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Microtomographic imaging of multiphase flow in porous media: Validation of image analysis algorithms, and assessment of data representativeness and quality

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Significant strides have been made in recent years in imaging fluid flow in porous media using x-ray computerized microtomography (CMT) with 1-20 micron resolution; however, difficulties remain in combining representative sample sizes with optimal image resolution and data quality; and in precise quantification of the variables of interest. Tomographic imaging was for many years focused on volume rendering and the more qualitative analyses necessary for rapid assessment of the state of a patient's health. In recent years, many highly quantitative CMT-based studies of fluid flow processes in porous media have been reported; however, many of these analyses are made difficult by the complexities in processing the resulting grey-scale data into reliable applicable information such as pore network structures, phase saturations, interfacial areas, and curvatures. Yet, relatively few rigorous tests of these analysis tools have been reported so far. The work presented here was designed to evaluate the effect of image resolution and quality, as well as the validity of segmentation and surface generation algorithms as they were applied to CMT images of (1) a high-precision glass bead pack and (2) gas-fluid configurations in a number of glass capillary tubes. Interfacial areas calculated with various algorithms were compared to actual interfacial geometries and we found very good agreement between actual and measured surface and interfacial areas. (The test images used are available for download at the website listed below).
http://cbee.oregonstate.edu/research/multiphase_data/index.html