Contribution ID: **950** Type: **Oral 20 Minutes**

Is Ostwald Ripening Important in CO2 Geological Sequestration? A Micromodel Study of Bubble Repining Dynamics

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• Theoretical part of this work has just been accepted by Physical Review Letters

Long-term storage is necessary in order for CO2 geological sequestration in to be feasible. Leakage of CO2 by buoyant forces may occur if the trapping of CO2 in porous media is not stable with formation of large CO2 clusters. Ostwald ripening is a well-known phenomenon in two-phase mixtures that may affect bubbles' stability. During an Ostwald ripening process in an open system, the gas in small bubbles dissolves in the surrounding fluid and diffuses to larger bubbles to grow them. Thus, there is concern about whether a coarsening of CO2 bubbles can occur and lead to such leakage after injection into porous media.
Here we show that Ostwald ripening will not lead to considerable coarsening of CO2 bubbles trapped in porous media. The size evolution of bubbles in a micron-scale porous medium has been shown very different from that in an open system. Unlike the coarsening typically observed in open systems, an initially polydisperse population of bubbles will ultimately become monodisperse and there is egalitarianism in bubble size for sufficient confinement in a homogenous porous medium, with gas from the larger bubbles diffusing to smaller bubbles.
Experiments conducted on a 2.5-D micromodel validate the ripening dynamics models, with the bubble population evolution dynamics well quantified. Our results show that this anti-coarsening effect is driven by the capillary pressure difference, and directed by the micron-scale geometric confinement. A physical model for the evolution dynamics on bubble population is derived from first principles with no empirical parameters, and this model matches our experimental data very well.
Based on our experiments and models, we conclude that, Ostwald ripening can be a positive effect, rather than a negative effect, to improve bubble stability. If bubbles are initially dispersed into small size (similar to or smaller than pore size) during injection, no significant coarsening will happen that lead to gas leakage. In addition, understanding this anti-coarsening effect of bubbles/droplets in porous media is also of great significance for better description and operations in many other applications which involve time scales similar to or longer than several hours, such as the formation and concentration of oil and gas in reservoirs (millions of years), transport of NAPLs in soil (days or even years), foam-based enhanced oil recovery (months to years).

References

Ke Xu, Roger Bonnecaze, Matthew Balhoff. " Egalitarianism among bubbles in porous media: An Ostwald ripening derived anti-coarsening phenomenon", Physical Review Letters, just accepted

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