OUTDOOR COUNCIL OF CANADA
CONSEIL CANADIEN DE PLEIN AIR
Partners In Leadership / Partenaires En Leadership

Get Outside -GO (Use a Compass)

Student Manual

Second Edition

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Table of Contents

Introduction

Navigation is a vital aspect of outdoor leadership at any level of activity or terrain choice. As terrain becomes more complex, navigation becomes more challenging and requires a higher level of skill.

Navigation is in fact something we do all the time. We successfully find our way around our house, our neighbourhood, and other places we visit frequently. Most of the time this is an effortless process since we have a comprehensive mind map of these places. This helps us recognize where we are and how to get to where we want to be.

As we move from familiar to unfamiliar places, we need to collect additional information to keep track of where we are and where to go. This can become very complex and challenging. Building navigational skills should be seen as a work in progress requiring practice and self-discipline. This will build reliable competence even for the most challenging navigation techniques.

About this course

The GO (Use a Compass) course is part of a program at supporting the development of foundational outdoor skills. The aim of this course is to provide students with knowledge and applied opportunities to develop skills to navigate with a compass in order to:

a) Help the student become more proficient in navigating in familiar terrain
b) Help the student become more proficient in the use of maps for terrain recognition and navigation.

Chapter 1

The Compass

If you are hiking in terrain with lots of features, good visibility, and a topographic map you will rarely need to use your compass. Where the terrain lacks features, the visibility is bad, or both, a compass becomes an important tool.

Navigating such featureless terrain is very challenging. This requires a high degree of skills, which are usually honed over years of experience. Consequently, this course is not designed to certify to that level. However, even in highly-featured terrain a compass can be useful to help you check that you are on track, with route finding, and with identifying your surroundings.

There are many types of compasses, but the one most suited for most outdoor activities is the base-plate compass. For the type of navigation this course is designed for, an adequate base-plate compass will have the features named in Figure 1.

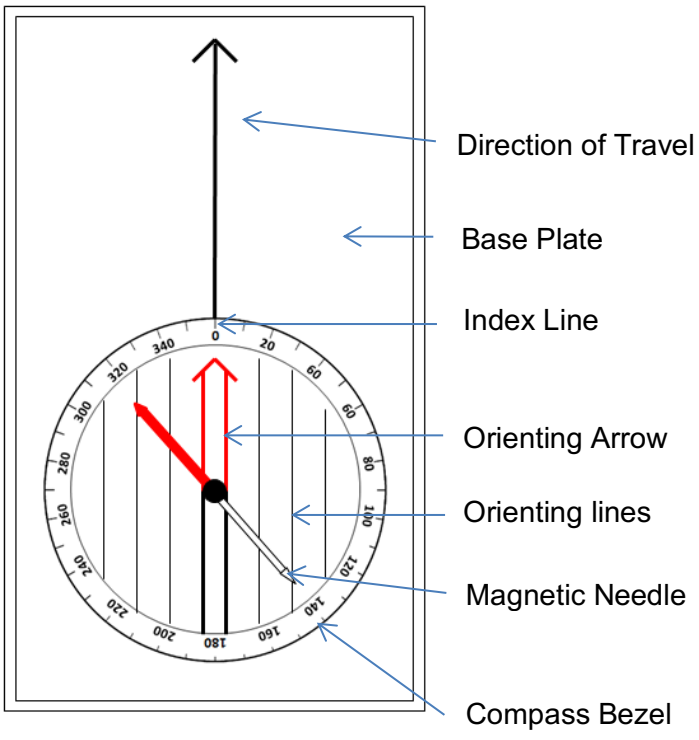

Figure 1: The parts of a Base Plate Compass

Chapter 2

Using the Compass without a Map

The compass can be used without a map to take a bearing or follow a bearing. A bearing is another name for direction. Taking a bearing means figuring out what direction something is relative to your current location, or another feature. Following a bearing means walking in a particular direction. To do either of these things we will need to introduce the compass bezel.

The Compass Bezel

When you look at the compass bezel, you will notice that it is marked with a set of numbers that usually jump in sets of 20 from 0 to 340. Outside of those numbers will be marks that are finer divisions of the circumference of the bezel.

The arcs of a circle add up to 360°. Thus, on the bezel, the 360° mark is the same as the 0°. The 0° or 360° mark is associated with North, 90° with East, 180° with South and 270° with West.

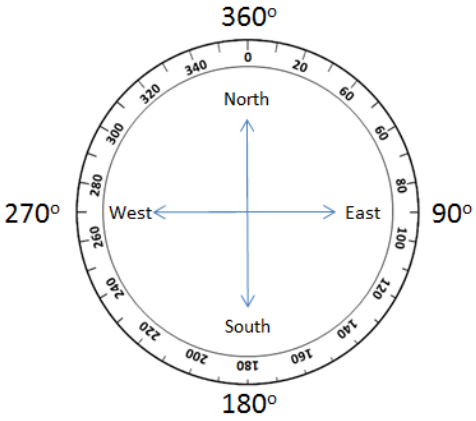

Figure 2: The Compass bezel (with the four Cardinal Directions indicated)

The Magnetic Needle

Inside the Bezel is a chamber filled with mineral oil in which the Magnetic Needle rotates (see Figure 1). The oil is there to dampen the movements of the needle for ease of use. In order for the needle to rotate freely, the compass has to be held approximately level. If it is tipped too much, friction may prevent it from giving you an accurate reading.

The Magnetic Needle aligns itself with the magnetic field of the earth. The needle is marked so that the red end points toward *Magnetic North* and the white end points toward *Magnetic South*. Because the needle always points north, you can always find this direction and use it to find other directions.

A word of warning: if the needle is too close to magnetized metals, like steel, or other magnets (e.g. cell phone) it will no longer point North. Be aware that radios and avalanche beacons contain magnets and if you hold the compass close to them they will affect the reading. To be sure this is not happening, keep the compass about a 30cm away from metal or other magnets.

Underneath the floating needle is another arrow marked onto the bottom of the oil-filled chamber. This arrow is called the orienting arrow (see Figure 1). In less-expensive models this arrow is fixed and is always pointed at the 0^{o} point on the bezel. (In more expensive models it can be rotated so that it points elsewhere. There will be more about that later). Whether you are taking or following a bearing you will want to align the magnetic needle with the orienting arrow.

The Base-Plate

The compass bezel is attached to, and rotates on, the transparent base-plate (see Figure 1). Marked on the base plate is the Index Line that ends in the Direction of Travel Arrow. If you are taking a bearing, the Direction of Travel Arrow will need to be pointing at the landmark you are getting a bearing for. If you are traveling on a bearing, the direction of travel arrow will be pointing in the direction in which you should walk.

Holding the Compass

When using the compass to take or follow a bearing it is very important that you hold the compass correctly. Hold the compass about 30 cm (1 ft) in front of you and at the level of your sternum (mid ribcage). The direction of travel arrow needs to be pointing away from you and square to your chest.

Figure 3: Holding a compass

Taking a Bearing

By taking a bearing on a landmark, such as a mountain top we mean finding what direction it is relative to Magnetic North.

To take a bearing:

1) Hold the compass in the correct body position
2) Rotate your whole body until the direction of travel arrow is pointing directly at the landmark you want a bearing for (Figure 4, icon #1)
3) Holding the base plate steady, rotate the bezel on the base plate until the orienting arrow lies directly under the magnetic needle (Figure 4, Icon #2)

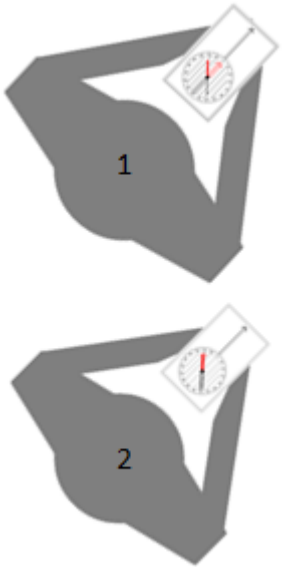

Figure 4: Steps in taking a bearing

Now that you have taken a bearing, what does it mean and what can you do with it?

First of all, notice that the 0^o mark is most likely no longer aligned with the index line. In the example in Figure 4 the 40^o mark is aligned with the index line. This means that the landmark you have taken a bearing on is located 40^o to the east of Magnetic North. It is a good idea to record the bearing. This way, if the Bezel is moved, either accidentally or because you have taken another bearing, you can remember what the initial bearing is.

If you come back to this exact point, or a friend is going to be there later, the landmark will always be on that bearing. This can be useful to locate that landmark at a later date. You can also use this bearing to walk to the landmark even if for most of the journey between here and there you can't actually see your destination due to weather or forest cover for example.

Following a Bearing

Once you have a bearing for a landmark, you can get to it by following that bearing. In Figure 4 that would mean walking at a 40^0 angle to Magnetic North. This can be harder than it might at first appear.

If you were to keep the compass oriented with the magnetic needle over the orientating arrow and then walk in the direction of the direction of travel arrow, you would get there. However, this is not really a practical thing to do, especially when walking over rough ground. There are often objects like trees, rocks, streams, etc. in the way that force a detour. It is more practical to follow a strategy like this:

1) Pick an object such as tree or a rock that is on the line between you and the final destination. This object must be close enough that you can keep it in sight while you walk to it.
2) Once you have reached the first object, use your compass to locate another object that is on the same bearing and then walk to that. Note that as you take this second bearing you do not need to be able to see the final destination to know where you are going.

Chapter 3

Using the Map and Compass Together

In order to use a map and compass together, we need to know about the three different types of North.

The earth rotates around an axis and that axis joins two points on the surface of the earth. These are the North and South Poles. If you travel in a straight line from where you are to the North Pole, you are traveling True North. Ironically, true north is the one north you don't need to use to navigate with a map and compass.

If you look at your topographic map you will see grid lines that run from the bottom of the map to the top. These lines are almost oriented toward True North, but not quite. They are oriented toward Grid North. Grid North is slightly different from True North due to the difficulties of representing a 3D Earth on a 2D map, but the difference is small enough to be irrelevant for most navigational purposes.

The third north is Magnetic North. Why, you might ask, do they not just align the map with Magnetic North and make life simple? Unfortunately, Magnetic North is constantly moving. It currently lies somewhat south of the North Pole and is slowly migrating north. That means that it is in a different place every year. This means that the bearing for Grid North with respect to Magnetic North is different for every map and different every year. This difference is called the declination. We need to know what the declination is in order to use our compass with a map.

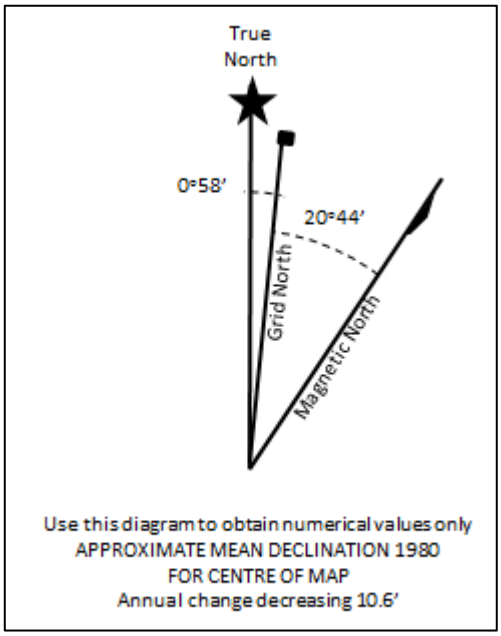

Figure 5: True, Grid and Magnetic North

Calculating Declination

Every topographic map will have somewhere on it a diagram like that in figure 5. This diagram allows you to calculate the relationship between True, Grid, and Magnetic Norths for your map and for this year.

Since we are not concerned about True North, the only thing you need to look at is the relative positions of Grid and Magnetic North. Be aware that the relationship

between Grid and Magnetic North depends on where you are on the face of the earth. The diagram in Figure 5, is from a particular topographic map, which happens to be for an area along the BC-Alberta border. If you look at a map to the East or West of this map, and to a lesser degree, a map North or South, the relationship between the two Norths will change

You will notice that Magnetic North lies east of Grid North. If you look at a map in Ontario, Magnetic North would lie to the west of Grid North. There is a line that currently runs through Manitoba where Grid and Magnetic North are the same. That line is slowly moving west.

The number 20°44' is the angular difference between Grid and Magnetic North on the date stated in the text below. (i.e. 1980) You should know that 44' is shorthand for "44 minutes" and that there are 60 minutes in one degree.

The last line of text tells us that the angle between Grid and Magnetic North is decreasing by 10.6' each year. In the year 2014, the declination for this map will have decreased by 34 times 10.6', which is 360.4' or 6°. Since the declination in 1980 was 20°44', in 2014 it will be 14°44'. Since we cannot read our compass to such a fine accuracy we will round that up to 15°.

_____	-	_____	=	_____	
Current year		map year		# of years	
_____	x	_____	=	_____	
# of years		min. yearly change		min. of change	
_____	/ 60 =	_____	°	_____	'
min. of change		° of change		+ remainder	
_____	-	_____	=	_____	
old declination		change		current declination	

Adjusting for Declination

For our first task, we will align the map with the real world. Place the compass on the map so that one edge of the base plate is parallel with a North-South grid line (blue line). Then, rotate the map so that the compass needle is over the orienting arrow. The map is now aligned so that the map's grid lines are pointing toward Magnetic North. (Figure 6)

But what we want is to align the map so that the grid lines are pointing toward Grid North. To do that we will need to adjust for declination.

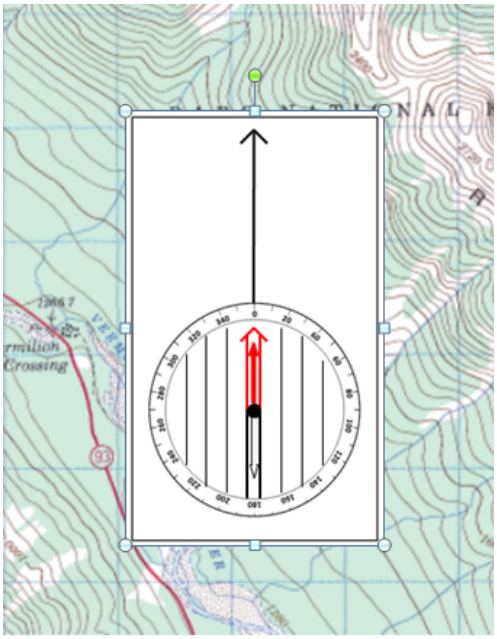

Figure 6: Map oriented toward Magnetic North

If you look at Figure 5 you will see that Magnetic North lies east of, or to the right of, Grid North. If the map were correctly aligned, the 0º (360º) mark on the compass bezel would be pointing toward Magnetic North. For that to happen, the bezel would need to be rotated on its base in a clockwise direction for 15º. This would result in the index line being aligned with the point on the bezel that equals 360º minus 15º, which is 345º.

So, to correctly align this map, first rotate the bezel so as to reduce 360º by 15^0. Now place the compass on the map with the base plate against the grid line as before. Now rotate the map so that the needle rests over the orienting arrow. Now the map is aligned so that Grid North on the map points toward Grid North and the orienting arrow is pointing toward Magnetic North, as in Figure 7. A good double check is to compare the angle on your compass to the diagram on your map. If they look similar, you have done this correctly.

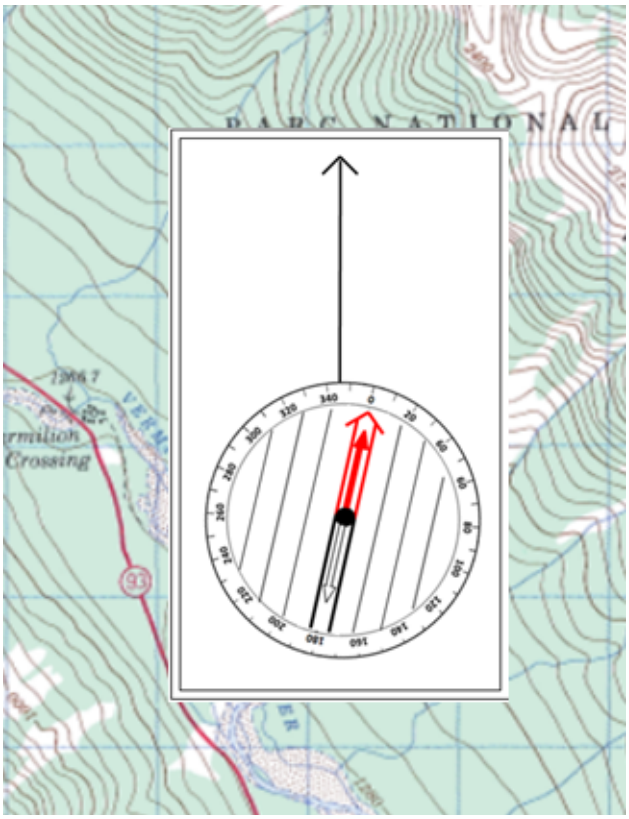

Figure 7: Map oriented toward Grid North

In this case, because the map is for Western Canada, where Magnetic North is east of Grid North, we **deducted** the declination from 360º. A useful way to remember this is the phrase East is Least.

In Eastern Canada, Magnetic North is West of Grid North, and so you have to **add** the declination to 360º (0º). Note also that whereas declination is decreasing each year in the West, it is increasing in the East.

Calculating a Bearing from a Map

You will recall that when we took a bearing on a landmark with a compass alone, we did not adjust for declination. However, doing so when taking a bearing to a landmark on a map will not work. This is because the map is aligned with Grid North and the compass is aligned with Magnetic North. Thus, declination will need to be factored in when taking a bearing on a map and using it on a compass to the real life landmark.

In Figure 8 we are going to calculate the bearing for an unnamed peak as seen from the highway at Vermillion Crossing. This we achieve in 5 steps.

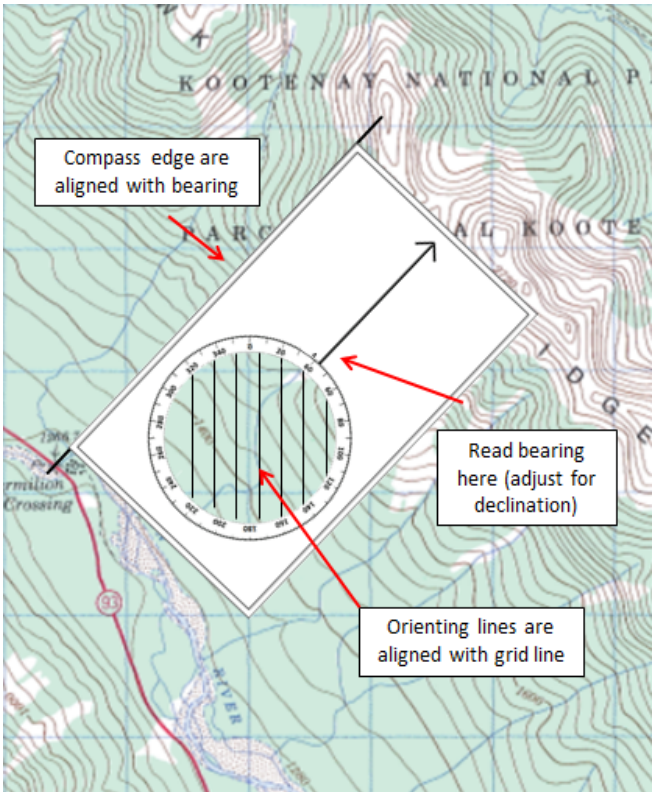

Figure 8: Taking a bearing from the map

1) With a pencil, draw a straight line that joins the two points
2) Align the straight edge of the compass with the pencil line. Since that edge is pointing at the summit, the Direction of Travel Arrow is pointing in the same direction.
3) Turn the Bezel so that the orienting lines within the compass are aligned with the grid lines (Hint: this is easier and more accurate if you slide the compass up and down the pencil mark until one line is very close to the grid). During this step, confirm that the 0 ^{o} mark on the bezel points to the top of the map. Otherwise, your bearing will 180^{o} off.
4) Read the angle where the Bezel touches the Direction of Travel Arrow. (in this case 44^{o})
5) Adjust for declination to get the bearing. (In this case 44^{o} – 15^{o} = 29^{o})

Now you have calculated the bearing, you can stand on the starting spot and the landmark will be on that bearing in the real world. In this case, if you are standing on the highway at Vermillion Crossing with the 29^{o} mark on your compass touching the Direction of Travel Arrow, and the magnetic needle over the Orienting Arrow, then the Direction of Travel Arrow will be pointing directly at the summit.

Locating a Landmark on the Map From Bearing

We can also use a compass with a map to positively identify particular landmarks. This process is the reverse of the one in the previous exercise:

1) In the field, take a bearing on the landmark.
2) Now adjust for declination. (Note that for an east declination you now ***add*** the declination, and for a west declination you ***subtract*** it).
3) Place the compass on the map so that the edge of the compass is at the spot you are on.
4) Align the orienting lines with the grid lines. Do this without turning the Bezel and while ensuring that 0° on the Bezel points to the top of the map.
5) A line drawn through the place you are on the map, and parallel to the compass edge will go through the landmark as it appears on the map.

For example (Figure 9): I am on a summit just east of the L in parc national. I can see another mountain to the East. With my compass, I take a bearing of 65°. I rotate the compass until the 80° (65+15) mark is next to the Direction of Travel Arrow. Now I put the compass on the map with one edge running through the summit I am on. I rotate the compass on the map until the orienting lines are parallel to the grid lines (0° mark on the Bezel points to the top of the map). The line I draw parallel to the compass edge and through the summit of my peak also goes through the summit of The Monarch, the peak I am looking at.

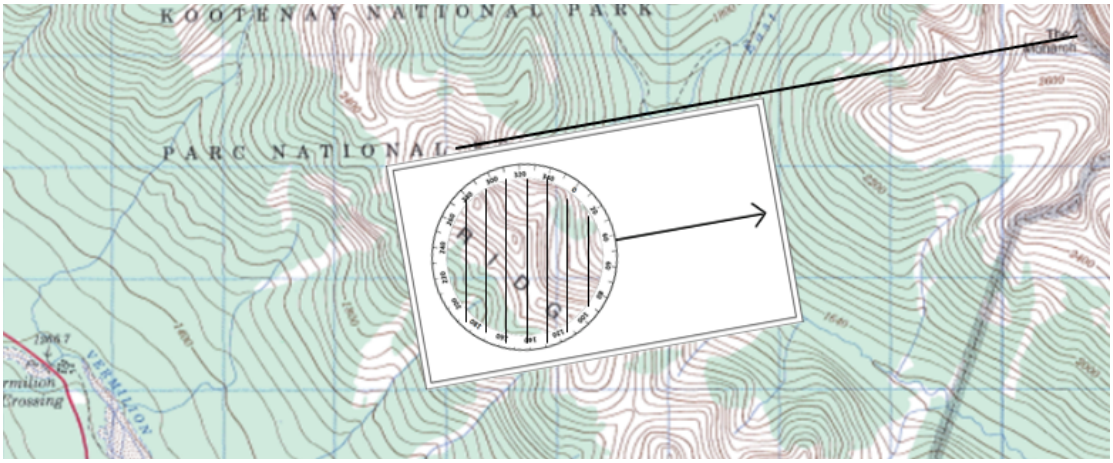

Figure 9: Finding a landmark from a bearing

Locating Yourself (Resection)

If you can see and identify two or more of the landmarks, you can also locate where you are on the map.

In Figure 10, I am standing on a creek and I see two summits I recognize. For the 1st Summit I follow an exercise similar to the previous one except that now I know where each summit is, but I don't know where I am.

In the field, I start by taking a bearing on the summit to the Northwest and find it to be 262°. I now need to adjust for magnetic deviation by adding 15° to get 277°. Now I rotate the compass bezel until 277° is aligned with the index line and put the compass on the map so that one edge aligns with the summit. I draw a line on the map.

I repeat the process for the second summit (bearing of 168°) and draw a second line on the map that goes through the second summit. Where the two lines meet is where I am.

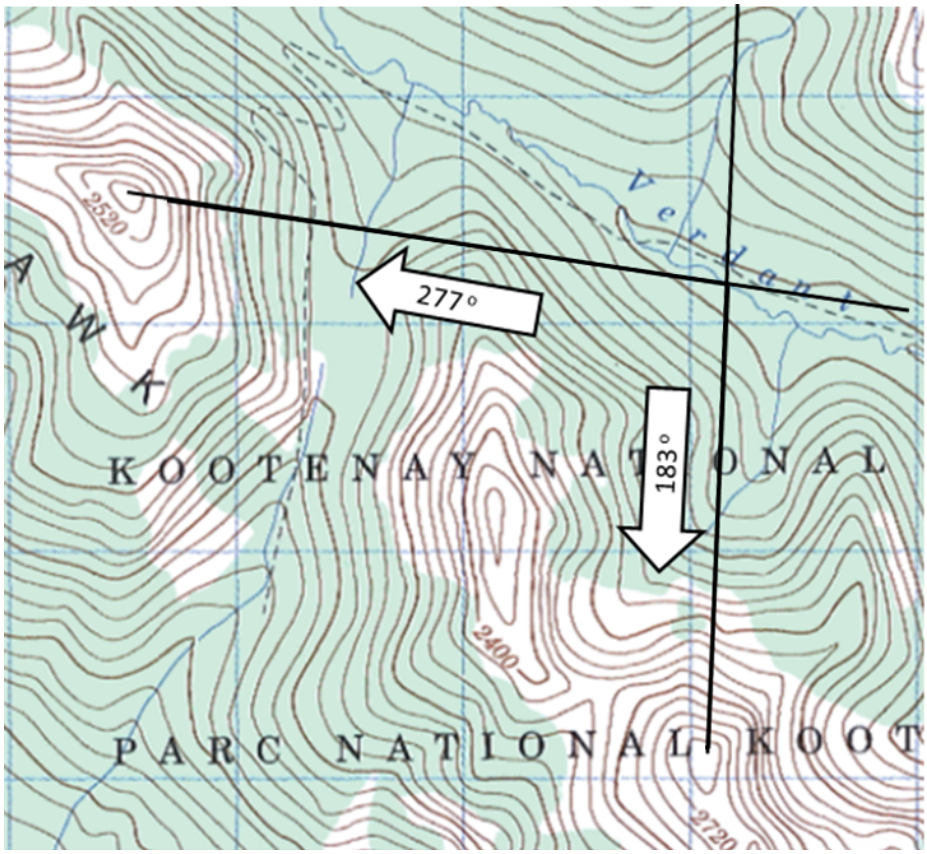

Figure 10: Resection to find position

This process, called resection, will be most accurate where the bearings of the two landmarks differ by about 90º. The closer the angle is to either 0º or 180º the less accurately you will able to pinpoint your position.

Note, that in this case, if I am certain that I am on the right creek, I only need to take 1 of these bearings since I am where the drawn line crosses the creek. Again, the process will be most accurate when the drawn line is at 90^0 to the creek. In this case that would be the line drawn from the southerly summit.

This technique is often referred to as triangulation in error. Triangulation is when observers at two different locations use bearings taken to an unknown location, and use the difference between the bearings and the known locations to determine the position of the unknown location. Resection, on the other hand, is when a single observer at an unknown location uses two or more known locations to determine and locate their position.

Adjustable Orienting Lines

More expensive base plate compasses have the ability to rotate the orienting lines against the Bezel. This allows you to adjust your compass so as to automatically compensate for declination at a specific location. While this is a nice feature, you will still have to understand the principles of taking and plotting bearings while adjusting for declination.

Appendix A

Scope of Practice

The successful graduate of the OCC GO (Use a Compass) course has demonstrated that they have an understanding of how to use a compass by itself and in conjunction with a topographic map so as to able to perform functions such as taking a bearing, following a bearing and adjusting for declination.

This module is not a leadership course. If the graduate wants to use the skills acquired in this module in an outdoor leadership context, they must acquire additional outdoor leadership training and must abide by the extensions and limitations within the scope of practice of this training.

For the OCC Field Leader program's Scope, this would mean validating their competence with other respected outdoor leaders and confirming with their supervisor that they can lead in more complex terrain.