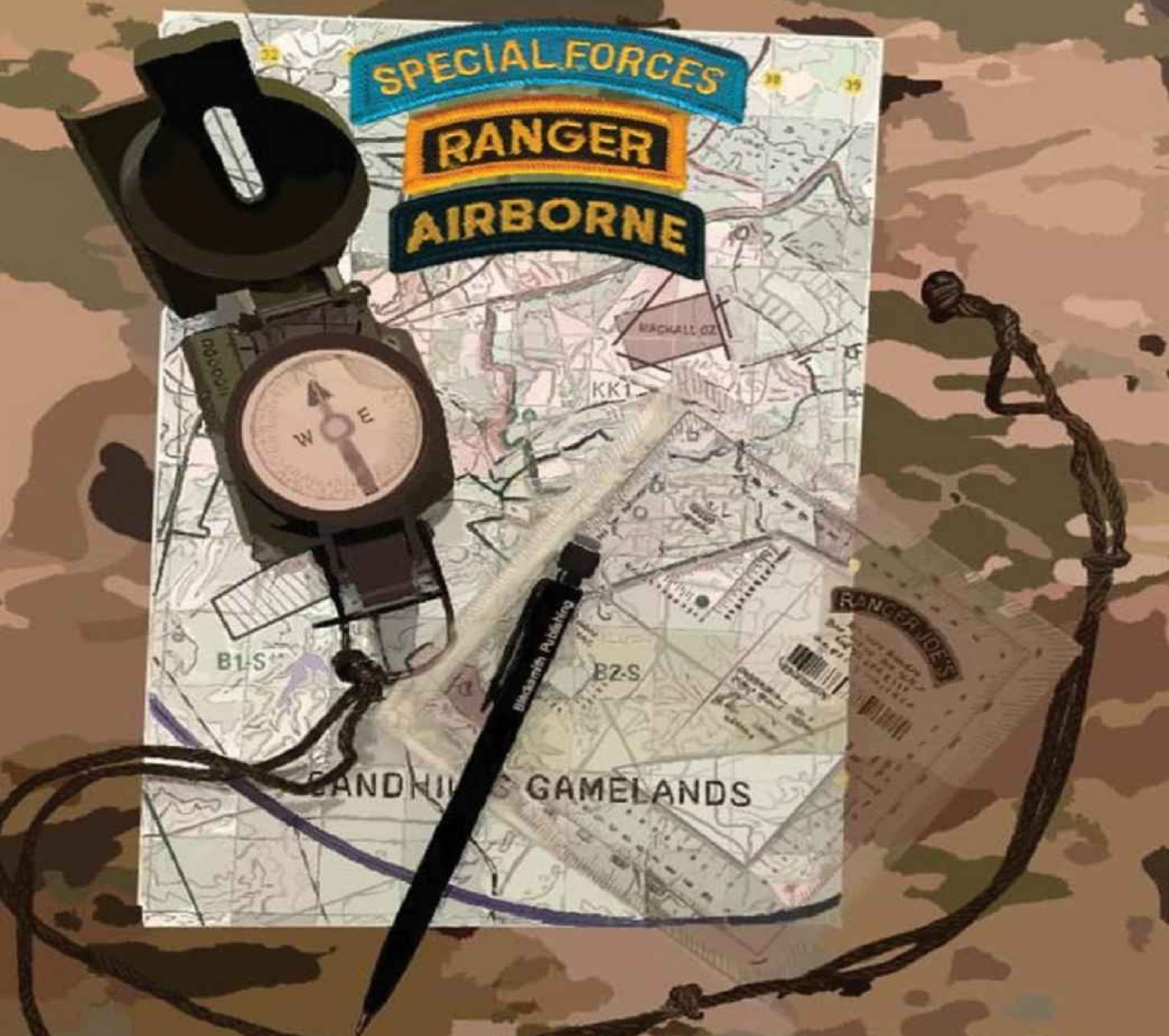
Land Navigation
From Start to Finish



Chris Imperial

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For the leaders of America’s Armed Forces, I offer these tools to help you in your efforts to lead with excellence. The troops you lead deserve the best. Godspeed in all your endeavors!

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Chris Imperial

Blacksmith Publishing
Fayetteville, North Carolina

"In a fight between a bear and an alligator,
it is the terrain which determines who wins."
– Jim Barksdale

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Preface

Freedom of movement, our right as individuals to travel from place to place is a fundamental human right. This right includes not only visiting places, but changing the place where we choose to reside or work. Therefore, learning land navigation skills is the same as studying how to be free; the ability to move from point to point knowing our location throughout our travels. The truly liberated are never lost.

The information in your hands was originally compiled, organized and presented for civilian Search and Rescue personnel working throughout the United States. In 2019, I was approached by cadre assigned to the United States Army John F. Kennedy Special Warfare Center and School (USAJFKSWCS) and asked if I would be willing to take my instructional material and write a book for soldiers attending US Army Special Forces training; specifically to assist them in satisfactorily completing the STAR Land Navigation Course. I agreed to the task and dug back into the Army's land navigation manual, and surprise, it was the same old manual with a new number.

Now admittedly, there is a lot of really good information in the manual, just not the information necessarily needed while busting through a draw in the middle of the night with a map and compass in our hand moving across unfamiliar ground. So this is how this book is laid out and the thought process behind it:

- Provide needed knowledge in order to pass a land navigation course such as the STAR exam.
- Be able to use the book as a lesson plan when assigned the task of teaching others land navigation skills.

I have done my best to format this book to replicate, as much as possible, how I would teach these topics in person, one on one, or in a classroom environment. The information is purposely designed to be quick to find, simple to understand, and easy to teach. Each chapter is designed to help the user better understand necessary land navigation skills and assist the practitioner, if needed, explain the skills to others.

This book is broken down into ten chapters covering basic fundamentals up to advanced techniques, with short quizzes at the end of each chapter as a check on learning. The final chapter covers some advanced skills and techniques or ‘useful tips’. The book is purposely condensed so we can painlessly work our way through the entire book without the feeling that our brain is about to explode from too much information.

It is my heartfelt desire that the information contained within this book will serve the reader well, and especially during those unfortunate times when technology fails us and, like it or not, we’re forced to rely on the basics.

Trust your azimuth and Godspeed,
Chris Imperial

1

Introduction to the Compass

Our ability to understand and take full advantage of and use our equipment correctly, such as our compass, will determine whether or not we achieve success or fail. In the modern age of technology, we've all seen soldiers use their cell phones or a GPS to do point to point land navigation while in the field. And while it is easy to put our full trust and faith in technology, it should only supplement, providing additional information to what we already know, such as confirming our location during a temporary halt or providing an accurate grid coordinate for a report to higher once we've stopped the patrol for the night.

Here's an example of how NOT to use technology. During a training exercise not long ago, I observed a Special Forces (SF) team leading their civilian 'guerrillas' to the target. The point man for the SF team was using his cell phone to navigate. And even though he was using a Military GPS application, which works very well, it was not updating fast enough, therefore the entire group walked around in circles over the same terrain for quite a while. Needless to say, the 'guerrillas' were tired and getting really upset to the point they rebelled against the SF team. The point man's sole reliance on technology in this instance caused the team to lose whatever hard-earned credibility they had previously established with the guerrillas.

In an overwhelming preponderance of instances, the difference between success and failure rests solely on a soldier's desire to learn and master the 'basics'. Developing a strong foundation of basic skills is crucial for success. Land navigation is definitely a basic skill that must be mastered in order to be successful.

Getting to know our compass

The compass is comprised of two halves, the cover and the base, connected by a hinge. The cover holds the sighting wire and luminous sighting dots. The base holds all the inner workings of the compass.

Within the base, we notice a floating dial, which includes the luminous magnetic arrow and scale for the degrees and mils. On the outside of the floating dial, there is a bezel ring which allows us to move the short luminous line. We will discuss the importance of the short luminous line in another chapter. If we move the bezel ring one complete revolution, it has 120 clicks. Each click equals three degrees; information that is useful to know for Soldier of the Month and Promotion Boards. However, the real reason for needing to know that there are 120 clicks and each click equals three degrees is that if it is so dark that we are unable to see the floating dial, we can count the amount of clicks needed to set our azimuth on our compass. A good example would be Panama, under triple canopy jungle, visibility so poor we’re unable to see our own hands in front of our faces. Being able to set the correct azimuth on a compass by counting clicks without relying on the printed degrees on the floating dial is a basic level skill (illustration 1-1).

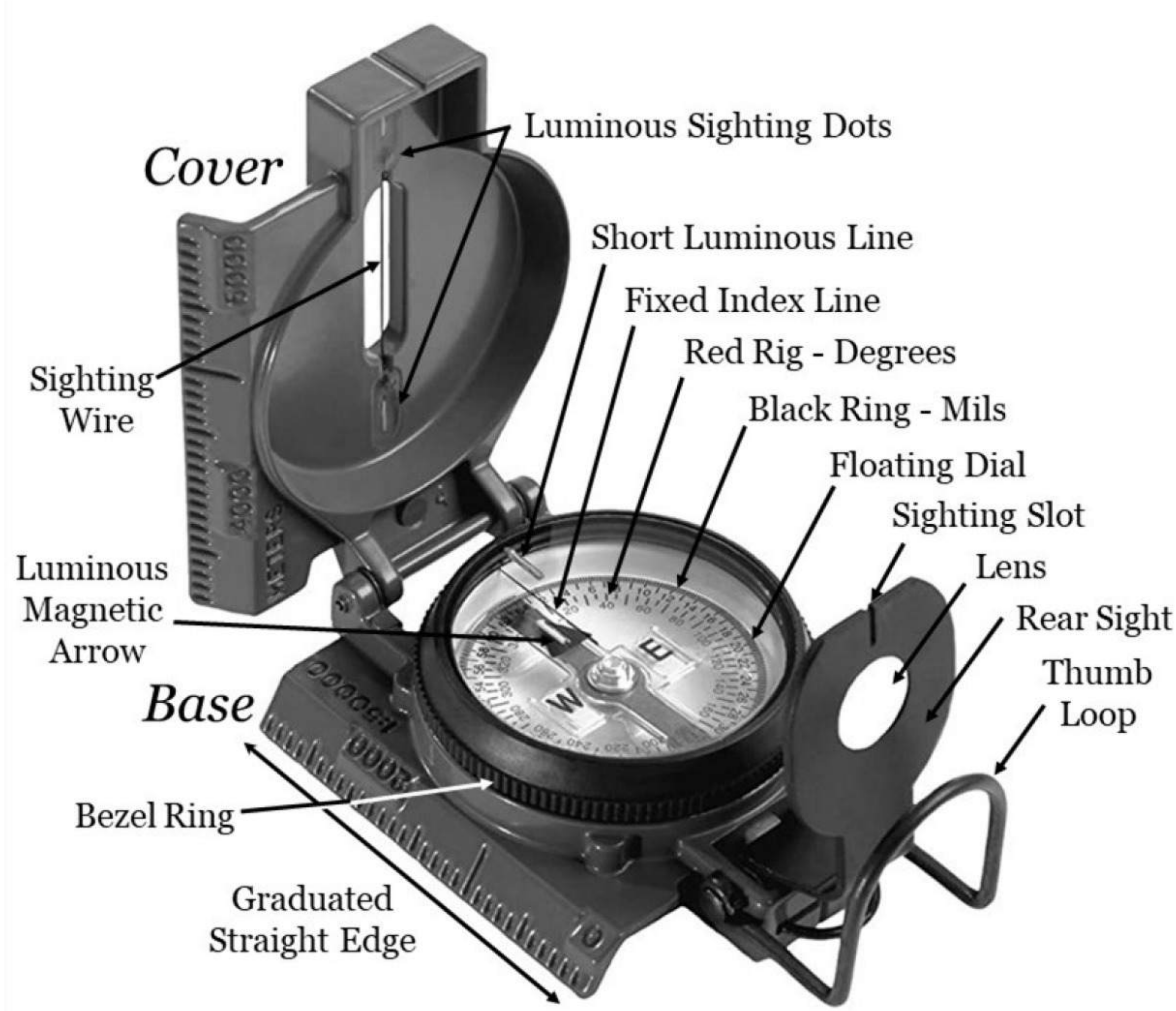


Illustration 1-1 Lensatic Compass.

Next, we'll discuss what my first noncommissioned officer (NCO) called the 'locking lever', but what is actually referred to as the lens or rear sight. The lens or rear sight locks the floating dial and prevents it from getting damaged. When using the compass, make sure the lens is in the 45-degree position with the compass level with the ground, otherwise the floating dial could drag and not provide a true magnetic reading.

The lensatic compass has other features specifically designed for certain tasks that will be discussed in detail later throughout this book. The manual states there are two ways to get an azimuth; the centerhold and compass to cheek techniques.

The centerhold technique is performed by holding the compass using both hands with index fingers running along each side of the base and cover while looking straight down at the floating dial (illustration 1-2 and illustration 1-3).

Illustration 1-2 Centerhold Technique.

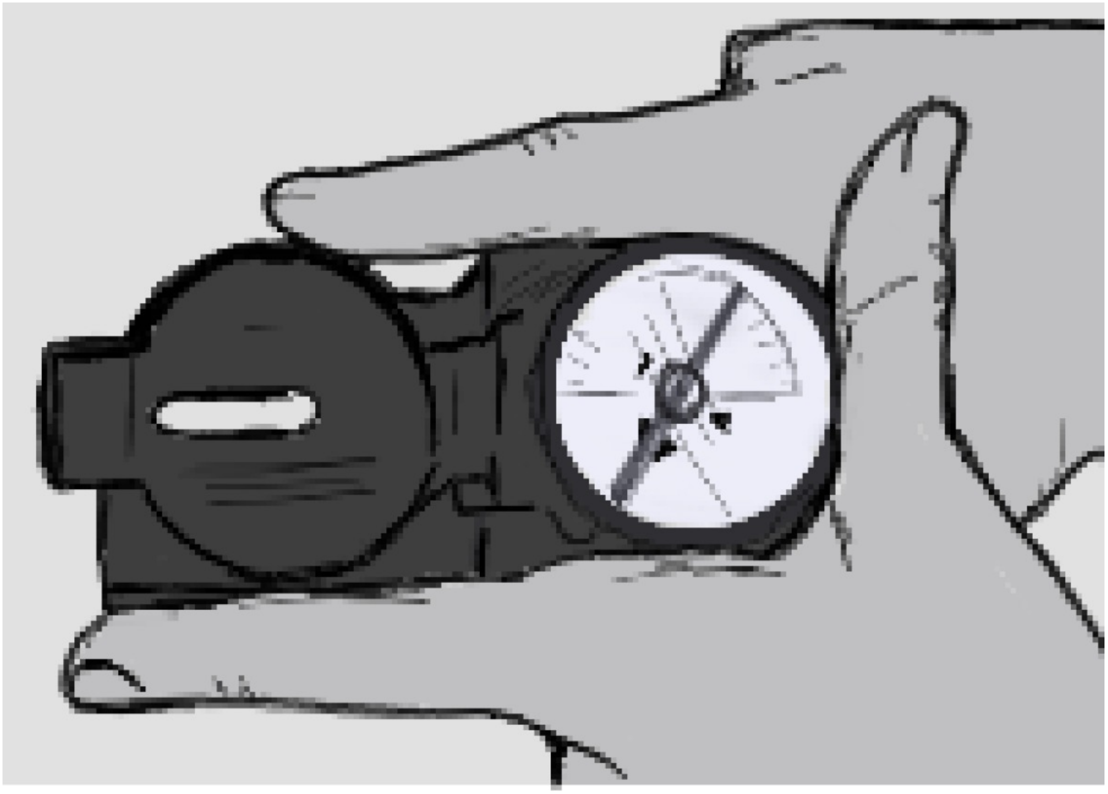


Illustration 1-3 Centerhold Technique.

The compass to cheek method involves bringing the compass up close to our cheek in order to use the sights (illustration 1-4). The technique is primarily used when we need as accurate a heading as possible. A good example would be we've arrived at our predesignated attack point and we're within a couple hundred meters and a specific azimuth from our final point. In land navigation terminology, this is known as dead reckoning.

Both techniques are taught by instructors since, most likely, both techniques are used interchangeably depending on the type of navigation being conducted at any particular time during movement.

Illustration 1-4 Compass to Cheek Technique.

In reality, we'll most likely use a variation of these techniques when moving through the wilderness. A common field technique might look something like the compass lanyard secured to ensure we don't lose our compass, utilizing the thumb loop to attach to either our shirt or chest rig / fighting load carrier (FLC) approximately chest height on our non-firing side for easy access utilizing our non-firing hand. With the lens/rear sight all the way open to the rear, we'll easily be able to hold the compass up in our palm for a quick glance at the short luminous line above the pre-set azimuth. The non-firing hand is used to hold the compass since most of the time our rifle will be in our firing hand while moving through the bush.

The instructors will also cover other features of the compass such as the graduated straight edge and the sighting wire. In the interest of brevity, those features won’t be explained in this chapter.

An important note is <u>always check the compass to ensure its accuracy.</u> If our compass is off and we don’t know it, we are going to find ourselves in a world of hurt and most likely we will fail our land navigation examination.

Check on Learning

Question 1: Explain the importance of the lens/rear sight.

Question 2: How many total clicks on the bezel ring and how many degrees does each click equal?

Question 3: What are the two techniques used to obtain an azimuth / heading using the compass?

Question 4: Of the two techniques used to obtain an azimuth / heading with a compass, which one is the most accurate?

Question 5: True or False: Should you check the accuracy of your compass?

2

Marginal Information and Topographical Symbols

Most people know very little to anything about the information contained in the margins of a map. If it is our desire to become a quiet professional, then this chapter is just another small step toward our destination of belonging to a fraternity of professional warriors. Let's get started.

The map sheet contains a lot of information that enhances our ability to land navigate. We simply need to be able to understand the information in order to put it to good use.

Most of the information is located in the lower margin, but there is also a lot good information located on the sides and the top of the map. Some of the information on the map sheet is crucial to understand in order for us to be able to navigate through the woods. Other information informs us of how accurate the map is and also allows us to order additional maps for the surrounding area.

Using marginal information

For this chapter we'll need our Camp Mackall Military Installation Map, the 'Camp Mackall Special' or any other military map we can get our hands on. Generally, the information is the same for all US government maps. We will be identifying on the map where information is located.

First of all, the definition of a map may be useful. A topographic map is a graphic representation of a portion of the earth's surface drawn to scale on a flat surface as seen from above. Man-made and natural features are depicted by symbols, lines, colors and forms.

Our hopes are that after working with different maps for a while, we will start visualizing the map maker's drawings almost in 3D; imagining the terrain and quickly recognizing if it's somewhere we can go, or more importantly, avoid.

Marginal information

The sheet name is in bold print and is located in two places: the center of the upper margin and the left side of the lower margin. Generally, a map is named for an outstanding feature in the area (illustration 2-1).

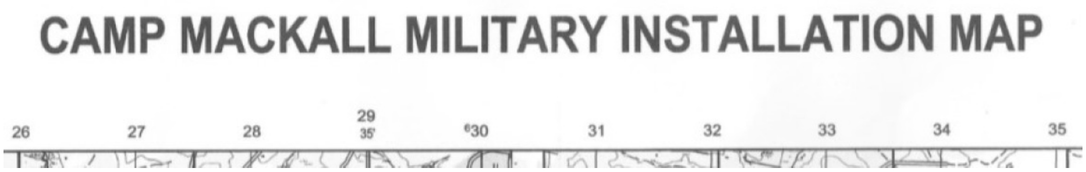


Illustration 2-1 Sheet Name.

The <u>map series name</u> is in bold located in the upper left margin along with the scale. A map series usually includes a group of similar maps at the same scale and the same format designed to cover a particular geographic area or major political subdivision, such as a state within the United States or a country within the European Union. The scale is also located in the center of the lower margin. To the right, in red letters is WGS 84. This will be explained later (illustration 2-2).

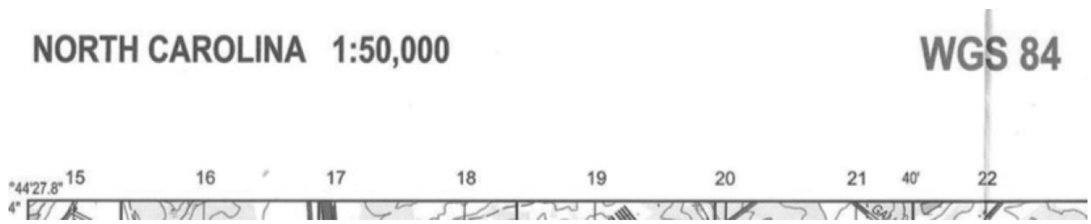


Illustration 2-2 Series Name and Scale.

The <u>edition number</u> appears in the upper right margin and the lower left margin. It represents the age of the map in relation to other editions. The higher the edition number the newer the map. Small units, such as SF teams, frequently rely on larger conventional units for support when deployed. It is important that all units working together are using the same edition, looking at the same version of the same map sheet to avoid mistakes (illustration 2-3).

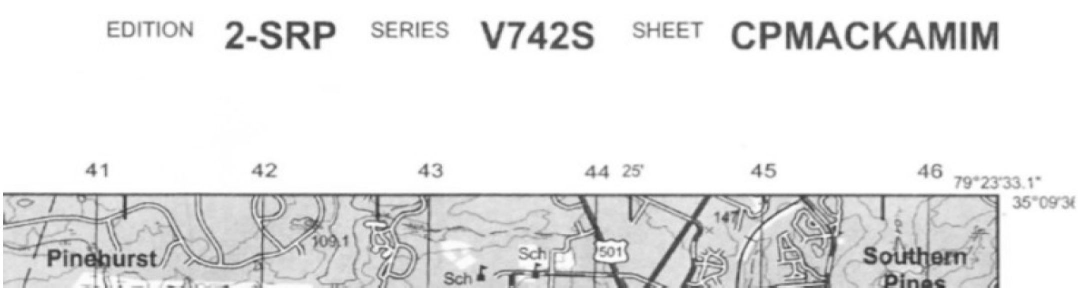


Illustration 2-3 Edition Number.

The <u>series number</u> also appears in the upper right margin and the lower margin. It is a sequence reference expressed either as a four-digit numeral (example 1125) or as a letter followed by a three or four-digit number (V742S).

The ‘S’ stands for ‘special,’ which is a map that was made for a very specific reason. The Camp Mackall map was made for the Special Forces community.

The final item located in the upper right and lower left margin is the sheet number. It is used as a reference in order to acquire additional map sheets. We also find the sheet number in the adjoining sheets diagram located in the lower right of the margin. Because the Camp Mackall map is a ‘special’ map it does not have a typical sheet number. If you look to the lower margin you will see ADJOINING SHEETS. There we see that the Camp Mackall map is a ‘special’ map and is part of four different map sheets. If we are looking at a typical map, it would have a Sheet Number of 50542 or one of the other three sheet numbers around the 50542 number.

The bar scales are located in the center of the lower margin (illustration 2-6). The vertical distance between adjacent contour lines is known as the contour interval. This distance is located just beneath the bar scales. Most military maps are going to be in meters rather than feet.

Directly below the contour interval is the ellipsoid information. An ellipsoid or spheroid is simply a shape used by cartographers to create maps of Earth’s surface. Since the planet is not a perfect sphere as depicted (illustration 2-4) by the uneven geoid line, cartographers create an ellipsoid and superimpose it onto the planet. Keep in mind the horizontal datum, which will be discussed later, frequently uses the same ellipsoid. As seen below, there are places on Earth where the actual surface of the planet, depicted by the geoid line, and the cartographer created surface, depicted by the ellipsoid line are quite different and can affect distance from one point to another.

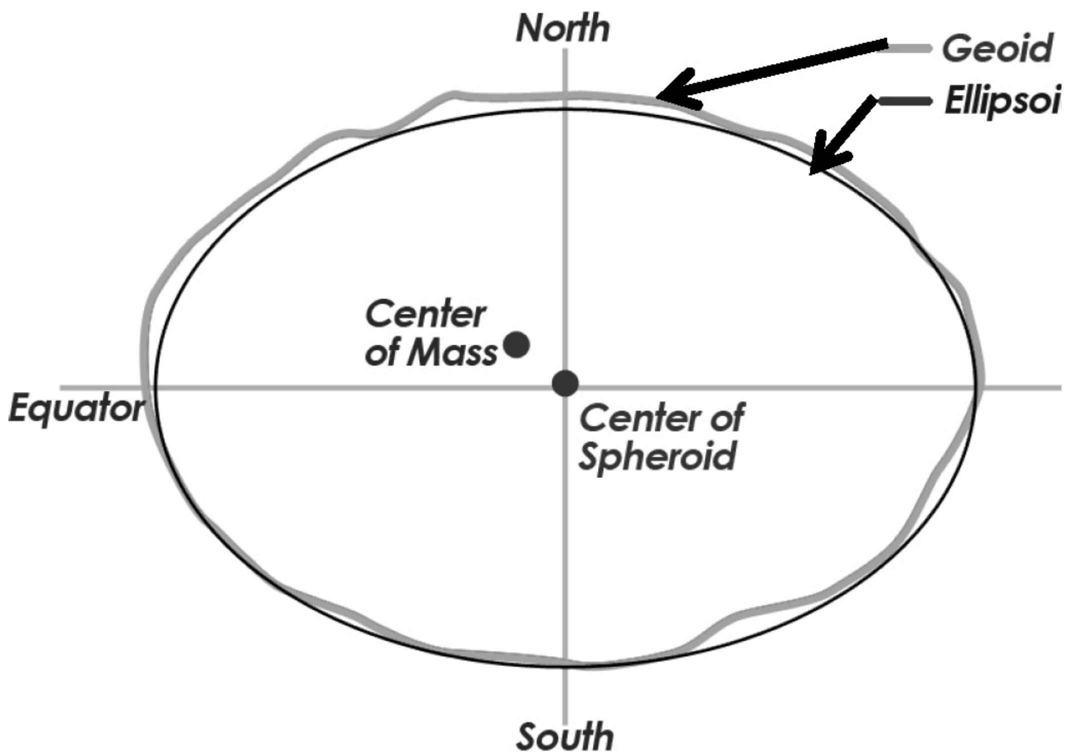


Illustration 2-4 Ellipsoid.

The grid system informs us what system is used for coordinates. The Camp Mackall map utilizes the Universal Transverse Mercator (UTM) coordinate system and the map is located within zone 17. The UTM coordinate system will be explained in the next chapter.

Projection is the process that transforms a sphere onto a flat surface. The cartographer provides axis and line of tangency used for the cylindrical projection. Common projections are Normal, Transverse and Oblique Mercators (illustration 2-5).

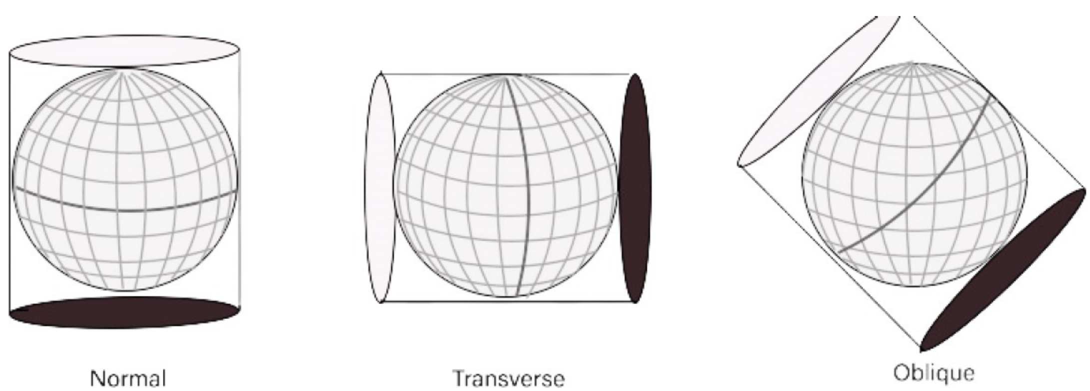


Illustration 2-5 Projection.

Vertical Datum designates the basis for all vertical control stations, contours, and elevations. It provides a set of fundamental elevations to which other elevations are referenced. These fundamental elevations are determined for a country or continent through measurements in a network of reference benchmarks which are connected to sea level. In the US, Canada and Europe the vertical-control datum refers to the mean sea level surface, the average level between high and low tides.

Horizontal Datum provides the model used to measure positions on Earth. Similar to vertical datum, except horizontal datum are reference values for a system of location measurements, such as latitude and longitude. Two of the most common datums frequently used by the Defense Mapping Agency (DMA) are North American Datum (NAD) and the World Geodetic System (WGS). A word about WGS-84 and NAD-27, both look the same but your coordinates will be off as much as 900 meters in either direction or both. The issue shows itself mostly using older civilian maps that use NAD-27 format. WGS-84 and NAD-27 are not compatible with each other. Nothing wrong with either, you can still navigate from point to point with no issues. The problem shows itself when one party is using NAD-27 and sends a coordinate to another party using WGS-84. As a general rule, we stay with one datum otherwise we'll be forced to do a lot of converting.

Published by and printed by are self-explanatory. Frequently map publishers, such as the Defense Mapping Agency (DMA) utilize non-governmental agencies (NGA) to print and distribute maps. Other information provided might include when the map was last updated and the date of printing. The Camp Mackall map was printed 06-2017. If you look to the far left above the word LEGEND you will see map information as of 2016, which is telling us it was printed in 06-2017 using 2016 data. Sometimes a note is added below the Publisher that provides information on how to convert datum such as converting from WGS84 to NAD27 or vice versa. Needless to say, it is easier if everyone is working off the same map datum than be forced to convert coordinates from one datum to the other.

The grid reference box contains instructions for composing or understanding a grid coordinate. This topic will be discussed in the next chapter.

The declination diagram (illustration 2-6) provides the GM angle and indicates the angular relationships of true, grid and magnetic norths. The declination diagram will be covered in depth in chapter six.

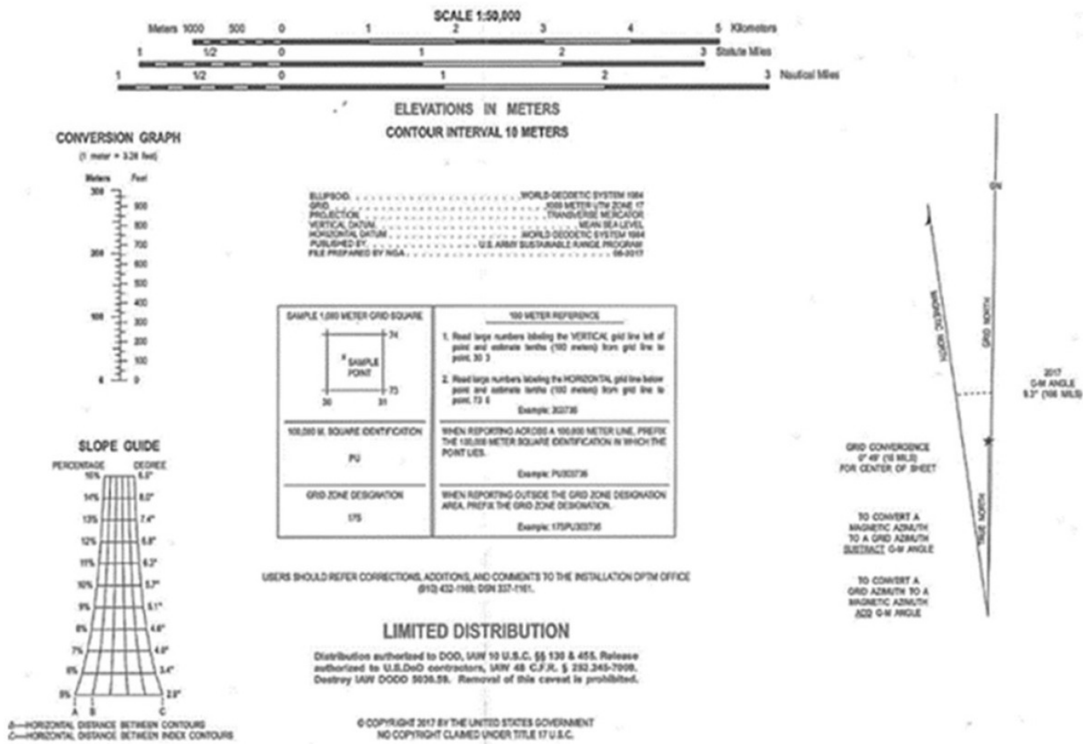


Illustration 2-6 Lower Margin.

The index to boundaries diagram shows boundaries located on the map sheet such as parks, county lines, and state or national boundaries (illustration 2-7).

The adjoining sheets diagram illustrates adjoining map sheets and their sheet numbers in the event the map by itself isn't large enough to cover the area needed.

Stock number identification is located in the right lower margin. TC 3-25.26 chap 3 para 3-2, is an excellent reference and provides information on how to order maps.

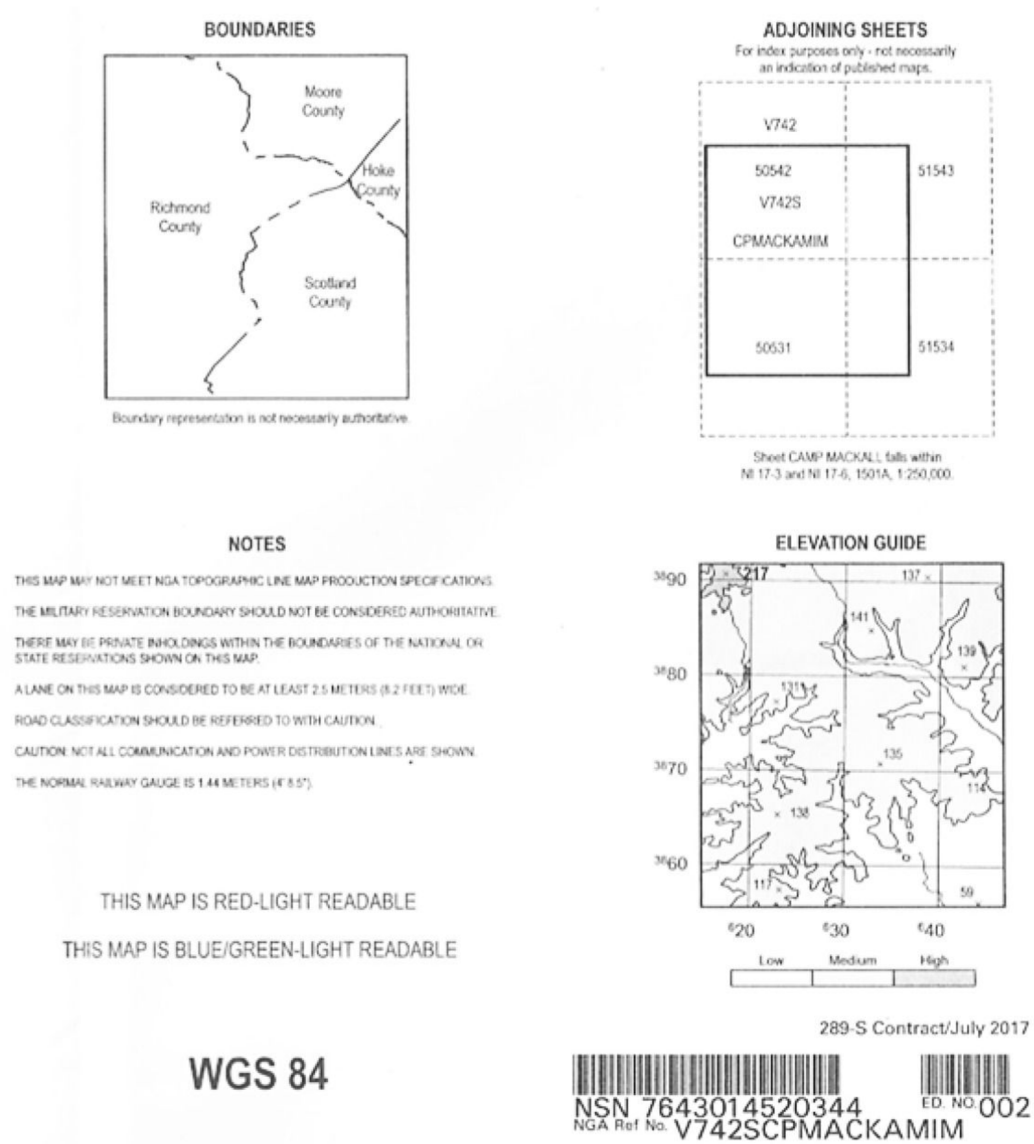


Illustration 2-7 Margin Information.

Topographical symbols

Topographical Symbols are located to the far left in the lower margin in what is called the Legend. The symbols located within the Legend are common symbols all map makers use. The first basic military map symbols and colors began to be used by western armies in the decades following the end of the Napoleonic Wars and harmonization of information used specifically by militaries continues to this day.

Military specific colors and symbols are usually located to the far right in the lower margin in what is called the Military Legend or Military Overprint

Information (illustration 2-8).

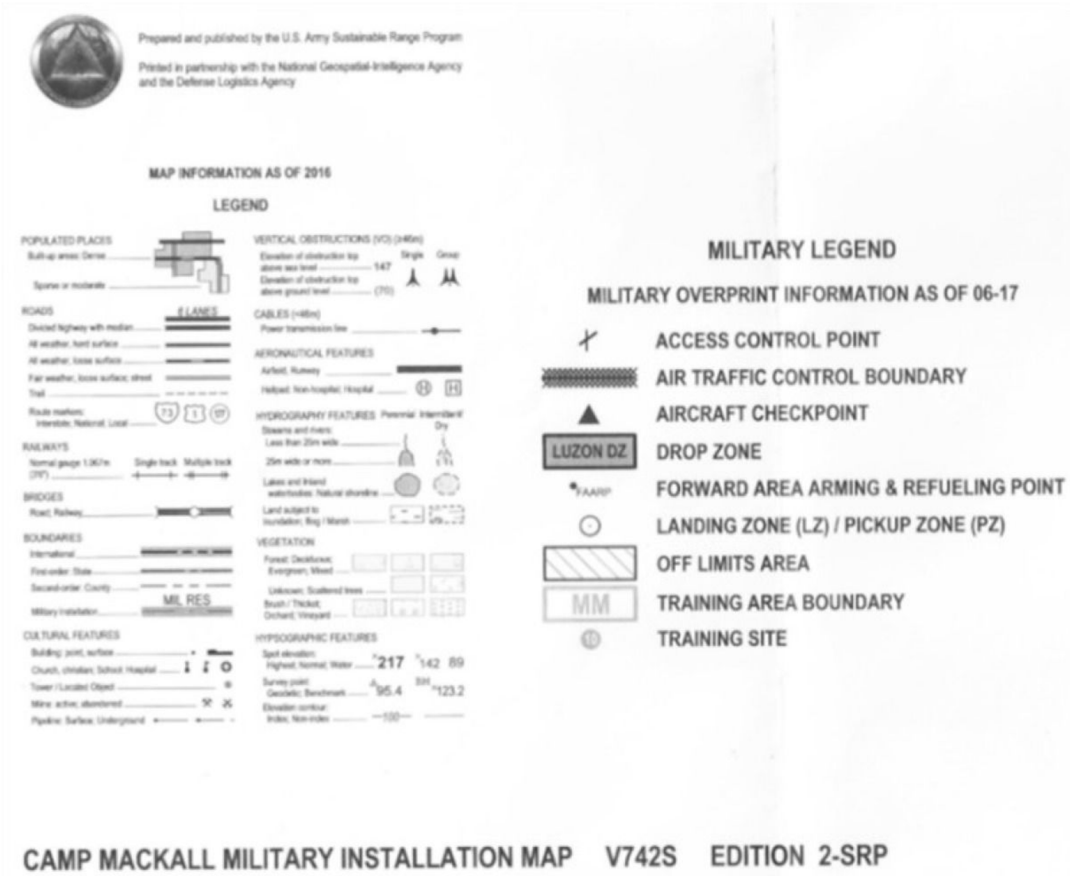


Illustration 2-8 Legend.

Besides the symbols, there are six colors found on military maps:

Black - Indicates cultural, man-made features other than roads such as buildings, surveyed spot elevations, and labels.

Blue - Identifies hydrography or water features such as lakes, swamps, rivers, and drainage.

Brown - Identifies all relief features and contours lines on older editions maps, and cultivated land on red-light readable maps.

Green - Identifies vegetation with military significance such as woods, orchards, and vineyards.

Red - Signifies major roads, cultural features, populated areas, and boundaries on older maps.

Red Brown - Signifies all relief features and main roads on red light readable maps.

Check on Learning

Question 1: What information is found at #1 below?

Question 2: What information is found at #3 below?

Question 3: What information is found at #19 below?

Question 4: Where is the information about true north located on the map?

Question 5: Name the six colors found on a military map?

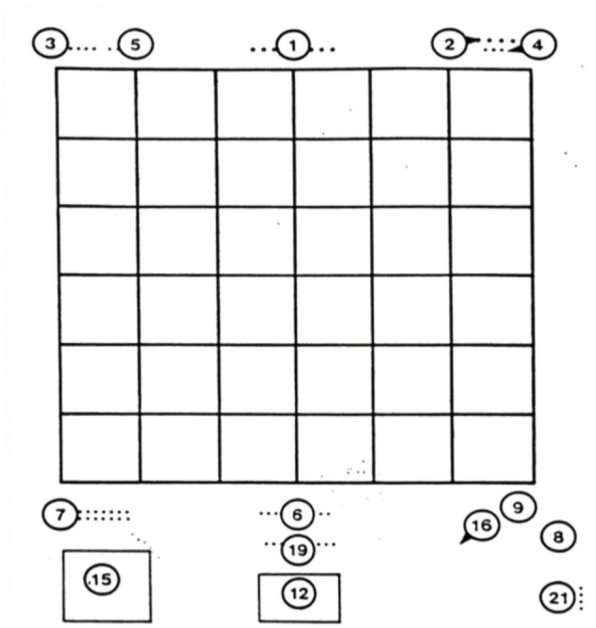


Illustration 2-9 Check on Learning Quiz.

3

Grid Reference System

Land navigation is a critical task that will either make or break a military career. All military selection courses and most schools require proficiency in land navigation. Understanding how to obtain a grid coordinate is a key element of land navigation. As we go through understanding how we come up with an 8-digit grid coordinate, it is important to become familiar with the ‘big picture’ and understand how the world is broken down for the purpose of mapping. Understanding this larger system helps us avoid mistakes when plotting from point A to point B.

Universal Transverse Mercator System

The most common system used on military maps is the Universal Transverse Mercator (UTM) system. It is a system of grids superimposed over Earth’s surface allowing users the ability to quickly locate and accurately communicate to others specific points on a map.

First, we need to define a few commonly used terms. The equator is an imaginary line drawn around the earth equally distant from both poles, dividing the earth into northern and southern hemispheres and constituting the parallel of latitude 0°.

A meridian (or line of longitude), unlike the equator, is only half of an imaginary circle on the Earth's surface. Meridians travel from one pole to the opposite pole (illustration 3-1).

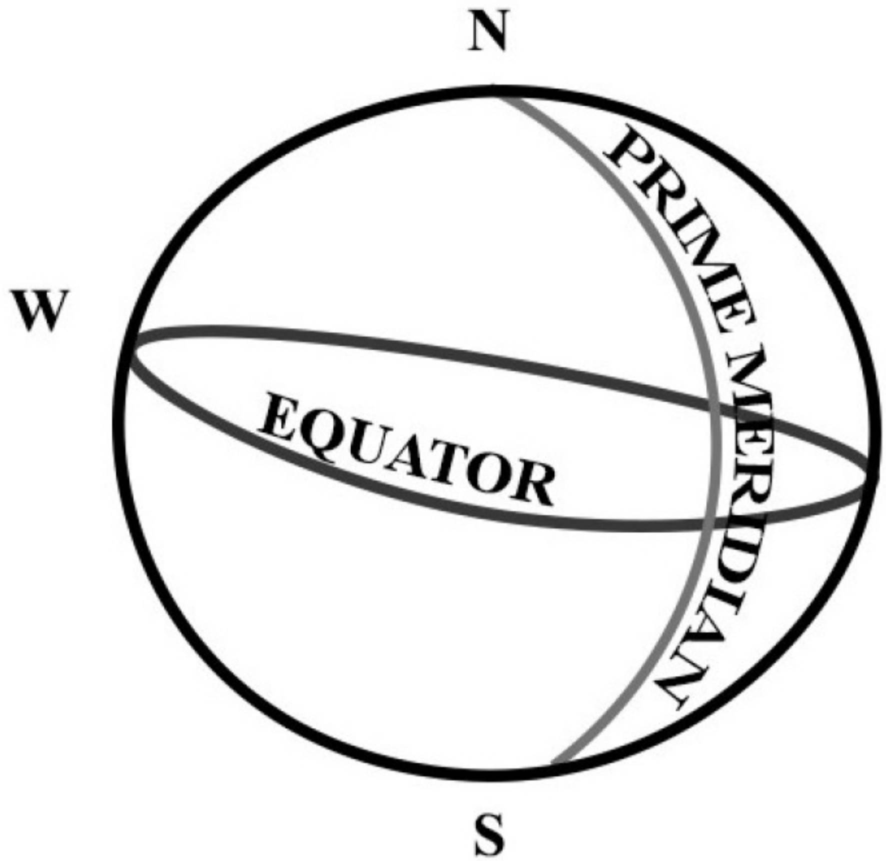


Illustration 3-1 Prime Meridian and Equator.

The Prime Meridian establishes longitude 0° and runs through Greenwich, England, the site of the Royal Greenwich Observatory, which was founded in 1675. It is also where we get our universal standard time or Zulu Time. The Prime Meridian, together with its opposite meridian having a longitude of 180°, divide the earth roughly into the Eastern and Western Hemispheres. The 180° meridian also serves as the International Date Line (IDL) in the Pacific.

The UTM covers the entire planet minus the North and South Pole areas. The poles have their own coordinate system called the Universal Polar Stereographic (UPS) system. Disregarding the poles and the UPS, we've divided the earth into four sections; two above and two below the equator (0° latitude) and then divided again by the Prime Meridian (0° longitude) and the IDL (180° longitude). Additional latitude and longitude lines are added, but generally, this is the foundation of the UTM system.

As a reminder, longitude lines run north and south and converge on the poles. However, latitude lines never converge like longitude lines. Instead, they run east and west from the equator working their way to the poles like the rungs on a ladder (illustration 3-2).

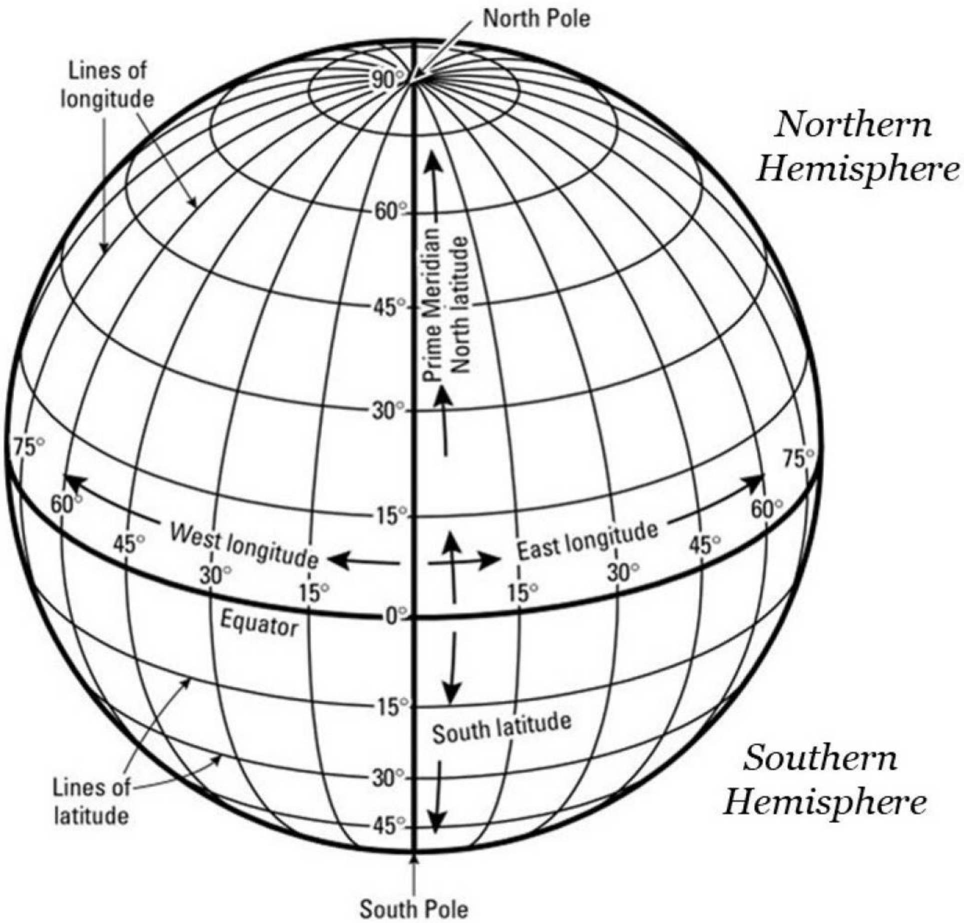


Illustration 3-2 Longitude and Latitude.

Next, the earth gets divided and numbered into 60 longitudinal 'slices' like an orange between 84° north and 80° south. Each 'slice' is numbered beginning with the number one at the IDL and then get larger moving east. Each of these longitudinal 'slices' are then divided and lettered from 'C' in the south to 'X' in the north with 'I' and 'O' omitted. 'A, B, Y and Z' are used for the Polar grid system (UPS). This system of numbers and letters form a grid of UTM zones (illustration 3-3).

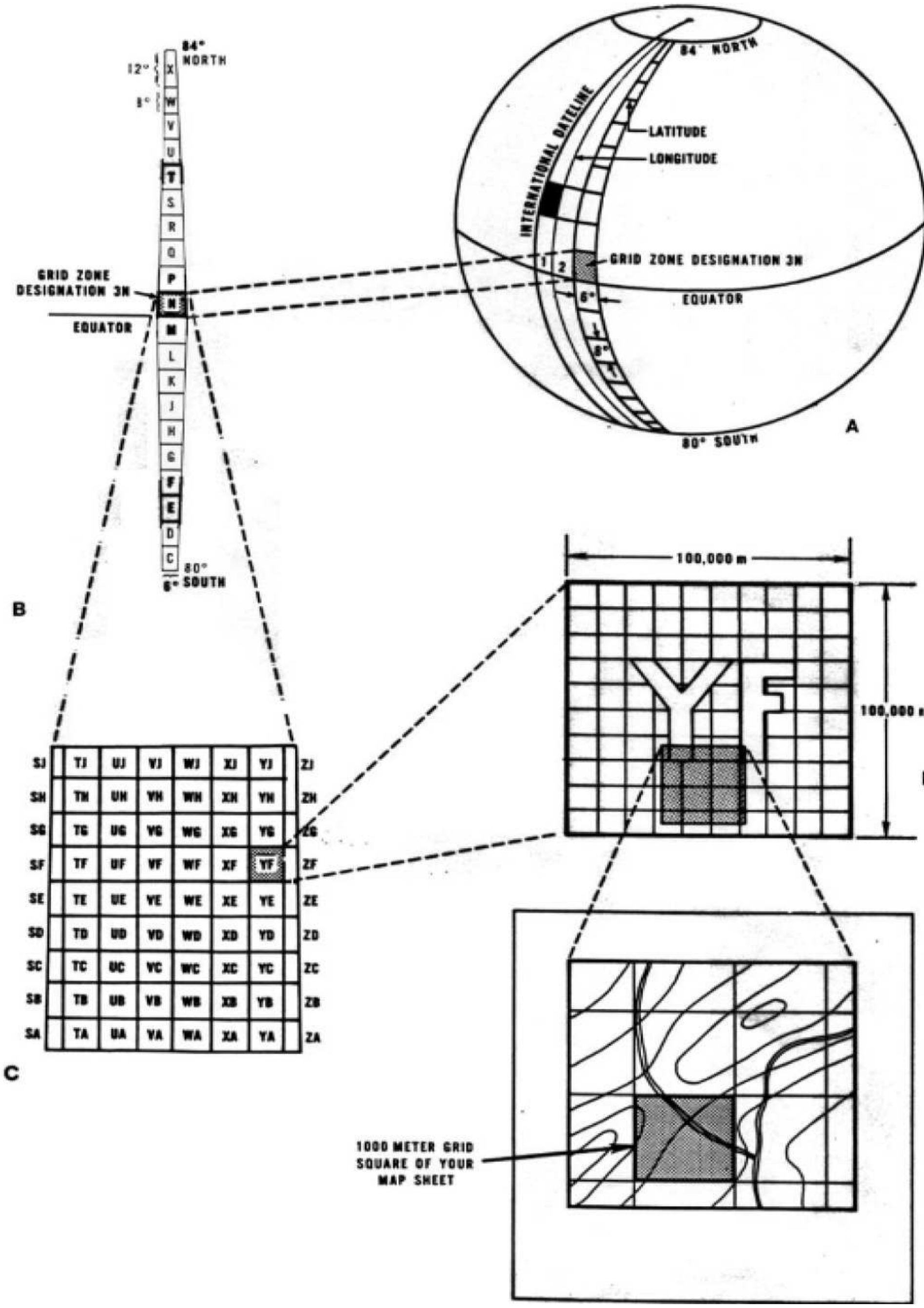


Illustration 3-3 Example of UTM System.

Military Grid Reference System

Using the Camp Mackall map, looking at the center lower margin, we see that we are located in UTM zone 17. This means that Camp Mackall is located in the 17th 'slice' east of the International Date Line. The coordinates for a point plotted within any UTM zone, such as UTM zone 17S located in North Carolina, may contain as many as 17 digits or more. The Military Grid Reference System (MGRS) reduces the length of written coordinates by substituting letters in lieu of several latitude/longitude alphanumeric characters.

Also, without the zone provided, a UTM coordinate could be plotted in several different areas of the planet. Therefore, MGRS reduces the probability of mistakes by reducing the number of characters needed and ensures a grid coordinate relates to a single point on the surface of the earth.

The MGRS is designed for use with both the UTM and UPS systems. Most likely we won't be navigating the polar regions of the planet, therefore we'll focus on the MGRS overlay of the UTM system.

The MGRS further breaks down UTM zones, such as 17S, by further dividing the large rectangular UTM zone into numerous 100,000 x 100,000-meter squares and each square is then given a unique two-letter identification. Camp Mackall is in the two-letter identification PU (diagram 'C' & 'D', illustration 3-3).

Again, using the Camp Mackall map, looking at the center lower margin, we see the 'sample point' coordinate 17S PU 303736. This is a MGRS six-digit grid coordinate. The UTM grid coordinate for this 'sample point' is 17S 630300mE 3873600mN. MGRS simplifies the coordinate by having PU replace the first 6 and the 00mE as well as the 38 and the 00mN thereby eliminating unnecessary characters and reducing the probability of mistakes. The 100,000 x 100,000-meter squares are further broken down into 1,000 meter squares. We use these 1,000 meter squares to obtain a MGRS grid coordinate of our point.

Map protractors have been in common use throughout the military since World War II, and even earlier by certain branches of the military such as engineering and field artillery. A common military protractor used today is the GTA 5-2-12, which hasn't changed much since the Vietnam War (illustration 3-4). There are numerous versions of map protractors available on the market for purchase, but our focus will be the standard issue GTA 5-2-12 military protractor.

The protractor is remarkably simple; mills are located on the outside scale, degrees are on the inner scale (we'll mostly be using the degrees scale). This protractor provides three different map scales that are common on military maps, 1:50,000, 1:100,000 and 1:25,000/1:250,000. 1:25,000 maps, though not common but are nice to have in certain situations due to their ability to provide more information due to the larger, 'zoomed in' characteristic of the map. The center lines are the north-south, east-west lines. The 1:25,000 and 1:50,000 scales subdivide the 1,000 meter square block into 10 major divisions, each equal to 100 meters. Each 100 meter block has five graduations, each equal to 20 meters. The smaller 1:100,000 scale subdivides the 1,000 meter square block into 5 major divisions, each equal to 200 meters. Each 200 meter block has two graduations, each equal to 100 meters.

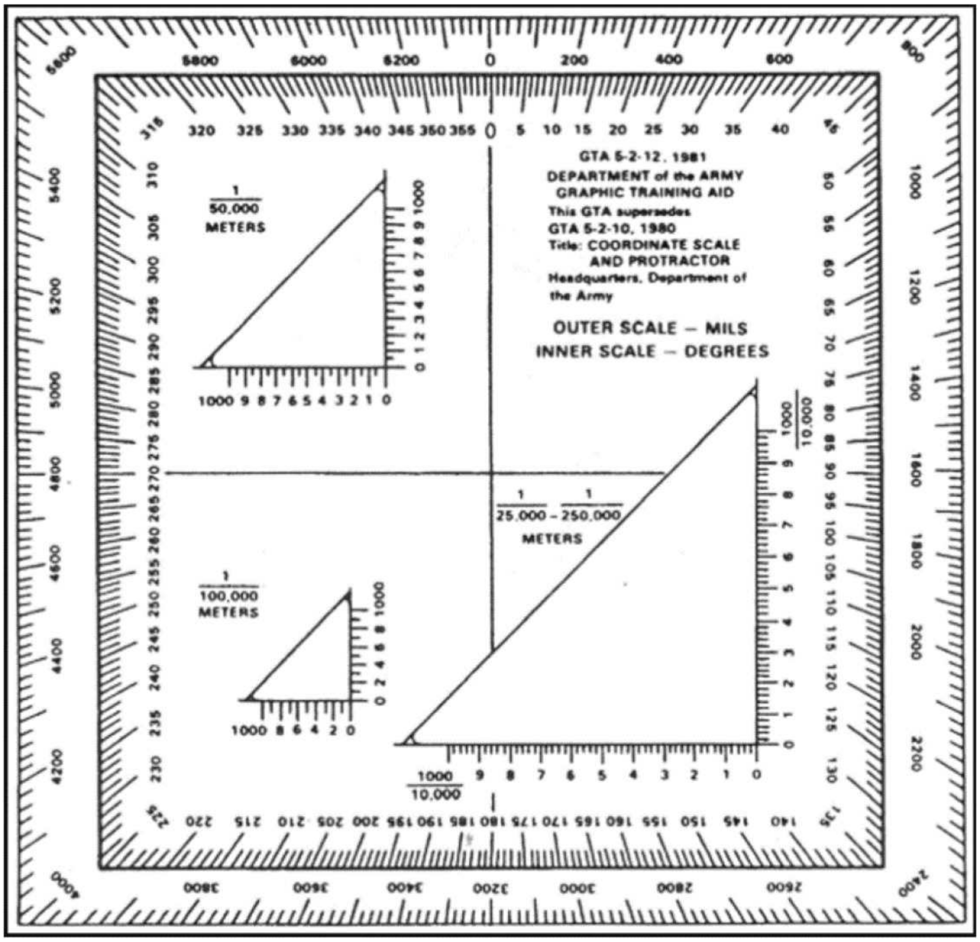


Illustration 3-4 Military Protractor, GTA 5-2-12.

Reading and understanding grid coordinates

To better understand grid coordinates, we will break down the six-digit 'sample point' provided, 17S PU 303 736. Grid coordinates are always written in a specific order:

- UTM grid zone designation (17S).
- 100,000 meter square identification (PU).
- Complete easterly and northerly coordinates (30, 73).
- What the protractor says reading RIGHT then UP (303 736).

As previously explained, 17S refers to UTM zone '17' (the slice) and the grid designation within that zone is the rectangular area labeled 'S'. Next, within this very large rectangular area known as 17S, we know we are located within the smaller 100,000 x 100,000 meter square area identified as PU.

Upon further examination, we notice that the 'sample point' is located right of the 30 northerly line and above the 73 easterly line. This gets us within the 1,000 meter square that our 'sample point' is located within. To get within 100 meters from the 'sample point', we use the protractor and find that the point is 300 meters further east of the 30 northerly line and 600 meters further north of the 73 easterly line, thereby providing the last numbers ‘3’ and ‘6’. Therefore, our six-digit grid is 303 736, within 100 meters of the ‘sample point’ (illustration 3-5).

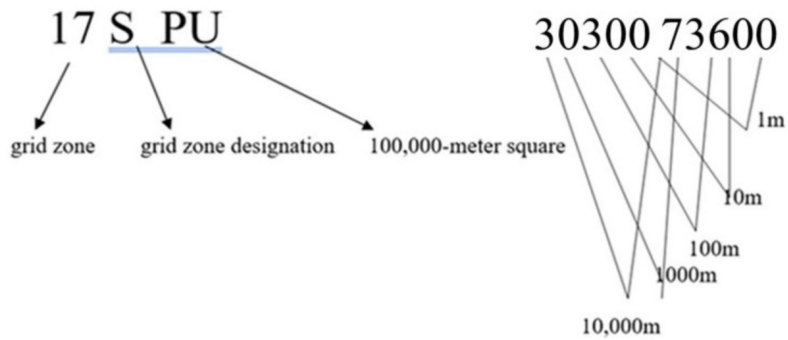


Illustration 3-5 Ten Digit Grid.

With each number added to both the easterly and northerly lines, we get ten times more precise. The four-digit grid of 30 73 got us within 1,000 meters of our point. When we added a single digit to both the easterly and northerly grid coordinate (303 736), we got to within 100 meters of the point. The more digits, the closer and more precise we get. The most common grid coordinate used in dismounted land navigation is the eight-digit coordinate that puts one within 10 meters of the actual point. As a recap:

Four digits = within 1,000 meters
Six digits = within 100 meters
Eight digits = within 10 meters
Ten digits = within 1 meter

Obtaining a grid coordinate

Now that we understand how to decipher a grid coordinate, next we will cover the basics in obtaining an eight-digit grid coordinate. Our point is Watson Cemetery and we need an eight-digit grid coordinate for the cemetery. We already know we are located in UTM grid zone 17S and the 100,000 meter grid zone designator is PU. For everything else, we are going to read RIGHT (east) and UP (north).

Using the Camp Mackall map, starting at the bottom left corner, we are going to slide our finger to the right until we hit the 36 easterly and up until we hit the 66 northerly. We are now at the 1,000 meter square 17S PU 36 66. A good habit to get into is to write this information down first before obtaining additional digits from the protractor. We’ll leave ourselves plenty of room to add digits from the protractor scale between the easterly (36) and northerly (66) coordinates.

Using the 1:50,000 scale, we place the 0/0 directly onto where the 36 and 66 lines cross, or the bottom left of the 1,000 meter 36 66 grid square. Remember, we’re going to be reading RIGHT and UP. Next, we’ll slide our protractor to the RIGHT until the vertical axis of our scale touches Watson Cemetery. Our 36 easterly line should be running through the ‘8’ on our scale. This means the cemetery is 800 meters east of the 36 line, or written as 3680 (illustration 3-6).

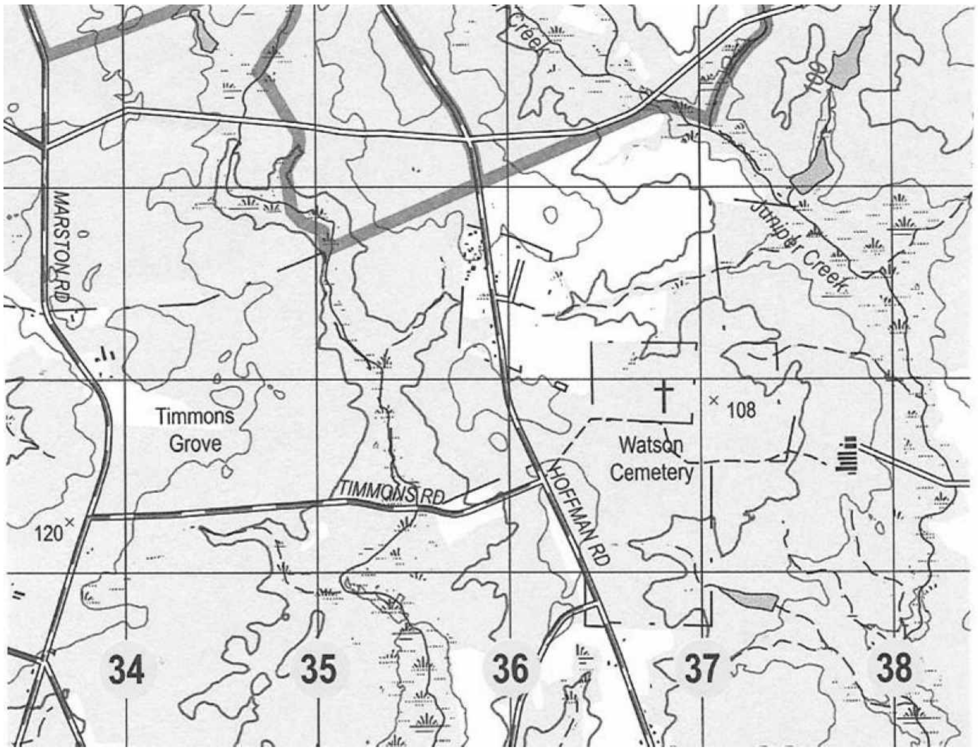


Illustration 3-6 Watson Cemetery.

Next, we read UP and obtain our northerly. The cemetery is touching the '9' on the scale therefore our northerly coordinate is 6690. If the cemetery was located between the 9 and the 1,000 mark on the scale, the northerly coordinate would be 6695. Fortunately, our cemetery was directly on the '8' and the '9' allowing us to use zeros for our eight-digit grid coordinate. The final eight-digit grid coordinate for Watson Cemetery is 17S PU 3680 6690.

The tick marks located between the numbers on the 1:50,000 scale represent '5'. Any eight-digit coordinate ending in either 1-4 or 6-9 must be estimated since no marks exist on the protractor for use. As an example, the eight-digit grid coordinate for Wrights Cemetery is 17S PU 4118 6406.

If we are working on the extreme left side of the map without the benefit of a complete 1,000 meter square such as the 17S PU 14 90 grid square, simply place the protractor's scale 0/0 directly onto where the 15 easterly and 90 northerly cross, or the bottom right of the 14 90 grid square. Place the sharpened tip of your pencil on the scale's 1,000 mark. Holding the pencil steady, slide the protractor left until it stops where your pencil is. The protractor is now ready to read RIGHT and UP since the 0/0 is sitting on the 14 easterly line, or the bottom left of the 14 90 grid square.

Eight-digit grid coordinates are the standard for dismounted land navigation. Get in the habit of always using and communicating eight-digit grid coordinates when dismounted. Six-digit grid coordinates are primarily used for mounted navigation. There is a reason for these standards. Even though an eight-digit coordinate should get one within 10 meters of the actual point, reality is, in the real world nothing is perfect. Maps are usually old and not completely accurate, plots are marked with stubby pencils and protractors, and nobody walks a precise azimuth or has a perfect pace count. If we're doing everything right, we're lucky to be within 50-100 meters of the actual point on the ground. This distance is usually close enough to find if we're dismounted. Also, we aren't going to waste our time trying to obtain a ten-digit grid coordinate since they usually require GPS for accuracy.

Acquiring an azimuth using string with the protractor

In the center of the protractor, where the east-west and north-south lines cross, more than likely there is a small hole. If our protractor does not have a small hole there, we'll make one. Then we'll take a needle and thread a 5" to 6" piece of string (550 gut or similar) through the hole and then tie a couple overhand knots at each end to make sure the string can't separate from the protractor. Now, all we have to do is place the center of the protractor where the east-west and north-south lines cross on our position on the map, making sure we can read the protractor to ensure it is in the correct position. Then we move the string directly over the location where we want to go to on the map and read the degree scale on the protractor where the string crosses. This is the grid azimuth. We will need to convert the grid azimuth to a magnetic azimuth so we can use the compass. We'll discuss converting azimuths in chapter 6.

Check on Learning

Question 1: What is located at 17S PU 3443 7322?

Question 2: What is located at 17S PU 2405 8351?

Question 3: What is located at 17S PU 1548 6738?

Question 4: You are located at the intersection of Hwy 15/501 and Van Road in grid square 17S PU 44 77 and you need to move to 17S PU 4039 7524. What is the grid azimuth to that coordinate?

4

Slope and Distance

In order to plan movement distances, we need to understand how to estimate the slope of the terrain and how to measure distance to our point.

Estimating Slope

The Army states there are four types of slopes; gentle, steep, concave, and convex. The first two are self-explanatory. Concave is like the inside of a mixing bowl and convex is the opposite; like a turtle's shell. Whether mounted (in a vehicle) or dismounted (on foot), movement usually comes down to one simple question: Can we move through the terrain? Not, what is the slope percentage? If we need to know the slope percentage, the field manual for land navigation goes into great detail, dedicating three and half pages to figuring out slope.

The field manual also states that "airborne and light infantry are not restricted by most terrain," which, of course is true. However, even though Rangers are more than capable of scaling Pointe du Hoc, generally cliffs and large bodies of water are avoided.

Since we're primarily concerned with dismounted navigation, we want to pay particular attention to the contour lines on the map. Possessing an ability to mentally visualize what the terrain is like on the ground by simply looking at the mapmaker's contour lines is crucial to being successful at land navigation. If the contour lines are close together, it is letting us know that the ground is steep, and therefore movement will be more difficult. If the contour lines are spread out, the terrain is rolling to flat; ideal for those of us traveling by foot. For our purposes, the primary thing to remember is, the greater the slope, the more difficult the terrain, therefore, the more distance traveled and time spent during movement.

Measuring Straight Line Distance

The bar in the lower, center margin provides a scale for measuring distance in kilometers, statute miles and nautical miles. Primarily, we use kilometers in the military. A statute mile is a ground distance that figures in the average for varying terrain. A nautical mile differs in that it calculates the distance as if traveling on a smooth surface such as on water or in a straight line as if traveling in an airplane.

Looking at the scale, to the far left it is marked Meters 1000 and as we shift to the right we see ‘0’. The scale is set up just like the protractor and its measurements are identical. This portion of the scale is for measuring between ‘0’ and ‘1000’ meters. To the right of the ‘0’ we have ‘1’ to ‘5’. This portion of the scale is for measuring whole kilometers. To measure distance using the map’s scale, we use the straight edge of a piece of paper and mark where we are on the map (point A) and where we are going on the map (point B). After making our tick marks on the straight edge of the paper, we then measure the distance on the kilometer bar scale sliding the paper left or right until we can get an accurate measurement.

If we don’t have paper available or simply don’t want to use the aforementioned technique, the left side of the military lensatic compass provides a 1:50,000 scale stamped into the metal. A common mistake when using the lensatic compass’s scale is occasionally one might start measuring from the edge of the compass rather than the marked ‘0’. Another option for attaining measurement, and least preferred, is the protractor, since it is limited to only measuring up to 1,000 meters.

Measuring Road Distance

Measuring road distance varies slightly from straight line measurement primarily because we are measuring the distance by road rather than direct to our destination via a straight line. Therefore, measuring road distance takes a little longer and has a greater chance for error.

We begin just as we did for straight line measuring by marking where we are (point A). Then we will mark the map and the edge of the paper using <u>one side of the road</u> only from point A all the way by road to our destination (point B). We recommend using only one side of the road when measuring road distance because this technique provides a more accurate measurement since it prevents the curves in the road from inadvertently shorting the actual distance. Needless to say, we'll be moving the paper quite a bit as we attempt to keep the edge of the paper lined up with one side of the road.

Using the straight edge of a piece of paper is the best technique to use when measuring road distance. Start with a tick mark on the paper representing the start point (point A). Stay on one side of the road, measuring straight line distance and making tick marks on the paper at each turn. Continue measuring by turning the paper with the road and making tick marks until we get to the final destination (point B).

Use the map's bar scale in the center lower margin to measure the total distance in kilometers or statue miles. Remember, we won't be using the nautical mile bar scale since we aren't traveling by air or sea. Nautical miles are based on the circumference of the earth and are slightly shorter than a statute mile.

Check on Learning

Question 1: Using our compass and a piece of paper, what is the straight line distance from hilltop x114 in grid square 36 64 to the saddle in grid square 38 65?

Question 2: If we decide to move along the aforementioned route, will we walk more or less than 2,200 meters to the saddle?

Question 3: What is the road distance from 17S PU 4325 6505 to 17S PU 4080 6053?

Question 4: Why are statute miles longer than nautical miles?

5

Elevation and Relief

We briefly covered contour lines in the previous chapter as they related to slope. This chapter is going to take a deep dive into understanding contour lines and give us the ability to better understand the terrain around us and thereby help us make good choices when it comes to selecting our routes.

Let's face it, the vast majority of military land navigation courses, like the ones found in any of the typical career track education and training requirements for officers and noncommissioned officers, are easy and purposefully designed so everyone passes and gets a 'GO'. The student simply needs to plot the next point on the map, draw a straight line to the next point and then attain the desired magnetic azimuth that will take them the entire way to the next point. Route selection on these types of land navigation courses is not necessary, and is not a skill the course designers are evaluating. Year after year, hundreds of students have taken the exact same azimuth to the exact same point. So many in fact, most courses have an established path all the way to the next point!

Land navigation courses such as these only reinforce a false sense of ability and knowledge of our 'real' land navigation skills; skills we may need to rely on some day in the future.

Knowing how to 'read' the contour lines on a map and visualize the terrain on the ground in order to plan an efficient and tactical route is what separates the novice from the expert, an amateur from the professional.

Elevation

The elevation of a point on the earth's surface is the vertical distance above or below mean sea level. Looking at the center lower margin of the map, we notice the VERTICAL DATUM is MEAN SEA LEVEL. The mean sea level is a scientific term used to describe the average height of the oceans around the world, between high and low tide using tidal markers.

Contour Lines

Contour lines are imaginary lines on the ground that connect points of equal elevation, thereby remain at a constant elevation. There are three types of contour lines the mapmaker uses to depict elevation.

Index lines are the heavier drawn lines. They are typically every fifth line. The elevation of the line is written within the line as it meanders throughout the map. We may have to trace with our finger on an index line for quite some distance to find where the mapmaker labeled the elevation, especially if the terrain is relatively flat.

Intermediate lines are thinner lines drawn between the heavier index lines. Normally there are four and they do not contain elevation information. Elevation is figured by adding or subtracting the contour interval from the elevation provided by the nearest index line. The contour interval on the map of Camp Mackall is 10 meters. Therefore, if we are at slightly higher elevation, located directly on the nearest intermediate contour line to the index line marked 100, then that puts us at 110 meters elevation above mean sea level.

Supplementary lines are dashed lines used for sudden elevation changes and generally do not provide written elevation information contained within the line. Similar to intermediate lines, value is figured by either adding or subtracting half the contour interval provided by the nearest intermediate line. Supplementary lines on the Camp Mackall map depict an elevation value of 5 meters (illustration 5-1).

When attempting to ascertain elevation information for a point located between two intermediate lines, we will have to estimate, just like we do when using the protractor. Again, using the Camp Mackall map, the contour interval is only 10 meters, so we aren't dealing with major elevation changes. However, some maps with contour intervals of 50 meters or more require paying close attention to the distance a point is from an intermediate contour line.

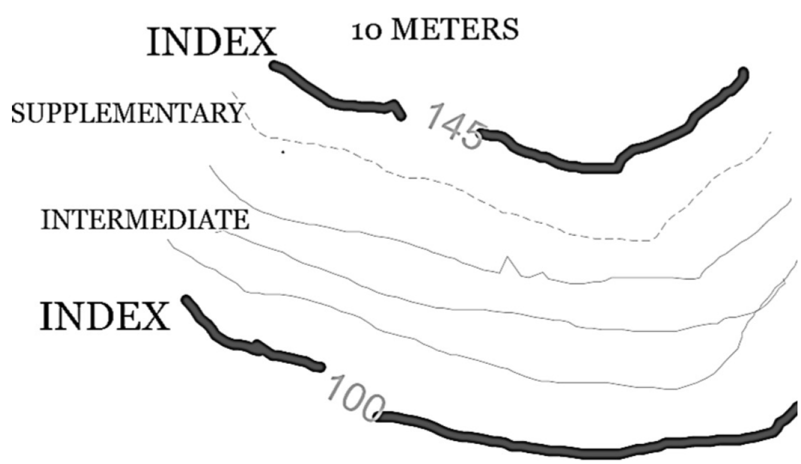


Illustration 5-1 Contour Lines.

Relief and Terrain

Besides providing valuable elevation information, mapmakers use contour lines on a topographic map to depict relief. Relief is the representation of hills and valleys and other important terrain features depicted by man-made symbols such as the shapes of contour lines thereby allowing us to visualize the Earth's surface.

Many are familiar with the teaching method of using the hand made into a fist as a training aid. With the knuckles facing up, all of the knuckles together form a ridgeline. Each individual knuckle is a hilltop along the ridge with low ground on all sides (illustration 5-2).

The most prominent and common terrain features are called major terrain features. There are five major terrain features and five, less prominent minor terrain features.

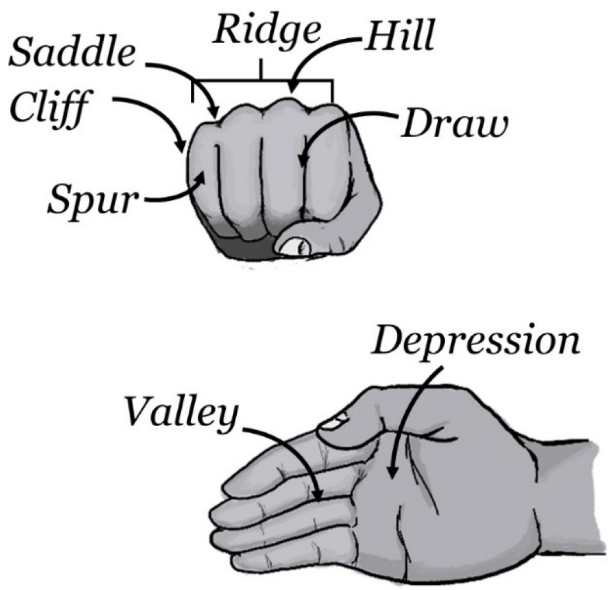


Illustration 5-2 Terrain Features Using the Hand.

Major Terrain Features

Hill is an area of high ground. From a hilltop, the ground slopes down in all directions. A hill is shown on a map by contour lines forming concentric circles (illustration 5-3). The inside of the smallest closed circle is the hilltop. To measure the elevation of a hilltop you add the contour lines full value counting your way to the top contour line and then to account for the center of the hilltop we add one half of the contour interval. Frequently, mapmakers will annotate the elevation of hilltops on maps. Looking at the hilltop in the grid square 36 64 on the Camp Mackall map, we notice the hilltop has an X with the elevation 114 written beside it. This means the elevation of the hilltop is 114 meters.

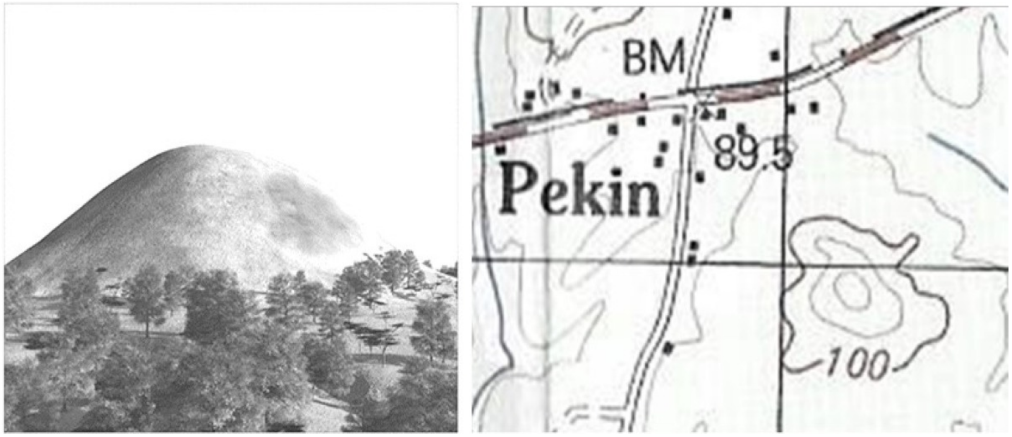


Illustration 5-3 Hilltop.

Ridge is a sloping line of high ground. If we are standing on the centerline of a ridge, we will normally have low ground in three directions and high ground in one direction with varying degrees of slope. If we elect to cross a ridge at a right angle, perpendicular to the high ground, we will climb steeply to the crest and then descend steeply to the base. If we move uphill along the crest of a ridge, depending on the geographic location, there may be either an almost unnoticeable slope or an obvious incline. Both humans and animals frequently travel along the top of ridgelines and trails are usually found there. This is known as traveling along a natural line of drift, where movement by foot is easiest. Moving along the slope, parallel to the crest of a ridge is difficult and usually avoided. Contour lines forming a ridge tend to be U-shaped or V-shaped. The ‘tip’ or ‘point’ formed by the contour line point away from high ground. A ridge usually is the high ground beside a valley and leads up to a hilltop (illustration 5-4).

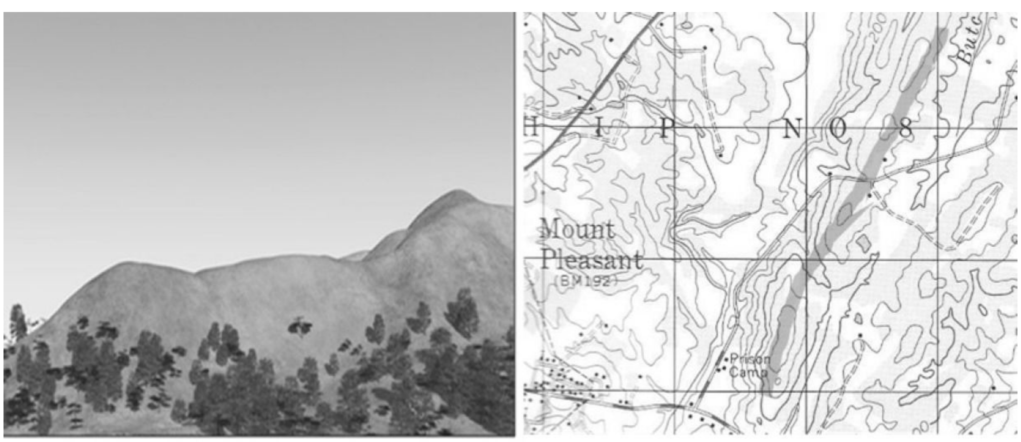


Illustration 5-4 Ridge.

Valley is a long groove in the land, usually formed by streams or rivers. A valley begins with high ground on three sides, and usually has a course of water running through it. Like ridgelines, valleys frequently serve as natural lines of drift depending on the width of the valley and thickness of the vegetation. Contour lines forming a valley are either U-shaped or V-shaped. The ‘tip’ or ‘point’ formed by the contour line point ‘upstream’ toward high ground (illustration 5-5). The more distance between the contour lines, the gentler the slope and easier the movement. If the contour lines are close together, the narrower the valley and steeper the slope.

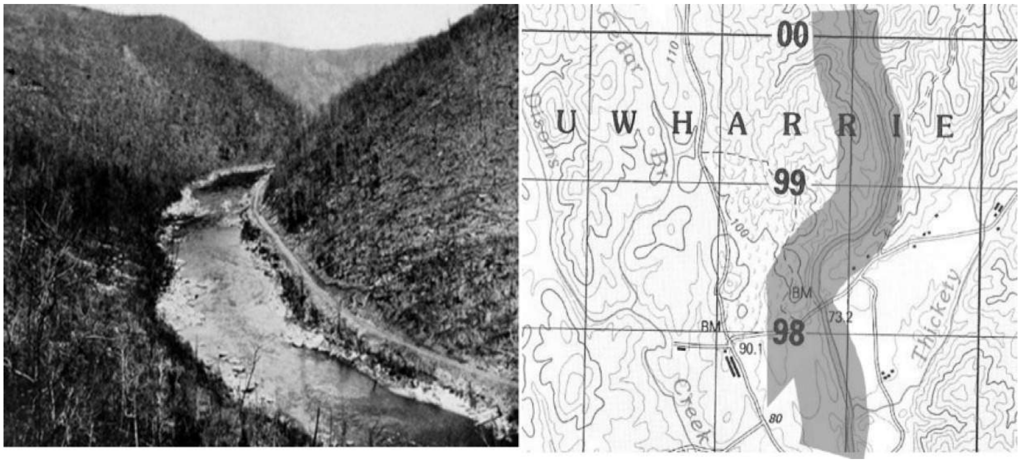


Illustration 5-5 Valley.

Saddle is a dip or low point between two areas of higher ground, not just lower ground between two hilltops. A saddle could also be a minor dip or break along a level ridge line. Standing in a saddle, we would have high ground in two opposite directions and lower ground in the other two directions. The contour lines for a saddle form a shape similar to an hourglass; starting wide, narrowing, then returning wide again (illustration 5-6).

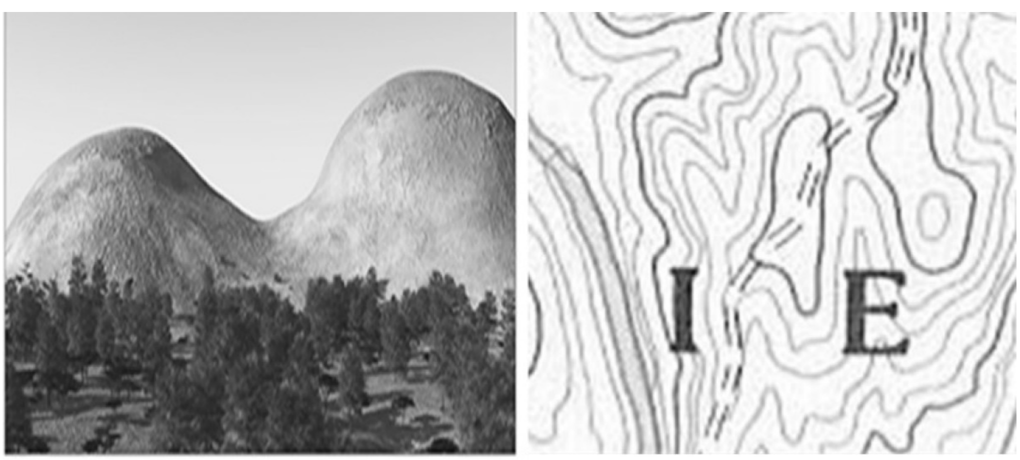


Illustration 5-6 Saddle.

Depression is a low point in the ground or a sinkhole. Generally, depressions are man-made, like a sand pit or a strip mine, but in certain parts of the world, there are a lot of natural depressions. Some natural depressions can be large enough to accommodate vehicular movement within their borders. Depressions can also be described as an area of low elevation surrounded by steep walls and higher elevation in all directions. Usually, only depressions that are equal to or greater than the contour interval will be shown on a map. A depression is represented by the mapmaker with a closed contour line that has tick marks pointing inward toward the low ground (illustration 5-7). To measure the elevation in a depression we count the contour lines and then subtract one half of the contour interval to attain the elevation of the bottom of the depression. Mapmakers will generally post the elevation in a depression just as they do for hilltops.

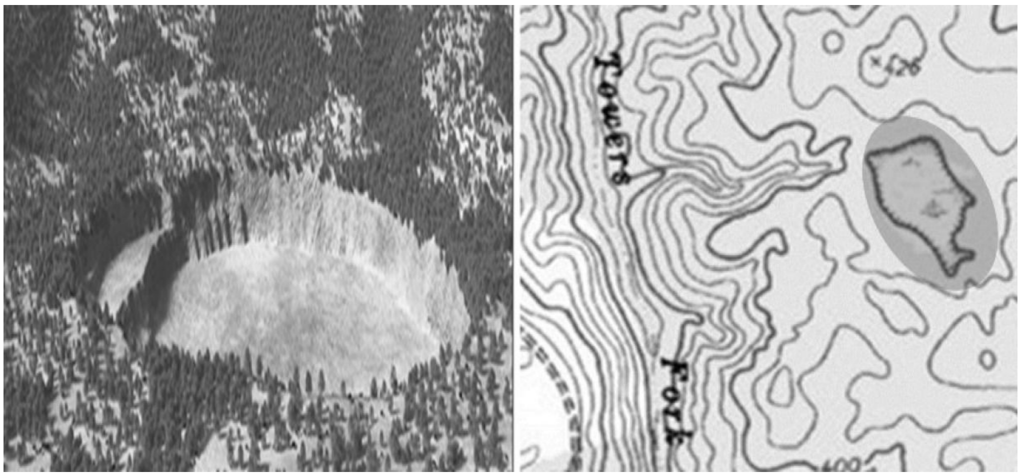


Illustration 5-7 Depression.

Minor Terrain Features

Spur is a short, continuous sloping line of higher ground, normally jutting out perpendicular from the side of a ridge. Spurs are often formed by parallel streams, which cut draws down the sides of a ridge. The ground slopes down in three directions and up in one direction. In hilly terrain, spurs are quite often used for movement in order to avoid draws when heading down into a valley from a ridge. Contour lines on a map depict a spur with U or V-shaped contour lines pointing away from high ground. Do not confuse a spur with a ridge. Spurs are considerably smaller and generally branch off from a ridge (illustration 5-8).

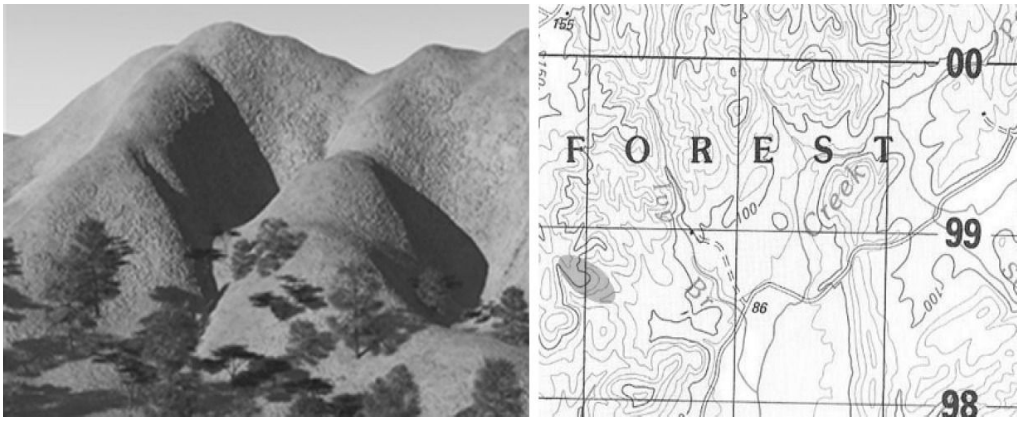


Illustration 5-8 Spur.

Draw is a less developed stream course than a valley. Draws could also be considered the initial formations of a valley. If we are standing in a draw, the ground slopes upward in three directions and downward in the other direction. Generally, draws have little to no room for maneuver within their confines and depending on location, are usually overgrown with thick vegetation making movement difficult to nearly impossible. The contour lines depicting a draw are U-shaped or V-shaped and point towards high ground. Do not confuse a draw with a valley. Draws are considerably smaller and generally empty the water from their intermittent streams and creeks into a valley, the significantly larger terrain feature. In areas with gentle rolling hills, relatively flat terrain and significant annual rainfall, draws must be considered during route selection for dismounted movement and are generally avoided whenever possible (illustration 5-9).

Cliff is a vertical or near vertical feature; it is a significant and abrupt change of elevation. Cliffs are shown by contour lines very close together and, in some instances, converge and touch each other.

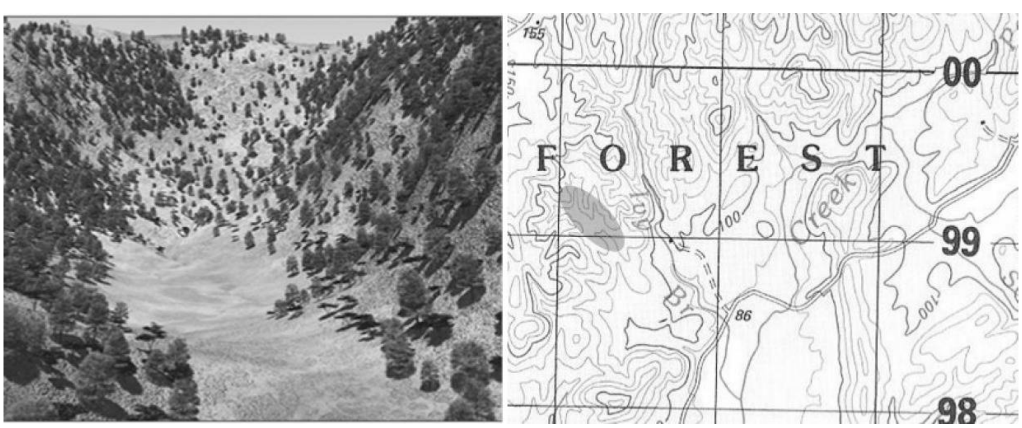


Illustration 5-9 Draw.

When contour lines converge into a single contour line that "carries" the other nearby contour lines, the mapmaker is depicting a very steep, vertical or near vertical terrain feature. The cliff is further depicted with tick marks pointing toward the bottom of the cliff and the lower elevation. One can expect to see numerous cliffs in mountainous terrain. Cliffs are generally avoided whenever possible (illustration 5-10).

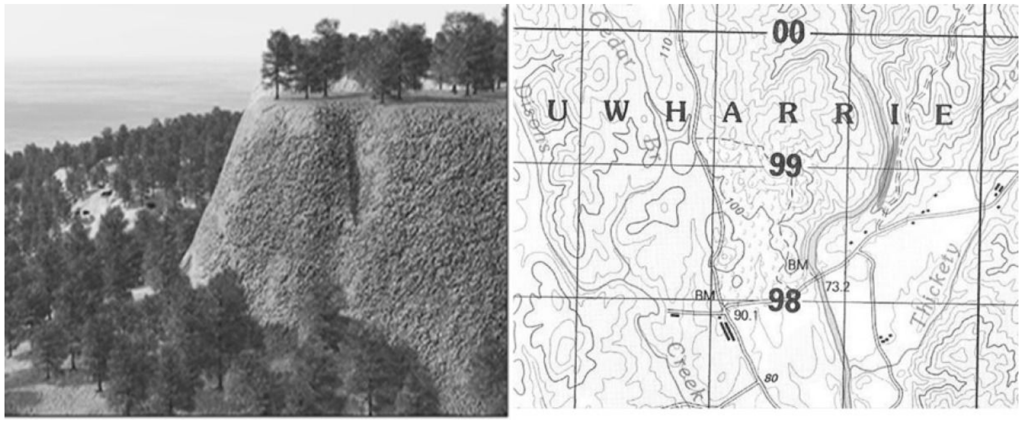


Illustration 5-10 Cliff.

Cut is a man-made feature resulting from cutting through elevated ground, usually to form a level bed for a road or railroad track. Cuts are shown on a map when they are at least 10 feet high and are drawn with a contour line along the cut line. This contour line extends the length of the cut and has tick marks that extend from the cut line to the roadbed if the map scale permits this level of detail. Contour lines depicting a cut can be drawn as if they are a cliff, with the contour lines converging together. However, if there is a railroad bed or road then it is obviously a cut rather than a cliff (illustration 5-11).

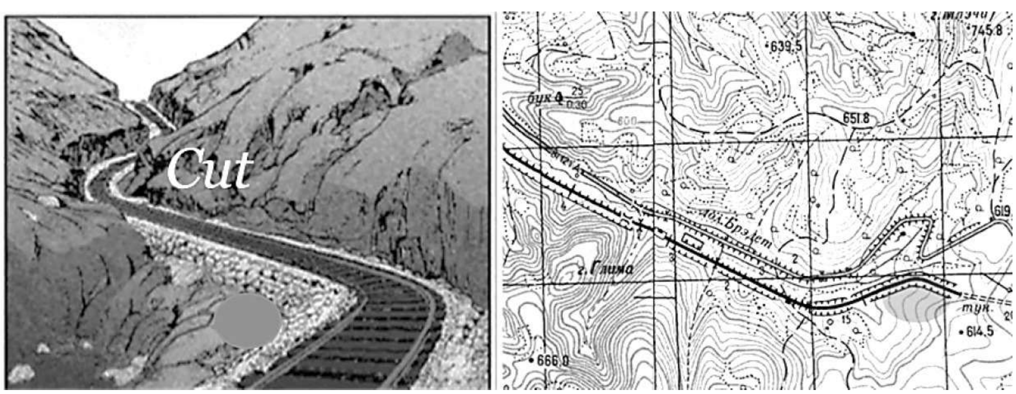


Illustration 5-11 Cut.

Fill: A fill is a man-made feature resulting from filling in a low area such as a draw or depression, usually to form a level bed for a road or railroad track. Fills are shown on a map when they are at least 10 feet high, and they are drawn with a contour line along the fill line. This contour line extends the length of the filled area and has tick marks that point toward lower ground. If the map scale permits, the length of the fill tick marks are drawn to scale and extend from the base line of the fill symbol (illustration 5-12).

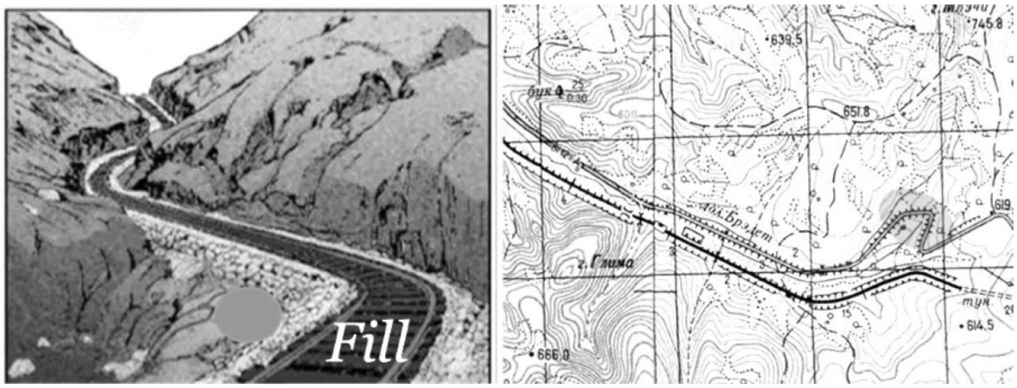


Illustration 5-12 Fill.

Benchmarks and Spot Elevations

The term benchmark is generally applied to any item used to mark a point as an elevation reference. Frequently, bronze or aluminum disks (illustration 5-13) are set in stone or concrete, or on rods driven deep into the ground to provide a stable elevation point and are meant to stay in place 50-100 years. The height of a benchmark is calculated relative to the heights of nearby benchmarks in a network extending from a fundamental benchmark. A fundamental benchmark is a point with a precisely known relationship to the vertical datum of the area, typically mean sea level. The position and height of each benchmark is shown on large-scale maps.

Illustration 5-13 Benchmark.

If an elevation is marked on a map, without a physical marking (monument) on the ground, it is a spot height, or what is commonly referred to as a spot elevation.

A spot height is an exact point on a map with an elevation recorded beside it that represents its height above a given datum. Spot elevations are checked and unchecked. Spot elevations are marked on maps with an ‘X’ with the elevation. If the numbers are black in color, they have been checked by someone who actually went out to the marker and surveyed the point. If the numbers are brown in color, then it is unchecked and the elevation is merely estimated.

Besides having elevation information provided by vertical datum, benchmarks are also frequently used to provide triangulation points, which are marks with a precisely established horizontal position. These points may be marked by disks similar to conventional benchmark disks, but set horizontally instead of vertically.

Prominent features on buildings such as the tip of a church spire or a chimney stack are also used as reference points for triangulation. With the increasing use of

GPS and electronic distance measuring devices, the same techniques and equipment are used to fix the horizontal and vertical position of a survey marker at the same moment, and therefore the marks are usually regarded as "fixed in three dimensions."

If you find a benchmark while in the field, it is like a “you are here” marker. Another marker you may see is a 10” x 10” short concrete post that has R/W stamped on top. This is a Right of Way marker and they are usually found near main road intersections that are owned by the state or federal government. Unlike, benchmarks, R/W markers are not depicted on the map.

Check on Learning

Question 1: Name the five major terrain features and briefing describe how they are depicted using contour lines.

Question 2: Name the five minor terrain features and briefing describe how they are depicted using contour lines.

Question 3: What is the definition of a contour line?

Question 4: What are the three types of contour lines and the difference between them?

Question 5: What are benchmarks and what is their purpose?

6

Grid Magnetic Angle

Map makers create grid lines on the earth that travel from one axis to the other; the North and South Poles. Unfortunately, our compass points to Earth's magnetic field which is currently located approximately 500 kilometers south of the North Pole at a place called Ellesmere Island in northern Canada (illustration 6-1). And to make matters worse, Earth's magnetic field is on the move. Scientists tracking the magnetic field say that for the last 150 years the magnetic field only moved 1,000 kilometers, but recently is moving up to 40 kilometers a year and the field is expected to end up somewhere near Siberia, Russia in a few decades.

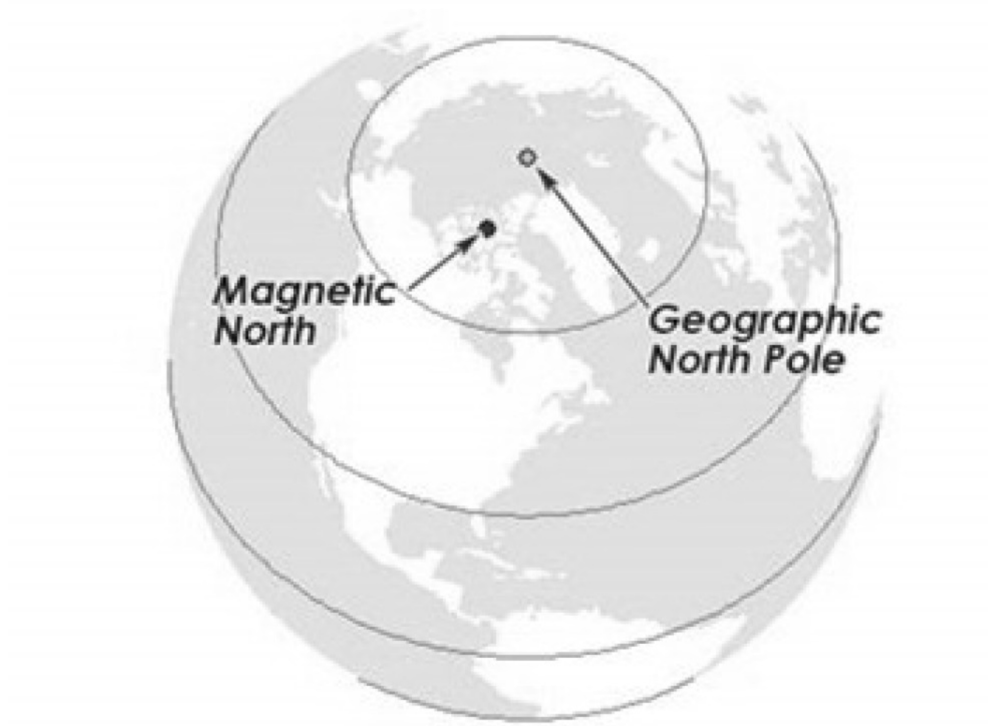


Illustration 6-1 Magnetic North.

The difference between the map makers' grid north and magnetic north is what is referred to as the Grid-Magnetic Angle (G-M angle). The G-M angle value is the angular difference that exists between grid north and magnetic north. It is an arc, indicated by a dashed line in the declination diagram connecting the grid north and magnetic north prongs. This value is expressed to the nearest 1/10 degree and mil equivalent. The G-M angle is important to the navigator because azimuths translated between ground (magnetic) and map (grid) will be in error by the size of the angle if not adjusted for it. This is why it is so important to know what the G-M angle is on the map.

Depending on where we are, the G-M angle can be as much as 28 degrees. For instance, Cape Town, South Africa has an easterly G-M angle of 25 degrees. Other places, such as Monroe, Louisiana don't have a G-M angle to worry about. Generally within the United States, west of the Mississippi River will have an easterly G-M angle and everything east of the Mississippi River will have a westerly G-M angle.

It is important to check the date when the map was last updated. Approximately every five to ten years, map makers check the G-M angle to see how much it has changed on various maps. See https://www.magnetic-declination.com/ for up-to-date declination. Camp Mackall provides a good example of how the G-M angle changes over time: As of 2017 the G-M angle is 9.3 degrees. In 2001, the G-M angle on the same map was 7.5 degrees. In 2024, future Special Forces students will be using a westerly G-M angle that is projected to be 8.5 degrees.

Converting azimuths

Looking at the lower margin of the Camp Mackall map, we notice the declination diagram contains three lines; a magnetic north arrow, a true north star, and a grid north line. We only need to concern ourselves with the magnetic north arrow and the grid north line. We notice the magnetic north arrow is to the left of the grid north line making it a westerly G-M angle (illustration 6-2).

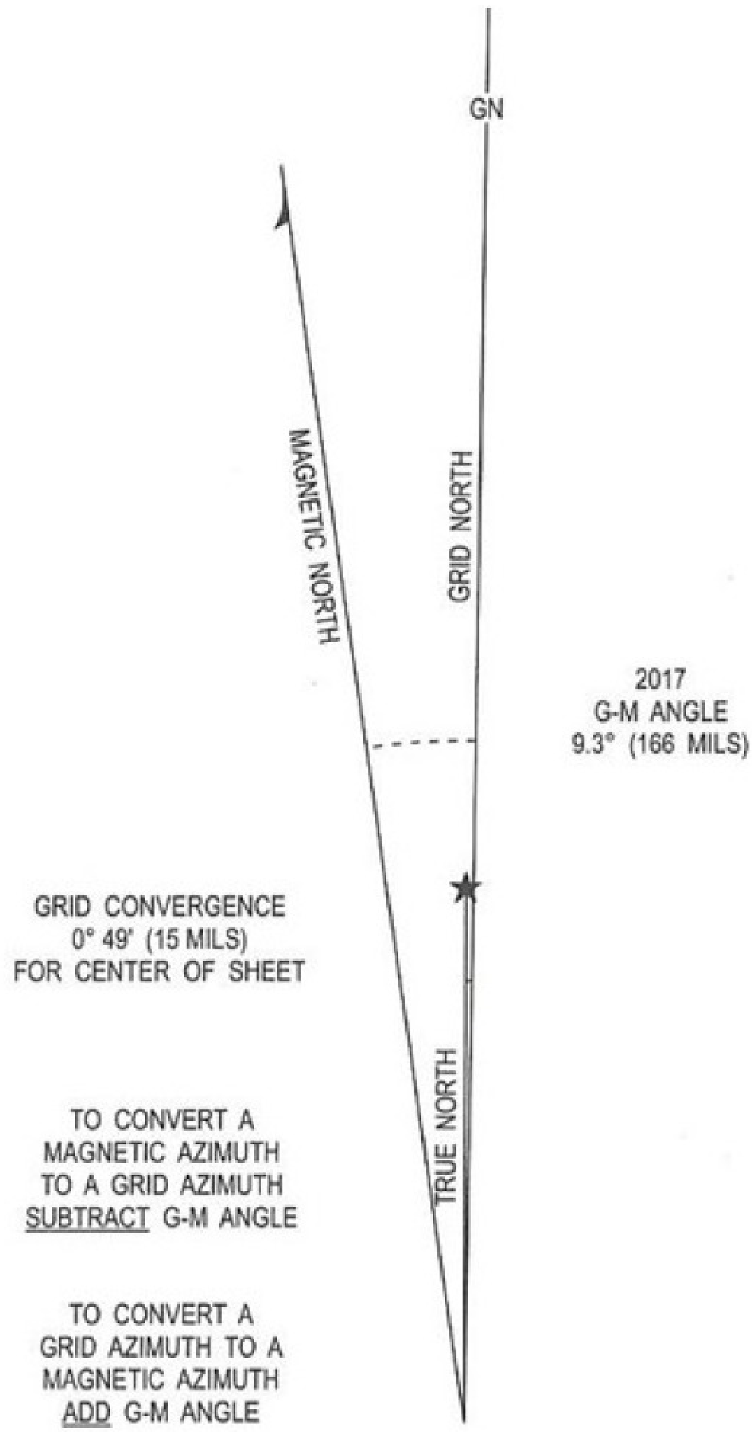


Illustration 6-2 G-M Angle.

If the magnetic north arrow was on the right side of the grid north line, it would be an easterly G-M angle. The diagram also informs us that as of 2017 the G-M angle is 9.3 degrees (166 mills).

The information provided with the declination diagram instructs us that to convert a grid azimuth to a magnetic azimuth we should add G-M angle. For Camp Mackall, the G-M angle is 9.3 degrees westerly. If we have a grid azimuth of 261 degrees that we desire to convert to a magnetic azimuth, then we add 9 degrees (the G-M angle) to our 261 grid azimuth 261 + 9 = 270 magnetic degrees. It's that easy. Likewise, if we desire to convert our 270 degrees magnetic azimuth to a grid azimuth, we are instructed to subtract G-M angle: 270 – 9 = 261 degrees grid azimuth.

For the vast majority of instances, military maps provide a declination diagram just like the one provided on the Camp Mackall map. There is no need to try to guess how to convert azimuths since the instructions are clearly provided on the map in order to reduce the possibility of mistakes. However, what about those times when we are handed a military map that someone was kind enough to remove what they considered all the useless information contained in the margin? Or those instances when we are forced to use a civilian map or a map from another country that just has a declination diagram with two lines and no instructions? If we're lucky, the lines will be marked 'GN' and an arrow for magnetic north. We only need to remember that grid north will always be straight up and down and the magnetic north line will have an arrow and lean either left or right of grid north.

If we find ourselves in a predicament and need to convert an azimuth without any instructions provided, we may need to resort to one of the useful mnemonics taught by land navigation instructors worldwide. If the mnemonic you learned works, keep using it! If not, we suggest using the acronym **L.A.R.S.**; left add, right subtract. Here's how it works: Regardless of whether or not we are converting azimuths from grid to magnetic or magnetic to grid, or using a westerly versus an easterly angle, all we need to know is if we are moving left on the declination diagram (illustration 6-3), we add the G-M angle and if we are moving right, we subtract the G-M angle. It's just that simple.

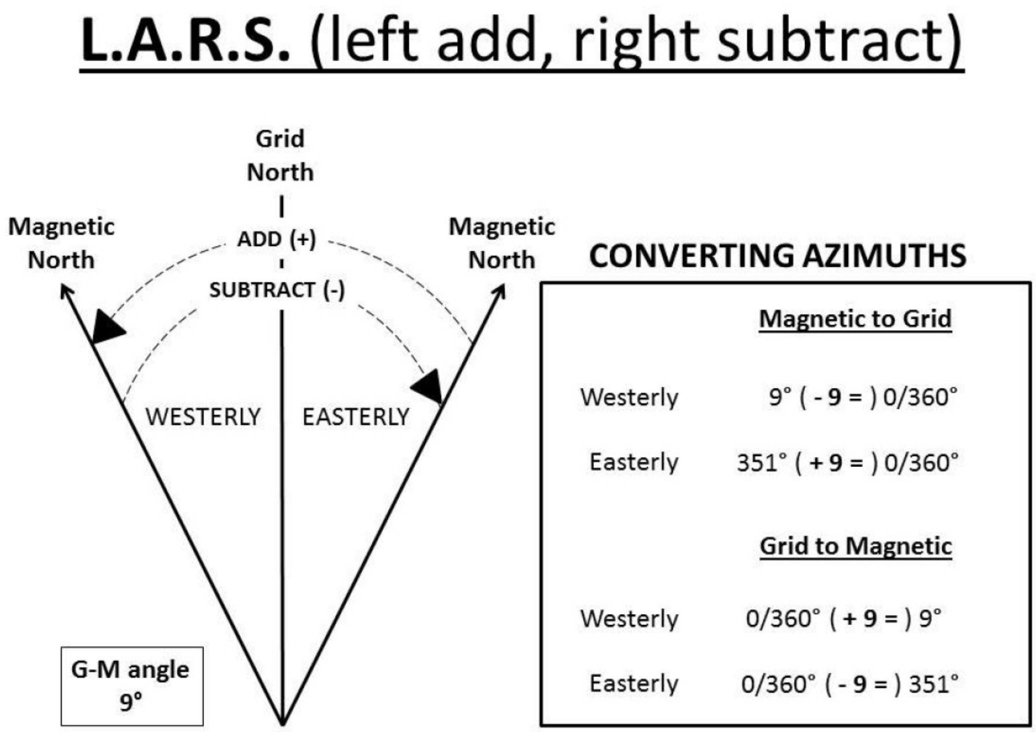


Illustration 6-3 L.A.R.S.

Check on Learning

Question 1: A map shows an easterly G-M angle of 21 degrees. To convert from a grid azimuth to a magnetic azimuth, do we add or subtract the G-M angle?

Question 2: According to our map, with its westerly G-M angle of 14 degrees, we need to travel on a heading of 281 degrees. Using our compass, what azimuth should we walk?

Question 3: During a patrol, we shoot a 180 degree magnetic azimuth to the other side of a large open area. In order to plot this azimuth on our map, what is the grid azimuth? Our area of operations has a westerly G-M angle of 5 degrees.

7

Intersection and Resection

Intersection and resection are additional navigation skills we need to understand and be proficient with in order to locate certain positions on a map. Intersection helps us locate distant unknown positions and resection assists us in locating our own position.

Intersection

Intersection is a skill used to locate distant or inaccessible points, objects or activity, such as an enemy target or the sound of gunfire. Basically, intersection is used when we know our location and we are trying to find an unknown location so it can be plotted on our map. I used intersection when I was stationed in South Korea, while doing patrols in the De-Militarized Zone (DMZ) between South and North Korea. Every night there were two to three patrols out at a time. The North Koreans at the time were digging infiltration tunnels under the DMZ to South Korea. The S-2 wanted us to take a compass azimuth every time we heard loud explosions and mark our location at the same time. Once the patrol was over, us patrol leaders would plot with the S-2 our location and azimuth when we heard an explosion. After being plotted, the S-2 could see where the lines crossed between the patrols, and it was a pretty close proximity to where the explosions were being conducted in North Korea.

There are a number of techniques that can be utilized to perform an intersection; the standard compass technique, the straightedge technique (if a compass isn't available), the modified, single azimuth technique, and using multiple observers (illustration 7-1).

Probably the most common method used to obtain an intersection is multiple observers at known locations using compasses. The illustration shows how the method works from two known positions. Both Patrol A and Patrol B are observing the same object at an unknown distant point. Using their compasses, both patrols shoot azimuths to the object, convert the azimuth from magnetic to grid, then plot the azimuths. Where the azimuths intersect on the map, is the Unknown Location of the distant object, which can be plotted now.

If fortunate enough to have a third known position occupied by Patrol C, then the third azimuth will either perfectly intersect the other two azimuths, or most likely, create a small triangle around a more accurate 'Unknown Location'. In this case the center of the small triangle is the Unknown Location.

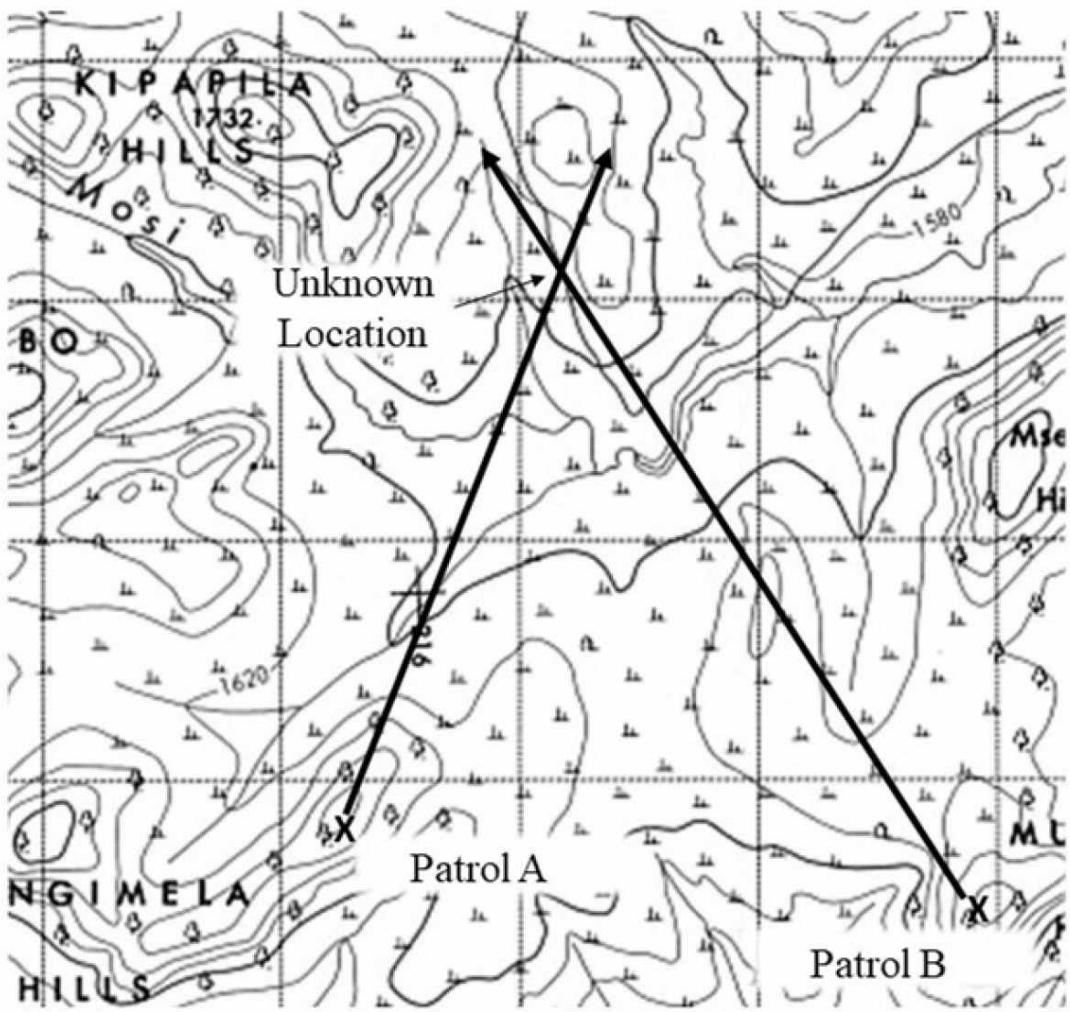


Illustration 7-1 Intersection.

In the rare event we don't have a compass available, the straightedge technique can be used. Orient the map to the ground on a flat surface making sure the terrain on the ground matches the contour lines on the map. Once we are satisfied the map is properly oriented to the ground, we simply locate and mark our position on the map. Finally, draw a line from our position in the direction of the distant unknown location. This line serves as a substitute for a grid azimuth to the unknown location.

Understanding a more accurate intersection utilizes azimuths from three known positions, there are instances when one azimuth from a single known position is the best we can do. In this situation, a modified, single azimuth technique is utilized. Once the azimuth has been drawn on our map, we need to be able to identify recognizable terrain or observe any linear feature to intersect with our azimuth. This technique works well when observing roads, railroads, airfields, ridgelines, rivers, and valleys.

Resection

Resection is a skill used to locate our position by determining the grid azimuth to two, preferably three known locations that can be pinpointed on a map. In other words, resection is used when we don't know our location, but we do know the exact location of objects we can see in the distance. I taught resection to African platoon size mortar crews when they were going to support their platoons on a raid. They needed to know their exact location in relation to the target so they could set up their mortars to be able to engage the platoons' target. They would orient their map to magnetic north and then take an azimuth to the target and an azimuth to another known point and then do a resection to get their exact location.

Similar to intersection, there are a number of techniques that can be utilized to perform a resection; the standard compass technique, a straightedge technique (see previous section), and the modified, single azimuth technique.

The most common technique requires us to identify at least two distant objects we can locate on our map. Next, after orienting the map to magnetic north, we mark the two distant objects on our map. For our example, we'll use two distant hilltops labelled 'Known Location A & Known Location B' (illustration 7-2). Next, using the compass technique, we shoot a magnetic azimuth to each distant object and write down 333 degrees magnetic to the hilltop at Known Location A and 255 degrees magnetic to the other hilltop at Known Location B.

Before we add or subtract 180 degrees to obtain the needed back azimuths, we ought to first convert our two magnetic azimuths to grid azimuths. Looking at the bottom portion of the map, we learn this area has a westerly GM angle of 9 degrees. Therefore, using LARS, we subtract 9 from the magnetic azimuths to get 324 degrees grid azimuth to hilltop at Known Location A and 246 degrees grid azimuth to the other hilltop at Known Location B.

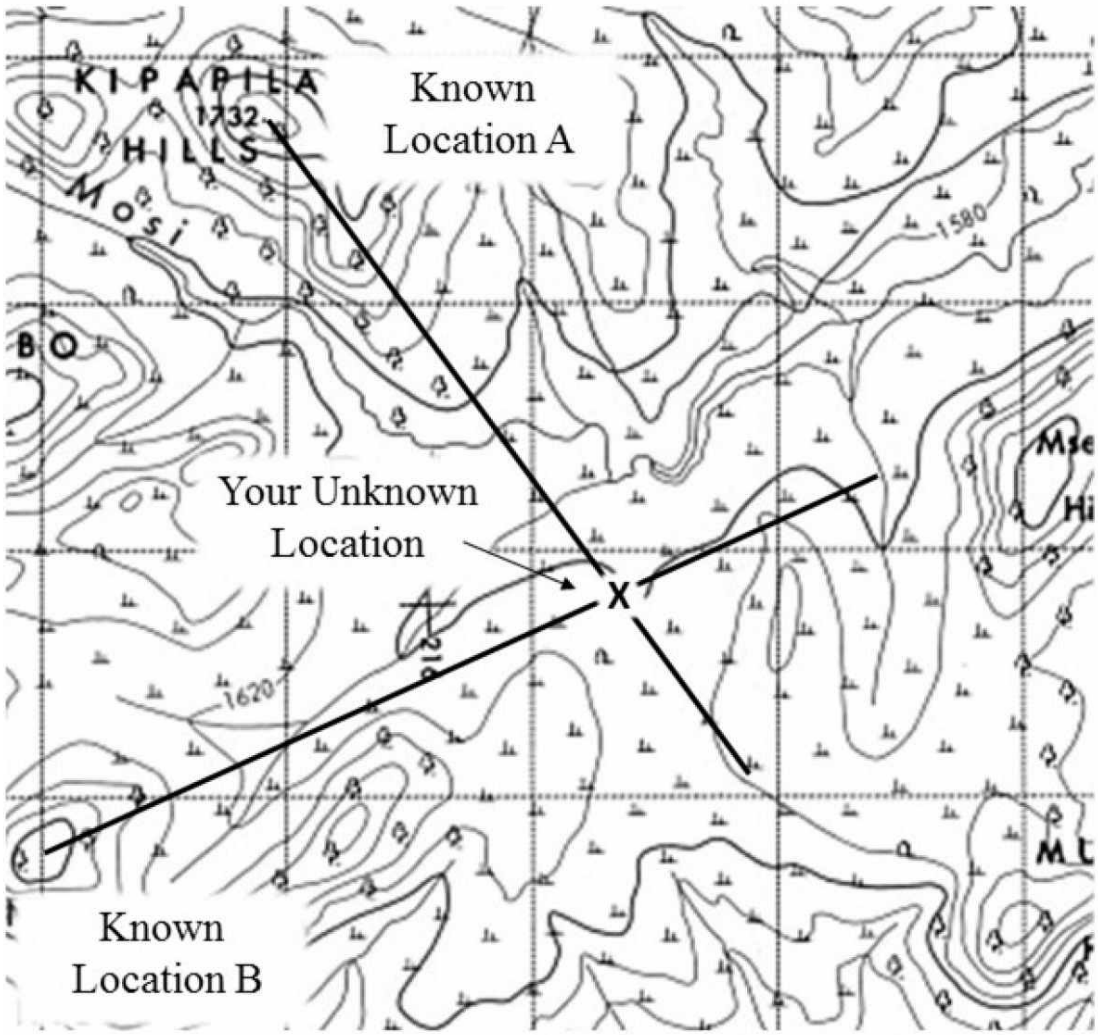


Illustration 7-2 Resection.

Finally, we need back azimuths from the two Known Locations in order to draw lines on our map and complete the resection. Since both of our grid azimuths are >180 degrees, we simply subtract 180 degrees from both to get the needed back azimuths of 144 degrees grid azimuth from Known Location A and 66 degrees grid azimuth from Known Location B. Starting with the first hilltop, we center our protractor on Known Location A and mark the grid azimuth on our map using a pencil. Next, we draw a line from the hilltop to that mark. Next, we repeat the process from the other hilltop and where the two lines cross is our Unknown Location.

As with intersection, a third, or more known locations increases the accuracy of the resection. However, occasionally we'll find ourselves in situations when one back azimuth from a single known position is as good as its going to get. In this situation, a modified, single azimuth technique is utilized. Once the back azimuth has been drawn on the map, we estimate our distance from the known point and then attempt to identify the terrain around us on the map. If we are fortunate enough to be on or near a linear feature such as roads, railroads, ridgelines or power transmission lines that intersects with the back azimuth, identifying our position becomes fairly simple.

Check on Learning

Question 1: A halted patrol located at 17S PU 2590 8268 hears what sounds like a generator running on a magnetic azimuth of 242 degrees.
A guard on duty in a lookout tower located at 17S PU 2175 8342 reports the same generator sound on a magnetic azimuth of 325 degrees. Where is the generator located at? The area has a westerly GM angle of 9 degrees.

Question 2: A patrol recently disembarked from their truck transport vicinity BM 162.7 located near 17S PU 1887. They have been moving south by foot and are conducting a long halt beneath power transmission lines. The squad leader wishes to quickly pinpoint the patrol's position using a modified resection. Noticing the lookout tower in the distance, the squad leader takes out his compass and shoots a 134-degree magnetic azimuth to the lookout tower. What is the patrol's exact location?

8

Useful Techniques

Map orientation

How fast our brain is able to understand our location in relation to our surroundings and which way we need to travel has a lot to do with how we view our map. Most global positioning devices today offer choices on how the user wants to view the screen. For some, having the top of the map or screen reflect the direction of travel is best. No matter what direction the user is traveling, the map always shows the user moving towards the top of the screen. Others prefer the top of the map or screen to always be oriented north. This means if the user is traveling east, the screen shows the user moving from left to right, if traveling south, the screen shows the user moving from the top of the screen to the bottom, et cetera.

The same rules apply to standard paper maps. We need to know the best way for us to view the map in order to better understand the information. When stationary, most of us prefer to orient the map to the ground around us. This means north on the map is facing north on the ground. This helps us identify nearby terrain from the contour lines on our map, as well as knowing exactly what direction we're traveling in without having to shoot an azimuth. To achieve this, we lay our map down on a flat smooth surface and take out and open our compass. Next, using our bezel ring, we dial in the G-M angle. For Camp Mackall, the angle is 9 degrees westerly, meaning we simply move the short luminous line on our bezel ring to the left 3 clicks equaling 9 degrees. Finally, lay the straightedge of the compass along any north south grid line on the map and then turn the map with the compass on top until the luminous magnetic arrow on the compass is lined up with the short luminous line on the bezel ring. The map is now properly oriented with the magnetic arrow pointing 9 degrees westerly (towards Ellesmere Island in Canada) left of the map maker's north south grid lines that travel Earth's axis from the North Pole to the South Pole.

During movement, most prefer to have their map folded in such a way it only shows the area currently traveling through with the map oriented in the direction of movement. Generally, the map takes up no more space than 6” to 8” and easily fits into a common map case or large zip lock bag.

Map orientation is always user preference and there is no wrong way to hold or orient a map. However, it is important to figure out what works best for the user and is most efficient thereby reducing confusion and the possibility of mistakes.

Pace count

After we’ve measured the distance to our next point on the map, we need a method we can use to keep track of the distance we’ve traveled. To achieve this, we’ll use what is called a pace count. A pace count is the number of steps (by foot) it takes an individual to travel 100 meters. The preferred method is to count, either the left or right foot every time it strikes the ground, “one, two, three, …” until 100 meters have been traveled. Finding an individual’s pace count is generally achieved by walking an established course through varying terrain that is usually 300 to 500 meters long. As an example, if it takes an individual 180 steps, counting every time the left foot hits the ground, to walk 300 meters, then dividing the 180 steps by 3, provides the individual’s 100 meter pace count. In this example the individual’s pace count is 60, meaning his 60 steps equals 100 meters. Most adults have a pace count that ranges anywhere from 55-67 paces.

Keep in mind a few factors can affect our pace count; weight of any equipment we may by carrying like our rucksack, the terrain we are traveling through, and finally, visibility. If we are weighted down with a 60 pound rucksack, walking at night in low illumination with little to no moon light, over difficult terrain with numerous thick draws, our pace count might be off quite a bit considering we’re probably taking more steps than usual to travel 100 meters. One method frequently used to get a more accurate pace count is making sure we are loaded down with our rucksack and walk the pace count course during hours of limited visibility.

Once we are satisfied with a reliable number for use on an actual land navigation course, we need a method to keep track of the distance traveled. Again, no need reinventing the wheel. Most professionals use what is commonly referred to as a pace count cord. You can buy them or make your own. If you buy the plastic “Ranger beads” get two sets and keep one as a backup. If the beads get stepped on, they do break. It consists of a piece of cord with a couple of knots and several beads to keep track of distance. These cords typically have 4 beads above a knot (the top) representing kilometers traveled and 9 additional beads below the knot (the bottom) that each represent 100 meters traveled. As we hit our pace count, we move one of the bottom beads representing 100 meters. Once we've moved all nine beads equaling 900 meters traveled, we continue to count our pace as we walk. When the last 100 meters has been traveled, we simply move or reload all nine beads to their start position and move one of the top kilometer beads representing the current 1,000 meters traveled. The process continues as we travel.

Checkpoints

We are purposefully going to address checkpoints immediately following pace count for a good reason. Checkpoints are crucial for assisting us in keeping track of actual distance traveled. Even though we have a reliable pace count we trust, we are also going to use our checkpoints to confirm distance traveled.

Checkpoints are primarily used for two important reasons. One, they provide a type of terrain count-down or checklist that confirms our route. For instance, if our route takes us across two draws, then over a hill before arriving at our final destination just beyond a depression, then we should expect to come to and pass two draws, a hill and a depression enroute to our point. If we don't negotiate a draw during our movement, something is wrong. We need to halt immediately in order to figure out our mistake and then make the necessary correction.

The other important reason for using checkpoints is they break up our route into manageable pieces of shorter distances. Obviously, it is easier for us to manage a 300 meter movement to our first draw than try to keep track of the 1,500 meter movement all the way to our final point. We confirm our pace count when we hit the draw since we know it is exactly 300 meters distance from our start point on the map. After passing the first draw, we can begin the next leg of our movement, which is 450 meters to the next draw.

Checkpoints also provide a great opportunity for a quick map check in order to pinpoint our location during movement. Needless to say, our checkpoints need to be easily identifiable both on the map and by observation during our movement on the ground.

The terrain count-down provides us small victories along our route. Each time we arrive at our checkpoint, we've just managed another portion of our route successfully and confirmed our pace count, providing confidence in our skills knowing we're doing everything right (illustration 8-1). Terrain count-down also assists us when an instructor asks you where you are by allowing you to quickly determine your location.

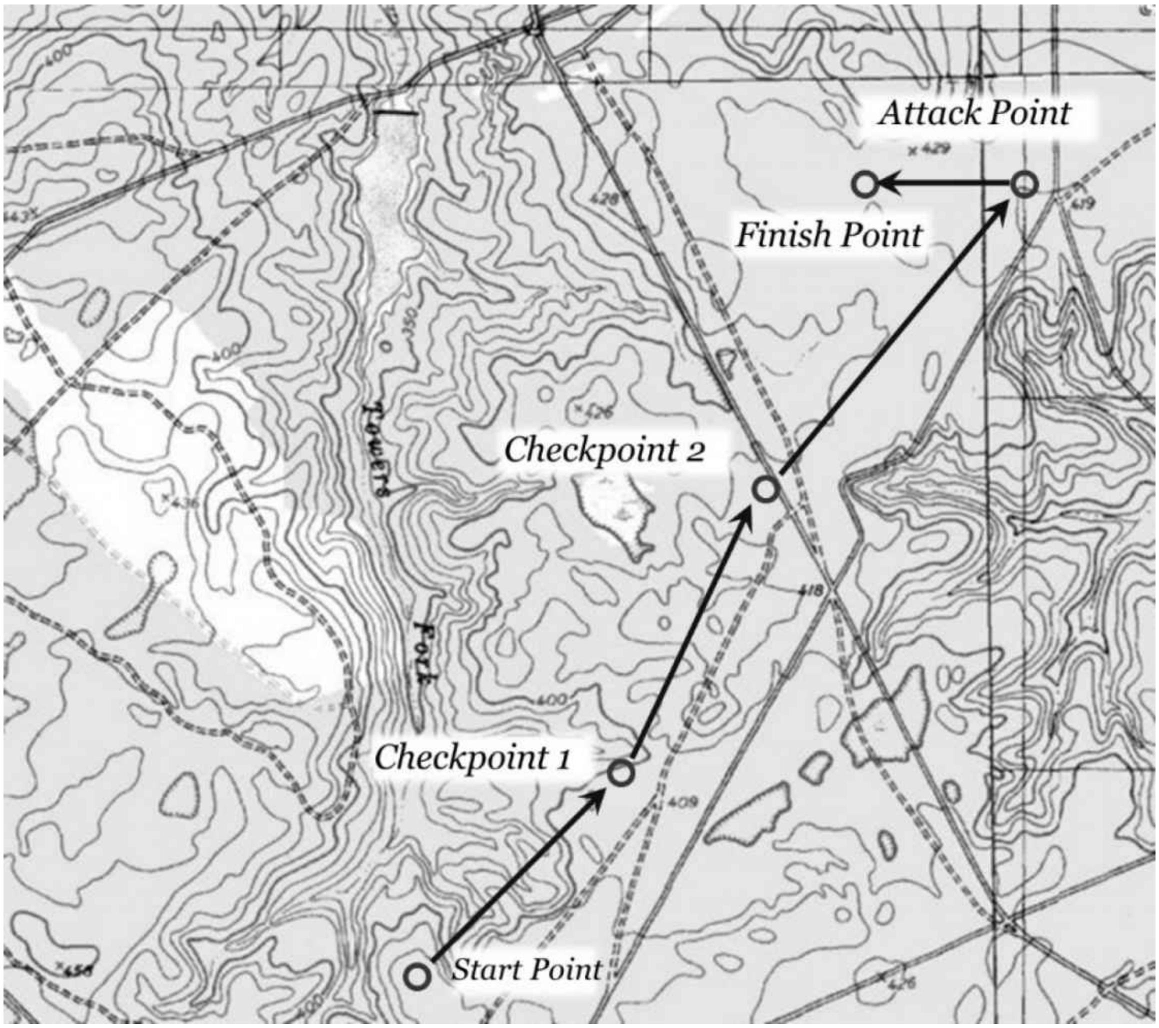


Illustration 8-1 Checkpoints.

Dead reckoning

As discussed previously in this book, most so-called land navigation courses are what we term as 'dead reckoning' courses, meaning they are purposely designed to be simple courses that confirm basic navigation skills such as being able to locate a position on a map, plot a grid coordinate, convert grid to magnetic azimuth, figure and track distance, and finally, walk a heading at an acceptable rate to an easily identifiable landmark or point. The process is repeated for a sufficient number of times to satisfy confirmation of knowledge in basic, elementary level land navigation skills.

Understanding finite details on a map, such as interpreting contour lines with the ability to conduct detailed route planning due to difficult terrain, isn't necessarily a required skillset for these military schools and/or professional development courses. Generally, one can stand at a start point, shoot an azimuth using the compass-to-cheek method, and then walk at a brisk pace straight to the next point.

Consider the basic skills required to successfully negotiate a typical 'dead reckoning' style course as a 'foundation' for additional skills needed to successfully accomplish an advanced land navigation course.

Terrain association

Terrain association is exactly what it sounds like; an ability to understand contour lines on the map and the actual terrain around us in order to make sensible decisions for movement based on that knowledge. Terrain association requires additional skills and an ability to absorb lots of information and then prioritize information based on probability of accuracy and impact on our movement.

'Terrain association' type courses generally don't rely heavily on specific headings, rather the compass is used primarily to confirm cardinal direction such as traveling northeast down a ridge or moving south to cross a creek, but you would be smart to set your general azimuth on your compass so while moving through the terrain, your heading will help keep you straight and not drift to far left or right. By using our terrain count-down, general azimuth and pace count together offers you the greatest chance for success.

In reality, all skills associated with both dead reckoning and terrain association must be used together, interchangeably in order to be successful on challenging, long distance land navigation courses.

Bypassing obstacles

There are times when it is going to be advantageous for us to bypass, or avoid a specific area altogether in order to maintain momentum, even though we've previously selected the most advantageous route. Some examples of situations where bypassing obstacles is advantageous would be an open area in hostile territory during a reconnaissance patrol, or in our case, perhaps running into the head of a thick draw that can be easily avoided.

There are two ways to bypass obstacles. One is the contour method and the other is the box method. We'll discuss the box method since it is the best method for keeping track of distance using a pace count.

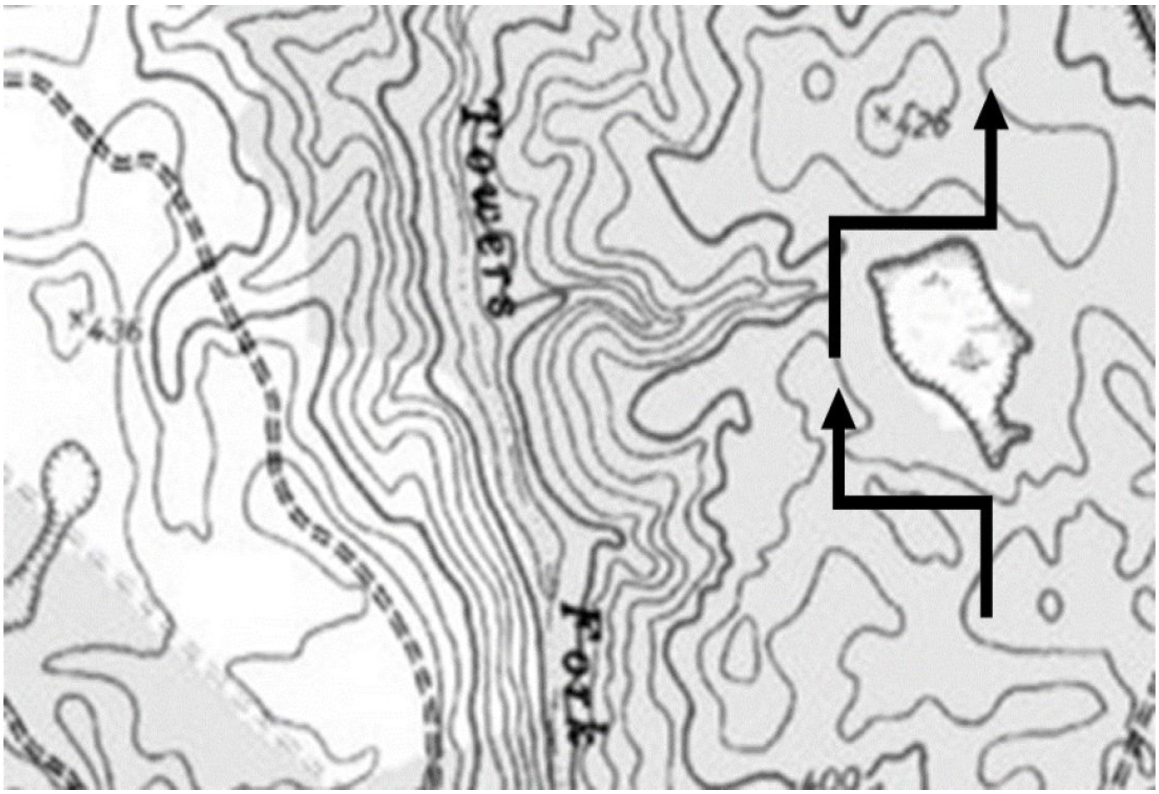


Illustration 8-2 Bypassing an Obstacle.

To bypass, we simply make a 90 degree turn from our current heading, either left or right or whichever makes the most sense, until we have shifted far enough left or right to turn back onto our original heading and have a clear path past the obstacle. Once past the obstacle, we make another 90 degree turn, this time in the opposite direction, and travel the same distance in order to return to our original route. If we had to travel 200 meters to the left in order to bypass, then we simply want to travel 200 meters to the right in order to return to our original route once past the obstacle (illustration 8-2).

Deliberate offset

We use deliberate offset when we are looking for a point on a linear feature, such as a T intersection. If we attempted to walk straight to the T intersection we wouldn't know if we were left or right of the intersection once we arrived at the linear feature, such as a road. By deliberately plotting our general azimuth left or right of the T intersection, when we arrive at the liner feature, we will know which direction the T intersection is.

Handrails

Similar to how we used a deliberate offset when looking for a point on a liner feature running perpendicular to our direction of movement, we use what are known as handrails in order to move quickly when we have a linear feature running parallel to our direction of movement.

An example would be a dirt road that happens to run north south in proximity to the area we are moving through. If we need to move south to get to our next point, it may be advantageous for us to use this road as a handrail by simply moving close enough to the road, perhaps to within 100 meters of it, depending on visibility, vegetation and terrain, to keep it within site and then be able to move quickly through the brush in the same desired direction.

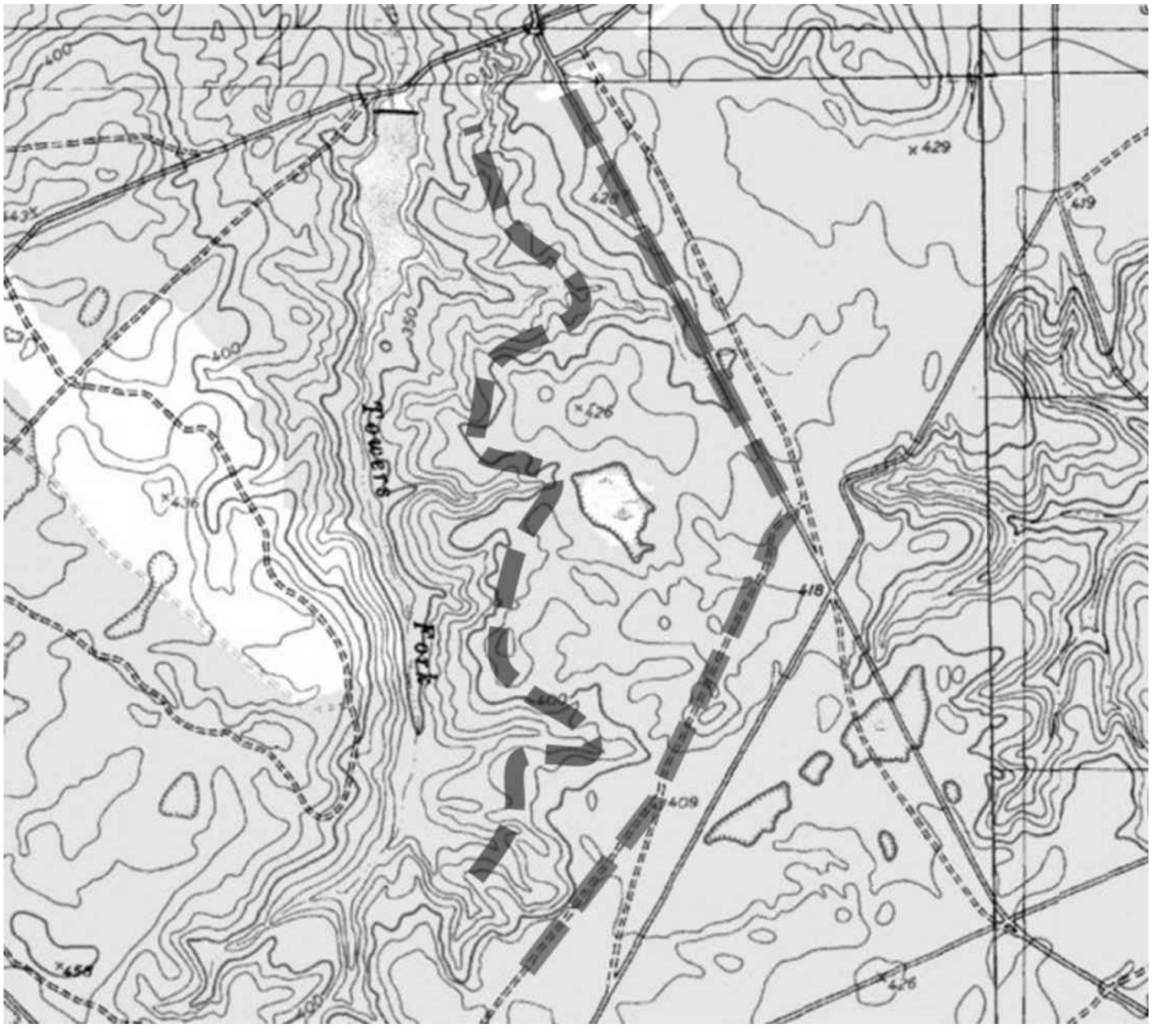


Illustration 8-3 Handrails.

Once we arrive at the road we think is the same road on the map we desire to use as the handrail, <u>we must confirm it by using our compass.</u> Using our example, the road we want to use as our handrail should run north south. Once we have confirmed we are at the correct road, we simply turn south and move out keeping the road within site (illustration 8-3). A word of caution here, keep checking your compass to ensure the road is indeed going in the direction you need to be going. Remember the map you are using is using 2017 information. A road could have been added and we don't want to be handrailing the wrong road (illustration 8-3).

Attack point

An attack point is a feature that can be positively identified both on the ground and on the map that is within 500 meters of the target. An attack point is an easily identified ‘last known point’ before walking an azimuth to the point we are looking for that isn’t as easily identified on the ground, such as an engineer stake in the middle of nowhere.

The closer we can identify an attack point to our target, the better. Anything over 500 meters away from the target defeats the purpose of the attack point and anything less than 500 meters, the more accurate it will be for us to ‘walk our compass,’ staying on azimuth and keeping track of the pace count. The ideal distance for an attack point is between 200 and 300 meters. If we mess up, it’s easy to return to the attack point and try again. If we fail to find our target, it’s time to search.

Backstop

A backstop is any feature on the map that can be positively identified both on the ground and on the map that we use to let us know we’ve traveled too far and passed our desired attack point or just a check point. Generally speaking, we shouldn’t hit our backstop, but sometimes we’ll use the backstop in order to positively identify our position and then make any necessary adjustments to our movement.

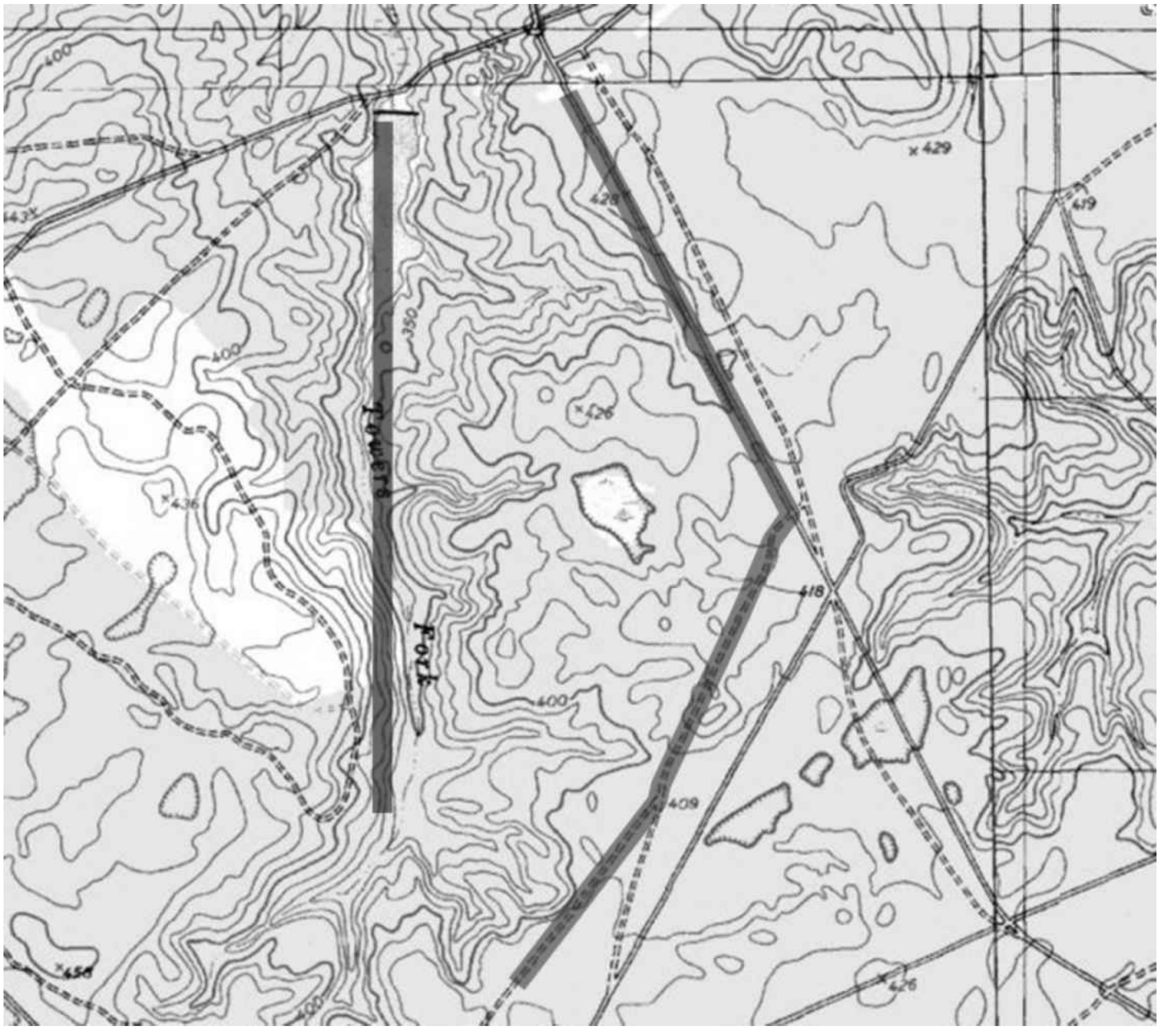


Illustration 8-4 Backstops.

The backstop is just what it states, an easily identified piece of terrain or feature on the map and on the ground that ‘stops’ us from going too far (illustration 8-4). Roads, rivers, large creeks and bodies of water make excellent backstops.

Cardinal direction search

In the event we fail to find our target, even though we’re confident we are in the right location, first thing is don’t panic and start second guessing yourself. Take a deep breath and walk another 100 meters on your azimith and look around. If you don’t see the point it is time to conduct a search. Like everything else we’ve learned about navigation, we need to have a well thought out plan for conducting our search. The last thing we ought to do after spending time planning a detailed route and then conducting our deliberate movement complete with handrails, checkpoints and an attack point is decide to start moving around without a plan.

Therefore, the first thing we'll do is find something we can use as our start/reference point; a large tree, rock or anything easily identifiable. We may need to mark our start point with a man-made item. From this point, we will move/ search out 100 meters during the day or 50 meters at night in four cardinal directions; either north south, east and west or northeast, southwest, southeast and northwest depending on which four cardinal directions make the most sense to use.

As an example, during hours of limited visibility, we shoot a 360 degree azimuth and walk due north 50 meters from our start point. Once we've walked the 50 meters due north, we then shoot a 180 degree azimuth and walk 100 meters passing our start point heading due south. Once at our second cardinal direction, we then turn around and head due north 50 meters returning to the start point.

We repeat the process this time walking 50 meters on a 90 degree azimuth due east. Once we've walked 50 meters, we turn around and walk 100 meters passing our start point heading due west on a 270 degree azimuth. After hitting our fourth and final cardinal direction, we head back 50 meters to the start point on a 90 degree azimuth due east (illustration 8-5).

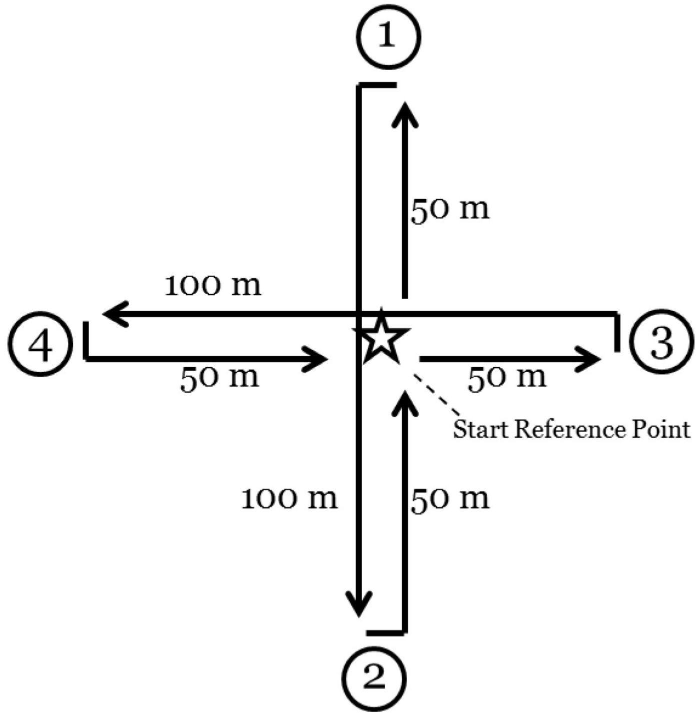


Illustration 8-5 Cardinal direction search.

If we still haven't found our target, we can repeat the entire process using different cardinal directions and/ or searching further out. If we're in the right area, we shouldn't have to go any further out than 200 meters at most. Majority of the time you are just a little left or right of the final point.

Using an attack point with a well thought out search pattern keeps us in a very small, controlled area that makes it easy for us to locate our point.

Check on Learning

Question 1: Why is it important to orient the map and why is it important to keep the map oriented during movement?

Question 2: How are checkpoints used to confirm a pace count during movement?

Question 3: What is a deliberate offset and why is it used?

9

Putting It All Together

The difference between the individual that has the ability to select the most advantageous route, knows his location throughout movement regardless of weather and visibility, manages time, and understands the terrain, and demonstrates these skills consistently throughout his career, and that "other guy" who gets lucky knowing just enough to pass a required elementary level land navigation course, is the ability to see and comprehend all of the information around him and apply multiple skills and techniques simultaneously. This is what is required from a professional leader who is competent at land navigation.

A challenging land navigation course, such as the STAR exam, may seem daunting and unattainable for those just beginning to learn the art of land navigation, but we've developed an acronym that hopefully will help to put it all together; **P.O.I.N.T.**

P – <u>Pinpoint locations:</u> Where we are and where we are going. Yes, this is common sense and sounds so simple that it probably shouldn't have to be included in the list of things to do, but we should never lose sight of the fact that incorrect plotting accounts for most of the failures in any land navigation exam. Think about all of the negative consequences one has from plotting a wrong point. Everything that follows plotting a point incorrectly is useless information and worse yet, time consuming. By the time one figures out the mistake, it is usually too late and not enough time remains to correct the deficiency and move to the correct point. In carpentry, there is an old saying; "Measure twice, cut once." When navigating, we like to say, "<u>Plot twice, walk once.</u>" Remember read RIGHT then UP.

O – <u>Orient the map and self:</u> We need to orient the map to the ground around us so that north on the map is facing north on the ground. We accomplish this by dialing in the G-M angle and then laying the straightedge of the compass along any north south grid line on the map.

Next, we turn the map with the compass on top until the luminous magnetic arrow on the compass is lined up with the short luminous line on the bezel ring. Remember to keep your map protected in the map case.

Refold your map to the area you are working in and store in your map case that way, not too small or too big. You should be able to open your map case and see the area you are working in. Try not to pull your map out of your map case while out in the elements. Bad things happen to your map when you start doing that. Always have a small back up flashlight and protractor when working with maps out in the field. Mechanical pencils sizes 0.5/0.7 are the best to use. The lead is protected, and it makes a very small mark on your map. You buy them in a pack of 5 or 10, so you will always have a spare. You can use the pencil to point to your location if an instructor asks you.

I – <u>Identify the ABCs:</u> Attack point, backstop, and checkpoints. It all starts with good route selection. Calculate azimuth and pace count for each leg of the route for our terrain countdown. We need to use backstops and attack points to our advantage. This way we are just following a general azimuth to our features and moving quickly on the path of least resistance. It is also a good idea to keep our attack points within the 200-300-meter range. The closer we are, the quicker we can reset and avoid having to do a search pattern if we don't find our point.

When figuring out elevation, count the contour lines a few times. It is easy to mess this up. On the Camp Mackall map, elevation does not play a huge part of route selection but in other places around the world it will. The plastic credit card size magnifying cards advertised for old people at the checkout line at Wal-Mart work great for detail route planning when looking at contour lines that are really close together, or when our map is not a sharp copy. They also work great when planning using an aviation chart.

N – <u>Navigate using terrain association:</u> Set the general azimuth on our compass. Read the terrain throughout movement utilizing natural lines of nature that take the least amount of effort. Use high ground whenever possible and avoid movements that traverse multiple low areas. "<u>Stay high, stay dry.</u>"

While handrailing linear features, pull the compass out and keep an eye on it. Once as an E4, I was handrailing a road, staying the required 50 meters from the road of course, and unknown to me, there was a fork in the road that was not on the map. Inadvertently I followed the 'new road' to the right using my planned distance and realized things were not matching up with my terrain countdown. I knew something wasn't right and had to regroup, which took me almost an hour to get back on the correct azimuth. If I would have had my compass out, I would have caught the mistake right away and saved valuable time.

T – <u>Time management:</u> Don't be in a hurry and don't worry about taking time to ensure accurate plots and azimuths, or conducting detailed route planning; remember, "<u>Smooth is fast.</u>" Always weigh time against a route. A good route will always save you time but trying to avoid every draw along your route might take you way out of your way, which will cost you time. These skills are critical tasks for success and will always save us time in the long run by helping us avoid unnecessary and ill-advised movement.

Lastly, we need to stay aware of time throughout our movement. Route selection should consider the constraints and impact of time. Choose a route that takes into account the type of terrain being traversed.

Type of terrain & distance covered in meters/hour:

Trail/Lines of Drift	1,500 m/hr
Temperate Forest	1,000 m/hr
Tropical Rain Forest	500 m/hr
Swamp	300 m/ hr

Check on Learning

Question 1: What does P.O.I.N.T. stand for?

Question 2: Why is it a useful acronym to remember?

10

Advanced Skills and Techniques

There comes a time in everyone's military career when they are tasked to become an 'expert' in some particular subject in order to teach a class. Hopefully, I have imparted enough knowledge within the limited confines of this little book to assist those needing to become an 'expert' in land navigation.

The previous nine chapters have covered simple, easy to use concepts of land navigation. Here are some additional useful land navigation skills that I have used and taught when teaching evasion land navigation. These tips are for when we are tired, hungry and it is do or fail time.

Finding or avoiding water

During the summertime at Camp Mackall, we should be able to notice when we are getting close to any type of water obstacle. A majority of the time, we should sense stale humid air when approaching and a slightly different kind of humid air, perhaps with a slight breeze, when we are walking away from water. During the wintertime it is the opposite. Colder air settles in low areas so we should feel it getting colder as we approach water and slightly warmer as we move away from water.

When needing to cross a water obstacle, we should try to cross at the narrowest point and where higher ground closes in on the water obstacle from both sides. When entering a draw, we need to keep our wits about us. The draw monster is in there and he will mess us up if we let him.

If we are on hilly terrain and can see our route from high ground in the distance, we need to remember this tip. Pine trees will grow right up to the water line but prefer not to be in the body of water. Oaks and other type of trees will grow in the body of water. So, if we can see pine trees and then no pine trees, chances are there is a body of water there. I have used this tip in a lot of different places in the world to find water or to avoid water obstacles.

Movement and the compass

Always "stay high, stay dry." Do not give up the high ground willingly. Ridges and spurs are our best friends while conducting land navigation by foot.

Don’t run. There is no reason to run unless you are behind on time. A good route will allow plenty of time to get to the objective without running. If we must run, the best way to run without getting hurt is what we call the ‘Airborne Shuffle’. We keep our back and shoulders upright and move from the waist down in small shuffle steps. This prevents our rucksack from bouncing all around and reduces injury to our back and other joints. We can move long distances using this technique.

I carry my compass tucked in the top of my OCP top/coat in the open mode with the rear sight folded down over my top/coat to keep the compass secured and within easy reach. Figure out what works best for you during movement.

Next, I set my azimuth under the fixed index line and rotate the bezel with the short luminous line over the luminous magnetic arrow (north seeking arrow) so I can quickly glance at the north seeking arrow to see if I’m staying on azimuth. I always look at my compass every 10-20 paces to make sure I’m staying on the correct general heading. It is easy to get turned around without knowing it. Even when on patrol, I recommend checking the azimuth often even if you aren’t the compass man. No one looks after you better than you.

I also use the graduated straight edge of the compass to quickly measure distance on the map while on the move. This way I don’t have to pull out a protractor. When combined with the pace beads, I can quickly get the general distance in under a minute. It takes most folks a lot longer than that just to pull out the map and compass.

Check the accuracy of the compass often, no such thing as a lucky compass. Keep in mind whatever dominate hand you are, you will move around an obstacle in that direction. Try to alternate from left to right when moving around obstacles to keep yourself on a steady azimuth.

Having a wrist compass is a good investment. The same company, Cammenga that makes the lensatic compass for the military also makes a wrist compass that maintains illumination on its dial throughout the night. It is kind of pricey, but it ought to last throughout your career. Remember, the pace count and azimuth are the keys to finding your location on a map.

Useful markings on the map

I like to add more grid square numbers to my map and highlight all the numbers in yellow. The map maker puts them on there for us but it always seemed they were not where I needed them when I folded my map. Therefore, I would add more numbers halfway between where the map maker put the designators so wherever my map was folded I could see the grid numbers.

A technique that I’ve seen civilians use is they will extend the magnetic north line from the declination diagram through their map. What this does for them is they can quickly orient their map using their compass. Just lay the straight edge of your compass on the magnetic north line and then turn your map until the compass reads 0 degrees, or magnetic north.

Now, with the map oriented towards magnetic north, one can plot azimuths with the protractor without having to convert. You just need to pay attention to make sure you don't make mistakes.

Extending the magnetic north line mentioned previously is easy if you use a wide ruler or carpenter's level. Just line it up against the magnetic north line, extend your line and then on the other side of the wide ruler draw another line and now you have two magnetic north lines running through your map that can be used.

Get organized

Put your terrain countdown/checklist, protractor, and mechanical pencil in your map case so it is protected and located in one place. You are not displaying confidence when an instructor asks you where you are and you have to fumble for your equipment in three or four different places.

I worked with an individual that liked to write his terrain countdown on a 3" x 5" piece of luminous tape that he stuck to the inside of his map case and he used a grease pencil. Sticking a piece of luminous tape to the inside cover of your notebook and then having a twist type grease pencil in a pocket allows you to write quick notes without needing a flashlight.

I carry a small push-type light around my neck for quick looks while on the move. If I needed to really look at my map, I would pull out my larger light that was secured on my kit.

Don't waste your money on those different types of protractors you find at Military Clothing and Sales. Most of those protractors are for use with civilian type compasses. Same thing goes for the civilian compasses; they are good compasses and work great, but they use a different way to get an azimuth. The biggest issue is you cannot see your azimuth in the dark with them, which means you will wind up carrying a lensatic compass anyway.

When working in a small group and getting ready to read out coordinates, either tell others to "prepare to copy" or tell them the grid square first. After they've found the grid square, provide the inside coordinates or read the whole coordinate to them at that point. Nothing is more frustrating than standing next to someone who reads a whole coordinate without giving folks a chance to write it down; a lot of wasted time.

As mentioned in chapter 3, read 'right then up'. Start at the lowest grid numbers that you can see and slide your finger to the right to the grid number you are looking for and then slide your finger up to the grid square you are looking for. When figuring out a coordinate while working on your map, write the grid square first and then leave a space for the additional digits. Fill in the remainder of the grid coordinate from the protractor.

Urban areas

Maintaining an accurate location within an urban environment is much more of a challenge than one would think. A popular technique is to break down the area into sectors and then pinpoint known features within each sector that can be observed from various sectors. This enables individuals to communicate their location to others by simply identifying the sector they are in with a direction to the known feature. This technique works in lieu of an accurate grid coordinate and also is used for evasion planning.

Navigating without a compass

We can determine our location by using the earth's relationship to other celestial bodies. Here are a couple of methods:

Shadow-tip method: (1) We place a stick that is at least 3 feet long upright into level ground free of leaves and brush so we can see its shadow. We then mark the tip of the shadow cast by our stick. (2) After approximately 15 minutes, we then mark the new position of the shadow's tip with another small object. (3) Finally, we draw a line between the two marks. This is an approximate east-west line. If we stand with our left foot on the first mark and our right foot on the second, we are facing north (illustration 10-1). If we are in the Southern Hemisphere, we would be facing south.

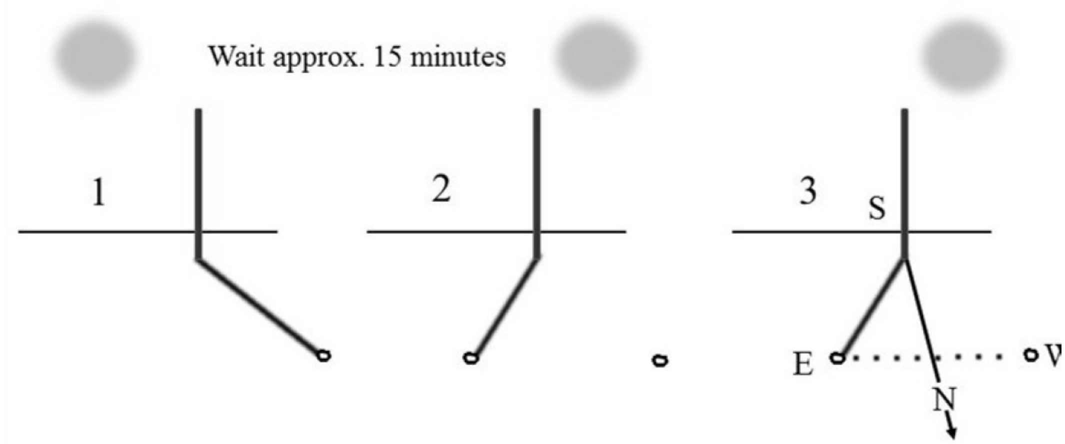


Illustration 10-1 Shadow Tip.

Analog wristwatch method: Another method that can be used to determine direction without a compass involves using an analog wristwatch. Thankfully, the wristwatch is enjoying a bit of a comeback lately as many who had previously abandoned the wristwatch have been returning to wearing wristwatches simply for fashion.

(1) First, we hold the watch horizontally and point the hour hand toward the direction of the sun. (2) Next, we bisect the angle between the hour hand and the 12 o’clock position and that bisected angle points south (illustration 10-2).

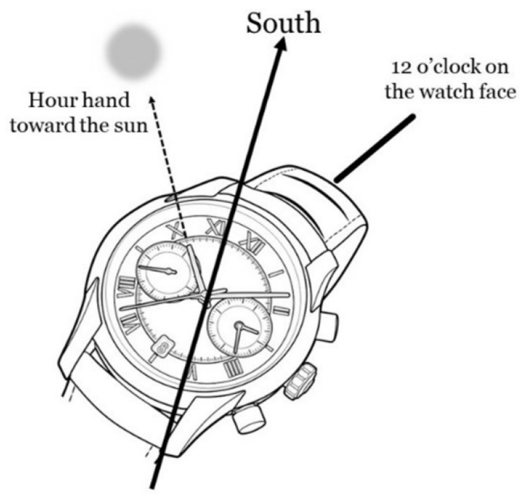


Illustration 10-2 Watch Method, Northern Hemisphere.

In the Southern Hemisphere, (1) hold the watch and point the 12 o’clock mark at the sun. (2) Bisect the angle between the 12 o'clock mark and the hour hand and that bisected angle points north (illustration 10-3).

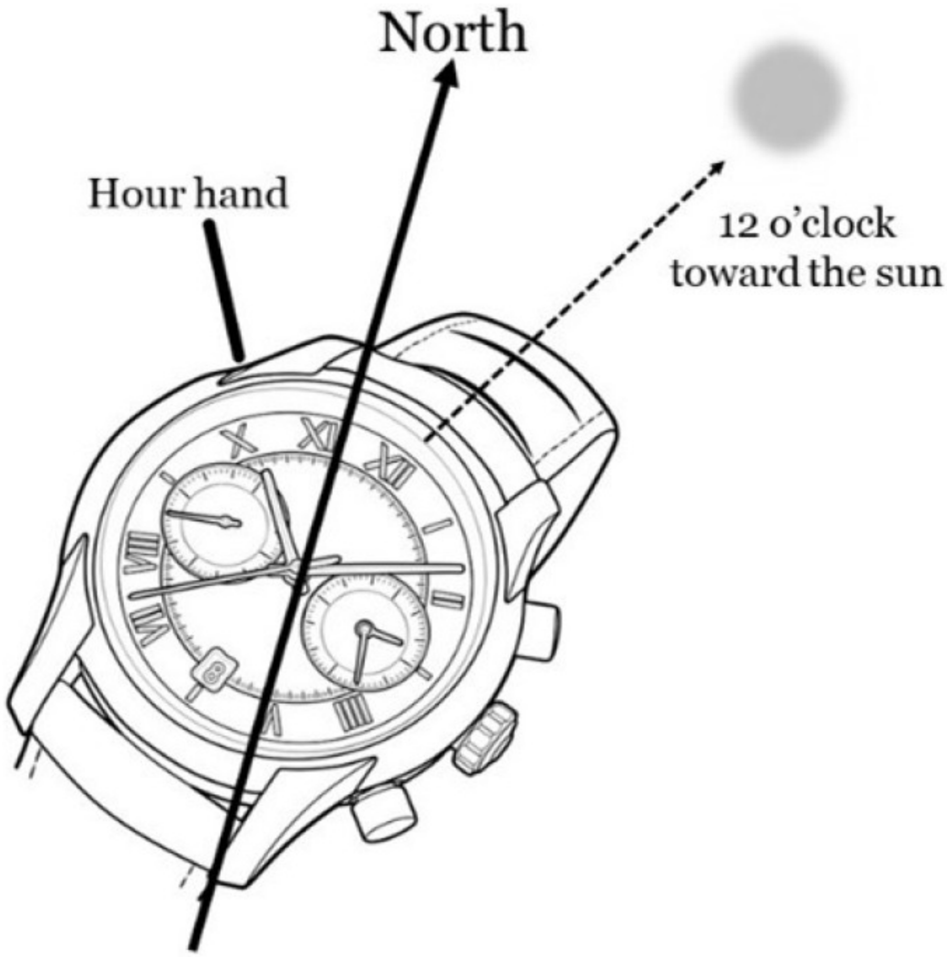


Illustration 10-3 Watch Method, Southern Hemisphere.

Navigating with Stars

When using constellations to determine our direction, we need to first identify our location's Temperate Zone. For example, the North Star (Polaris) provides an excellent nighttime navigational aid in the Northern Temperate Zone / Northern Hemisphere. In order to locate it, we need to find the Big Dipper constellation, which is made up of seven fairly bright stars in the shape of a dipper with a long-curved handle (illustration 10-4).

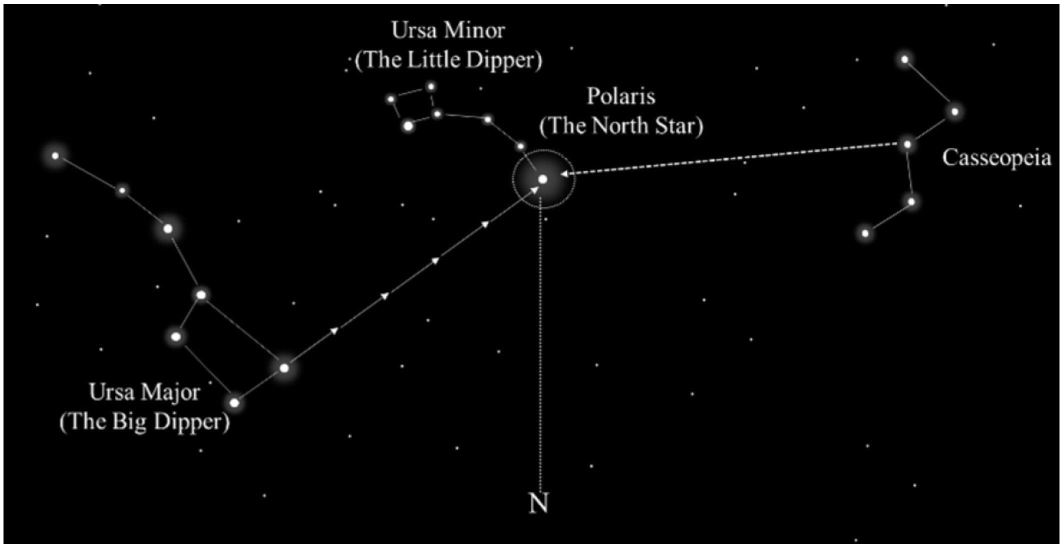


Illustration 10-4 Polaris.

The two stars that form the side of the cup farthest from the handle, used as pointers, are situated in the direction of the North Star which is about five times the distance between the two stars of the dipper cup. For additional help, the North Star is located about midway between the central star of Cassiopeia and the Big Dipper. Once we've found the North Star (Polaris), we can draw an imaginary line straight down from it to the ground. This direction is true north, and if we can find a landmark in the distance at this point, we can use it to guide ourselves.

In the Southern Temperate Zone / Southern Hemisphere, true south is determined in relation to the Southern Cross, a constellation composed of five stars. The four brightest stars form a cross. First, we need to identify the two stars that make up the long axis of the cross. These stars form a line which 'points' to an imaginary point in the sky which is above the South Pole. Next, we follow the imaginary line down from the two stars five times the distance between them. Draw an imaginary line from this point to the ground, and then identify a corresponding landmark to aid us navigationally (illustration 10-5).

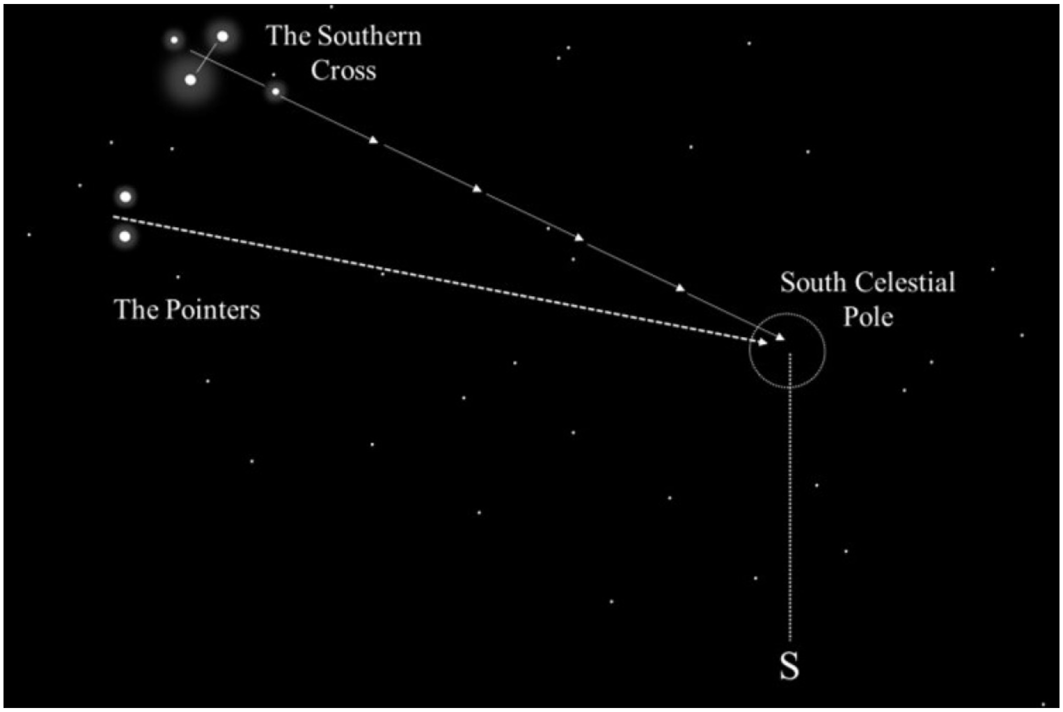


Illustration 10-5 Southern Cross.

Using the Moon – the moon, having no light of its own, orbits the earth on a 29-day circuit, and reflects light according to its position (new moon, full moon, etc.). If the moon rises before the sun has set, the illuminated side will be the west. If the moon rises after midnight, the illuminated side will be the east. This obvious discovery provides us with a rough east-west reference during the night.

Improvised Compass

We can construct an improvised compass with (1) a needle or some other wire-like piece of steel such as a straightened paper clip, double-edged razor blade, etc. and (2) something small that floats such as a piece of cork, the bottom of a Styrofoam coffee cup, a piece of plastic, a leaf, or the cap from a milk jug, et cetera. Once we have obtained both implements, all we need is to magnetize or polarize the metal. This can be done by either slowly stroking it in one direction with a piece of silk or scrapping it with a knife. Next, we find some standing water and place the magnetized metal on the float and it will align itself with a north-south line, with the magnetized end facing north (illustration 10-6).

Illustration 10-6 Improvised Compass.

Last tip, remember that you can learn important tips/ skills from anyone. From the lowest private, NCO's, to senior officers, you just need to keep your eyes and ears open.

Check on Learning

Question 1: Describe how to use the shadow-tip method in order to locate a cardinal direction (North)?

Question 2: The North Star (Polaris) forms the very tip of the Little Dipper constellation. What two major constellations found on either side of the Little Dipper do we look for to help us locate Polaris?

Check on Learning
Answer Key

Chapter 1

Answer 1: It locks the floating dial during storage and is used when getting a pinpoint azimuth.

Answer 2: There are 120 clicks in a complete revolution of the bezel ring with each click equaling three degrees.

Answer 3: TRUE: You should use every opportunity provided to check the accuracy of your compass. Military compasses used exclusively in school environments go through a lot of abuse. If you have to hold a compass at a weird angle in order to get the floating dial to rotate freely, then it is time to DX that compass.

Chapter 2

Answer 1: The sheet name.

Answer 2: The series name and scale.

Answer 3: The contour interval.

Answer 4: The declination diagram.

Answer 5: Black, Blue, Brown, Green, Red, Red Brown.

Chapter 3

Answer 1: Oran Drop Zone.

Answer 2: X146.

Answer 3: School

Answer 4: Grid azimuth 224.

Chapter 4

Answer 1: The straight line distance from hilltop X114 to the saddle is 2,175 to 2,200 meters.

Answer 2: We will walk more than 2,200 meters. The straight line distance is about 2,200 meters. However, looking at the map we notice the route takes us through a narrow draw and a fork in Juniper Creek. The associated slopes with the more difficult terrain will increase our distance slightly.

Answer 3: The road distance is approximately 3,000 to 3,100 meters.

Answer 4: Statute miles account for additional distance caused by slope whereas nautical miles do not account for slope since they are used primarily for air and sea travel.

Chapter 5

Answer 1: Contour lines are imaginary lines on the ground that connect points of equal elevation, thereby remain at a constant elevation.

Answer 2: Index, Intermediate and Supplementary. Index lines are usually every fifth line and are the heavy line with elevation information written into the line. Intermediate lines are the thinner lines between the index lines. They represent the contour interval of the map. Supplementary lines are dashed lines used for sudden elevation changes and represent half the contour interval of the map.

Answer 3: Hill, Ridge, Valley, Saddle, Depression.

Answer 4: Spur, Draw, Cliff, Cut, Fill.

Answer 5: A benchmark is usually a concrete marker driven deeply into the ground that provides elevation information. Frequently, they are also used to provide horizontal information as well.

Chapter 6

Answer 1: An easterly G-M angle means the magnetic north arrow is to the right of the grid north line. To convert from grid azimuth to magnetic azimuth, we will need to move right and therefore subtract the G-M angle, 21 degrees.

Answer 2: A westerly G-M angle means the magnetic north arrow is to the left of the grid north line. To convert from grid azimuth to magnetic azimuth, we will need to move left and therefore add the G-M angle, 14 degrees (281 + 14 = 295). Using our compass, we will walk a 295 degree magnetic azimuth.

Answer 3: A westerly G-M angle means the magnetic north arrow is to the left of the grid north line. To convert from a magnetic azimuth to a grid azimuth, we will need to move right and therefore add the G-M angle, 5 degrees (180 + 5 = 185). We will draw a line on our map from our current location on a 185 degree grid azimuth.

Chapter 7

Answer 1: 17S PU 2403 8115 Unimproved road running through a saddle. The answer was obtained by first identifying the two known locations on the map. Next we converted the two magnetic azimuths to grid azimuths (right, subtract GM angle) and drew our lines from the two known locations. Where the lines cross is the location of the generator.

Answer 2: 17S PU 1852 8560 Hilltop beneath power transmission lines. The answer was obtained by first identifying the linear feature (power transmission lines) on the map where the patrol was currently conducting their long halt. Next, we found the known location (lookout tower) on the map. We then converted the squad leader's magnetic azimuth of 133 degrees to a grid azimuth (right, subtract GM angle) and added 180 to get the back azimuth. We drew a line from the lookout tower on a 304 degree grid azimuth and where the line crossed the power transmission lines is the patrol's location.

Chapter 8

Answer 1: Orienting the map reduces confusion by allowing the navigator to quickly understand the map maker's contour lines and the surrounding terrain. During movement, the navigator should fold the map into an appropriate size that can easily fit into a conventional map case or zip lock bag and keep it oriented to the direction of movement.

Answer 2: Generally long legs (> 1km) of a movement are broken up into smaller, manageable sections (< 1km) distinguished by easily recognizable checkpoints (depending on terrain). Knowing the map distance from checkpoint to checkpoint allows the navigator to confirm his pace count during movement.

Answer 3: A deliberate offset is used to eliminate having to guess whether the target (point) is right or left once we have traveled the required distance. It is meant to negate the effects of inadvertent drift during our movement.

Chapter 9

Answer 1: P.O.I.N.T. stands for: **P** – pinpoint locations, **O** – orient map and self, **I** – identify the ABCs (attack point, backstop, checkpoints), **N** – navigate using terrain association, **T** – time management.

Answer 2: It is easy for the student navigator to get overwhelmed by the amount of tasks required. Conditions such as fatigue and adverse weather only worsen the situation. The P.O.I.N.T. acronym is provided to assist the navigator in simplifying the process and to ensure crucial tasks are not neglected.

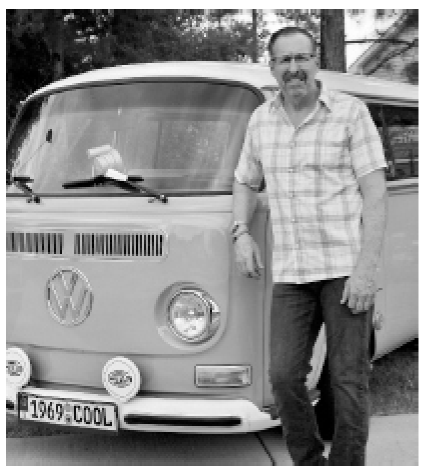
Chapter 10

Answer 1: In North Carolina, we're located north of the equator therefore the shadow from the stick moves northwest to northeast as the sun travels west. Left foot on the original marking and right foot on the last marking will have us facing north.

Answer 2: Ursa Major (The Big Dipper) and Cassiopeia.

About the Author

Chris Imperial learned his land navigation skills from serving over 21 years in the US Army. Chris was Airborne, Light Infantry, Ranger and Special Forces. Land navigation skills have always been an integral part of his life; from navigating through the open deserts of the Middle East to the thick jungles and swamps of Central America, to teaching land navigation skills to soldiers in several different Sub-Saharan African countries. Much knowledge has been passed on from others greatly contributing to Chris's overall navigation skills and it is his desire to continue the tradition of passing along as much knowledge of land navigation skills as possible to the next generation of warriors. This book is just one small part in fulfilling that obligation.



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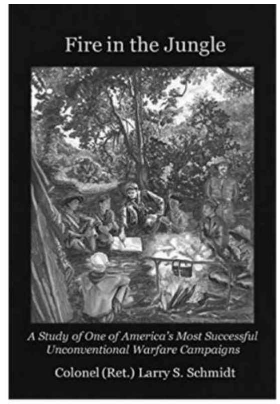

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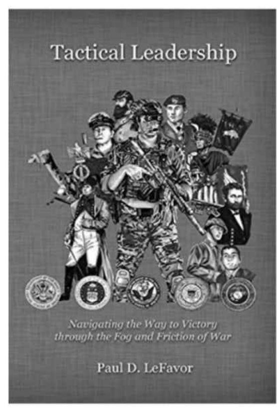

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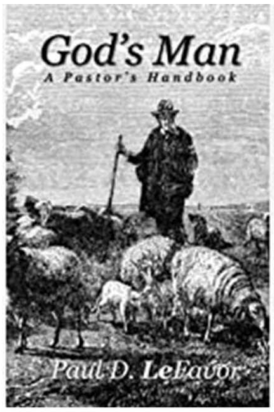
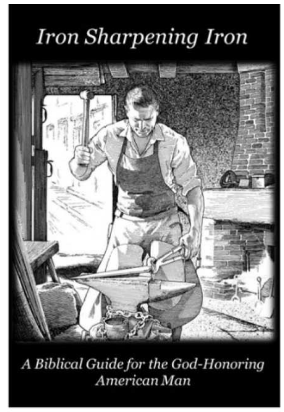


God's Man



Iron Sharpening Iron

Unto the Thousandth Generation

Notes