ATTITUDES SCRIPT

Geologists make two-dimensional flat maps that describe local three-dimensional geology. The goal is to capture on a map all the information a geologist in any other location would need to accurately recreate and visualize the geology from the map area. Field geologists must explore the landscape, stopping wherever rocks are visible to gather and record details such as the type of rock and the orientation that the rocks crop out (and descends into) the Earth.
For example, imagine that this stack of books is a pile of horizontal rock beds. Normally these bedding planes would continue on in all directions for many kilometers (so imagine kilometer-square books). For this demonstration, we have eroded the rock beds into a rectangular cliff. Remember, the topography is captured with contours and is a function of erosion and uplift. The geology is what the rocks are doing in the ground. These are separate concepts! For example, a cliff could have inside it horizontal beds or dipping beds. A hill could form atop a syncline (when it first forms) or an anticline (after erosion). Geologists begin their field work with a topographic map and atop that they record the underlying geology. They do not measure or record topography.
The orientation of a bed in 3-D space is called its **attitude**. The attitude of these books right now is horizontal. A horizontal bed is parallel to a flat surface. It's easy to recognize if you use a simple device like a construction level with a window of liquid with a bubble inside. The bubble helps you make the level parallel to a flat plain. A similar device exists in miniature inside a device called a Brunton compass, which is what geologists take into the field to measure the attitude of bedding.
Once we've measured the attitude of the bedding, we indicate such on our map by drawing the appropriate mark. For a horizontal bed, the mark is a circle with a plus sign inside. Remember, the goal is for a geologist in another location to read this map, recognize the symbol and know these beds here are flat.
For horizontal beds, the contact between them is NOT visible on the surface and thus only the top bed would show up on the map unless a river or other erosional agent has cut through parts of the rock and exposed the underlying rock. In this case, we can clearly see now the contact between the two beds from a map or birds-eye view. And because the beds are horizontal, the contact is exposed at the same elevation throughout, meaning it parallels the topographic contours. We also call this layer-cake stratigraphy.
So what do we do if a bed is not horizontal? Let's tilt our stack a bit. Now the bedding contacts are quite visible on the surface. To help a geologist somewhere else recreate this exact bedding orientation and geometry, we need to record two characteristics of the bedding planes: dip and strike. **Dip** is the angle the bedding plane makes with a horizontal plane. For a horizontal bed, dip is 0. Here you can see me increasing the dip from 0 to 30 to 45 to 60 to vertical, or 90 degrees. To measure the dip of these beds, we can use a protractor, setting it up alongside the flat table top and the beds arising up out it. Let's set up a bed with a dip of 30 degrees. Now let's talk about **strike**. As you can see, I can rotate this stack of books and change the direction the beds are dipping. The angle stays the same, 30 degrees, but the direction changes. Notice that where the beds intersect the flat table (a horizontal surface), there is a line of intersection. That line is called a strike line, and we give its orientation the same way we learned in the first few labs on map skills and orientations –N45W. So now we have a dip angle– 30 degrees – and a strike – N45W, but we still need one more piece of information about our dip – its direction. Notice that there are two ways to have these books lined up with a North 45 West strike and a 30 degree dip – one in which the beds dip down toward the southwest, and one in which the beds dip down to the northeast. These directions represent the direction water would flow if we could let it run down the bedding plane. Note that in this case, water runs down perpendicular to the strike line and towards the southwest. So the unique orientation of this bed can be conveyed by a strike of N45W and a dip of 30SW. And we show that on a map with the following symbol. This part is the strike line, and it's oriented N45W. The tick mark is the dip direction, and note how it indicates the direction water would flow down the bedding face – perpendicular to strike and towards the southwest. The number 30 sits next to the tick mark and indicates the one thing we can't see from the surface – the direction the bed is going into the ground. Again, with this symbol, a geologist somewhere else can recreate the exact geometry of the beds in this example. And you can do so as well while watching this video. Pull out a book and orient it N45W with a dip of 30SW. Pause the video recording until you have the orientation correct. Then when you return to the video you can change the orientation of your book to follow along with the examples in the rest of this video.
So what do we do if a bed is vertical? Let's turn our stack of books to see what happens. Note that the strike is still the same, but the dip is 90 degrees, and any water that would pour down this bedding plane would go straight down, not to the NE or SW quadrants. So the symbol we use for a vertical bed has to be different, and we indicate it with two tick

marks, one on each side of the strike line, with no numbers.
Let's see a few more examples. In this case, we see the following three attitude marks on a map. What do I have to do with these books to line them up in the exact same orientation as these marks? First I line the strike of the books up with the strike line, in this case it looks like it's about N15E, then I dip it 60 degrees to the northwest. Would water flow down the tick mark? Yep! And this next one looks to have a strike of close to N60E. After lining up the strike, I dip it at 90 degrees, vertical. This attitude is striking due North, and the dip is 45 degrees west. And finally, we return to a horizontal bed. Note the zero degree dip. And the strike? Since strike is the line that forms when the bed intersects a flat plain, and this bed is parallel to the table, never crossing it, there is no strike line. Note that each unique attitude mark describes a unique bedding orientation.
So how do we measure attitude when the beds aren't coming out of a flat table? How do we find the strike and dip when we don't have a parallel surface provided for us? We have to bring and create a parallel surface. Let's return to the levels. As long as we keep the bubbles centered, this level will always be flat. Now we can lay it next to a rock outcrop, center the bubbles, and the line it makes is the strike line. We can get out a protractor and measure that strike line, or we can set a compass along it and use the compass to measure the direction, just like we did in the compasses lab. Notice that this particular compass has a bubble inside, and it can be used in lieu of the level to create a strike line AND measure its orientation. For dip, we can use the protractor again, but the compass also has a built-in protractor in the center, and we can set it perpendicular to the strike line and get the correct dip measurement as well.
Bedding attitudes – strike and dip measurements – are the unique indicators of a bedding plane's orientation in 3-D space. Measuring and recording these on 2-dimensional maps is one of the key roles of a field geologist.