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MAP READING AND FIELD SKETCHING

The Use of the Protractor and Field Compass and Reconnaissance for Battalion Intelligence

Compiled and written by

CAPTAIN A. S. KEIGHLEY, M.C.
A.M.F.

Late G.S.O. 3, 4th Div. A.I.F.

Bde. Intelligence Officer, 3rd Bde. A.I.F.

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MAP READING

Military maps are topographical maps to which additional information of a military nature has been added.

The five essential features or divisions of a topographical map are:—

(a) **The title** showing the location of the country represented, when the map was made, who made it, etc.

(b) **The conventional signs,** by means of which various features such as roads, streams, towns, etc., are represented.

(c) **The pointers or arrows** by means of which the map can be properly oriented and directions determined.

(d) **The scale,** which shows relations between lengths or distances as they appear on the map and the actual distances on the ground.

(e) **The relief,** or the method of showing the shape, slope and height of the hills and valleys.

Most systems of projection, or methods adopted to show on a plane surface the meridians or parallels of the globe, require that the meridians at the top of the map be closer together than at the bottom for Northern Hemisphere and vice versa for Southern Hemisphere—such maps cannot be fitted exactly edge to edge so as to lie flat, but may be made to do so, by leaving a small space between the vertical edges.

In other cases the edges of the map are not based on latitude and longitude lines but are perfectly rectangular. Therefore the meridians and parallels shown will not be parallel to the edges of the map.

Index maps show a large section of country and outlines of sheets with names and numbers.

On most maps the name of adjoining sheet is given by small index map in margin. The date of issue for military maps is important—in war, maps are issued daily from aeroplane photographs.

Many have list of conventional signs.

On any map made a balance must be sought between clearness and legibility and the amount of detail that can be shown, bearing in mind the use to which the map has to be put.

Relief

Three methods—hachures, contours and shading.

The method adopted to show the Relief must indicate clearly three things:—

(1) The shape and size of hills;

(2) The slope;

(3) The height of ground.

The contour system does all these three with the highest accuracy of any method but it is harder to understand — more difficult to visualise what the ground looks like — but accuracy is essential and shading may be used in conjunction.

The hachure method is from 16th and 17th Century — short shade lines running down slopes showing direction water will flow — slope is indicated by the thickness and spacing of lines — i.e., a steep slope is shown by heavily inked lines close together. Lightly shaded portions are gentle slopes — level areas left without shading. Exact height of ground is shown on hachure maps by spot levels or height marked thus, "103," "153." Thus hills became known as "Hill 60" etc. In naming hills thus, however, locality must be given as other hills are also marked similar heights.

Hachure method common in European maps. "Carte de France." German, 1:100,000 and British Ordnance.

The Contour System

The contour system is used by most countries. A contour line marked means so many feet above zero level or datum—which is usually shore or sea level.

Contours are sometimes described as successive shore lines.

Contours alone will not give the exact height of a hill. These, in important cases, are shown on the map by points or spot levels such as 135. Where no spot level is given, say we want to estimate the height of a hill where the contour below the top is 130. We know it must be less than 140 for 130 is the highest shown so we can estimate 135.

Depressions and basins below the ground surface are shown by closed contours just like hill tops but every contour is not numbered. Therefore, when a contour shows a depression level, short lines are drawn on the inside of the "depression contour" (pointing down slope). A special hachure sign is also employed for cliffs, sand dunes, etc., shown by fine stippling.

The layer system shows relief: Cut the contours out on cardboard, of equal thickness corresponding to the V.I. Trace contours off map and then with blue carbon copying sheet trace on to cardboard, cut board to shape of contours and place one on top of each other, fastening on to a base—there you have a relief map—if covered with modelling clay it becomes a model.

Reading Contours

The relative position and curvature of contours affords clear evidence of the shape of the ground. The main conclusions which may be drawn from their shape and spacing are here considered. A comparison of the ground with a well-contoured map will suggest others. This subject must be studied with care, as he who cannot understand the evidence of contours will understand neither the map nor the country it represents.

An expert map reader will seldom consult contour numbers or spot heights for the general purpose of distinguishing hill from valley, because there is generally clear evidence of the slope of the ground in streams, lakes and ponds. A stream must be in a valley and a lake or pond in a depression. It is this simple fact that makes a study of the drainage the first step in the examination of any map.

Uniform, convex and concave slopes are represented as follows:

i. When the contours are evenly spaced the slope represented is uniform. (The slope of river and stream beds is generally uniform except near the source).

ii. When the spacing, reading from high to low, **decreases** the slope is convex. (The top slopes of hills are often, though not always, convex.)

iii. When the spacing, reading from high to low, **increases**, the slope is concave. (The bottom slopes of hills are generally concave).

Uniform and concave slopes viewed by an observer from above, are visible throughout; in other words, there are no concealed portions to form "dead ground," convex slopes, on the other hand, imply dead ground.

Contours drawn close to each other indicate a steep slope; the farther apart they are, the more level is the ground.

It is important to realise not only the capabilities, but also the limitations of contoured maps. A small-scale map has no room in which to show the number or the accurate shape of contours characteristic of a larger scale. If the V.I. is 50 feet (as on one-inch maps), features of real tactical importance (but of a lesser height than 50 feet) may not be shown. On quarter-inch maps the V.I. is generally 200 feet, and comparatively large features are not shown.

Horizontal Equivalent (usually written H.E.) — is the distance in plan between two adjacent contours.

Vertical Interval (usually written V.I.) — Is the difference in level between two adjacent contours.

Slopes and Gradients

The slope (rise or fall) of the ground between any two points may be expressed as an angle — e.g., 5 degrees — or as a gradient — e.g., 1/15. The slopes of roads and railways are usually expressed as gradients, or as a rise or fall of so many units in a given distance.

The gradient is the tangent of the angle of slope

$$\left(\frac{\text{V.I.}}{\text{H.E.}}\right)$$

and the relationship between slope V.I. and H.E. may be founded on the fact that the tangent of 1 degree is approximately 1/60th (or, when the slope is 1 degree the ground rises (or falls) one foot in a distance of sixty feet.

Thus a slope of 1/20 feet equals 3 degrees, i.e. — $\frac{60 \text{ feet}}{20 \text{ feet}}$

One word of caution must be added. The V.I. is usually expressed in feet and the H.E. is generally measured in yards, but the rules given above are only true when both are measured in the same unit.

Examples of Working in Slopes and Gradients

A certain M.T. Column, fully loaded, cannot climb gradients steeper than 1/5, and it is required to find from the map a practicable road from A to B.

A convenient road goes up a hill on which contours (V.I. of 50 feet) are, at the minimum, 100 yards (or 300 feet) apart. What is the gradient?

$$\text{The gradient} = \frac{V.I.}{H.E.} = \frac{50}{300} = \frac{1}{6}$$

and the road is therefore passable.

Direction

The direction of the north is given by an arrow or pointer. When parallels of latitude and longitude are shown by lines the latter are true meridian north and south lines. When no other information is given, it is safe to assume that the top of the map is north and the edges north and south lines. The compass needle rarely points to the north.

The divergence of the compass needle from the true north is the error known as declination — this is because of the magnetic attraction at the poles, and these poles do not coincide with the geographical poles. The compass needle points to the magnetic pole and the angle between true and magnetic varies according to time and place (magnetic variation).

In Paris in 1580 the declination was 9½ deg. E. of true—in 1810, 22½ deg. W. of true.

In America there is a curving line running south passing through the Great Lake district, leaving the coast in Southern California. At any point on this line, the declination is zero and the compass points to the true north, whereas at New York, east of this line, the compass points west of north and at San Francisco west of this line, "agonic line," it points east.

When using a map in the field, it is necessary to turn or orient the map till its sides point north and south, so that objects on the ground appear to you in the direction as shown on the map.

The direction of the north and south line or meridian on the ground can be determined by using the compass—release the needle and hold compass horizontal. Turn the box till the north end of the needle reads the declination, then a line through the zero of the scale of the box will be true north and south.

If a compass is not available, use a watch. In the Northern Hemisphere point hour hand at Sun. A line between hour hand and 12 noon gives South. In Southern Hemisphere point noon at Sun and a line between 12 and hour gives north.

The Polar Star and two pointers point north.

Southern Cross, prolong the greater axis four and a half times to obtain South.

Bearings

A bearing is the angle measured clockwise from a certain fixed line to any line in question. The fixed line may be the true north, grid north or magnetic north.

Definitions of True, Grid and Magnetic North

Before proceeding further, it is necessary to understand the meaning of the terms, true north, grid north and magnetic north.

1. **TRUE NORTH.**—True north means the direction of the north pole from the observer.

The north pole is a point, and the earth is a sphere. It is thus evident that the meridan of an observer in England, and that of another observer in, say, Finland, will not be parallel straight lines. They will converge inwards towards the pole, where they will meet.

ii. **GRID NORTH.**—Grid north is the direction in which the grid lines point towards the top of the map.

To be of value a grid must be rectangular. It is obvious that if the grid lines everywhere point to true north, the grid cannot be rectangular. It is usual to make one grid line coincide with a meridan. On this "standard" meridan the grid points to the true north. All other vertical grid lines are drawn parallel to it, and do not point to the true north, but in each case to a different and imaginary point called the grid north.

The angle between grid north and true north is known as "the angle of convergence," and it is evident that this angle increases the farther the grid departs from the standard meridan.

111. **MAGNETIC NORTH.**—Magnetic north is the direction in which the compass needle points (unaffected by any local attraction); i.e., the direction of the magnetic pole at any point. The magnetic north pole changes from year to year, and thus the magnetic variation, which is the angle between true north and magnetic north, varies from year to year as well as from place to place.

It should be noted here that (a) every ordinary compass has its own individual variation which will differ by a constant amount from the local magnetic variation, and (b) that compasses are affected by local attraction, such as a hill in which magnetic iron ore is to be found, guns, tanks, etc. Thus, before using a compass for accurate work, certain precautions must be taken.

To test the individual variation of the compass proceed as follows:—

1. Identify on the Map and Ground, the standpoint "A" and some distant object "B."
2. From map with protractor find Grid (or True) bearing of "B."
3. With compass, find compass bearing of "B."
4. From the Grid (or True) and Compass Bearings, find the compass variation.
5. Compare the compass variation with local magnetic variation.

   (a) If they coincide, the compass is correct.

(b) If different, the compass will have an individual variation of so many degrees East or West of Magnetic North.

Conversion of Bearings

The bearing of any object on a map may be expressed in one of three ways, i.e., with reference to the true north, grid north or magnetic north. On a gridded map all bearings must be given with reference to grid north, and not to true or magnetic north.

Gridded maps show in the margin the angle between grid north and magnetic north with an additional note stating the angle between the grid north and the true north for that sheet. This enables the user of a map to convert a bearing given with reference to magnetic or true north to grid north.

Supposing the variation of a compass in a particular locality to be 20 degrees West, a magnetic bearing of 20 degrees will give true North. Similarly, if the variation is 20 degrees East, a magnetic bearing of 340 deg. (360 minus 20) will give truth North. It will therefore be seen that when the variation is West it must be deducted from, and when the variation is East it must be added to the magnetic bearing in order to give the true bearing. It will also be seen that when grid North is west of true North the difference must be added to, and when the grid North is east of true North the difference must be subtracted from the true bearing to give the grid bearing. If these rules are followed, conversion presents no difficulty, but it is essential to draw a rough diagram to prevent errors of sign being introduced.

Scales

There are 63,360 inches to the mile.

Scales on maps in the U.K., India, Canada, and Australia are usually expressed in words showing relations between inches on the map and miles or yards on the ground—

$$\frac{1}{63{,}360} \text{ or 1 inch to 1 mile.}$$

The fraction in each case is called the Representative Fraction or R.F., and means one unit on the map (numerator) represents a certain number of miles on the ground (denominator).

To find the number of English miles to the inch in any map that has an R.F., divide the denominator of the R.F. by 63,360; this gives the number of miles to the inch.

Thus if the R.F. is $\frac{1}{15{,}840}$, then $\frac{15{,}840}{63{,}360} = .25$ miles on the ground to one inch on the map.

To find the number of inches to the mile then, reverse and divide 63,360 by the nominator of the R.F.

Thus if the R.F. is $\frac{1}{15{,}840}$, then $\frac{63{,}360}{15{,}840} = 4$ inches to the mile.

A scale should be about six inches long. The size depends on the object for which the scale is made Reconnaissance sketches of an area to explain a plan of attack or to show lines of advance, of a road or a river, or of a defensive or outpost position, are usually made to the scale of 1 to 4 inches to the mile.

Scale to show yards on a map, 4 inches to the mile $= \frac{1}{15{,}840}$. Say you want 2,000 yards, then $\frac{2{,}000 \times 36}{15{,}840}$ = 4.54 inches, length of scale required.

If you want to show yards on a map, two inches to the mile, or $\frac{1}{31,680}$ when the number of yards is 5,000

then $\frac{5,000 \times 36}{32,680}$ = 5.68 inches required.

(a) Scale 1 inch to mile $\frac{1}{63,360}$ six inches divide into six miles and one mile on left of scale into quarters, or 5.1 inches showing 9,000 yards divided into 1,000 yards.

(b) Scale 1 inch to 2 miles $\frac{1}{126,720}$ wanted scale for body of troops marching three miles per hour.

Scale of six inches equals 12 miles. Divide into four sections each equalling three miles or one hour's march. Subdivide left division into twelve parts each equalling 5 minutes march.

To construct a scale for paces on a map, one over 15,840 (four inches to the mile) six inches would show $1\frac{1}{2}$ miles or 2,640 yards. Assuming the pace to be equal to 30 inches, this would equal 3,168 paces, therefore you would take 3,000 paces as the length of the scale.

$\frac{3,000 \times 30}{15,840}$ = 5.68 inches, length of scale required.

MAP REFERENCES

The Modified British System

To describe any position or point on a map the numbered grid lines must be read, first from West to East and then from South to North, and the square in which the point is situated must be mentally further sub-divided into tenths on the grid lines in order to give a pin point accurate reference. Thus a point lying between, say West to East grid, 23-24 and South to North grid 10 and 11, in the centre of this square would be described by the following co-ordinates, 235105.

All points of reference are co-ordinated from the South-West corner of any map or square.

The 1 Inch to 1 Mile and Larger Scale Maps

The 10,000 yard squares are further subdivided into 100 squares of 1,000 yards each side; the sides of the 10,000 yard squares are thickened and the grid lines are numbered. The numbers appearing on any grid line denote, this time in 1,000 yard units, the distance of the grid line north or east of the point of reference. In the sheet margin, every grid is so numbered and to every tenth number is added, in smaller print, the figure required to convert the shortened coordinate into the full co-ordinate referred to the (false) origin of the grid system. A pin point reference can be given to the nearest tenth of a 1,000 yards.

Australian Military Maps

The Australian Military Survey is divided into zones, and again subdivided into squares with a number and a letter of the alphabet preceding and following the number—thus (1.56H.) 1.56 representing a large area of which 1,56H is a 24th part. These squares (1.56H) measure approximately 100,000 yards West to East and 120,000 yards South to North. The lettered square is again divided into sections which are numbered 1, 2, 3 and 4. Each of these sections measures approximately 50,000 yards West to East, and 60,000 yards South to North. Each of these numbered squares is again divided into two sheets, a North-east, North-west and a South-east, South-west and these are each given a name, e.g., "Singleton-Cessnock," "Broken Bay-Sydney." Thus we have a sheet covering, say, "Sydney," which is the South-east South-West portion of the No. 3 sheet of 156H, and this is the size of the map issued for general purposes and its scale is one inch to the mile. This map covers an area of ground 50,000 yards, approximately, West and East, and 30,000 yards, South and North. It is divided by rectangular grids, each marked with a number along the margin of the map and on the map face, every fifth grid west to east is numbered, and every fifth grid south to north is numbered, and every 10th grid running West and East and South and North is marked in heavy lines. The square within these heavy lines shows an area containing 100 squares each 1,000 yards by 1,000 yards.

At the top left-hand corner in the margin of the map is the name of the country, "Australia," and the scale, 1:63,360. In the centre is given the State (N.S.W.), and under that the name, e.g., "Sydney," which shows what part of the numbered sheet the map belongs to. In the right-hand corner will be found the main reference to the map as:—

South 156

H III. S.E. & S.W.

Thus we see we are dealing with the south portion of No. 3 sheet.

Pointers showing grid north and magnetic north and the variation of grid north and true north are shown on the map. On each corner, the distances North and East, or South and West from the point of grid origin are shown, e.g., 450,667 y.E, 830,203 y.N., and underneath these the bearing in degrees. Other figures in blue and yellow around the margin are for artillery use only. At the bottom of the map is given a chart showing how to give a pin point reference as explained before. The immediately adjacent sheets are shown in the margin and the adjacent sheets over a wide area are given in the index on the cover.

The scale shown on the map is a six inch scale divided into six miles, and a 9,000 yard scale measuring 5.1 inches, showing divisions of 1,000 yards with the secondaries down to 100 yards. The Vertical interval of the contours is also shown in feet, and along the bottom of the margin are shown the conventional signs used on the map. In giving a map reference on this scale, it can be given to within an area of 100 yards. For example, taking the Sydney Observatory as a point for reference, the grid map reference would be Sheet 1.56H III S.E. & S.W. or "Sydney" 207,168.

VISIBILITY

It is often of importance to discover from the map whether two points are mutually visible. On open ground where there are no trees, hedges, buildings, etc., one point is visible from another so long as the ground does not rise above the line which joins them. Thus, if the country between two points is level, slopes evenly, is concave, or lower than both of them, they will be intervisible. But, where a hill or a convex slope intervenes, one point will not be visible from the other.

Visibility problems can be answered by inspection of a contour map or sketch in most cases. But there may be a doubt. For example, a hill between two points may be higher than one of them, but if it does not rise above the line joining them they will still be intervisible. A quick method of finding whether this is so is as follows:—

To find whether two points A and C are intervisible draw a line joining them, and on that line note any point likely to interfere with the line of sight between A and C and estimate its height. Suppose there is a point B the height of which is 260 feet, and suppose the height of A is 300 feet, and that of C 200 feet. Measure up on the map the distances A to B and A to C, suppose A-B is 1,200 yards and A-C is 2,700 yards.

The slope A-B drops 40 feet in 1,200 yards or $\frac{1}{90}$.

The slope A-C drops 100 feet in 2,700 yards or $\frac{1}{81}$.

This shows that the slope A-C is steeper than slope A-B, and therefore B will obstruct the view.

Another method by simple proportion sum is as follows:—

Suppose distance A to D, 700 yarsd
A to E, 1,520 yards
Difference in height A and D, 50 feet.
Difference in height A and E, 75 feet.

The line of sight from A to E rises 75 feet in 1,520 yards. The amount it will rise in 700 yards is found by proportion to be 34.5 feet. It therefore passes 15 feet below the summit of D and E will not be visible from A.

Another method is by drawing a section. This however, requires time, but it has the advantage that dead ground is clearly shown.

The extent to which visibility problems can be solved from the map, depends on the size of the V.I. If the V.I. is small, the unrepresented ground features are small, and visibility can be determined with some accuracy, but if the V.I. is large the reverse is the case. The unrepresented ground features are large. Visibility therefore should seldom be assumed without inspection of the ground.

From the foregoing the following rules can be formulated:—

i. If the map or sketch shows two points on the opposite sides of a valley standing well above any intervening ground, these will be intervisible.

ii. If, between any two points, a feature is represented higher than both, the points will not be intervisible.

iii. If, between any two points, a feature is represented higher than one of the points, the points may, or may not, be intervisible.

iv. When a slope is shown by the map to be convex, two points thereon will not be intervisible.

v. When a slope is shown by the map to be concave, two points thereon will probably be intervisible.

vi. When ground is shown by the map to be level, the intervisibility of two points will depend entirely upon the absence or presence of such objects as houses or trees.

A visibility diagram showing points visible and invisible from an observation post can be drawn. To construct this, identify the observation post and a reference object on the map. Draw a line between these and mark it zero. Set off lines at 10 degrees interval radiating on either side of zero line. Study the features, mark on the map the objects and features which interfere with the view from the observer's position and shade these in. By this means a diagram showing no more than grid lines invisible areas and zero line can be drawn which suffice as a guide for use on any map of the same scale and copies can be taken from it.

SECTIONS

Section drawing is seldom necessary in practice. It is explained because under certain circumstances it may be a useful method of finding the extent of dead ground, or of ascertaining whether one point is visible from another point.

A section has been defined as "the outline of the intersection of the ground by a vertical plane"; a railway cutting affords a good illustration of a section. Another good illustration is a cottage loaf of bread cut in half from top to bottom, for the outline seen when one-half of the loaf is removed is a full-sized section of the loaf. A knowledge of the contours and of the V.I., enables us to draw a section of a hill which will present a fairly accurate picture of the slopes as they would appear if a cutting were made right through that hill.

It is drawn as follows:—

On the map draw any straight line through the portion of the hill of which a section is required. Mark on this line the points at which the contours intersect it. Then on another piece of paper, draw a horizontal line of equal length to represent the level of the lowest contour and mark on it the contour intersections. From each of these points draw a perpendicular line and mark on the right and the left of the uprights equidistant points representing the V.I. of the map. Through these points draw lines parallel to the lowest line and mark these lines corresponding to the heights of the contours they represent. Then draw your section ascending from the bottom to the top through the points where the perpendicular lines cut the horizontal lines.

SETTING A MAP AND FINDING A POSITION ON IT

To set or "orient" a map, lay it out to correspond with the ground directing the true north point on the map to the north. When this is done it will be seen that the features on the ground will be shown in the same direction as they are shown on the map. A map can be set by compass by taking the bearings of objects both on the ground and on the map.

Setting by Compass

Lay the compass open on the map and taking a line through the notch in the handle, through the centre axis of the compass, along the hair line to the notch in the tongue lay this over the magnetic north line on the map. Revolve the map and compass together until the needle pointing to magnetic north is on the same line as the magnetic north line on the map. The map is now set.

Supposing only true north is shown on the map, by using a protractor lay off the magnetic north from the true north and draw in a magnetic north line, then carry out the above method.

Setting by Objects

A map can be set on the ground without the use of a north point in the following manner:—

(a) If the position of the observer can be recognised on the map look for some distant object on the ground and identify this on the map. Then join the two points (the position of the observer and the distant object) by a straight line. Turn the map until this line coincides with the distant object. The map is then set.

(b) Supposing the position of the observer cannot be accurately placed on the map it may be possible by moving to one side or the other to find some spot in prolongation of a fence, row of trees, railway line or stream or some other feature shown on the map. It is possible that a distant church spire or water tower could be identified in a straight line on the map with some road corner or feature close to the observer. If the map is placed to coincide with this line, the map is set.

(c) The simplest way is to identify prominent features or objects on the map which can be seen from the observer's position and hold the map so that the directions between these objects on the ground and the map are parallel.

Finding Position on a Map

From the above examples it will be seen that the position of the observer is not actually fixed, but only a straight line on which it must lie. But having got so far, the map now being set, it is quite easy to determine with sufficient accuracy the position for map reading though not for sketching. The correct position can be determined from the detail on the map. First of all, get an approximate position in relation to the general prominent features such as a hill, road, river, buildings, etc. Once you have got the general locality you can work out your position exactly by the smaller objects. For instance, you can use cross roads, a bend in a stream or river, prominent building, a bay or a coastline feature, and when the map is set it is not difficult to find objects through which a straight line can be produced which will intersect and thus determine the required position.

Resection

It may happen occasionally that the country is so open, or the mapped detail so meagre, that position cannot be found from detail near by. In this case it is necessary either to move to some spot which can be identified, or to employ one or other of the methods of resection by compass.

The Method of Enlarging a Map

The general idea of enlarging by eye is to copy the detail shown inside a small figure (square, triangle, etc.) on the map into a similar but larger figure on the fresh paper.

To enlarge a portion of a map, say, of a scale $\frac{1}{63,360}$ to a scale $\frac{1}{15,840}$, the ratio of increase in the size of square required for this enlargement is easily found by proportion. $\frac{63,360}{15,840} = 4$ inches. This means that all four sides of the square of the original map have to be increased by this ratio, and to make it easier to copy in the detail, it is advisable to divide the squares on the original map into still smaller squares and to divide the squares on the enlargement into similar smaller divisions and copy by eye from one map to the other.

The one inch to the mile Ordnance Map is a scale useful for general purposes, but for operations in which very much more detail is required, a scale of $\frac{1}{15,840}$ (4 ins. to the mile), or even larger is requisite.

THE SERVICE PROTRACTOR

The following scales in British units are shown on the rectangular service protractor:—

On the Front—

	Primaries	Secondaries
1/50,000	1,000 metres	100 metres
1/25,000	500 metres	20 metres and 50 metres
1/250,000	1 mile	¼ mile 1,000 yards
1/250,000	5,000 yards	100 yards and 200 yards
1/50,000	1,000 yards	20 yds., 50 yds. and 100 yds.
1/25,000	500 yards	

On the Back—

1 inch to 1 mile	1,000 yards	100 yds; 25 yds.
¼ inch to 1 mile	4,000 yards	1,000 yards
¼ inch to 1 mile	1 mile	¼ mile
1/20,00	100 yards	20 yards
¼ inch to 1 mile	4,000 metres	1,000 metres
1 inch to 1 mile	1,000 metres	100 metres; 250 metres

The protractor has degree graduations along three edges of the face. The point from which the rays are drawn is marked by an arrow head on the fore edge. There are two sets of figures to these graduations. The outer reads from zero to 180 degrees, and the inner from 180 degrees to 360 degrees. All readings are clockwise, measured from north by east.

The angle marked by any graduation on the edge of the protractor is marked by a line joining the arrowhead to the graduation in question.

To plot any bearing from any point, lay a protractor with the zero edge along the line running parallel through this point, with the arrowhead on the point and the graduated edge to the right of it. Then any bearing can be marked off by drawing a line through the arrow point and degree shown on the graduated edge. To plot bearings between 180 degrees and 360 degrees reverse the protractor and proceed as before. It is not always necessary to draw a line north and south from the point from which bearings are plotted, because the meridan or grid lines on the map can be used for setting the protractor parallel to north and south.

On taking a bearing, it should be noted that the reverse bearing can be read at the same time.

THE PRISMATIC COMPASS

The service prismatic compass of the dry type, Mk. VIII, is enclosed in a brass box and has on the lid a window. There is a nail clip on the box to the left of the handle by which the compass can be opened.

The compass is a card beneath a glass cover, and the needle is fastened beneath the card. The card is of mother-of-pearl, blackened in the centre with an arrow painted with radium so as to be visible at night. The needle and its attached card are suspended on a pointed steel pivot which works on a jewelled boss. On the dial there are two graduations, both increasing when read clockwise, the inner figured inwards from zero, and the outer figured outwards from zero. Fastened to the inside of the box at the hinge is an index with a short vertical line. This is called the lubber line. There is a clamp screw on the right of the hinge, which, when slackened, enables the glass cover of the box to be rotated, and attached to the glass cover near the edge is a luminous radium index known as the direction mark and corresponding to it, cutting the milling on the cover casing, there is an index called a setting vane which marks off 5 degree graduations around the box. The compass card is motionless being held clear of the pivot. It can be released by pushing a stop away from the ring handle. This lifts the card and its boss off the steel pivot so that no damage is done when the boss is not in use, and this stop is automatically brought into action when the lid is closed.

There is a vertical hairline on the window, at the ends of which are two luminous strips for night sighting. There are two small holes drilled through these strips so that if the glass is broken, a horse hair or thread can be substituted. A tongue extends from the lid. Within the ring handle there is a small magnifying prism hinged to a slit in a shield screwed to the box. Tilt up the casing of this and an eye hole is revealed above which the prism casing is slotted. When the hair line is vertical, the edges of this sighting slot should be seen as parallel to it. For focussing with the magnifier it is necessary to draw up the prism.

Observing with the Compass

To make an observation with the prism, put the left thumb through the ring and the left forefinger underneath the box. The right forefinger should be on the tiny stud which is found to the left of the hinge. This regulates the spring which steadies the swing of the needle. The hair line must be vertical. Look through the sighting slot, keep it vertical with the object to be sighted and, at the same time, read the card. If the hand is steady the bearing can be read to a quarter of a degree.

For use at night, turn the glass cover until the setting vane is over the bearing on the outside graduation of the box, then screw and clamp the cover at this bearing and then direct the axis towards the object. It will then be seen that the direction mark and the arrowhead coincide. The compass is then set for night marching on this particular bearing.

To March to this Bearing at Night

The direction mark and arrowhead must coincide, and the movement must be made in the direction of the hair line and the luminous patches on the cover. You will then be marching on the bearing indicated by the setting vane. The rubber on the bottom of the cover is to prevent the compass from slipping.

Compass Errors

The compass is affected by the presence of iron, heavy guns, telegraph wires, barbed wires, dumps, tractors, iron huts, etc. All the surface disturbing elements can be avoided, but those underground cannot be detected except by an error in the compass, but when there is this slightest sign of disturbance, if the compass is shifted, unless there is some wide magnetic field, this difficulty can be got over. Every ordinary compass has its individual error and therefore all compass users should test their compass on true bearings such as trigonometry points. Bearings can be taken also by a circular protractor on a large scale map.

Night Marching

Night marching requires long practice and care. A slight knowledge of elementary astronomy is useful. The line of luminous patches in the lid fully extended will indicate the line of advance, but it is always wise to try and pick up from the compass bearing some point or object which can be seen in the dark to march on. When no object or star is available as guide, a white patch sewn on the back of a guide who will be sent forward by stages and halted when indistinguishable will simplify the correct movement on a bearing.

RECONNAISSANCE REPORT

The value of a report is enhanced if accompanied by a map, sketch, drawing or photograph. But these must only be used to make the subject matter clearer to the reader and to decrease the written word.

Before proceeding on a reconnaissance the best available map must be procured and in one's own territory all topographical information should be gathered from local council administrative maps, etc. A report should include details of the nature of all features which may affect operations, movements, supplies. Included in it should be seasonal weather effects, such as floods or droughts, and particular attention paid to the classification of all roads. From a geological point of view the nature of the soil and its conditions in wet periods, rocks and broken country which would make it difficult for aeroplane landing, places where water may be had by boring, deposits of stone or metal for road mending. Most of this information can be procured from the local inhabitants in advance. Maps are never perfect even where there are large scale maps a great deal of detail has to be added to bring them up-to-date and to make them of any value from a military point of view. Do not hesitate to make an enlargement of a given area, adding to it any detail or information relevant to the report to be prepared.

Drawings and Sketching

A panorama drawn from an observation post is of great value. It need not be an artistic drawing, but practice is necessary to obtain clarity. The following rules will aid:—

i. A considerable portion of time should be spent by studying the ground by eye and field glasses.

ii. The perspective must be taken into account. Objects far away appear to be smaller, and must be so represented on the drawing. Roads, railway lines, represented by parallel lines appear to meet at a vanishing point on the horizon.

iii. All buildings, trees, natural features should be drawn in outline only in order to convey the impression of shape. Any wooded areas may be slightly "hatched."

iv. Simplicity is the basis of a drawing and firm continuous lines must be used throughout.

Before commencing a drawing, decide how much is to be included. Military panoramas are, as a rule, limited to a 30 degrees of arc. If the service protractor is held horizontally eleven inohes from the eye, it covers an angle of approximately 25 degrees.

Framework

Draw a mean horizontal line along the horizon and through the centre draw a vertical line from the observer as the central axis of sight. Fix all outstanding points and prominent objects in their correct positions. By using the protractor and the graduated edges, it can be observed what graduation coincides with the object to be drawn and the position of these can be marked on the paper by laying the protractor on the drawing and marking them off. Vertical distances can be obtained by using the protractor with the long side vertical. Thus any point can be accurately plotted on the drawing. When this is done, other detail can be fitted in by eye or further measurement. Sketch the whole in, lightly at first, then thoroughly examine the sketch and compare it with the area it represents seeing that no detail is omitted, then complete the sketch by drawing in with further lines, thick in the foreground and thinner as they recede into the distance. All outstanding points should be marked by a vertical line running to the top of the drawing, their map location given, their description and their bearing written in block letters at the top of the vertical line. When the drawing is complete, the following information must be added, in addition to above:—

i. The position of the observation post by map reference, the bearing of the centre of the sketch from the observation post.

ii. The name, rank, and regiment of the observer.

iii. The date, the time and the weather conditions.

iv. Any indication of our own or enemy troops in the usual conventional sign, blue or red.

Small Sketches

Small sketches can be used to illustrate details, such as bridges, fords, watering points, road detours, etc. Where there are difficult turns through built-up areas, a small sketch with map reference and description showing an arrowhead for change of direction will be of great value. These little sketches must be prepared in the same way as the panorama—main details first and in correct position distance.

Roads

Most information required about roads can be shown on a map and roads should be classifid with regard to width, surface and foundation. An A Class road, wide enough to take two streams of traffic.

B Class road wide enough to take one stream of traffic with an occasional vehicle passing in the stream. C Class road only wide enough for one stream of traffic.

These A, B and C Class roads should again be divided into different categories.

A No. 1 road capable of taking three ton lorries, heavy guns, etc.
No. 2 road capable of taking light cars and one ton lorries.
No. 3 road fit only for horse transport.
No. 4 notfit for any vehicles.

Thus we have a road described as A 1, 2, 3 or 4, etc. The surface of a road deteriorates in wet weather, therefore classify this. Also mention the type of metalling employed and what wearing it will stand up to, also mention where the nearest supply of road metal for mending purposes is available.

Military Bridges

i. Light Bridges (a) Foot Bridges, Inf. in single file;
(b) Pack bridges, Inf. in file pack animals, etc.

ii. Medium Bridge. Inf. in column, motor cars, armoured cars, light and medium artillery, 3-ton lorries and all M.T. up to 5½ tons axle load, also track vehicles to 8 tons, track not to exceed 8 foot 9 inches.

iii. Heavy Bridges. Heavy artillery, tractors, M.T. to 16 tons axle load tanks up to 18 tons.

iv. Superheavy Bridges. Axle loads and tanks in excess of above.

A guard should be posted to control traffic and check unauthorised weights. Notices should be posted showing traffic allowed. Traffic over bridge generally slow.

Fords

The following are the fordable depths:—

Cavalry—4 feet.
Infantry—3 feet.
Tanks—4 feet.
Light Artillery—2 feet 6 inches.
Dragons—2 feet 6 inches.
Lorries—2 feet.
Motor Cars—1 foot 6 inches.
Motor cycles—1 foot.

Good bottoms are essential for heavy traffic. Sandy bottoms get stirred up and depth increases. In the straight part of a river the depth is uniform, generally greater at a concave bank and less at a convex bank and when a river is not fordable straight across, a passable slanting course can often be found between two bends.

All fords should be clearly marked, pickets should be driven in above and below a ford, their heads connected by strong rope and the marks on the pickets should show three and four feet above the bottom to mark the rise of the water.

The velocity of a river can be found by throwing a piece of wood well out into the stream and measuring—and timing it over a given number of feet. The mean velocity equals 4-5ths of the surface velocity, and 7/8ths of the mean velocity in feet per second equals the number of miles per hour.

To get the yield of a stream select some 15 yards of fairly uniform channel, take the breadth and average depth in feet at several places, get the surface velocity as shown above, then multiply the mean velocity by sectional area, this will give yield per second in cubic feet.

One cubic foot equals six and a quarter gallons and one gallon weighs 10 lbs.

Daily average man, drinking and cooking 1 gallon.

In a standing camp, average for man 5 gallons, for horse or camel 10 gallons.

RANGE CARDS

Attack

i. Ranges to be taken in direct line of advance.

ii. Draw parallel lines and fill in starting point and objective.

iii. Take range to objective and write in right-hand column, select some object half-way to objective and enter range in right-hand column.

iv. Select and take ranges to other intermediate objects, those easily recognised when reached and which appear to be near probable fire positions.

v. Simple subtraction will give you range for each successive object to objective. Enter these in left-hand column and strike out right-hand column.

Yards		Yards
0	Objective (described)	1,700
100	Small wood	1,600
700	Ruined Farm	1,000
900	Mound with bush	800
1,300	Line of poplars	400
1,700	Starting point (described)	0

Defence

i. Mark off on card positions from which range is taken.

ii. Describe position accurately.

iii. Select an unmistakable object and draw a thick setting ray to it.

iv. Draw these semi-circles representing 600, 1,000, 1,500 yards respectively. This can be conveniently drawn with a circular protractor.

vi. Select objects to range on, e.g., positions which enemy may occupy or have to pass, obstacles, bridges, gaps in fences, etc.

vi. Keeping card on setting ray, draw rays to show direction of objects and of lengths corresponding to distances.

vii. Write short description of each object in block lettering or draw signs.

viii. Write distance to each object against description.

N.B.: Avoid drawing too many rays which are apt to confuse and where possible, make one ray do for more than one object.

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