MAPWORK AND PRACTICAL GEOGRAPHY

BY GOTT

AN INTRODUCTION TO

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BY

JOHN BYGOTT, M.A., B.Sc. (Oxon.)

Sixth Form Master, Humberstone Foundation School, Old Clee, Grimsby
Sometime University Scholar and Research Student in Geography in the University of Oxford. Oxford Diploma in the History, Theory and Practice of Education

Author of "Eastern England," etc.
Contributor to "Great Britain"

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PREFACE

This book has been designed to provide an introductory course in map reading and practical geography suitable for use in the upper forms of schools and in first year University classes. Care has therefore been taken to include all that is required in the subject for the various Higher School Certificate and University Intermediate examinations. The first ten chapters, especially those dealing with Ordnance and Weather Maps, contain much material suitable for School Certificate purposes.

The scope of the book will be apparent from the table of contents. The chapters have been so arranged that matter required in connection with the various examinations may be easily referred to. Thus Part I. directly covers the London University Intermediate Arts and Science syllabus in Mapwork. Part II. first gives some elementary aspects of surveying relative to map-making, and then in Chapter XVIII. deals with the interpretation of Geological maps as an aid to the study of topographical maps. Thus Part II. will serve as an introduction to the knowledge of surveying methods and uses of instruments required for most degree examinations in Geography.

A notable feature is the inclusion of portions of actual Ordnance Survey maps. These, together with the notes provided, should prove invaluable to the student. The weather map is also dealt with in great detail, and many typical examples are reproduced and discussed.

The problem of map-making is approached in a clear manner, so that students will realise how survey work gives the data for the map, and why particular projections are selected for particular purposes. Simple graphical methods for constructing important projections are carefully explained.

Many useful questions and exercises have been included at the end of the book. These have been carefully selected and grouped into sections, at the head of which reference is made to chapters dealing with the subject of such sections. Many of the mapwork exercises are actual questions set at various Cambridge School Certificate and Higher School Certificate examinations, and for permission to include these thanks are due to the Local Examinations Syndicate of the University of Cambridge. They form excellent groundwork for map analysis exercises set in London Intermediate and similar examinations. Many are based on Ordnance Maps, and are more concrete than "manufactured" examples. Numerous original questions are set on the Ordnance Maps included in this book, and most of them can be applied to other Ordnance Maps. Some tolerably advanced exercises are given in connection with Part II. They are mainly designed to emphasise the application of surveying methods to mapwork.

Thanks are also tendered to the Directors of the Ordnance Survey, the Geological Survey, and the Meteorological Office, as well as to the Controller of H.M. Stationery Office, for permission to reproduce certain maps and diagrams, etc., and to Messrs. J. H. Steward, Ltd., for the loan of blocks for Figs. 86, 87, 88, 96, 97, 106, 110, 114, and 115. Acknowledgement is made to Messrs. George Routledge, Ltd., for permission to use some diagrams from the writer's *Eastern England*. In the text specific reference is made to such diagrams and to those reproduced by permission of the various authorities noted above.

Professor A. G. Ogilvie of Edinburgh University, Professor Kenneth Mason of Oxford University, Mr. J. A. Steers, Dean of St. Catharine's College, Cambridge, have read proofs and made valuable suggestions concerning chapters devoted to subjects in which they are specially interested. Dr. R. E. Dickinson of University College, London, has helped with useful suggestions. To all these and to Mr. S. L. Boot, who kindly checked the mathematical calculations, the author expresses his deep gratitude.

J. B.

INTRODUCTION TO

MAPWORK AND PRACTICAL GEOGRAPHY

PART I

CHAPTER I

OUR CONCEPTION OF MAPWORK AND OF PRACTICAL GEOGRAPHY RELATIVE TO MAPWORK. TYPES OF MAPS

1. INTRODUCTORY

The term "mapwork" may seem rather vague and generalised, but it is usually taken to comprise the study of various types of map, and consideration of the methods and principles underlying map construction.

We shall assume that the map is before us, and that in an elementary study of maps we are mainly concerned with an attempt to analyse it and to explain what it is intended to depict. It is with such aspect of mapwork that the earlier chapters of this book are concerned. Later chapters will deal with some aspects of map construction, including elements of the field-work on which maps, particularly large-scale maps, are based. In some respects this order may seem illogical. It might seem more logical at the outset to ascertain how a map has been made, or at any rate to link the details of construction with description and analysis. This is not expedient, because it is possible to use a map without knowing how it has been made, but such knowledge adds to the interest of map study and is required in more advanced examinations. Some examination syllabuses require merely study of certain maps, with no knowledge of the surveying methods necessary in the construction.

The second part of the book is concerned with certain aspects of map construction, which, when desired, can easily be correlated with earlier chapters. For instance, methods of contouring (Chapter XVII.) can readily be correlated with the study of contours on a large-scale map (Chapter IV.). In this book the term "practical geography" includes surveying and other details of map construction. It includes what is sometimes known as the "cartographical and diagrammatic representation of geographical data," in other words, the preparation of distributional maps and graphs founded on statistics illustrating some aspect of geography, such as climate, trade, crops, stock, or population (Chapter VIII.).

2. TYPES OF MAPS

It is desirable to explain certain terms connected with maps. **Cartography** is the science of map construction, and cartographical representation of statistical data means the representation on a map of facts shown by the statistics.

CADASTRAL MAPS.—The largest scale maps are generally known as **Cadastral maps.*** They show such detail as the boundaries of fields, individual buildings, etc., and are useful for purposes of taxation or to define property in legal documents.

TOPOGRAPHICAL AND ATLAS MAPS.—**Topographical maps** are large-scale maps founded on actual surveys, and show considerable detail of natural and man-made features. They are not on so large a scale as cadastral maps, and do not show detailed property boundaries. **Atlas maps** are on a smaller scale, and generally show details condensed and generalised from topographical maps. Scale (see Chapter II.) represents the ratio of distances on the map compared with the same distances in actual country. A scale of six inches to the mile means that six inches on the map represent a distance of one mile in the real country. A scale of 1 : 1,000,000 means that any distance on the map is one-millionth of the same distance on the ground. Maps on a smaller scale than 1 : 250,000 are not regarded as topographical maps. Maps on scales smaller than 1 : 1,000,000 are often termed atlas maps. (See Chapter XIV.).

ORDNANCE MAPS.—This is the name applied to British topographical maps produced by the Ordnance Survey, which is manned largely by Royal Engineers, but is under the Ministry of Agriculture and Fisheries. Its Director is always a distinguished officer of the Royal Engineers. Ordnance maps were first made in the eighteenth century, and were based on surveys by Engineer officers, being intended for military purposes, such as defence against invasion. Their use to-day is largely by civilians, and they are essentially road maps. Most European countries, the United States of America, and some of the British possessions have their own topographical maps.

In a study of topographical maps it is necessary to examine the methods of representing relief and drainage, and thus to obtain some idea of the physical features. Knowledge of the various methods of representing relief and ability

* From a French word *cadastre*, meaning a detailed register of territorial property.

to visualise a three dimension picture of what they represent is necessary (see Chapter IV.). Especially important is ability to read **contours,** namely, lines on the map made up of all points which in the actual country are the same height above sea-level. A thorough grounding in some of the elementary principles of physical geography is indispensable if full advantage is to be derived from analysis of physical features shown on the topographical map. A chapter (VI.) endeavours to explain a few points connected with physical features such as stream valleys. Various symbols known as **conventional signs** are used on topographical maps to represent natural features such as marshes and cliffs, man-made features such as roads, railways, buildings. It is necessary to know them and to explain their presence, which can often be done by a consideration of the influence of physical features. Conventional signs are dealt with in Chapter IV., and their application is often apparent in the analyses of typical Ordnance maps (Chapter VII.). Much of the study of topographical maps should be devoted to interpretation of land forms and their influence on human geography, such as the distribution and character of settlements, and the development of communications.

Weather and Climate Maps.—Each day **Weather maps** are prepared for that day by the Meteorological Office in London from data founded on observations made at various observing stations. They deal mainly with temperature, pressure, winds, and rainfall, and in addition to showing the general weather conditions of the British Isles and adjacent regions at a specified time, form the basis of a weather forecast for the succeeding twenty-four hours. Various symbols (see page 95) are given on each weather map to indicate certain aspects of weather. Study of weather maps includes ability to read them and to describe the current weather conditions, as well as to suggest likely developments in the near future. Weather maps dealing with their own local conditions are issued by the larger European countries, the United States of America, Canada, Australia, etc. If a few specimens of any such maps can be obtained, much benefit will result from their study and comparison with the British maps.

Weather maps deal with conditions at a specified instant of time, **Climate maps** with the sum total of weather conditions spread over a longer period, for instance, a month or a year. The data for weather maps are absolute, that is, conditions which were actually observed at the time in question. Climatic data are generally averages for a considerable number of years or months as the case may be. A map showing January temperatures would be based on the average figures for the Januaries of a number of years. A map showing mean annual rainfall would be based on the average rainfall of many years. A weather map usually shows the various elements of weather on the same map, for instance, temperature, pressure, winds, rainfall. A climatic map is more specialised, that is, there are generally separate maps for temperature, pressure, rainfall, etc. Given a set of such maps for January and July, usually (in the Northern Hemisphere) the coldest and hottest months, or better still, for January, July, October, and April, representative of each season, it is possible to build up a generalised description of the climate of a region. Weather may be compared with the news in a daily newspaper, climate with the summary of a year's events.

Distributional Maps.—Maps which, with the aid of certain symbols or shading schemes, show the distribution of crops, stock, or people in a given area are known as **Distributional maps.** Such maps dealing with crops, stock, or minerals, are sometimes termed **Commodity maps.** The distribution may show actual figures, generally expressed in round numbers, or may show numbers of stock or people per square mile or per 1,000 acres, or percentage of area under any specified crop. In Chapter VIII. the various methods of making distributional maps, with their respective advantages and disadvantages, are discussed.

Geological Maps.—Some maps show the distribution of different rocks, usually in combination with contours, so that they guide us in interpreting physical features and in tracing their evolution: such maps are called **Geological maps.** They are useful aids in the study of physical geography. Chapter XVIII. is a very elementary guide to the reading of some of the more common features of such maps. Geological maps of newly developed colonies are very important as guides to mineral wealth and soils. Government geologists, on whose surveys such maps are based, perform very valuable work, especially where mineral deposits or artesian water may make all the difference between a district being developed and settled or left derelict. Geological maps should be made on the basis of topographical maps. The geological data of such maps must be inserted upon a previously constructed topographical map.

The Land Utilisation Map.—An interesting adaptation has recently been made of the Ordnance Survey map. Some sheets have been issued to show the cartographical results of a Land Utilisation Survey directed by Dr. Dudley Stamp, the object of the Survey, in the words of its Director, being "to make a complete record over the whole of Britain of the uses to which the land is put at the present time."

The basis of the special **Land Utilisation map** is the one-inch map (Popular Edition) on which additional information is printed in six colours. A distinctive letter symbol is used with each colour. Dark green (F) is used for forest and woodland; light green (M) for permanent grass and meadow; brown (A) for arable land; yellow (H) for heath, moorland, commons, and rough pasture; purple (G) for allotments, gardens, and orchards; red (W) for land of no agricultural value. The method is easy to follow, and the ordinary details of the map can be read quite easily, though the added colour tends to obscure the relief features. These can, however, be read. Two of these new maps are the One-Inch Sheet No. 114, Windsor, covering the region south-west of London, and Sheet No. 142, Isle of Wight, including also part of the New Forest and Portsmouth. They are examples of two contrasted areas, the one typically urban and suburban, the other largely rural.

The Land Utilisation map, as well as being of interest to contemporary geographers, should not be without historical value subsequently, in the same way as the Agricultural Surveys of Arthur Young give a picture of the agriculture of certain British counties at the end of the eighteenth century. His surveys were more generalised and were descriptions of farming methods seen during journeys rather than detailed scientific surveys of all the land.

THE INTERNATIONAL MAP, 1 : 1,000,000.—An important map is the **International map,** which, with the co-operation of various countries, was designed to produce a uniform map of the World, divided into sheets uniform in scale, size, shape, and style of drawing. The map was suggested at an International Geographical Congress as far back as 1891, but little progress was made until nearly twenty years later (1909), when, at the invitation of the British Government, a committee representing the governments of various countries met in London and formulated plans for a World map. The various governments accepted the recommendations of this Committee, and though the War of 1914–18 interrupted the scheme, some progress has been made with the map.

As regards every detail, the recommendations have not been uniformly observed in the sheets published, but in principle the map can be termed international. The sheets are based as far as possible on official surveys. Relief is supposed to be shown by a uniform scheme of colour shading, and there is a recognised system of conventional signs, and style of printing for various features. The scale of 1: 1,000,000 (1/M) is intermediate between that of large topographical maps and the scales usually adopted in atlases. A single sheet will suffice for all except the largest countries. Adjacent sheets can be made to fit when they border each other on their east and west and north and south margins. If sheets such as those named for Edinburgh and Paris are studied, it will be seen what a large extent of country can be shown with reasonable clarity.

Chapter IV. of Hinks' *Maps and Survey* (3rd edition, 1933) has a helpful description and criticism of the International map.

3. MAP MAKING AND MAP READING

All maps are representations on a plane surface of some part of the earth, which for comparative purposes is a sphere, though geometrically it is not a perfect sphere, being slightly flattened at the extremities of its axis. On globes which represent the earth, distances and the relative position of places are reckoned with respect to certain lines known as parallels of latitude and meridians of longitude. (See Chapter XI. for explanation of latitude and longitude.) On the globe, such lines are circles, but they cannot be exactly copied on the plane surface. With certain reservations, it is possible to project them on to a plane surface, and a network known as a **graticule** or **projection** is the result. Such network is the basis of properly drawn maps, but there are many types of network, some of the most important of which will be treated in later chapters (Chapters XI., XII., XIII.).

The most important problems of map making are:—

(1) Selection of a suitable scale, which determines the size of a country on the map compared with its real size.

(2) Choice and construction of a projection, considerations which govern the representation of the outline shape of a country.

(3) Representation of relief.

(4) Data for the map when the three preceding essentials have been determined.

The features of the map referred to under the last heading may concern the course of rivers, sites of fords and bridges, direction of roads and in undeveloped countries of primitive routes, and sites of human settlement. Such data are obtained from surveys made roughly by explorers in an undeveloped country, or by more carefully conducted and more elaborate surveys by trained surveyors, who are usually government servants. In subsequent pages (Chapters XIV.–XVII.), methods of survey will be described from the geographer's point of view, so as to make clear how the material of our maps has been obtained. These methods concern the topographical map, which is the skeleton of distributional and similar maps, the data of which must be derived from reliable statistics.

Given the map, a geographer needs systematic training to enable him to get the best out of it. This particularly applies to topographical maps, though, without training and thought, it is impossible to derive full benefit from distributional, commodity, weather, or other types of what might be termed the specialised map. Suggestions will be given for obtaining the best results from a study of such maps (Chapters IV–VII.).

To-day the best school atlases, despite their limitations of space and the necessity of keeping the price within a reasonable limit, are compiled on logical and scientific lines. Maps of the world showing relief, vegetation, climatic data, or ocean currents, ought to be drawn on the most suitable projection, and though sometimes improvement could be suggested, a good modern atlas usually shows wise choice of projections. The continents and the larger countries often have a physical map and a political map on opposite pages, drawn on the same graticule and scale, so that the political map can be read in the light of physical factors. Where two such maps are not deemed possible, boundaries, routes, railways, and other political details are usually shown on a colour-layered relief map, and if some overcrowding does result, such a map is better than the purely political one. Some atlases give distributional maps, sometimes of crops or natural vegetation, of occupations or mineral deposits, but such maps are not always based on quantitative statistical data and are too generalised to be anything more than a broad guide as to the location of, say, temperate grassland (often largely under cultivated crops), or the rice-lands or rubber plantations of the tropical zone.

The reader, after working through this book, will find it a good exercise to take his atlas and to consider how far its maps are helpful for the purpose for which they are intended.

CHAPTER II

SCALES: THEIR MEANING, USE, AND CONSTRUCTION

1. THE MEANING OF SCALE

Scale has the meaning of a ratio. It signifies the proportion which a length on the map bears to actual distance on the ground. To speak of the scale of one inch to a mile means that if we measure one inch as the distance between two churches shown on the map, this distance would be a mile in the actual country.

If the earth were perfectly flat, such a definition would apply without any qualification. The earth, however, is not flat. On a small globe try to paste a tiny piece of paper to cover, say, Denmark. It would probably not pucker and would remain flat. Now try to cover Europe or the Americas with a larger piece of paper. This would show wrinkles and creases, and might require folding to make it fit on the globe. Scale on the larger paper would not correspond with that on the part of the globe we attempt to cover with it. Hence we must apply our definition to short distances only, because on different parts of a fairly large map, the scale may vary somewhat. It is important that the distance on the map should correspond in direction with what is assumed to be the similar direction on the earth.

It is not possible that the scale of every map should be correct in all directions. Some projections, however, give correct scale in certain directions, as along all or particular parallels and meridians. On other parts of the map the scale may not be true.

2. USE OF SCALES

It is essential that on any plan or map there should be some indication of the scale in order that distances may be easily calculated. There are various ways of indicating scale. In British maps the scale is indicated by one of two common methods.

(1) By direct statement of so many inches to a mile or so many miles to the inch.

(2) By use of a fraction whose numerator, 1, indicates the length on the map, and whose denominator indicates the length in the actual country. Thus the fraction $\frac{1}{63360}$, sometimes written 1 : 63,360, indicates the scale of one inch to a mile. There are 63,360 inches in a mile, and the fraction signifies that one inch on the map represents 63,360 inches in the real country. Such a fraction is called the **Representative Fraction.** This method is very useful where a map may be consulted by people outside the country for which it is primarily intended. A Frenchman unfamiliar with English measures might not be very confident in calculating distances from a map which was labelled with a scale of six inches to a mile. But tell him that the scale of this map is $\frac{1}{10560}$ and he can use it readily, because this method is employed for his own country's maps. He would not think in English measure, but in metres, with the decimal notation to which he is accustomed. Thus, $\frac{1}{10560}$ to a Frenchman would mean 1 cm. to 10,560 cm., etc.

The following simple rules are useful:—

(1) *Given the Representative Fraction, to find (a) the number of inches to the mile, (b) the number of miles to an inch.*

(*a*) Divide 63,360 by the denominator of the fraction,

e.g. if R.F. is $\frac{1}{10000}$, then $\frac{63360}{10000} = 6{\cdot}336$ (6·34 approx.) inches to 1 mile.

(*b*) Divide the denominator of the fraction by 63,360,

e.g. if R.F. is $\frac{1}{316800}$, then $\frac{316800}{63360} = 5$ miles to 1 inch.

(2) *Given the number of miles to the inch, to find the Representative Fraction.*

Multiply 63,360 by the number of miles to the inch in the given scale, and you will have the denominator of the R.F., *e.g.* 4 miles to the inch

$$= 1 : 63{,}360 \times 4 = \frac{1}{253440} = \text{R.F.}$$

(3) *Given the number of inches to the mile, to find the Representative Fraction.*

Divide 63,360 by the number of inches to the mile in the scale, and you will have the denominator of the R.F.

E.g. If the scale is 4 inches to the mile, denominator of R.F. is

$$\frac{63360}{4} = 15{,}840, \text{ and R.F. is } \frac{1}{15840}.$$

It is convenient to note the following tables:—

R.F. FROM SCALE.

Scale-Inches to the Mile.	R.F.
$\frac{1}{4}$	$\frac{1}{253440}$
$\frac{1}{2}$	$\frac{1}{126720}$
1	$\frac{1}{63360}$
6	$\frac{1}{10560}$

SCALE FROM R.F.

R.F.	Scale-Inches to the Mile.
$\frac{1}{10000}$	6·34 (approx.)
$\frac{1}{50000}$	1·27

R.F.	Scale-Miles to the Inch.
$\frac{1}{100000}$	1·58
$\frac{1}{250000}$	3·95
$\frac{1}{500000}$	7·89

3. PLAIN SCALES

On maps, in addition to the statement of scale or indication of the Representative Fraction it is convenient to give what is known as a **plain or linear scale.** Thsi is merely a line conveniently subdivided so that distances on the map can readily be calculated from it with the aid of a compass or divider. A plain scale should be long enough for measurements to be reckoned from it easily, and it should represent a convenient round number of the unit selected so that subdivision is facilitated.

EXAMPLES

1. *Construct a plain scale to show yards on a scale of 5 in. to 1 ml.* (See Fig. 1.) Work out the denominator of the R.F. according to rule on page 9.

$$1 : \frac{63360}{5} = \frac{1}{12672}.$$

As unit is the yard, the scale will be best worked out to show the primary divisions as hundreds of yards, and the secondary divisions as 25 yd.

N.B.—The secondary divisions are got by subdividing the first primary division which is on the left-hand side of the scale.

A convenient length for a scale is usually 5 or 6 in.

5 in. would represent 1,760 yd., and 6 in. would represent 2,112 yd., so that a good length would be to show 2,000 yd. for the primary divisions and 100 yd. for the secondary, altogether 2,100 yd.

It is a simple proportion sum. If 5 in. represent 1,760 yd., how many inches represent 2,100 yd.?

i.e. $\frac{2100 \times 5}{1760} = 5{\cdot}96$ in.

Draw a line AB, 5·96 in. long, and divide it into 21 equal parts, each of which will represent 100 yd. Subdivide the left-hand 100 into 4 equal parts, each to show 25 yd. The method is as follows:—

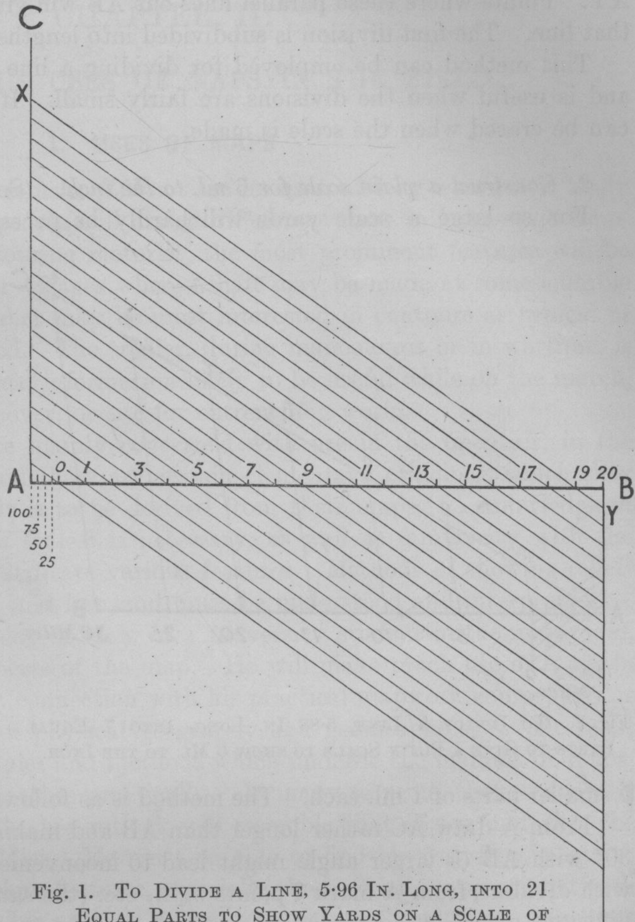

Fig. 1. To Divide a Line, 5·96 In. Long, into 21 Equal Parts to Show Yards on a Scale of 5 In. to 1 Ml.

With set-square at A and B draw perpendiculars AC, BD respectively above and below AB. Along AC and BD, from A and B, mark off 20 (*i.e.* one less than the number of divisions required on AB) points any equal distance apart. Join the point X on AC to Y on BD and join the other points to give lines parallel to XY. Points where these parallel lines cut AB will give the required divisions of that line. The first division is subdivided into lengths representing 25 yd.

This method can be employed for dividing a line into any number of parts, and is useful when the divisions are fairly small. If desired the diagonal lines can be erased when the scale is made.

2. *Construct a plain scale for* 6 *ml. to the inch.* (See Fig. 2.)

For so large a scale yards will hardly be necessary, so take miles as the unit. For the primary divisions take 5 ml.

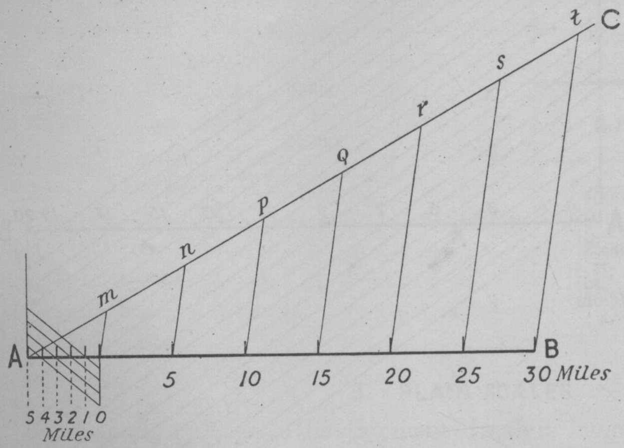

Fig. 2. To Divide a Line, 5·83 In. Long, into 7 Equal Parts to Give a Plain Scale to show 6 Ml. to the Inch.

By the given scale 5 in. represents 30 ml., giving six primaries. Take another 5 ml. to divide amongst the secondaries.

If 5 in. represent 30 ml., we must determine how many inches represent $30 + 5 = 35$ ml.,

$$i.e. \ \frac{35 \times 5}{30} = 5{\cdot}83 \text{ in.}$$

Draw a line AB, 5·83 in. long, divide it into seven parts, and subdivide the left-hand side part into 5 smaller parts of 1 ml. each. The method is as follows:—

From A draw AC rather longer than AB and making an angle not more than 30° with AB (a larger angle might lead to inconvenience in drawing). On AC, with dividers, from A mark 7 points *m*, *n*, etc. (the same number as the required divisions of AB) at equal distances, which may be approximately $\frac{1}{7}$ of AB. Join *t*, the last point, to B, and from the other points draw lines parallel to *t*B. These parallel lines cut AB and give the required divisions.

The first division can be subdivided into 5 equal parts by the method given on page 11. (Note that the method of Fig. 2 is suitable when there are few divisions.)

CHAPTER III

THE VARIOUS USES OF MAPS IN THE FIELD

1. USES OF MAPS

Given a map, it is well to ask: " What are its uses, and by whom is it likely to be used ? " Different people will assign different values to large-scale topographical maps. To the touring motorist, the most prominent features will be the roads and the towns or villages where a halt may be made at some suitable hotel. The mountain climber may be most interested in contours as typical of the heights to be conquered. The soldier, during manoeuvres or in wartime, is concerned with topographical information likely to be useful while on the march, or as a guide to bivouac, cover, or site for entrenching work.

Such users of maps are mainly concerned with use in the open air, in the actual country mapped, and there are certain elementary principles which they must observe if full benefit is to be derived from their maps. A knowledge of the use and application of scales[1] is necessary, as well as familiarity with the conventional signs[2] which indicate various features. Methods of showing relief[3] or difference between high and low land must be understood and interpreted.

From the academic point of view of a university student in the map-room, there are several other aspects of the map. He will make much use of maps in outdoor excursion work, in connection with his practical mapwork course, and as an aid to realistic study of physical geography and geomorphology. He must be familiar with the principles and methods which underlie the making of maps, and he must be able to use them practically. In many respects, though adapted to his own particular needs, his outlook will resemble that of the motorist, the walking tourist, or the soldier. He must be able to find his way from place to place, and to recognise various features, especially those which are associated with physical geography. But his outlook is based on deeper foundations than that of the mere user of maps. He must be so familiar with maps and what they signify that, in the map-room or study, a topographical relief map will enable him to visualise the actual country depicted on the map.

[1] See page 8. [2] See page 24. [3] See page 19.