Bottom-up approach of multiscale dynamics in porous media. Application to Gas Shale

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In the context of high fuel prices the reserves of natural gas stored in shales are too large to be ignored. A major difficulty for a proper description of fluid transport in such systems stems from its multiscale texture characterized by a wide pore size distribution. Mass transfer in micropores and mesopores is very different from that in macropores and models for conventional reservoirs, intended to describing transport in macropores, are unsuitable for shale. As a result, any attempt in understanding overall transport requires a multiscale modeling approach. In this work, we built a hierarchical model of kerogen (the carbon-based matrix containing gas or oil in shale reservoir) which includes microporous, mesoporous and macroporous domains as shown in Fig.1. A transmission electronic microscopy (or any imaging technique) image of kerogen obtained from experiments is divided into a grid of equal-size tiles, each of them represents subnanoporous, nanoporous, or macroporous domain.

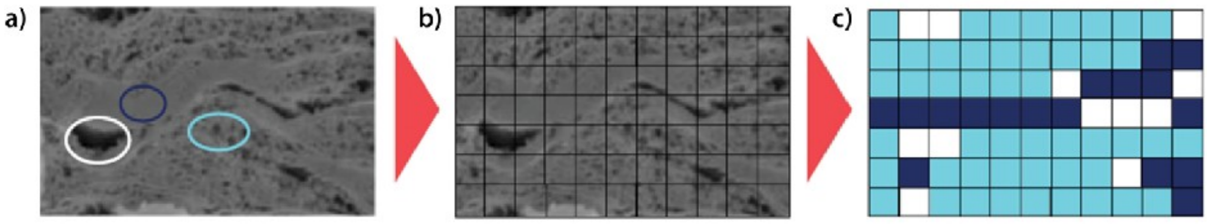

Figure : Hierarchical model of kerogen. A TEM image of kerogen (a) is divided into a grid of equal-size tiles (b), each of them represents subnanoporous (cyan colour), nanoporous (dark blue) or macroporous (white) domain.

Then fluid flow from domain i to domain j (therefore permeability of the whole sample) is described using a novel lattice model originated from the lattice gas automata method.

The foundation of this lattice model will be atom-scale molecular simulations of mass transport processes. The flow behavior will be averaged to allow upscaling of length and time, and the eventual combination with continuum fluid mechanics solvers. An overview of the proposed model and comparison with Lattice Boltzmann Dynamics will be provided.