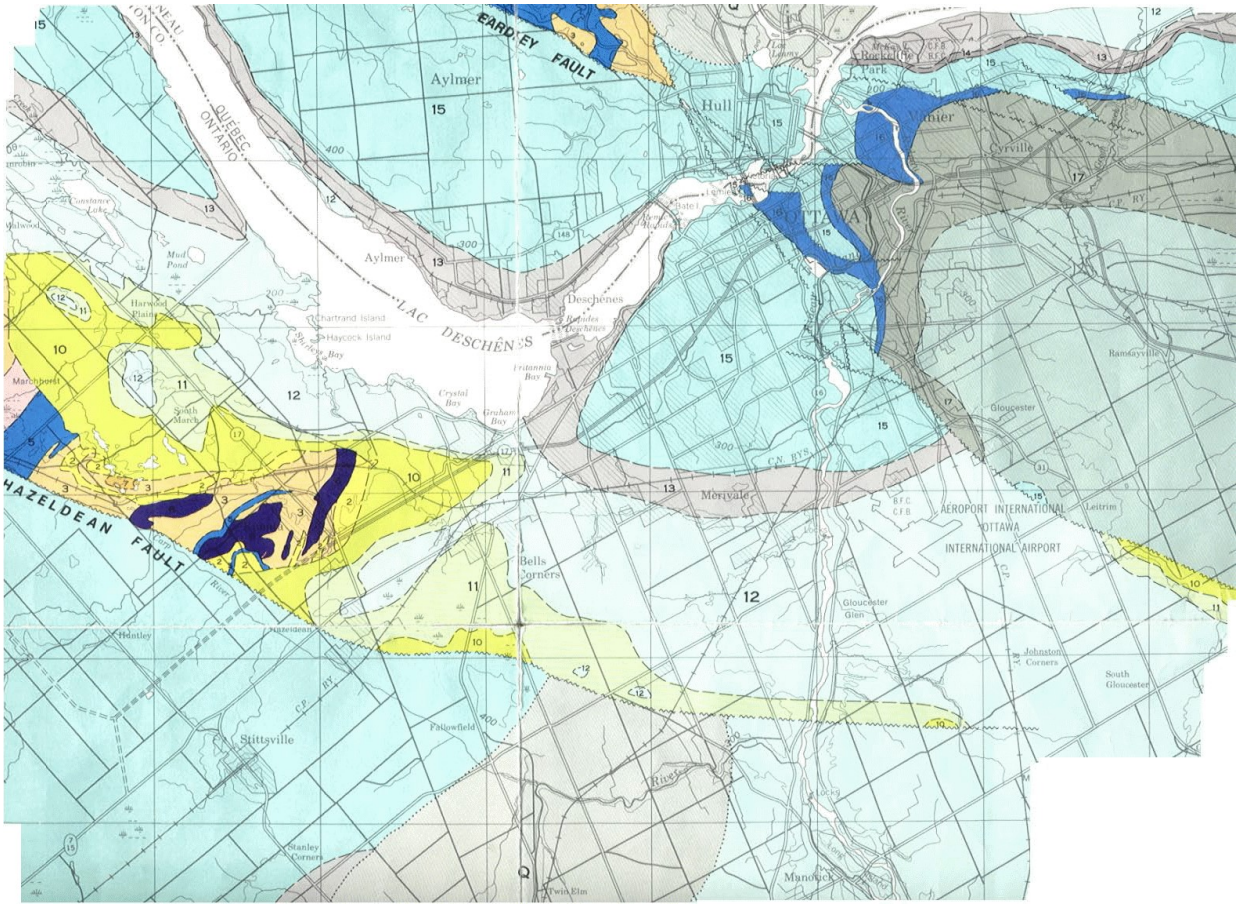
Geological Maps

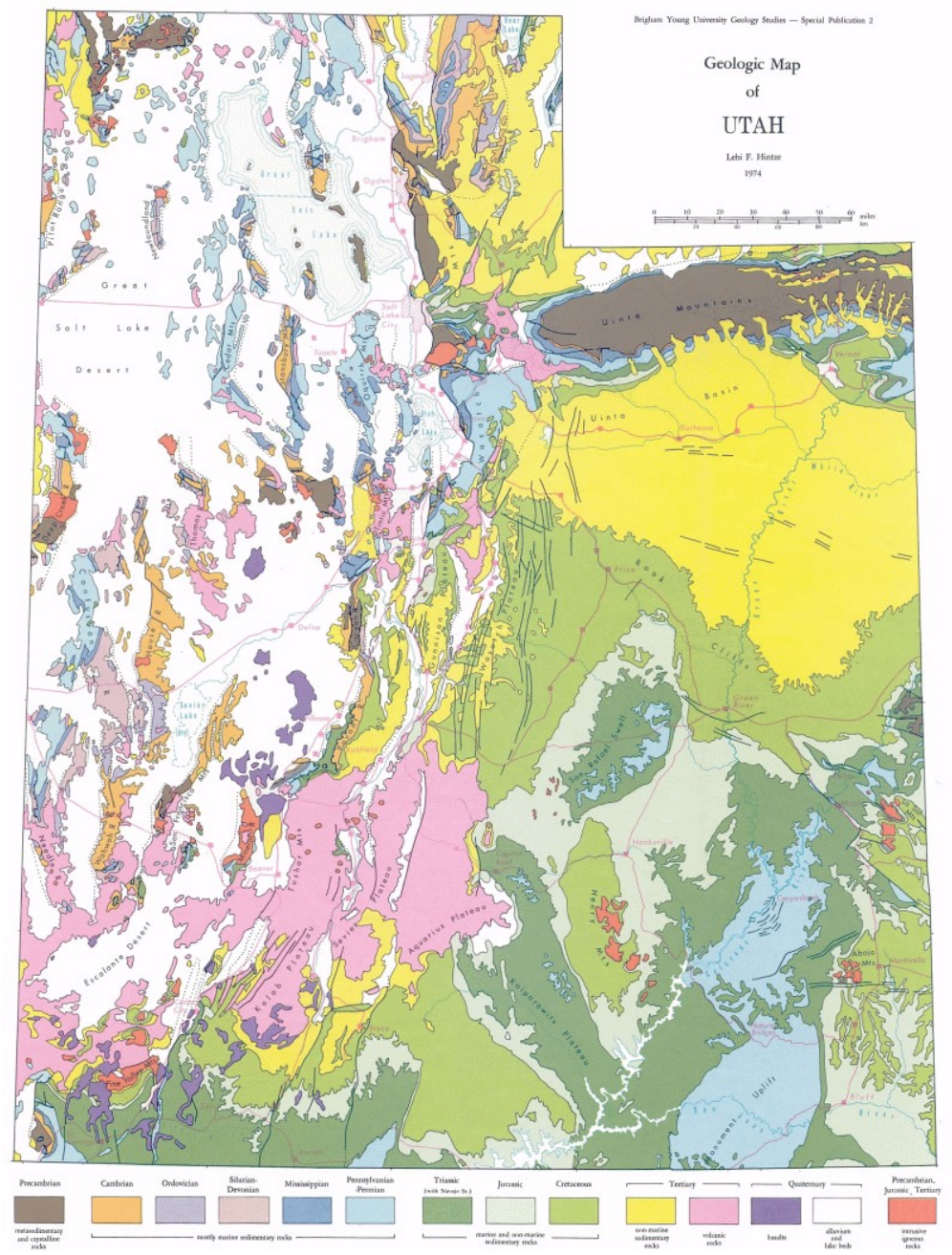
Geologic maps, such as the bedrock map for the City of Ottawa depicted below, show what geological formations (rock layers or non-layered bodies of rock) are exposed at the surface or just under the overlying soil and vegetation. They typically also show where fault planes intersect the ground surface. Some maps explicitly show the presence of folds and other structural features. The map below leaves it up to the reader to infer those.

In addition to the usefulness of knowing what rocks are to be seen at the surface, a geologic map also allows a skilled geologist (as we will become) to infer how the rock layers are oriented and arranged under the surface. The allow us to see in our mind's eye into the third dimension under our feet.

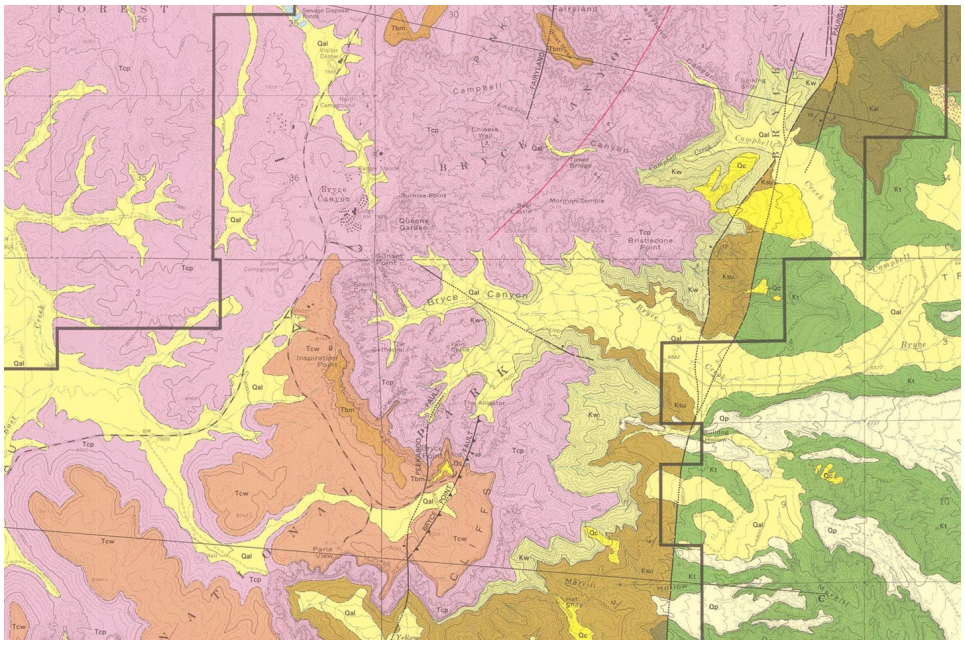


Link to the complete map with legend:
http://ftp.geogratis.gc.ca/pub/nrcan_rncan/publications/ess_sst/109/109223/gscmap-a_1508a_e_1980_mn01.pdf

Geologic maps come in different scales. For example, the map of the state of Utah shows large scale features:

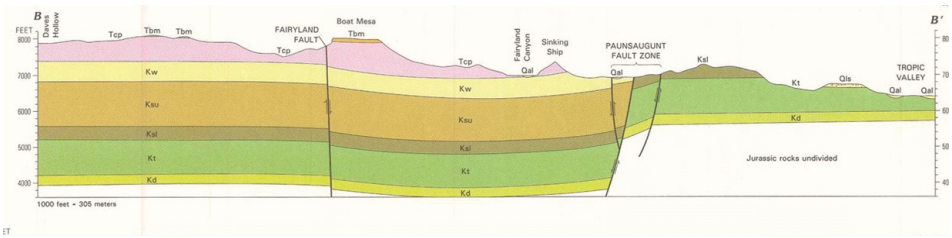


At a larger scale, small features are more clearly evident. The map below shows an area a few tens of kilometres across centred on the part of the previous map identified by the arrows in its margins. Individual roads, hills, and valleys can be seen. Also displayed are contour lines showing elevation above sea level.



Of interest to us is that these contour lines are parallel to the boundaries between different rock layers (shown by the different colours). This tells us that those rock layers are horizontal. This is made clear in the following photograph from the centre of the map area above labeled Bryce Canyon.

So in a cross-section through the earth, we would expect to see:



Components of a Good Contour Map

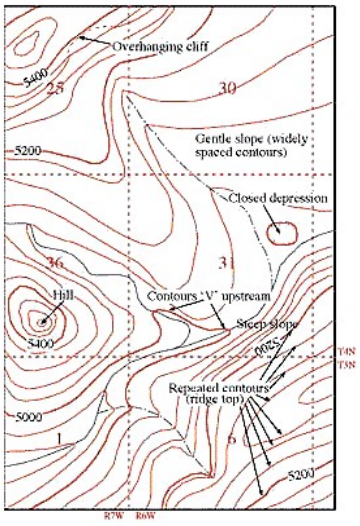
Contour lines connect parts of a map with the same elevation above sea level.
In your geography class you will have learned about the properties of contour lines and rules that they must follow.

What does a Good Topographic Map Need?

1) Title
2) Scale
3) Orientation arrows showing true and magnetic north
4) Legend for symbols used
5) Big picture context
6) Contour lines showing elevation

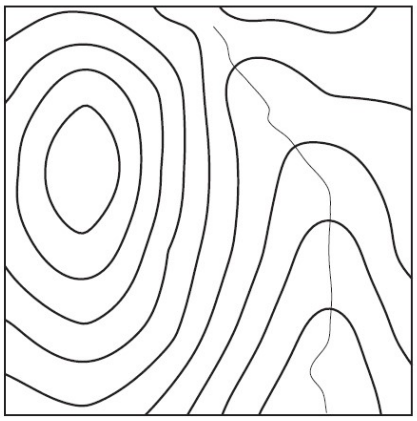
Contour Line Rules

a) Contour lines never cross or split
b) The closer they are spaced, the steeper the slope of the land surface
c) They always form closed loops, even if this happens off the map
d) Where the closed loops on the map describe a depression, place hash marks in the downward direction
e) At the middle of a valley, contour lines form a V pointing up slope



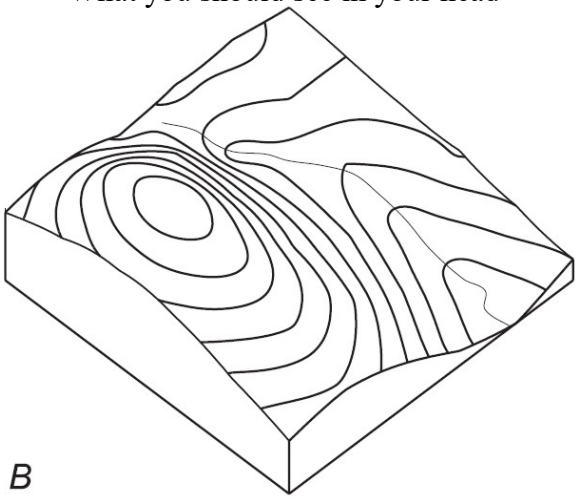
What you want to be able to do is form a mental picture of the lay of the land when you look at a map:

What you see on a map



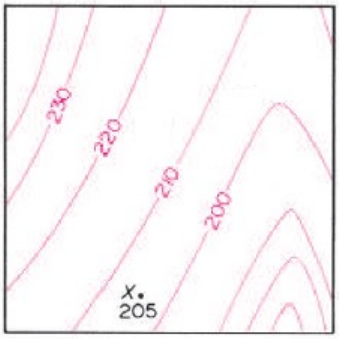
A

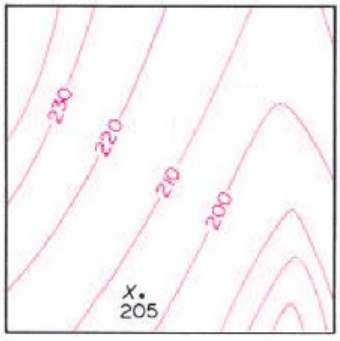
What you should see in your head



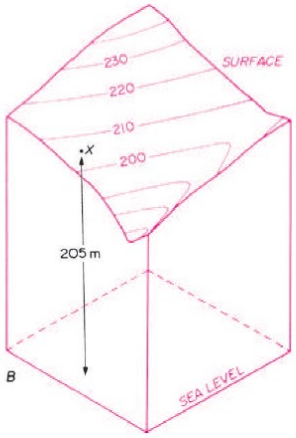
B

Try to picture the lay of the land from this map image before you turn to the next page.



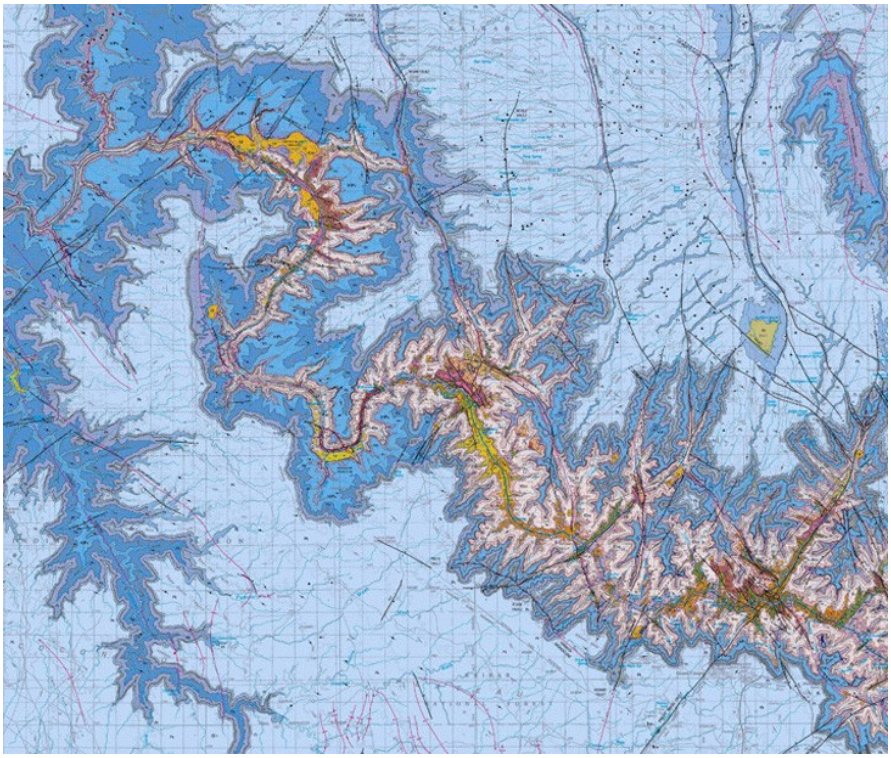


Interpretation of the previous map:

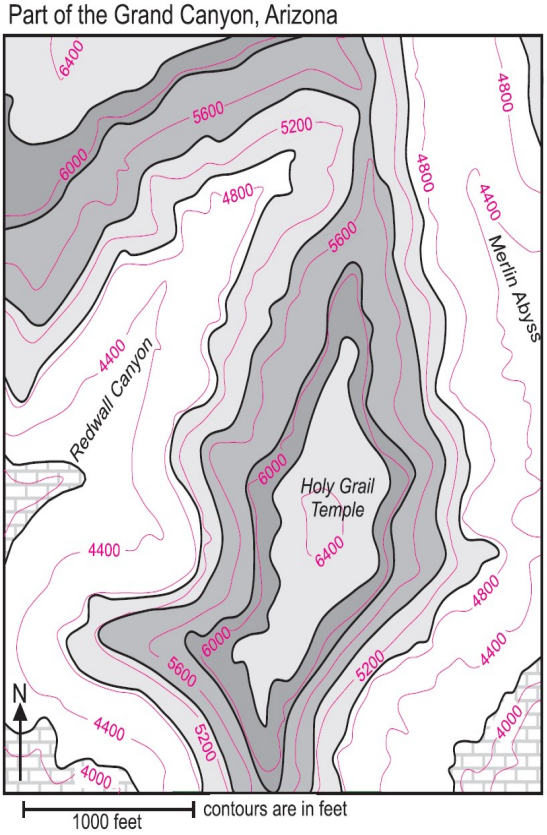


Inferring Orientation of Rock Layers

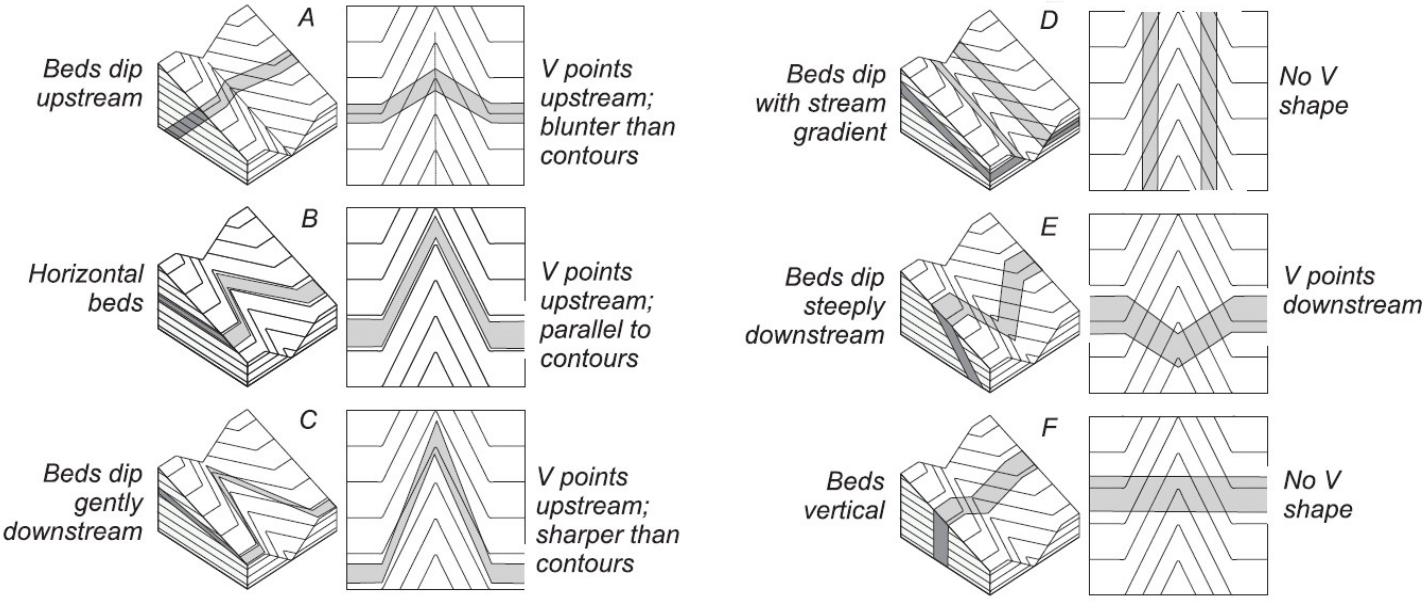
The map below of the Grand Canyon shows a similar geological situation as that in Bryce Canyon: deep valleys cutting into horizontal rock layers.



A much larger-scale map of a small part of the canyon shows clearly that the rock layer boundaries are parallel to the contour lines. This indicates that the rock layers must be horizontal.



The relationship between the contour lines and the rock layer boundaries shows us how the rock layers are oriented in three dimensions.



In each of the following map images, try to picture how the boundary between the spotted rock layer and the white rock layer is oriented in space. Then proceed to the next page to see the solutions.