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HWRS 482

February 1, 2021

Challenge Questions

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.

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.

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

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?