COMPASS AND MAP READING.

By D. P. Levack.

Skill in map reading and the proper employment of compass and aneroid are matters in the education of a mountaineer which cannot be too strongly stressed, and in which a little instruction and much practice can be of immense value. From time to time situations arise in which a party finds itself absolutely isolated in circumstances where the accurate reading of a map and the proficient use of a compass will save not only valuable time but much anxiety, and indeed even the lives of the party. Apart from the factor of safety which a knowledge of this subject provides, many expeditions under adverse weather conditions would often become impossible, and for that reason a great deal of pleasure and satisfaction would be lost if the parties undertaking these expeditions had no knowledge of the fundamental principles of map reading and compass work. And the intelligent appreciation of a map, with the extraordinary amount of information contained in it, will add greatly to the interest and pleasure of any expedition.

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For the purpose of this article, compasses may be divided into two classes, the needle compass and the card compass. The latter type is, of course, an offspring of the former and depends for its function upon a needle, usually placed out of sight under the card. Card compasses can again be divided into two main classes, those swinging freely on a pivot in a box or some form of casing, and those on which the whole card and its pivot are immersed in fluid, usually some form of oil.

Without going into any great detail, I think that most people with any experience at all will agree that the card compass is the one of choice for our purpose. The needle compass has the irritating habit of being very unstable, difficult to hold steadily in the hand, and, in most cases, calibrated only with the cardinal points of the compass and one or two intermediates. The card compass, on the other hand, is a much steadier and more sober instrument, and lends itself to calibration in a number of ways. It may be marked by the major points of the compass alone, but frequently, and for many reasons most important, it is divided into degrees, and marked from 0 through 90, 180, 270, to 360. Any number of subdivisions may be marked. Not only may the card compass have one scale of degrees marked on it but a second one is often arranged, so that, by the use of a small prism and lens, on holding the compass up to the eye, the card can be observed through the prism and a very accurate reading in degrees may be made by means of a hair-line. If we wish to be very expensive we may buy such an instrument with an oil-immersed card, the object of this immersion of the card in oil being to render the movements of the card comparatively slow and steady, so that it does not wobble about in the hand, but quickly reaches its resting-place or orientation without having to be checked for over-swinging. A compass of this type is said to be dead-beat, and it is an extremely nice instrument to use under all circumstances.

What does a compass do? It gives an accurate indication of that direction which is known as Magnetic North. Most of us know this already, but it is surprising how many people are somewhat vague as to what magnetic north really is and how it differs from True North. Briefly, magnetic north is that region of the earth's surface towards which magnetic lines of force converge to form one pole of a magnetic field. This magnetic pole does not correspond exactly with the north end of the true axis of the earth. From the region in which the British Isles are situated, the magnetic pole is a little west of the true north pole. Compasses, therefore, in this area of the earth's surface will have a slightly west deviation, and obviously the farther west we travel the less and less will this deviation become, until along a certain longitude, where the true north pole and the magnetic north pole and ourselves come into line, there will be no deviation of the magnetic north. If we travel still farther west of this longitude our magnetic deviation will again become greater and greater, but will be towards the east. I do not propose to go into any of the finer points with regard to the variation of the deviation at various points of the earth's surface, but would simply state that the angle between magnetic north and true north is known as the magnetic variation.

With modern maps, on each one of which this magnetic variation is clearly marked, there should be no difficulty whatever in setting the map, or orienting it, as it is called. Having grasped exactly what our compass is pointing to, it is a simple matter now to describe the position of any given point on the map in relation to this magnetic meridian. When we do so, we give what is called the bearing of the point. This bearing may be given in terms of the cardinal points of the compass and their subdivisions, but it is much more accurately described in degrees. Every bearing is described in degrees, measured clockwise from the direction of the needle of the compass, and, remembering that our compass needle points to the magnetic north, so we describe our bearing as a magnetic bearing. It is perfectly simple, of course, to convert the figures of our magnetic bearing into those of a true bearing, which would indicate the position of our point measured in degrees from the true north meridian. This calculation simply means the subtraction of the magnetic variation from the magnetic bearing, which therefore gives us our true bearing. For example, if we find the magnetic bearing of an object to be 20°, and we know the magnetic variation to be 17°, obviously the true bearing will be 3°. Under practically all circumstances, however, it is found possible to use the magnetic bearing alone, without having to bother correcting this bearing to a true bearing, but we shall see it is important to remember that we are using *magnetic* bearings, and not true bearings, after we have oriented or placed our map. How do we now find the bearing of any given point, by our compass, from the position in which we are standing? With a needle compass, this can be done by laying it on a flat surface and drawing a line along the direction in which the needle points. From the centre of our compass we now draw another line towards the point of our observation. Then by means of a protractor we simply measure the angle between these two lines. Note that it is not necessary to indicate whether the object is north, south, east, or west, as our bearing is always measured from the north, clockwise round the compass. If we do this we need never be confused by the cardinal points and their various subdivisions. These points, of course, have their equivalent in degrees. Thus if our magnetic variation is 17°, it is quite obvious that east will be 17° plus 90°, south will be 17° plus 180°, west 17° plus 270°, and so on.

In the taking of the bearing of a visible object, the prismatic compass is the instrument of choice, because one is able, simply by pointing the compass, held in the correct manner, at the object observed, to read directly from the compass card the exact number of degrees of the bearing. This renders the procedure not only very simple but very accurate. Those interested should try this out for themselves with a prismatic compass.

Having now grasped clearly the exact meaning of the bearing of an objective from a given point, and the way in which this bearing is arrived at, and how it is expressed in degrees, there is not very much else to worry about. There is one point, however, which is of some interest and which may be of some importance, and that is the finding of what is called the back-bearing of any particular objective. This back-bearing is in effect the bearing of the particular point at which we are from the point whose bearing we take originally. The usefulness of being able to calculate quickly a back-bearing may arise in circumstances where, between the time of taking a bearing and arriving at the point at which we are aiming, the visibility becomes *nil*, so that we cannot see the place we originally set out from. It is perfectly simple to calculate a back-bearing and about-turn and proceed in the direction of the back-bearing to the point from which we started.

With regard to the particular choice of a compass in walking during thick weather, there is no doubt that the card compass is by far the best instrument to use. It can be held in the hand, and by means of a movable cover on which a mark is fixed we can set our bearing accurately, lock the movable cover, and then proceed along the line of march, checking our direction as often as we please. With a needle compass, and with some of the cheaper forms of the card compass, such a procedure is not possible, and from that point of view alone the properly designed card compass is well worth the extra cost.

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Aneroid Barometer.—These instruments vary in price, accuracy, and size to an extraordinary degree. The type most frequently used and most convenient for all practical purposes is the small pocket instrument, accurately calibrated and of good quality, marked in thousands of feet, with suitable small subdivisions and with a movable dial or pointer. Naturally, the wider the range of heights which the instrument will measure the less accurate will be the readings, and in this country an instrument which will read up to 5,000 feet will obviously cover all possible heights in the hills. Elsewhere, of course, one would require an instrument recording greater heights. By means of an aneroid one can calculate how many feet has been ascended or descended in a given time, and in thick weather, in making a long ascent, the information may be valuable in indicating whether or not the end of the climb is near, at the same time making it possible to estimate the time likely to elapse before the climb is finished. The aneroid is also useful in making a long traverse round a mountain, for it will indicate whether one is making an unnecessary ascent or descent in the course of the traverse. This is particularly useful in thick weather on an unbroken slope without any particular features. Apart from these points the aneroid can be used as a pocket weather-glass in the camp or in the hotel. Because of the variation of the reading under various weather conditions a considerable error may creep into the readings, even during a relatively short day on the hills.

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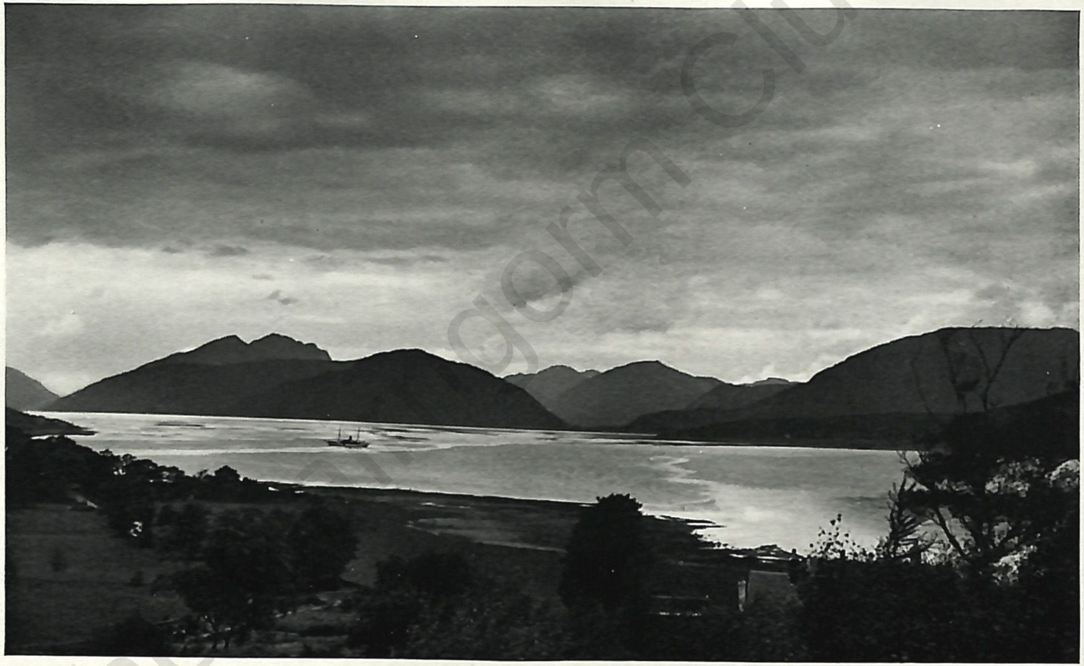
All of us are more or less familiar with maps of one sort or



Hugh D. Welsh

Sunset over Ardgour

another. A map is really a conventional picture in miniature of a particular part of the earth's surface. I say conventional, because in representing various formations of the earth's surface certain conventional signs and methods are used. Some of these we may touch upon a little later. There are certain important things about a map which one *must* know before it is of any use trying to read it. The first thing one must know is the scale of the map. The scale of the map indicates the distance on the earth's surface represented by a given distance on the map. Such a scale is usually expressed in terms of so many units of length on the earth's surface to a certain unit of length on the map surface. For example, a map may have a scale of 1 inch to 10 miles, or 1 inch to 1 mile. In whatever way the scale is expressed it is always clearly indicated in all modern maps. It may be indicated in another way, namely as a fraction, the numerator representing the unit of length on the map, and the denominator the units of length on the earth's surface. This method is not common in ordinary maps, and I do not think we need consider it at all. The representative fraction, as it is called, so produced, does not convey in any popular manner the size of the map. For instance, a map of 1 inch to 1 mile has a representative fraction of 1/63,360, the latter figure being the number of inches in a mile. The most usual scales of maps employed in walking and mountaineering are the $\frac{1}{4}$ inch to the mile, $\frac{1}{2}$ inch to the mile, and 1 inch to the mile. Very occasionally an Ordnance map of 6 inches to the mile may be used for accurate work. There are various excellent map-makers in this country, but there is no doubt that for our purpose in climbing mountains, the Ordnance Survey Map, with a scale of 1 inch to 1 mile, is by far the most useful and accurate.

We have seen how the scale of the map represents distance on the earth's surface, but the map must also represent height, so that by looking at it we can see at a glance what are the high parts of the country and what are the low parts. This is most important from our point of view, but does not appear in the average cheap motoring map, where heights do not interest the user. Height on a map may be represented by various methods, and is frequently represented by a combination of two methods, the use of contour lines and colours. The contour lines of a map represent imaginary lines on the surface of the earth joining all points at the same height above the mean sea-level. Depending upon the size of the map, we may have lines representing levels at intervals of 100, 200, 250 feet, and so on. In the Ordnance Survey 1-inch map the contour lines are drawn to represent levels at intervals of 250 feet, with intermediate lines for the intervening levels of 50 feet. Thus by studying the formation of the contour lines we can get a very accurate idea of the character of the ground which the map represents. It is obvious that when the contour lines are close together we must be dealing with a steep slope, and when they are widely spaced out the ground is less steep. Also by observing that the contour lines are grouped together in a particular region between two areas where they are widely spaced, we can tell quite definitely that we are dealing with a bulging-out formation of the ground or buttress, as opposed to a hollowed-out portion of ground or corrie. Contour lines alone, however, make a map very flat-looking and relatively uninteresting, and almost invariably they are combined with colouring to give a more vivid impression of the surface of the ground. This is perhaps best seen in the ½-inch Bartholomew's map, where a certain range of colours is employed to represent various levels. We are all perfectly familiar with the green colour representing low-lying ground, and the dark-brown colour representing the higher mountain tops, with, appropriately enough, pure white to represent levels about 4,000 feet. In certain of the Ordnance Survey maps the system of colouring is dispensed with, and a form of shading employed, commonly called "hachuring," where the sloping ground is shaded by closely drawn lines which run down the slopes in the direction in which water would flow. In the latest map of the Cairngorms (1935) these three methods of representing height are so combined as to give an immediate appearance of relief—a beautiful production.

The two features in a map which we have just discussed, namely the scale and the method of representing heights, are the most important. I need not go into any detail with regard to other conventional signs which are perfectly familiar to most of us, and which may be studied on any map from the table of signs which is nearly always printed at the bottom. All our maps are printed so that the top of the map is north and the bottom south, and the right and left sides are east and west respectively, but in every map, usually on the right-hand side, there is the conventional sign of the north and south meridian, together with a second line representing the magnetic meridian, with the angle between them marked in degrees and minutes, and a note indicating the annual variation of this angle and the year in which the map was produced. From our point of view the magnetic meridian line is important because by it we set or orient the map correctly.

(The foregoing is the substance of a paper read to the Club on February 22, 1937, by Dr Levack. The third section of his paper, which dealt with the use of map and compass together, is here replaced with the rather fuller dissertation which follows.)