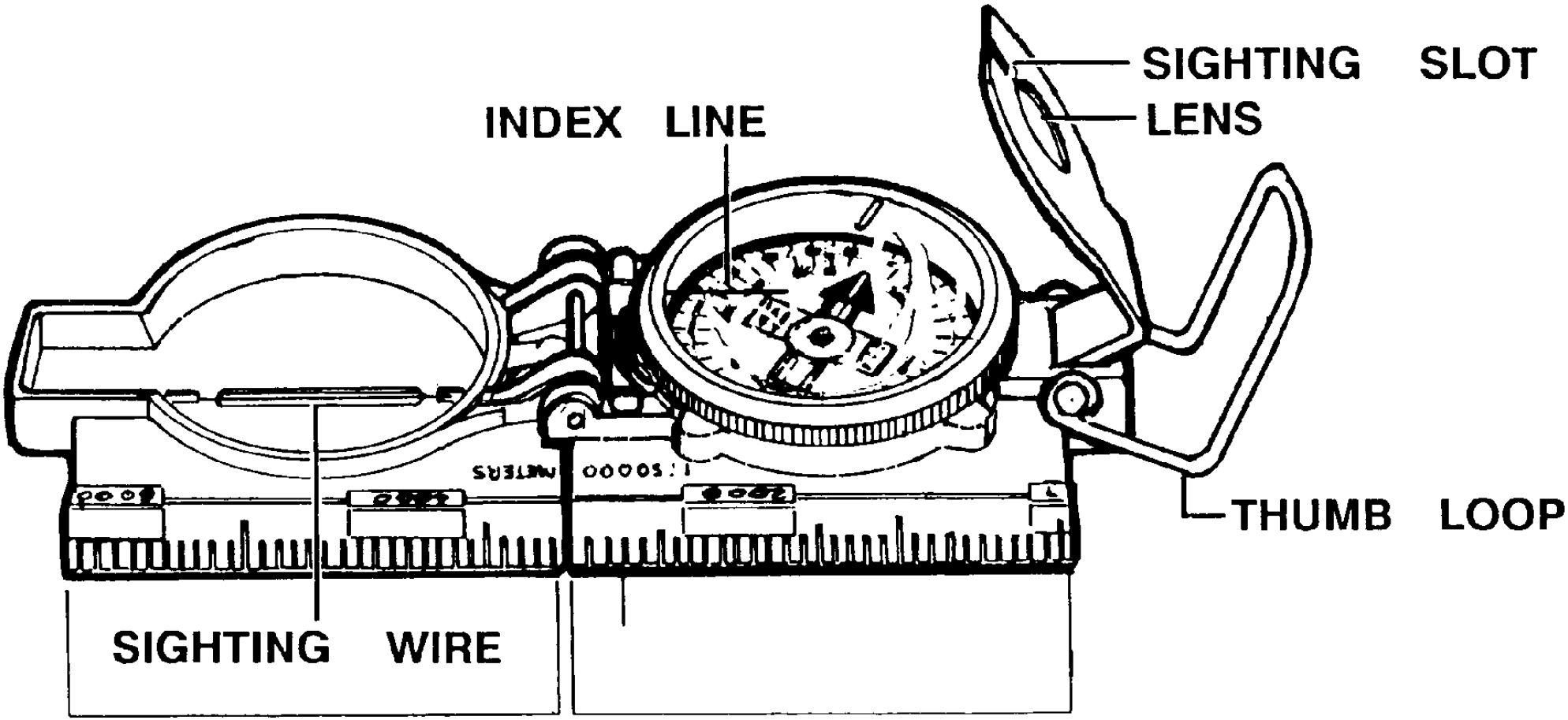
Grid Azimuth from Point A to Point B is 47 degrees.

Back Azimuth

Now suppose that you have moved from Point A to Point B. The light has faded; you can no longer make out any terrain features, and you forgot your protractor and map, but you still have your compass. You can calculate the back azimuth to get back to the Point A. To do this you must remember three rules:

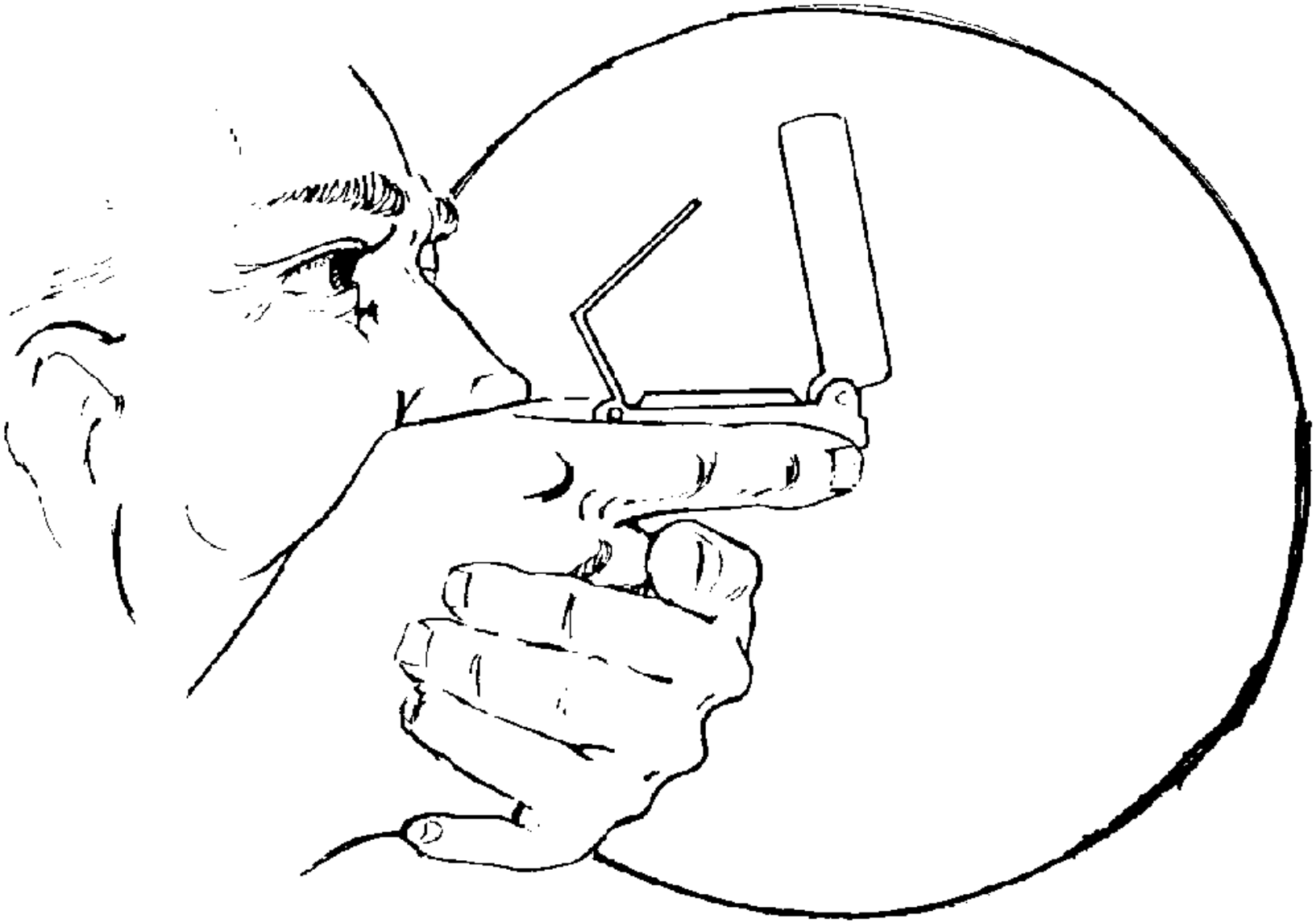
- If your original azimuth is less than 180 degrees, the back azimuth will be the original azimuth plus 180 degrees.
- If your original azimuth is more than 180 degrees, the back azimuth will be the original azimuth minus 180 degrees.
- If your azimuth is 180 degrees, the back azimuth is 0 degrees or 360 degrees.

Lensatic Compass

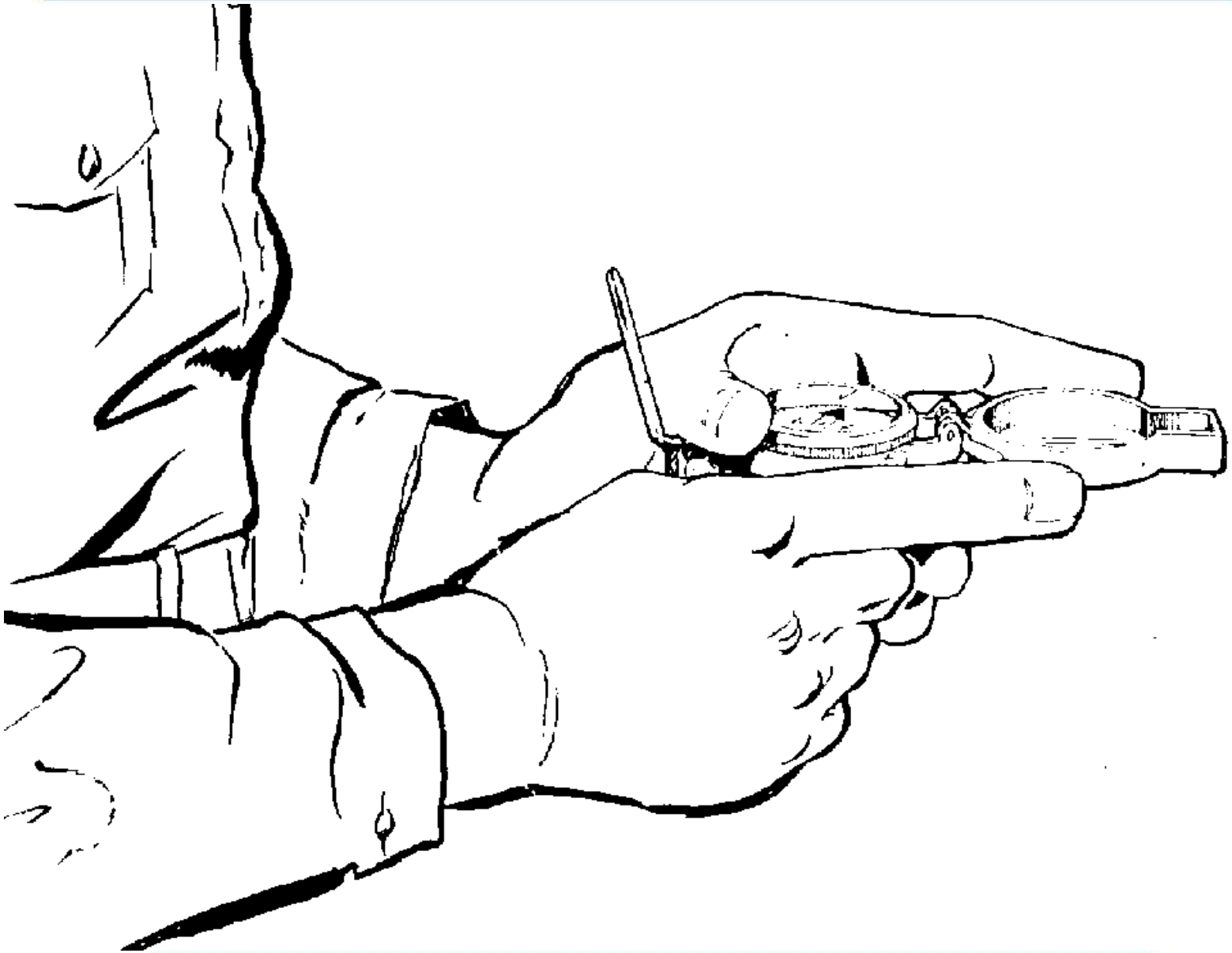


Lensatic Compass

Magnetic Azimuth: Compass to Cheek Method

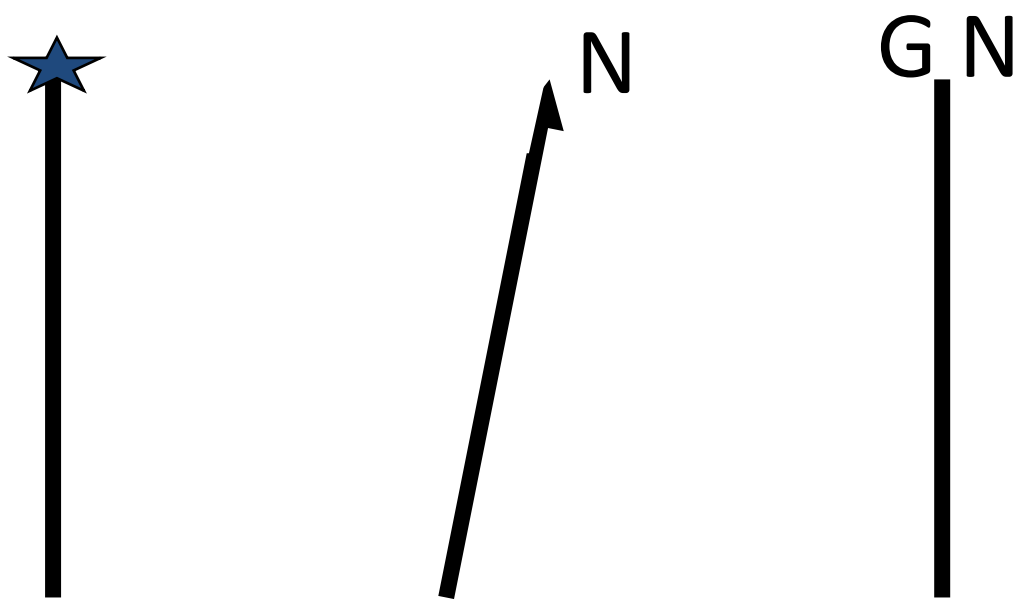


Magnetic Azimuth: Center Hold Method

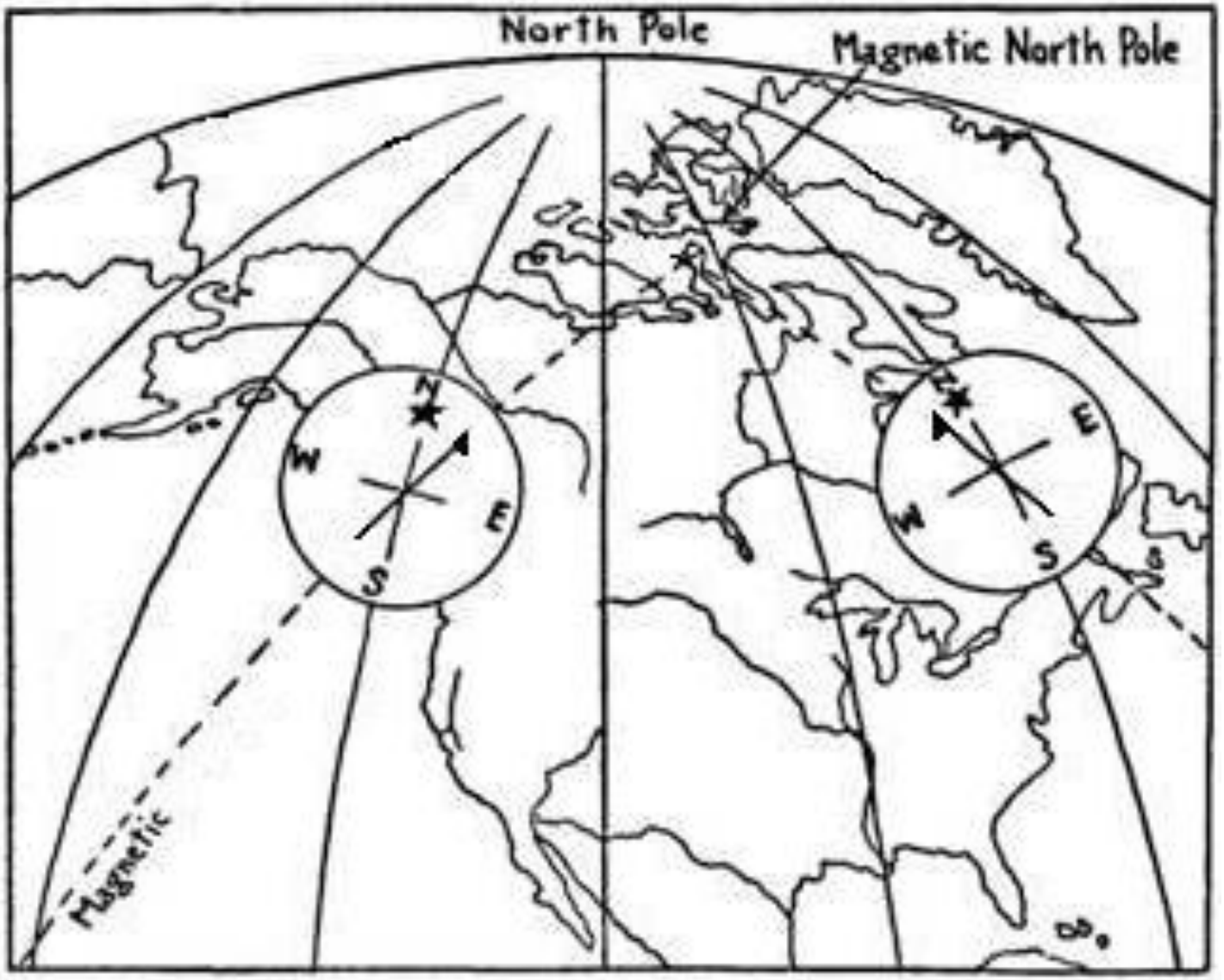


G-M Angle

THREE NORTH'S



G-M Angle



EASTERLY DECLINATION

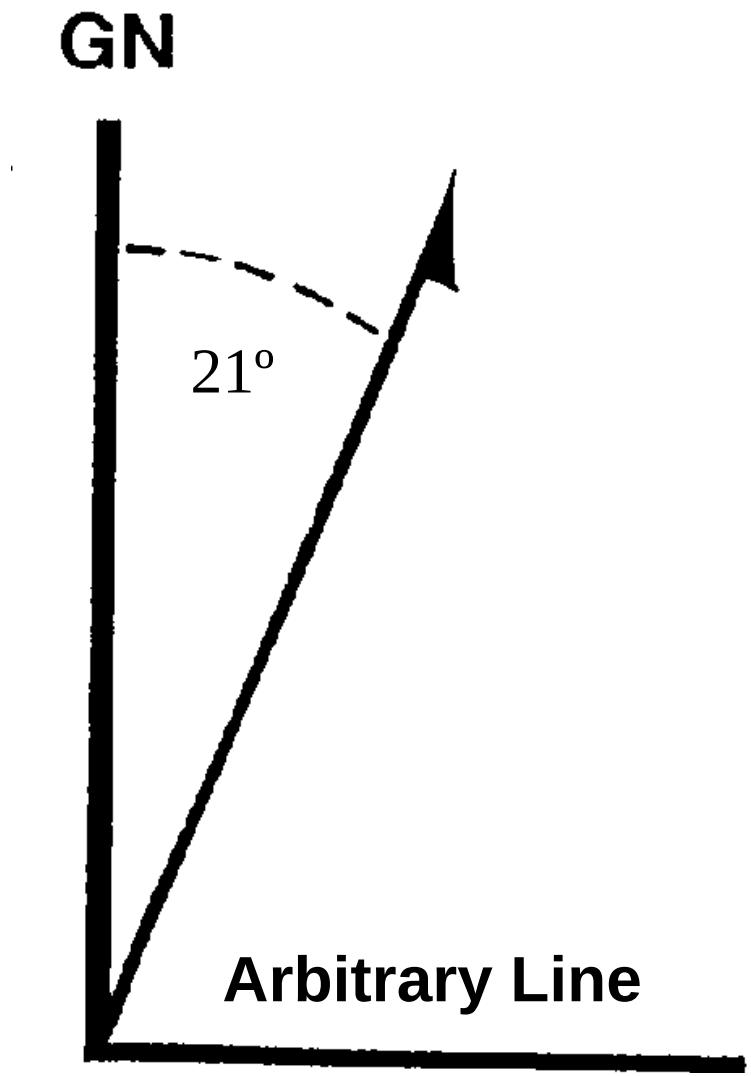
The declination here at
The Black Rapids Training Site
is easterly 21 degrees.

FOR AN EASTERLY DECLINATION:

To convert a magnetic azimuth
to a grid azimuth
ADD the G-M angle.

To convert a grid azimuth to a
magnetic azimuth
SUBTRACT the G-M angle.

A good way to remember
this is to think of Grid
as a General and Magnetic
as a Major. If you want to
convert a Major into a
General you need to ADD rank.
If you want to demote a General to
a Major you need to SUBTRACT rank.

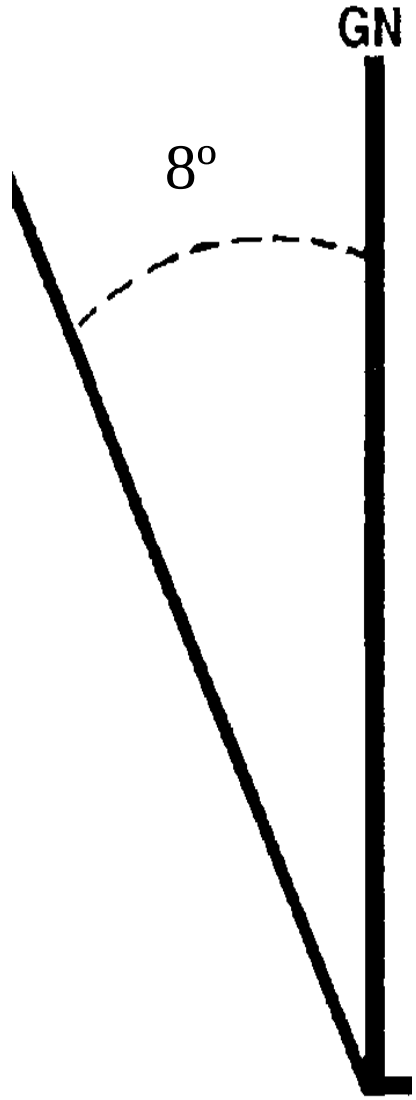


WESTERLY DECLINATION

FOR A WESTERLY DECLINATION THE OPPOSITE RULES APPLY:

To convert a magnetic azimuth to a grid azimuth
SUBTRACT the G-M angle.

To convert a grid azimuth to a magnetic azimuth
ADD the G-M angle.



Practical Exercise
Grid and Magnetic Azimuth

1. *Convert 39 degrees grid azimuth to a magnetic azimuth. (Given an easterly G-M angle of 21 degrees)*

   18 degrees

2. *Convert a 356 degree grid azimuth to a magnetic azimuth. (Given a westerly G-M angle of 15 degrees)*

   11 degrees

3. *What are the grid and magnetic azimuths from WF59554880 to WF56604583?*

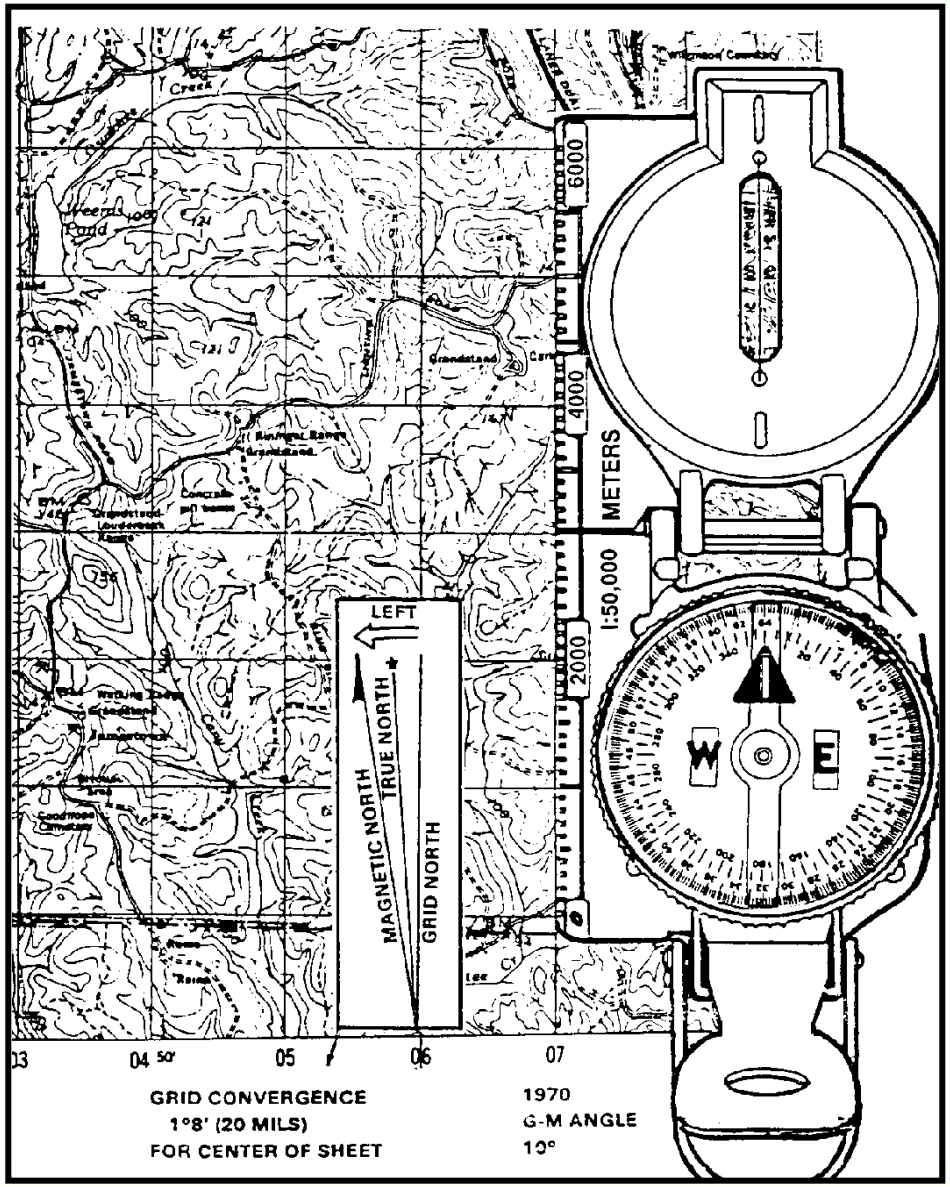
   Magnetic = 225 degrees
   Grid = 204 degrees

Questions?

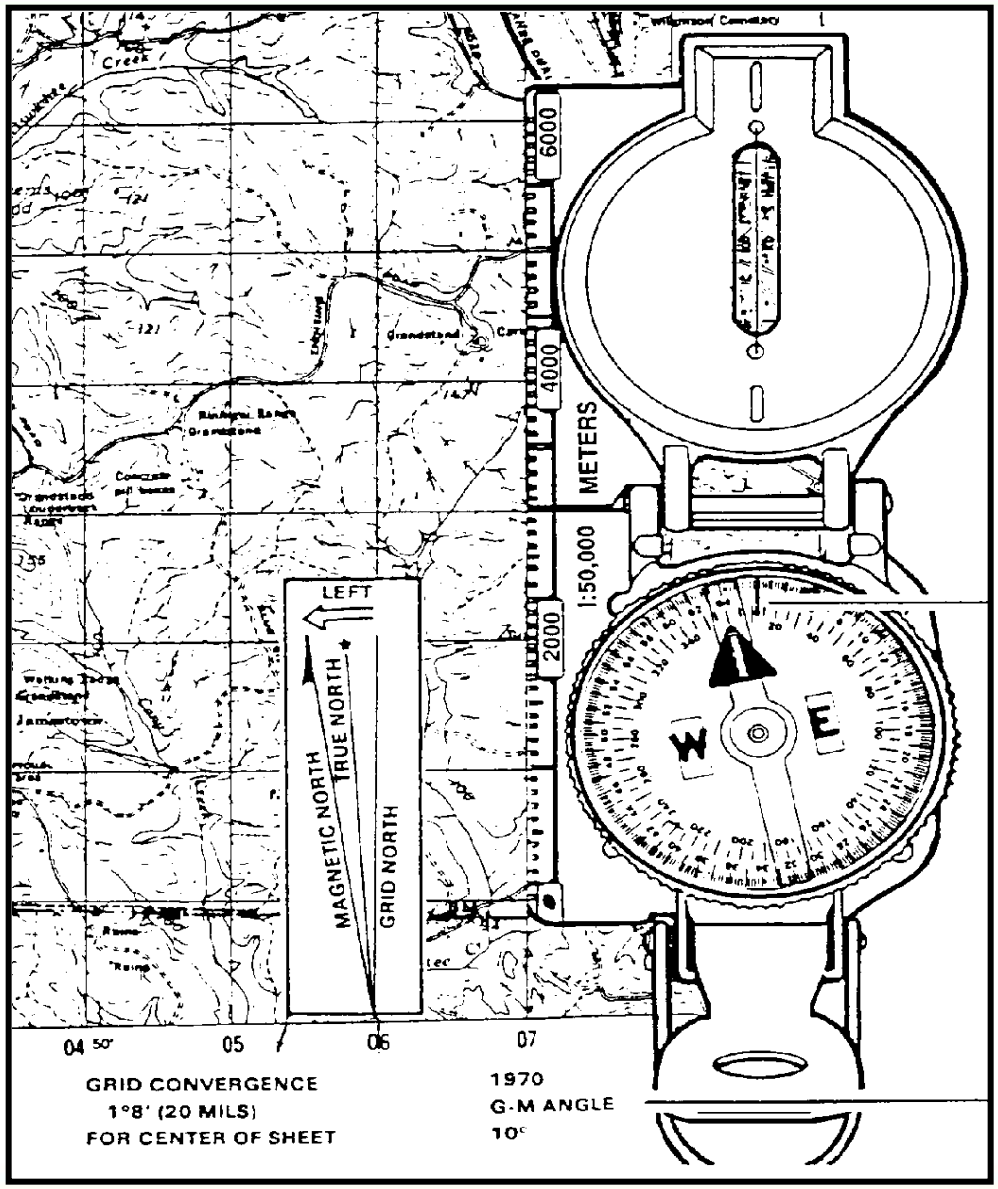
Module 3

1. Orient a Map
2. Polar Coordinates
3. Intersection
4. Resection
5. Modified Resection
6. Use of Altimeter as an aid to navigation

Orient a Map

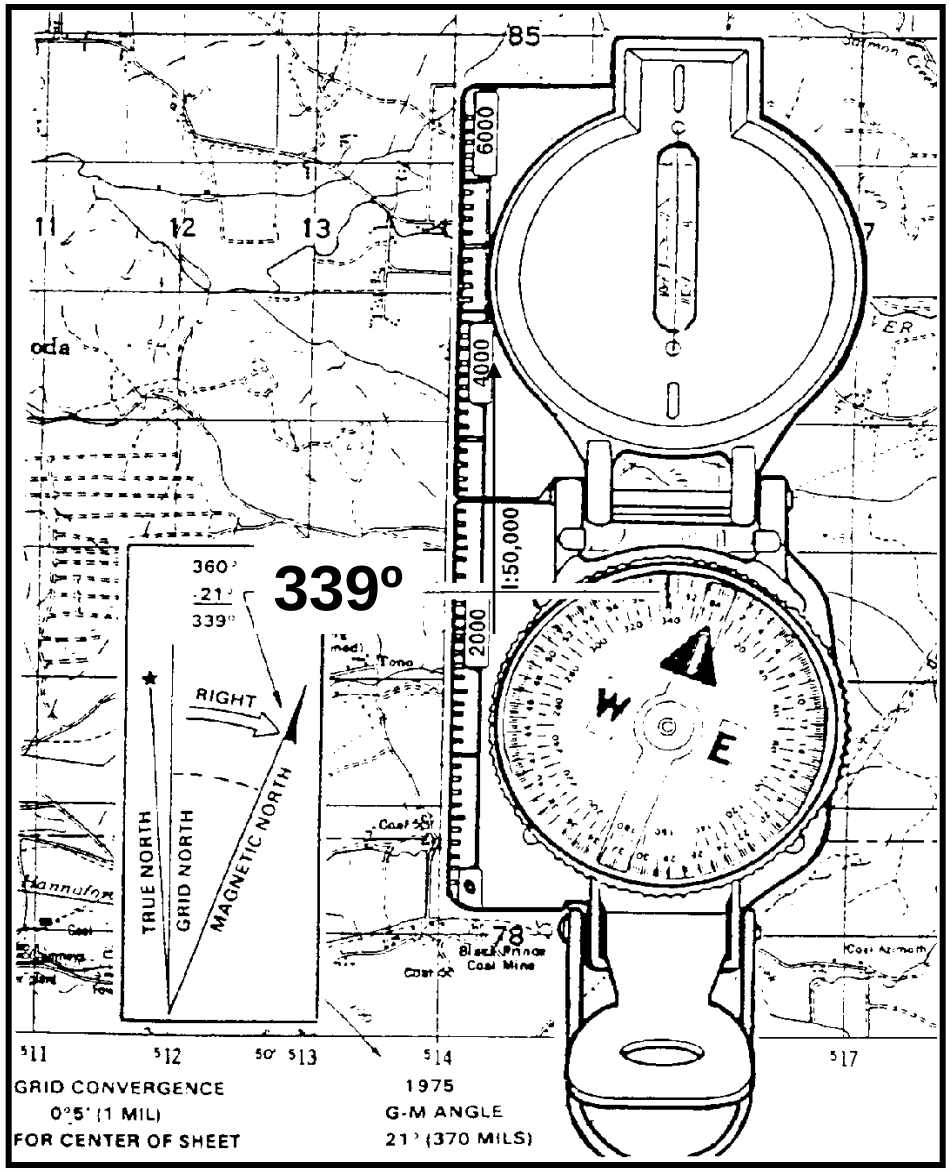

LEFT
MAGNETIC NORTH
TRUE NORTH
GRID NORTH
6000
4000
2000
METERS
1:50,000
W
E
03
04
05
06
07
GRID CONVERGENCE
1°8' (20 MILS)
FOR CENTER OF SHEET
1970
G-M ANGLE
10°

Orient a Map with a Westerly Declination

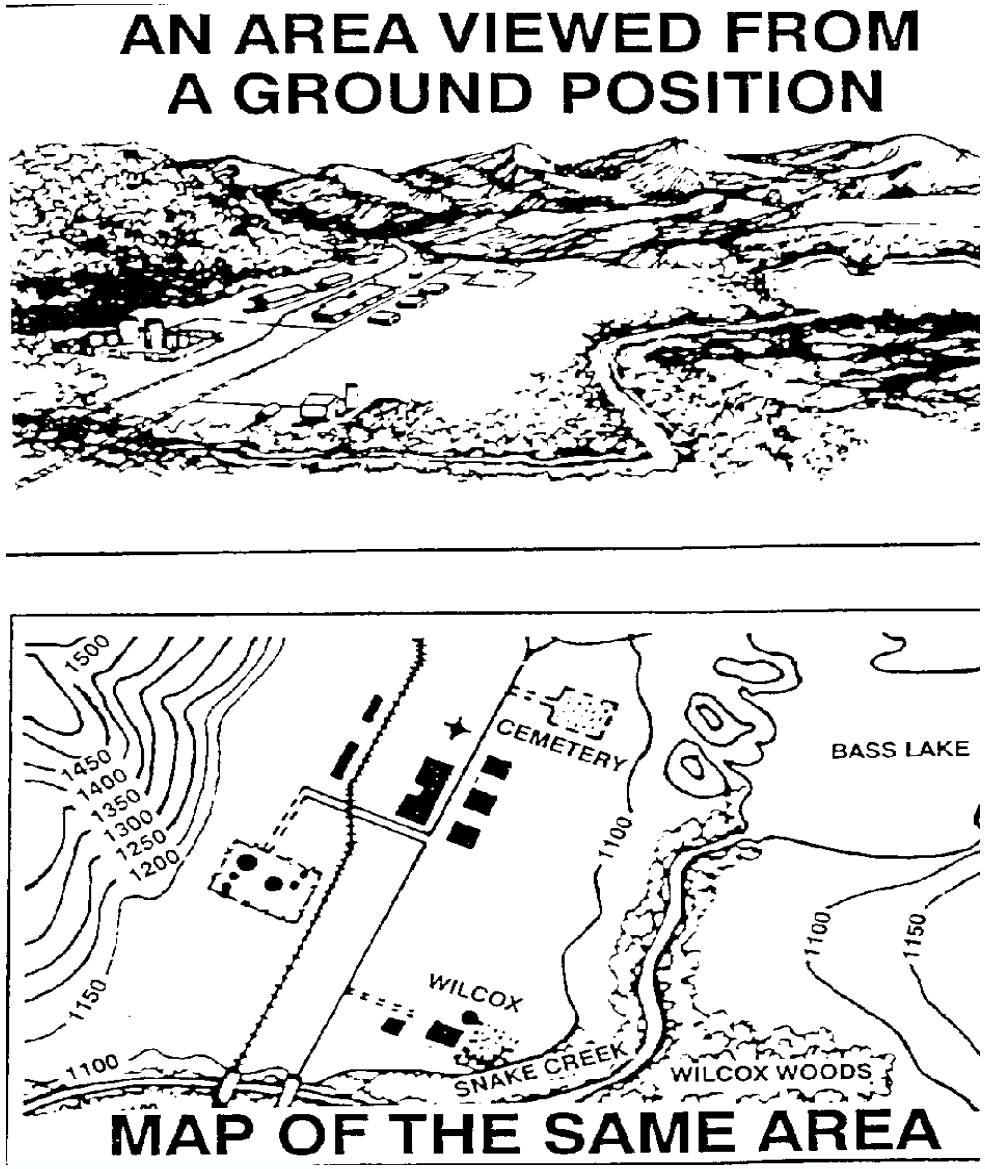


10°

Orient a Map
with an Easterly Declination



Orient a map using terrain association

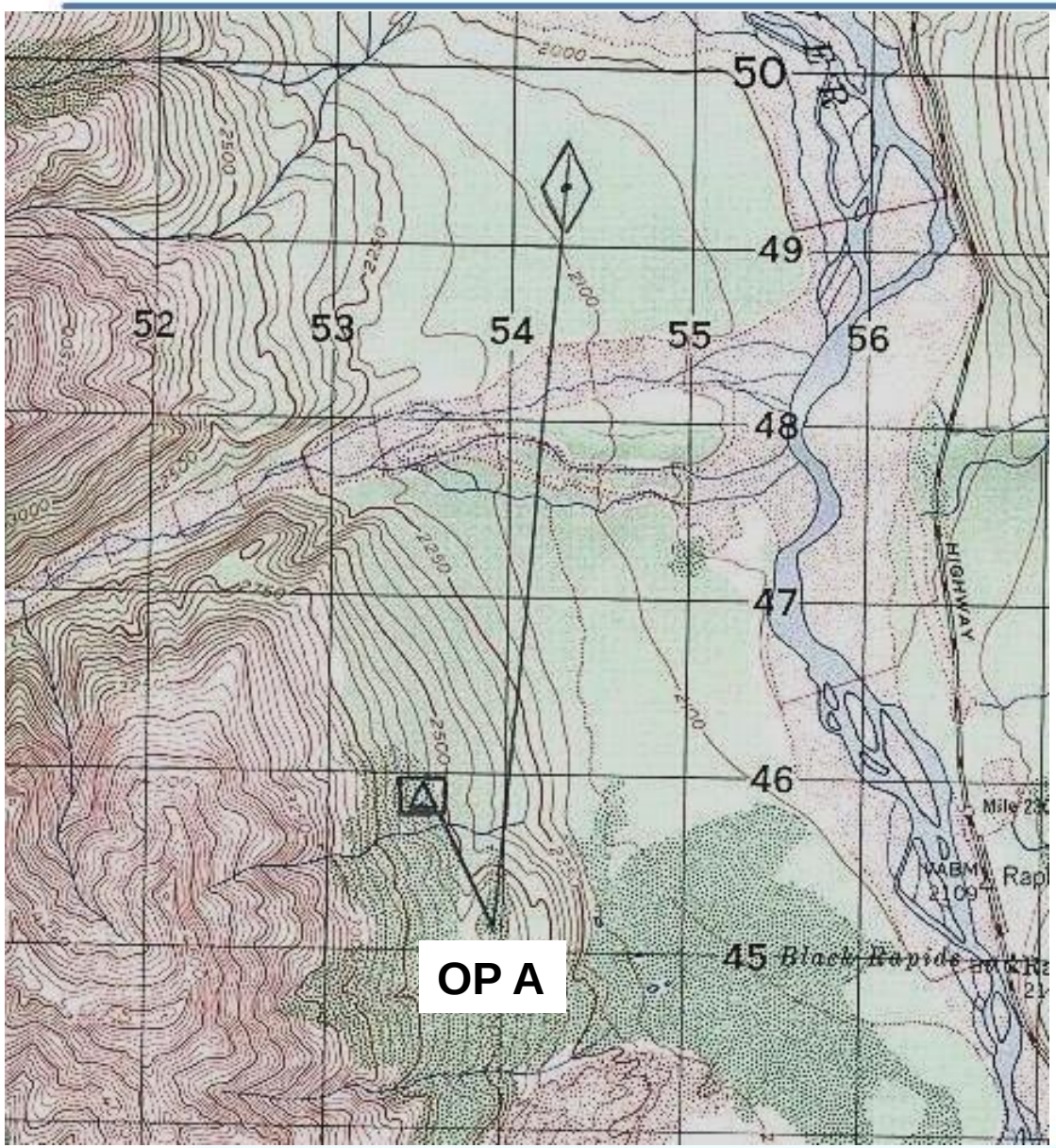


Polar Plot

Polar plot is a method of locating or plotting an unknown point using only a direction and a distance from a known starting point. The procedure is as follows:

(1) Plot your location on the map.
(2) Determine the magnetic azimuth to the unknown point.
(3) Convert the magnetic azimuth to grid azimuth and draw this azimuth on your map from your known location.
(4) Estimate the distance to the unknown object in meters(using a laser ranger finder increases the accuracy of this method).
(5) Determine the location of the unknown point by marking the distance estimate on the azimuth line from the known point. Determine the grid coordinates to the desired accuracy.

Polar Plot Demonstration



From OP A (WF53944513) you can see a tank in the open. What is the six digit grid coordinate of the tank?

The magnetic azimuth from the OP to the tank 343°.
+21° G-M angle
4° GRID azimuth

The distance to the tank is approximately 4200m.

This puts the tank at WF543493.

Polar Plot Practical Exercise

Your location is OP A at WF58205135.

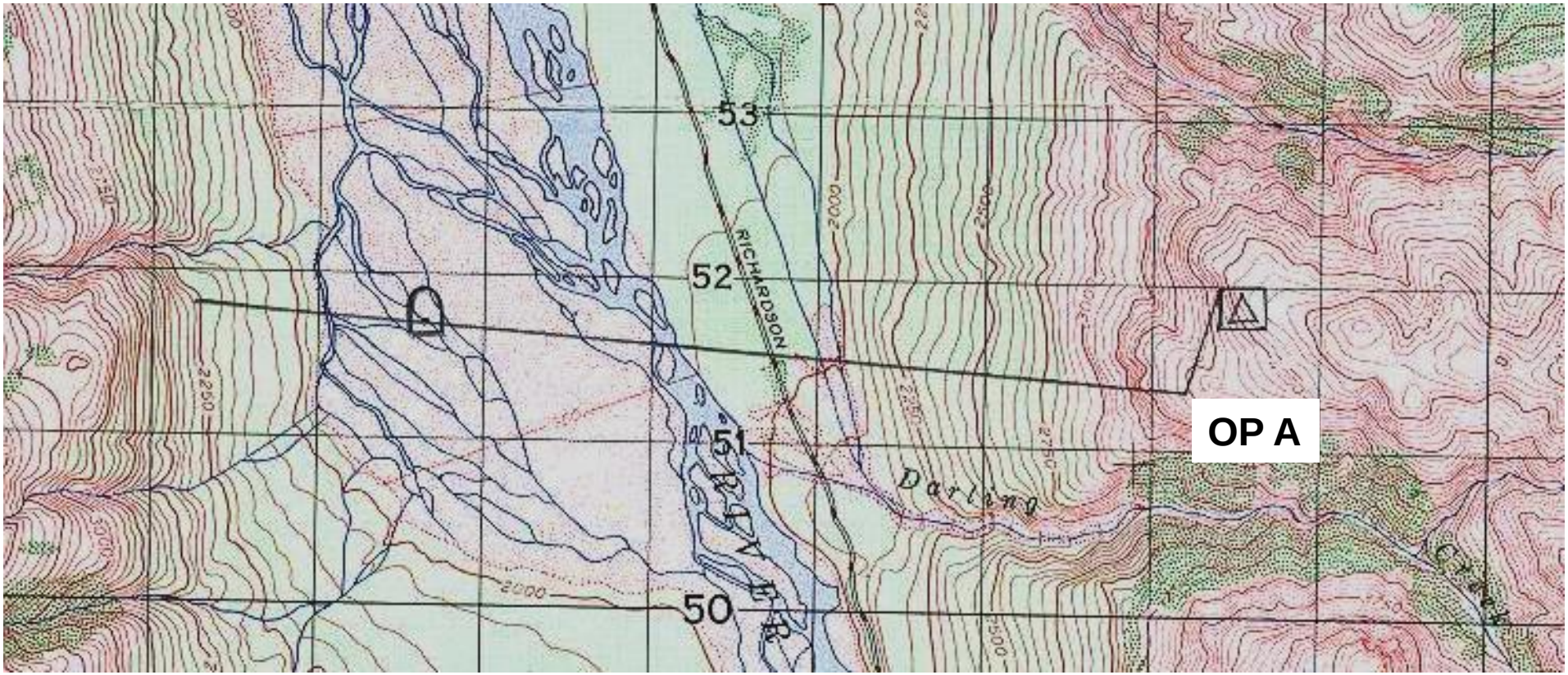
You spot an enemy vehicle in the open just across the Delta River.

The magnetic azimuth to the enemy vehicle is 253º.

You estimate the distance to the vehicle to be 4600m.

What is the six digit grid coordinate to the enemy vehicle?

Polar Plot PE Solution



OP A WF58205135

253° mag. azimuth

+21° G-M angle

274° *GRID azimuth*

Distance: 4600m

Enemy vehicle at grid coordinate WF536517

Intersection

Intersection is the location of an unknown point (such as enemy targets) by successively occupying a least two (preferably three) known positions on the ground and then map sighting on the unknown location. The procedure is as follows:

(1) Locate and mark your position on the map.
(2) Determine the magnetic azimuth to the unknown position using the compass.
(3) Convert the magnetic azimuth to grid azimuth.
(4) Using a protractor, draw a line on the map from your position on this grid azimuth.
(5) Move to a second location and repeat steps 1-4.
(6) The location of the unknown point is where the lines cross on the map. Determine the grid coordinates to the desired accuracy.

Intersection Demonstration

Your platoon has two Observation Posts in front of your position.

OP A is located at WF 58105265.

OP B is located at WF 58205135.

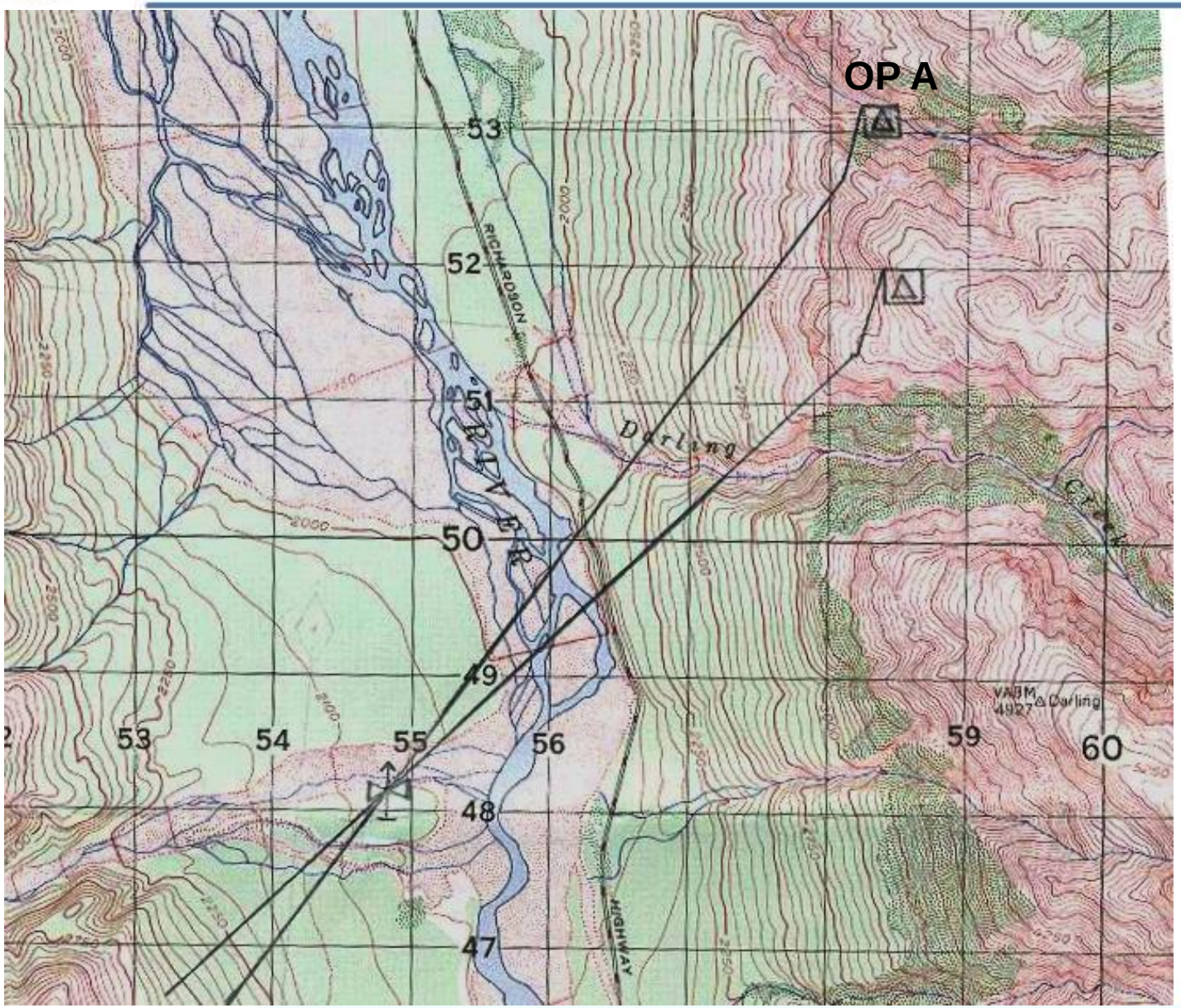
OP A and OP B report that a helicopter has set down southwest of your position.

OP A reports that the helicopter is on a magnetic azimuth of 195º.

OP B reports that the helicopter is on a magnetic azimuth of 205º.

Determine the six digit grid coordinate to the helicopter.

Intersection Demonstration



OP A
195° Mag.
+21° G-M angle
216° GRID

OP B
205° Mag.
+21° G-M angle
226° GRID

Helicopter location
Is WF548481.

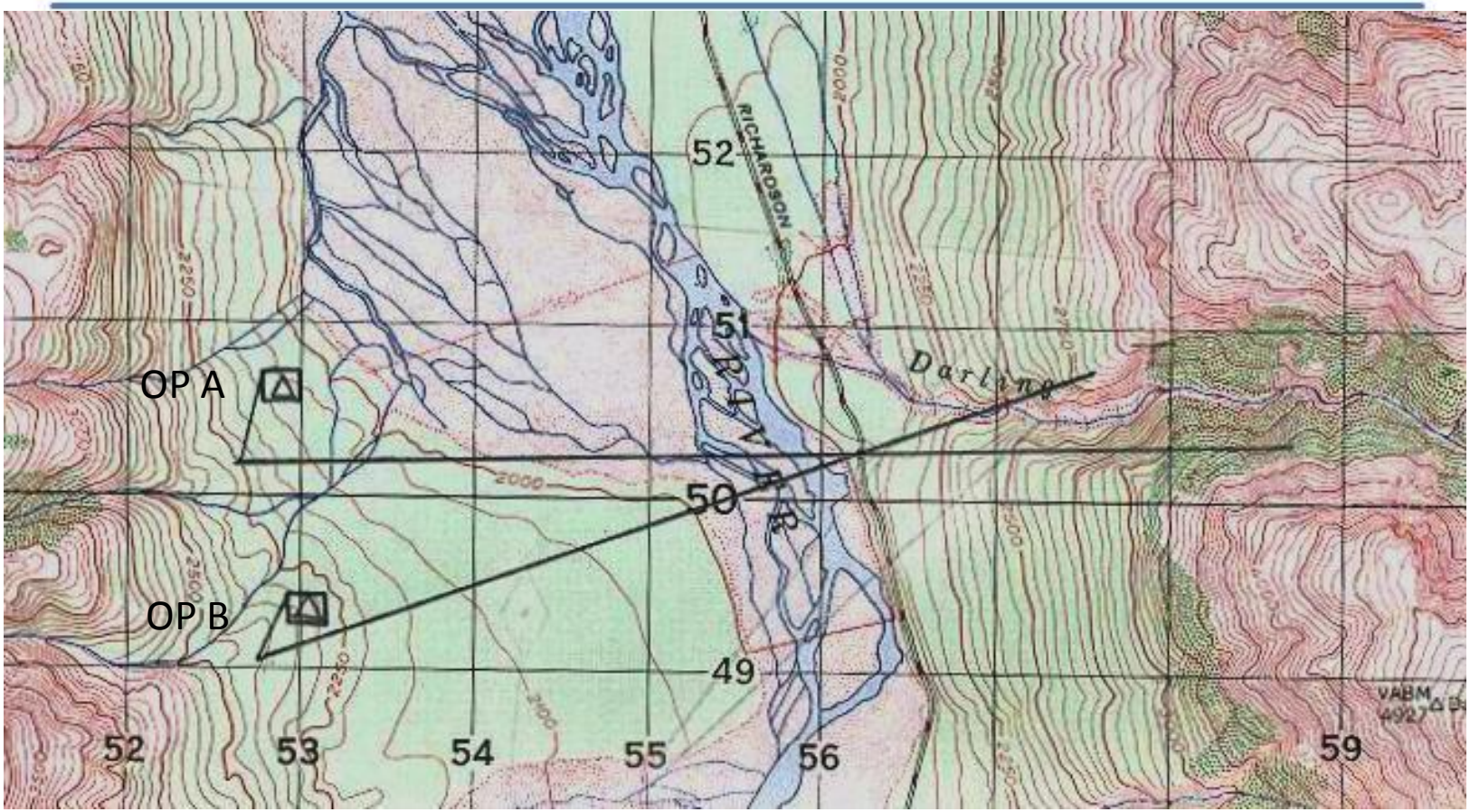
Intersection Practical Exercise

OP A, located at WF 52665019, observes enemy activity on a magnetic azimuth of 67 degrees.

OP B at WF 52754904 sees the same enemy activity on a magnetic azimuth of 49 degrees.

What is the enemy location to the nearest 10 meters?

Intersection PE Solution



OP A WF52665019
67° Mag. azimuth
+21° G-M angle
88° GRID azimuth

OP B WF52754904
49° Mag. azimuth
+21° G-M angle
70° GRID azimuth

Enemy activity at WF56235026

Resection

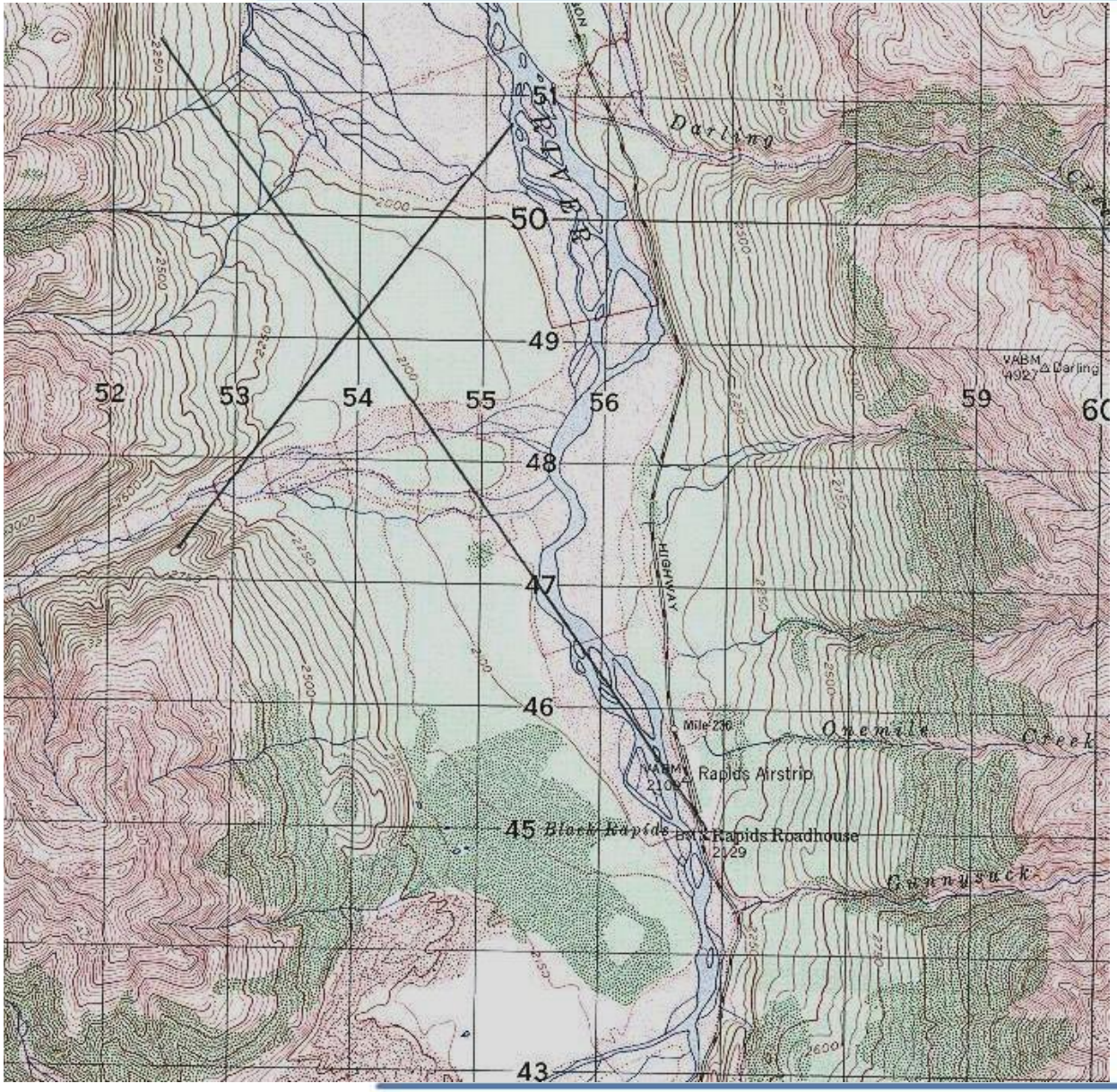
Resection is the method of finding your location (your location being the unknown point), by sighting in on two known points. Resection is generally used when you are navigationally challenged (lost). The procedure for this is as follows:

(1) Orient the map using the compass.
(2) Identify two or three known distant locations on the ground, then find and mark them on the map.
(3) Measure the magnetic azimuth to one of the known positions from your location using a compass.
(4) Convert the magnetic azimuth to grid azimuth.
(5) Convert the grid azimuth to a back azimuth. Using a protractor, draw a line for the back azimuth on the map from the known position back toward your unknown position.
(6) Repeat steps 3, 4 and 5 for a second position and a third position, if desired.
(7) The intersection of the lines is your location. Determine the grid coordinates to the desired accuracy.

Resection Demonstration

Your platoon was engaged in a fierce firefight. The enemy has pulled back due to the overwhelming volume of firepower that your platoon hit him with. You have become separated from the rest of the platoon. You can see the Rapids roadhouse and the top of a hill in WF5247. You shoot magnetic azimuths to both of these features. The Rapids Roadhouse is at 124 degrees, and the Hilltop is at 196 degrees. You quickly convert the azimuths to grid azimuths, convert these to back azimuths and plot them on your map. Determine your location to within 10 meters.

Resection Demonstration



Rapids Roadhouse
124° Mag
+21° G-M angle
145° GRID
+180° (Add)
325° Back azimuth.

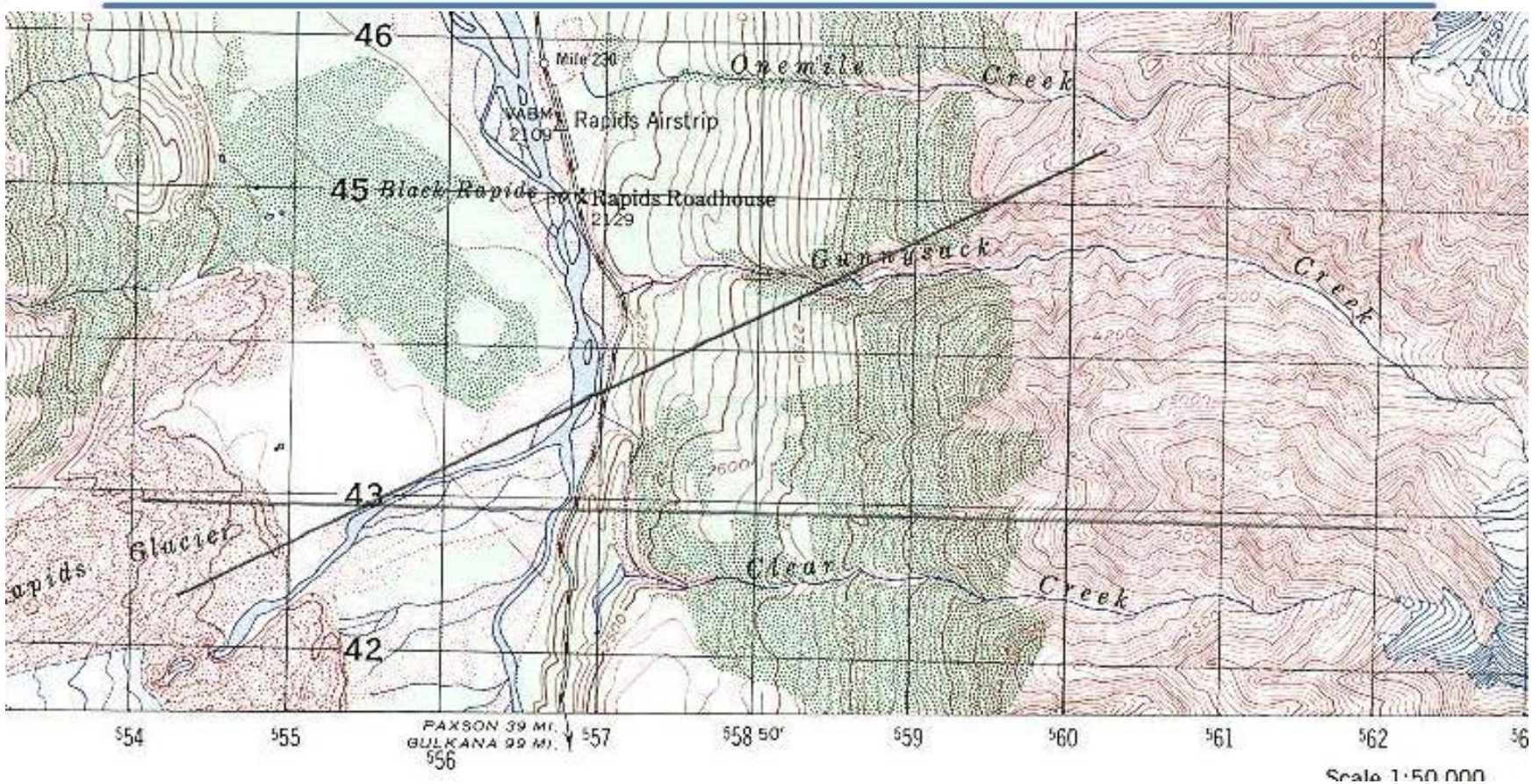
Hilltop
196° Mag
+21° G-M angle
217° GRID
-180 (Subtract)
37º Back azimuth

This places
you at
WF 53974914.

Resection Practical Exercise

Your location is unknown. You can see the Hilltop in WF6045 that is south of One Mile Creek. From your position, it is on a magnetic azimuth of 42 degrees. You also see the top of a mountain in grid square WF 6242 at a magnetic azimuth of 69 degrees. Where are you located?

Resection PE Solution



Hilltop WF6045
42° mag. azimuth
+21° G-M angle
63° GRID azimuth
+180° (ADD)
243° back azimuth

Gunnysack Mt. WF6242
69° mag. azimuth
+21° G-M angle
90° GRID azimuth
+180° (ADD)
270º back azimuth

This places you at
WF55514294

Modified Resection

Modified Resection is a method of locating your position on the map when you are located on a linear feature on the ground, such as a road, canal, or stream. The procedure is as follows:

(1) Orient the map using the compass.
(2) Find a point that can be identified on the ground and on the map. Mark this point on the map.
(3) Determine the magnetic azimuth from your location to the distant known point.
(4) Convert the magnetic azimuth to a grid azimuth.
(5) Convert the grid azimuth to a back azimuth. Using a protractor, draw a line for the back azimuth on the map from the known position back toward your unknown position.
(6) Your position is where the line crosses the linear feature. Determine the grid coordinates to the desired accuracy.

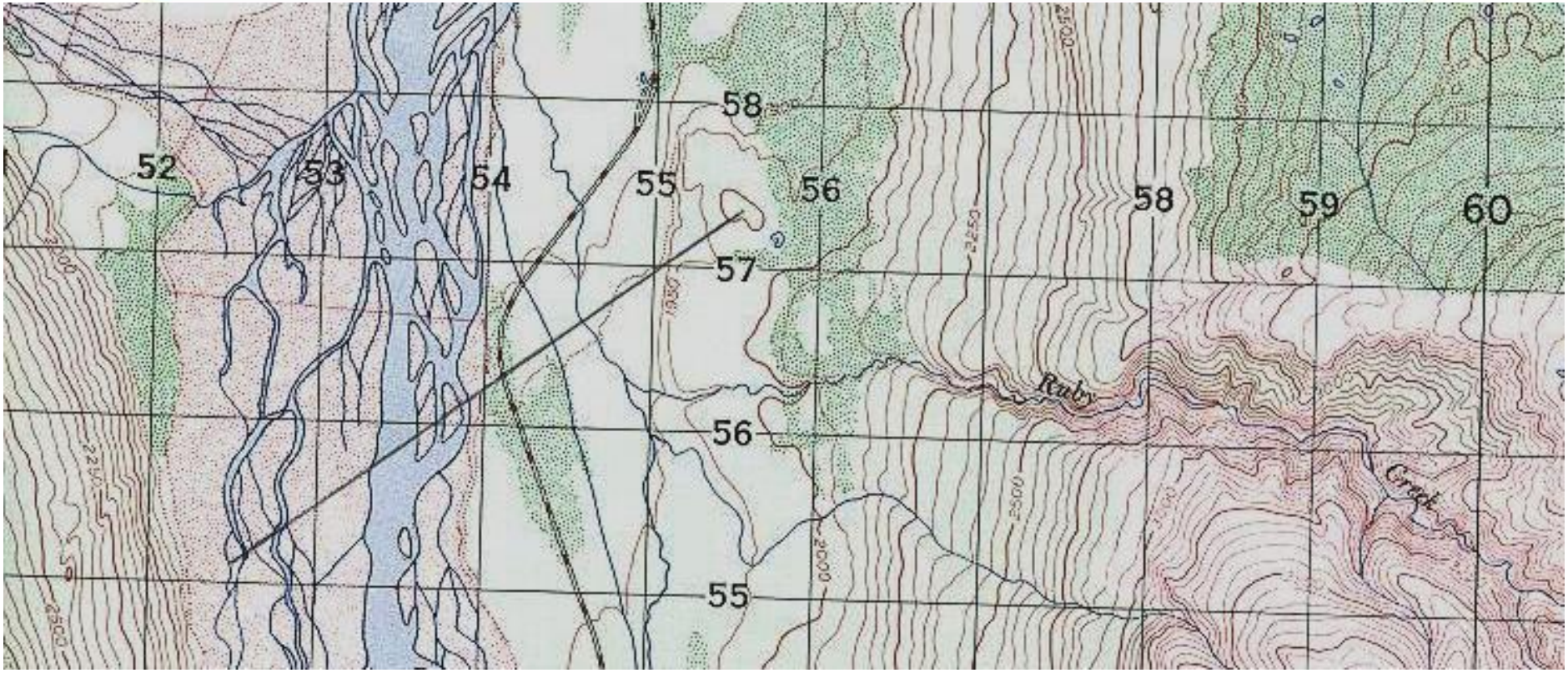
Modified Resection Demonstration

Your Stryker platoon is moving down the Richardson Highway and you need to do a quick check on your location.

You can see the hilltop located in WF 5557. You shoot a magnetic azimuth to it of 33 degrees.

What is your eight-digit location?

Modified Resection Demonstration



33° Mag. azimuth

+ 21° G-M angle

54°GRID azimuth

+180° (ADD)

234° Back azimuth

The line intersects the highway at WF54145630 This is your location.

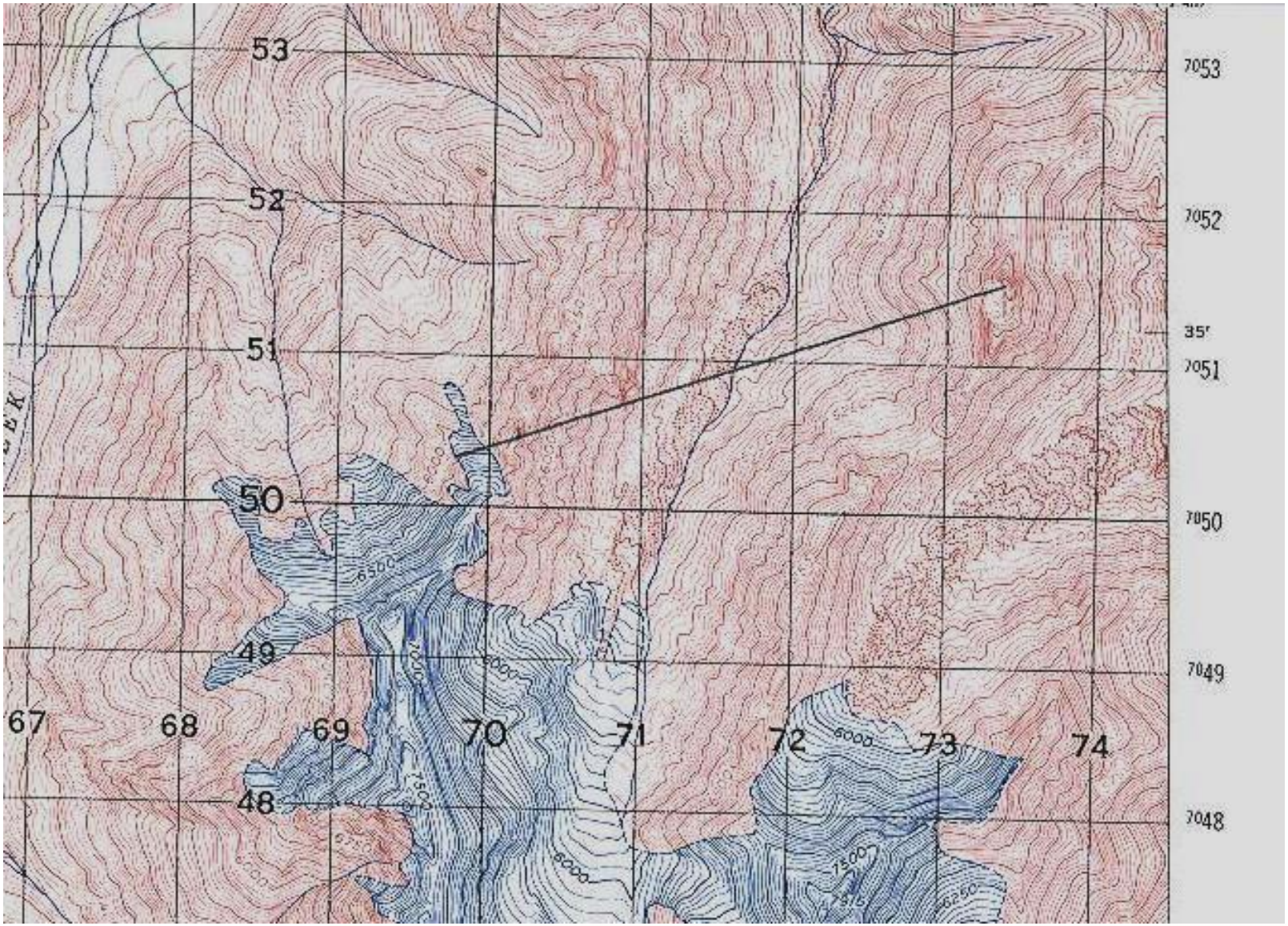
Modified Resection Practical Exercise

Your platoon is moving down Riley creek and you need to do a quick check on your location.

You can see the hilltop located in WF 7351. You shoot a Magnetic azimuth to it of 50 degrees.

What is the eight-digit grid to your location?

Modified Resection PE Solution



50° mag. azimuth
+21° G-M angle
71° GRID azimuth

71° GRID azimuth
+180º (ADD)
251° Back azimuth

The line intersects Riley Creek at WF71595094. This is your location.

Altimeter

- Altimeters provide one simple piece of information – elevation
- Available in digital and analog (NWTC uses analog)
- Works like a barometer – measures the pressure of the air
- Barometers are scaled to read air pressure in inches or millimeters of mercury
- Altimeters are scaled to read in feet or meters above sea level
- GPS can also serve as an altimeter by providing elevation measurements

How to Use the Altimeter

- Must be set to a known elevation
- Should be periodically checked and re-set to new elevation upon reaching a known point
- To read, hold level in the palm of one hand; look directly down on the needle, your eyes about one foot above the device
- Tap the device lightly several times to reduce friction in the device
- Take several readings to improve accuracy

Uses of the Altimeter

- Calculate rate of movement
- Can help track progress during travel along a trail, road, ridge, creek bed etc.
- Used during route planning
- Used during travel to help determine where a direction change is required
- Determine present location using modified resection

Modified Resection with Altimeter

You can determine your location by sighting in on a known point and using your altimeter to determine elevation. The procedure is as follows:

(1) Orient the map using the compass.

(2) Find a point that can be identified on the ground and on the map. Mark this point on the map.

(3) Take a magnetic azimuth to a known feature.

(4) Convert the magnetic azimuth to grid azimuth.

(5) Convert the grid azimuth to a back azimuth and plot this on the map from the known feature back towards your location.

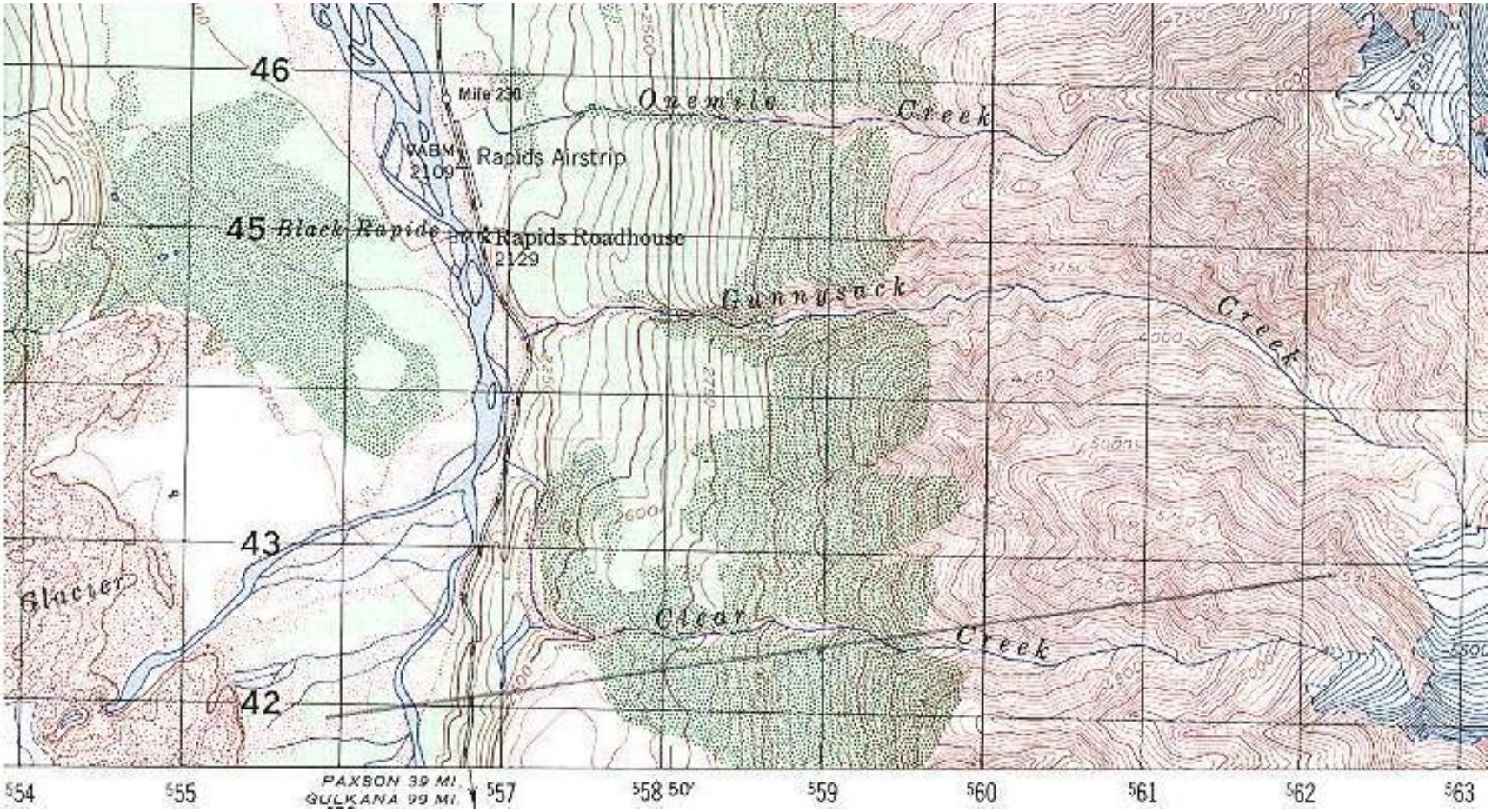
(4) Take an elevation reading.

(5) Find the elevation (using contour lines) along the grid azimuth line that you have drawn on the map. This is your location. Determine the grid coordinates to the desired accuracy.

Modified Resection with Altimeter Demonstration

You are at an elevation of 2,750 feet. You can see the top of a mountain in grid square WF6242. You need to determine your location. The magnetic azimuth to the mountain is 60 degrees. What is your 6 digit grid?

Modified Resection with Altimeter Demonstration



60° Mag. azimuth

+ 21° G-M angle

81° GRID azimuth

+ 180° (ADD)

261° back azimuth (Plot this from hilltop)

Your location is the point that the plotted azimuth crosses the 2750 contour line: WF580423

Modified Resection With Altimeter (cont.)

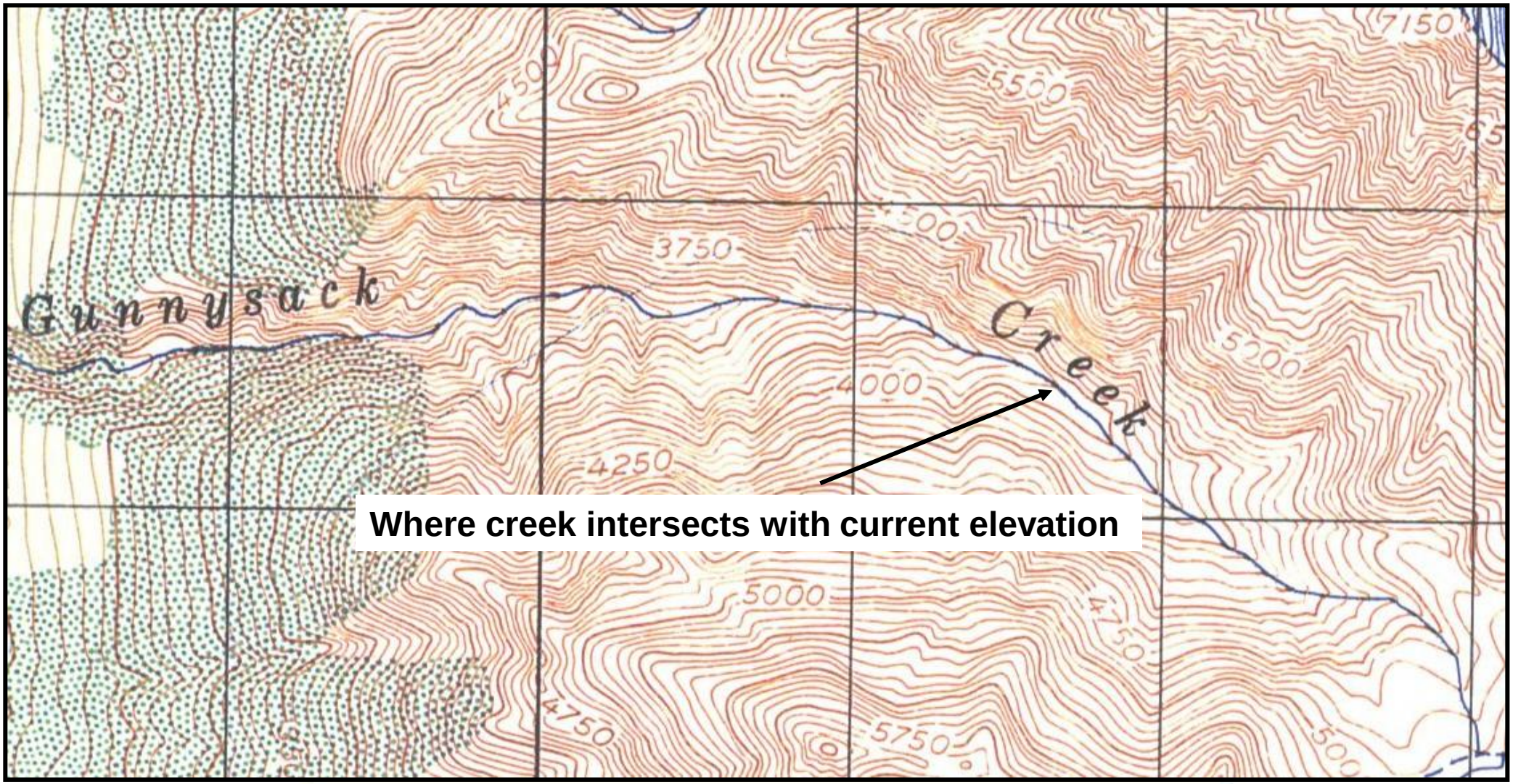
If you are walking on a linear feature depicted on the map with a consistent gain or decrease in elevation (eg. up a creek bed), you can determine your location by your specific elevation on the linear feature.

Modified Resection with Altimeter Practical Exercise

You are walking east on Gunnysack creek, and your altimeter is reading 3950 feet. What is your 6 digit grid?

Modified Resection w/ Altimeter PE Solution

Your location: WF 617444



Questions?

Summary

Action: Navigate from one point on the ground to another in snow covered and/or mountainous terrain while dismounted

Condition: In a field environment, given a map, compass, protractor and altimeter

Standard: Soldier scored a 70% or better on the land navigation written practical exercise (BMC and CWLC). Soldier found 3 of 4 points within five hours (BMC) on the land navigation course.