Contribution ID: **226** Type: **Poster**

A digital rock workflow to quantify sub-core scale spreading and mixing in reservoir rocks

Monday, 14 May 2018 16:00 (1h 30m)

We report on an extensive investigation of solute mixing and spreading in reservoir rocks, including Bentheimer Sandstone (BS), Ketton Limestone (KL), Edward Brown (EB) carbonate and Indiana Limestone (IL), as well as unconsolidated bead pack (BP) as control material. We observe that the selected rock samples possess distinct strength of subcore-scale heterogeneity and present characteristic features, such as uniform pore structure (BS), a significant degree of microporosity (KL, IL) as well as vuggy porosity (EB). Helium pycnometry, mercury intrusion porosimetry and micro-CT image analysis were applied on small sub-sets (plugs) of each rock samples to provide a distribution of baseline microscopic properties, such as skeletal density, porosity, pore- and grain-size distribution. Unidirectional pulse-tracer tests have been carried out on each rock core over a range of Peclet numbers (Pe = 20-400) and by simultaneously measuring breakthrough curves to provide estimates of the solute longitudinal dispersivity. The unique aspect of this study is that the tracer tests are supplemented by the combination of two imaging techniques: X-ray Computed Tomography (CT) is used to quantify subcore-scale heterogeneities in terms of porosity and permeability contrasts at a spatial resolution of approximately 10 mm3, while Positron Emission Tomography (PET) is applied to image the spatial and temporal evolution of the full tracer plume non-invasively. The latter provides unprecedented insight on the transport mechanisms inside the porous sample at a resolution of a few mm (Figure 1 - image attached). Most significantly, PET imaging enables computing macroscopic measure of mixing as a function time, such as spatial moments, the dilution index and the scalar dissipation rate, which in turn serve as quantitative metrics to compare observations for the different rock samples. Different models have been successfully applied to match the observed breakthrough curves, including the classic Advection-Dispersion Equation, the Multi-Rate Mass Transfer model and their combination within a streamtube framework. The validity of each model was assessed by evaluating its capability to predict the internal tracer concentration profiles measured by PET. We observe that the effects of macrodispersive spreading can overcome those of local dispersion for heterogeneous rocks (particularly carbonates). In this context, the use of PET in combination with X-ray CT provides significant opportunities to advance our understanding of miscible displacements in consolidated porous media, thus including those involving additional phenomena, such as adsorption, chemical reactions and capillary effects.

Indico rendering error

`Could not include image: Cannot read image data. Maybe not an image file?`

References

Acceptance of Terms and Conditions

Click here to agree

Primary author: KUROTORI, Takeshi (Imperial College London)

Co-authors: ZAHASKY, Christopher (Stanford University); Mr HOSSEINZADEH HEJAZI, Sayed Alireza (Imperial College London); Prof. BENSON, Sally (Stanford University); PINI, Ronny (Imperial College London)

Presenter: KUROTORI, Takeshi (Imperial College London)

Session Classification: Poster 1

Track Classification: MS 1.04: Upscaling of mixing, dispersion and reaction processes from pore to continuum scale