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QUANTITATIVE CHARACTERIZATION OF POROUS ROCKS: STOCHASTIC CONSTRUCTION OF REPRESENTATIVE PORE NETWORKS

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Summary. In order to better understand multi-phase flow through porous rocks, it is useful to characterise the pore space in terms of its microstructure and to assess how the particular pore system relates to the pore systems of similar rocks. Our approach is to segment the pore space from three dimensional (3D) rock images and to idealize the pore system as a model comprising a network of nodes linked by bonds. The morphology and topology of the nodes and bonds that constitute the pore network structure allows a quantitative comparison to other rocks. Importantly, we can use the pore network model to accurately predict petrophysical properties of the rock.

Although significant improvements both in imaging technology and in numerical simulations have already been achieved, the study of several critical issues is still actively pursued: (1) the parameterised quantification of porous media, (2) the reconstruction of representative stochastic pore networks, and (3) the integration of multi-scale networks.

In this paper, we demonstrate progress on these critical topics. We characterise the pore space in terms of 1) the empirical probability distributions for basic geometrical and topological properties, 2) the explicit analytical representation of important correlations, and 3) the parameterised description f network structures. With parameterised distributions and analytical correlations, we use a set of statistics (parameters) to characterise types of rocks in terms of probability distributions or approximate function coefficients. With statistical information about a rock sample, an effective and robust approach is presented to reconstruct a representative pore network of arbitrary size. Furthermore, we introduce an innovative approach to create a multi-scale network based on the information derived from multi-scale images (e.g. micron scale and submicron scale). Examples are presented to illustrate the representivity of integrated pore structure in determining rock petrophysical properties.