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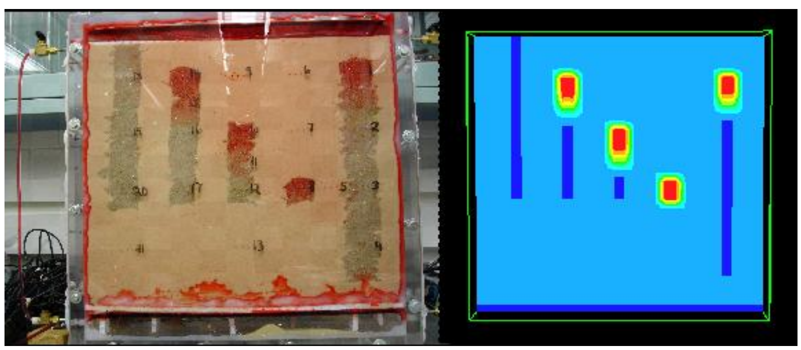
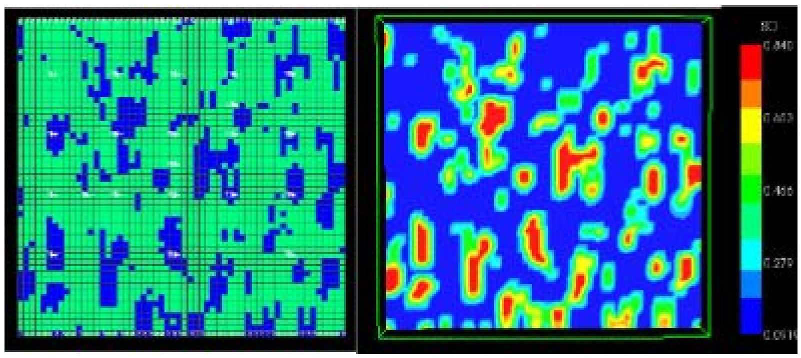
The overall view of my dissertation research is the investigation of air and LNAPL entrapment in the Partially Saturated Fringe (PSF – the region bounding the water table in the groundwater system) in heterogeneous systems in the presence of a rising water table. There are several components to this research. I have conducted laboratory experiments that have been used to verify the air and LNAPL entrapment behavior demonstrated by the TOUGH2 and T2VOC models. The figure below shows the results of a laboratory experiment (left) and numerical (T2VOC) simulation (right) at the end of imbibition in an LNAPL/water system. As can be seen here, and is demonstrated by the moisture content data recorded at various points in the system (both in the laboratory and numerical simulations), that the numerical simulations accurately reflect the LNAPL entrapment behavior seen in the laboratory. These experiments and simulations were conducted at varying flow rates, and the numerical simulations and laboratory data results were consistent in these experiments as well.



After verification of the model, the research was extended to investigate how various sediment properties (specifically air entry pressure of the sediment and the uniformity of the grain size of the sediment) effected air entrapment in heterogeneous, air/water systems. This was done by varying different input parameters in PetraSim while using the van Genuchten- Maulem and van Genuchten models for relative permeability and capillary pressure, respectively. These simulations were conducted in a field that contained coarse sand lenses in a finer sand matrix and imbibition was simulated. It was determined that an increase in the air entry pressure of the enclosed sand lens leads to less air becoming entrapped in the sand lens and that increasing the degree of sorting or uniformity of grain size of the enclosed sand lens leads to more air becoming entrapped in the lens.

Investigation of degree of connectivity of coarse regions is an important aspect of my research as well. I have already demonstrated experimentally and numerically that the degree of air entrapment in an air/water system during imbibtion is highly dependent on the connectivity of the coarse regions. It has been shown experimentally that this is also true for LNAPL entrapment, and I am currently investigating, numerically with statistically similar derived fields, how connectivity of coarse regions surrounded by a finer sand matrix effects the degree of entrapment of LNAPL in the system. The following figure illustrates that connectivity matrix for the sediments on the left and the results of the simulation after imbibition on the right. The red color in this result indicates high LNAPL saturation and the blue indicates high water saturation. As is demonstrated here again, LNAPL is entrapped in the system below the water table.



These are the major areas of research in which I have used PetraSim to enhance my laboratory investigations of air and LNAPL entrapment in a groundwater system in the PSF region. PetraSim has been very helpful and an extremely important part of my research in allowing me to use TOUGH2 and T2VOC in an efficient manner without having to manually create all input files for each simulation.