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Hw 2 Challenge Questions

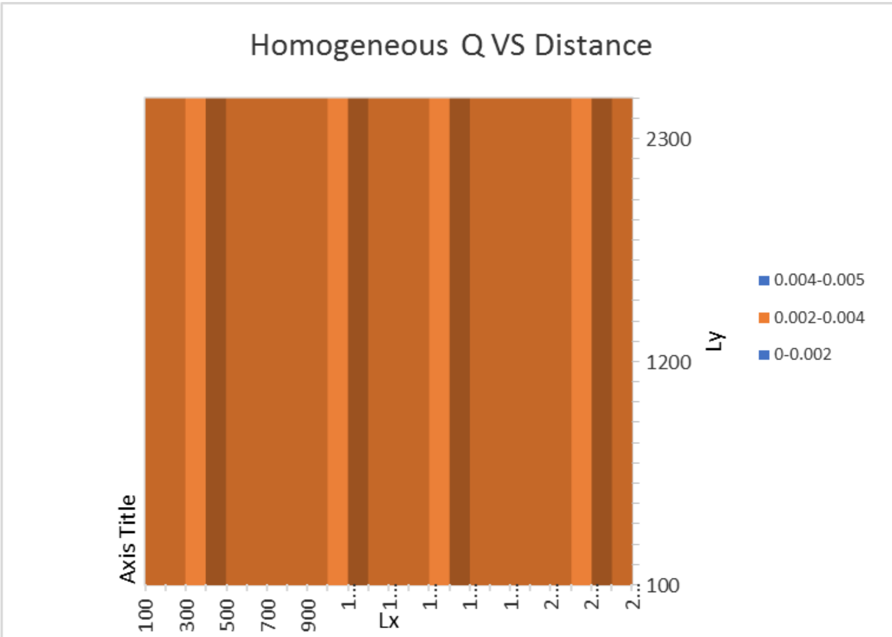
"Show, based on the flux with horizontal distance from a constant head boundary, that the model is steady state. Repeat this for a homogeneous and for a heterogeneous column for which zones of different K are placed in series with the direction of flow. Note that the best way to do this is to take the values from the .list file into Excel, combine them with the K values from the .bcf file, and calculate the flux at each point. Keep in mind that heads are calculated at the center of a cell (a node) and the K values are defined over each cell.

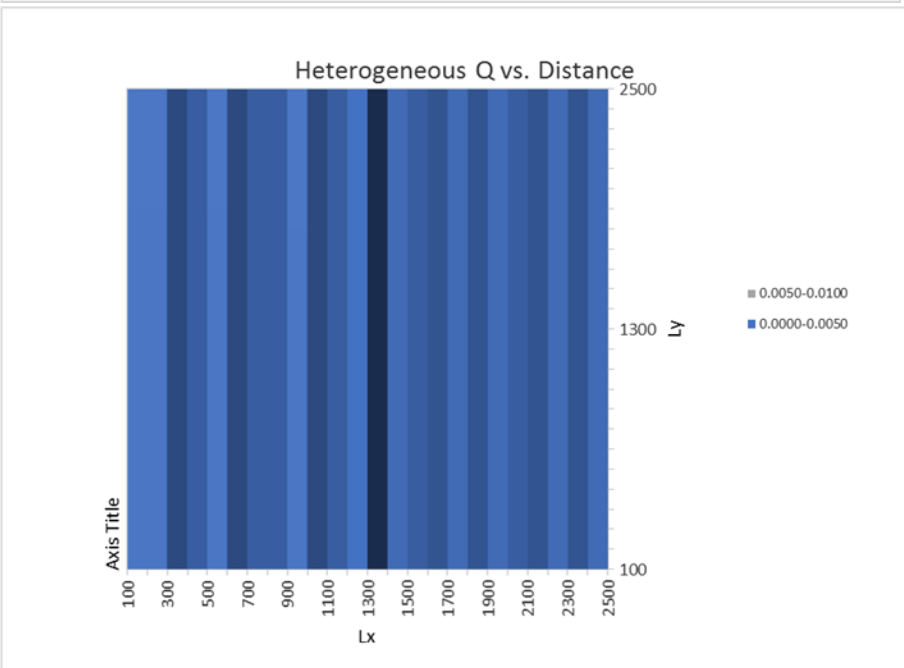
Show the steady state head contour in plan view for the heterogeneous (zones in series) condition. Use this plot to defend a contention that flow is 1D. Then, drawing on your Excel assignment, use the results to explain WHY the equivalent hydraulic conductivity, Keq, is closer to the lower of the two K values.

Build a model based on a homogeneous domain with a square region of lower K in the middle of the domain. What can you learn based on your explanation of what controls the effective K for a 1D flow system now that you are applying it to a 2D system? What do you think the Keq of this entire system would be compared to the high and low K values? Explain why it is much more difficult to develop a direct solution for this 2D system than it was for a 1D system (including the zones placed in series)."

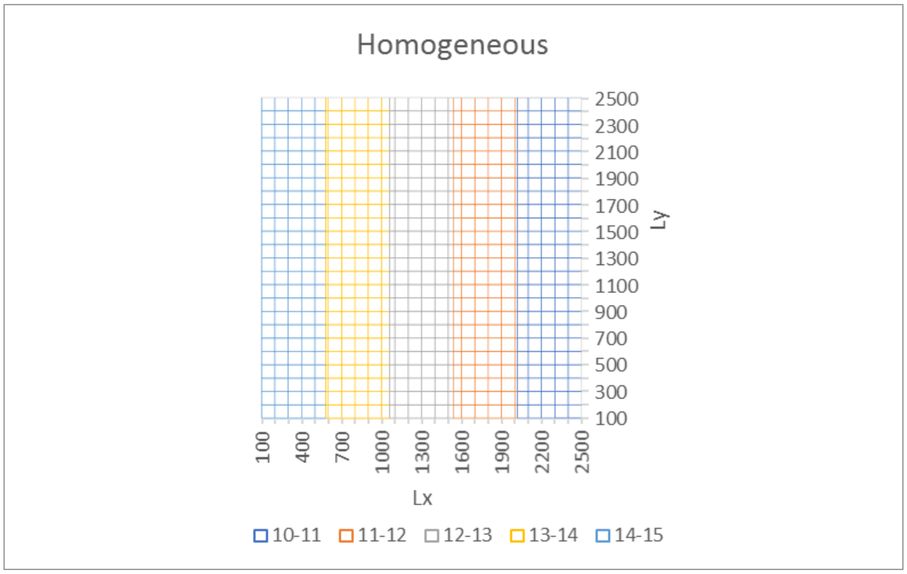
Answers:

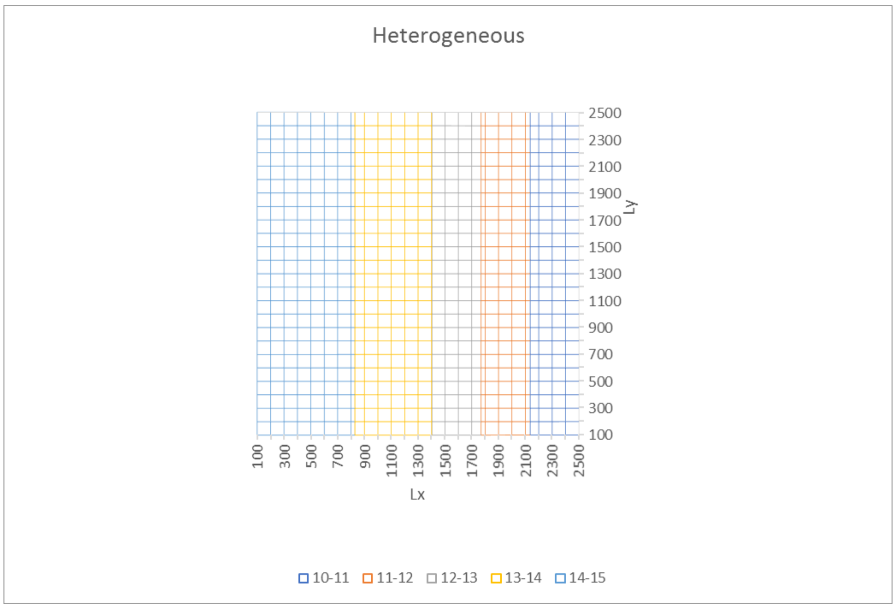
Based on the flux with horizontal distance from a constant head boundary, the model is steady state when head and distance are not changing with time/are stable. With homogeneous flux properties (k being the same) you can see a constant pattern along the flux contour. With heterogeneous, you can see a changing pattern along the contour as we set one half of the columns of the bcf file at one k value and the other half at another k value. This is expected with both homogeneous and heterogeneous systems.



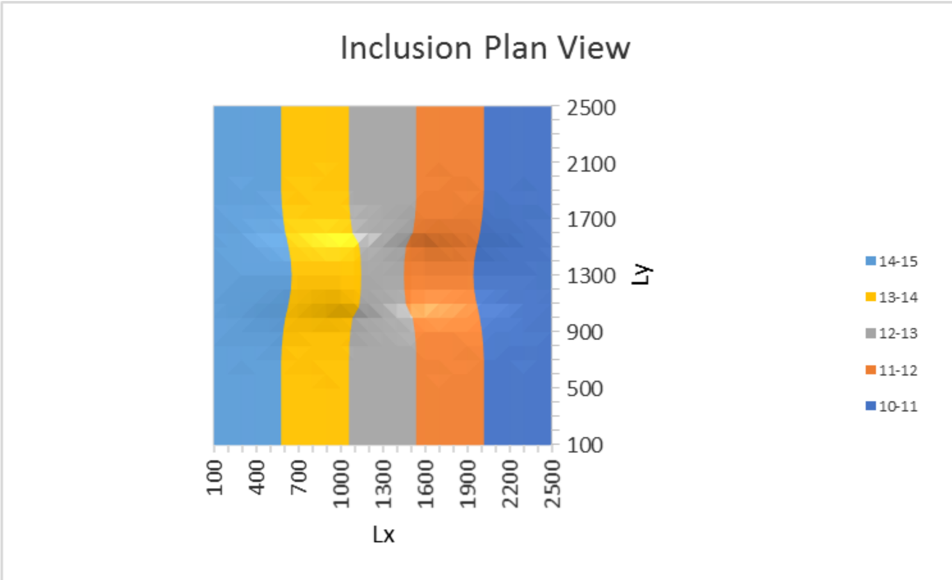


Shown below are the steady state head contours in plan view for homogeneous and heterogeneous systems. The flow of the heterogenous system is 1D as the head values change independently of flow in all directions but the horizontal direction as the K values change. The Keq is closer to the lower of the two K values because as the water flows along the system with changing mediums and flow volumes, the smaller flow volumes allow smaller K values (resulting in less available flow per unit volume). The energy is mostly used up in the lower K value areas here as the flow volumes change more with lower K values. There is more energy used to move the water through the system.





When we use a 2-D model, looking at effective K gets a little more complicated. This is because the system is not independent in every direction. Given this matrix, more directions of flow would occur which would mean that the flow volumes would increase and therefore increase the overall K values. This would decrease the loss of energy in the system.



Inclusion Plan View
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