



أرامكو السعودية
Saudi Aramco

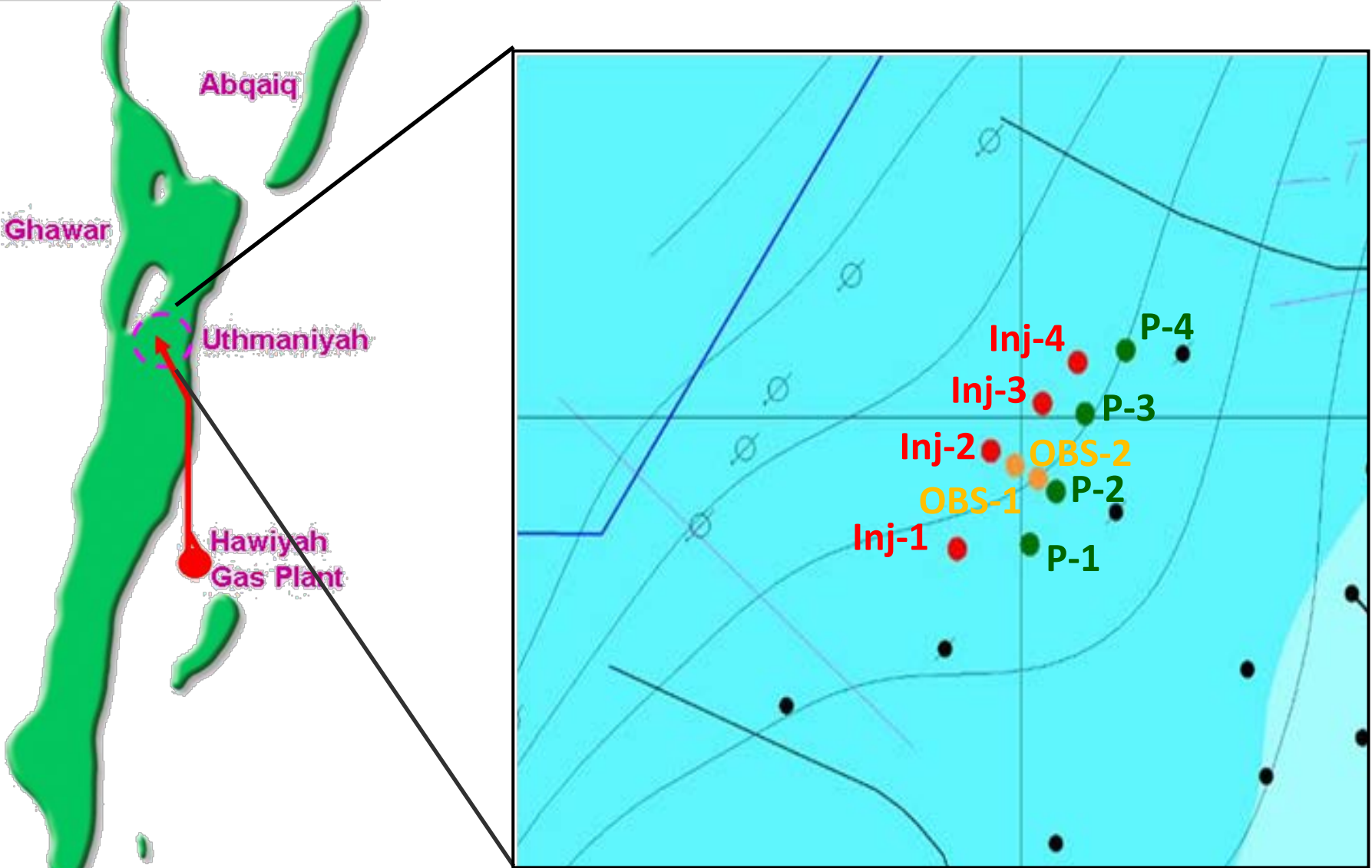
UTMN CO₂-EOR Demonstration Project

Dr. Ali Almeshari

Overall Coordinator

Saudi Aramco Corporate Carbon Management Team

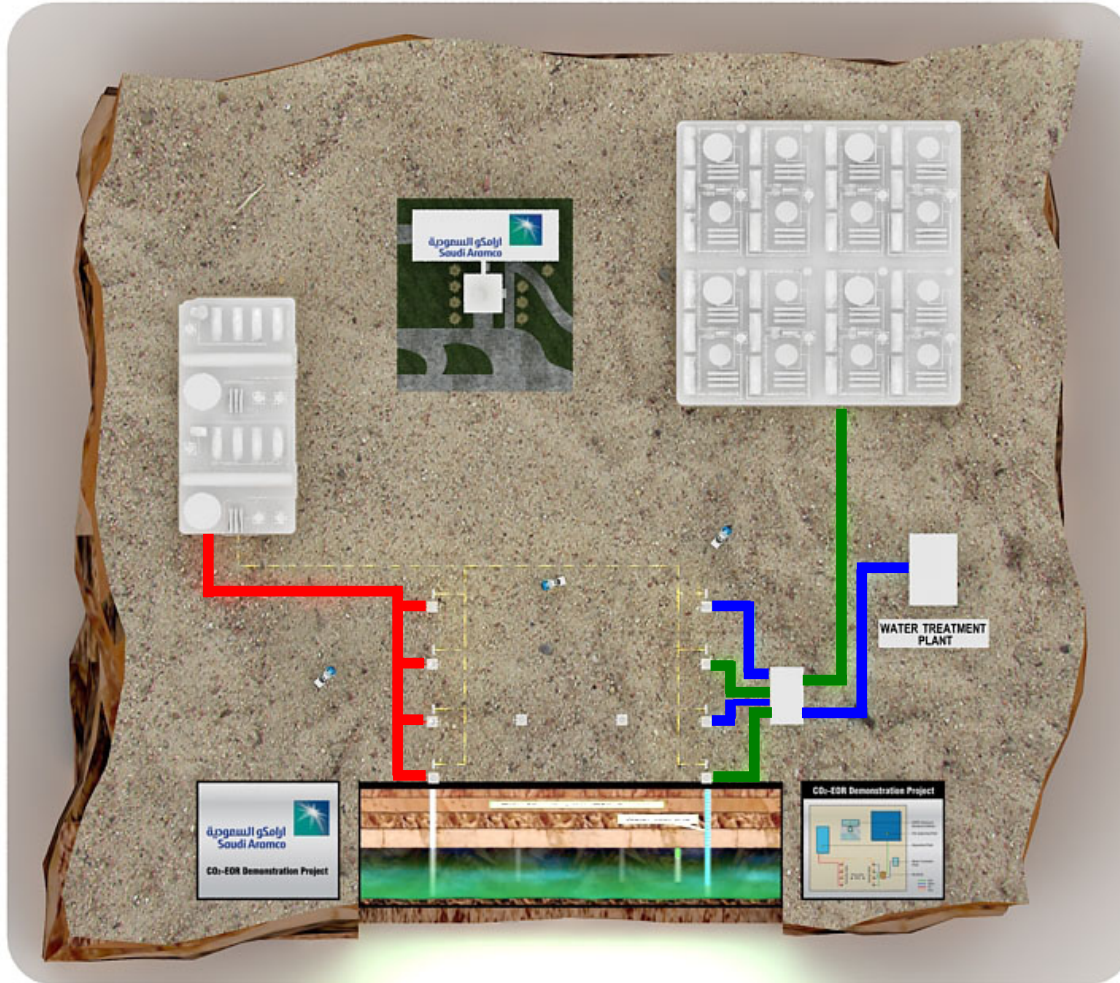
CO₂-EOR Demonstration Project



Injection Strategy

- ⦿ CO₂ injection 40 MMscfd
- ⦿ 4 injectors and 4 producers
- ⦿ WAG cycle of 3 month gas/3 month water for 3-5 years
- ⦿ Well spacing ~2,000 ft
- ⦿ Switch CO₂ between wells

Injection Strategy

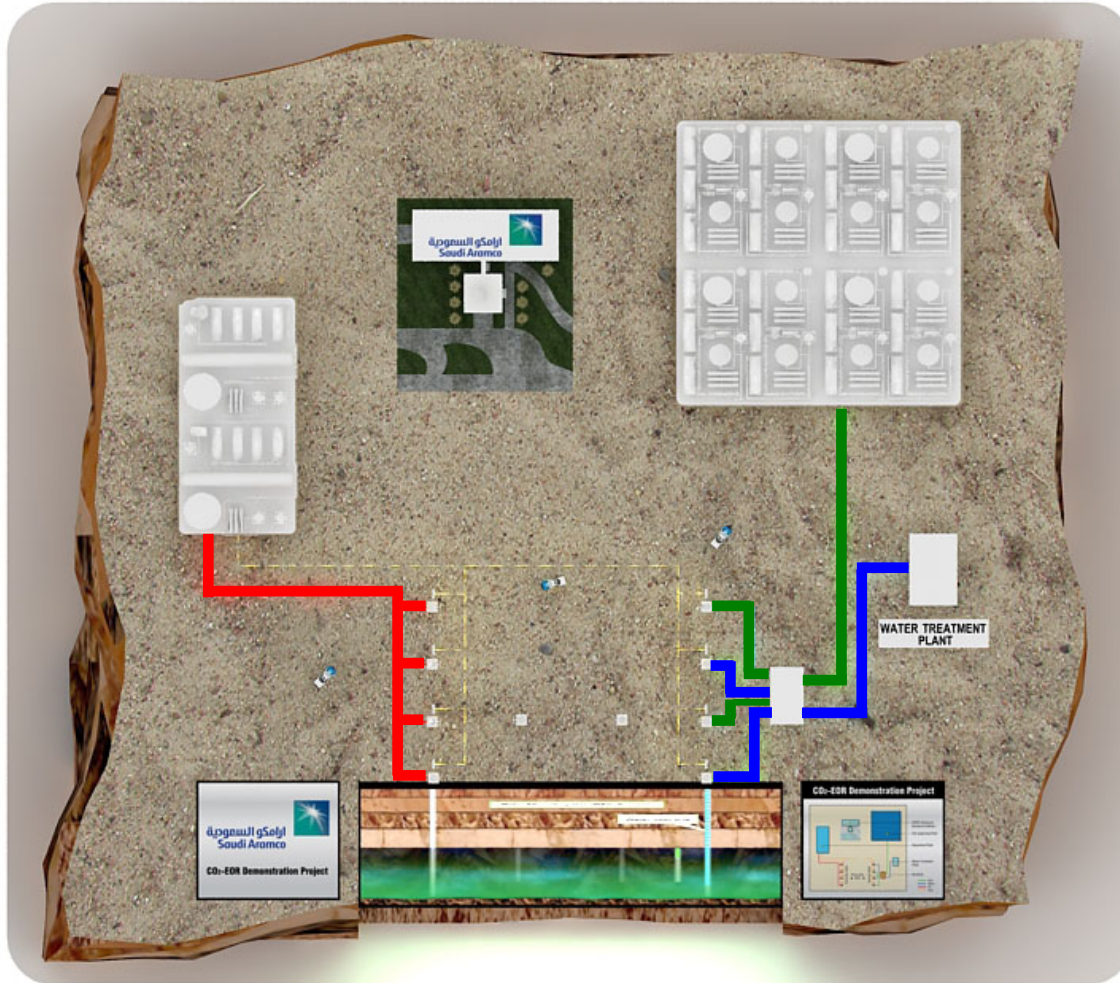


First Three months:

- CO₂ is injected in Wells 1 and 3
- Water is injected in Wells 2 and 4



Injection Strategy

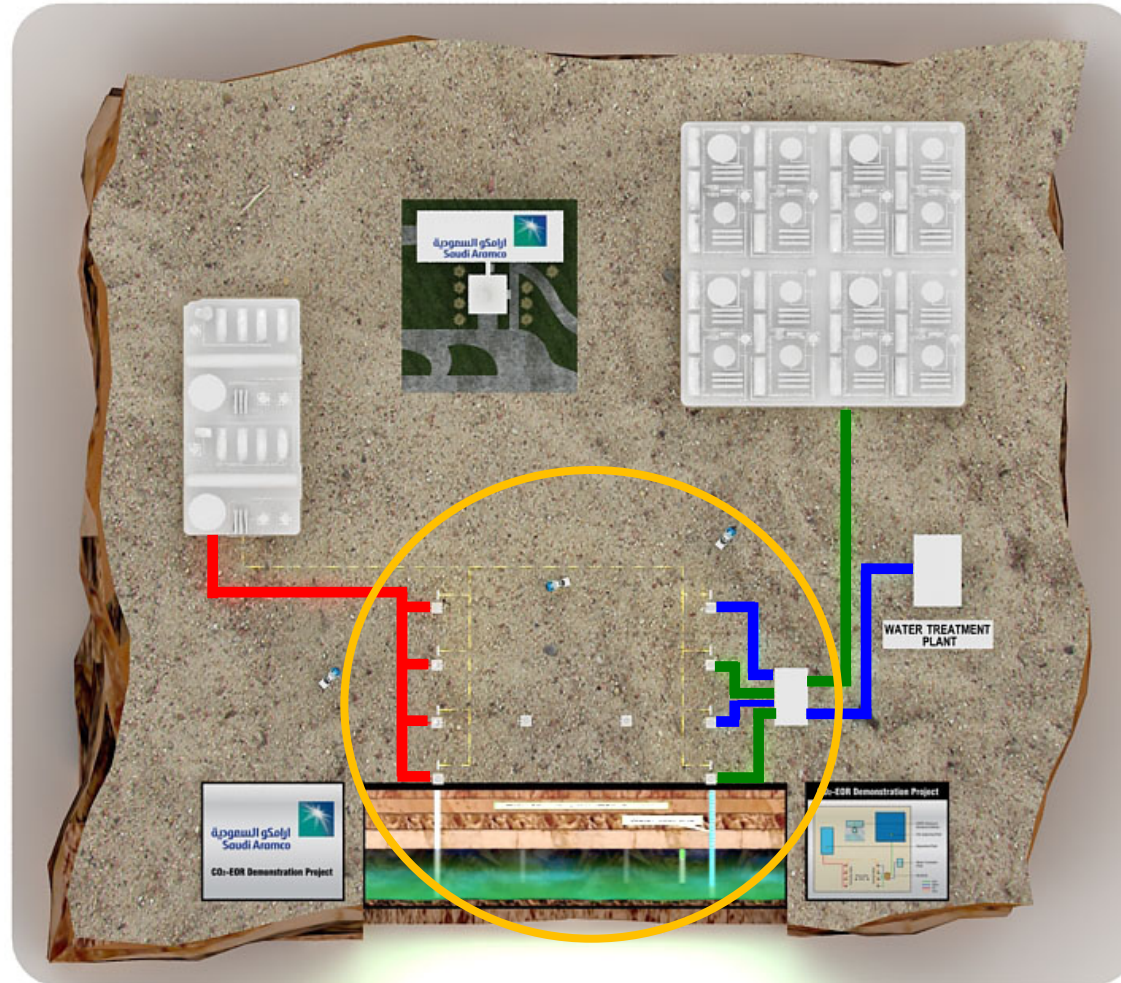


Next Three months:

- CO₂ is injected in Wells 2 and 4
- Water is injected in Wells 1 and 3



Monitoring and Surveillance



- CO2
- Water
- Produced Fluids
- Communication

Monitoring and Surveillance (M&S)

- ◎ Objectives:
 - Clear assessment of CO₂ potential (EOR and Storage).
 - Test new technologies for M&S.
- ◎ What to monitor?
 - Production/injection rates.
 - Changes in residual oil saturation (ΔS_{or}).
 - Plume evolution (flood front).
 - Well integrity (cement, corrosion, scales, etc.).
 - Quantification of sequestered CO₂.

M&S Master Plan

- ◎ Field activities ...
 - Producers are being tested ... with and without water.
 - Single well tracer tests.
 - Sampling and geochemistry.
- ◎ Routine logging and testing:
 - Comprehensive base logging and data acquisition.
 - Core, SCAL and advanced petrophysical analyses.
- ◎ Many new technologies being deployed:
 - Plume tracking and CO₂ saturation monitoring using seismic, EM and gravity.
 - Inter-well connectivity using chemical tracers.

M&S Overall Strategy

Tools/Technology	EOR for Storage Monitoring Objectives									
	Res. Charac.		Plume Tracking		Saturation Monitor		CO ₂ Leakage		Well Integrity	
	Near WB	Deep	Near WB	Deep	Near WB	Deep	Surface	Subsurface	Cement	Corrosion
Routine Well Logs (OH)	✓		✓		✓		✗		✗	✗
Routine Well Logs (CH)	✓	✗	✓	✗	✓	✗	✗	✓	✓	✓
Cores (Normal, Sponge)	✓	✗	✓	✗	✓	✗	✗		✗	✗
Tracers (SWCT, IWCT)		✓	✓	✓	✓		✓		✗	
Geochem Analysis		✓		✓	✗	✗			✗	✗
Soil Gas Sampling	✗	✗	✗	✗	✗	✗	✓		✗	
Seismic		✓		✓					✗	✗
Electromagnetic (EM)	✓	✓		✓					✗	✗
Borehole Gravimetry (BHGM)	✓	✓		✓			✗		✗	✗

Monitoring Using Seismic

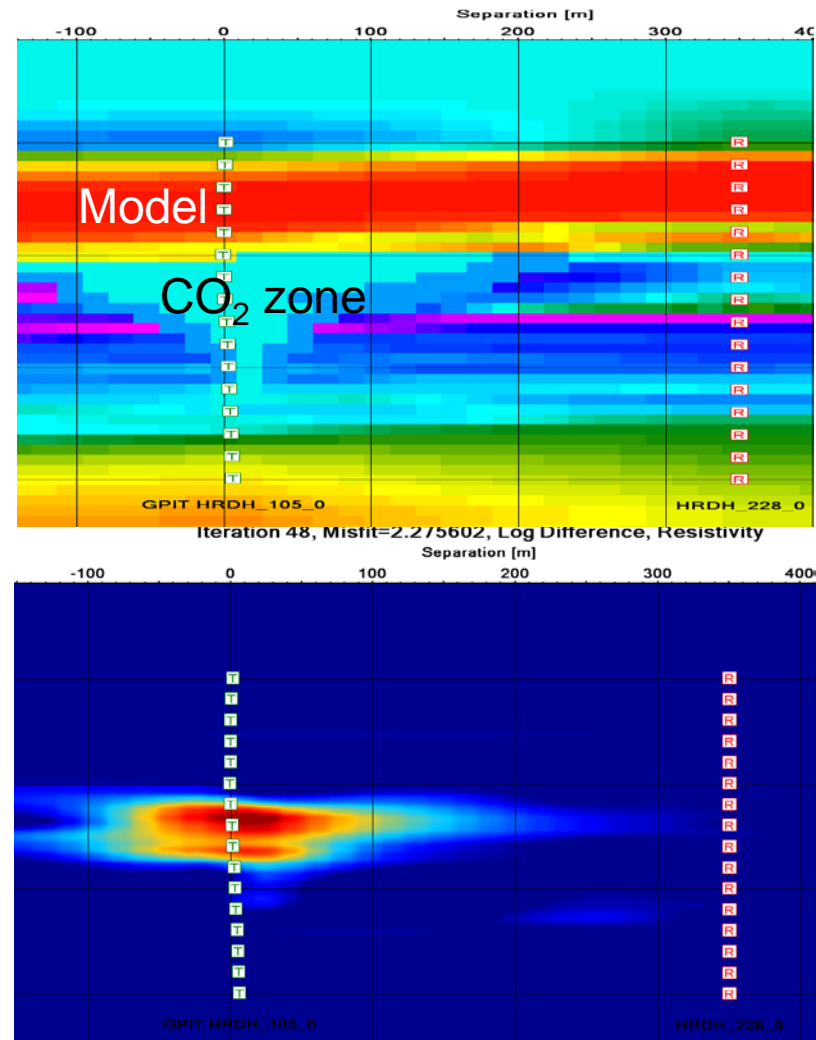
Status

- ◎ Receivers installation Q42012
- ◎ Data Acquisition in July 2013
- ◎ Baseline during waterflooding
- ◎ 3+ years continuous monitoring for CO₂
- ◎ In-house analysis

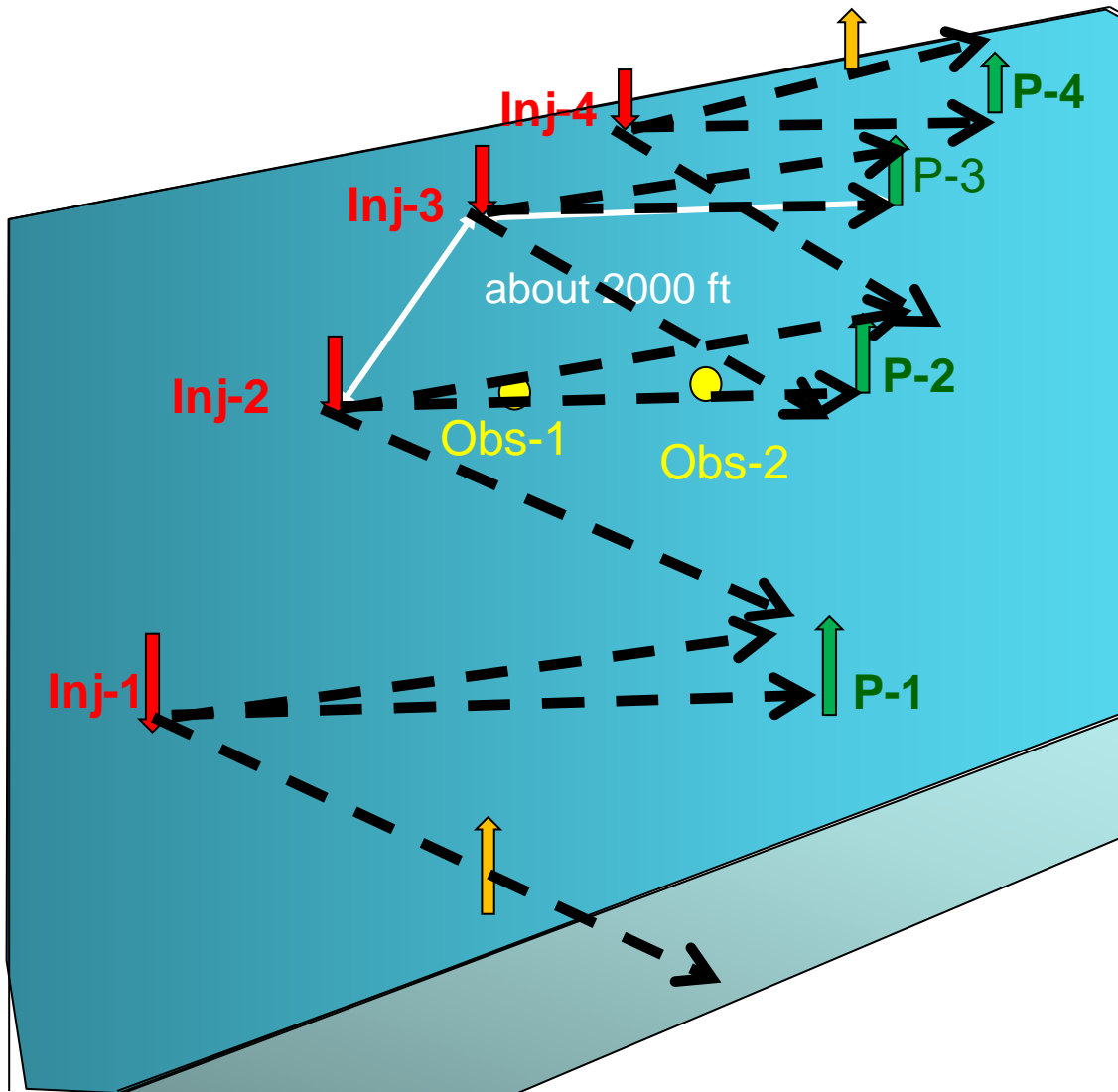


Monitoring Using EM

- Accomplished:
 - X-Well EM for WF monitoring.
 - Successful BSEM.
- Challenges:
 - Mixed salinity challenges.
 - Some uncertainties need to be addressed.
- Example:
 - Vertical wells, 300 m separation.
 - CO₂ is 25 Ohm·m, 15 Ohm·m mixing zone.



Inter-Well Chemical Tracer Test



- Preferential flow directions
- Oil saturation between wells
- Injection strategy
- Future observation wells' locations
- During water injection

Summary

- ◎ Project proceeding as per plans:
 - 9 wells drilled ... producers tied-in, injectors being tied-in.
 - Baseline production testing, logging ongoing.
 - CO₂ capture and well production facilities on track.
 - CO₂ injection start date October 2013.
- ◎ Extensive M&S being conducted.
- ◎ Many new technologies being deployed:
 - Plume tracking and CO₂ saturation monitoring using seismic, EM and gravity.
 - Inter-well connectivity using chemical tracers.

UTMN CO₂-EOR Demonstration Project

Dr. Ali Almeshari

Overall Coordinator

Saudi Aramco Corporate Carbon Management Team
