Contribution ID: **244** Type: **Poster Presentation**

Microfluidic study on the gas-water flow behaviors at pore-scale in tight sandstone rocks

Wednesday, 15 May 2024 16:10 (1h 30m)

Gas-water two phases flow behavior is fundamental to understand the underground gas exploitation. Due to the limitations that core-scale displacement experiments cannot reveal the evolution of gas-water interface and distribution of gas and water at pore-scale, a visualization study of gas-water two-phase flow at pore-scale using microfluidics was conducted in this study. Both a single capillary model and pore network model were designed based on CT images of real tight sandstone rocks and related microchip models were fabricated and etched. Then the dynamic evolution of gas-water interface and flow phenomena at pore-scale were investigated using these two micro models. The core-scale flow experiments were also carried out to analyze the gas and water flow mechanisms. The results shows that snap-off and bypass flow were the two most important pore-scale events that occurred during the evolution of gas-water interface to break the continuity of gas flow. Once the gas phase is discontinuous, the Jamin effect became remarkable to hinder the gas flow and water drainage, resulting in gas entrapment and residual water produced. Combined with the core-scale analysis and pore-scale visualization, the damage mechanisms of water blocking in tight sandstone reservoirs is elucidated from the perspective of pore-scale evolution of gas-water interface. These findings will improve the knowledge of gas-water flow mechanisms and reveal the intrinsic mechanism of the water blocking in tight formations.

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Primary author: TIAN, Jian (Chongqing University)

Co-author: Prof. QIN, Chaozhong (Chongqing University)

Presenter: TIAN, Jian (Chongqing University)

Session Classification: Poster

Track Classification: (MS11) Microfluidics and nanofluidics in porous systems