# Visualizing outcrop patterns from strike/dip data

*by Charly Bank, University of Toronto, Canada – December 2018*

## Learning outcomes

By the end of this activity you will be able to

1. infer strike direction of a plane from its outcrop pattern on a topographic map,
2. differentiate between shallow and deeply stipping beds, and
3. predict an outcrop pattern given strike/dip values at a location.

## Note

To run this activity you need to have MATLAB installed on your computer. You also need to know (or be shown) how to run a script from the MATLAB window.

The exercise uses a graphical user interface built using the MATLAB GUIDE tool; it was coded in 2014 by Luke Graves, an undergrad at the University of Toronto. Since then MATLAB has come out with app developer which in its current form does not allow for mouse input. Once it does I plan to revise the code so that it also can run as standalone feature.

## Introduction

Visualizing the 3D geology from a geologic map is a key learning outcome of an introductory course on geologic structures and maps. Most often, students have to work on pen-and-paper exercises with maps of increasing complexity. This exercise aims at the most basic of exercises: the interaction of a plane with a given topography. The GUI tool allows you to choose values for strike/dip and select a point on the map where these would have been measured; it will then show you the outcrop of that plane on the map and in a perspective view. This allows you to visualize the location of both surfaces in 3D.

This exercise uses the right-hand rule convention: strike is measured clockwise from North and can range from 0 to 359 degrees, dip is measured from the horizontal and can range from 0 to 90 degrees (note that a vertical plane will not be displayed in the perspective view).

In my experience the ability to visualise the outcrop pattern of a plane marks a threshold in student learning; more complicated patterns created by folding or faulting can often be considered as built by locally planar surfaces. Therefore I hope that this exercise sets you up for successful interpretation of geologic structures displayed on maps, and that you will use the script also in your own time to review the concepts.

## Activity

1. Preliminaries

a) The zipped directory contains the necessary files. Unzip the directory, open MATLAB, and change into the directory you just unzipped (either using the `cd` command, or by changing the path that is displayed near the top of the MATLAB main window).

b) Let's check that the script is working on your computer. To run it double-click on file `outcrop.m` (not outcrop1.m) or by typing `outcrop` into the command window. After a while it should open a blue window, with fields for typing in values of strike and dip at the top, a map on the left, and perspective view on the right. Change the boxed words "strike" and "dip" to some reasonable values (strike from 0 to 359 degrees, dip from 0 to 90 degrees) and hit "set". When you now move the mouse you will see crosshairs. Move the mouse to a point on the map where you would measure the strike/dip values, and click. You should see a black line added to the map, and a black plane added to the perspective view. These are the outcrop of the plane. An example is shown in figure 1.

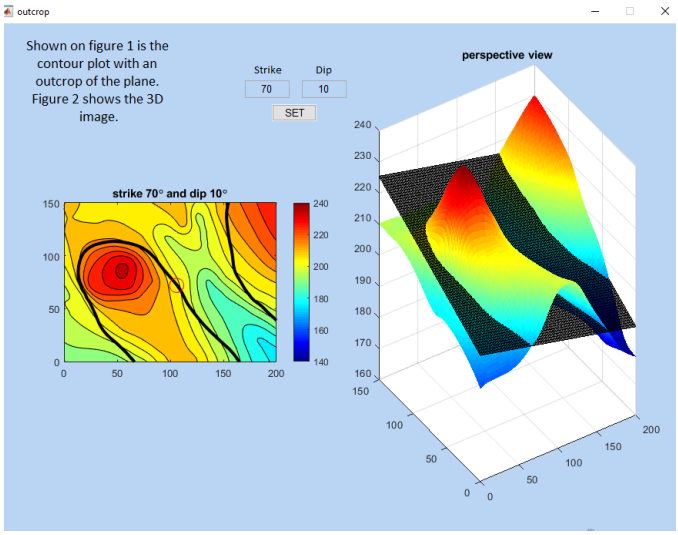


Figure 1: Example of an outcrop pattern.

c) If you move the mouse over the perspective view you will be able to rotate this. You can take any viewpoint, including looking at the pattern from above (that is in map view, the topography below the plane will not show) or along strike (that means horizontally along the plane).

2. Investigating outcrop patterns

a) Choose a value for strike and insert a dip of 5 degrees. Click on the map (remember this spot). Sketch the resulting outcrop pattern onto the contour map (figure 2) and play with the perspective view.

b) Using the same strike and the same spot on the map now make successive runs increasing the dip to 10, 15, 20, 30, 40, 60, and 85 degrees. After each run add the outcrop pattern to figure 2 (you may use different colours).

c) Describe in words what you notice regarding the relation of outcrop pattern to topographic contours and how outcrops intersect.

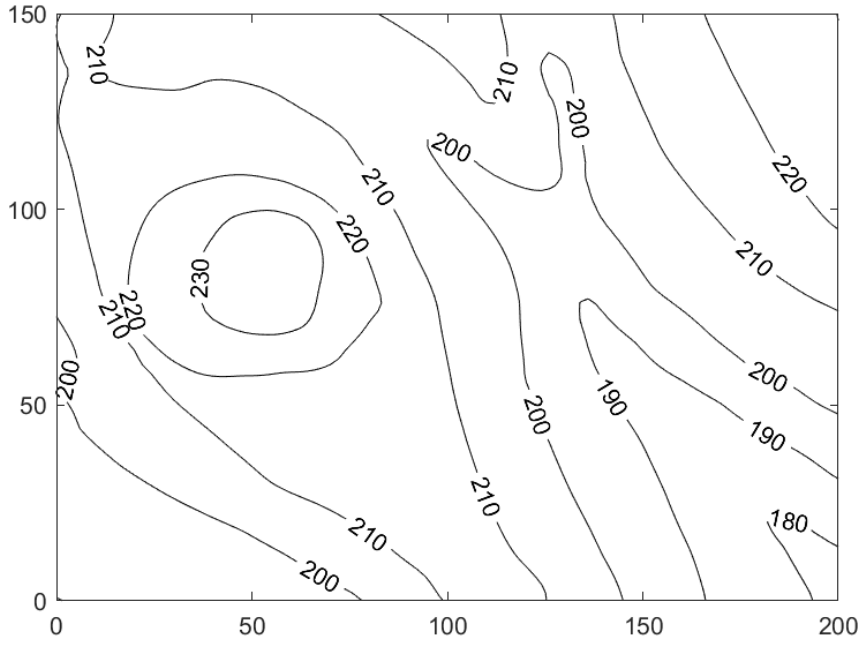


Figure 2: Topographic base map for part 2 (distances and elevations in meter).

3. Predicting outcrop patterns

In this part of the exercise you will first construct an outcrop pattern by hand, and then verify with the script that your answer is reasonable. Don't skip ahead - you will learn more if you wait with the script until the end.

a) Choose another value for strike. Pick a spot on the map (figure 3) and mark the strike/dip symbol there. Draw the strike line.

b) Assuming a value of rise-over-run of 1:2 draw other strike lines to both sides of the line you drew in (a). Label them with the corresponding elevation.

c) Mark where strike lines cross elevation contours of equal height, and sketch out the outcrop pattern.

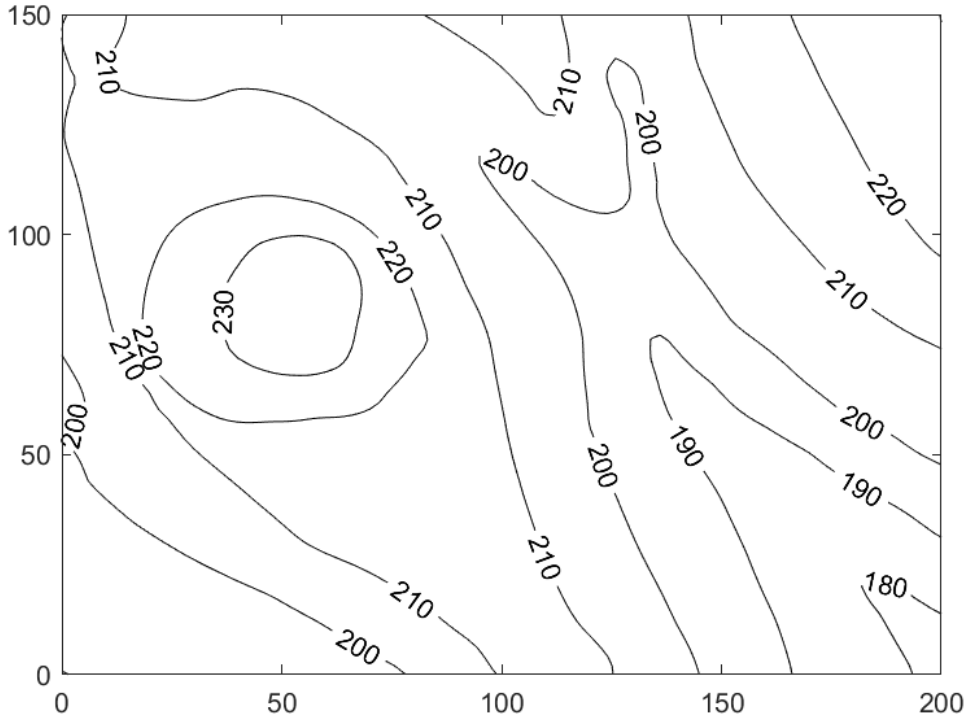


Figure 3: Map to complete part 3.

d) Finally compare your result to the output from the script. Before you can do that you need to convert the rise-over-run value to a degree of dip. You can calculate it using a trigonometric relationship, or you can do it graphically...

... and you determine a degree of dip as _____

Use the script with your values of strike and dip and the location to visualize the outcrop pattern. Does your map resemble the figure on the screen? If not, what did you do wrong?

## Final word

The topographic map for this exercise has been digitized from problem 2.14 in Lisle's book. If you are asked to solve this problem I suggest you use the script presented in this exercise to verify your answer. You may also use this script for self or group study before a test. I hope you enjoy working with our script.

## Reference

Lisle, Richard, 2004. Geological structures and maps - a practical guide. 3rd edition. Elsevier, Oxford, UK. 106 pg.