Contribution ID: **483** Type: **Oral Presentation**

Capillary-controlled phase transitions in caprock over CO2 storage in aquifer simulated by nanofluidic pore models

Wednesday, 24 May 2023 12:15 (15 minutes)

CO2 injection in deep aquifers is a way to perform CO2 storage, but it requires an impervious overlying formation called caprock to avoid any catastrophic leakage. The post-injection CO2 bubbles accumulate rapidly at the aquifer-caprock interface, creating a multiphasic situation and drying the caprock interface. Due to the thinness of the pore size distribution, this drying can lead to the formation of nanoscale capillary bridges, meaning that the entire water-bearing caprock is put in a capillary state, i.e., liquid under negative pressure (tension) [1, 2]. Therefore, the evolution of geochemical reactions and the dynamics of liquid-air partitioning must be capillary-corrected.

To study the capillary-driven mass balance and its associated geochemical features, capillary water bodies were experimentally investigated within synthetic lab-on-a-chip pore models with perfectly controlled inner geometries. As shown in Fig.1, these experiments are carried out using nano/microfluidic chipsets designed based on two feeding micro-channels connected by a series of nano-channels. These nano-channels, etched in a silicon wafer, have a depth varying from 5 to 100 nm and allow us to control or change the capillary states and relative humidity (RH) of a flowing aqueous solution of known composition.

The capillary features of the solution were investigated by employing the 5 nm depth channel and tuning the relative humidity at 50% (capillary evaporation) and 80% (very close to capillary equilibrium). We observed that water boiled in the big reservoir (micro-channels) behind the nano-channels after 60 days at 80%, while no significant evaporation was measured. Meanwhile, permanent capillary evaporation occurs in nano-channels maintained at 50%, and the corresponding kinetic rate was measured. These experiments give insights into the coupling between pore-size-controlled and capillary-controlled geochemistry in porous media, which will be discussed.

Participation

In-Person

References

1) Mercury, L., & Tardy, Y. (2001). Negative pressure of stretched liquid water. Geochemistry of soil capillaries. Geochimica et Cosmochimica Acta, 65(20), 3391-3408.
2) Vincent, O., Szenicer, A., & Stroock, A. D. (2016). Capillarity-driven flows at the continuum limit. Soft Matter, 12(31), 6656-6661.

MDPI Energies Student Poster Award

Yes, I would like to submit this presentation into the student poster award.

Country

France

Acceptance of the Terms & Conditions

Click here to agree

Energy Transition Focused Abstracts

Primary authors: Mr MOZHDEHEI, Armin (Institut des Sciences de la Terre d'Orléans - UMR 7327 Université d'Orléans, CNRS, BRGM - 45071 Orléans Cedex, France); Prof. MERCURY, Lionel (Institut des Sciences de la Terre d'Orléans - UMR 7327 Université d'Orléans, CNRS, BRGM - 45071 Orléans Cedex, France); Dr SLODCZYK, Aneta (Institut des Sciences de la Terre d'Orléans, CEMHTI, UPR 3079 CNRS- Université d'Orléans, F-45071, Orléans, France)

Presenter: Mr MOZHDEHEI, Armin (Institut des Sciences de la Terre d'Orléans - UMR 7327 Université d'Orléans, CNRS, BRGM - 45071 Orléans Cedex, France)

Session Classification: MS11

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