**SPE 89341: Implications of Coupling Fractional Flow and Geochemistry for CO2 Injection in Aquifers: Noh, Lake, and Bryant**

This paper gives the mathematical formalism of combined geochemical reactions and multiphase flow. If the local-equilibrium assumption applies, the theory leads to a graphical solution, from which it is easy to see when and under what conditions mineralization will occur. The theory also illustrates the modes of CO2 trapping.

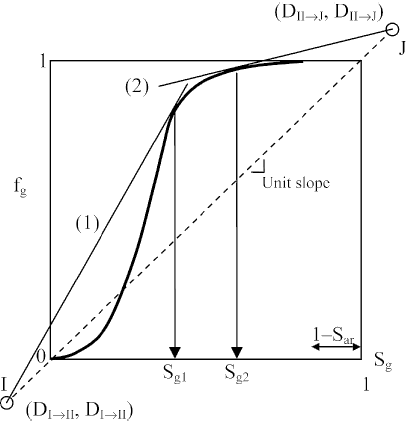
Assumptions:

1. Dry injected CO2
2. Semi-miscible displacement, since there is substantial dissolution of CO2 in brine
3. Incompressible fluid

Shock Velocity: Gas Displacing Brine

Without dissolution of gas in water, the gas-saturation profile for gas displacing water is given by:

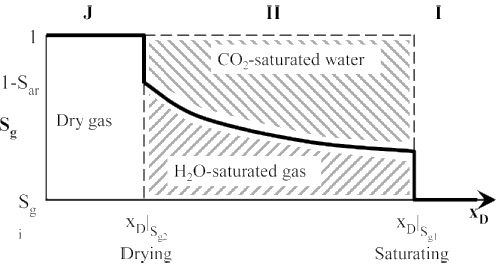
Initially, the reservoir is brine saturated, and the injected CO2 displaces the brine (drainage). The paper proposes the formation of three separate zones: single phase dry CO2, two-phase dissolution zone, and a pure brine zone. The shock front for the two-phase/brine interface moves with a velocity given by and the shock between dry gas/two-phase zones moves at. This is shown in the figure below.



The points on the graph are given by:

Velocity of fast shock, xD|Sg1=slope of line (1)

Velocity of slow shock, xD|Sg2=slope of line (2)



Injection of a single-phase, single-component CO2 gas into an aquifer (Figure 2): The profile consists of one mixed wave that contains two shocks (between Regions II and I and between Regions J and II). The spreading portion of the mixed wave is Region II. Region II contains wet CO2; the gaseous phase is saturated with respect to water. Similarly, the aqueous phase is saturated with CO2. The specific velocity (normalized by a macroscopic velocity) of the downstream shock is given by:

Figure 2

Figure 1

Where *fg*  is evaluated at Sg1 from Figure 1.

The velocity of the upstream shock is given by:

In the region between the shocks, the velocity is given by: