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HWRS 482

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Challenge Questions_Updated

1. For the initial values of background and inclusion K, plot the flow into the left and out of the right boundary. (The code, as provided, makes this plot for you.) Explain why the values are not constant along the boundary (relate to the definition of a Type I boundary). Explain why the flow distributions are the same for the left and right boundaries.

   The values along the boundary would not be constant because the flow changes as it passes through a medium. I think this graph is showing a cone of depression for the model of flow. It would be the same for the left and right because the flow values change over distance while the head values stay the same. The graph decreases on both sides equally from the center.

   Definitely some wrong answers in the first part but I did pick up on the symmetry of the graph. In class I thought more about it and connected Darcy's law to the graph by using Q=-K(dh/dl) and then rearranging the equation to find the dl. When I apply this equation to the graph I noticed that the Q would have to change from a changing K value, so that is why the values are not constant along the boundary.

2. Add a plot of the left-to-right flow along a line that passes through the center of the inclusion. What can you learn from comparing this distribution to that seen on the boundaries?

   From the second graph we can see that when there is inclusion, the flow is becoming larger but also decreases rapidly in the center as a result of a change in K values. In the middle, the flow rapidly decreases because the K values are lower and the water will flow in the path of least resistance, which would be the higher K values around it.

There would be high Q next to the inclusion since it would be taking a shorter path which is less energy. The center line going through the middle of the inclusion shows a jump down in flow values, which would be caused by a smaller K inclusion value. The flow will decrease as the medium is more restrictive and allows less flow paths to meet, since water wants to take the path of least resistance.

3. Calculate the total flow into (and out of) the domain. Use this to calculate the Keq of the heterogeneous system with the K values as given in the starter code. Repeat this calculation for the following K values for the inclusion (keeping the background K as it is given): 0.01, 0.1, 1, 10, 100. Compare the Keq to the harmonic and arithmetic mean K values based on the area occupied by each medium (rather than the length for a 1D system). Can you draw any general conclusions about the impact of high or low K heterogeneities on the equivalent K for the flow system examined?

   For the Keq and K harmonic data, it seems that the values are more alike for the values above 1 than lower than 1, and for Keq and K arithmetic the opposite happens where the values above 1 are not alike compared to the ones below 1. I would say this makes sense from looking at the formulas for K harmonic and arithmetic that I used.

For flow parallel to layers, effective K is called K_h (for horizontal flow, because parallel flow is typically found in a horizontal layered sedimentary sequences).

$$K_h = \frac{\sum_{i=1}^{n} K_i b_i}{\sum_{i=1}^{n} b_i}$$

arithmetic mean

For flow normal to layers, effective K is called K_v (for vertical flow, because normal flow is typically vertical, across horizontal layers).

$$K_v = \frac{\sum_{i=1}^{n} b_i}{\sum_{i=1}^{n} \frac{b_i}{K_i}}$$

harmonic mean

What I have above is the right idea, noticing that when you have extremely high or low values the actual Keq values can vary significantly from their calculated values. For the low K inclusion, the Keq isn't greatly affected by this small area. This makes sense because again, the water will take the least path of resistance and least energy to flow across.

4. Does the equipotential distribution depend on the absolute or relative K values for the background and the inclusion? How would you use the model to test your answer?
The equipotential distribution depends on relative K values because like the first graphs for flow, it isn't constant and depends on K values and location. We could use the model to test these values along different equipotential lines in order to determine whether the absolute or relative K values are more important. → I'm not too sure on this one?
I still have my first impressions of the relative and absolute K values and how which depends on the equipotential distribution. This could be correct after changing the model to be homogenous and see where the background and inclusion K values would be the same along the equipotential lines.