Section 4

INTRODUCTION TO MAP READING

Key Points

1. Marginal Information
2. Topographic Symbols
3. Terrain Features
4. Determining Four- and Six-Digit Grid Coordinates

> With our military forces dispersed throughout the world, it is necessary to rely on maps to provide information to our combat elements and to resolve logistical operations far from our shores. Soldiers and materials must be transported, stored, and placed into operation at the proper time and place. Much of this planning must be done using maps. All operations require a supply of maps; however, the finest maps available are worthless unless the map user knows how to read them.
>
> FM 3-25.26

Introduction

In Section 1, you learned how to navigate using information from a civilian-style map and a compass. In doing so, you learned that in order to navigate accurately, the map is one of your most important pieces of equipment. In this section, you will examine a military map, study its parts, and learn more about its uses. To be safe in a battle zone, you must know how to read a map, plot your location, and move in the right direction. If you can't navigate correctly, you risk getting lost—or worse, stumbling into dangerous territory. Consider the experience of MAJ Robert K. Wright Jr., historian for XVIII Airborne Corps. MAJ Wright accompanied the Corps in Operation Just Cause, the American liberation of Panama in 1989.

Lost in Panama

I had one last interview to do on [January] 13th[, 1990].... So I went over and got that interview; they were off at a different location, so I'd gotten a driver to take me over, and I got one of their drivers to take me back to Fort Clayton, to the battalion headquarters. And I'd really gotten to know that battalion … very, very well while I was down there. So I asked the S-3 could he get me a ride to the airport. So he gave me an NCO and a driver and a 'Hummer' [HMMWV; M-998-series High Mobility Multi-Wheeled Vehicle] and said "Sure, just take the Doc out."

So we swung by, picked up my gear. I cleared post. And off we went. And we're driving and driving and driving, and I know it isn't that far. Plus, we're going through the jungle. We're going up a paved highway and everything, but passing traffic and whatnot, which is taking forever. And then we went past this one area and I recognized it from aerial recon that I had done in the helicopter photography missions—this was Cerro Tigre, the PDF [Panamanian Defense Force] supply depot. Which was about 120 degrees in the wrong direction from the airport.

So at that point I casually inquired of the driver "Do you know where we're going?" And he said, "Why no, sir, I thought you knew where we're going." And I turned around and looked at the NCO, and he said "Don't look at me, I don't have a map either." So I said "Oh, O.K., well, hang a right and we'll keep going until we find the ocean or something and we get oriented." And we literally wandered around.

And I remembered thinking at the time, yeah, I've got seven rounds in my .45 . . . . So here we are, traveling through the countryside and had . . . I mean, we were out in the boonies. And had there been a disgruntled PDF guy still running around loose, it was me and my seven rounds from the .45, and that's all we had to protect us.

Department of the Army, XVIII Airborne Corps

Critical Thinking

What mistake did MAJ Wright, his driver, and the NCO make? Who was responsible for the mistake: MAJ Wright, the driver, or the NCO?

Marginal Information

The Army defines a map as "a graphic representation of a portion of the earth's surface drawn to scale, as seen from above."

Because the map is a *graphic* representation, you'll need a written explanation of the graphic elements. You'll find that explanation in the margins of the map: the *marginal information*. (Chapter 3 of FM 3-25.26 explains all the marginal information in detail.)

Figure 4.1 Scaled Representation of the Earth's Surface

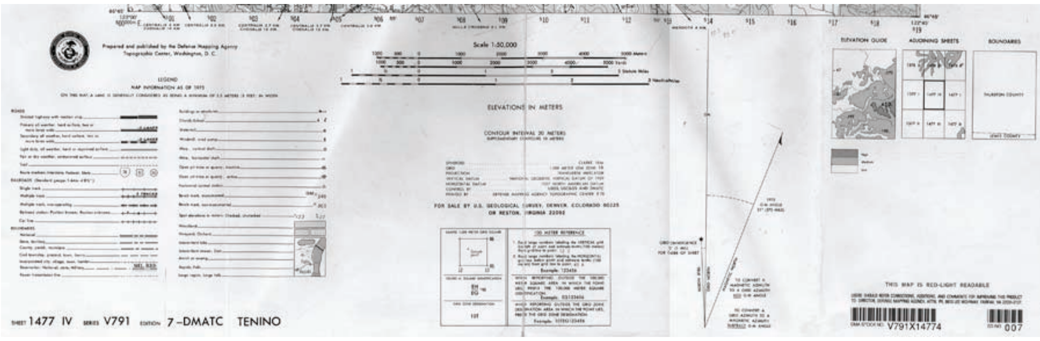

Figure 4.2 The Bottom of a Map

The map **legend** identifies the symbols used to depict the prominent natural and man-made objects that exist on the ground. These symbols are not the same on every map, especially foreign maps. Check the legend to avoid making serious mistakes. The legend from the bottom of the map in Figure 4.2 is shown enlarged in Figure 4.3.

The *sheet name and number* provide the title and the reference number for the map. Maps usually take their sheet names from the largest settlement or natural feature on the map. For example, the "Tenino Map" includes the community of Tenino, Wash.

The sheet number is in bold print in the upper right and lower left areas of the margin (Figures 4.2 and 4.3). At the lower right margin on the map is a diagram that shows adjoining map sheets. Your map sheet will always be depicted in the center of this diagram. You will learn later in your military studies how to link adjoining map sheets to operational overlays, operation orders, and operation plans.

legend

the section on a map that contains the symbols you need to read the map

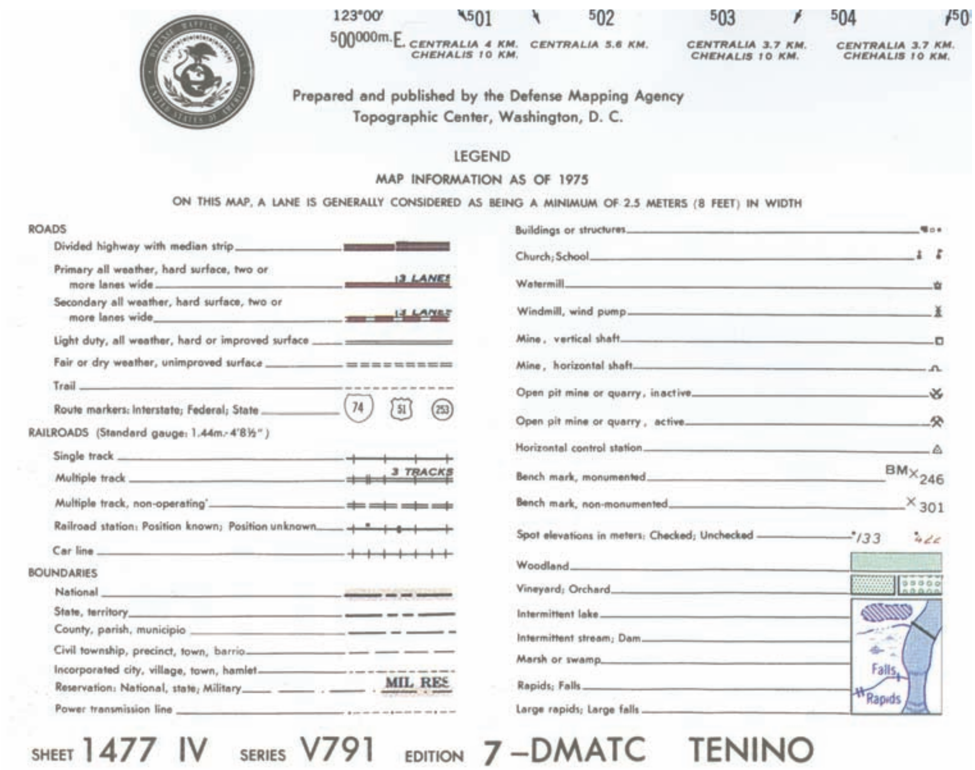

Figure 4.3 Map Legend

scale

the ratio of the map distance to the corresponding distance on the earth's surface

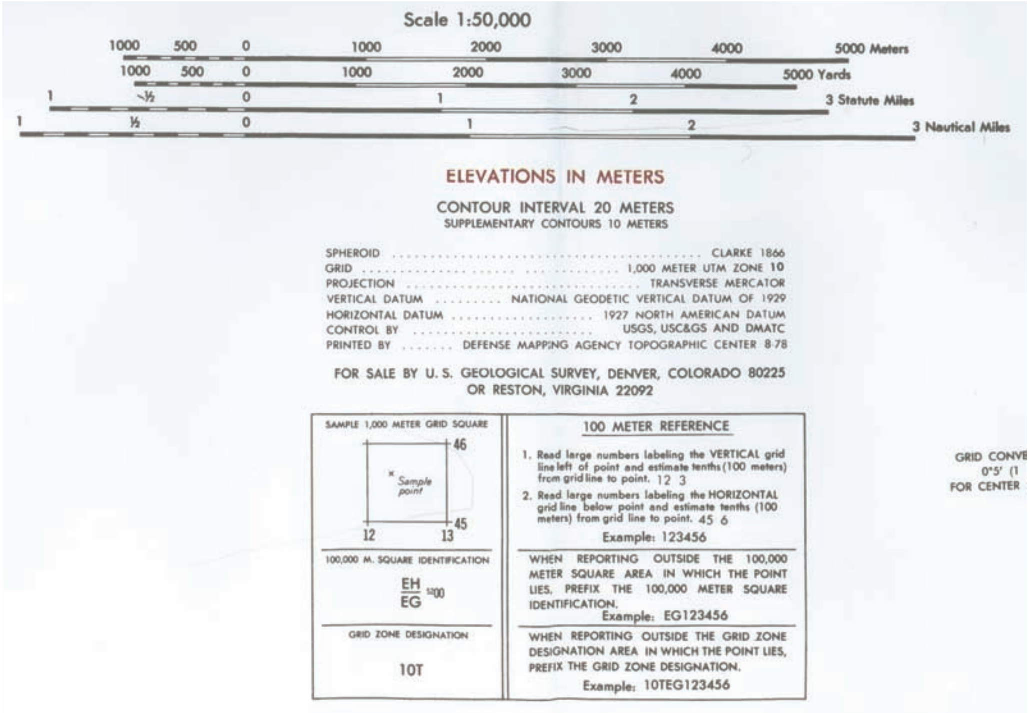

Figure 4.4 Map Scale, Contour Interval, and Grid Reference Box

The **scale** gives you the ratio of the distance on the map to the distance on the ground. For example, a scale of 1:50,000 (Figure 4.4) indicates that one unit of measure on the map equals one unit of measure on the ground. In other words, one inch on the map equals 50,000 inches on the ground, or approximately 8/10ths of a mile or 1.27 kilometers. The larger the ratio, the less detail can be placed on the map. Likewise, the smaller the ratio, the more detail can be placed on the map. Therefore, a 1:25,000 map will have larger grids, allowing the map-printing agency to place more details onto the map.

The *contour interval*, also found in Figure 4.4, specifies the vertical distance between contour lines. The contour interval for each map will be listed in the lower center of the map margin. Make sure you note whether the interval is in meters or feet.

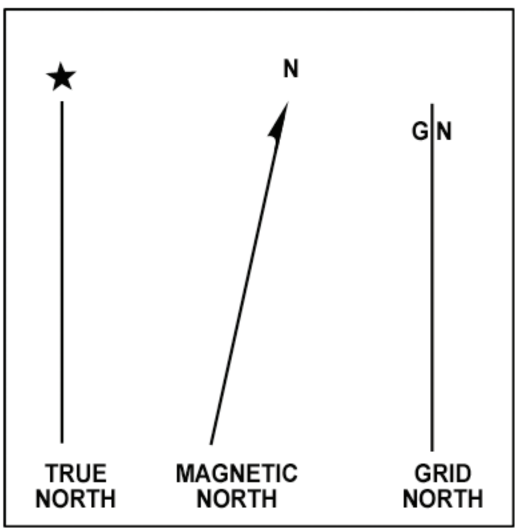

Figure 4.5 The Three Norths

The **declination** *diagram* depicts the three norths on your map: **true north**, **magnetic north**, and **grid north** (Figure 4.5). The declination diagram also lists the grid to magnetic angle (**G-M angle**) in degrees. The G-M angle is the angular difference between grid north and magnetic north. The closer to the poles you go, the greater this angle becomes. Understanding the G-M angle is critical. In order to use a grid map and compass to navigate, you must know how to convert a magnetic azimuth from your compass to a grid azimuth onto your map (or vice versa). You'll learn more about azimuths in the next section.

The *adjoining sheets diagram* tells you the sheet numbers of the adjoining sheets (Figure 4.6). You'll see a checkerboard-like display with the square in the center of the display representing the map you are reading. For example, if you need the map to the east of the map you're reading, look at the adjoining sheets diagram, identify the sheet number of the adjoining map, and request the map.

The *notes* tell you—among other things—the references the mapmakers have used in determining vertical and horizontal distances and the agencies responsible for the map information.

Mapmakers have divided the world into 60 grids and given those grids short letter-and-number (alpha-numeric) designators called *grid zone designators*. The grid zone designator for your map sheet is located at the bottom center of the map inside the *grid reference* box (Figure 4.4). The information in this box gives you the grid zone designation and the 100,000-meter square identification for your map sheet. You need to know the grid zone designator and the 100,000-meter square identification in order to convey information to others about your location or accurately call for indirect fire or close air support.

declination

the angular relationships between grid north and true north or magnetic north measured in degrees or mils east or west—a circle has 360 degrees or 6400 mils

true north

a line from any point on the earth's surface to the North Pole

magnetic north

the direction to the north magnetic pole, as indicated by the north–seeking needle of a magnetic instrument, such as a compass

grid north

the north that is established using the vertical grid lines on a map

G-M angle

the angular distance between grid north and magnetic north

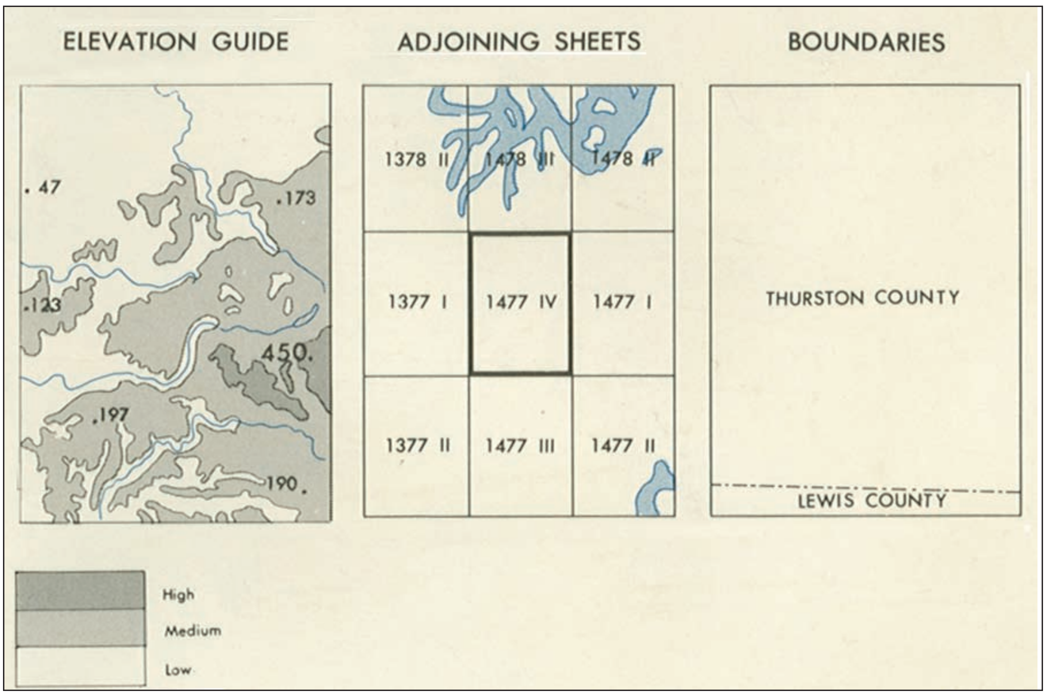

Figure 4.6 Adjoining Sheets

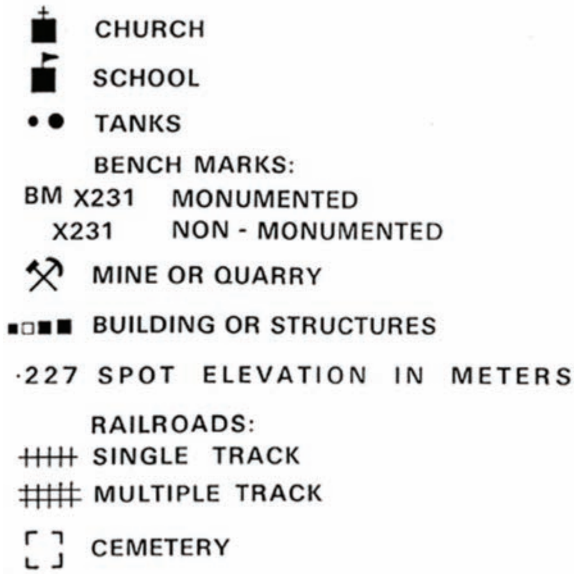

Figure 4.7 Topographic Symbols

topographic symbols

symbols on a map that represent natural and man-made features found on the earth's surface

*The word **topography** comes from two Greek words: **topo**, meaning "place or region," and **graphos**, meaning "to write." So a topographic symbol or a topographic map is a detailed and precise description of a place or region.*

In order to maintain operational security and your night vision, you will use a red-lens flashlight when conducting operations during limited visibility. Older maps printed major roads and built up areas in a red ink that "disappeared" in red-filtered light. Imagine the difficulty of navigating at night when your major roads and built up areas disappeared after you turned on your red-lens flashlight! Mapmakers have recognized the problem and now print military maps with a red-brown ink color that is red-light readable.

Topographic Symbols

Military maps show various man-made and natural features using **topographic symbols** and different colors.

Topographic Symbols

Mapmakers draw maps so you can visualize the landscape with the features in the right place. Your map legend defines the topographic symbols the mapmakers have used to identify the man-made and natural features on the map (Figure 4.7).

For example, the topographic symbol used on your map to represent a school would be a small, black rectangle with a pennant drawn on the top. Another example would be a vineyard depicted on your map as a series of close tiny green dots. The legend may show a place of worship as a small rectangle with a cross, an upward arrow, or a crescent drawn on the top. Most maps of the United States will identify churches—no matter the religious denomination—with a cross. This practice will vary in foreign areas. Check the legend to be sure.

The legend may show a cemetery as a small rectangle drawn with dotted lines and marked "Cemetery." In foreign areas, the mapmakers may indicate the religious denomination, if that information is available.

Army FM 21-31, *Topographic Symbols*, describes the symbols, features, and abbreviations approved for military maps. Do *not* assume that all maps use the same symbols.

Colors

Imagine the difficulty of using a map printed only in black and white. Roads and rivers would look the same—probably with disastrous consequences. As early as the 15th century, mapmakers were coloring their maps. The use of color has become standardized, but check the legend to be sure.

1. *Black* indicates cultural (man-made) features such as buildings, railroads, and roads

2. *Red and brown* combinations identify cultural features (such as major roads), relief features, and contour lines on red-light readable maps
3. *Blue* identifies water: lakes, swamps, rivers, and coastal waters
4. *Green* identifies vegetation such as woods, orchards, and vineyards
5. *Brown* identifies cultivated land on red-light readable maps—on older maps, brown represents relief features and elevation such as contours
6. *Red* was used on older maps to mark populated areas, main roads, and boundaries
7. *Other colors* may show special information. Check the legend.

Be aware of how the seasons and climate may affect the presence or depth of intermittent water sources. Maps will display intermittent water sources as blue, but water may not actually be present at the time you are navigating.

Terrain Features

As you look at the land around you, you will notice different **terrain features**: the hills, valleys, and other features on the ground. Maps represent these features in specific ways.

terrain features

characteristics of the land, such as hills, ridges, valleys, saddles, depressions, and so forth

The Army divides terrain features into three groups: major, minor, and supplementary terrain features.

Major terrain features include *hills*, *saddles*, *valleys*, *ridges*, and *depressions*.

a. A *hill* is an area of high ground. If you stand on a hilltop, the ground slopes away from you in all directions. A map represents a hill with contour lines forming concentric circles. The inside of the smallest circle is the hilltop (Figure 4.8).

b. A *saddle* is a dip or a low point between two areas of higher ground. If you stand in a saddle, you have high ground in two opposite directions and lower ground in the other two directions. The contour lines on a map representing a saddle are shaped like an hourglass (Figure 4.9).

c. A *valley* is a groove in the land, usually formed by a stream or a river. A valley usually begins with high ground on three sides and has a course of running water through it. If you stand in a valley, you will have higher ground in three directions and lower ground in one direction. Depending on the size of the valley and where you are standing, you may not see the higher ground in the third direction, but the stream or the river will flow from higher to lower ground (Figure 4.10).

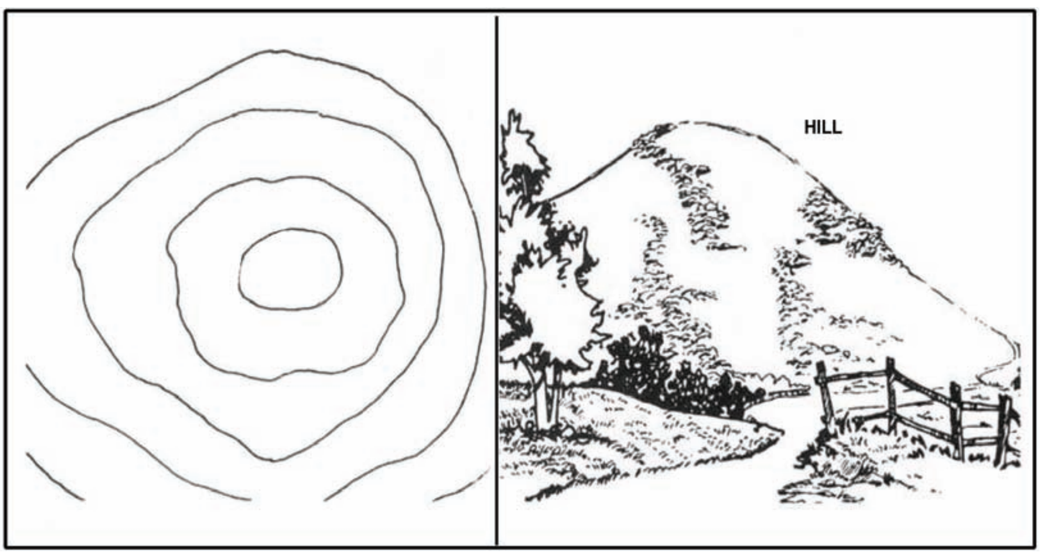

Figure 4.8 Hill

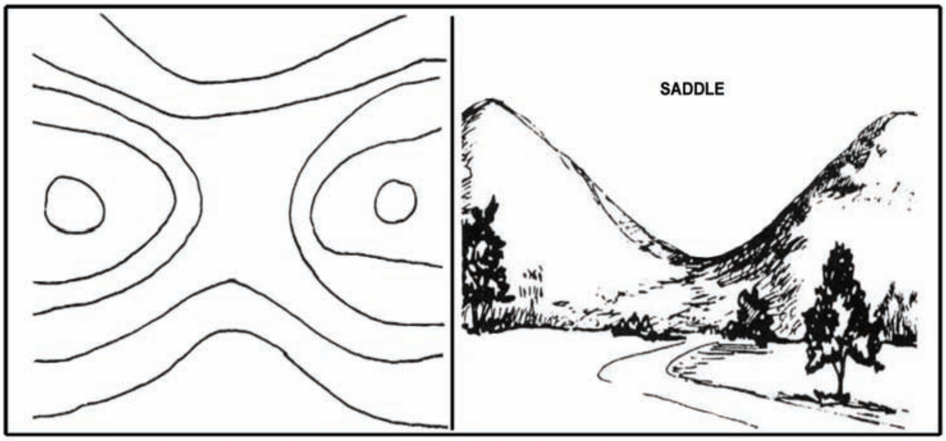

Figure 4.9 Saddle

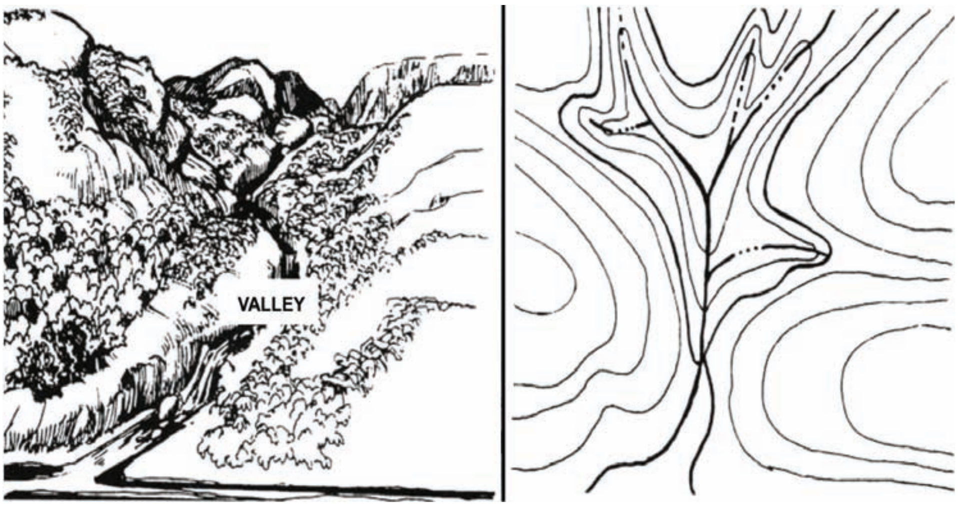

Figure 4.10 Valley

To the untrained eye, the contour lines of a valley and a draw (Figures 4.10 and 4.13) look very similar on a map. From a military consideration, a valley will afford a degree of maneuver room for troops and equipment, whereas a draw may only accommodate a small maneuver element, such as a squad or platoon.

*Not too long ago, the military term for a ridge was **ridgeline**. Many older Soldiers will still refer to a ridge as a ridgeline, as ridges will generally join a series of hills along a line.*

A map represents a valley with U-shaped or wide V-shaped contour lines. Look at the contour lines to determine the direction the stream or the river is flowing. The closed end of the contour lines (the U or the V) points upstream and toward higher ground.

d. A *ridge* is a sloping line of high ground. Think of a ridge as the high ground that runs along a hill. A series of hills connected forms a ridgeline. If you stand on the centerline of a ridge, you will normally have low ground in three directions and high ground in one direction. If you cross a ridge, you will climb to the crest and descend to the base. A map represents a ridge with U-shaped or V-shaped contour lines, but, unlike a valley, the closed end of the contour lines point to lower ground. A ridge can be easily confused with a spur (see Figure 4.14). The difference is that a spur will generally run perpendicular to a ridge or ridgeline, while a ridge will run directly off a hill or a series of hills (Figure 4.11).

e. A *depression* is a sinkhole, a pit, or a low point in the ground. Think of a depression as an upside-down hill. If you stand in the center of a depression, you will have higher ground in all directions. A map represents a depression with contour lines forming concentric circles; tick marks point to the lower ground (Figure 4.12).

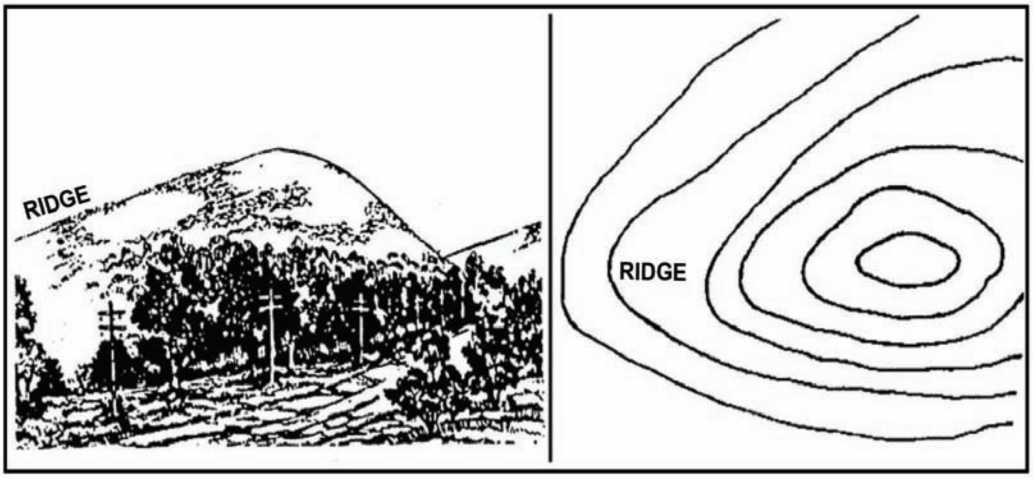

Figure 4.11 Ridge

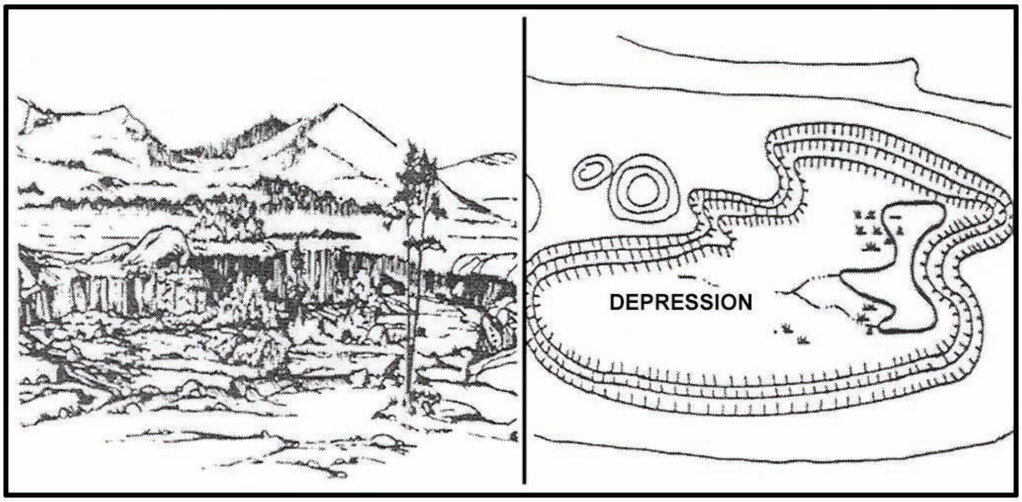

Figure 4.12 Depression

Minor terrain features include *draws, spurs,* and *cliffs* (Figures 4.13 through 4.15).

a. A *draw* is a small valley. A draw has essentially no level ground and little or no maneuver room. If you are standing in a draw, the ground slopes upward in three directions and downward in the other direction. You could consider a draw to be the initial formation of a valley. A valley will usually have many draws feeding into the valley with streams or intermittent streams feeding into the body of water flowing through the valley. On a map, the contour lines depicting a draw are sharply V-shaped, pointing to higher ground. In most cases, a draw will be situated to the left or right of a spur or lying between two spurs (Figure 4.13).

b. A *spur* is a short ridge. The ground will slope downward in three directions and upward in one direction. On a map, the contour lines depicting a spur are U-shaped pointing away from higher ground. In most cases, a spur will have draws to the left or right, or a spur is situated between two draws (Figure 4.14).

c. A *cliff* is a vertical or near-vertical feature. On a map, the contour lines for cliffs are nearly touching or the contour lines come together to form one contour line depicting the edge of the cliff. Newer maps may also depict a cliff with the

Figure 4.13 Draw

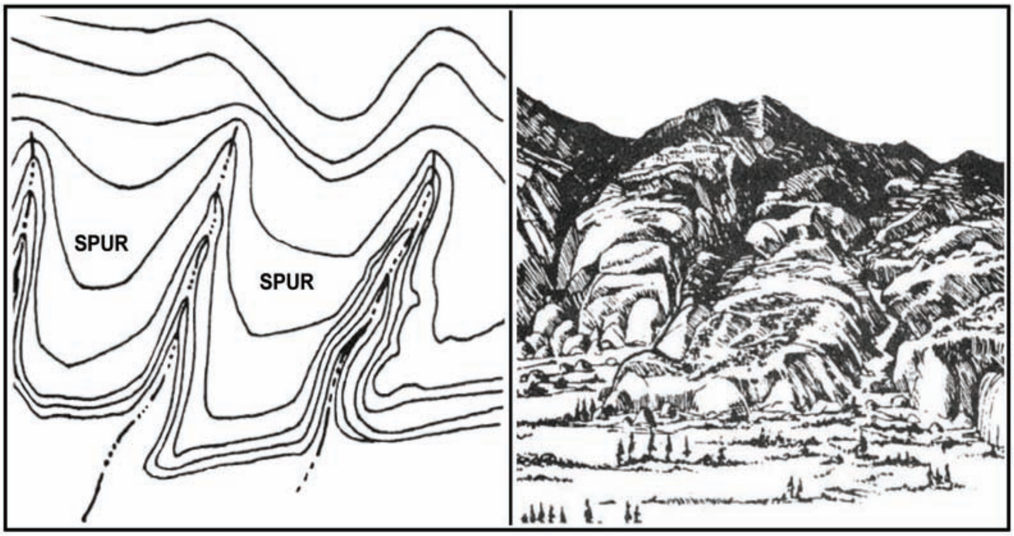

Figure 4.14 Spur

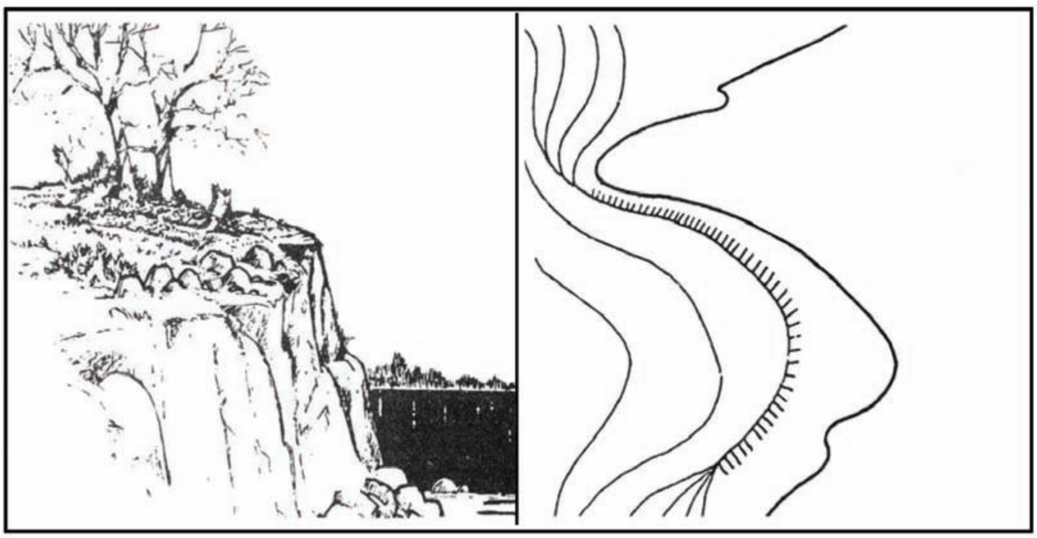

Figure 4.15 Cliff

same type tick marks used in depicting a depression, with the tick lines facing downward representing the vertical face of the cliff (Figure 4.15).

Supplementary terrain features include *cuts* and *fills* (Figure 4.16).

a. A *cut* is a man-made feature that cuts through raised ground. You may see a cut on a map forming a level bed for a road or railroad track.

b. A *fill* is a man-made feature that fills a low area. Again, you may see a fill on a map forming a level bed for a road or railroad track.

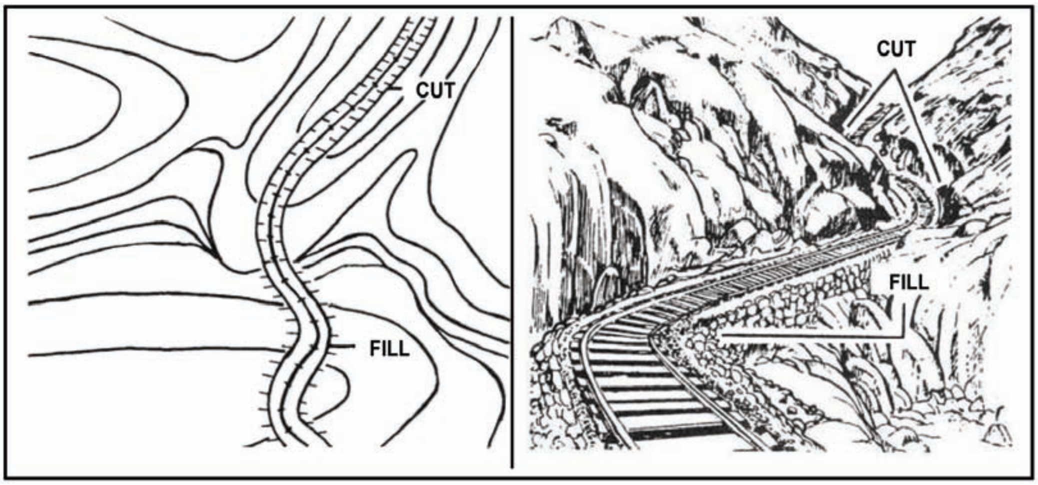

Figure 4.16 Cut and Fill

Using Four- and Six-Digit Grid Coordinates

grid coordinates

letter and number designations that allow you to locate a point on a map

Grid coordinates are very important to the daily life of the Soldier. Soldiers use grid coordinates to find locations or convey locations on maps to others. They use grid coordinates to navigate, report enemy activity, request medical evacuation, or call for additional supplies and ammunition. Soldiers use grid coordinates to request indirect fire support from field artillery and naval gunfire. They also use grid coordinates to request close air support from fixed- and rotary-wing aircraft. As you read earlier, you'll find the grid reference box at the bottom center of the map. This gives you the grid zone designation and the 100,000-meter square identification for your map sheet. With more-exact grid coordinates you can more precisely plot or convey a location on the map. An important tool for doing so is your protractor.

Think about the coordinates on the map at a multistory shopping mall. The directory might tell you that the store is at F23. You examine the map and find that Section F is located on the third floor. Store 23 is in a side corridor at a right angle to the main shopping corridor, just before you reach the food court. Once you've located the store on the map, you find the nearest escalators and you're on your way. Using grid coordinates on a military map is quite similar.

Protractor

A protractor is a tool for working with maps. Protractors have an index mark in the center and divide a 360-degree circle into units of angular measure that are marked on two scales (degrees and mils) along the outside edge. The index mark is the center of the protractor circle, from which you measure all directions.

The Army protractor is Graphic Training Aid (GTA) 5-2-12, 1981 (Figure 4.17). It has four major parts:

1. A cross-hair in the middle, which you use to reference the north-south and east-west grid lines on a map

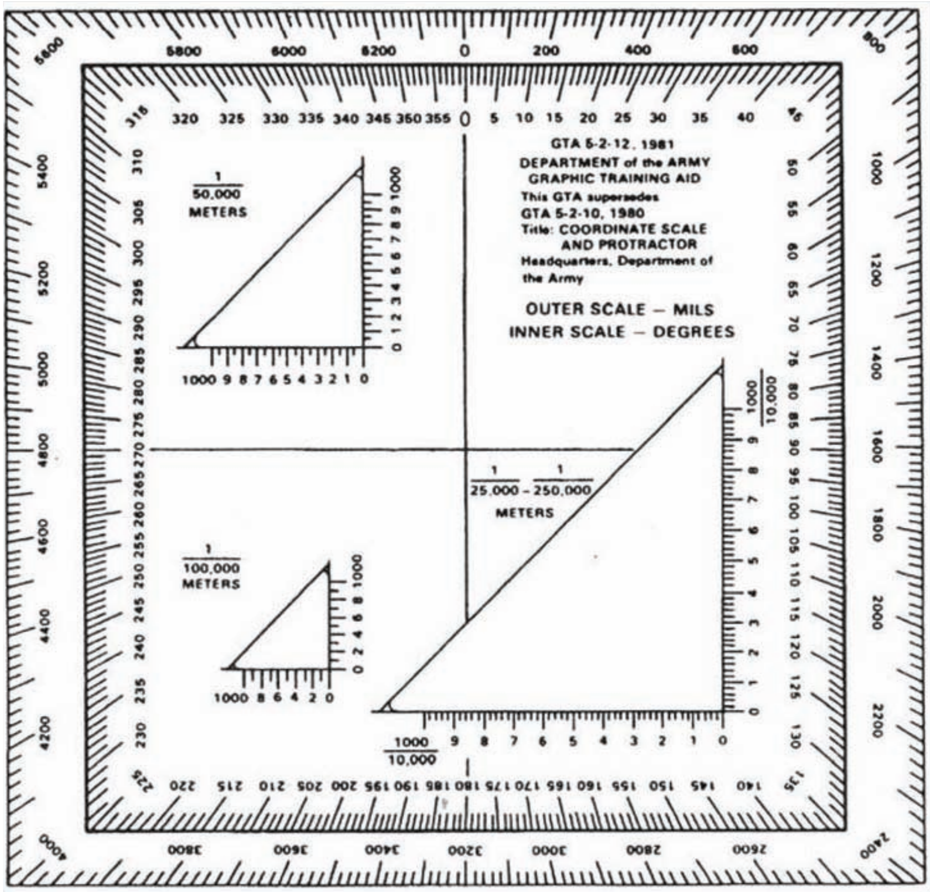

Figure 4.17 Army Protractor (GTA 5-2-12, 1981)

2. Three scales—1:100,000; 1:50,000; and 1:25,000
3. An inner scale of 360 degrees, which you use to plot azimuths (You'll learn more about azimuths in the next section.)
4. An outer, mils scale. (There are 6400 mils in a circle. You'll learn to use this scale for indirect fire.)

Using Four-Digit Grid Coordinates to Determine a Location

Earlier in this section you learned that mapmakers break down the earth's surface into 60 grid zone designators. The grid zone designator for your Tenino map, for example, is 10T. Each of these grid zone designators covers very large areas of the earth's surface. Because grid zones are not manageable in size when navigating, the mapmakers further break down each grid zone into 100,000-meter squares to make the grid zones more manageable. This means that the distance between each grid line is 100,000 meters.

For example, the area on your Tenino map covers portions of two 100,000-meter squares, and their identification is EH and EG. Unless you are flying, you will never need to navigate over an area as large as a 100,000-meter square. So mapmakers break down the earth's surface within the 100,000-meter squares into 10,000-meter squares (Figure 4.18) and then into even smaller, 1,000-meter squares (Figure 4.19) and number them beginning with 00 and ending in 99 (see Figure 4.4). Between each number, 01 and 02 for example, the distance is 1,000 meters.

Now imagine you are behind enemy lines and you are in satellite radio contact with your rescue aircraft, which is in another part of the world. You cannot simply give your

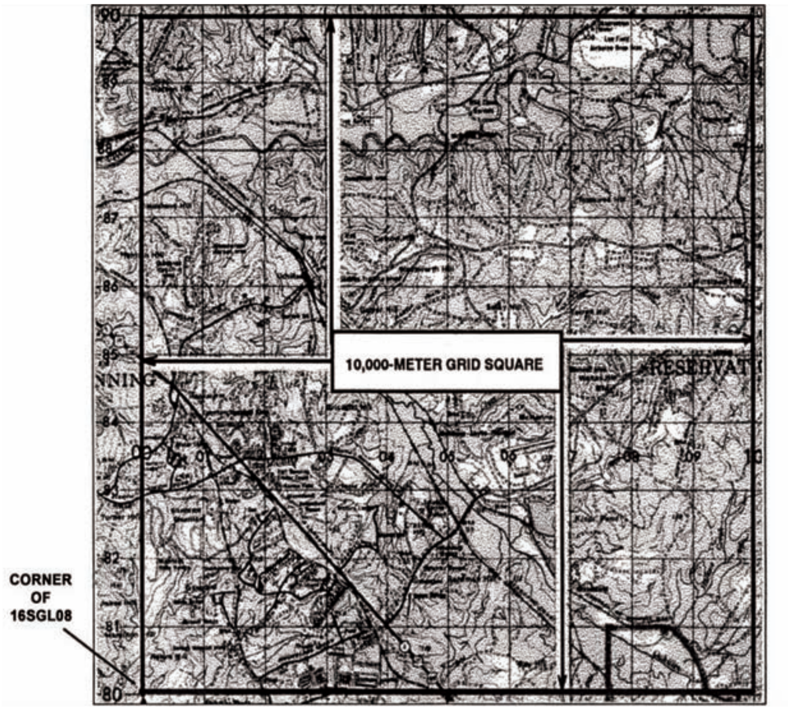

Figure 4.18 10,000-Meter Grid Square

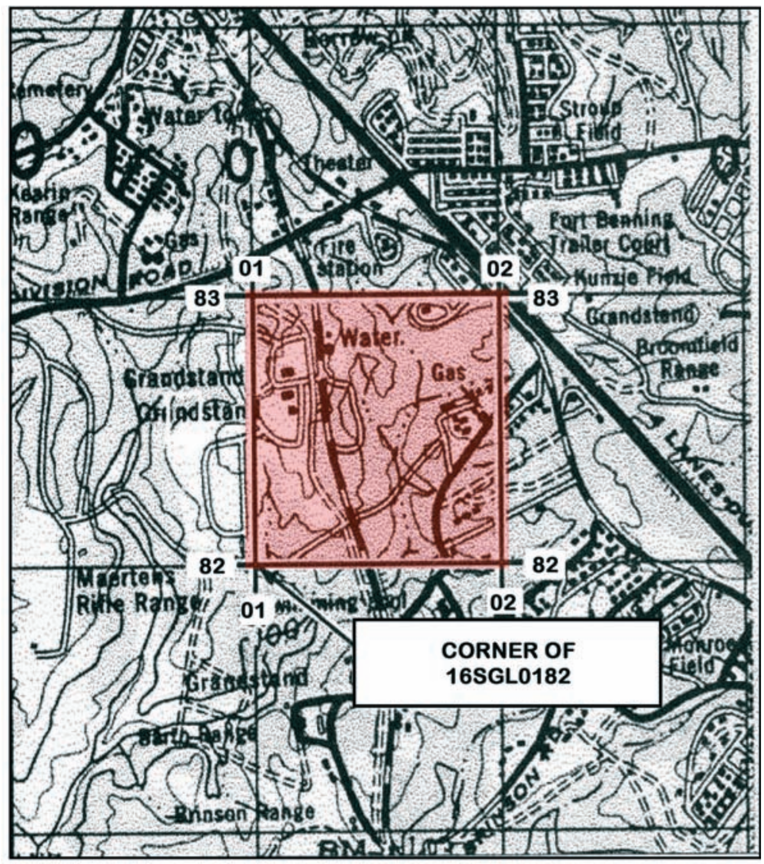

Figure 4.19 Four-Digit or 1,000-Meter Grid Square

rescuers the four-digit grid to your location because every one of the 60 grid zones has thousands upon thousands of similar four-digit grids. You radio the aircraft, "Rescue 6 this is Lost Sheep 3—I am in grid zone Sixteen-Sierra." With this information, your rescuers can now narrow down your location on the earth to one of the 60 grid zones around the world. They begin to fly toward your area of the world, but need to narrow their search. You radio in your 100,000-meter square identification, "Rescue 6, I am at Sixteen-Sierra, Gold Lima." Your rescuers now know where you are within a 100,000-meter square. This is still too large of an area to search, so they ask you for more detailed coordinates. You radio back, "Rescue 6, I am at Sixteen-Sierra, Golf Lima, Zero One, Eight Two (Figure 4.19)." With this information. The pilots have to search only a 1,000-meter square, or one grid square on your map. Aided by your complete four-digit grid, your rescuers are able to spot your infrared emergency beacon and rescue you in a short period of time.

The pairs of numbers on the horizontal (east-west) and vertical (north-south) grid lines on your map are used to identify grid squares. Every set of grid coordinates will

The Phonetic Alphabet

The phonetic alphabet is used to spell out letters in place of just saying the letter itself. By using a word for each letter, there is less chance that the person listening will confuse letters. For instance, two letters that can easily be confused are "D" and "B." When a speaker uses the phonetic alphabet, a listener can easily distinguish between "*D*elta" and "*B*ravo." The phonetic alphabet is used primarily in two-way radio communications. Using the phonetic alphabet reduces the effects of noise, weak signals, distorted audio, and radio operator accent. Maritime units, aircraft, amateur radio operators, and the military around the world use this system of spelling letters.

Letter	Pronunciation	Letter	Pronunciation
A	Alpha (AL fah)	N	November (no VEM ber)
B	Bravo (BRAH VOH)	O	Oscar (OSS cah)
C	Charlie (CHAR lee)	P	Papa (pah PAH)
D	Delta (DELL tah)	Q	Quebec (keh BECK)
E	Echo (ECK oh)	R	Romeo (ROW me oh)
F	Foxtrot (FOKS trot)	S	Sierra (see AIR rah)
G	Golf (GOLF)	T	Tango (TANG go)
H	Hotel (hoh TELL)	U	Uniform (YOU nee form)
I	India (IN dee ah)	V	Victor (VIK tah)
J	Juliet (JEW lee ETT)	W	Whiskey (WISS key)
K	Kilo (KEY loh)	X	X Ray (ECKS RAY)
L	Lima (LEE mah)	Y	Yankee (YANG key)
M	Mike (MIKE)	Z	Zulu (ZOO loo)

Note: Stress the syllables printed in capital letters.

have an even set of numbers. In a four-digit grid, the first half of the grid coordinate numbers represents the horizontal, "left-to-right" or "easting" reading. The second half of the grid coordinate numbers represents the vertical, "bottom-to-top" or "northing" reading. For example, grid coordinate 16SGL0182 in Figure 4.19 would identify all of the area within the grid square to the right of line 01 and above line 82.

The *critical* rule is to read *right* and then *up*. Notice how the example reads *right* and then *up*: Grid square 0182 was to the *right* of line 01 and above—*up* from—line 82.

Using Six-Digit Grid Coordinates to Determine a Location

Submitting a four-digit grid location may be acceptable for large-scale operations or large-scale units. For example, a one-grid-square location might be sufficient for identifying the location of a brigade combat team forward operating base or a zone reconnaissance for a company-sized element. There are other situations, however, where your grid locations must be narrowed down in order to be more accurate than a 1,000-meter square For situations in which you need to be within a 100-meter square—such as calling for indirect fire or close air support, or calling for an emergency resupply or medical evacuation—you will need to know how to determine and plot six-digit grid coordinates.

Think back to the earlier search-and-rescue scenario. Imagine you are hunkered down in hiding because enemy forces are actively searching for you. It is crucial to your survival that your rescuers find you quickly. Rather than have them search an entire grid square for you, you radio your rescuers, "Rescue 6, this is Lost Sheep 3, I am at grid Sixteen-Sierra, Golf Lima, Zero-One-Two, Eight-Two-Eight (Figures 4.20, 4.21, and 4.22). Rather than searching for an hour, your rescuers hover within 100 meters of your location within a matter of minutes.

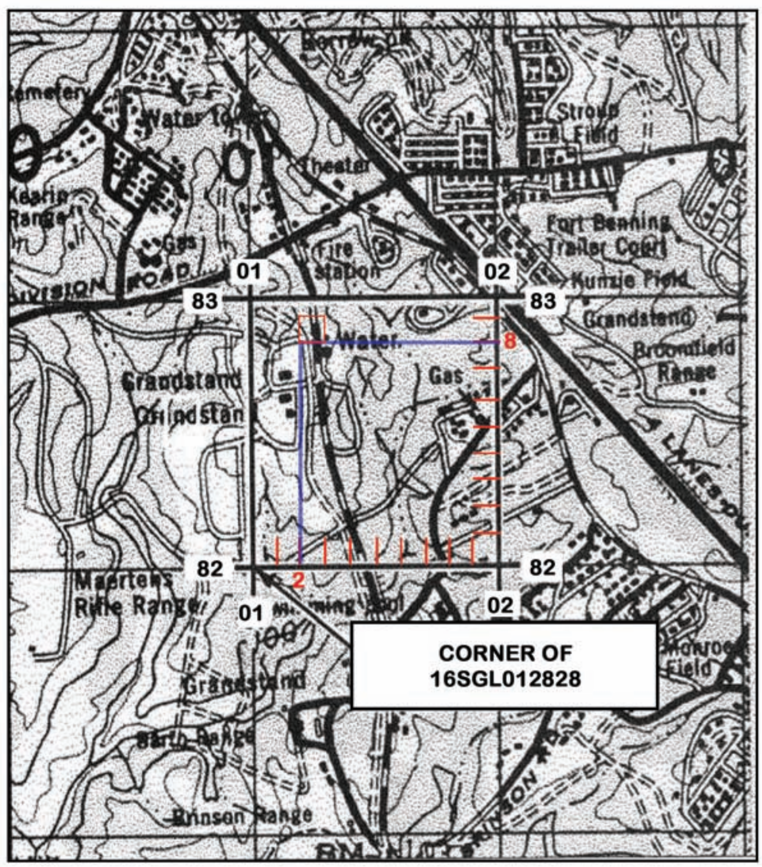

Figure 4.20 Six-Digit or 100-Meter Grid Square

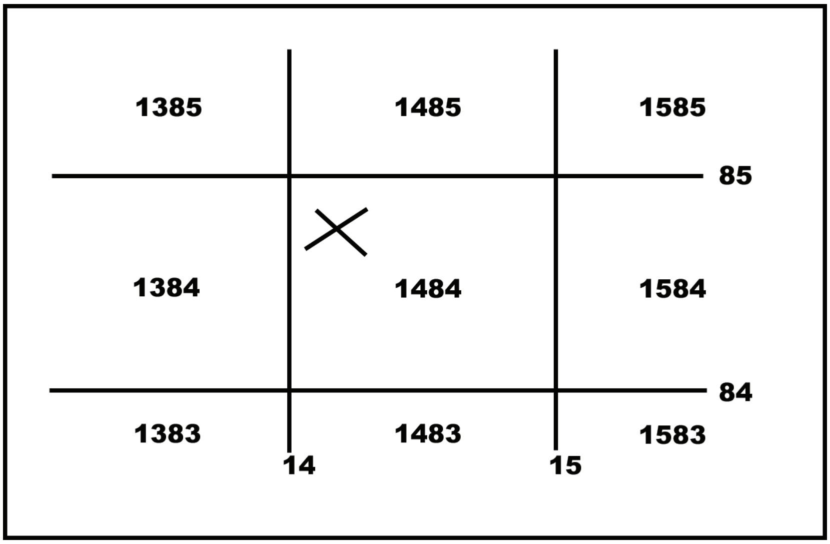

Figure 4.21 Plotting a Specific Point

Follow these five steps to identify a more specific location:

1. Make sure you are using the appropriate scale (check the scale in the map's marginal information) and make sure the scale is right side up
2. Place the protractor scale with the zero-zero point at the lower left corner of the appropriate grid square
3. Keep the horizontal line of the protractor's scale directly on top of the horizontal, left-to-right, or "easting" grid line, and slide the protractor—and its scale—to the right until the left vertical line of the grid square touches the point on the protractor scale for the coordinate you want
4. Read up the vertical scale until you reach the coordinate you want
5. Mark the location.

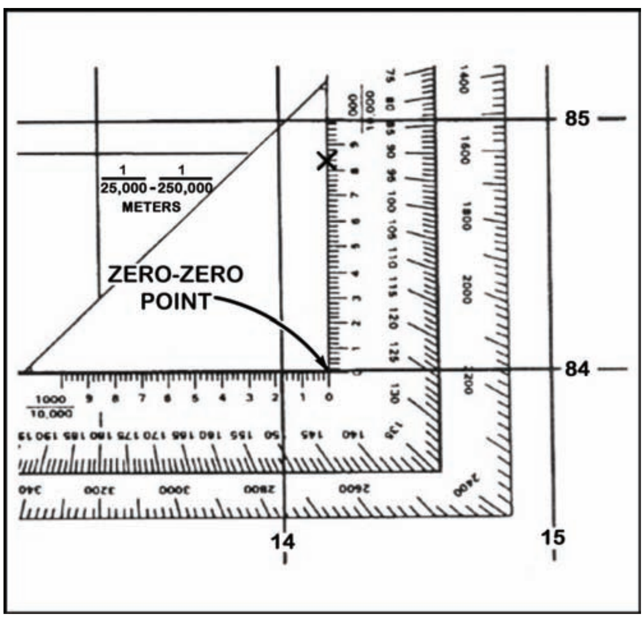

Figure 4.22 Read Right, Then Up: Six-Digit Grid Coordinate 16SGL142848

Make sure the horizontal line of the protractor's scale is lined up with the horizontal, left-to-right, or "easting" grid line, and the vertical line of the scale is parallel with the vertical, bottom-to-top, "northing" grid line.

Remember to write coordinates as one continuous number without spaces, parentheses, dashes, or decimal points. Write them as an even set of numbers so that whoever uses your coordinates knows where to make the split between the *right* and *up* readings.

Be *very* careful not to misidentify or transpose the grid numbers. Double- and triple-check the numbers. Ask someone else to review your numbers. If you send wrong or transposed numbers, the rescuers may not find you or the artillery rounds will not fall where you want them to—they may fall on your position.

Critical Thinking

Discuss some consequences (other than those discussed in the text) of misidentifying or transposing grid coordinates. Think about how far off your grid coordinates will be if you just make one numerical error.

How could you make sure your grid coordinates are accurate in a pressure situation?

CONCLUSION

MAJ Wright, his driver, and an NCO wound up "out in the boonies" because none of them had looked at a map before leaving for the airport. Knowing how to read a map and plot coordinates are essential military skills. In this section, you learned how to determine and plot a grid coordinate with 100-meter square accuracy. In later sections, you will learn how to plot and determine grid coordinates within a 10-meter square by using eight- and 10-digit grid coordinates. During any mission you must always know where you are and where you are going. If you are to be a credible leader, your Soldiers must be confident that you are proficient in map reading and land navigation. Take the time now to gain and polish your map-reading skills. Not only are they important to your Army career—they can save your life or your Soldiers' lives in combat.

Learning Assessment

1. Describe and explain in your own words the five major terrain features of hill, valley, saddle, ridge, and depression.
2. Explain the difference between a draw and a valley; and between a spur and a ridge.
3. Define man-made and natural objects depicted on a military map by topographical symbols.
4. Which is more precise—a four-digit or six-digit grid location?
5. Explain how to determine a four-digit grid location of an object on a military map.
6. Explain how to determine a six-digit grid location of an object on a military map.
7. Describe how to identify a four-digit grid coordinate on a military map.
8. Describe how to identify a six-digit grid coordinate on a military map.

Key Words

legend
scale
declination
true north
magnetic north
grid north
G-M angle
topographic symbols
terrain features
grid coordinates

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