Discerning the Rule of V's using the Visible Geology program

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Name: _____

**Note to instructors: This exercise is included as part of a larger lab assignment that includes a review of geologic maps, investigation of outcrop patterns, and three point problems.

Link to the software: http://app.visiblegeology.com/

Visible Geology was written by Rowan Cockett, a program which began as part of a class project in his Engineering Geology course. It is freely available, and the author has given permission for people to distribute the models they create (so you can post these to Facebook, websites, etc.).

Use the online tutorial videos as a preview for constructing your own geologic block diagrams, and explore the controls for the software. You should be able to perform the following basic tasks before you come to lab on Monday. I'll be available on Friday after class if you have specific questions or problems with these.

Prelab assignment:

For these exercises, you will need to use a browser OTHER than Internet Explorer. Firefox had some issues, but Google Chrome seems to work fine.

(A) Set up a free account, so that you can save your final models.

(B) Familiarize yourself with the following basic tasks within the software:

- Rotating blocks and panning the image (use space bar to toggle control between the two)
- Toggle between 2D (map) and 3D (block) views
- Creating a series of geologic beds
- Tilting beds in various strike and dip orientations
- Creating folds with various fold axis orientations
- Deleting geologic events from the geologic history
- Inserting dikes, and subsequently deform them by folding and/or faulting
- Creating cross sections of your models using the 'explore' tab
- Using strike and dip symbols on the map surfaces

Materials needed for lab:

Lab handout

Colored pencils

Computer (laptop or you can use the lab computers)

Visible Geology Lab Part I: Model Preparation

Now that you are familiar with the basic tools in the Visible Geology software, you are going to create and analyze block diagrams to describe the outcrop patterns that occur when dipping rock layers are exposed in a valley. You will be analyzing several different situations:

* Horizontal rock layers

*Vertical rock layers (90o dip)

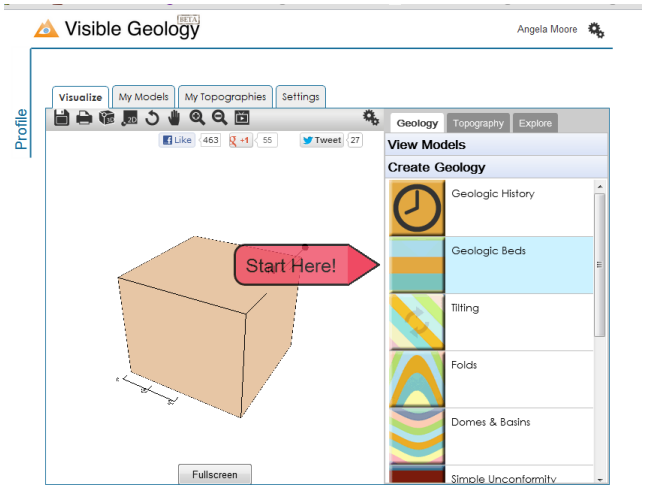
*Layers dipping "up" the valley; i.e. dipping in the upstream direction

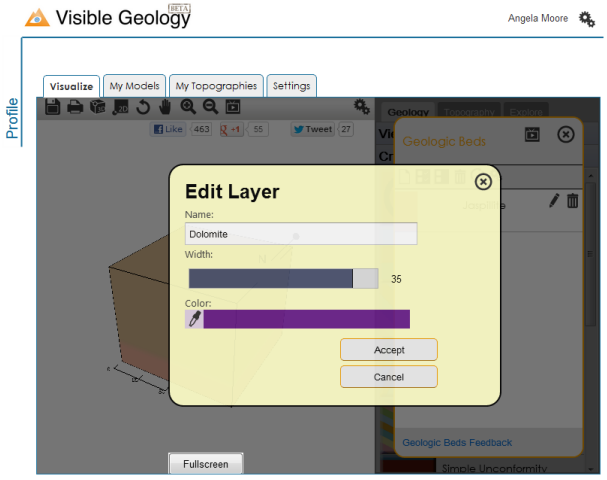
* Layers dipping steeply "down" valley, i.e. dipping in the downstream direction

*Layers dipping gently "down" valley, at an angle less steep than the slope of the valley floor

(A) Go to the Visible Geology site and log in

(B) Create the following series of horizontal geologic beds on the block diagram, using the tool on the 'Geology' tab. You can use whatever colors that you'd like, but use the 'edit' and slider bar to adjust the thickness.



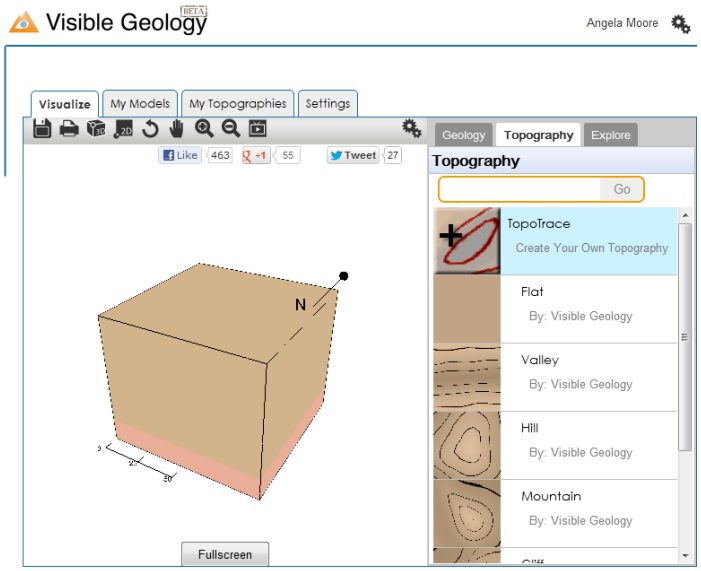


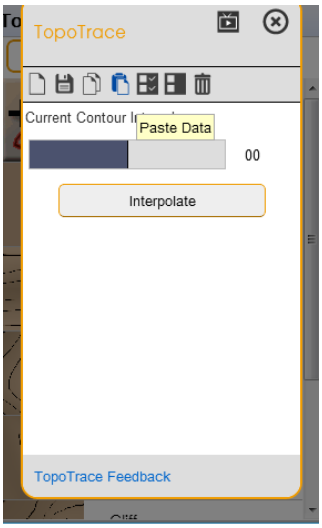
Rock Type	Relative Thickness
Conglomerate	25
Quartz Sandstone	20
Siltstone	10
Shale	20
Limestone	20
Dolomite (oldest)	35

When you are done, exit out of the "Geologic Beds" module.

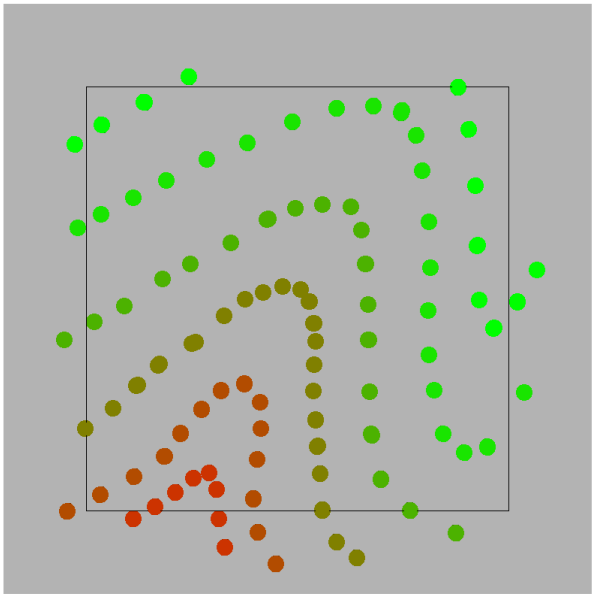
Note: If at any time your layers appear 'fuzzy' or terribly pixilated, refreshing the image will often improve things.

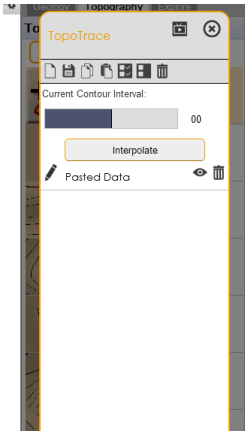
(C) Next, go to the Topography tab and select the "Topotrace" button to create our topography.





In the upper part of the window there is an icon that says “Paste Data” when you mouse over it. . Copy all of the numerical coordinate data from the file I posted on Moodle, click on the icon in Visible Geology, and paste the data into the window. Click “submit”. You should have something that looks like this:

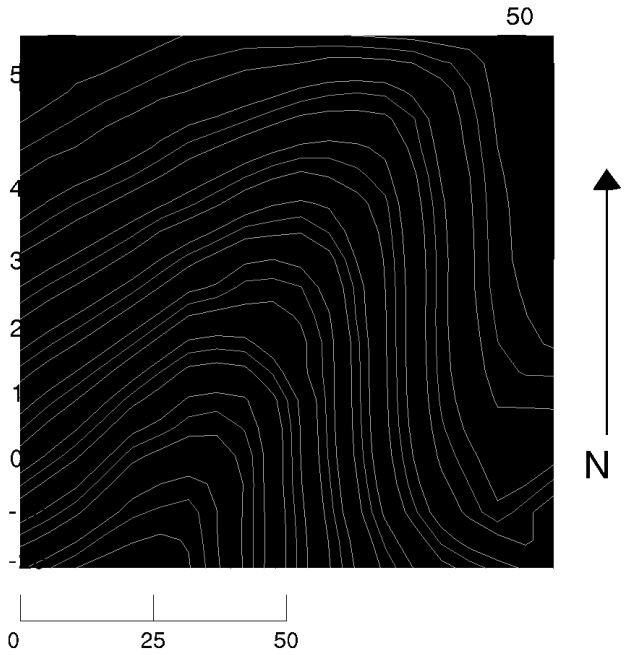




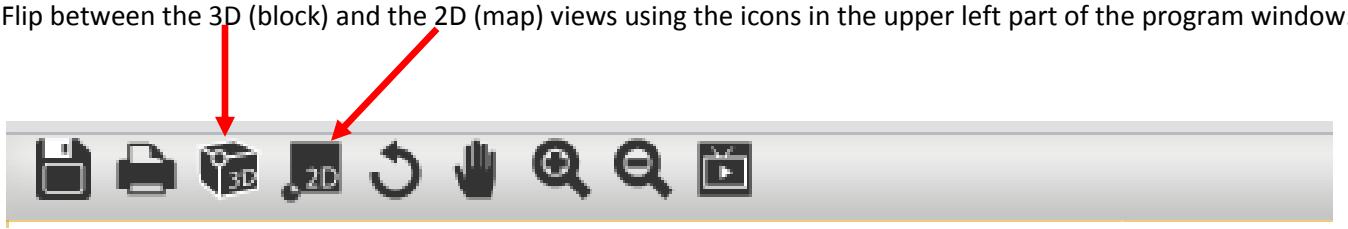
These are elevation data points. Click OUTSIDE for the gray square and rotate the image to see where the different dots are located in 3D space. When you are done, click the ‘Interpolate button’ in the right hand frame. The program is going to use the data points to generate topographic contours.

The generated contours should now look like this:

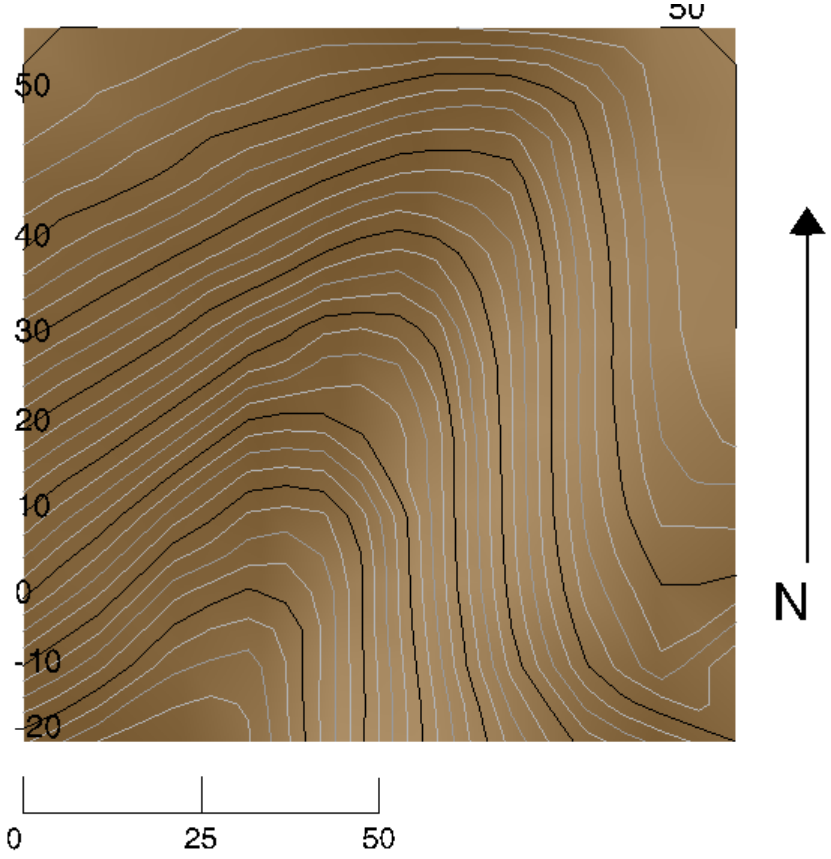
When you exit out of the topography module, your block diagram should now reflect this topography, and your geologic layers should also show up. If they do not, you may need to refresh the image.



Flip between the 3D (block) and the 2D (map) views using the icons in the upper left part of the program window.



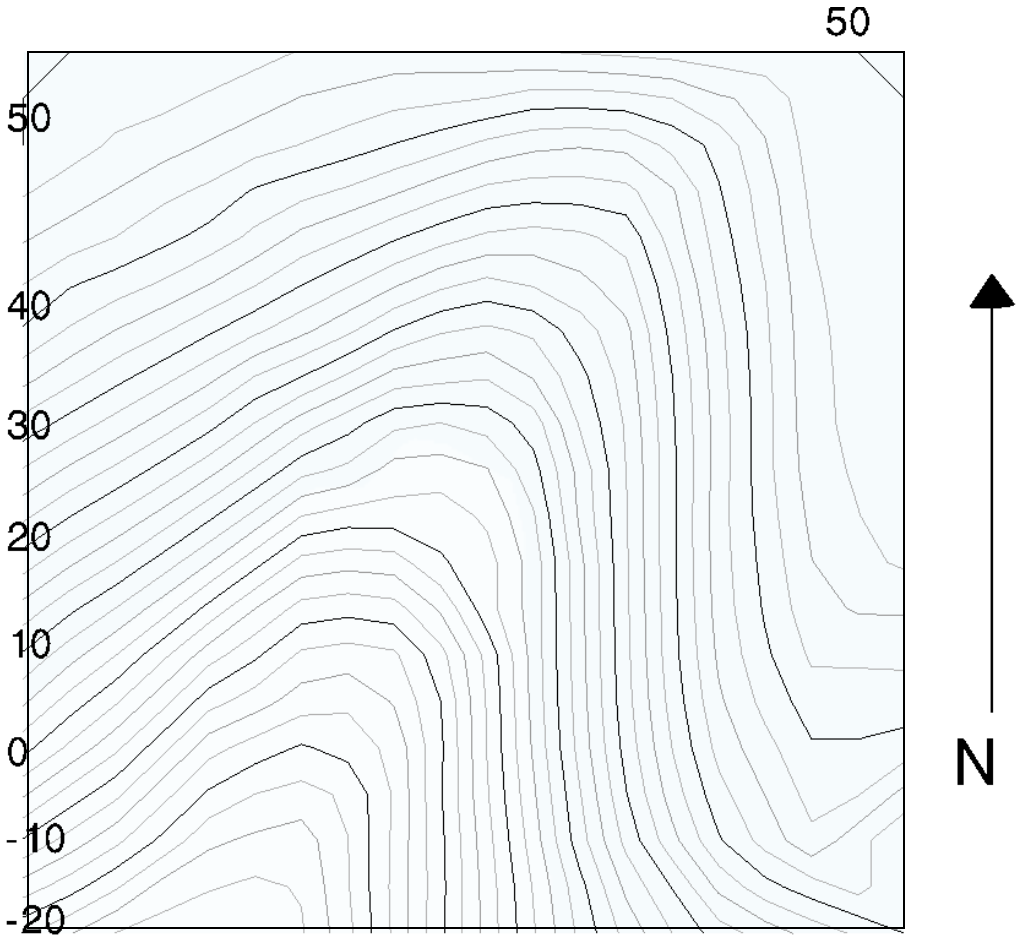
(D) On the image below, use a pencil to draw in a heavy line to mark location of the stream located in this valley, along with an arrow indicating flow direction. The black numbers on the left show the elevation of the contour (in m).



Visible Geology Lab Part II: Deriving the Rule of V's for Dipping Beds

Now you are going to investigate the interaction of dipping geologic beds and topography, using the valley topography that you just created. If you haven't already, go into the 3D view and play around with your block. Rotate it, tilt it, look at your valley from several different angles.

(A) **Horizontal bedding** Return to the 2D map view of your system. The model should consist of the topography and the 6 horizontal beds that you created earlier. In the box below, sketch in the geologic contacts as they are exposed in the map view of YOUR model. Color in the mapped units to match (as closely as possible) the colors selected for your computer model:



In your own words, describe how the shape and position of the geologic *contacts* compares with the topographic *contours* in the case of horizontal bedding:

The geologic contacts form a 'V' as they cross the valley. Use your own words to explain why this happens:

(B) **Geologic Beds dipping in the "upvalley" or "upstream" direction.**

Now you will modify your model so that the geologic layers dip down in the upstream direction. Select the "Tilting" option under the Create Geology tab

An image with a large red plane will appear on your screen. If you haven't already, familiarize yourself with how to move and rotate the plane. This plane represents your beds, and can be used to create your own custom configurations.

However, in this case I'm going to give you a specific orientation to start with. You can enter in strike and dip information using the slider bars in the upper right hand part of your screen:

The beds should be tilted into the following orientation:

Strike: 285 Dip: 20

(if you can't get the slider to these exact numbers, just get within a degree or two)

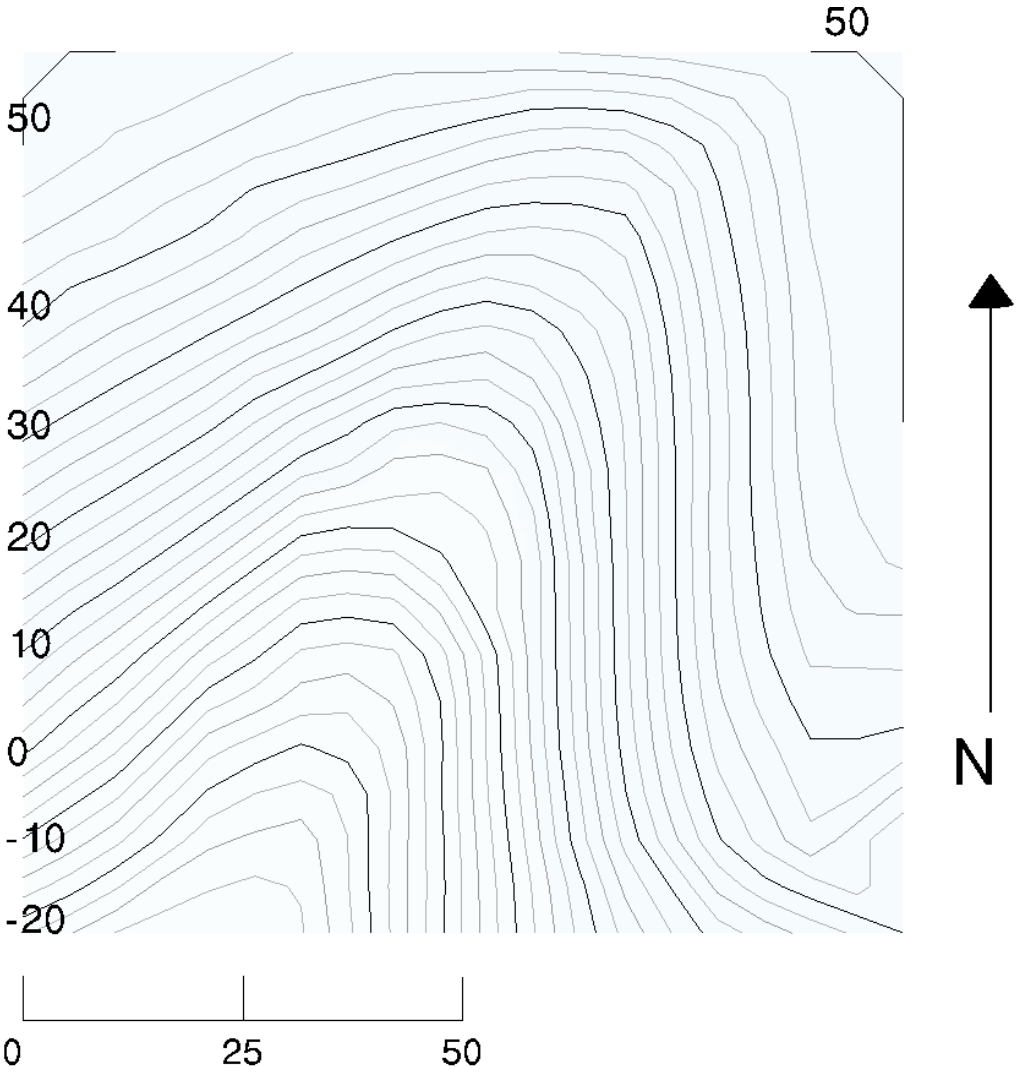
<u>Explain why the strike is designated as 285 instead of 105:</u>

Click on "Add New Tilting Event" to modify the beds, and exit out of this module to view your new model.

Experiment with rotating and tipping your new model and explore how the beds outcrop at the surface before moving on to the next question. Toggle between the 2D and the 3D views.

(B) **Geologic Beds dipping in the "upvalley" or "upstream" direction (continued)**

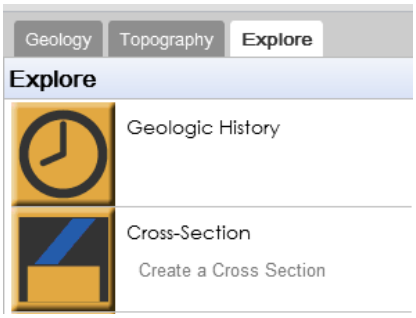
Jn the box below, sketch in the geologic contacts as they are exposed in the map view of YOUR model. It may be easiest to use the 2D view for this . Lightly color in the mapped units to match (as closely as possible) the colors selected for your computer model:



The mapped geologic contacts make a 'v' shape as they cross the valley. In your own words, describe how the shape and position of the geologic *contacts* compares with the topographic *contours* for the case of bedding dipping 'upvalley' or 'upstream'. Do the V's point in the same direction? Are they tighter or more open than the topographic 'Vs'?

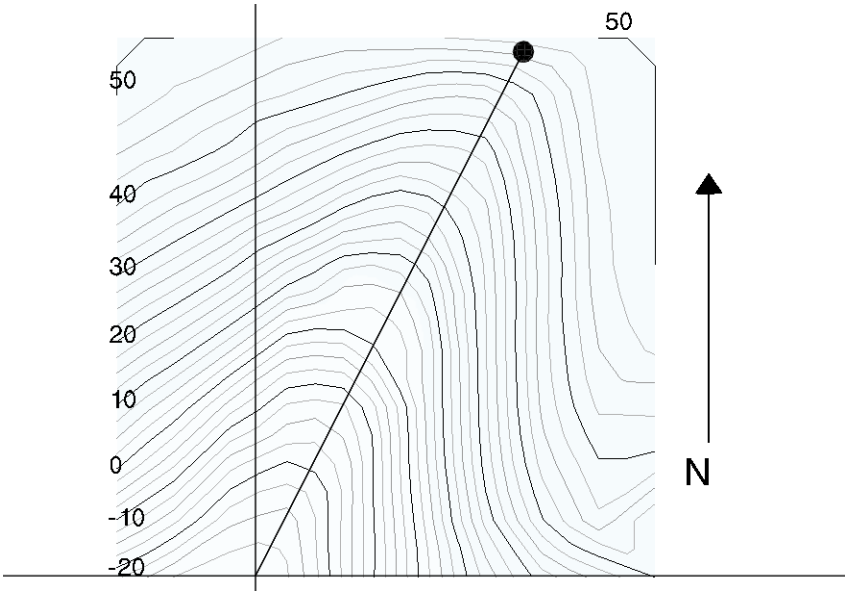
(B) **Geologic Beds dipping in the "upvalley" or "upstream" direction (continued)**

Now you are going to construct a cross section of your model , to further examine the relationship between the land surface and the topography.



Click on the "Explore" tab in the upper right hand corner and select the "Cross Section" option.

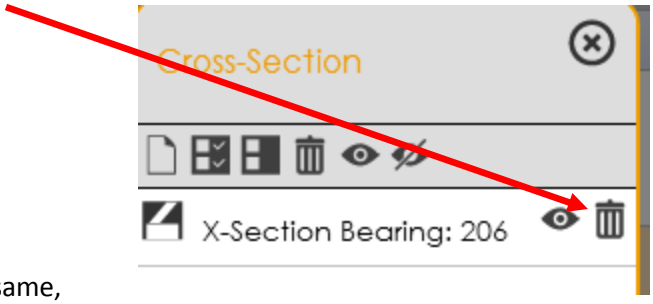
A cross-hair will pop up and allow you to select the two end points for your cross section. Select a point in the upper part and the lower section of the valley as shown below:



Once your cross section has been displayed, use Alt + 'Print Screen' to copy the image and Ctrl V to paste it below:

(B) **Geologic Beds dipping in the "upvalley" or "upstream" direction (continued)**

After you have completed the cross section, go back into the Cross Section option and use the 'trash can' to delete that cross section (it messes up the viewing if you keep it).



Return to the Geology → Tilting section, and delete your last tilting event so that we can start with a clean slate.

For this next question, the strike of the beds will remain the same, (285°) but the dip will be steeper, say 50° or 60°)

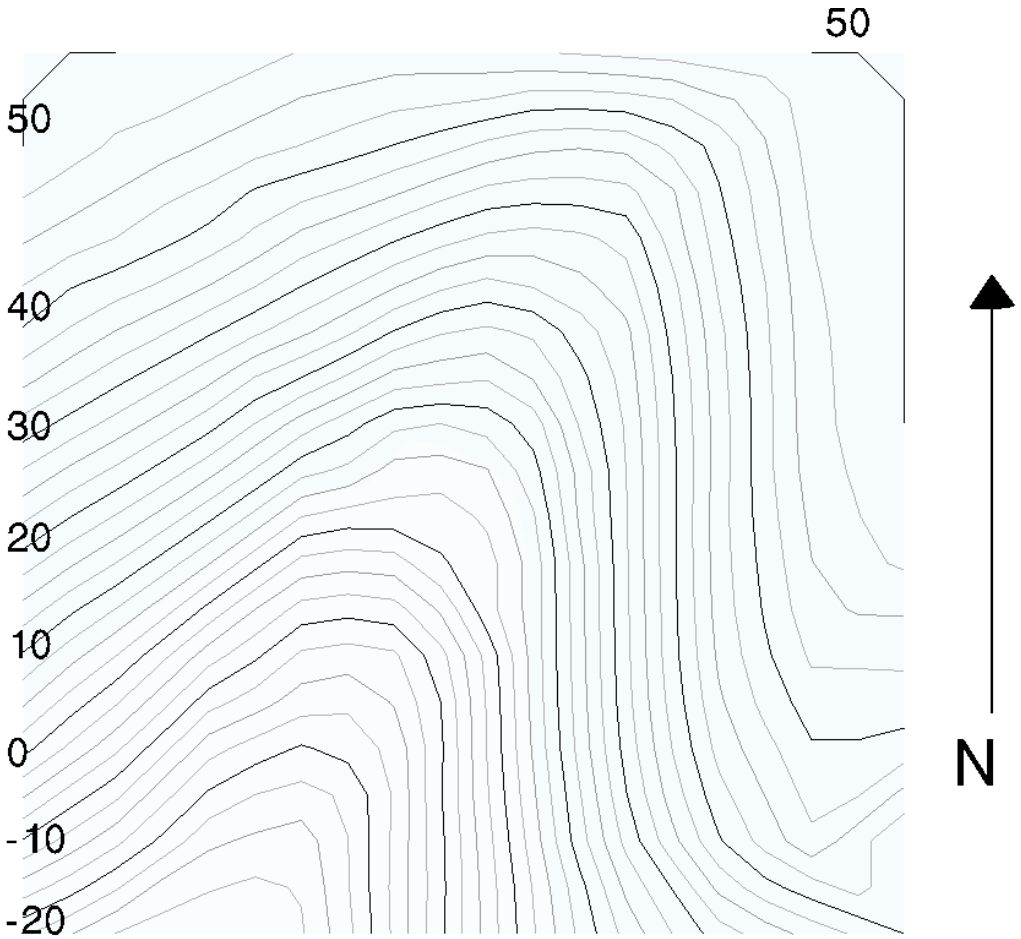
Use the 2D view to answer the first part of the question. You might want to toggle to the 3D view to help answer the second!

<u>How does the shape and orientation of the 'V's shown by the geologic contacts as they cross the valley compare with the 'Vs' formed at a dip of 20°? Can you explain why this happens? (remember, the topography has not changed)</u>

(C) **Vertical Geologic Beds**

Delete your previous tilting event, and add in a new tilting event so the beds have a strike of 105^{o} and a dip of 90^{o} (vertical)

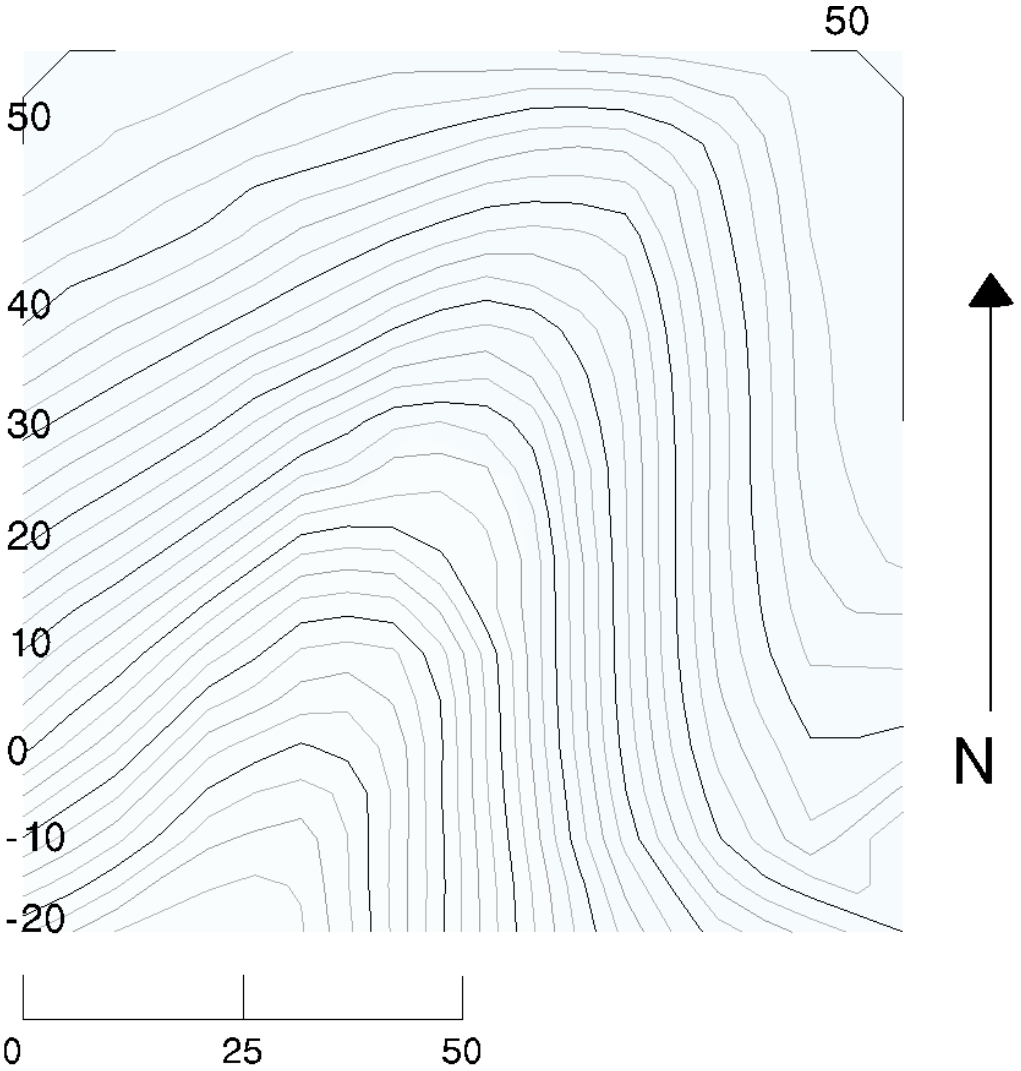
In the box below, sketch in the geologic contacts as they are exposed in the map view of YOUR model. It may be easiest to use the 2D view for this . Lightly color in the mapped units to match (as closely as possible) the colors selected for your computer model:



In your own words, describe how the shape and position of the geologic *contacts* compares with the topographic *contours* for the case of bedding dipping 'upvalley' or 'upstream'. Do you see any 'V's formed by the geologic contacts?

(E) **Geologic Beds dipping steeply in the "downvalley" or "downstream" direction (continued)**

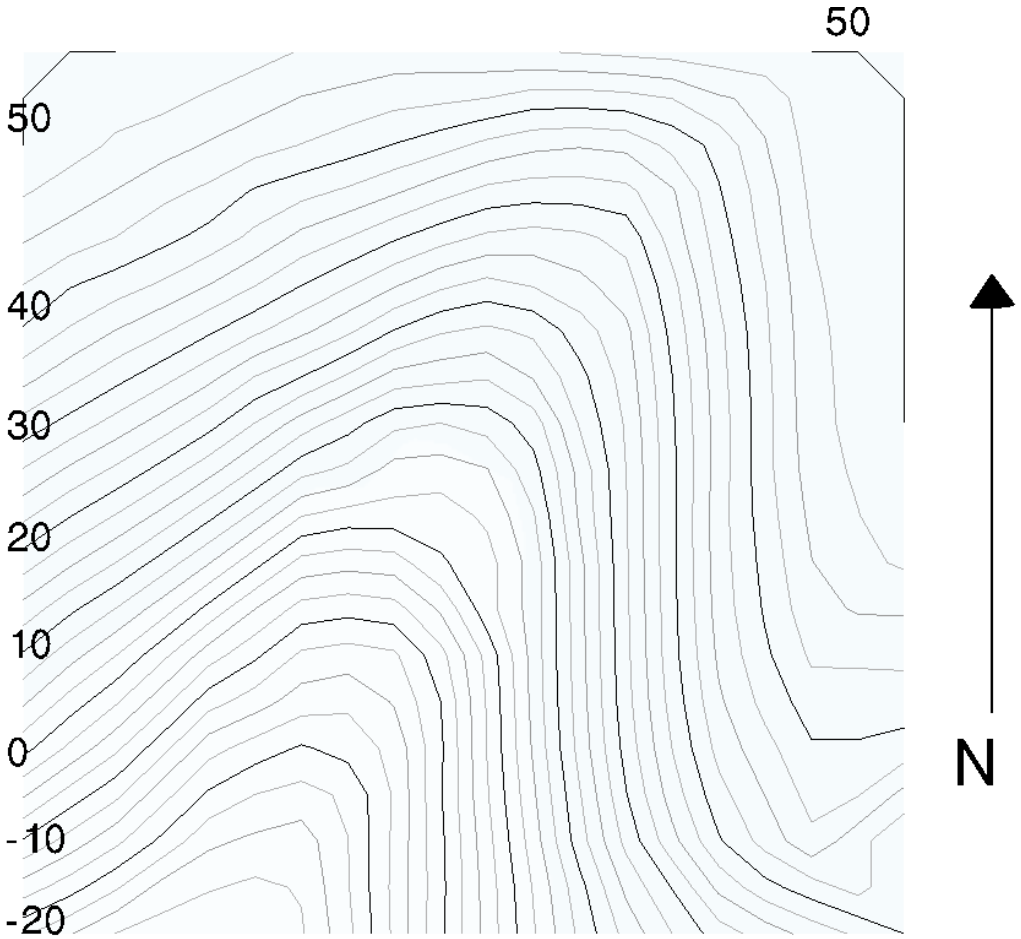
Delete any previous tilting events and/or cross-sections. Model a new tilting event to create beds with a strike of 115° and a dip of 60°. Rotate and tip the model to get a good view of how the beds are exposed at the land surface.
On the map below, sketch in the geologic contacts as they are exposed in the map view of your model. It may be easiest to use the 2D view for this . Lightly color in the mapped units to match (as closely as possible) the colors selected for your computer model:



In your own words, describe how the shape and position of the geologic *contacts*. Be sure to include a focused description of the 'Vs' that are formed by the geologic contacts as they cross the valley:

(F) **Geologic Beds dipping gently in the "downvalley" or "downstream" direction (continued)**

Delete any previous tilting events and/or cross-sections. Model a new tilting event to create beds with a strike of 115° and a dip of 20°. Rotate and tip the model to get a good view of how the beds are exposed at the land surface.
On the map below, sketch in the geologic contacts as they are exposed in the map view of your model. It may be easiest to use the 2D view for this . Lightly color in the mapped units to match (as closely as possible) the colors selected for your computer model:



In your own words, describe how the shape and position of the geologic *contacts* compare with the topographic contours:

How do the 'Vs' that are formed by the geologic contacts as they cross the valley compare with those formed by beds dipping steeply in the same direction (i.e. downvalley)?

How do the 'Vs' that are formed by the geologic contacts as they cross the valley compare with those formed by beds dipping *upvalley*? Are there any noticeable differences between these two cases?

Explain *why* the dipping beds outcrop in this way. You should construct a cross-section and paste it into the space below to support your response:

Summarize the Rule of V's for valley outcrop patterns in your own words for the following geologic situations. Your description should be written for another geology student who does not already know these rules, and should be detailed enough so they could apply them to analyze a new map area they have not seen before.

Horizontal Beds

Vertical Beds

Beds dipping upstream (include a note about how the dip angle affects V shape)

Beds dipping downstream (more steeply than the slope of the valley floor)

Beds dipping downstream (less steeply than the slope of the valley floor)