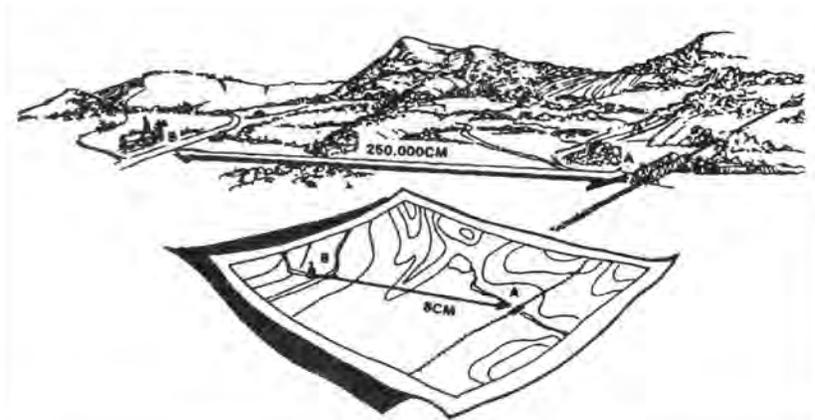


MAP READING AND LAND NAVIGATION



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MAP READING AND LAND NAVIGATION

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PREFACE

The purpose of this field manual is to provide a standardized source document for Armywide reference on *map reading* and *land navigation*. This manual applies to every soldier in the Army regardless of service branch, MOS, or rank. This manual also contains both doctrine and training guidance on these subjects. Part One addresses map reading and Part Two, land navigation. The appendixes include a list of exportable training materials, a matrix of land navigation tasks, an introduction to orienteering, and a discussion of several devices that can assist the soldier in land navigation.

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Unless this publication states otherwise, masculine nouns and pronouns do not refer exclusively to men.

PART ONE
MAP READING

CHAPTER 1
TRAINING STRATEGY

This manual is in response to an Armywide need for a new map reading and land navigation training strategy based on updated doctrine. This chapter describes and illustrates this approach to teaching these skills.

1-1. BUILDING-BLOCK APPROACH

Institution courses are designed to prepare the soldier for a more advanced duty position in his unit. The critical soldiering skills of move, shoot, and communicate must be trained, practiced, and sustained at every level in the schools as well as in the unit. The map reading and land navigation skills taught at each level are critical to the soldiering skills of the duty position for which he is being school-trained. Therefore, they are also a prerequisite for a critical skill at a more advanced level.

a. A soldier completing initial-entry training must be prepared to become a team member. He must be proficient in the basic map reading and dead reckoning skills.

b. After completing the Primary Leadership Development Course (PLDC), a soldier should be ready to be a team leader. This duty position requires expertise in the skills of map reading, dead reckoning, and terrain association.

c. A soldier completing the Basic NCO Course (BNCOC) has been trained for the squad leader position. Map reading and land navigation at skill level 3 requires development of problem-solving skills; for example, route selection and squad tactical movement.

d. At skill level 4, the soldier completing the Advanced NCO Course (ANCOC) is prepared to assume the duty position of platoon sergeant or operations NCO. Planning tactical movements, developing unit sustainment, and making decisions are the important land navigation skills at this level.

e. Officers follow similar progression. A new second lieutenant must have mastered map reading and land navigation skills, and have an aptitude for dead reckoning and terrain association.

(1) After completing the Officer Basic Course, the officer must be prepared to assume the duties and responsibilities of a platoon leader. He is required to execute the orders and operations of his commander. Map reading and land navigation at this level require development of the problem-solving skills of route selection and tactical movement.

(2) After completing the Officer Advanced Course, the officer is prepared to assume the duties and responsibilities of a company commander or primary staff officer. The commander must plan and execute operations with full consideration to all aspects of navigation. The staff officer must recommend battlefield placement of all administrative, logistical, and personnel resources. These recommendations cannot be tactically sound unless the estimate process includes a detailed analysis of the area of operations. This ability requires expertise in all map reading and navigation skills to include the use of nonmilitary maps, aerial photographs, and terrain analysis with respect to both friendly and enemy

forces. The commander/staff officer must plan and execute a program to develop the unit's train-the-trainer program for land navigation.

f. A program of demonstrated proficiency of all the preceding skill levels to the specified conditions and standards is a prerequisite to the successful implementation of a building-block training approach. This approach reflects duty position responsibilities in map reading and land navigation. An understanding of the fundamental techniques of dead reckoning or field-expedient methods is a basic survival skill that each soldier must develop at the initial-entry level. This skill provides a support foundation for more interpretive analysis at intermediate skill levels 2 and 3, with final progression to level 4. Mastery of all map reading and land navigation tasks required in previous duty positions is essential for the sequential development of increasingly difficult abilities. This building-block approach is supported by scope statements. It is part of the training doctrine at each level in the institutional training environment of each course.

g. Exportable training and instructor support/certification packages are being developed based upon the updated map reading and land navigation field manual. Innovative training devices and materials are being developed for use in the institution, ROTC regions, and the field. (See Appendixes E and H.)

1-2. ARMYWIDE IMPLEMENTATION

A mandatory core of critical map reading and land navigation tasks and a list of electives will be provided to each TRADOC service school and FORSCOM professional development school. Standardization is achieved through the mandatory core. Exportable training material is made available to support Armywide implementation.

1-3. SAFETY

Unit leaders plan to brief and enforce all safety regulations established by local range control. They coordinate the mode of evacuation of casualties through the appropriate channels. They review all installation safety regulations. Unit leaders must complete a thorough terrain reconnaissance before using an area for land navigation training. They should look for dangerous terrain, heavy trafficked roads, water obstacles, wildlife, and training debris.

CHAPTER 2

MAPS

Cartography is the art and science of expressing the known physical features of the earth graphically by maps and charts. No one knows who drew, molded, laced together, or scratched out in the dirt the first map. But a study of history reveals that the most pressing demands for accuracy and detail in mapping have come as the result of military needs. Today, the complexities of tactical operations and deployment of troops are such that it is essential for all soldiers to be able to read and interpret their maps in order to move quickly and effectively on the battlefield. This chapter includes the definition and purpose of a map and describes map security, types, categories, and scales.

2-1. DEFINITION

A map is a graphic representation of a portion of the earth's surface drawn to scale, as seen from above. It uses colors, symbols, and labels to represent features found on the ground. The ideal representation would be realized if every feature of the area being mapped could be shown in true shape. Obviously this is impossible, and an attempt to plot each feature true to scale would result in a product impossible to read even with the aid of a magnifying glass.

a. Therefore, to be understandable, features must be represented by conventional signs and symbols. To be legible, many of these must be exaggerated in size, often far beyond the actual ground limits of the feature represented. On a 1:250,000 scale map, the prescribed symbol for a building covers an area about 500 feet square on the ground; a road symbol is equivalent to a road about 520 feet wide on the ground; the symbol for a single-track railroad (the length of a cross-tie) is equivalent to a railroad cross-tie about 1,000 feet on the ground.

b. The portrayal of many features requires similar exaggeration. Therefore, the selection of features to be shown, as well as their portrayal, is in accord with the guidance established by the Defense Mapping Agency.

2-2. PURPOSE

A map provides information on the existence, the location of, and the distance between ground features, such as populated places and routes of travel and communication. It also indicates variations in terrain, heights of natural features, and the extent of vegetation cover. 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 by using maps. Therefore, any operation requires a supply of maps; however, the finest maps available are worthless unless the map user knows how to read them.

2-3. PROCUREMENT

Most military units are authorized a basic load of maps. Local command supplements to AR 115-11 provide tables of initial allowances for maps. Map requisitions and distributions are accomplished through the Defense Mapping Agency Hydrographic and Topographic

Center's Office of Distribution and Services. In the division, however, maps are a responsibility of the G2 section.

a. To order a map, refer to the DMA catalog located at your S2/G2 shop. Part 3 of this catalog, Topographic Maps, has five volumes. Using the delineated map index, find the map or maps you want based upon the location of the nearest city. With this information, order maps using the following forms:

(1) *Standard Form 344*. It can be typed or handwritten; it is used for mailing or over-the-counter service.

(2) *Department of Defense Form 1348*. Same as SF 344. You can order copies of only one map sheet on each form.

(3) *Department of Defense Form 1348M*. This is a punch card form for AUDODIN ordering.

(4) *Department of Defense Form 173*. This is a message form to be used for urgent ordering.

With the exception of the message form (DD 173), the numbered sections of all forms are the same. For example: In block 1, if you are in CONUS, enter "AOD," if you are overseas, enter "AO4." In block 2, use one of the following codes for your location.

<u>LOCATION</u>	<u>CODE</u>
Europe	CS7
Hawaii	HM9
Korea	WM4
Alaska	WC1
Panama	HMJ
CONUS	HM8

Your supply section will help you complete the rest of the form.

b. Stock numbers are also listed in map catalogs, which are available at division and higher levels and occasionally in smaller units. A map catalog consists of small-scale maps upon which the outlines of the individual map sheets of a series have been delineated. Another document that is an aid to the map user is the gazetteer. A gazetteer lists all the names appearing on a map series of a geographical area, a designation that identifies what is located at that place name, a grid reference, a sheet number of the map upon which the name appeared, and the latitude and longitude of the named features. Gazetteers are prepared for maps of foreign areas only.

2-4. SECURITY

All maps should be considered as documents that require special handling. If a map falls into unauthorized hands, it could easily endanger military operations by providing information of friendly plans or areas of interest to the enemy. Even more important would be a map on which the movements or positions of friendly soldiers were marked. It is possible, even though the markings on a map have been erased, to determine some of the erased information. **Maps are documents that must not fall into unauthorized hands.**

a. If a map is no longer needed, it must be turned in to the proper authority. If a map is in danger of being captured, it must be destroyed. The best method of destruction is by burning it and scattering the ashes. If burning is not possible, the map can be torn into small pieces and scattered over a wide area.

b. Maps of some areas of the world are subject to third party limitations. These are agreements that permit the United States to make and use maps of another country provided these maps are not released to any third party without permission of the country concerned. Such maps require special handling.

c. Some maps may be classified and must be handled and cared for in accordance with AR 380-5 and, if applicable, other local security directives.

2-5. CARE

Maps are documents printed on paper and require protection from water, mud, and tearing. Whenever possible, a map should be carried in a waterproof case, in a pocket, or in some other place where it is handy for use but still protected.

a. Care must also be taken when using a map since it may have to last a long time. If it becomes necessary to mark a map, the use of a pencil is recommended. Use light lines so they may be erased easily without smearing and smudging, or leaving marks that may cause confusion later. If the map margins must be trimmed for any reason, it is essential to note any marginal information that may be needed later, such as grid data and magnetic declination.

b. Special care should be taken of a map that is being used in a tactical mission, especially in small units; the mission may depend on that map. All members of such units should be familiar with the map's location at all times.

c. Appendix B shows two ways of folding a map.

2-6. CATEGORIES

The DMA's mission is to provide mapping, charting, and all geodesy support to the armed forces and all other national security operations. DMA produces four categories of products and services: hydrographic, topographic, aeronautical, and missile and targeting. Military maps are categorized by scale and type.

a. **Scale.** Because a map is a graphic representation of a portion of the earth's surface drawn to scale as seen from above, it is important to know what mathematical scale has been used. You must know this to determine ground distances between objects or locations on the map, the size of the area covered, and how the scale may affect the amount of detail being shown. The mathematical scale of a map is the ratio or fraction between the distance on a map and the corresponding distance on the surface of the earth. Scale is reported as a representative fraction with the map distance as the numerator and the ground distance as the denominator.

$$\text{Representative fraction (scale)} = \frac{\text{map distance}}{\text{ground distance}}$$

As the denominator of the representative fraction gets larger and the ratio gets smaller, the scale of the map decreases. Defense Mapping Agency maps are classified by scale into three

categories. They are small-, medium-, and large-scale maps (Figure 2-1). The terms "**small scale**," "**medium scale**," and "**large scale**" may be confusing when read in conjunction with the number. However, if the number is viewed as a fraction, it quickly becomes apparent that 1:600,000 of something is smaller than 1:75,000 of the same thing. Therefore, the larger the number after 1:, the smaller the scale of the map.

(1) **Small**. Those maps with scales of 1:1,000,000 and smaller are used for general planning and for strategic studies (bottom map in Figure 2-1). The standard small-scale map is 1:1,000,000. This map covers a very large land area at the expense of detail.

(2) **Medium**. Those maps with scales larger than 1:1,000,000 but smaller than 1:75,000 are used for operational planning (center map in Figure 2-1). They contain a moderate amount of detail, but terrain analysis is best done with the large-scale maps described below. The standard medium-scale map is 1:250,000. Medium scale maps of 1:100,000 are also frequently encountered.

(3) **Large**. Those maps with scales of 1:75,000 and larger are used for tactical, administrative, and logistical planning (top map in Figure 2-1). These are the maps that you as a soldier or junior leader are most likely to encounter. The standard large-scale map is 1:50,000; however, many areas have been mapped at a scale of 1:25,000.

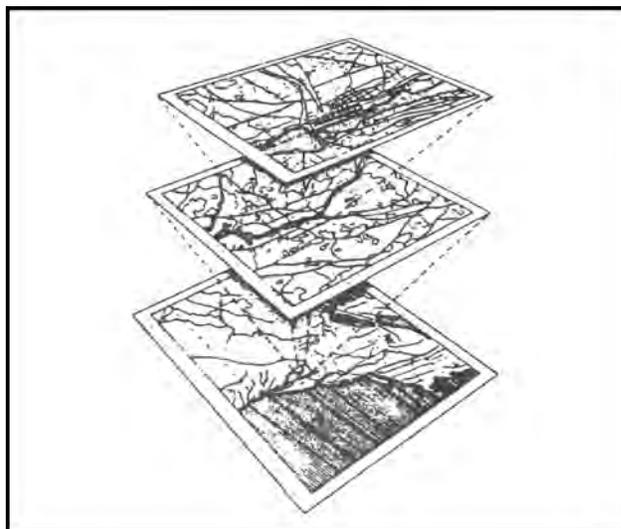


Figure 2-1. Scale classifications.

b. **Types**. The map of choice for land navigators is the 1:50,000-scale military topographic map. It is important, however, that you know how to use the many other products available from the DMA as well. When operating in foreign places, you may discover that DMA map products have not yet been produced to cover your particular area of operations, or they may not be available to your unit when you require them. Therefore, you must be prepared to use maps produced by foreign governments that may or may not meet the standards for accuracy set by DMA. These maps often use symbols that resemble those found on DMA maps but which have completely different meanings. There may be other times when you must operate with the only map you can obtain. This might be a commercially produced map run off on a copy machine at higher headquarters. In Grenada, many of our troops used a British tourist map.

(1) **Planimetric Map.** This is a map that presents only the horizontal positions for the features represented. It is distinguished from a topographic map by the omission of relief, normally represented by contour lines. Sometimes, it is called a line map.

(2) **Topographic Map.** This is a map that portrays terrain features in a measurable way (usually through use of contour lines), as well as the horizontal positions of the features represented. The vertical positions, or relief, are normally represented by contour lines on military topographic maps. On maps showing relief, the elevations and contours are measured from a specific vertical datum plane, usually mean sea level. Figure 3-1 shows a typical topographic map.

(3) **Photomap.** This is a reproduction of an aerial photograph upon which grid lines, marginal data, place names, route numbers, important elevations, boundaries, and approximate scale and direction have been added. (See Chapter 8.)

(4) **Joint Operations Graphics.** These maps are based on the format of standard 1:250,000 medium-scale military topographic maps, but they contain additional information needed in joint air-ground operations (Figure 2-2). Along the north and east edges of the graphic, detail is extended beyond the standard map sheet to provide overlap with adjacent sheets. These maps are produced both in ground and air formats. Each version is identified in the lower margin as either Joint Operations Graphic (Air) or Joint Operations Graphic (Ground). The topographic information is identical on both, but the ground version shows elevations and contour in meters and the air version shows them in feet. Layer (elevation) tinting and relief shading are added as an aid to interpolating relief. Both versions emphasize airlanding facilities (shown in purple), but the air version has additional symbols to identify aids and obstructions to air navigation. (See Appendix D for additional information.)

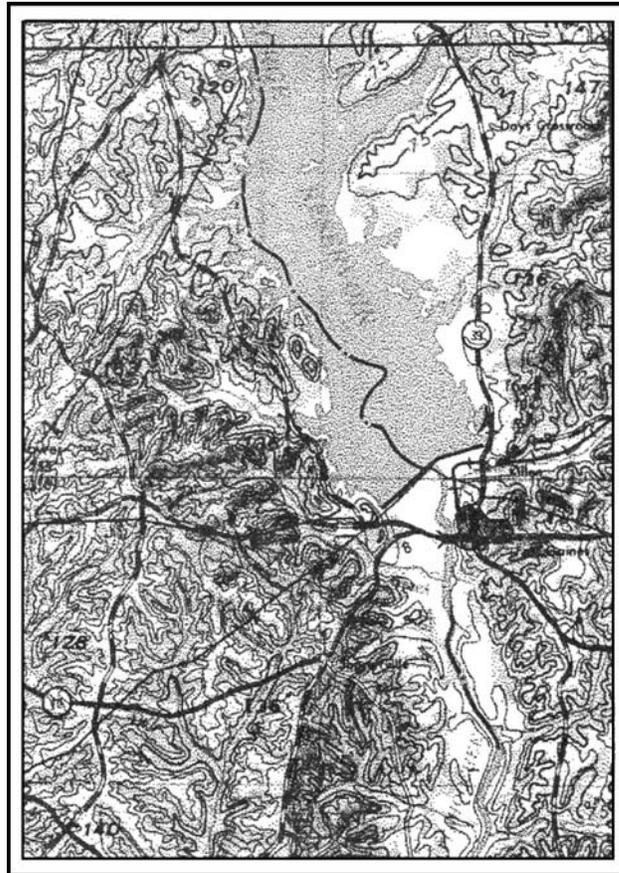


Figure 2-2. Joint operations graphic (air).

(5) **Photomosaic.** This is an assembly of aerial photographs that is commonly called a mosaic in topographic usage. Mosaics are useful when time does not permit the compilation of a more accurate map. The accuracy of a mosaic depends on the method employed in its preparation and may vary from simply a good pictorial effect of the ground to that of a planimetric map.

(6) **Terrain Model.** This is a scale model of the terrain showing features, and in large-scale models showing industrial and cultural shapes. It provides a means for visualizing the terrain for planning or indoctrination purposes and for briefing on assault landings.

(7) **Military City Map.** This is a topographic map (usually at 1:12,550 scale, sometimes up to 1:5,000), showing the details of a city. It delineates streets and shows street names, important buildings, and other elements of the urban landscape important to navigation and military operations in urban terrain. The scale of a military city map depends on the importance and size of the city, density of detail, and available intelligence information.

(8) **Special Maps.** These are maps for special purposes, such as trafficability, communications, and assault maps. They are usually in the form of an overprint in the scales smaller than 1:100,000 but larger than 1:1,000,000. A special purpose map is one that has been designed or modified to give information not covered on a standard map. The wide range of subjects that could be covered under the heading of special purpose maps prohibits,

within the scope of this manual, more than a brief mention of a few important ones. Some of the subjects covered are:

- Terrain features.
- Drainage characteristics.
- Vegetation.
- Climate.
- Coasts and landing beaches.
- Roads and bridges.
- Railroads.
- Airfields.
- Urban areas.
- Electric power.
- Fuels.
- Surface water resources.
- Ground water resources.
- Natural construction materials.
- Cross-country movements.
- Suitability for airfield construction.
- Airborne operations.

2-7. MILITARY MAP SUBSTITUTES

If military maps are not available, use substitute maps. The substitute maps can range from foreign military or commercial maps to field sketches. The DMA can provide black and white reproductions of many foreign maps and can produce its own maps based upon intelligence.

a. **Foreign Maps.** These are maps that have been compiled by nations other than our own. When these must be used, the marginal information and grids are changed to conform to our standards if time permits. The scales may differ from our maps, but they do express the ratio of map distance to ground distance and can be used in the same way. The legend must be used since the map symbols almost always differ from ours. Because the accuracy of foreign maps varies considerably, they are usually evaluated in regard to established accuracy standards before they are issued to our troops. (See Appendix I for additional information.)

b. **Atlases.** These are collections of maps of regions, countries, continents, or the world. Such maps are accurate only to a degree and can be used for general information only.

c. **Geographic Maps.** These maps give an overall idea of the mapped area in relation to climate, population, relief, vegetation, and hydrography. They also show general location of major urban areas.

d. **Tourist Road Maps.** These are maps of a region in which the main means of transportation and areas of interest are shown. Some of these maps show secondary networks of roads, historic sites, museums, and beaches in detail. They may contain road and time distance between points. Careful consideration should be exercised about the scale when using these maps.

e. **City/Utility Maps.** These are maps of urban areas showing streets, water ducts, electricity and telephone lines, and sewers.

f. **Field Sketches.** These are preliminary drawings of an area or piece of terrain. (See Appendix A.)

g. **Aerial Photographs.** These can be used as map supplements or substitutes to help you analyze the terrain, plan your route, or guide your movement. (See Chapter 8 for additional information).

2-8. STANDARDS OF ACCURACY

Accuracy is the degree of conformity with which horizontal positions and vertical values are represented on a map in relation to an established standard. This standard is determined by the DMA based on user requirements. A map can be considered to meet accuracy requirement standards unless otherwise specified in the marginal information.

CHAPTER 3

MARGINAL INFORMATION AND SYMBOLS

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

3-1. MARGINAL INFORMATION ON A MILITARY MAP

Figure 3-1 (page 3-4) shows a reduced version of a large-scale topographic map. The circled numbers indicate the items of marginal information that the map user needs to know. These circled numbers correspond to the following listed items.

a. **Sheet Name (1).** The sheet name is found in bold print at the center of the top and in the lower left area of the map margin. A map is generally named for the settlement contained within the area covered by the sheet, or for the largest natural feature located within the area at the time the map was drawn.

b. **Sheet Number (2).** The sheet number is found in bold print in both the upper right and lower left areas of the margin, and in the center box of the adjoining sheets diagram, which is found in the lower right margin. It is used as a reference number to link specific maps to overlays, operations orders, and plans. For maps at 1:100,000 scale and larger, sheet numbers are based on an arbitrary system that makes possible the ready orientation of maps at scales of 1:100,000, 1:50,000, and 1:25,000.

c. **Series Name (3).** The map series name is found in the same bold print as the sheet number in the upper left corner of the margin. The name given to the series is generally that of a major political subdivision, such as a state within the United States or a European nation. A map series usually includes a group of similar maps at the same scale and on the same sheet lines or format designed to cover a particular geographic area. It may also be a group of maps that serve a common purpose, such as the military city maps.

d. **Scale (4).** The scale is found both in the upper left margin after the series name, and in the center of the lower margin. The scale note is a representative fraction that gives the ratio of a map distance to the corresponding distance on the earth's surface. For example, the scale note 1:50,000 indicates that one unit of measure on the map equals 50,000 units of the same measure on the ground.

e. **Series Number (5).** The series number is found in both the upper right margin and the lower left margin. It is a sequence reference expressed either as a four-digit numeral (1125) or as a letter, followed by a three- or four-digit numeral (M661; T7110).

f. **Edition Number (6).** The edition number is found in bold print in the upper right area of the top margin and the lower left area of the bottom margin. Editions are numbered consecutively; therefore, if you have more than one edition, the highest numbered sheet is the most recent. Most military maps are now published by the DMA, but older editions of maps may have been produced by the US Army Map Service. Still others may have been drawn, at least in part, by the US Army Corps of Engineers, the US Geological Survey, or

other agencies affiliated or not with the United States or allied governments. The credit line, telling who produced the map, is just above the legend. The map information date is found immediately below the word "LEGEND" in the lower left margin of the map. This date is important when determining how accurately the map data might be expected to match what you will encounter on the ground.

g. **Index to Boundaries (7).** The index to boundaries diagram appears in the lower or right margin of all sheets. This diagram, which is a miniature of the map, shows the boundaries that occur within the map area, such as county lines and state boundaries.

h. **Adjoining Sheets Diagram (8).** Maps at all standard scales contain a diagram that illustrates the adjoining sheets. On maps at 1:100,000 and larger scales and at 1:1,000,000 scale, the diagram is called the index to adjoining sheets. It consists of as many rectangles representing adjoining sheets as are necessary to surround the rectangle that represents the sheet under consideration. The diagram usually contains nine rectangles, but the number may vary depending on the locations of the adjoining sheets. All represented sheets are identified by their sheet numbers. Sheets of an adjoining series, whether published or planned, that are at the same scale are represented by dashed lines. The series number of the adjoining series is indicated along the appropriate side of the division line between the series.

i. **Elevation Guide (9).** This is normally found in the lower right margin. It is a miniature characterization of the terrain shown. The terrain is represented by bands of elevation, spot elevations, and major drainage features. The elevation guide provides the map reader with a means of rapid recognition of major landforms.

j. **Declination Diagram (10).** This is located in the lower margin of large-scale maps and indicates the angular relationships of true north, grid north, and magnetic north. On maps at 1:250,000 scale, this information is expressed as a note in the lower margin. In recent edition maps, there is a note indicating the conversion of azimuths from grid to magnetic and from magnetic to grid next to the declination diagram.

k. **Bar Scales (11).** These are located in the center of the lower margin. They are rulers used to convert map distance to ground distance. Maps have three or more bar scales, each in a different unit of measure. Care should be exercised when using the scales, especially in the selection of the unit of measure that is needed.

l. **Contour Interval Note (12).** This note is found in the center of the lower margin normally below the bar scales. It states the vertical distance between adjacent contour lines of the map. When supplementary contours are used, the interval is indicated. In recent edition maps, the contour interval is given in meters instead of feet.

m. **Spheroid Note (13).** This note is located in the center of the lower margin. Spheroids (ellipsoids) have specific parameters that define the X Y Z axis of the earth. The spheroid is an integral part of the datum.

n. **Grid Note (14).** This note is located in the center of the lower margin. It gives information pertaining to the grid system used and the interval between grid lines, and it identifies the UTM grid zone number.

o. **Projection Note (15).** The projection system is the framework of the map. For military maps, this framework is of the conformal type; that is, small areas of the surface of the earth retain their true shapes on the projection; measured angles closely approximate true values; and the scale factor is the same in all directions from a point. The projection note

is located in the center of the lower margin. Refer to DMA for the development characteristics of the conformal-type projection systems.

(1) Between 80° south and 84° north, maps at scales larger than 1:500,000 are based on the transverse Mercator projection. The note reads TRANSVERSE MERCATOR PROJECTION.

(2) Between 80° south and 84° north, maps at 1:1,000,000 scale and smaller are based on standard parallels of the Lambert conformal conic projection. The note reads, for example, LAMBERT CONFORMAL CONIC PROJECTIONS 36° 40' N AND 39° 20' N.

(3) Maps of the polar regions (south of 80° south and north of 84° north) at 1:1,000,000 and larger scales are based on the polar stereographic projection. The note reads POLAR STEREOGRAPHIC PROJECTION.

p. **Vertical Datum Note (16).** This note is located in the center of the lower margin. The vertical datum or vertical-control datum is defined as any level surface (for example, mean sea level) taken as a surface of reference from which to determine elevations. In the United States, Canada, and Europe, the vertical datum refers to the mean sea level surface. However, in parts of Asia and Africa, the vertical-control datum may vary locally and is based on an assumed elevation that has no connection to any sea level surface. Map readers should habitually check the vertical datum note on maps, particularly if the map is used for low-level aircraft navigation, naval gunfire support, or missile target acquisition.

q. **Horizontal Datum Note (17).** This note is located in the center of the lower margin. The horizontal datum or horizontal-control datum is defined as a geodetic reference point (of which five quantities are known: latitude, longitude, azimuth of a line from this point, and two constants, which are the parameters of reference ellipsoid). These are the basis for horizontal-control surveys. The horizontal-control datum may extend over a continent or be limited to a small local area. Maps and charts produced by DMA are produced on 32 different horizontal-control data. Map readers should habitually check the horizontal datum note on every map or chart, especially adjacent map sheets. This is to ensure the products are based on the same horizontal datum. If products are based on different horizontal-control data, coordinate transformations to a common datum must be performed. UTM coordinates from the same point computed on different data may differ as much as 900 meters.

r. **Control Note (18).** This note is located in the center of the lower margin. It indicates the special agencies involved in the control of the technical aspects of all the information that is disseminated on the map.

s. **Preparation Note (19).** This note is located in the center of the lower margin. It indicates the agency responsible for preparing the map.

t. **Printing Note (20).** This note is also located in the center of the lower margin. It indicates the agency responsible for printing the map and the date the map was printed. The printing data should not be used to determine when the map information was obtained.

u. **Grid Reference Box (21).** This box is normally located in the center of the lower margin. It contains instructions for composing a grid reference.

v. **Unit imprint and Symbol (22).** The unit imprint and symbol is on the left side of the lower margin. It identifies the agency that prepared and printed the map with its respective symbol. This information is important to the map user in evaluating the reliability of the map.

w. **Legend (23).** The legend is located in the lower left margin. It illustrates and identifies the topographic symbols used to depict some of the more prominent features on

the map. The symbols are not always the same on every map. Always refer to the legend to avoid errors when reading a map.

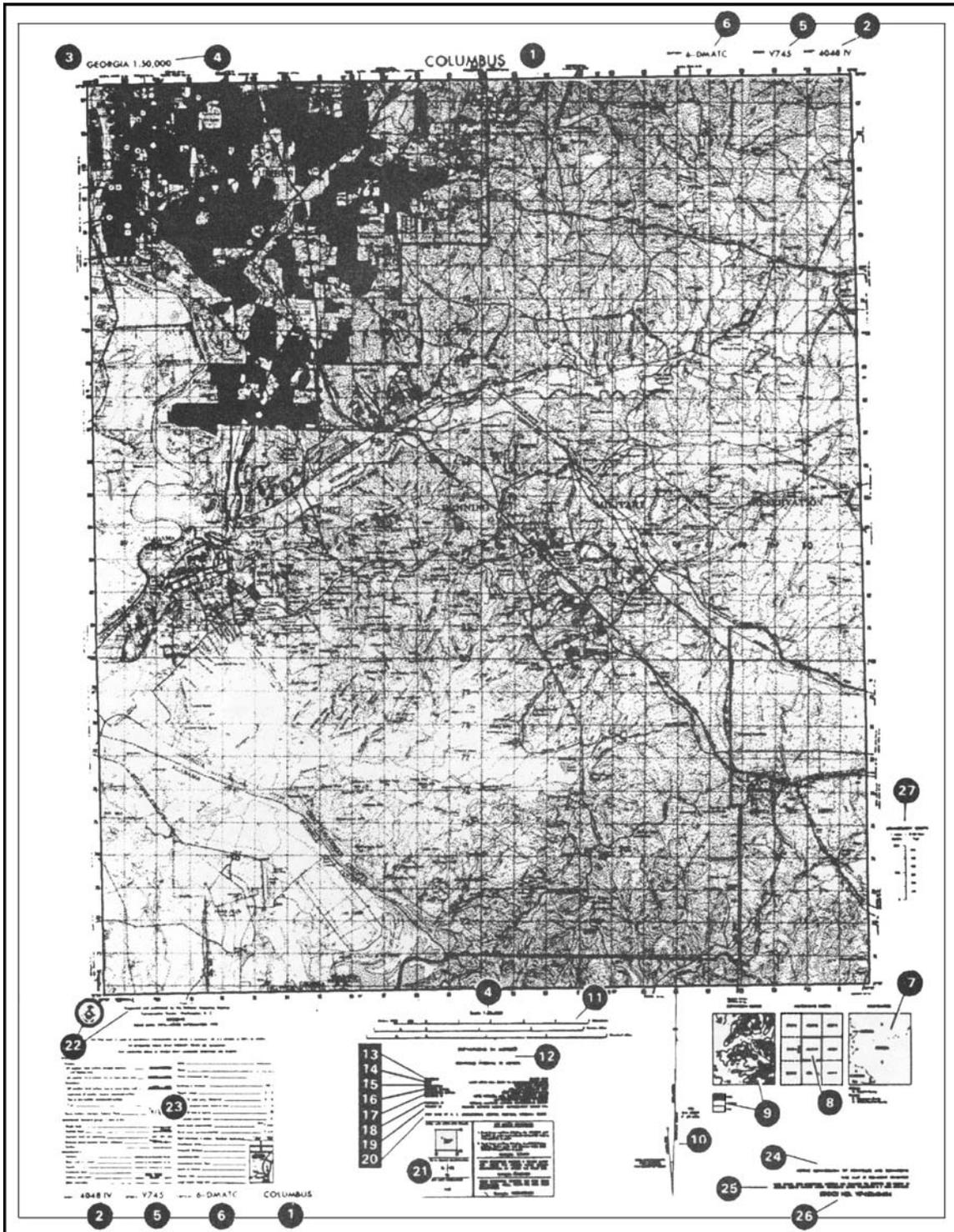


Figure 3-1. Topographical map.

3-2. ADDITIONAL NOTES

Not all maps contain the same items of marginal information. Under certain conditions, special notes and scales may be added to aid the map user. The following are examples:

a. **Glossary.** This is an explanation of technical terms or a translation of terms on maps of foreign areas where the native language is other than English.

b. **Classification.** Certain maps require a note indicating the security classification. This is shown in the upper and lower margins.

c. **Protractor Scale.** This scale may appear in the upper margin on some maps. It is used to lay out the magnetic-grid declination for the map, which, in turn, is used to orient the map sheet with the aid of the lensatic compass.

d. **Coverage Diagram.** On maps at scales of 1:100,000 and larger, a coverage diagram may be used. It is normally in the lower or right margin and indicates the methods by which the map was made, dates of photography, and reliability of the sources. On maps at 1:250,000 scale, the coverage diagram is replaced by a reliability diagram.

e. **Special Notes (24).** A special note is any statement of general information that relates to the mapped area. It is normally found in the lower right margin. For example: This map is red-light readable.

f. **User's Note (25).** This note is normally located in the lower right-hand margin. It requests cooperation in correcting errors or omissions on the map. Errors should be marked and the map forwarded to the agency identified in the note.

g. **Stock Number Identification (26).** All maps published by the DMA that are in the Department of the Army map supply system contain stock number identifications that are used in requisitioning map supplies. The identification consists of the words "STOCK NO" followed by a unique designation that is composed of the series number, the sheet number of the individual map and, on recently printed sheets, the edition number. The designation is limited to 15 units (letters and numbers). The first 5 units are allotted to the series number; when the series number is less than 5 units, the letter "X" is substituted as the fifth unit. The sheet number is the next component; however, Roman numerals, which are part of the sheet number, are converted to Arabic numerals in the stock number. The last 2 units are the edition number; the first digit of the edition number is a zero if the number is less than 10. If the current edition number is unknown, the number 01 is used. The latest available edition will be furnished. Asterisks are placed between the sheet number and the edition number when necessary to ensure there are at least 11 units in the stock number.

h. **Conversion Graph (27).** Normally found in the right margin, this graph indicates the conversion of different units of measure used on the map.

3-3. TOPOGRAPHIC MAP SYMBOLS

The purpose of a map is to permit one to visualize an area of the earth's surface with pertinent features properly positioned. The map's legend contains the symbols most commonly used in a particular series or on that specific topographic map sheet. Therefore, the legend should be referred to each time a new map is used. Every effort is made to design standard symbols that resemble the features they represent. If this is not possible, symbols are selected that logically imply the features they portray. For example, an open-pit mining operation is represented by a small black drawing of a crossed hammer and pickax.

a. Ideally, all the features within an area would appear on a map in their true proportion, position, and shape. This, however, is not practical because many of the features would be unimportant and others would be unrecognizable because of their reduction in size.

b. The mapmaker has been forced to use symbols to represent the natural and man-made features of the earth's surface. These symbols resemble, as closely as possible, the actual features themselves as viewed from above. They are positioned in such a manner that the center of the symbol remains in its true location. An exception to this would be the position of a feature adjacent to a major road. If the width of the road has been exaggerated, then the feature is moved from its true position to preserve its relation to the road. Field Manual 21-31 gives a description of topographic features and abbreviations authorized for use on our military maps.

3-4. MILITARY SYMBOLS

In addition to the topographic symbols used to represent the natural and man-made features of the earth, military personnel require some method for showing identity, size, location, or movement of soldiers; and military activities and installations. The symbols used to represent these military features are known as military symbols. These symbols are not normally printed on maps because the features and units that they represent are constantly moving or changing; military security is also a consideration. They do appear in special maps and overlays (Chapter 7). The map user draws them in, in accordance with proper security precautions. Refer to FM 101-5-1 for complete information on military symbols.

3-5. COLORS USED ON A MILITARY MAP

By the fifteenth century, most European maps were carefully colored. Profile drawings of mountains and hills were shown in brown, rivers and lakes in blue, vegetation in green, roads in yellow, and special information in red. A look at the legend of a modern map confirms that the use of colors has not changed much over the past several hundred years. To facilitate the identification of features on a map, the topographical and cultural information is usually printed in different colors. These colors may vary from map to map. On a standard large-scale topographic map, the colors used and the features each represent are:

a. **Black.** Indicates cultural (man-made) features such as buildings and roads, surveyed spot elevations, and all labels.

b. **Red-Brown.** The colors red and brown are combined to identify cultural features, all relief features, non-surveyed spot elevations, and elevation, such as contour lines on red-light readable maps.

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

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

e. **Brown.** Identifies all relief features and elevation, such as contours on older edition maps, and cultivated land on red-light readable maps.

f. **Red.** Classifies cultural features, such as populated areas, main roads, and boundaries, on older maps.

g. **Other.** Occasionally other colors may be used to show special information. These are indicated in the marginal information as a rule.

CHAPTER 4

GRIDS

This chapter covers how to determine and report positions on the ground in terms of their locations on a map. Knowing where you are (position fixing) and being able to communicate that knowledge is crucial to successful land navigation as well as to the effective employment of direct and indirect fire, tactical air support, and medical evacuation. It is essential for valid target acquisition; accurate reporting of NBC contamination and various danger areas; and obtaining emergency resupply. Few factors contribute as much to the survivability of troops and equipment and to the successful accomplishment of a mission as always knowing where you are. The chapter includes explanations of geographical coordinates, Universal Transverse Mercator grids, the military grid reference system, and the use of grid coordinates.

4-1. REFERENCE SYSTEM

In a city, it is quite simple to find a location; the streets are named and the buildings have numbers. The only thing needed is the address. However, finding locations in undeveloped areas or in unfamiliar parts of the world can be a problem. To cope with this problem, a uniform and precise system of referencing has been developed.

4-2. GEOGRAPHIC COORDINATES

One of the oldest systematic methods of location is based upon the geographic coordinate system. By drawing a set of east-west rings around the globe (parallel to the equator), and a set of north-south rings crossing the equator at right angles and converging at the poles, a network of reference lines is formed from which any point on the earth's surface can be located.

a. The distance of a point north or south of the equator is known as its latitude. The rings around the earth parallel to the equator are called parallels of latitude or simply parallels. Lines of latitude run east-west but north-south distances are measured between them.

b. A second set of rings around the globe at right angles to lines of latitude and passing through the poles is known as meridians of longitude or simply meridians. One meridian is designated as the prime meridian. The prime meridian of the system we use runs through Greenwich, England and is known as the Greenwich meridian. The distance east or west of a prime meridian to a point is known as its longitude. Lines of longitude (meridians) run north-south but east-west distances are measured between them (Figures 4-1 and 4-2, page 4-2).

Figure 4-1. Prime meridian and equator.

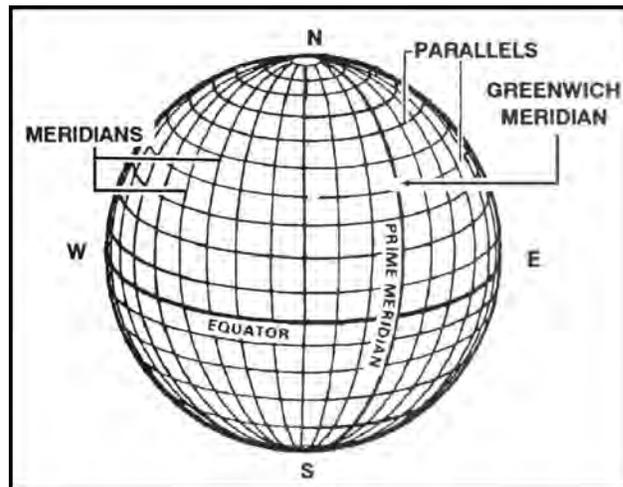


Figure 4-2. Reference lines.

c. Geographic coordinates are expressed in angular measurement. Each circle is divided into 360 degrees, each degree into 60 minutes, and each minute into 60 seconds. The degree is symbolized by $^{\circ}$, the minute by $'$, and the second by $''$. Starting with 0° at the equator, the parallels of latitude are numbered to 90° both north and south. The extremities are the north pole at 90° north latitude and the south pole at 90° south latitude. Latitude can have the same numerical value north or south of the equator, so the direction N or S must always be given. Starting with 0° at the prime meridian, longitude is measured both east and west around the world. Lines east of the prime meridian are numbered to 180° and identified as east longitude; lines west of the prime meridian are numbered to 180° and identified as west longitude. The direction E or W must always be given. The line directly opposite the prime meridian, 180° , may be referred to as either east or west longitude. The values of geographic coordinates, being in units of angular measure, will mean more if they are compared with units of measure with which we are more familiar. At any point on the earth, the ground

distance covered by one degree of latitude is about 111 kilometers (69 miles); one second is equal to about 30 meters (100 feet). The ground distance covered by one degree of longitude at the equator is also about 111 kilometers, but decreases as one moves north or south, until it becomes zero at the poles. For example, one second of longitude represents about 30 meters (100 feet) at the equator; but at the latitude of Washington, DC, one second of longitude is about 24 meters (78 feet). Latitude and longitude are illustrated in Figure 4-3.

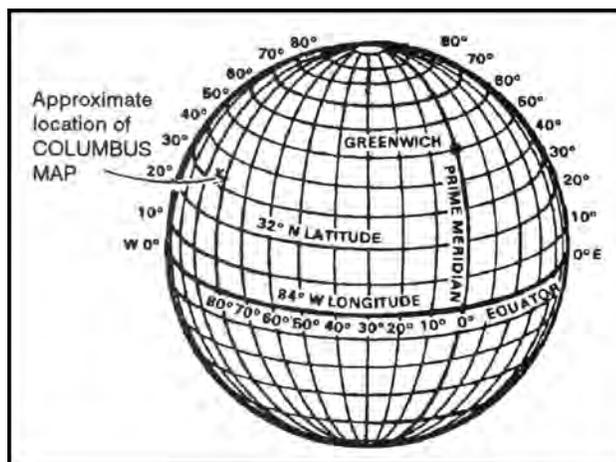


Figure 4-3. Latitude and longitude.

d. Geographic coordinates appear on all standard military maps; on some they may be the only method of locating and referencing a specific point. The four lines that enclose the body of the map (neatlines) are latitude and longitude lines. Their values are given in degrees and minutes at each of the four corners. On a portion of the Columbus map (Figure 4-4), the figures $32^{\circ}15'$ and $84^{\circ}45'$ appear at the lower right corner. The bottom line of this map is latitude $32^{\circ}15'00''N$, and the line running up the right side is longitude $84^{\circ}45'00''W$. In addition to the latitude and longitude given for the four corners, there are, at regularly spaced intervals along the sides of the map, small tick marks extending into the body of the map. Each of these tick marks is identified by its latitude or longitude value. Near the top of the right side of the map is a tick mark and the number 20'. The full value for this tick mark is $32^{\circ}20'00''$ of latitude. At one-third and two-thirds of the distance across the map from the 20' tick mark will be found a cross tick mark (grid squares 0379 and 9679) and at the far side another 20' tick mark. By connecting the tick marks and crosses with straight lines, a $32^{\circ}20'00''$ line of latitude can be added to the map. This procedure is also used to locate the $32^{\circ}25'00''$ line of latitude. For lines of longitude, the same procedure is followed using the tick marks along the top and bottom edges of the map.

e. After the parallels and meridians have been drawn, the geographic interval (angular distance between two adjacent lines) must be determined. Examination of the values given at the tick marks gives the interval. For most maps of scale 1:25,000, the interval is $2'30''$. For the Columbus map and most maps of scale 1:50,000, it is $5'00''$. The geographic coordinates of a point are found by dividing the sides of the geographic square in which the point is located into the required number of equal parts. If the geographic interval is $5'00''$ and the location of a point is required to the nearest second, each side of the geographic square must be divided into 300 equal parts ($5'00'' = 300''$), each of which would have a