Lab 5: DEM Analysis (40pts); Up to 10pts extra credit
Due: Friday, Dec 2, 11pm

Your assignment for this lab is simple, though parts will be challenging. There are four landscapes for you to interpret, plus another (Tonto River Watershed) for extra credit. The question for each one is the same (see below); your response will consist of your best interpretations of the climatic, lithologic, and tectonic conditions (in space and time) that could explain the landscape morphology, a brief paragraph explaining how you arrived at your interpretation, and a statement of what data you would need to determine which among multiple alternative hypotheses is the most correct.

Data for the exercise consists of DEMs of the 4 landscapes (C1a, C2, C3, C5 – undisclosed locations) and associated channel steepness index values on the major rivers in each landscape. Ignore DEMs C6, B1, and B2 unless you really want a headache. Source data is posted to the class website, and is loaded onto the C:\geomorphology drive on the computers in H461. These files are located in a folder named “glg362_dem”. Stream profiles are available for each DEM in the file “DEM_Analysis_Lab_Pt_1_channel_profiles.pdf”.

To make the best interpretations, you will need to look at the available data from all angles. For each DEM I recommend computing hillshade, slope, and possibly local relief (use Spatial Analyst: Neighborhood Statistics) grids to look at the surrounding landscape as well as the channel steepness index data. Multiple views in conjunction are always the most powerful. Contour lines can be helpful as well. I further recommend that you should set the same symbology for ksn, slope, relief to make comparisons most effective (indeed this is virtually required to make sense of the data). Also be aware that, as in all DEMs of natural landscapes, there is noise in the data, so there will be scatter about mean values of the ksn and slope. In the DEMs, channel profiles are least reliable where small tributaries enter mainstem rivers – artificial local oversteepenings are to be expected. In both cases viewing the landscapes in 3D with ArcScene may be helpful.

As you work on this, avail yourself of all the clues you’ve heard in lecture about the fingerprints of tectonic vs. climatic vs. lithologic controls on landscape form. However, be aware that in at least some cases there are multiple equally valid alternative explanations that are realistic in terms of potential spatial variability in climate, rock strength, and rock uplift rate and potential temporal variability in climate or rock uplift. Its your assignment to determine all *reasonable* combinations that could have produced each landscape and to speak to how additional data could resolve which is most accurate.

Be complete but do not go overboard - this is a 2-week lab exercise, you are not asked for a lengthy report on each landscape: limit yourself to a short paragraph (3-4 sentences) on each landscape. Include whatever figures best make your point or illustrate your findings.

Common Questions for Each Landscape:

1. What are the plausible explanations for the landscape morphology?
2. How does this landscape relate to the others?
3. Discuss how you reached your conclusion – what combination of observations are most diagnostic?
4. What data would you need to distinguish between plausible alternatives?

Extra Credit: Interpreting the Tonto Creek Watershed (Part 2) (10 pts)

If you choose to do the extra credit (Part 2), the essential problem and questions are the same. Limit your response to a long paragraph, between 0.5 and 1 page at 12 pt font and 1.5 spacing.

For Part 2 stream profiles of a subset of 19 streams are available as jpeg images in the folder "tonto_dem_project\stream_profiles". On each profile I have drawn regression lines fit to major river segments on the slope-area diagram to help you see the main patterns. These "fit" segments are shown in cyan on the channel profile so you can see how well (or poorly) they approximate the actual profile. You should recognize some patterns we have discussed in lecture. I have also marked any major knickpoints where channel slope significantly increases downstream (marked on the profiles with blue "+" and on the slope-area diagrams with blue "o"). The knickpoints are in the shapefile "tonto_knicks".

The 19 stream profiles are simply named "tc#" where # ranges from 1 to 19. To see where each profile comes from on the DEM, turn on the "tonto_streams" shapefile in the ArcGIS project and then querry the streams rendered on the map with the "identify" tool. At the very top (and again at the very bottom) of the identify dialog box it will list the filename of the associated stream profile (e.g., "Y:\Projects\tonto_watershed\gisfiles\tc#.jpg" – the details reflect the pathname to the file location on my PC where this project was built; for you plots of these stream profiles are available in " … \tonto_dem_project\stream_profiles").

The layer ksn_1e7 gives local ksn values every km along the channel network, just as in Part 1. Layer "tonto_streams" can also be rendered to color-code by ksn value (follow the example of how Symbology is set for the ksn_1e7 layer) and will show a simpler pattern of ksn averaged along each of the interpreted channel segments defined by regression lines on the 19 profiles described above.

IMPORTANT: For the Extra Credit (Part 2), you are only asked about the Tonto Creek Watershed demarcated by the streams in ksn_1e7 layer and you need only look at the section of Tonto Creek that flows to the SW (you can ignore the SW corner of the drainage basin). The lithologic information on the geologic map is very useful to you, but don't allow yourself to get overly distracted by details in the geology. Fundamentally what I want you to address is how it has come to pass that there is a deep and rugged canyon on Tonto Creek and its tributaries (Hell's Gate Wilderness) that is cut into a broad low-relief topographic bench that we could refer to as the "Payson Plateau" since Payson sits on this surface. The challenge is to think about this canyon and whether it represents primarily tectonic, lithologic, climatic controls (or a combination of these factors).