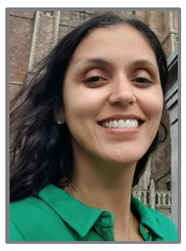

Water Management in Carbonate Reservoirs

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energi SIMULATION

BACKGROUND

Water Management Under CO_2-WAG EOR

- WAG injection has become widely applied in Brazilian pre-salt fields due to its potential to control CO_2 emissions by reinjecting the produced CO_2.
- These reservoirs are primarily formed by calcite and dolomite, but the presence of other minerals, such as anhydrite, can impact geochemical reactions and brine composition.
- Mineral equilibrium reactions can also be significantly affected by CO_2 concentration in the original reservoir condition.

WHY / PURPOSE

- This research studies the geochemical impact of reservoir properties on brine composition in different carbonate reservoirs.
- The main goal is to better predict the composition of produced brine in order to define effective reservoir management strategies from the early stages of an oilfield project.

METHODOLOGY

Sensitivity Study

- Reservoir flow simulation coupled with geochemical modelling – GEM software (CMG group).
- Two models – Two different oil compositions.
- 3D model - WAG injection – Low Sulphate Seawater (LSSW) and pure CO_2
- Mineralogy = *Calcite (40%), Dolomite (20%), Anhydrite (9%), Barite (0.1%), Gypsum (<0.001%).*

$$CaCO_3 + H^+ \Leftrightarrow Ca^{2+} + HCO_3^-$$

$$HCO_3^- + H^+ \Leftrightarrow H_2O + CO_2$$

$$CO_3^{2-} + H^+ \Leftrightarrow HCO_3^-$$

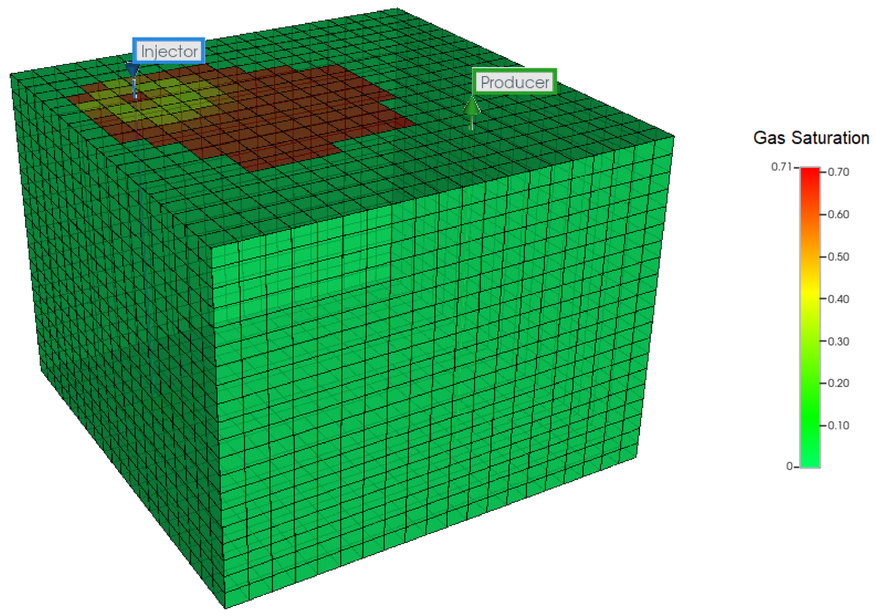
$$OH^- + H^+ \Leftrightarrow H_2O$$

$$CaSO_4 \Leftrightarrow Ca^{2+} + SO_4^{2-}$$

$$BaSO_4 \Leftrightarrow Ba^{2+} + SO_4^{2-}$$

$$CaMg(CO_3)_2 + 2H^+ \Leftrightarrow Mg^{2+} + Ca^{2+} + 2HCO_3^-$$

$$CaSO_4.H_2O \Leftrightarrow Ca^{2+} + SO_4^{2-} + H_2O$$



Oil Compositions (mole fraction)

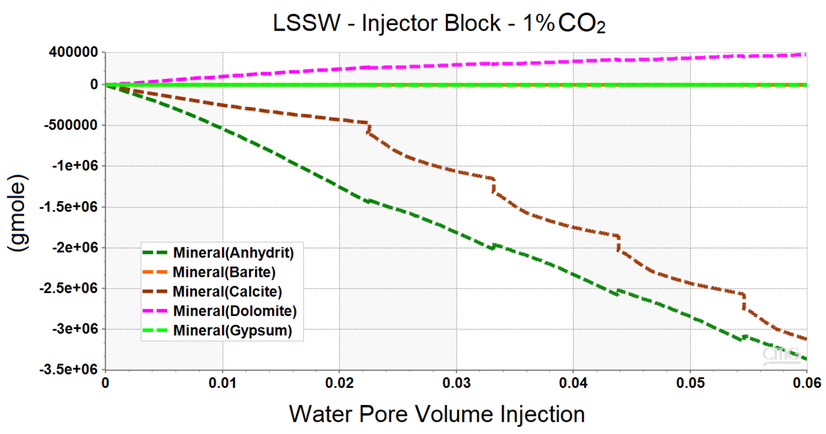
Components	1% CO_2	18% CO_2
CO_2	0.01	0.18
N2 to CH4	0.20	0.03
C2H to NC4	0.16	0.16
IC5 to C07	0.21	0.21
C08 to C12	0.17	0.17
C13 to C19	0.13	0.13
C20 to C30	0.12	0.12
Total	1.00	1.00

Reservoir properties

Model Properties	Value
Temperature	90ºC
Original Pressure	650 bars
Depth of reservoir top	5,750 m
Depth of water-oil contact	6,700 m
Connate water saturation	0.29
Porosity	0.20
Permeability	200 x 200 x 20 mD
Number of grid blocks	20 x 20 x 20
Total model dimensions	2000 x 2000 x 100 m

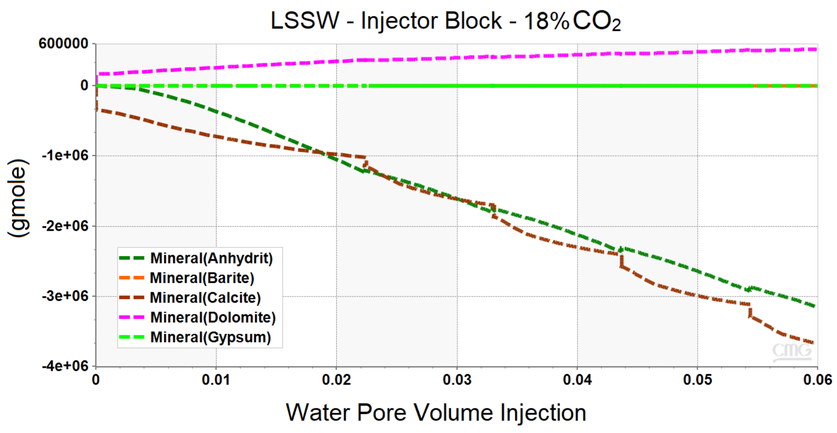
RESULTS

1% CO_2



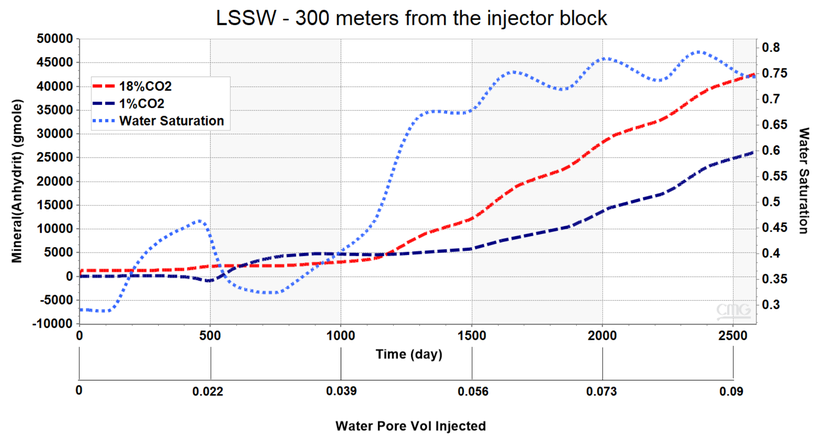
Components (mg/L)	FW	LSSW	Produced Brine @32.8%LSSW
	1% CO_2		
Ca^{2+}	1732	128	1441
Mg^{2+}	43	117	36
K^+	1893	401	1383
Na^+	60915	10799	44550
Sr^{2+}	84	2	61
Ba^{2+}	0.4	0	0.3
SO_4^{2-}	849	4	976
Cl^-	97286	17512	71106
HCO_3^-	180	105	229
pH	5.54	7.08	7.38

18% CO_2



Components (mg/L)	FW	LSSW	Produced Brine @38.2%LSSW
	18% CO_2		
Ca^{2+}	25287	128	19503
Mg^{2+}	2613	117	480
K^+	750	401	513
Na^+	20709	10799	14164
Sr^{2+}	436	2	298
Ba^{2+}	12	0	4
SO_4^{2-}	117	4	71
Cl^-	90743	17512	62747
HCO_3^-	614	105	290
pH	4.31	7.08	6.13

- The amount of CO_2 in the oil phase significantly affects brine composition despite the large volume of CO_2 injected during CO_2 WAG EOR.
- CO_2 partitioning from the oil into the water phase has a greater impact on mineral reactions than CO_2 partitioning from the injected gas into the water phase.



Gusmao, P.B. and Mackay, E., "The Impact of Reservoir Properties on the Sulphate Content of Produced Brine in Carbonate Reservoirs under Seawater-Alternating-Gas Injection", SPE Oilfield Chemistry 2025, https://doi.org/10.2118/224282-MS.