Geochemical Monitoring in CO_2-Enhanced Petroleum Recovery

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Geochemistry Task Purpose

To monitor and predict the reactions taking place between CO_2, reservoir fluids and the minerals in the reservoir:

- For reservoir management (short term)
- For greenhouse gas sequestration (long term)

Geochemistry Task Objectives

To establish a chemical history for the reservoir:

- To monitor the movement of the CO_2 front in the reservoir
- To validate the short term modelling of CO_2 water-rock reaction in the reservoir
- To predict the long term geochemical fate of CO_2 in the reservoir

Geochemistry Task Problems being addressed

- Short term: Breakthrough of CO_2 at the production wells, which limits oil production and CO_2 storage
- Long term: How much CO_2 can be ultimately locked up by mineral formation in the reservoir

Geochemistry Task

- Baseline Geochemistry (before CO_2 injection)
  - Sample & analyze reservoir fluids and injection fluids
  - Identify reservoir mineralogy
  - Determine reservoir heterogenity in the geochemical properties
- Geochemical Sampling of Production/Injection Fluids
- Core floods and experiments for calibration
- Geochemical Modelling

Geochemistry Task

- Geochemical Sampling
  - Sample and analyze production fluids (water and gas for:
    - major inorganic and organic ions,
    - pH, TIC/alkalinity, temperature, and pressure,
    - stable isotopes of Carbon,
    - gasses (both free and dissolved),
  - as a function of location and time in the pilot

Analytical Data

WATER

pH@T°C

Alk H_2S Na K Ca Mg Mn Li Fe Sr Ba Si Cl SO_4

$\delta^{18}O$ SO_4, $\delta^{34}S$ SO_4, $\delta^{18}O$ H_2O, δD H_2O, $\delta^{13}C$ HCO_3^-, $\delta^{34}S$ H_2S

GAS

$\delta^{34}S$ H_2S, $\delta^{13}C_{1-3}H_{4-6}$, $\delta^{13}CO_2$

Mole amounts C_1-C_1, CO_2, H_2S

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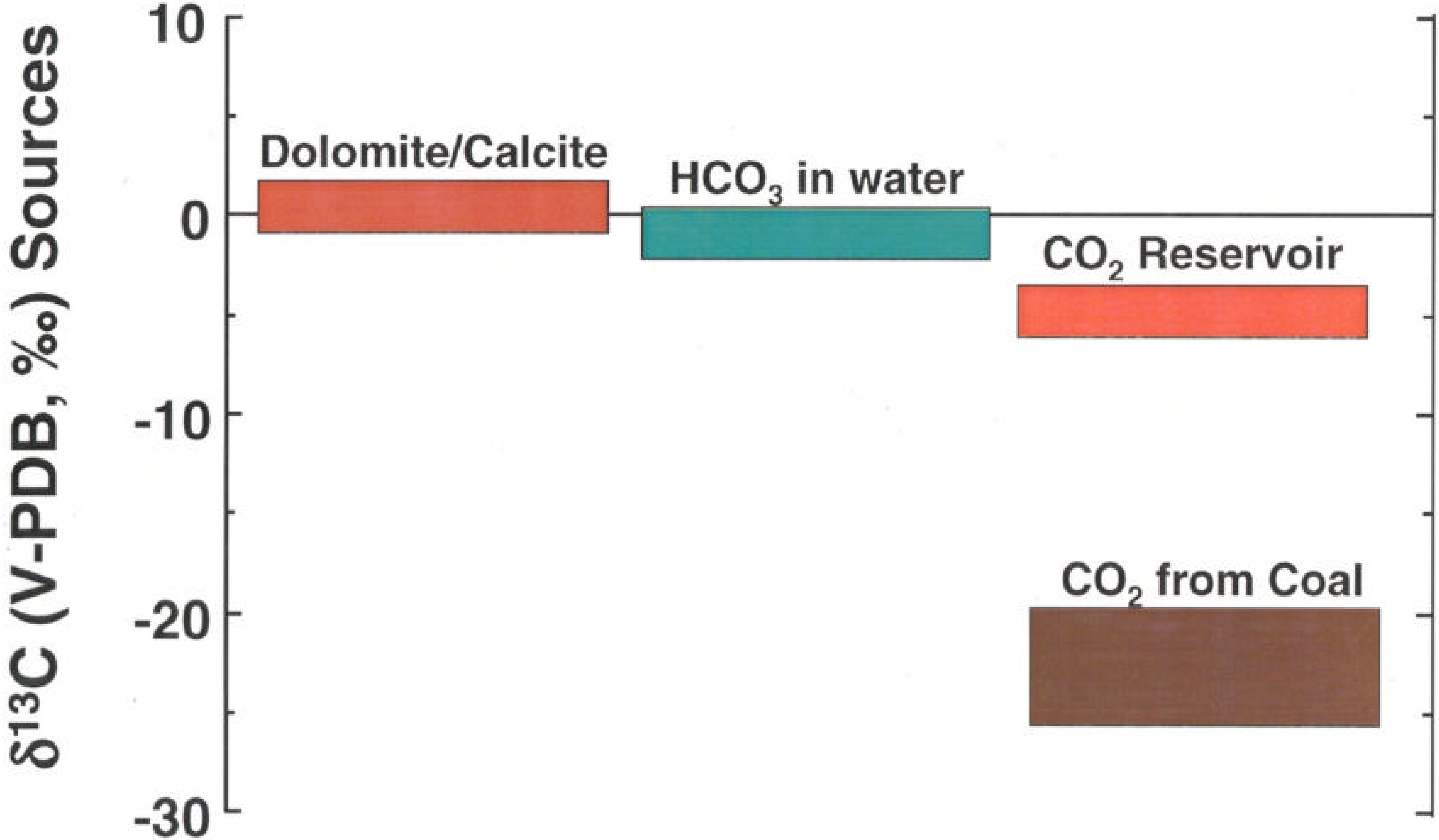
Geochemistry Task

Geochemical Modelling (short term)

- Use a two phase model to track the movement of CO_2 between the gas and aqueous phases.
- Determine if scaling will occur in the production wells.
- Determine the nature and scope of the reactions occurring in the wellbore and the reservoir in years.

Probable Isotope composition - CO_2 Sources



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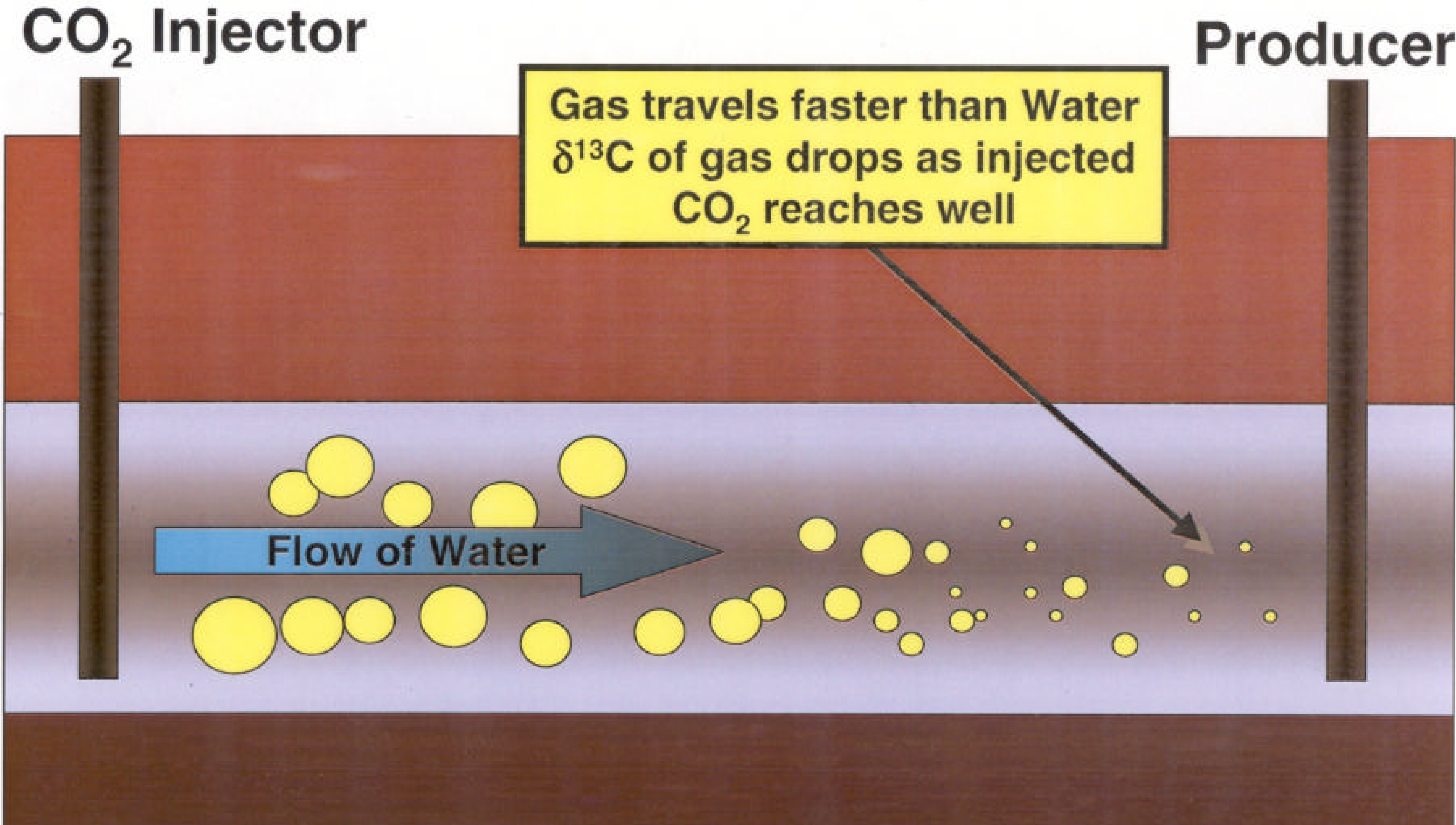
Using CO_2 as a Tracer



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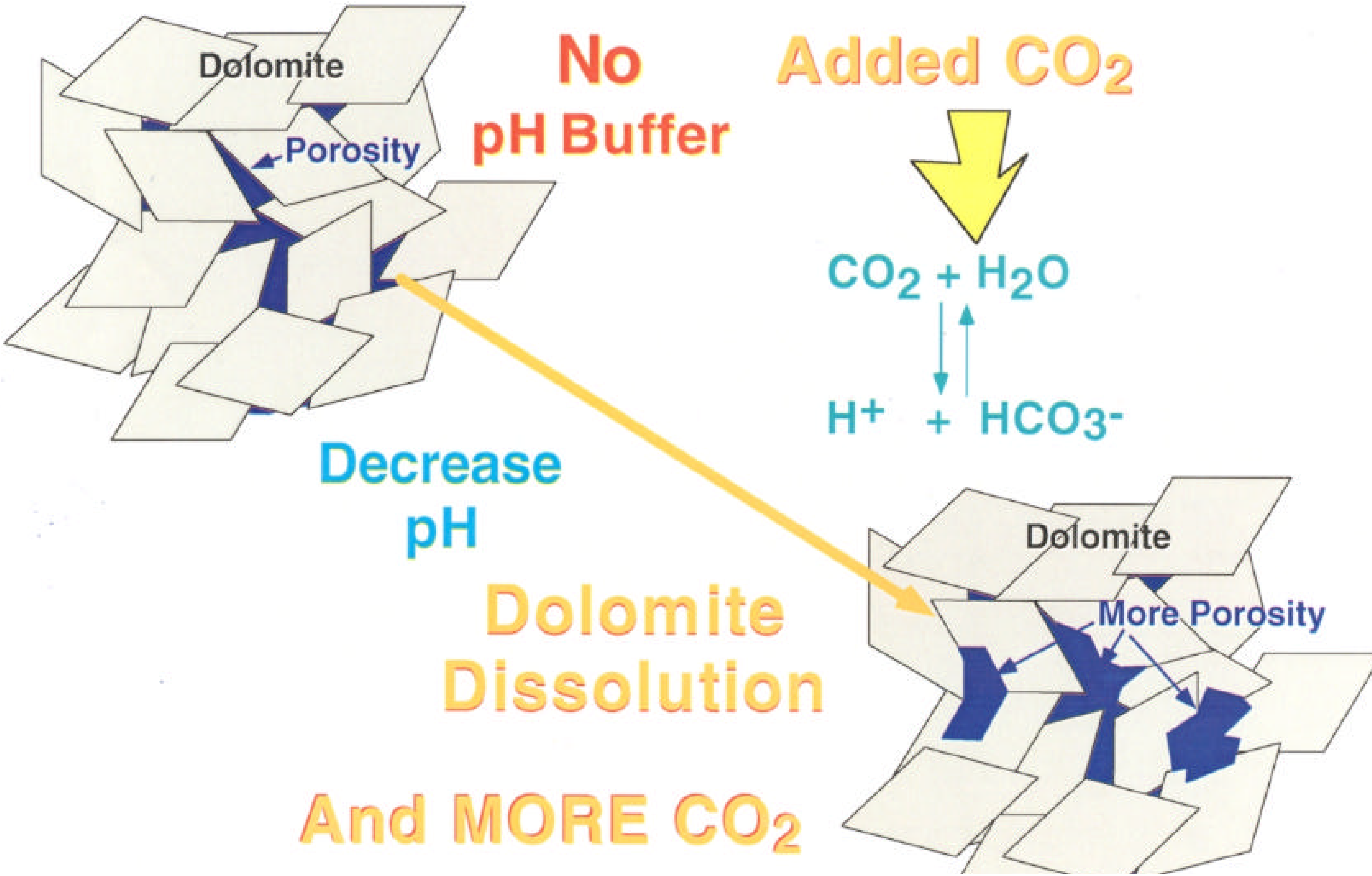
Adding CO_2 to Dolomite

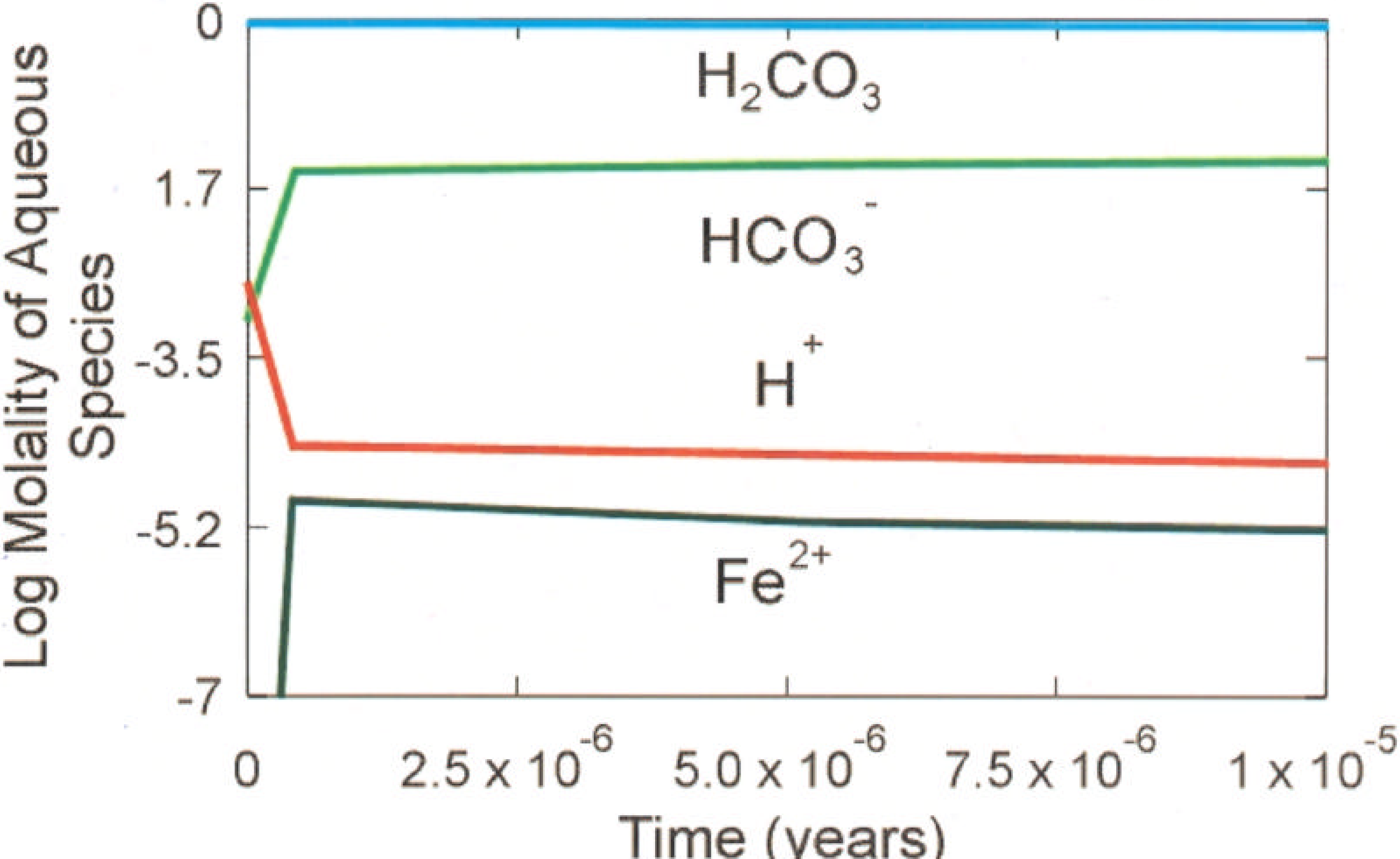


CO_2 (1molal) = P_{CO2} of 87 bars

Nisku Carbonate

P_{CO2}: 87 $\longrightarrow$ 86 bars

Nisku Aquifer (CO_2)



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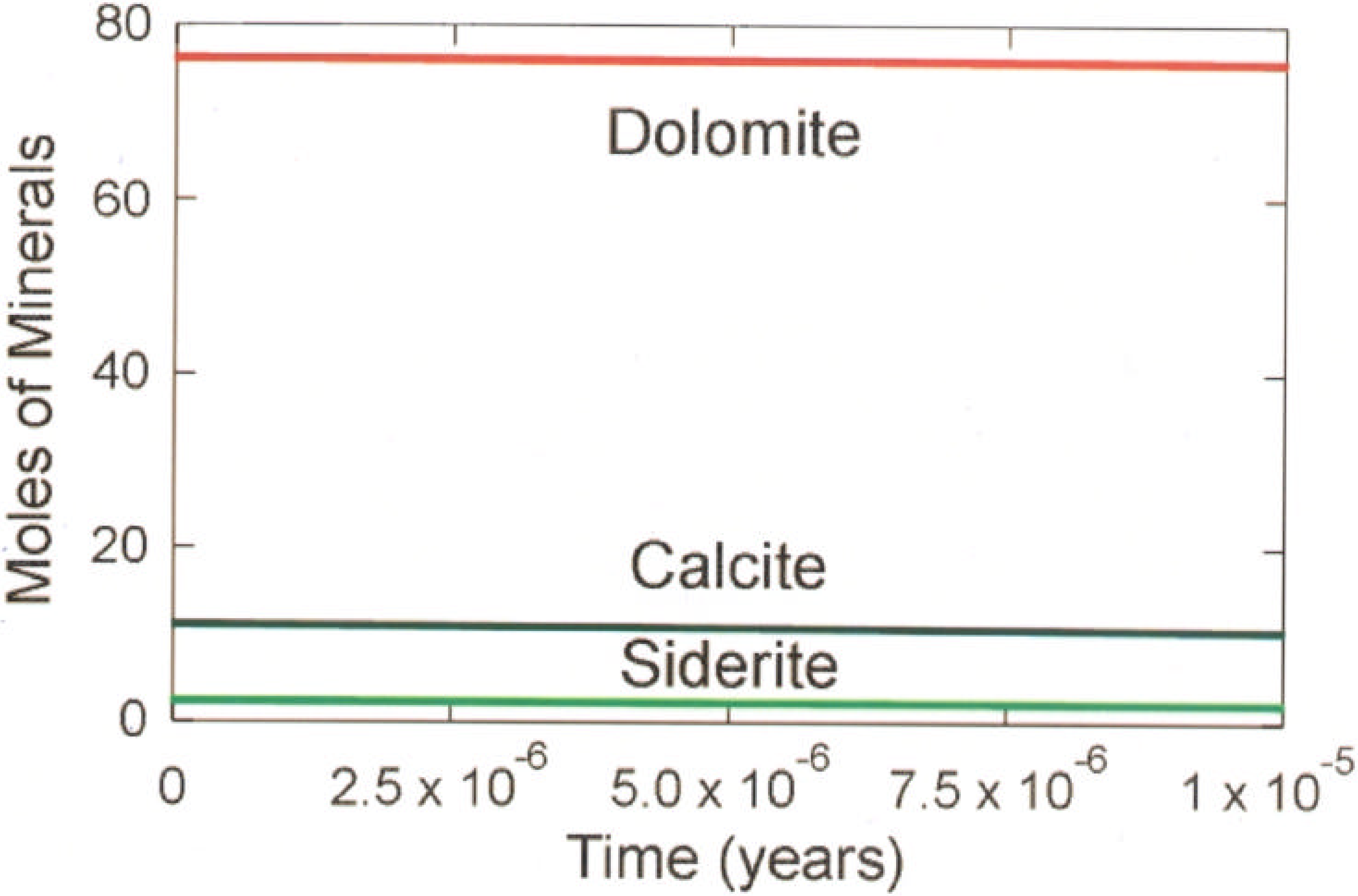
Nisku Aquifer (CO_2)



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Geochemistry Task

Geochemical Modelling (long term)

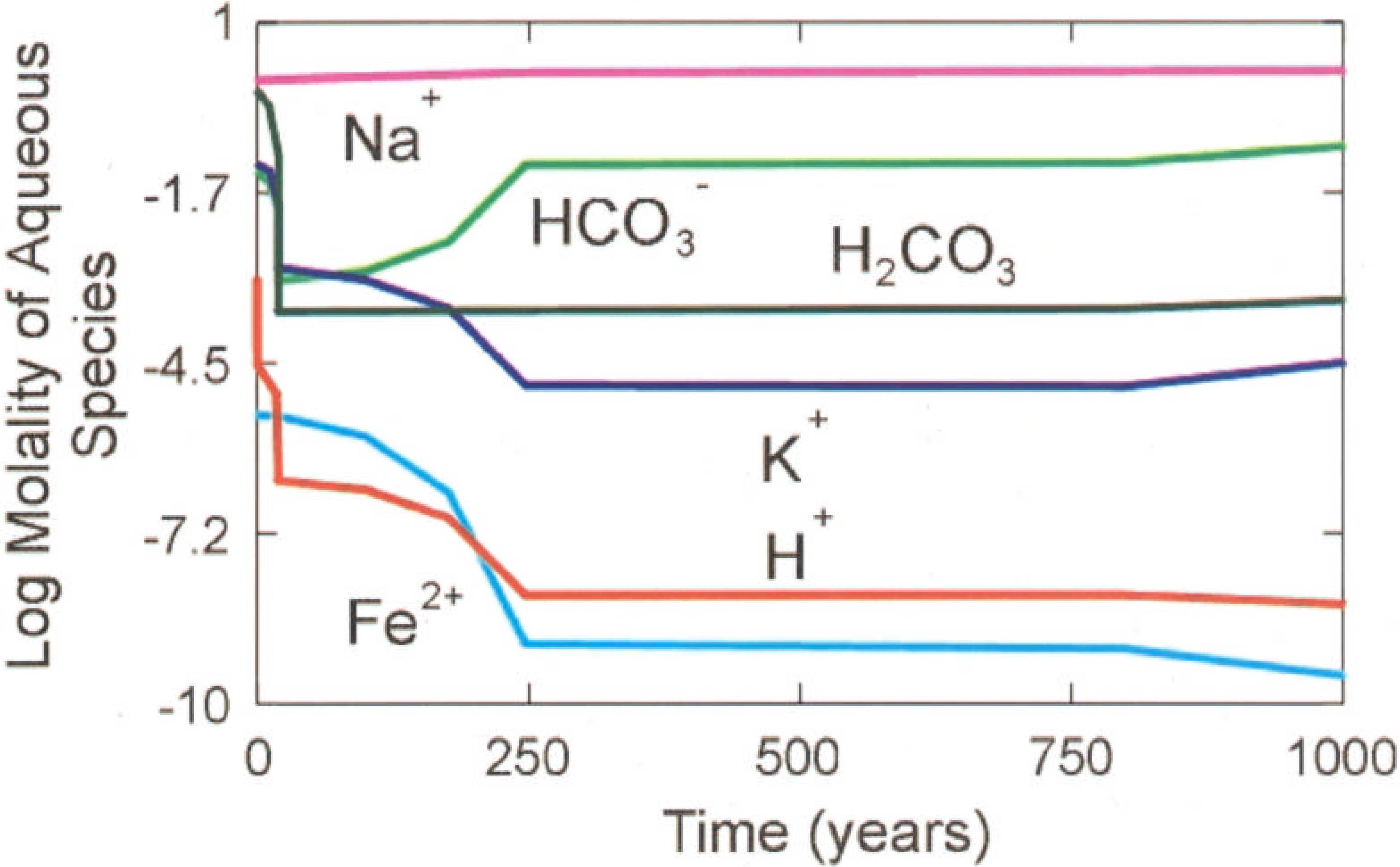
- Predict the amount of CO_2 sequestered in the subsurface in 100's of years.
- Predict cap rock chemical integrity.

CO_2 (1molal) = P_{CO2} of 87 bars

Glauconitic Sandstone

P_{CO2}: 87 $\longrightarrow$ 0.02 bars

Glauconitic Aquifer (CO_2)



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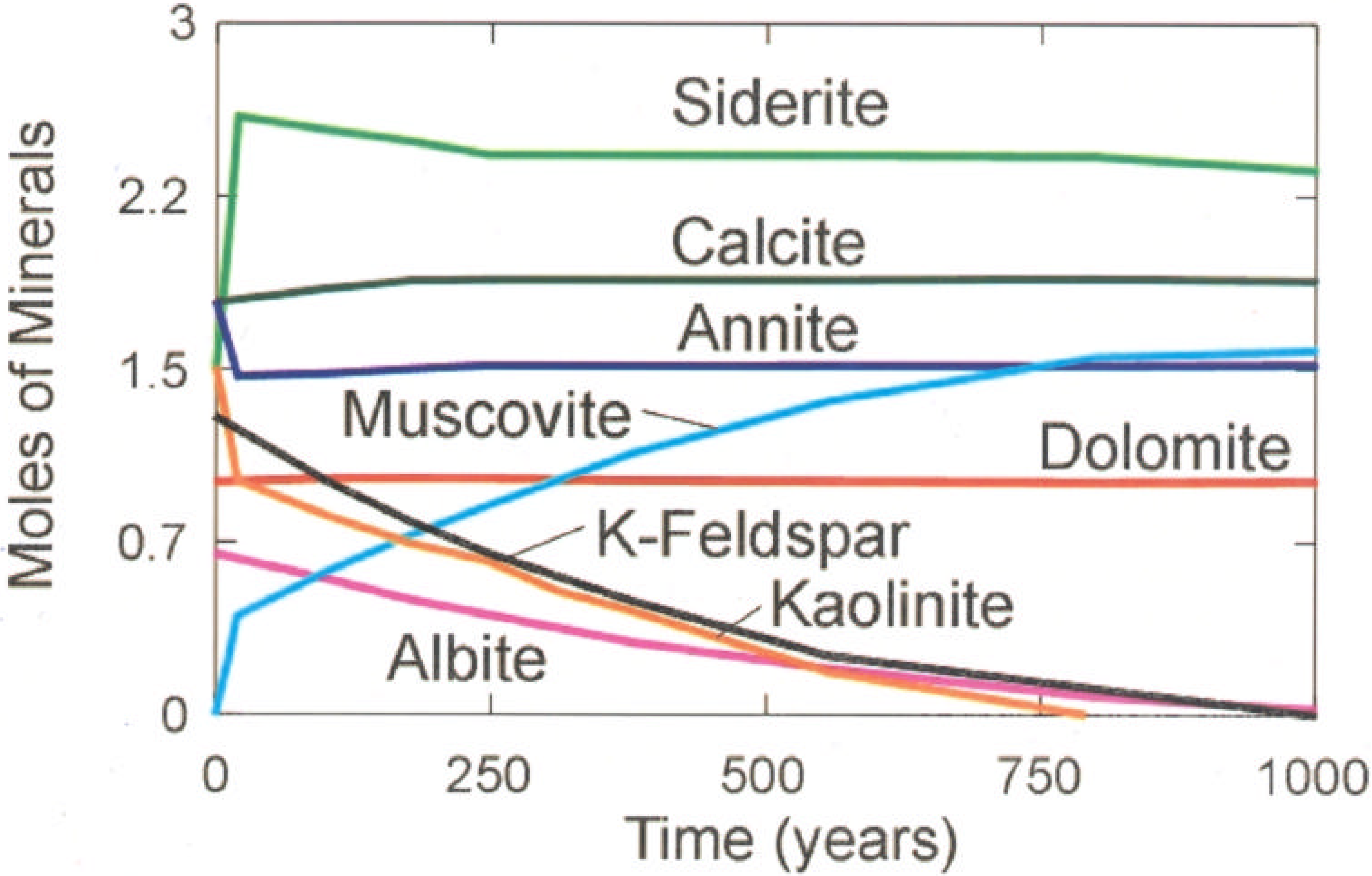
Glauconitic Aquifer (CO_2)



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Geochemistry Task Benefits

- Short Term: Allows the prediction of the movement of the CO_2 in the reservoir.
- Long Term: Establish the basis for greenhouse gas credits.