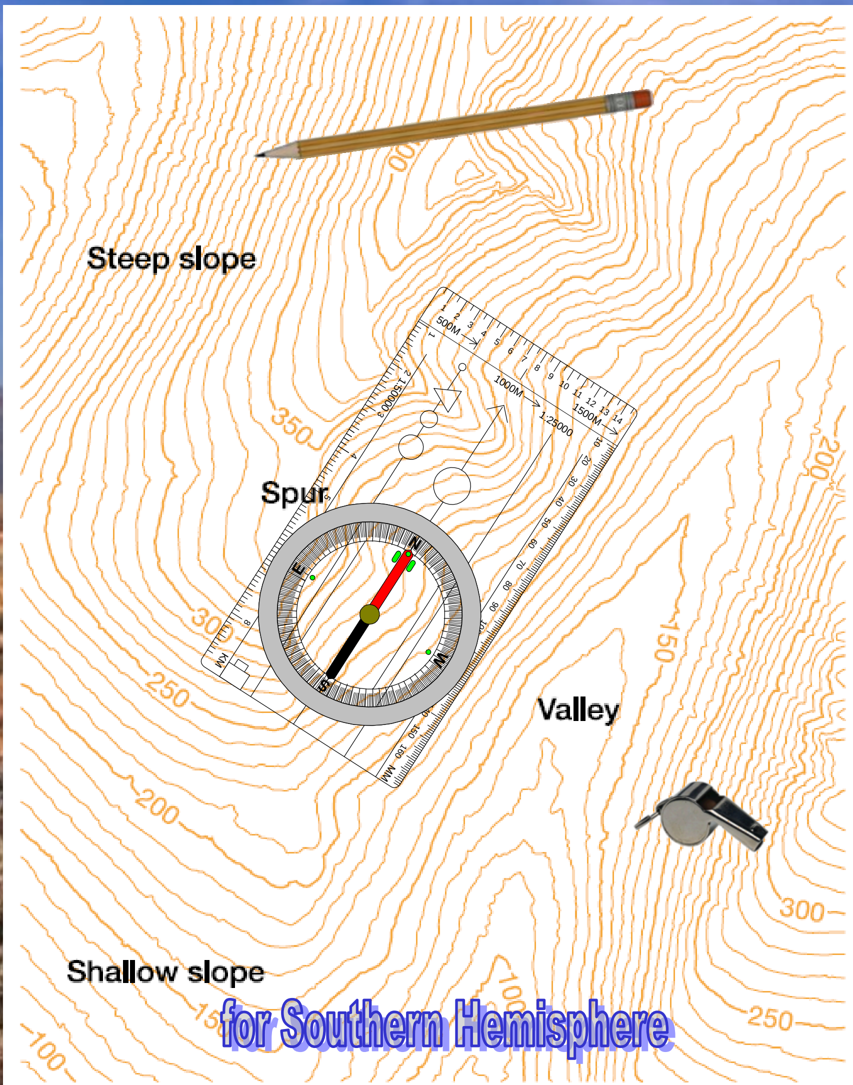
Map Reading & Navigation

- for everyone.

Mike MacLeod



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Introduction

Hiking is a fun activity for everyone, whether you're a family or one of the more serious hiking clubs. But what may start out as a fun casual stroll through the woods could end up in a nightmare. While hiking is not as strenuous or challenging as mountaineering, it should still be taken seriously because there are many hazards waiting for the unwary walker.

A few years ago my brother and some of his friends went hiking up to the top of the Berg at Witsieshoek. They wore casual clothing for a simple day walk but luckily my brother insisted on taking a backpack with at least water and some snack bars. The weather was mild and clear. They had just finished the climb up the 'chain ladder' when they saw some other hikers just ahead of them heading off the beaten track. His group carried on to the edge where the Tugela Falls starts its kilometre plunge down to the bottom of the Amphitheatre. They then headed off towards the Devils Tooth when suddenly a snow blizzard hit the mountain from the Lesotho side.

With visibility down to zero, my brother took the lead as they struggled to find their way back but navigation became difficult and darkness was closing in. He knew of a cave close by and headed blindly down the path hoping that it was the right one when suddenly they bumped into the boys and girls that they had seen earlier, who were now lost and wandering off towards the cliffs edge and certain death.
Long story short, he managed to get everyone safely into the cave where they huddled for warmth. Eventually a day later a rescue party found them and got them all down safely.

The moral of the story: be prepared for any eventuality no matter how trivial the hike may seem.

Map Reading & Navigation

Navigation is a skill that allows you to plot a course between two points on a map and to follow that route along the ground. To be able to navigate accurately in any weather condition is key to mountain and trail safety. You need to have a thorough understanding of the basics of map reading and navigation before adventuring out into the wilds. Navigation in theory is not complicated, but in reality things are somewhat different. There are a number of factors which have to be taken into account.

These include:

The actual conditions underfoot (loose rocky gravel, slippery mud, steep inclines etc.), the skill of the group and most importantly, weather conditions, which could change within minutes. Of all the meteorological conditions that one can encounter, **mist** is probably one of the most dangerous, as you can easily become disorientated. Your planning therefore has to be flexible and you must be able to use the map to work out alternative routes, especially catering for when things go wrong.

In order to navigate with confidence, you should:

- ✓ Understand map distance, symbols and scale.
- ✓ Know what terrain forms are represented by various contour lines.
- ✓ Supply a grid reference.
- ✓ Orientate a map visually and by compass.
- ✓ Use a map with or without a compass to determine your position.
- ✓ Know the current magnetic declination for the area.
- ✓ Take a true and a magnetic bearing and convert one to the other.
- ✓ Calculate a back bearing.
- ✓ Walk on a bearing in any weather.
- ✓ Be able to navigate around obstacles.

Navigation can be further complicated for the climber or hiker by:

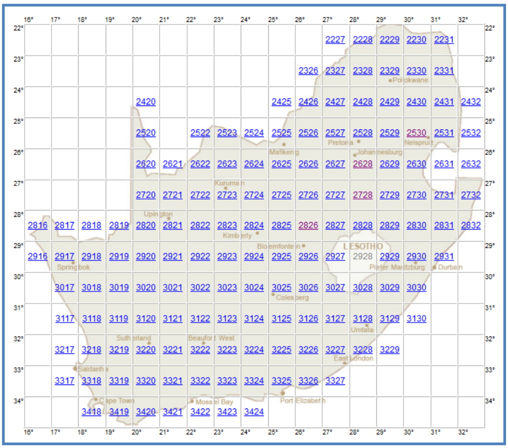
- Unfamiliarity with the terrain.
- The restricted line of sight in mountains or forests.
- Adverse weather conditions – hailstorms and lightning.
- The limited number of possible routes.

The more unfamiliar or difficult the terrain, the more reason for the leader of the group to be thoroughly versed in the use of the two most important navigational aids — the map and the compass and don't rely on a GPS unit as there are several possible failures that can occur – flat battery, no signal or damage from being dropped.

Maps

A map is simply a plan of the earth as viewed from directly above, drawn to a specified scale showing the natural and man-made features on it. Different kinds of maps are used for different applications, for example: road maps, geological maps, sea and air navigation maps and topographic maps. The maps most commonly used by mountaineers are topographic maps.

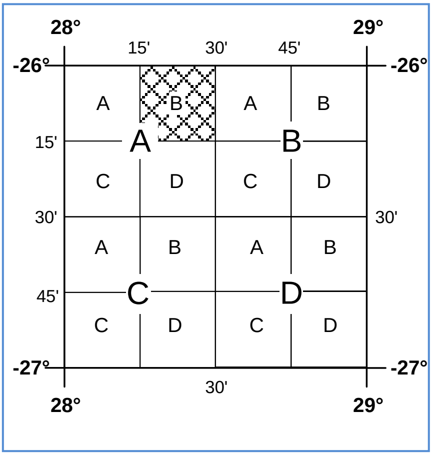
Topographic maps



Topographic maps (ordinary survey maps) provide an accurate representation of the area covered by the map and are usually drawn to a scale of 1:50 000. They are drawn from aerial photographs and checked on the ground by field survey. They are well detailed and use conventional map symbols that are easy to use and understand. Relief or height is indicated by contour lines denoted in metres above sea level.

South Africa is divided up into a system of squares, 1 degree apart, from 16°E to 33°E and -22°S to -35°S. Each 'Degree Square' is designated by a 4- digit number made up of the values of the latitude and longitude at its top left or NW corner. Each Degree Square is divided up into four squares, lettered A, B, C, D, which are then sub-divided into another four squares also lettered A, B, C, D, totalling sixteen 1:50 000 sheets, each 15' by 15' (minutes) as shown:

The shaded area in the diagram on the right indicates sheet 2628AB in the 1:50 000 series, which covers the Benoni area.



Degree Square

A series of topographic maps on 6 cd's covering the whole of South Africa is available from:

National Geo-Spatial Information:

sales@ruraldevelopment.gov.za

http://www.spatialreference.co.za/Maps.asp

Scale

The scale of a map is the ratio of the distance between two points on the map and the actual distance between these same two points on the ground. Because of its importance, the scale is usually indicated in more than one place and in different ways on a map. The three most common ways of indicating the scale are:

1. In words (two centimetres to one kilometre).
2. As a representative fraction, or R.F. (e.g. 1:50 000).
3. By a scale line.

Topographic maps in South Africa have a scale of 1:50 000. This means that one unit on the map (e.g. one millimetre) represents fifty thousand of the same unit (i.e. 50 000 millimetres, or 50 metres) on the ground. Twenty millimetres or two centimetres on the map will therefore represent 100 000 cm, or 1 kilometre, on the ground.

To calculate the straight-line distance between two points:

1. Use a ruler or pair of dividers to measure the distance on the map.
2. Compare this distance with the scale line, or multiply this distance by the representative fraction.
3. To calculate a distance along a winding path or river: use a piece of string, dental floss, shoe lace or even a blade of grass to measure the distance and then compare it with the scale line.
4. Another way of calculating distance on the map involves the use of a pencil and paper: divide the distance into a series of straight lines from bend to bend; mark each straight section along the edge of a piece of paper, rotating the paper at the end of each section and measure the distance obtained by comparing the paper with the scale line. (This method is not very accurate over long distances.)

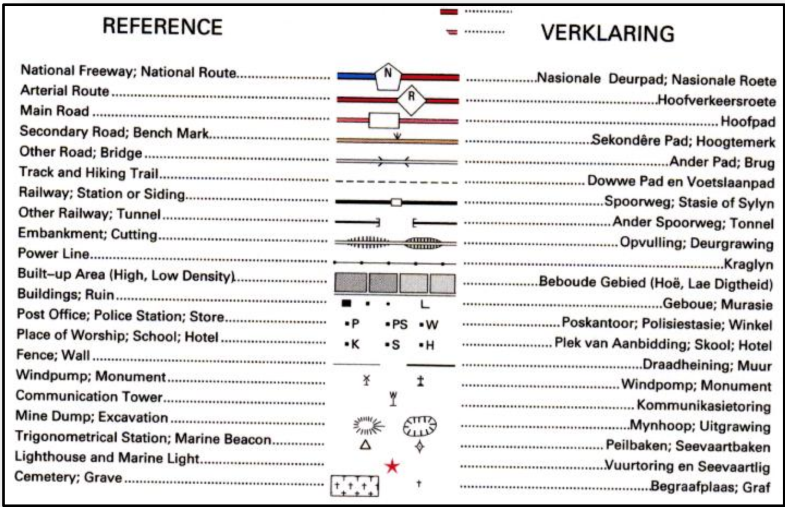
Conventional map symbols

Topographic maps in South Africa use symbols to depict features on the ground. These symbols are also colour-coded to simplify map reading.

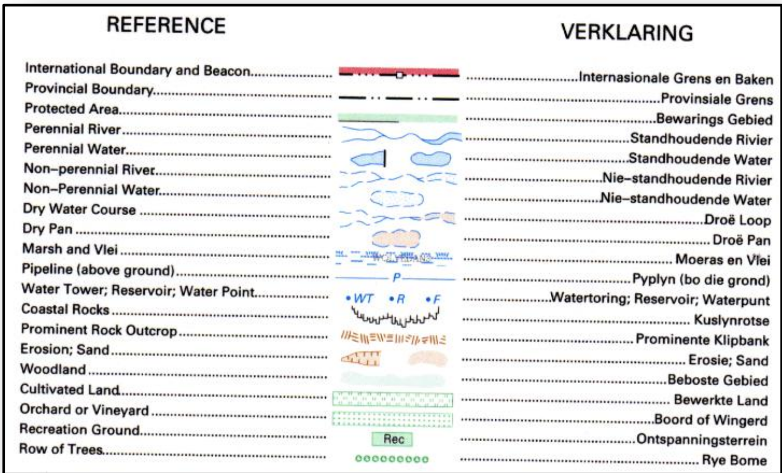
- **Black** symbols are for man-made features such as buildings, power lines, telephone lines, fences, paths, boundaries, etc.
- **Red** symbols are used to depict certain classes of roads.
- **Green** symbols are used to indicate agricultural and natural features of vegetation, such as cultivated land, forests, grassland, etc.
- **Blue** symbols are used to indicate water features.
- **Brown** is used for contour lines, rocky outcrops and secondary roads.

The key to these symbols is found in the lower margin of the map.

Conventional map symbols



REFERENCE	VERKLARING
National Freeway; National Route	Nasionale Deurpad; Nasionale Roete
Arterial Route	Hoofverkeersroete
Main Road	Hoofpad
Secondary Road; Bench Mark	Sekondêre Pad; Hoogtemerk
Other Road; Bridge	Ander Pad; Brug
Track and Hiking Trail	Dowwe Pad en Voetslaanpad
Railway; Station or Siding	Spoorweg; Stasie of Sylyn
Other Railway; Tunnel	Ander Spoorweg; Tonnel
Embankment; Cutting	Opvulling; Deurgrawing
Power Line	Kraglyn
Built–up Area (High, Low Density)	Beboude Gebied (Hoë, Lae Digtheid)
Buildings; Ruin	Geboue; Murasie
Post Office; Police Station; Store	Poskantoor; Polisiestasie; Winkel
Place of Worship; School; Hotel	Plek van Aanbidding; Skool; Hotel
Fence; Wall	Draadheining; Muur
Windpump; Monument	Windpomp; Monument
Communication Tower	Kommunikasietoring
Mine Dump; Excavation	Mynhoop; Uitgrawing
Trigonometrical Station; Marine Beacon	Peilbaken; Seevaartbaken
Lighthouse and Marine Light	Vuurtoring en Seevaartlig
Cemetery; Grave	Begraafplaas; Graf



REFERENCE	VERKLARING
International Boundary and Beacon	Internasionale Grens en Baken
Provincial Boundary	Provinsiale Grens
Protected Area	Bewarings Gebied
Perennial River	Standhoudende Rivier
Perennial Water	Standhoudende Water
Non–perennial River	Nie–standhoudende Rivier
Non–Perennial Water	Nie–standhoudende Water
Dry Water Course	Droë Loop
Dry Pan	Droë Pan
Marsh and Vlei	Moeras en Vlei
Pipeline (above ground)	Pyplyn (bo die grond)
Water Tower; Reservoir; Water Point	Watertoring; Reservoir; Waterpunt
Coastal Rocks	Kuslynrotse
Prominent Rock Outcrop	Prominente Klipbank
Erosion; Sand	Erosie; Sand
Woodland	Beboste Gebied
Cultivated Land	Bewerkte Land
Orchard or Vineyard	Boord of Wingerd
Recreation Ground	Ontspanningsterrein
Row of Trees	Rye Bome

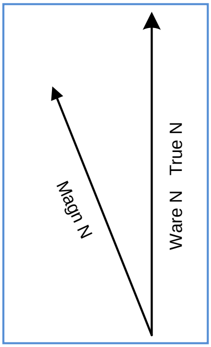
Direction indicator

Topographic maps are usually printed with north at the top of the map. The left and right edges therefore run in a north-south direction, but may not always be the case. An arrow indicating true north is always printed somewhere on the map, usually in the lower margin– see below. A second arrow, with the same origin as the first one, indicates magnetic north. The angle between these two arrows is called the magnetic declination. Maps are printed using true (geographic north) as the reference direction, but the compass needle points to the magnetic north pole, which is a point somewhere in Canada, west of true north for South Africa. Unless magnetic declination is taken into consideration when you use a compass and map together, your bearings will be out by the number of degrees represented by magnetic declination in your area.

PLACE	LONG	LAT	MD
Alexanderbaai	19.6	-28.34	-19.6
Beaufort West	22.34	-32.21	-25.12
Bloemfontein	26.12	-29.7	-22.27
Cape Town	18.25	-33.55	-25.19
Durban	31.1	-29.51	-25.33
East London	27.55	-33.2	-28.26
George	22.7	-33.58	-26.55
Harare	31.05	-17.83	-8.22
Johannesburg	28.5	-26.12	-18.49
Kimberley	24.46	-28.44	-21.2
Komatipoort	31.56	-25.26	-19.9
Kosibaai	32.53	-26.54	-21.5
Luanda	13.17	-8.53	-3.31
Lusaka	28.16	-15.25	-5.22
Mafikeng	25.65	-25.88	-17.29
Maputo	32.58	-25.97	-20.14
Maseru	27.57	-29.47	-17.29
Messina	30.3	-22.21	-13.49
Phalaborwa	31.7	-23.57	-16.33
Pietermaritzburg	29.37	-29.62	-24.55
Pietersburg	29.27	-23.54	-15.52
Port Elizabeth	25.35	-33.58	-28.25
Pretoria	28.13	-25.42	-18.8
Upington	21.15	-28.26	-19.49
Walvisbaai	14.3	-22.98	-12.58
Windhoek	17.5	-22.34	-12.1
South African Astronomical Observatory Date: 2017			

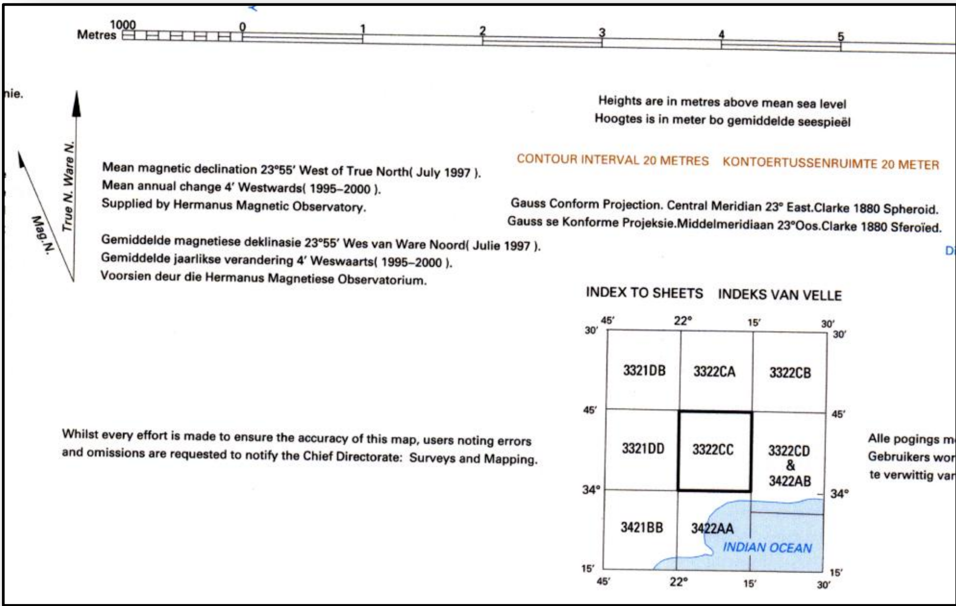
Magnetic declination chart

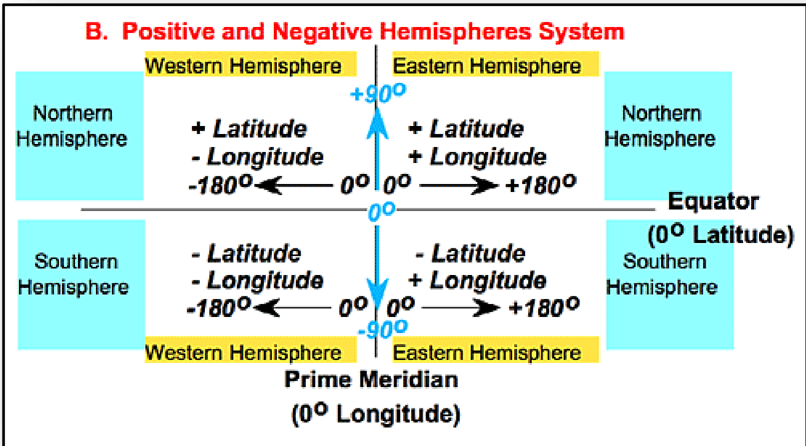
Magnetic declination varies from place to place and in South Africa by a fair amount (from 13° west of true north at Messina to 25° west of true north at Cape Town and up to 28° at Port Elizabeth, as of 2017).



The magnetic declination is given both graphically and in writing, with any annual change indicated in the lower margin of South African topographic maps**.** The minus numbers show that we are in the southern hemisphere.

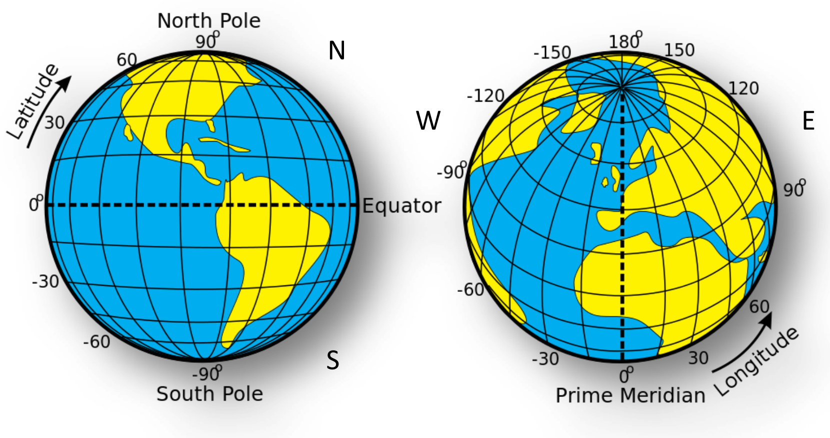
There is also an index to the other sheets or maps adjacent to the one that you are using.





Grids and grid references

All coordinates are given in the WGS 84 coordinate reference system. WGS 84 is the latest revision of the World Geodetic System, which is used in mapping and navigation, including GPS satellite navigation system (the Global Positioning System).
Geographic coordinates (latitude and longitude) define a position on the Earth's surface. Coordinates are angular units. The canonical form of latitude and longitude representation uses degrees (°), minutes (′), and seconds (″). GPS systems widely use coordinates in degrees and decimal minutes, or in decimal degrees.
Latitude varies from −90° to 90°. The latitude of the Equator is 0°; the latitude of the South Pole is −90°; the latitude of the North Pole is 90°.
Positive latitude values correspond to the geographic locations north of the Equator (abbrev. N). Negative latitude values correspond to the geographic locations south of the Equator (abbrev. S).
Longitude is counted from the prime meridian ([IERS Reference Meridian]() for WGS 84) and varies from −180° to 180°. Positive longitude values correspond to the geographic locations east of the prime meridian (abbrev. E). Negative longitude values correspond to the geographic locations west of the prime meridian (abbrev. W).



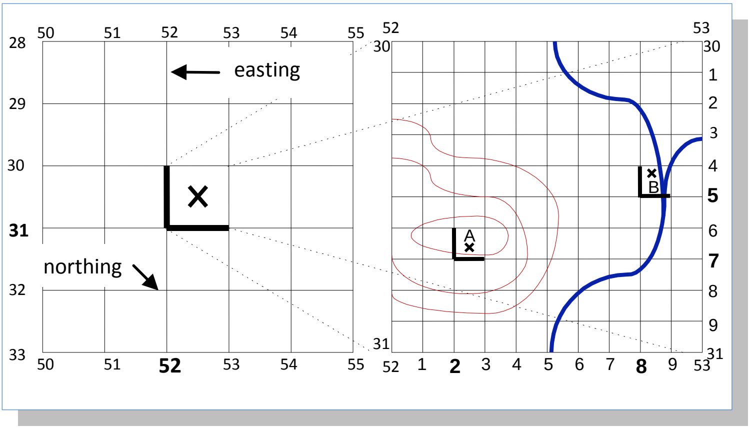
Due to the unpredictable nature of the magnetic fields around our planet, it is not feasible to use the declination rate of change that is printed at the bottom of the map. Rather visit: http://www.magnetic-declination.com/South Africa/Cape Town/2981393.html and get an up to the minute declination figure.

Generally topographic maps that are available in South Africa do not have grid lines printed on them. In order to simplify navigation and to increase accuracy it is a good idea to draw your own grid, particularly on maps you use often. If the grid is drawn parallel to true north i.e. the side of the map, you will be able to determine bearings from the map without first having to orientate the map. Should you draw the grid parallel to the magnetic north line on the map, the need to calculate true bearings from magnetic bearings and vice versa, will be eliminated.

A convenient size for the grid squares is 20 mm x 20 mm: the side of such a square will represent 1 km on a 1:50 000 topographic map. The area covered by a single 1:50 000 topographic map sheet varies with latitude, but it is approximately 27 kilometres by 25 kilometres. On maps supplied with a grid, the vertical grid lines running north/south are called **eastings** and the horizontal ones running east/west are called **northings**. A grid reference is a means of referring to a specific point on the map and usually does not coincide with the latitude and longitude of the map

To indicate a point on the map (such as your own position), quote **the closest easting to the Left** of the point **first**, followed by the **closest northing below** the point. This is an international convention and refers to the entire square in the grid which has the quoted easting and northing intersecting at its lower left corner. Just remember the letter **L=lower left**. Such a grid reference is called a four-figure grid reference and represents an area of 1 000 metres by 1 000 metres on a 1:50 000 scale map with a grid drawn at 2 centimetre intervals. If it is necessary to provide a more accurate reference, a six-figure grid reference can be given by sub dividing the square into 1/10th squares. You then use the same numbering convention as noted above. The number of 1/10th squares are then reported as a third digit for the easting and a third digit for northing. The area represented by a six figure grid reference will be 100 metres by 100 metres. Draw a letter **L** at your grid square and note the grid reference. See example on next page.

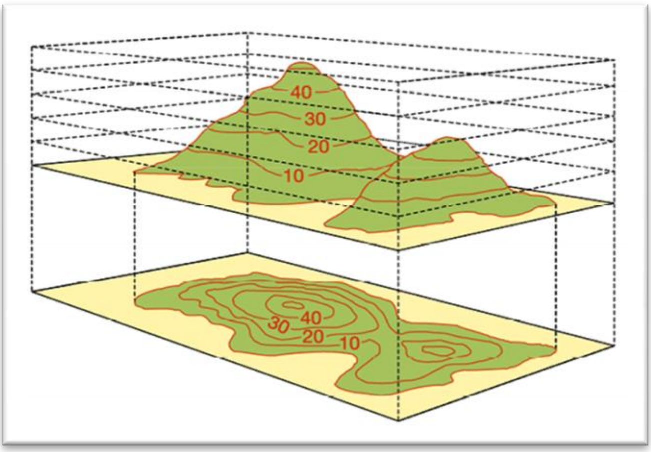
Grid lines on a map, at 1 km intervals.



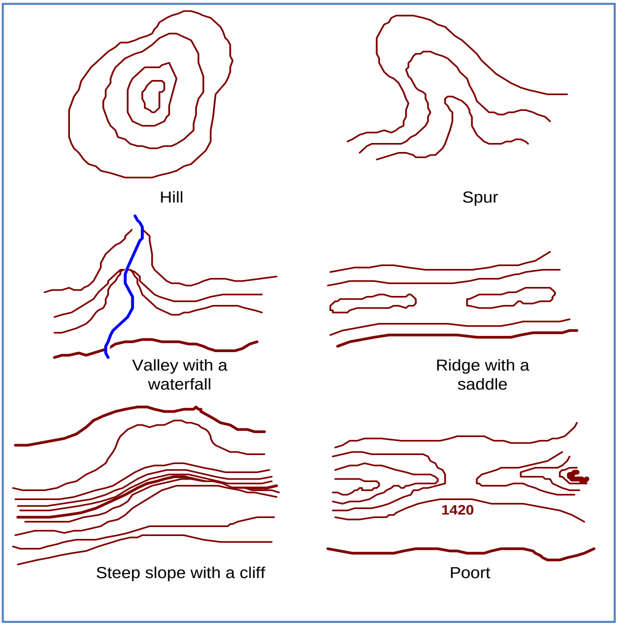
*The grid reference for the **X** square is: 5231. The six-figure grid references (an enlargement of the X square) for A and B are: A: 522307 (summit) B: 528305 (river junction)*

Contour lines

A contour line is an imaginary line joining all points of the same height above sea level. A contour line does not have a beginning or an end, but may run off the edge of a map onto an adjoining map. Contour lines represent the most accurate

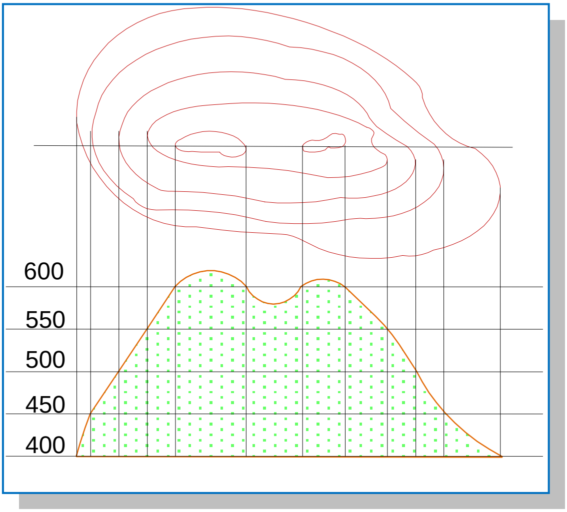


and the most easily interpreted method of indicating relief on a map. It is very important to know exactly what kinds of land form are represented by various groupings of contour lines; this allows you to choose the easiest and safest route between two points. On any given map, the height difference represented by the space between two adjacent contour lines is always the same, e.g. 20 m and this difference or interval is called the contour interval. It is usually indicated in the bottom margin of the map. Every fifth contour line (i.e. every hundred metres) is drawn thicker than the intervening contour lines to assist with the interpretation of the features and to make it easier to judge height differences. A convenient contour line is usually labelled with the height above sea level in metres. Because the vertical distance represented by the distance between any two adjacent contour lines never changes, an idea of the relative steepness of a slope can be formed by considering the distance between the contour lines on a map — the closer they are together, the steeper the slope. Where contour lines merge, they indicate a vertical cliff or an overhang. An experienced map reader should be able judge the lie of the land by just looking at the map, but if in doubt draw a side profile.



Contour line representation of various land forms

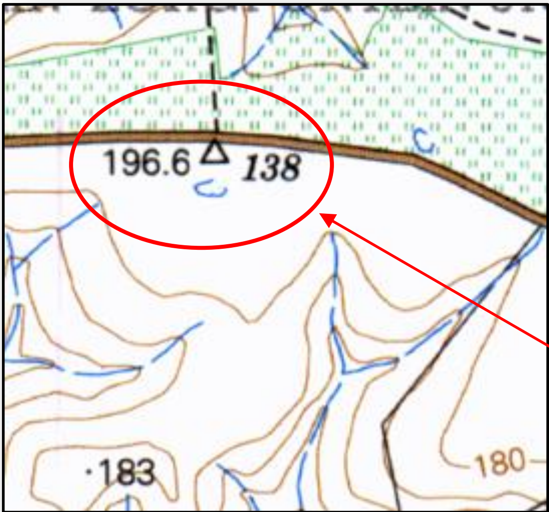
To draw the profile of a cross-section of a slope:



1. Draw a pencil line across the highest points on the map.
2. Place the edge of a sheet of paper along this line.
3. Project lines downward from each contour on the map.
4. Draw a base line equal to the length of the section. Choose a vertical scale at a right angle to the base line and mark the heights corresponding to the contours crossing the section.
5. Join the points with a line. (Note: This method exaggerates the vertical relief.)

Spot Height

Another feature shown on a map is the spot height or highest point in the area (Trigonometrical Station). It is denoted by a triangle on the map with the height written next to it, usually to one decimal point. The beacon is also numbered with the number written next to it as well. The beacon itself consists of a round concrete base normally painted white, with a black sheet metal vane on top of a pole.



Spot height on a map showing the height above sea level at 196.6 m.

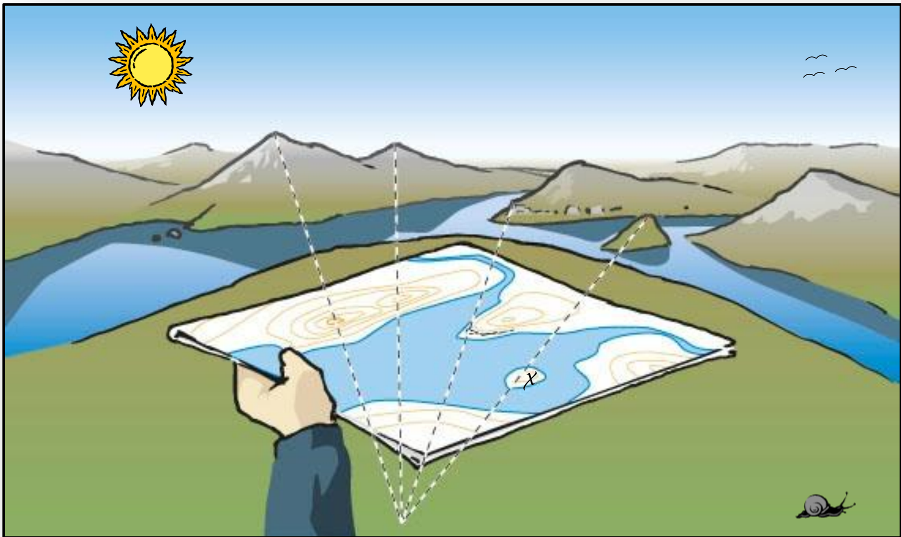
The corresponding beacon - #138

Using maps

Hikers and climbers use maps for three main purposes:

- To determine their own position in the area represented by the map.
- To plan a route between different points or to the next destination from their present position, taking into account the terrain (see the section on the compass).
- To determine distances between obstacles (as discussed under Scale) and
- just maybe to look for lost treasure.

Visual orientation of a map



Using a map to determine your own position

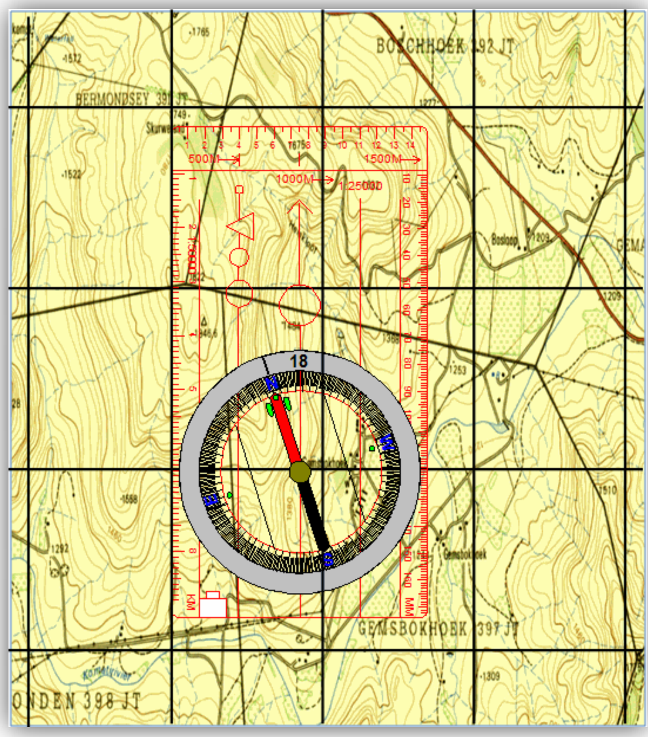
Before you can determine your own position on the ground using a map, you need to orientate the map with your surroundings. This simply means that you need to align the map in such a way that the true north arrow of the map points to true north. The features depicted on the map and the same features on the ground will then lie in the same orientation relative to you. A map can be orientated visually or with a compass.

Visual orientation of a map*:*

1. Observe at least two outstanding terrain features, such as two hills, which should have an angle of at least 60° between them (alternatively, the features can lie behind each other in a straight line, relative to you).
2. Locate these terrain features on the map.
3. Turn the map until the map features and the terrain features are aligned in the same direction relative to you — north on the map will now be approximately aligned with true north.

Once the map has been orientated you can determine where you are from the relative position of other terrain features around you. This is not very accurate, particularly if the terrain features are not clearly defined, or if visibility is very poor. However, visual orientation of the map is an essential, basic procedure. Orientate the map at regular intervals while walking, thus ensuring that you always know exactly where you are on the map.

Compass orientation of a map:



1. Lay the map out flat on level ground.
2. Set the magnetic declination on the compass, here 18°, and place it on the map so that the direction of travel arrow is on a true north grid line or a grid line in the map margin if you are using a compass with a non-transparent base.
3. Gently rotate the map and compass together until the compass needle coincides with the north Index line. North on the map will now be aligned with **True North**.

Having used a compass to orientate the map, you can now visually locate your own position by comparing features on the map with terrain features around you.

Map care

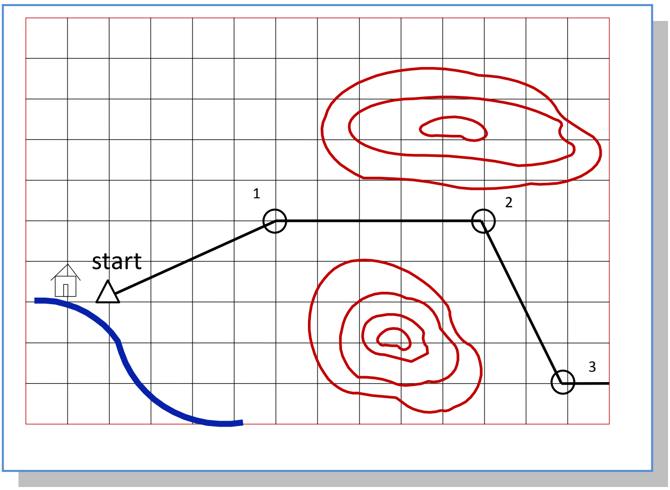
Maps are subjected to a lot of wear and tear. The ink used on maps is not always waterproof and maps can therefore soon become useless in the rain or from a coffee spill. Maps tear easily along folds when they have been folded repeatedly. They can also become so dirty that they can no longer be used.

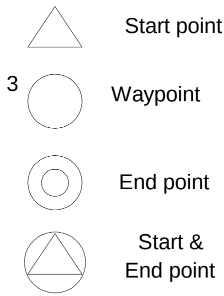
You can protect a map as follows:

Cover it with a clear adhesive plastic covering or spray it with the clear lacquer that is used on block-mounted posters (this also allows the map to be written on and easily cleaned). Some maps can be purchased pre-coated, but the coating used is not always easy to clean. Certain firms also offer a map coating service.

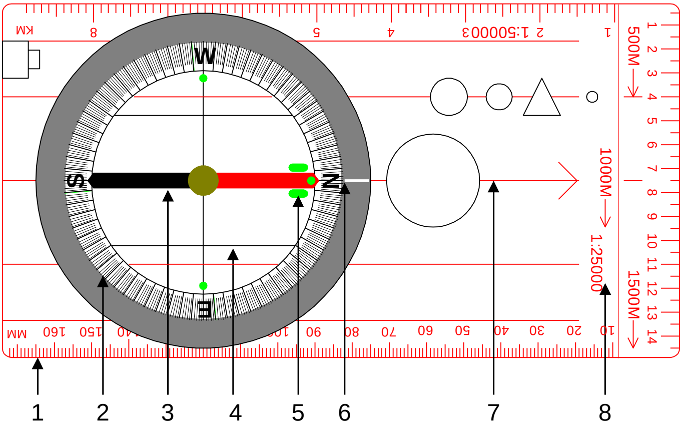
The compass

A hiking compass should be compact, light, robust and easy to use. There are a few compasses available that meet these requirements but the ones similar to the one overleaf are the niftiest and are relatively inexpensive**.** The triangle and circular cut-outs are stencils and are used to draw the start point and subsequent waypoints on your map. The triangle usually denotes the starting point and two concentric circles the end point. A triangle inside a circle denotes that the trail starts and ends in the same place. There is also a magnifying glass incorporated into the base of the compass for enlarging small features or names on the map.





A typical hiking compass



1. The base plate - The mounting for the compass, with a ruler for measuring scale and stencils for marking waypoints on your map.
2. The compass housing - Contains the magnetic *needle* and has the points of the compass printed on a circular, rotating bezel.
3. The compass needle - Floats on liquid so it can rotate freely, the red end should always point to magnetic north. * See page 17 - magnetic inclination.
4. Orientating lines - Fixed within the compass housing and designed to be aligned with the **eastings** on a map. On some compasses half the lines are coloured red to indicate north.
5. Luminous paint – Box for aligning the needle with index line and allows it to be seen in the dark.
6. The index line - Fixed within the outer edge of the compass housing as an extension of the direction of travel arrow. It marks the bearing you set by rotating the compass housing.
7. The direction of travel arrow - Shows the direction that you want to travel along or the bearing you are taking. It is fixed parallel to the sides of the base plate.
8. Compass scale - Displayed along the edge of the base plate so you can measure distances on maps.

* Make sure that your compass is made for the Southern hemisphere.

Bearings

A bearing is the angle between north and a specific point or course measured from a given position. It is always measured in degrees clockwise from true or magnetic north to give a true or magnetic bearing, respectively.

Taking a magnetic bearing to a terrain feature

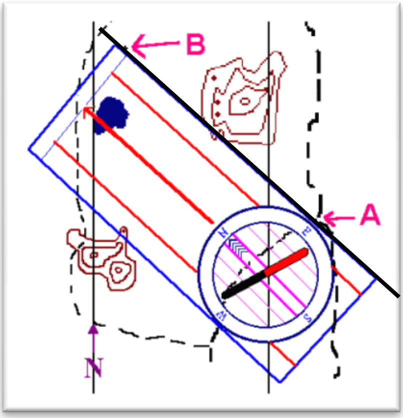
Magnetic bearings

To take a compass magnetic bearing to a visible object:

1. Face the feature or direction to where the bearing is to be determined, holding the compass level in one hand so that the direction-of-travel arrow points directly ahead of you.
2. Aim the direction-of-travel arrow at the object.
3. Turn the calibrated ring, or scale of degrees, (while holding the base plate still and level) until the north end of the compass needle points to the North (0°) Index line on the calibrated ring.
4. Read off the magnetic bearing on the calibrated ring at the index mark.

Map bearings

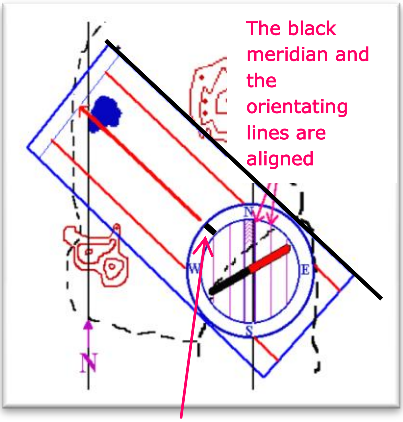
To measure a grid bearing to a destination point:
Silva and Recta or similar compasses can be used as a protractor — this eliminates the need to carry a separate protractor:



Draw a line from your position **A** to your destination, point **B**, on the map.

1. Place the long edge of the compass along this line with the direction-of-travel arrow pointing in the intended direction.

2. Rotate the calibrated ring (while holding the base plate firmly) until the orientating lines align with a north-south grid line on the map.



Index mark – read the bearing on the scale

3. Read off the bearing on the calibrated ring at the index mark (ignore the compass needle). This is a true north bearing and can be converted to a magnetic bearing by adding the magnetic declination.

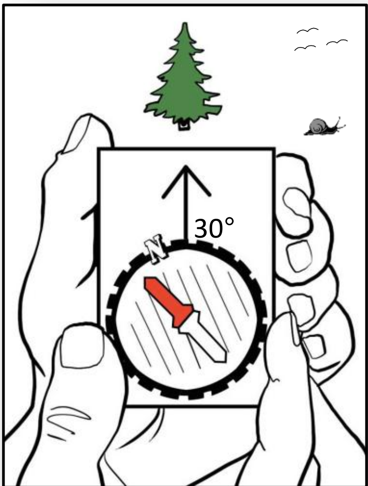
Walking on a bearing:

1. Set the magnetic bearing of your target, say a hill top, on the compass by turning the calibrated ring until the required bearing coincides with the index mark, for example 30°.

2. Holding the compass level, with the direction-of-travel arrow pointing directly in front of you, turn until the compass needle aligns with the orientating lines, with the north end of the needle pointing to the North (0°) Index line. Look down the direction-of-travel arrow and select a distinct feature between you and the hill top, e.g. a single tree or large rock.
3. Once you have reached that object, select another object on the same bearing and repeat the process until you reach your objective.

The ability to walk accurately on a bearing is the most important part of map and compass work and will be considered in greater detail later.

Walking on a bearing



Magnetic anomalies

Magnetic declination ('variation')

This is the angle between the bearing from your position to true (geographic) north and the bearing to the magnetic north pole (magnetic north) indicated by the compass needle. In other words, it is the variation between 'true' and 'magnetic' north. This magnetic anomaly occurs in the horizontal plane.

Magnetic inclination ('dip')

This little-known anomaly occurs in the vertical plane. It is the angle between the direction of the earth's magnetic field and the horizontal. This phenomenon is used to locate the precise position of the magnetic north pole — an inclinometer will point straight down at the magnetic north pole and will be horizontal at the equator.
To compensate for magnetic inclination, compass needles are minutely weighted so as to keep them close to the horizontal in the appropriate 'zones of inclination'. A compass weighted for the northern hemisphere will **not** necessarily function effectively in the southern hemisphere, and vice versa.
Incorrect readings can be obtained using a compass weighted for a different zone of inclination, as the needle might not swing freely. Reputable compasses bought locally are appropriately weighted; be careful though, of compasses you purchase abroad.

Conversion of bearings

Map to compass:

To convert a true **map** bearing to a compass **magnetic** bearing, **Add** the magnetic declination to the true bearing.

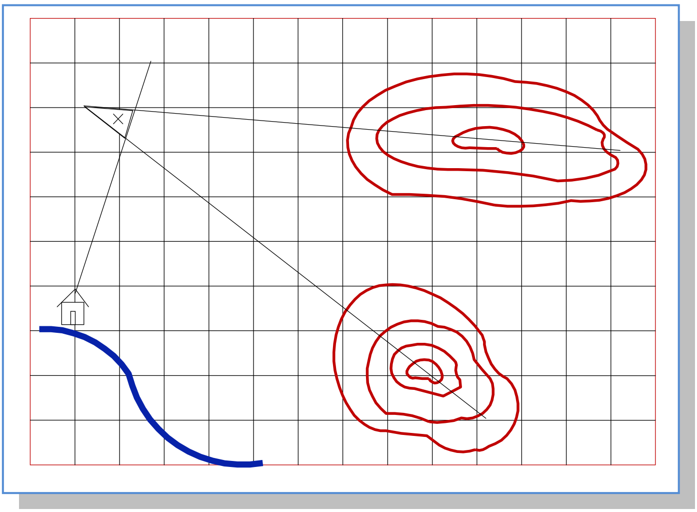
Since the compass needle points to a point on the earth's surface some 17° or so west of true north, you will bypass your objective if you walk on a true **map** bearing without first adding the magnetic declination to it.

Compass to map

To obtain the true **map** bearing, which can be drawn in on the map, **Subtract** the magnetic declination from the compass **magnetic** bearing.
Two useful mnemonics for remembering when to add or subtract the magnetic declination are:
UPMA — Up from the map = add and
DOMS — Down onto the map = subtract.

Determining your own position by resection

Determining your position on a map using compass Resection is a method for locating your position on a map with precision by using a compass. It can only be used when at least two terrain features can be observed which can also be identified on the map.



To find your position on the map, using resection:

1. Identify two or more landmarks on the ground and on the map.
2. Take magnetic bearings to the landmarks.
3. Subtract the magnetic declination to obtain true bearings.
4. Set the true bearing to a landmark on the compass and pencil in a line on the map on that bearing, with the line passing over the landmark. Repeat this process for each landmark with the calculated bearing.
5. The lines will intersect close to your position.

Less accurate map and compass work will produce a larger *'cocked hat'*.

Let us consider these steps in greater detail

- ✓ The terrain features, or landmarks, should be distinct, some distance apart and preferably be at right-angles to each other.
- ✓ At least two landmarks are required, so that you have cross-bearings to fix your position.
- ✓ The compass magnetic bearings must be converted into true map bearings by subtracting the magnetic declination - DOMS.
- ✓ Set the true bearing to the first landmark on the compass. Place the compass on the map so that the side edge of the base plate intersects the first landmark (provided you have a compass with a rectangular base plate). Keep the edge of the plate on the landmark and without disturbing the setting, swivel the compass on the map until the orientating lines are parallel to the grid lines (or the sides of the map) and the orientating arrow points to north on the map. Ensure that the edge of the compass base plate still passes over the landmark and then pencil a line on the map along the edge of the compass. Your position is somewhere along this line. Repeat this procedure for the compass bearings to the other landmarks.
- ✓ If you take bearings to three landmarks it is unlikely that the lines will intersect in exactly the same place. It is more likely that there will be a triangle of error (also called a 'cocked hat'), with your position somewhere in this triangle.
- ✓ The more accurately you work, the smaller the triangle will be.

Identifying unknown points with a map and compass

An unknown peak or feature can be identified if it appears on the map and if you can identify your own position on the map:

1. Find your own position on the map by resection.
2. Take a bearing to the unknown feature and calculate the true bearing by subtracting the magnetic declination.
3. Estimate the distance to the unknown feature, especially if there is more than one feature in the general direction of the unknown one.
4. Draw a line from your position on the map at the angle of the calculated true bearing. This line should pass directly over the unknown feature which can then be identified from the map. The distance is estimated to ensure that the correct feature is chosen on the map.

Back bearings

A back bearing is the bearing in the opposite direction to your objective. Knowing your back bearing allows you to go back to your previous waypoint in case of difficulties with the terrain e.g. a river or gorge blocking the way.

To calculate a back bearing

Take a map bearing or a bearing to a landmark, using a compass:

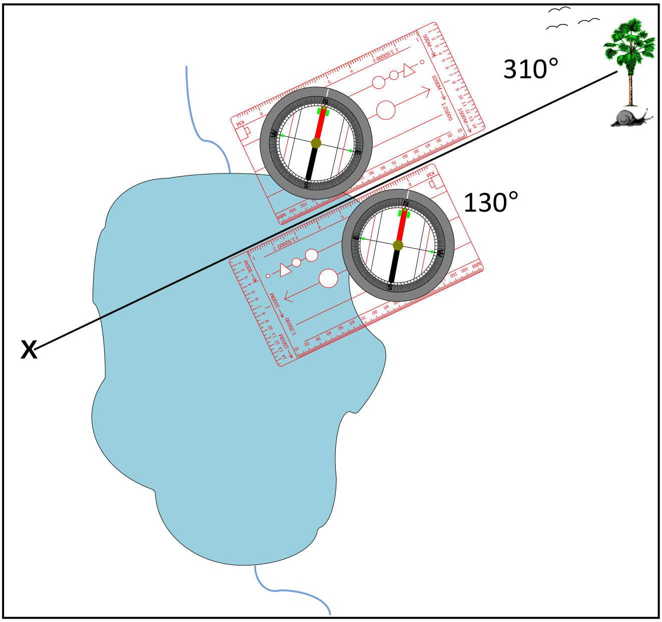
- If the bearing is less than 180°, add 180°.
- If the bearing is more than 180°, subtract 180°.

Example:

Bearing 50° Back bearing = 230° (50° + 180°)

Bearing 285° Back bearing = 105° (285° - 180°)

The relationship between a bearing and a back bearing



A simple means of checking: if the back bearing is greater than 360° you have made a mistake as there are only 360° in a circle.

Situations in which back bearings are useful

- ✓ If you have say a lake in front of you and you are walking on a given bearing, e.g. 130°, and you have no object ahead of you to aim towards, then keeping a visible object or landmark behind you on a constant bearing of 310° will ensure that you will be walking in the right direction.
- ✓ If mist obscures the point ahead of you, while a landmark behind you is still clear.
- ✓ If you are lost: you can retrace your route along the back bearing (this is called backtracking).

Backtracking

If you need to locate a particular place (where, for example, you left an injured person to seek help) backtracking is used as follows:

1. Take a bearing to a landmark in the direction in which you will go for help and which you will easily be able to identify again when you return.
2. Pace off the distance to this point, counting one for every step you take with your left foot.
3. Write down all your bearings and number of steps so that you can remember them for the return journey. When you return, walk on the back bearing from the distinct landmark originally chosen, checking the number of paces.

Walking a route in good weather

- Identify a distinct landmark in the distance which lies in the direction you must walk.
- Look for one or more smaller landmarks somewhat closer but in line with the distant landmark.
- Now you can simply walk from one feature to the next. This permits minimum use of the compass and makes allowance for contouring around ridges and obstacles. You can deviate from the direct route if you need to and return to the original route by realigning the landmarks that you originally identified and using the relative positions of the most distinct features that you pass.

This method works very well when the visibility is good and you can see distinct landmarks relatively far away. Remember to look for landmarks behind you as well as ahead of you; you can occasionally use back bearings to confirm that you are still heading in the right direction.

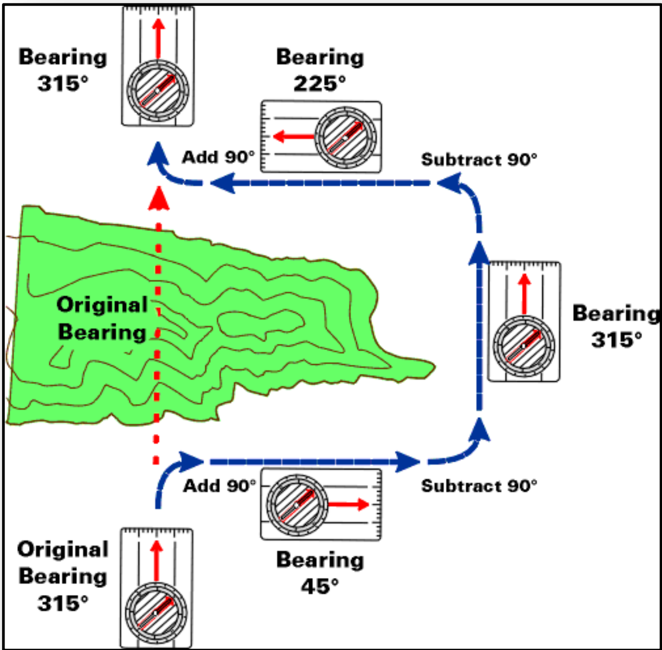
Walking a route in bad weather

- It is much more difficult to stay on course when visibility is limited.
- The same method as described above is used, but the landmark chosen will be much closer. If no landmark can be seen, a person can be sent ahead to act as a landmark. He can move left or right until he is standing in the right direction and the group then moves up to him.

- The process is then repeated. Another way to keep on course is to let the first and last person in the group walk by compass. The last person must check that the person in front (and the rest of the group) is moving in the right direction.

Navigating around obstacles

In thick mist it is very important to keep your compass handy so that you can take a bearing to a landmark if the mist should clear partially even for a few seconds. Remember — if visibility is extremely bad it is better to sit out the bad weather and to move only once visibility has improved sufficiently to allow you to keep moving safely. To blunder on, not knowing whether you are on course or not, is foolhardy and dangerous.



Navigating around an obstacle

If you can see a prominent feature

- If you can see a prominent feature (e.g. a single tall tree) in line with your bearing on the other side of the obstacle, walk around the obstacle towards the feature.
- Continue walking on your bearing to the landmark. If necessary, double-check by taking a back bearing to the point you came from.

If you cannot see to the other side of the obstacle

- On reaching the obstacle, change direction by 90° and walk until you are clear of it; count the number of paces you take.
- Return to your original bearing and walk until you have passed the obstacle.
- Change direction back again by 90° and walk the same number of paces back to your original route; continue walking on the original bearing.

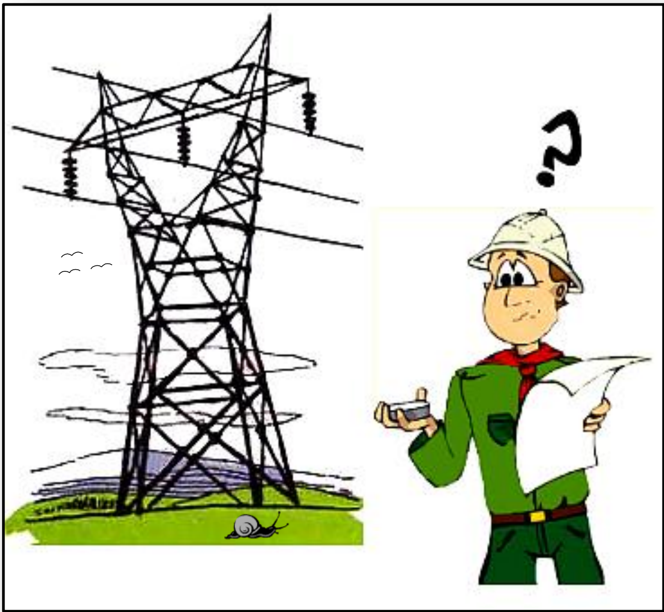
Common navigating errors

The two most common types of navigating error are:

- ❖ Errors of distance.
- ❖ Errors of direction.

Errors of distance are usually due to inexperience, difficult terrain, taking supposed short-cuts, fatigue, or a combination of these.
Errors of direction are usually caused by using incorrect bearings.
Occasionally, obstacles such as a rocky outcrop or dense thorny thickets will require you to change course and walk around the obstacle.

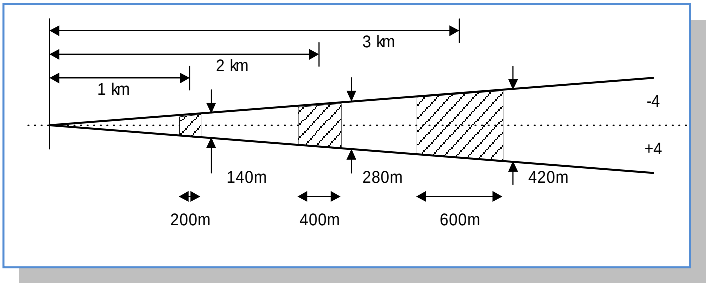
Metal objects such as electricity pylons can play havoc with compass bearings



Some causes of erroneous bearings

- Interference by the earth's magnetic field, caused by metallic deposits in the ground.
- Metal objects in your pockets, fences, power lines, rucksacks, and even spectacles can affect the direction indicated by the compass.
- Not holding the compass level or holding it upside-down. The compass needle will not be able to move freely to align with the earth's magnetic field.
- Aligning the wrong end of the compass needle with north — this 180° error is often made by beginners.
- Using magnetic bearings instead of true bearings, or vice versa.
- The incorrect calculation of true bearings from magnetic bearings, or vice versa.

An error of 4° over a distance of 1 km will give a possible error of 70 metres (an inexperienced person usually makes an error of this magnitude).
An error of 180° results in the hiker going in exactly the opposite direction to the intended direction and therefore gives an error of 2 km after only 1 km has been walked (another mistake commonly made by beginners).
An error of 0,5° over a distance of 1 km will give an error of approximately 9 m (an experienced person with a prismatic compass usually achieves this accuracy).
An error of 20° over 1 km will give an error of approximately 365 m (this is the approximate magnitude of error made in South Africa if magnetic variation is not taken into account).
The magnitude of these errors increases with the distance walked. This implies that even experienced hikers can make some impressive blunders if they do not regularly check the accuracy of their navigation.

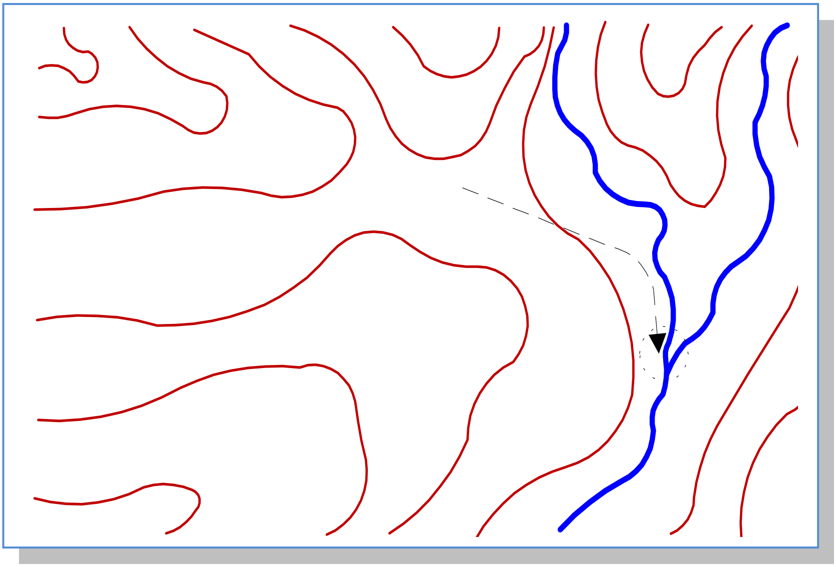


The effect of errors is compounded by distance

Aiming off

If your line of sight is limited and you arrive at the place where, according to your estimate, the point towards which you were heading should be; you are often unable to tell whether the objective is to your left or to your right. The technique of 'aiming off ' is based on the principle that it is virtually impossible to achieve complete accuracy when walking on a bearing.

The technique of aiming off :



By walking on a bearing which is sure to bring you to the left of the river junction, you are ensuring that you will simply have to turn right once you reach the river.

Instead of trying to achieve complete accuracy, you can deliberately build in a slight deviation in the bearing (e.g. 2°) and when the correct distance or a predetermined marker has been reached, the built-in 'error' indicates to which side the correct destination lies.

This built-in deviation should be about 1° more than the accuracy you usually achieve, to ensure that you are on the side to which you are aiming off.

Assume, for example, you were walking the route indicated in the diagram above, aiming to reach the junction of two rivers. If you aimed off as indicated, you would know that, on reaching the first river, you only had to turn right and walk along it in order to reach your destination.

Had you tried to walk on the precise bearing, you might have arrived to the right of the junction and 200m 400m 600m would not have known whether it was to your left or to your right.

Night navigation

Night navigation is difficult, even for experienced hikers, since landmarks usually cannot be observed and bearings therefore cannot be taken. In addition, it is very difficult to estimate distances at night. Plan a route which can be divided into stages which end at very distinct features, such as a river. Avoid heading towards dangerous points, such as the edge of an escarpment, and keep the stages short. Prior to a night hike, or even before planning the various stages of a night hike, you should know your exact location on the map. Work out compass bearings and distances for each leg of the hike and write them down in the side margin of the map. Set the first bearing on the compass and proceed, keeping as accurate a pace count as you can. At the end of each stage you should confirm that you have in fact reached the point you were aiming for, before continuing with the next stage.

Common sense navigation

- ✓ Above all, you should try to know at all times where you are on the map.
- ✓ Trust your compass, not your sense of direction, especially when tired, pressed for time, or in bad weather.
- ✓ Try to stay clear of metal objects when using a compass.
- ✓ Maps age — check the date of the survey if you suspect that the map does not show all the man-made terrain features.
- ✓ Get the latest magnetic declination for the area.
- ✓ Plan your route ahead.
- ✓ Observe the terrain around you and form an idea of the relative position of landmarks around you; try to anticipate when certain landmarks will become visible.
- ✓ Plan and execute your route in stages, or legs — keep direction by using landmarks in the far distance with a few closer ones in between.

- ✓ Use an off-route landmark that can be seen from almost anywhere along the route. This gives a good reference point at any time or place along your route.
- ✓ Use the technique of aiming off.
- ✓ Remember that you do not always see the true top of a peak when lower than the summit but that trigonometric beacons are excellent reference points.
- ✓ Contouring is often (but not always) easier and faster than a direct route.
- ✓ It is best to sit out conditions in which visibility is too poor to allow you to take any bearings:

  'when in doubt, sit it out'.
- ✓ Remember that you need to continue supervising the group even while coping with the problems of navigation.
- ✓ Experience, acquired by night and by day, in all weather conditions, is the best teacher.

Emergency navigation

Or what to do when your GPS quits on you or you've dropped the compass and now it's bust. And no you don't have to bend over and kiss your ass goodbye.

There are two things to do in any stressful situation, especially if you're standing in the middle of nowhere and you have no idea where to go.

1. Stop, sit down and rest.
2. Think rationally and try not to panic – deep breaths.

   Do the following:

- ✓ Take stock of your situation, hopefully there are no injuries.
- ✓ Try to look for shade or use a groundsheet to make a temporary shelter.
- ✓ Check on your food and water supply in case you need to ration yourself. You can survive a long time without food, but you need water to survive.

For a start, it may be a good idea to climb a hill and get a good look around. Try to look for traces of human activity – smoke rising, dust clouds from vehicles, groups of trees (most farmers shelter their houses with tall trees), cattle, sheep and windmills etc. These are good indications of civilization nearby. If you don't see anything, you should try and figure out which is the best direction to travel in. Hopefully you might have one of the big rivers nearby or perhaps the sea, especially if you're in the desert of Namibia. Walking westwards in this case will eventually lead you to the coastline and then it's a matter of heading either up or down the coast where you're bound to find a resort or town.

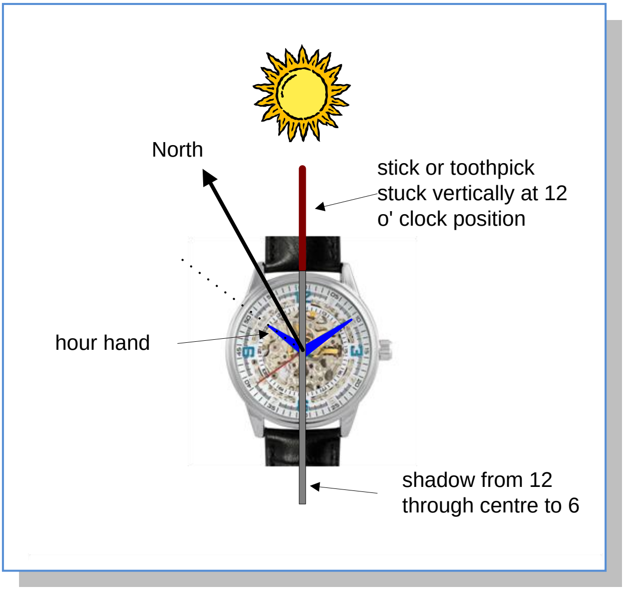
If there are trees in the area, have a look if they have moss growing on them as moss only grows on the south side of trees here in the southern hemisphere.

Moss growing on a tree trunk

This is why it is so important to plan your hike meticulously before leaving home. If you haven't got a map, try to draw one from the terrain in front of you and try to mark off where north is using the methods below.
If you have a map, try to determine where you are.

Using a watch as a compass

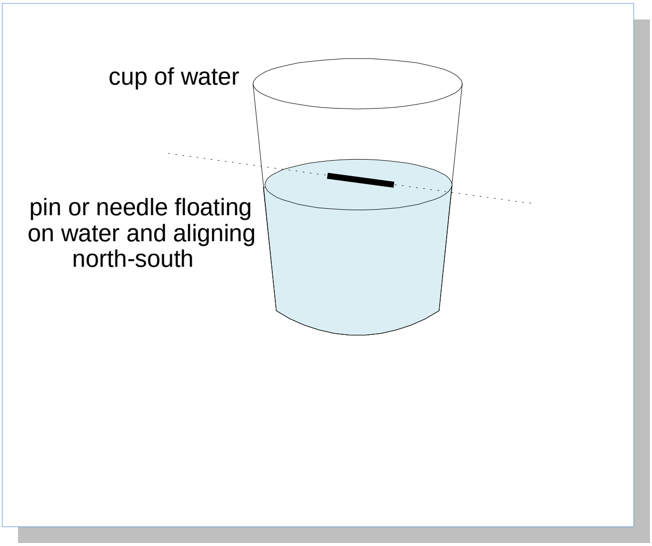
A rudimentary compass can be made using your wristwatch.



Jam a matchstick, toothpick or short blade of grass sticking up vertically at the 12 o' clock position, between the case and strap. Point your arm with the 12 o' clock pointing at the sun so that the shadow from the stick passes through the centre of the watch down to the 6 o' clock position while keeping the watch **parallel** to the ground. If you now bisect the arc formed by the hour hand and the 12 o' clock numeral, you have an approximate true north. If your watch is a digital one, then note the time. Draw an analogue face on a piece of paper or directly on your arm, with an hour hand pointing to the current hour. Place the paper on the ground with the 12 o' clock facing the sun or point your arm at the sun and hold your pen vertically at the 12 o' clock numeral. Turn the paper or yourself slowly till the shadow passes through the centre and the 6 o' clock numeral. Bisect the hour hand and the 12 o' clock numeral to find approximate true north.

An alternate compass

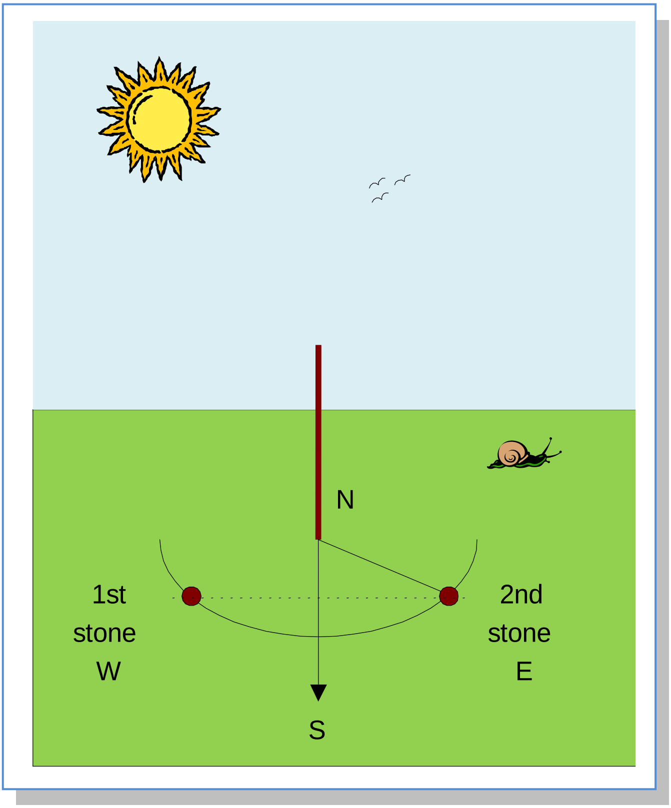
If you broke the compass don't panic, hopefully the needle is still available. Take a



glass or a container (non metallic) with some water in it and try and see if the needle will float on the water. It will settle and point to north. If you can't get it to float, place it on a leaf and then try and get the leaf to float, just be patient.

If anyone has a pin or sewing needle in their kit, you can rub it on a woollen item and then float it on the water. The only problem here is that it will align north-south, so you won't know which way is north. If you take the sun's position into account, you should be able to work out where north is, (the sun rises in the east and sets in the west), if it's not overcast that is. It would be a good idea to magnetize a pin or needle at home before going hiking just in case.

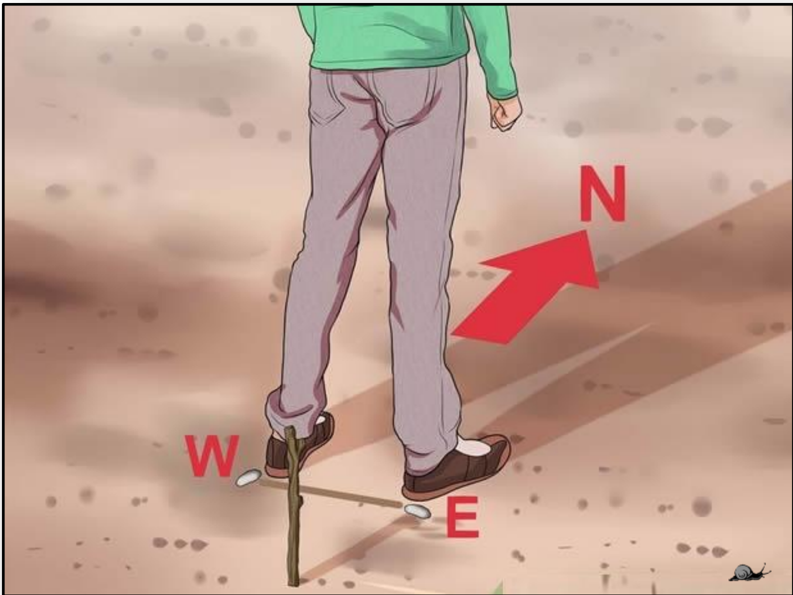
Using the sun and a stick



Find a stick about a metre long and peg it vertically into the ground. Make sure that the area around the stick is flat and clear of obstructions. By the way the best time to do this is either side of midday, say between 10 o' clock and 2 o'clock. Make a mark on the ground where the shadow from the stick ends or place a small stone on the ground as a marker; this is the West stone. Now take a shoelace, a piece of string or rope and tie a loop on one end. Drop this loop over the stick and pull it outwards towards the stone you placed on the ground and draw a semi circle in the sand. Now wait till the sun passes over and the shadow again just touches the arc you made in the sand. Make a mark or place another stone there; this is the East stone. Now draw a straight line from the first stone across to the second stone. This line lies East-West. If you stand with both feet planted over this line and the east stone is on your right hand side and the west stone on your left hand side, you will be facing true North and vice versa for South.

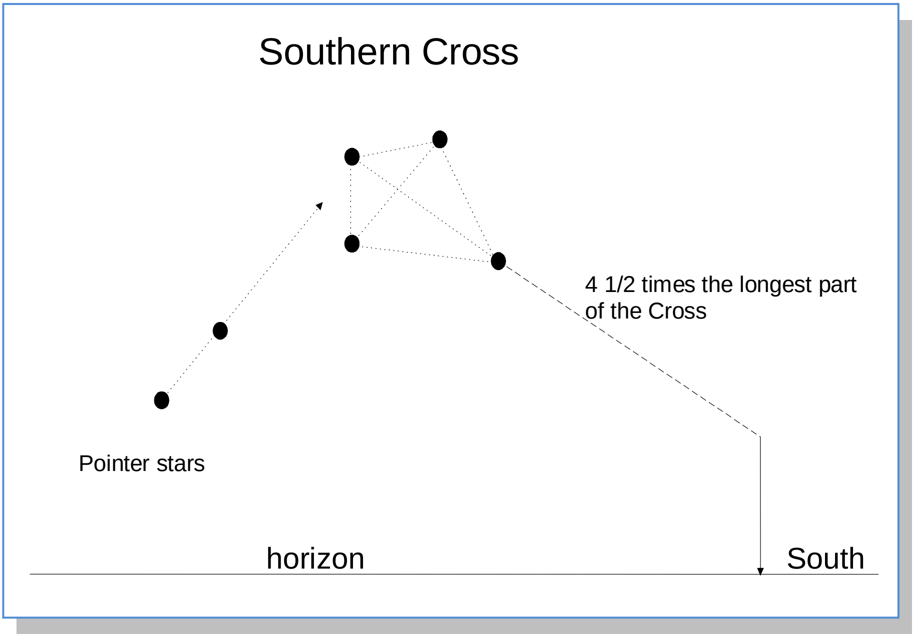
If you're in a hurry or impatient, you can use a shorter version of the above procedure. With your stick stuck vertically in the ground, place your first stone on the ground where the shadow ends. Wait fifteen minutes to half an hour and place a second stone over the place where the shadow now ends. Draw a straight line between the two stones, again this line lies East-West. Now find North or South the same way as for the longer version above. Note that this will give only a general northerly direction, it's not that accurate.

A quick method for finding true North or South.



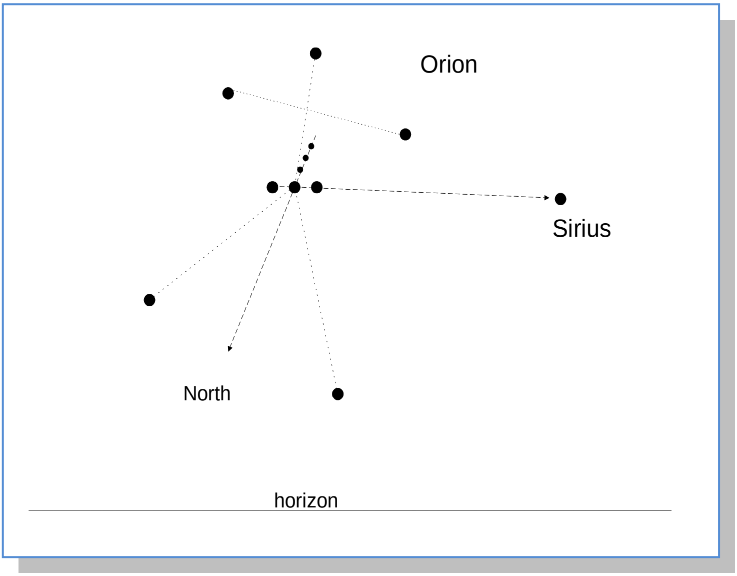
Using the Stars

At night time we're lucky, here in the southern hemisphere, as we have two star constellations that we can use to steer either north or south. The easiest constellation to find is the Southern Cross, which looks like a kite flying in the sky. To locate the correct cross (there are a number of false ones up there)



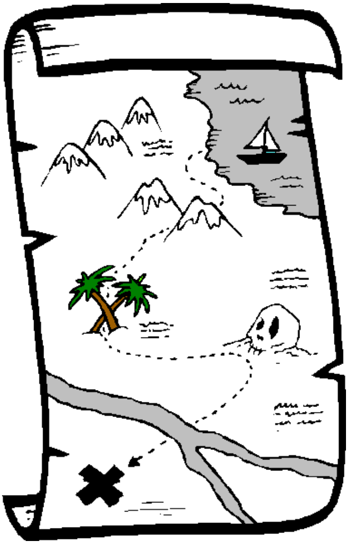
locate the two pointer stars that aim directly at the top of the kite. Note that the position of the kite, or Cross, changes during the year as well as at different times of the night, so it could be lying on its side or pointing upwards or downwards. The trick now is to make a fist and raise your arm, pointing it at the Cross and aligning your hand with the long axis so that you can measure the distance between the top of the cross and the bottom (where you would tie the tail if it were a real kite). Using this distance, draw an imaginary line four and a half times in length in line with the longest axis, (as if a tail is pointing straight out from the kite). Now drop a vertical line straight down to the horizon. This is **South**.

The other constellation that one can use is Orion, but the problem here is that unlike the Southern Cross, it is not always visible. If you can locate Orion, you will see that he looks like a kids drawing of a stick man, with three stars forming his belt. If you draw an imaginary line through his belt out to the right you will see



Sirius, the brightest star in our solar system. If you now look carefully you will notice three faint stars at a slight angle pointing to the middle star of his belt. This is the hilt of his sword that is stuck into his belt. Again using your imagination, draw a line through these three stars, pointing down through the middle star of the belt and bisecting his two feet till it touches the horizon. This is **North**. It is best to find somebody who is familiar with these constellations and ask them to point them out to you, as this could just save your life one day and besides, isn't it fun learning about the starry sky?

Looking for Treasure



Do's and Don'ts of treasure hunts

- Do not tell anyone, if you value your life.
- Keep a look out for strangers around you.
- Code all your clues and keep them locked in a safe place.
- Plant red herrings on your map.
- ...... :)

Though I speak in jest, there is a hobby that is growing very rapidly in SA and that is the art of metal detecting. Map craft is essential in covering the vast areas that we have, especially out in the 'Battle Fields'. There are huge areas that have never been explored and remember that there were many block houses built everywhere by the British during the Anglo Boer War. This chapter is just a basic review of metal detecting and one should join a club to get proper training and help. Successful treasure hunters will tell you that proper research will save you time and frustration.

The most important techniques include a combination the following:

- Proper Ground Balancing
- Correct Sensitivity
- Sweeping an area at different angles
- Sound knowledge of the machine you use and the interpretation of its signals......... Practice makes perfect
- Sweep speed and overlapping of sweeps
- Keeping the coil level and low to the ground without bumping it.

An essential component of metal detecting is the search pattern you use and a grid search is the best. Mark your area clearly and make sure that you walk in straight lines and overlap your previous path. Use empty 2 litre cold drink bottles filled with water or sand and sprayed ‘dayglo’ orange for markers. Don’t sweep too large an area at once, break your grid up into smaller areas and mark these on your map for when you return at a later date. Archaeologists and divers use a lattice work of rope and poles to form a grid that is then worked square by square.

There are many areas where one can search. Collect old map books at flea markets. These usually have an index showing areas of interest like open parks, picnic spots and sports stadiums. Larger maps of famous battle sites will help. Old paper maps are treasure themselves so keep a look-out for them. Visit your local museums as well as the fantastic war museums that we have around the country. It is also important to take note of local and national laws and request permission before hunting on private property.

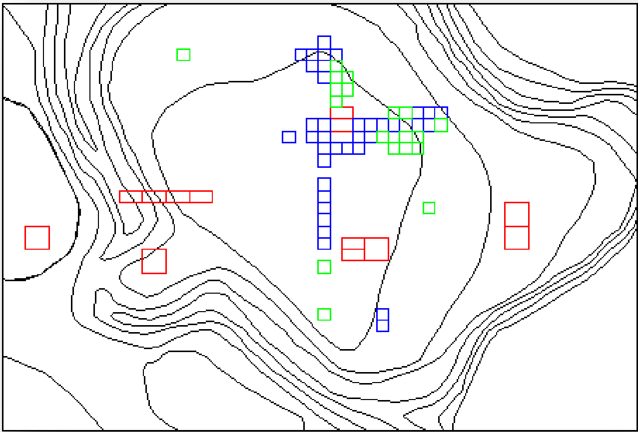
Record keeping

It is important to organise your records into the 3 main categories:

- Written record, description and location.
- Plans, Sketches and graphic location details
- Photographs

Search Areas

From these records you can then start the work on reporting and illustrating your work. On a clean map, plot out all your sites (in red, green and blue perhaps to denote those that have been done or those still to be done and the ones that were successful) and put the site number next to them.



Typical discoveries

Notes:

References:
The South African Mountain Leadership Guide.
Topographical Maps - National Geo-Spatial Information
Has anyone seen my pet, Dale the snail?

10 Essentials for casual day hikes

1. Map of area (in a case or covered with adhesive plastic)
2. Compass
3. Torch with extra batteries and bulbs (a headlamp leaves both hands free)
4. Emergency food supply and water bottle (energy bars, Super C, etc.)
5. Pocket knife (with tin opener)
6. Matches in waterproof container & a lighter
7. Storm gear (sweater, anorak, gloves etc.)
8. Whistle
9. Emergency shelter/space blanket
10. Personal First Aid Kit

Other items required on longer hiking trips

1. 5-litre water bag (box wine packet)
2. Handkerchief (very useful for wiping away perspiration!)
3. Sunglasses
4. Toilet paper
5. Ground sheet
6. Closed cell foam pad
7. Mug, plate, eating utensils
8. Sun block lotion and lip protection
9. Insect repellent (Peaceful Sleep – stick type)
10. Nylon cord
11. Pots, pans ('billies'), scouring pad
12. Billy grip for handling billy pots.
13. Stove, fuel and accessories (e.g. pricker for primus stoves)
14. Shelter (tent and accessories)
15. Sleeping bag and stuff sack
16. Sleeping bag inner (for mountain terrain or cold areas)
17. Repair kit (wire, cord, needle, thread, pins, clevis pins and split rings)
18. Candles or other lighting
19. Camera and film (also binoculars)
20. Inexpensive watch
21. Glasses strap for people who wear glasses
22. Small metal mirror (can also be used for signalling in emergencies)
23. Personal toiletries (toothbrush, etc.)
24. Housewife (sewing kit – magnetize a needle for emergencies)

25. Rucksack cover
26. Money
27. Entry permits and membership cards of mountain club (passport, if required)
27. Extra plastic bags – black as well as Ziplok
28. Clothing: shorts; collar shirt; underwear; socks; pullover; hat; gloves
29. Winter clothing, if required: thermal underwear; rain-pants; balaclava; mittens, outer gloves; down clothing; snow goggles

Notes:

Glossary of South African Names.

Berg: a **South African** word for mountain.

Berg wind: (from Afrikaans **berg** "mountain" + wind "wind", i.e. a mountain wind) is the **South African** name for a katabatic wind: a hot dry wind blowing down the Great Escarpment from the high central plateau to the coast.

Burg: Obs. a fortified or walled town. Informal a city, town, or village, esp. one regarded as quiet, unexciting, etc. Appended to town names in South Africa: Johannesburg for example.

Dorp: a village or small rural town.

Drift: a loose unstratified deposit of sand, gravel, etc, especially one transported and deposited by a glacier or ice sheet; also a ford: a shallow place in a river or stream allowing one to walk or drive across.

Donga: a narrow steep-sided ravine formed by water erosion but usually dry except in the rainy season.

Kloof: a steep-sided, wooded ravine or valley.

Koppie: a small hill in a generally flat area.

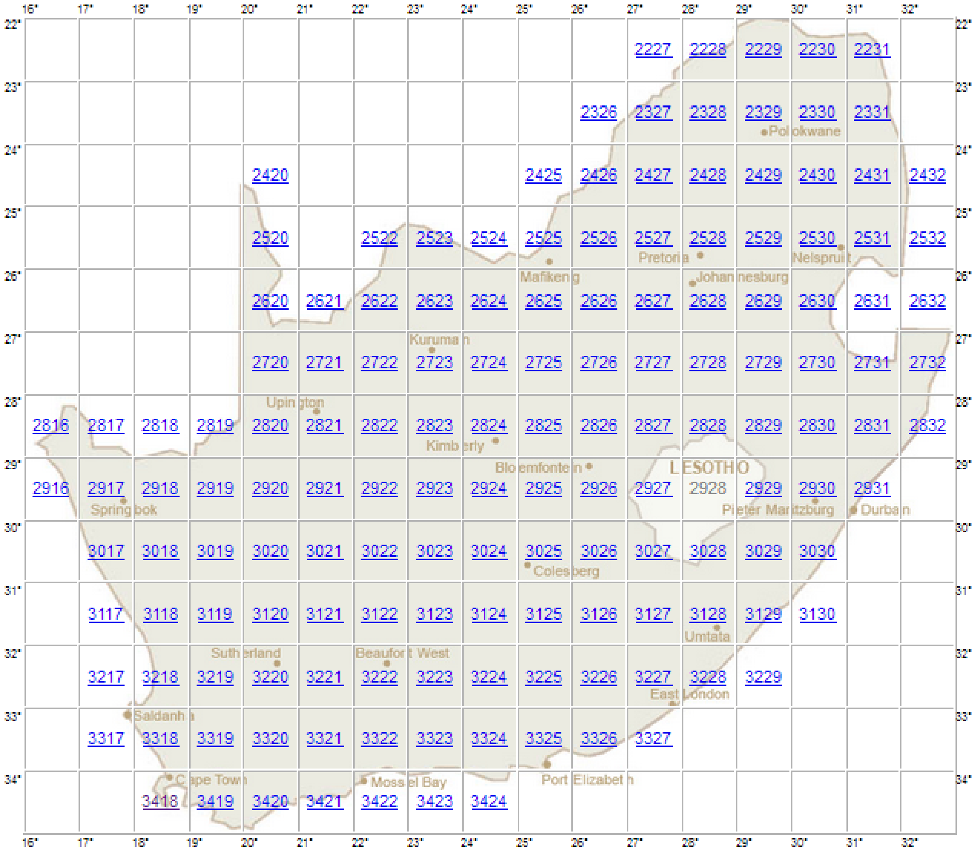
Nek: a mountain pass

Poort: a steep narrow mountain pass, usually following a river or stream

Spur: a mountain ridge projecting laterally from a main mountain or mountain range (not the chain of steak houses in South Africa).

Veld: is a type of wide open rural landscape in Southern **Africa**. Particularly, it is a flat area covered in grass or low scrub, especially in the countries of **South Africa**, Lesotho, Swaziland, Zimbabwe, Botswana and Namibia.

South African map system:



Typical topographic map