

The Geographical Journal, Vol.22, no.5, November 1903, pp.576-577

Cheap Ordnance Survey Maps for Teaching Purposes.

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May I through your columns call the attention of your readers to an important concession which has recently been made to schools by the Board of Agriculture? Most teachers know how necessary Ordnance Survey maps are for sound class teaching in local geography, but the price has hitherto been prohibitive. In response to memorials from various sources, the Board of Agriculture has now issued instructions that special editions of the one-inch outline sheets be supplied to educational authorities at the following prices: 200 copies, £1 5s.; 500 copies, £2; 1000 copies, £3; 5000 copies, £12. For larger numbers the estimated price would be £2 per 1000 copies. The only stipulation made is that on no account are the maps to be sold. It is universally agreed that all sound geographical teaching must begin in a study of the home region, and it is therefore to be hoped that most teachers will avail themselves of the facilities so generously granted, either individually or by making application through the local education authority.

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The Geographical Journal, Vol.25, no.6, June 1905, pp.633-647

THE IDEAL TOPOGRAPHICAL MAP.*

By Major C. F. CLOSE, C.M.G., R.E.

THE topographical maps considered in the following brief paper are those of which the scales vary from $\frac{1}{25000}$ to $\frac{1}{250000}$, or roughly, from 2 inches to 1 mile to 4 miles to 1 inch. And it is not proposed to discuss field procedure or survey methods, but only to consider the printed map.

A topographical map should possess the following qualities:—

1. All the information which it presents should be accurate.
2. It should present as much information as possible.
3. The information should be presented as intelligibly as possible.

* Research Department, December 15, 1904.

The first quality, that of *accuracy*, mainly depends upon the methods used in the field, and in this respect the government maps of most civilized countries can hardly be improved upon. The point is, moreover, one upon which all are agreed, *i.e.* that the field methods must be such that there shall be no plotable error on the printed map. But when we come to conditions 2 and 3, we find some divergence of opinion and practice.

The *amount of information* which can be shown and the selection of the information to be shown are two aspects of the same question. The insertion of unnecessary matter may harm a map considerably; as instances of this we have the parish boundaries on the Ordnance Survey engraved 1-inch, and the signs for cultivation on the Spanish $\frac{1}{50000}$. But the opposite defect is far more common, *viz.* the omission of useful matter. The most common fault, perhaps, is the want of numbered heights, and the next most common fault is insufficiency of names. As illustrations of the former defect may be quoted some Indian topographical maps, on which an abundance of heights are shown on the tops of the hills and very few in the valleys. Another common omission is that of essential details in the hill features, caused by a too rough generalization in the process of reduction from a larger scale.

Another defect, frequently met with in maps on scales of $\frac{1}{125000}$ and smaller, is the omission of minor roads and tracks. This is sometimes a serious mistake. It is often better to crowd the sheet with all the roads there are, rather than produce an easily read, simple, but misleading map. It is, however, clear that the whole matter of the selection of information to be shown on a map is mainly conditioned by two factors—the scale of the map and the character of the country; a statement which may be put in the form of a truism, *viz.* that, given the amount of information required, the scale of the map will depend upon the closeness of the detail. Thus, a 2-inch scale for Jersey is equivalent to a 1-inch for Kent, a $\frac{1}{2}$ -inch for South Africa, or a $\frac{1}{4}$ -inch for certain regions in tropical Africa.

It is, perhaps, possible that a class of map might be devised which would show the main features at a glance, and the minor features by means of a magnifying-glass. If we imagine a glass to be used with a power of 2, we could put as much information on a $\frac{1}{2}$ -inch map as we now find on a 1-inch map. There would certainly be great difficulties in printing such maps in colour, and simple reduction will not produce the required effect. But, though the attempt might result in failure, it would be worth making. From an army point of view, anything which reduces the bulk of the maps which have to be distributed and carried is to be encouraged.

Almost all Government maps are published with wide margins. These margins are only useful for holding the map by. They might be utilized for presenting additional information. This might conveniently

take the form of photographs likely to assist in conveying clear ideas of the surface features, especially of the vegetation, or of special objects and landmarks likely to help in identifying positions. Engraved views have long been the accompaniment of the Admiralty charts, and the same principle might usefully be adopted for topographical maps. It is, of course, not suggested that a map should be garnished with photographic "tit-bits" of local scenery. No photograph should be printed which is not typical and characteristic, or likely to be useful to a traveller. The photographs would be printed from "process" plates.

The quality of *intelligibility* depends more upon the use of colour than upon anything else. It may be taken as generally accepted that a topographical map should be printed in colours; and, further, the following colours are almost universally employed:—

Blue for water, green for woods, brown for contours, and black for lettering and for the graticule. Shades of brown or grey are commonly used for the representation of hill features on the layer system.

Other matters which affect the intelligibility of a map are—

The shading of the hill features.

The contour interval.

The lettering.

The bearing of the edges.

The conventional signs.

Unless the contours are very close together, the addition of *shade* much increases the legibility of a map. (Vertical hachures do not combine very satisfactorily with contours.) The depth of the shade should vary with the steepness of the slope, and should not depend on any imaginary direction of the incident light.

Examples of the combination of contours and vertical hachures are the Ordnance Survey 1-inch, the German $\frac{1}{100000}$. Examples of the combination of contours and shade, depending on an imaginary direction of the incident light, are the French colonial $\frac{1}{50000}$ and an edition of the Swiss $\frac{1}{50000}$. There is no satisfactory example of the best system, *i.e.* the combination of contours and shade varying with the steepness of the slope.

As regards *contour interval*, the following table will serve to give an idea of what may be considered the normal contour interval. The number in the right-hand column is found by multiplying the contour interval in feet by the scale in inches to the mile.

TABLE OF EQUIVALENT CONTOUR INTERVALS.

	Equivalent in feet on a scale of 1 inch to 1 mile.			
The United Kingdom, 1 inch to 1 mile	100
" " $\frac{1}{2}$ " 1 "	50
Ordnance Survey colonial maps	50

		Equivalent in feet on a scale of 1 inch to 1 mile.						
France	... ..	$\frac{1}{80000}$	...	...	...	...	...	52
"	colonial	$\frac{1}{50000}$	...	...	...	...	...	41
Germany, Prussia	...	$\frac{1}{33000}$	...	...	...	...	...	41
"	Baden	}	$\frac{1}{35000}$	...	...	...	...	81
"	Bavaria							
"	Wurtemberg							
Italy	... ..	$\frac{1}{35000}$	...	...	...	...	...	20
"	...	$\frac{1}{100000}$	...	...	...	...	...	102
Spain	... ..	$\frac{1}{50000}$	...	...	...	...	...	81
United States	... ..	$\frac{1}{62500}$	...	...	...	...	...	50
"	"	"	...	...	...	...	...	20
Mean								57

We may therefore say that the weight of authority is in favour of a contour interval of about 50 feet for a scale of 1 inch to 1 mile, and for other scales in inverse proportions; thus, 100 feet for a $\frac{1}{2}$ -inch map, 200 feet for a $\frac{1}{4}$ -inch map, and so on.

A similar result would have been arrived at on the merits of the case. Every one who uses the 1-inch Ordnance map knows that the contours are not sufficiently close to show the hill features clearly in ordinary country. It requires a very steep slope for contours at such a wide interval to attract the attention they should.

This rule need not be considered as applying to very mountainous countries, such as Switzerland. The Swiss Federal maps have the following intervals:—

$\frac{1}{25000}$	...	...	10 metres, equivalent to 82 feet for a 1-inch scale.
$\frac{1}{30000}$	...	...	30 " " 123 " 1 "

Lettering.—Nothing has so far equalled engraving on copper for clearness. Transfers from copper to stone or zinc give results nearly as good. Next to these comes handwriting on stone or zinc, or heliozincographic prints from manuscript; and the worst method of all is typing. This remark about lettering applies also to contour and detail; if fine work is required, it is best to engrave on copper for subsequent transfer to stone.

The Bearing of the Right and Left Edges of a Map.—It is of considerable assistance, in using a map, if the right and left edges are north-and-south lines, *i.e.* the map should be bounded by meridians. Many national maps fail in this respect; for instance, the Ordnance 1-inch, $\frac{1}{2}$ -inch and $\frac{1}{4}$ -inch maps are truly rectangular in shape, and the edges are not meridians. In the extreme eastern and western sheets the inclination of the edges to the true north line amounts to about 4° . The same defect occurs in other national maps.

Conventional Signs are undoubtedly an evil, but they cannot be dispensed with entirely. On certain foreign maps (for instance, some French maps) they are far too numerous. As a general rule, the more pictorial a conventional sign is the better. Thus, a windmill should

look like a windmill, and a wind-pump like a wind-pump. Railways should be given cross-bars. The different classes of roads should be distinguished conventionally.

Minor matters affecting the usefulness of a map may be briefly mentioned. The scale, even when metric scales are used, should be expressed in terms of two units—one on the map, one on the ground. Thus in addition to the statement that the scale is $\frac{1}{100000}$, should be added the words, "1 centimetre to 1 kilometre." When there is any chance of a colony adopting the metric system, the American compromise $\frac{1}{62500}$ should be used instead of 1 inch to 1 mile, and $\frac{1}{125000}$ instead of $\frac{1}{2}$ inch. The magnetic declination should be mentioned for the date of publication, and its annual variation given.

A map should be of moderate size, about 18 inches square, and when intended for use out-of-doors, should be mounted on linen and folded. The Ordnance coloured 1-inch maps are very convenient in these respects.

If the various national maps are criticized on these lines, they can be arranged in groups somewhat as below—

First-class maps—Ordnance Survey, coloured 1-inch.

Swiss, $\frac{1}{50000}$.

French colonial, $\frac{1}{50000}$.

United States, $\frac{1}{62500}$.

Second-class maps—German, $\frac{1}{100000}$.

German, $\frac{1}{25000}$.

Spanish, $\frac{1}{50000}$.

Russian, $\frac{1}{126000}$ (Balkan peninsula).

French, "Carte Vicinale."

French, $\frac{1}{80000}$.

Also Austrian, Italian, Danish, Belgian, and Roumanian maps.

It is not intended to imply that the above is an exact classification; such an arrangement must depend a good deal on individual taste and preference. Indian maps, of which the field work is so admirable, would, on account of the roughness of the reproduction, occupy a place below all those quoted above.

It is clear that, as the field of exploration narrows, this Society must devote an increasing amount of attention to mapping and topography as opposed to sketching and exploration. We should have our own standard of excellence in cartography, and the standard should be a high one. It is suggested that the Research Committee should recommend to the Council the expenditure of a sum not exceeding £100 in the production of a topographical map of a high degree of excellence, to serve as a guide for, and be used as a standard by, the Society.* This

* Better still would be a series of maps on the same scale depicting the same tract of country in various styles and on different systems.

typical map would be most useful in the settlement of cartographical questions which arise in all parts of the Empire—such questions, for instance, as were discussed at the recent Survey Congress in South Africa, or which arose in connection with the proposed Survey of Canada.

It would also serve as a standard for candidates for the Society's diploma.

Colonel JOHNSTON: I think Major Close's paper has been an excellent one. It deals in minute detail with a large number of more or less matters of opinion, and on the whole, I think, very fairly and very well, but there are a few points on which I do not quite agree.

In the first place, he mentions it as a very common fault that maps should show too little detail, too few names, and so on. My own feeling is that, as a general rule, the tendency is rather the other way. Of course, I quite admit some maps do show very little detail, but on the smaller-scale maps, reproduced by reduction from the larger scales, the tendency is to try to cram into the smaller scales everything on the larger. In entering this room I noticed some Japanese maps which exemplify this tendency; the $\frac{1}{200000}$ is a well-executed map, but on the smaller-scale map, $\frac{1}{1000000}$ I think, reduced from it the names are too numerous. Again, although hill features are often omitted, it is a common thing, in the case of engraved maps, to find small features over-shown, with the result that the main features are not brought out so thoroughly as they might be.

With regard to the proposal of Major Close about having pictures on the margins, it appears to me the main object of margins is to make the map look better. It is more or less a matter of opinion, but if you have pictures on the margins you rather do away with that. I suggest it would be better to cut the margins off if they are not needed for their present purpose.

As regards the question of colouring maps, I quite agree that for utilitarian purposes the introduction of colour has made a great improvement, and it is now very generally adopted; but I would certainly hardly like to rule out the black and white map so completely as Major Close has done. The Swiss Dufour atlas is probably as beautiful a specimen of map-making as you could find anywhere. Some of the 1-inch Ordnance sheets are also very good specimens, and I should hardly like to have them entirely put out of court. The Swiss, of course, as we know, have gone to colour printing, and their $\frac{1}{50000}$ is a very good example of colour-printing, but hardly so beautiful a map as the Dufour atlas.

I don't quite agree with Major Close when he says the depth of shade should vary with the steepness of the slope. The range that one can get between the darkest possible representation of hills and the lightest is hardly enough to cover any except very great differences of slopes, and my belief is that the best method of representation is contours, combined with shading as shown in the present Ordnance Survey 2-mile maps.

I quite agree when he says contours on the 1-inch Survey maps are not sufficiently close for topographical maps on that scale. It would be much better if they had been at 50 feet instead of 100. Unfortunately, the Survey contours are ascertained with great accuracy at great expense, and I am afraid the cost of the additional contours which he would like to have, and which I should very much like to see on the maps, would be prohibitive.

With regard to the lettering, I agree that good writing is better than typing, but I am afraid I am not prepared to condemn typing in the way he does. As

a matter of fact, nothing comes up to really good writing, especially when the writing is small. The larger the character the better typing compares with writing. When you come to maps reduced by photographic means, I believe typing is as good as any means that can be employed. First-class writers are not very easy to get, and the advantage of typing is that you get uniformity, which you cannot get in writing.

Major Close also mentions that he considers maps intended for use out-of-doors should be mounted on linen and folded. Well, I agree as to their being folded, but as regards being mounted on linen I am not quite so clear. We have introduced recently in the Ordnance Survey a new method of folding, and my belief is that unmounted maps folded in this way are almost better than maps that are mounted. They take up less room, they don't go at the edges, and any part of the map can be read without unfolding the whole. Therefore in their case I don't think there is any advantage, except for very rough work, in mounting on linen. If you wish to get an ideal map for working in the roughest weather possible, I think the only thing is to mount in sections or print on Japanese paper and waterproof. The latter is a beautiful printing paper, and is practically untearable, but it takes wet badly. If you waterproof it, the objection as to its suffering in wet disappears, and you get what I consider a very good map, but unfortunately a rather expensive one. We prepared in this way a number of maps for the manoeuvres two years ago, where they had a good deal of wet, and I believe they answered very well.

As regards Major Close's suggestion that the Royal Geographical Society should give a sum of £100 for experiments, I cannot agree; I think the Royal Geographical Society can find better means of spending its money. I think you can safely say that all persons and firms making maps and dealing with them are doing all they can to improve the methods of reproduction, and I do not think the offer of £100 would do very much to further improvements. Moreover, I consider a map must be designed very largely with reference to the kind of country which it is to represent. For instance, I do not consider the style suited for a closely populated country like England would be suitable for a hilly and sparsely populated country like South Africa. To take one example, you find in the American methods a beautiful sample of map where ground forms are shown by close contouring, the same as in the Japanese maps. If you come to a country like Holland, I don't think that would answer as well. I think discussion is likely to do as much good as making experimental maps, and that the Royal Geographical Society would not benefit cartography by trying to lay down a standard. If the Royal Geographical Society take a different view of the matter, the proper authorities will probably have no objection to the experiment suggested on the map of Jersey or St. Helena.

For obvious reasons, I have referred mostly to points on which I differ from Major Close; but while I differ on a few points, I agree in many, and consider that his paper is a most valuable one.

Major HILLS: I should like to offer a few remarks on the very excellent paper we have had. I may, first of all, express my agreement with most of the points advanced by Major Close, and our differences are only in very minor points. He says, first of all, in speaking of the accuracy of a map, that all details should be accurate. It would be rather an interesting thing to discuss how we are to distinguish between the accurate and the inaccurate details of a map, because, of course, when we are dealing with maps produced from organized surveys, there is no want of accuracy; still, a large number of the maps we have to deal with are not so produced, and it would be useful if we could get any idea—I have never heard of any practical suggestion—as to some convenient method of

distinguishing what is absolutely fixed and what only depends upon inaccurate or hearsay evidence. The point raised by Major Close about the heights only being shown at the tops of the hills had not occurred to me before, but certainly it seems an extremely common defect. Of course, when one thinks of it, the heights of the valleys are just as important. The omission of essential details in hill features, caused by undue generalization in reduction, seems to me rather a survey question—that is to say, what it means is that it is of the utmost importance that the original survey should be made on the same scale as the final map; in other words, any generalization should be made, not by a draftsman, but by a man who has actually seen the ground and knows it. I don't think I can follow Major Close in his suggestion to print the minor details of a map so that it could be read through a magnifying-glass. It would be quite possible, of course, to reduce a map to such an extent so that it could only be read by a magnifier, and if on any occasion where lightness of transportation was of very great importance, it might be quite possible to make a map by photographic reduction which could be only used by using a magnifier of the power of, say, 10. But maps can now be produced so light, especially with these specimens Colonel Johnson has shown, that really the question of weight is not such a very important one. The suggestion to print photographs on the margin does not seem to me to be a very practical one. Major Close talks of the Admiralty charts, but I think he overlooks the fundamental difference that in the chart the important thing for the mariner to see is the appearance of a certain sea-port or headland from the sea. There is nothing equivalent to that in a map covering an ordinary area of land. If anything were to be put in the margin, it might possibly be plans of the towns, which must be shown in a very conventional way on a small scale. The representation of hills is the subject which will invoke most discussion, and it is very difficult to get any agreement on the question, but I think we may agree with Major Close that the combination of hachures with contours is not a good one. I think we may say that in the 1-inch Ordnance Survey coloured sheets the hachures really add nothing to the legibility of the map. I am not quite certain whether I agree with Major Close about whether the shade should follow the slope or whether it should be a conventional one. I should like to see his specimen-map first. One very important point is a practical question which I should like to ask practical people, and that is as regards the method of shading, the actual method by which the shading is to be drawn on the map. I should like to ask Colonel Johnson about that particularly. Of course, in the old days, it used to be drawn on a stone direct by the draftsman, and it was quite a laborious process. Now, on the half-inch Ordnance Survey maps, it is done with a process block from a brush original; but I cannot admit that the shading on the half-inch Ordnance Survey maps is sufficient to add to the legibility of the map. For instance, look at that map of North Wales, which is, as we know, a mountainous and diversified country. Seen from a little distance, the shading only gives the appearance of a flat tint with a few dark patches; it does not really show up the features of the ground, which is the only justification for adding the shading. The St. Helena map is quite a different sort of example. Looking at that from a distance, it shows up the main features of the ground very well. The suggestion of Major Close, that the Society should undertake the production of a model map, seems to me a very good one. But there is so much difference of opinion that I think it would be hardly sufficient for the Society to produce one map; it would have to produce five or six in different styles, and then let us see them, and we could have another discussion on the subject.

Mr. DOUGLAS FRESHFIELD: I feel as a mere amateur some diffidence in

speaking in the presence of so many professional map-makers. My remarks will not be in the sense of criticism, but mainly in the sense of appreciation of the excellent work done by the Survey. I think the Society may fairly congratulate itself on the adoption of a method it strenuously advocated—the use of colours. I do not say the universal use, because I entirely agree with the Director of Surveys on this point. I am sure that the new maps will be appreciated by the public. With regard to the question of how contoured maps should be coloured, whether the depth of the shade should correspond with the steepness of the slope, I cannot agree with Major Close. About fifteen years ago a new issue of beautifully contoured maps, called the Siegfried Atlas, was made in Switzerland. It did not give satisfaction; it was found that the public did not read it easily, and various experiments were made, of which I see one here, with a view to making the contoured maps picturesque by colouring them. From my point of view, contours give the kind of information we want for scientific use, and you put in the colouring for another purpose—to enable the average middle-class man to read the map easily. The preferable method, therefore, is that which best secures this end. I confess that until I have seen a satisfactory map produced in the way Major Close suggests, I shall lean to the artistic mode of colouring, which is intended, not to repeat, but to supplement the information which is adequately given by the contour. I feel some doubt as to the desirability of what has lately been done in one of our Ordnance maps in colouring the woods green. It may be valuable for military purposes, but for general purposes, I think it rather destroys the picturesque legibility of the map; it makes it look spotty at a distance, and, so far as I can judge, you only get approximate accuracy with regard to the woods. That may be partly owing to the constant destruction of woods. With regard to what is said about the quantity of names, I think there is another still more important question, and that is their selection. I know selection is difficult, and I appreciate the pains taken with regard to the retention of characteristic names. Then with regard to the distinction of roads, I notice in the new maps they are divided into three classes. I am curious to know what principle this classification is based on. In France the first-class road would be the Route Nationale, the second would be the Route Departementale, and the third the Route Vicinale. But I cannot make out on what principle it is done in England.* In the old maps the distinction between roads was one of the greatest defects; the new maps are improved. Again, I do not know whether I am quite in order in mentioning it here, but I cannot help feeling, as we are met to discuss maps, that we ought not to pass without mention their defective distribution. The clumsy and unpractical way in which the Post Office has taken in hand the distribution of Ordnance Maps is a misfortune. Perhaps some scheme might be introduced to improve the distribution. The present Director has done so much that I cannot help hoping he will succeed in this matter also. With regard to the suggestion that the Society should spend £100 in making a model map; I quite agree with the reasons given to show that it would not be a very desirable use of the Society's money, and I doubt if the sum suggested would produce anything useful. As the Director of Surveys has said, I think we may leave it to the people who make the maps to go on experimenting, and that if we produce a typical map, we shall probably within the next five years want to alter it again.

Mr. BOLTON: I should like to remind Major Close that a combination of contours and shade varying with the steepness of slope has already been tried. Some thirty years ago a map of Jerusalem was engraved for Murray's Ancient

* I have since been informed it is on the width of the roads.

Atlas. The Ordnance contours were used as a foundation, and a very careful arrangement of hachures according to a strict scale was drawn upon them, and the map engraved. I think if he were to try a combination map of that sort he would find it very successful. But, as has already been said, such a map is too expensive for the private publisher to undertake. A standard map is, I think, impossible; £100 would only produce a few inches. An ordinary 1-inch Ordnance sheet costs something like £500. And after all, is there anything better than an engraved Ordnance sheet?

Dr. HERBERTSON: I should like to thank Major Close for introducing this subject. He seems to me to have looked at the map too much from the point of view of the military man, who wants as much detail as possible. I often want names and roads and boundaries, which interfere with the clear representation of the surface features, eliminated from the map. At the present time the 1-inch sheets are printed from at least two plates, one containing the names, the rivers, the roads, and other features, and the other plate the hill-shaded plate, with spaces left for the names on the first-mentioned plate. I think a very considerable service would be done if those two plates were slightly modified, and if on one plate we had the coast, the rivers, the contour-lines, and the hill shading, and on the other the names, roads, boundaries, and other details—that is, the permanent physical features would be represented on one plate, which could be printed and studied separately, while for those who wished to read the names and other details the map could be produced, as at present, from two plates. Perhaps an even better way would be to use an ordinary paper print for the feature lines, and to print the names and roads and other symbols on transparent paper, which could be fitted over the configuration map. Of course, other distributions could be printed on tracing-paper in the same way. It seems to me important that, in addition to having the contours close enough, they should be at regular intervals. At the present time the Ordnance maps cannot always be used for the comparison of slopes without calculation, because the contour intervals are not uniform. I think we might quite well adopt the American plan of having a closer contour interval of 20 feet in the plain, and of 50 feet or 100 feet in the hilly parts of the country. The use of close contouring in geographical investigations has been very well shown in the work of Prof. Kendall on the 'Glacial Lakes of Cleveland, in North Yorkshire.' In connection with the specimen maps, I am sorry not to see the $\frac{1}{200000}$ French map and the $\frac{1}{300000}$ of Southern Germany, which I think ought to have been in the list of first-class maps. I think that making the margin meridians is a very bad plan, because if you want to look at many sheets at a time, which I constantly have to do, it is very difficult to make the sheets fit. It would be much better to make the sheets rectangular, fitting at the bottom (in the northern hemisphere), or else in the middle, and repeating a roughly triangular part on the next sheet. I think if we are to have an ideal map made, the island chosen might be the Isle of Man, with its contrasting plain and highland, the Isle of Arran, or even the Isle of Wight.

Dr. DRYER: I do not think I can say anything with authority on the subject, not having paid special attention to it. I am most accustomed to the contoured maps of the United States Geological Survey, which seem to me to be very clear, and to fulfil all the functions of a topographic map. Since coming to this country I have become more familiar with maps of other kinds, and I see some advantages in them over the strictly contoured map, the principal one being their graphic character. The objection to the purely contoured-map is its want of graphic character and the inability of the ordinary person to read it. But I find, as a teacher of geography, that it is necessary for most persons to learn to read any

kind of a map; even the simplest map is not read spontaneously, and I do not think that it is more difficult to teach a person to read a contoured map than any other. I do not know that I can add anything of value to this discussion. I will only express my preference for the contoured map for showing relief.

Captain RUSSELL-BROWN: I only wish to make a few remarks on two points. The first is the question of reduction of maps by photography. I have a specimen of the new Ordnance Survey $\frac{1}{1000000}$ map of England, which has been reduced by photography to a quarter of its size. All the names on the reduction are legible with the help of a magnifying-glass with a strength of about three. It seems to me that such reductions would be useful as key maps for military purposes. The other point I want to raise is a question on which there seems to be much difference of opinion, perhaps more so than on anything else connected with the reproduction of an ideal topographical map, and that is the best method of representing hill features. If you look round the maps on the walls, you will find a Swedish map which clearly represents the hill features on the "layer system." This, in my opinion, is the best way of showing hill features on small-scale topographical maps. I think this method is suitable for maps on a scale of 4 inches to a mile and under. A point about this Swedish map, which seems capable of improvement, is that all the hill features might be printed together from one copper plate or copper transfer, instead of requiring something like half a dozen plates. On this system, the Ordnance Survey $\frac{1}{4}$ inch to 1 mile maps of England and Wales would require about seventeen different gradations of colour to show all hills at contour intervals of 200 feet. There is a specimen on the table of this so-called "layer system" of reproducing hill features, showing something like thirteen or fourteen different gradations of colour reproduced simultaneously from one copper engraving. I agree with Mr. Reeves that this "layer system" could be improved by graduating the colours between each successive contour, so as to avoid giving the impression of steps to the slopes.

Mr. GEORGE PHILIP: In the preceding discussion I think, with Dr. Herbertson, that too much stress has been laid upon military requirements in a topographical map. But the scope of an inquiry like this is to find out what is for all purposes the ideal topographical map, and as regards this I think a solution has not been arrived at. If we banish the question of expense of production, which so largely handicaps the private publisher, there is no doubt that the use of colours makes for the beauty and value of a map. And if, in addition to the colours advocated by Major Close, we combine tints, contours, and hachures, we can obtain a still more graphic effect. To my mind a perfect topographical map would be a kind of picture in which the elevations would be shown in detail by hill shading, the relative height by contour-lines (which when used by themselves are apt to ignore incidental surface features), and the absolute height above sea-level by a system of tinting in "layers." I do not think such a combination of flat tints, contour-lines, and hill shading has been sufficiently emphasized; it seems to me it would give the most perfect result. In conclusion, I cordially agree with what Mr. Freshfield and Mr. Ravenstein have said on the question of educating the public. The general public expects the price of maps to be so low, that the production, by private enterprise at least, of really good and valuable maps printed in a number of colours becomes almost impossible.

Major C. B. SIMONDS, R.G.A.: I think no opportunity should be lost in affording information by styles of printing and use of colours, of which in English maps full advantage is not taken. For instance, following logical reasoning (for simplicity), nothing in nature being bolt upright, upright printing should only be used for everything artificial—the work of man's hands—names of towns, villages, buildings,

railways, roads, etc.; while, the natural slope of printing being to the right, names of mountains, forests, rivers, plains, etc., should be in type sloping to the right; and peoples, tribes, tribal districts, parishes, etc., in type sloping "back-hand," to the left. As to colours, where employed, heights of hills and contours should be in brown; heights of rivers across them in blue (at normal water-level or mean tide); anything artificial, roads, railways, bridges, etc., figures in black. Complete absence of artificial effect is imperative; the beauty of the ideal map must be beauty unadorned.

Major HILLS: I should like to make another remark or two. Dr. Herbertson was talking about the separation of the natural features on the map from the artificial features. That is one of the points of printing a map in colours. If, for instance, the hills are printed in brown, and the water in blue, and the detail and names in black, by printing only the blue and brown together you get a representation of the land and its surface features. A good deal of obloquy has been thrown on the British public in this discussion. They have been described as not using maps, and not being interested in them. I think that might have been very true ten years ago, but I doubt if it is the case now. I think if you went to, say, the Lake District, you would find just as many maps used as at Chamounix. I am sure, if the Ordnance Survey could arrange to put their maps on the railway book-stalls, they would have an enormous sale, especially for the half-inch maps. The question that has been raised as to representing slopes in different layers rather emphasizes what I said before about the necessity, if we are going to have a specimen map, of having two or more. Major Close proposed a system by which the steepness of the slopes was represented by the darkness of the shade. Now, here is a proposal by which the depth of shade depends on the height above sea-level; they are both consistent systems, and which has the advantage is a question of taste.

Mr. REEVES: I have listened with great interest to Major Close's paper and to the discussion that has followed, and think we ought to be obliged to him for re-directing our attention to this most important subject. I say re-directing, for it is a matter which, as most of us are aware, has been for a long time under the consideration of the Society, and I remember quite well, about fifteen years ago, a special committee being formed to deal with it. One of the many valuable results of Dr. Scott Keltie's 'Report on Geographical Education,' which appeared about that time, was to create a fresh interest in topographical methods, and since then the matter has not been lost sight of. It is, therefore, not a new subject to us. Personally I should very much like to see a specimen topographical map prepared, as it would be useful to me for instruction purposes. I could hand it round and show pupils what is required, and the sort of map that would be expected from them. The cost would naturally depend upon the method of production, but I doubt if £100 would be sufficient; however, I think it would be a good thing if it could be done. There are many points in Major Close's lecture I should have liked to have said something about, and several things I intended to say have been said already. The representation of the hill features is one of the most important matters. We are all well acquainted with the various methods shown on the different maps on the screens around the room. The layer system of tinting and contours is valuable for some purposes, but in many respects it is far from satisfactory. It always gives the impression of a country consisting of a series of steps or terraces, which, as a rule, is not in the least true to nature. Then, again, the tints are very often far from what they ought to be. It appears to me that if we are going to adopt this system at all we should use gradations of tints of one colour only, and not two or three different colours. For instance, I feel sure it is a mistake to jump suddenly

from green to brown. Such an abrupt transition is incongruous, to say the least, and without any change in the natural features to warrant such an abrupt change in colour. I have often known persons unacquainted with such maps to be misled by this sudden change in colour, and it certainly has a way of suggesting that where the green terminates is the limit of vegetation, in spite of any explanation of the tints which may be printed on the map. For ordinary purposes perhaps the combination of shading with contour-lines might be recommended; the contour-lines should show the difference of height with all the scientific accuracy required, and the shading ought to give the graphic effect. Doubtless for general purposes it is best to assume the light to fall vertically and the shading to increase in intensity with the slope, but I do not quite agree in condemning the oblique method altogether, for there are occasions, especially in mountainous regions, when this method gives a far better effect than any vertical lighting would do. Of course, the drawback to the oblique method is that it tends to give an erroneous impression of relative slopes, but this is greatly due to the fact that it is often overdone, as is the case with several of the maps before you. Whenever the system is adopted it should be combined with carefully drawn contours, which would prevent any one being misled. As to making use of the margins of the maps, I have often thought that there are times when they could be utilized with advantage, especially when space is a consideration. In addition to characteristic views, as suggested by Major Close, why not give vertical sections across the country in different directions upon them. There are many other points I might mention, but time will not permit. As to the method of folding so as to make the best use of space for tourist or military purposes, I had recently brought under my notice a suggestion, which seems very good. This consists in an ingenious system of mounting sections of the map upon the back so as to give the continuation in any direction by simply folding over. The idea can be seen from the map which I now place before you. It should be explained that the maps upon the screens are merely those referred to by Major Close in his paper, and no attempt has been made at a complete exhibition of specimens of topographical maps.

Captain CREAK: I have a small question to ask, but it is, however, an important one. Major Close says, "the magnetic declination should be mentioned for the date of publication, and its annual variation given." He has taken as an ideal island the island of St. Helena. Well, what declination could he give there, because its value varies in every part? All islands are similarly affected; in fact, wherever you go on land you will find local disturbances of magnetic declination from the normal value. I therefore suggest that the normal magnetic declination or variation should be given on maps, and instead of the words "annual variation," the annual decrease or increase. I think these are important for a map, and in regions where the magnetic declination is largely disturbed, a note to that effect should be given.

The CHAIRMAN: Before asking Major Close to reply to some of the criticisms that have been made, I should like to make one or two remarks. We have covered such a wide area this afternoon in our discussion, that it almost seems as if we had room enough for another afternoon's discussion on this subject. The discussion so far has only really referred to what may be called finished topographic maps. But there is a great deal to be said about maps which are not quite so complete as those you see on the walls around you. Major Close begins by stating that one requisite in a map should be that all the information it presents should be accurate. Nobody disagrees with that proposition, I am quite sure, but it is impossible sometimes to carry it out. The question is, when you have a map made up of material which is not homogeneous, some of which you know to be

inaccurate, but which at the same time represents country which is entirely new and has never been mapped before, what are you to do? Of this class are many maps of most important tracts of country extending beyond the frontiers of India. It is impossible to say of them that all the information contained is of equal value. It is most difficult to combine all sorts of material in the map so that there shall be no mistake as to what the actual value of any one part may be. I am inclined to agree with the remark made by Dr. Dryer, that some of the American maps as nearly approach to the typical topographical map as possible; but I have also a very great admiration for certain Swiss maps. As regards the representation of hill shading, there is just one method which I think no one has referred to, and which is the method which we have adopted in India after very many years of trial and experiment, which is found to answer best in the hands of our native topographers. That is the system of broken horizontal hachuring, combined with the continuous contour when possible. It is not always possible to secure the necessary time or money for running out accurate continuous contours. The continuous contour system is no doubt the most scientific method of representing ground yet devised, but I should doubt extremely whether it has been possible to carry out all the continuous contours shown in the American maps with strict accuracy; and if they are not accurate they are misleading. I have had lately to deal with maps in South America which were mapped on that system by continental topographers. The mapping was, of course, not of the highest order. It was carried out very rapidly under the sort of conditions in which we generally run out our geographical maps in India, and it was an attempt to represent the country by a system of continuous contours. The result was in many cases most misleading. In some instances it was impossible to tell whether a single contour represented a hill or a depression. I may add that the system of adding shading to the hachures in order to intensify the relief of the hills has also been tried very extensively in India, and found to fail in the field for the reason that no two men have the same idea as to the amount of shading which should be applied in order to give effect to a given slope. We do not find that difficulty as regards the pen and ink drawing of the horizontal hachuring. Men trained in the same school produce maps that are fairly concordant in their results. The representation of a slope of a certain steepness in one man's map will be about the same in all the field maps. That is not so when they are allowed to make use of the brush. Then their artistic fancy comes into play, and all sorts of errors creep in. But on the whole, in the reproduction maps, I may say that I agree that the addition of shading is most distinctly effective, if it is not absolutely instructive. Major Close calls attention to the deficiency in the number of heights shown on the face of the map as regards the plains. This undoubtedly is a very great and very common fault, but the reason of it is that the heights which are given are chiefly those of hill-tops fixed in the course of triangulation. It merely emphasizes the necessity for the free use of the clinometer in the topographer's hands. The topographer is generally responsible for heights of roads and rivers, but I admit that these are often deficient in number. Now, as regards the specimen map, for which it has been proposed to apply a given sum, I do not quite know whether it is clear to every one here that it was only intended to carry the proposal out strictly within the limits of the Royal Geographical Society's premises. There was no idea of offering £100 for competition; it was merely to be voted for the purpose of producing, so far as we could, what might be accepted generally as a typical topographical map. It has been suggested we recommend that proposition for the consideration of the Council of the Royal Geographical Society.

The CHAIRMAN put the resolution to the meeting, and declared it carried.

Major CLOSE: My difficulty in replying to the criticisms is that I agree with most of them. Most of the discussion turned on the representation of hill features, and I think it would be a very good thing if we could have a bit of country mapped which would give us before our eyes the same ground shown in four or five ways. It is very difficult to compare a bit of country somewhere in the Sahara with another bit of country in the United States, and another in Sussex. And it is very difficult to get any idea of the value of the different methods of representing hills unless we deal with the same tract of country. I was interested in Mr. Philip's suggestion of a combination of shading, tint, and contours. It would be a very good thing to try. The representation of the same ground on different systems has a distinct educational advantage. It brings up the different ideas of absolute height, relative height, and steepness in a way that no single form of representation can do. It seems clear that we should devote more attention to topography now that the Society's days of exploration are gradually drawing to a close. And if we are to delineate the surface features of the Earth effectively, we should make up our minds as to the best way to do it.

The CHAIRMAN: I have only now to ask you to join in thanking Major Close for coming here this afternoon to give us such an interesting paper. We have had a most valuable discussion. The only difficulty about it is that it has been almost impossible to compress the amount of information which might be gained from an assembly such as this into the space of time which was at our command.



Drawing by Ellis Martin, used on Ordnance Survey leaflet no 1, "Maps for Tourists - Notes on the Choice of a Scale". It has been suggested that the "customer" is Col. Sir Charles Close. The drawing was probably made c.1920.