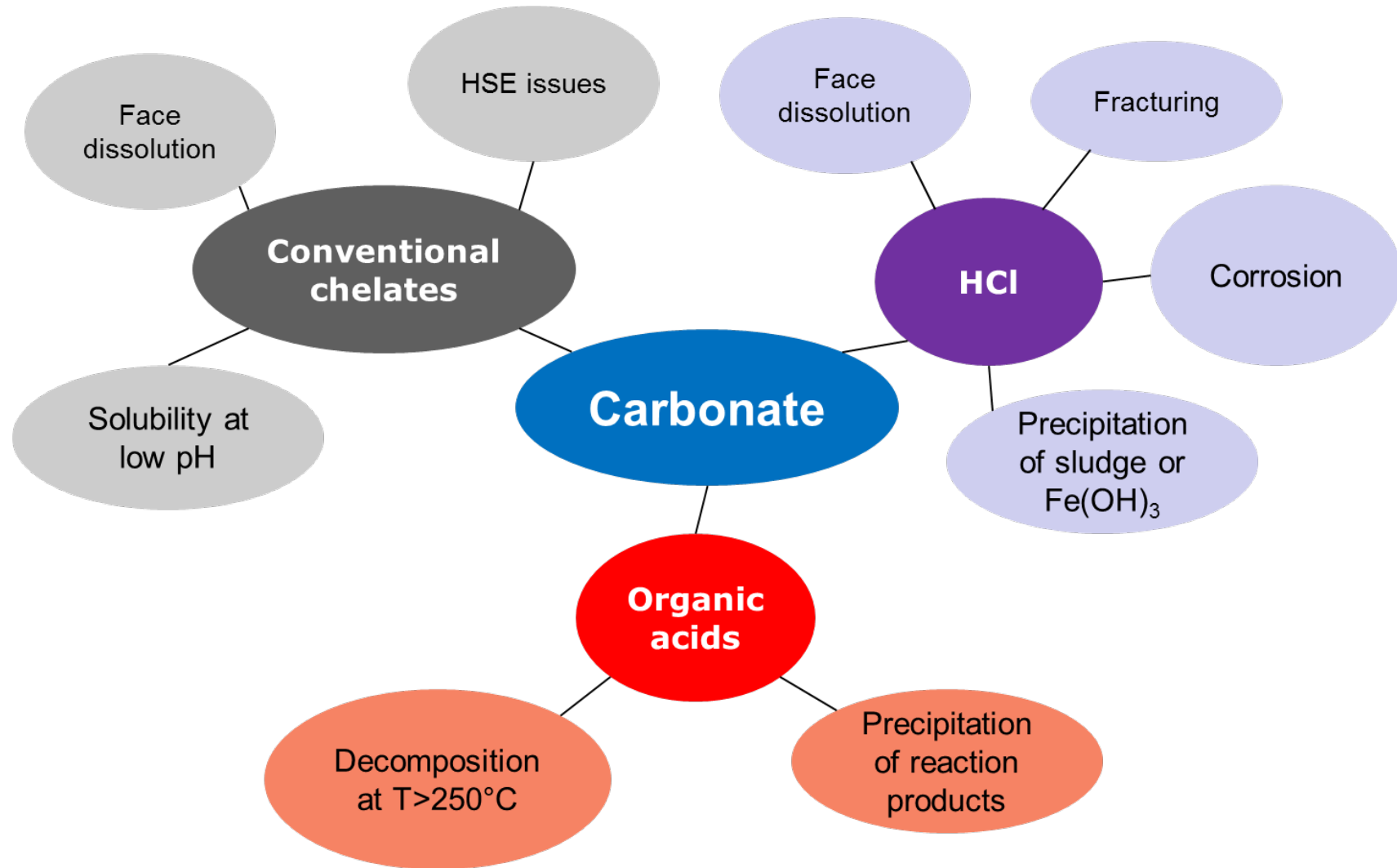


# **Stimulation of Sandstone and Carbonate Reservoirs Using Chelating Agents**

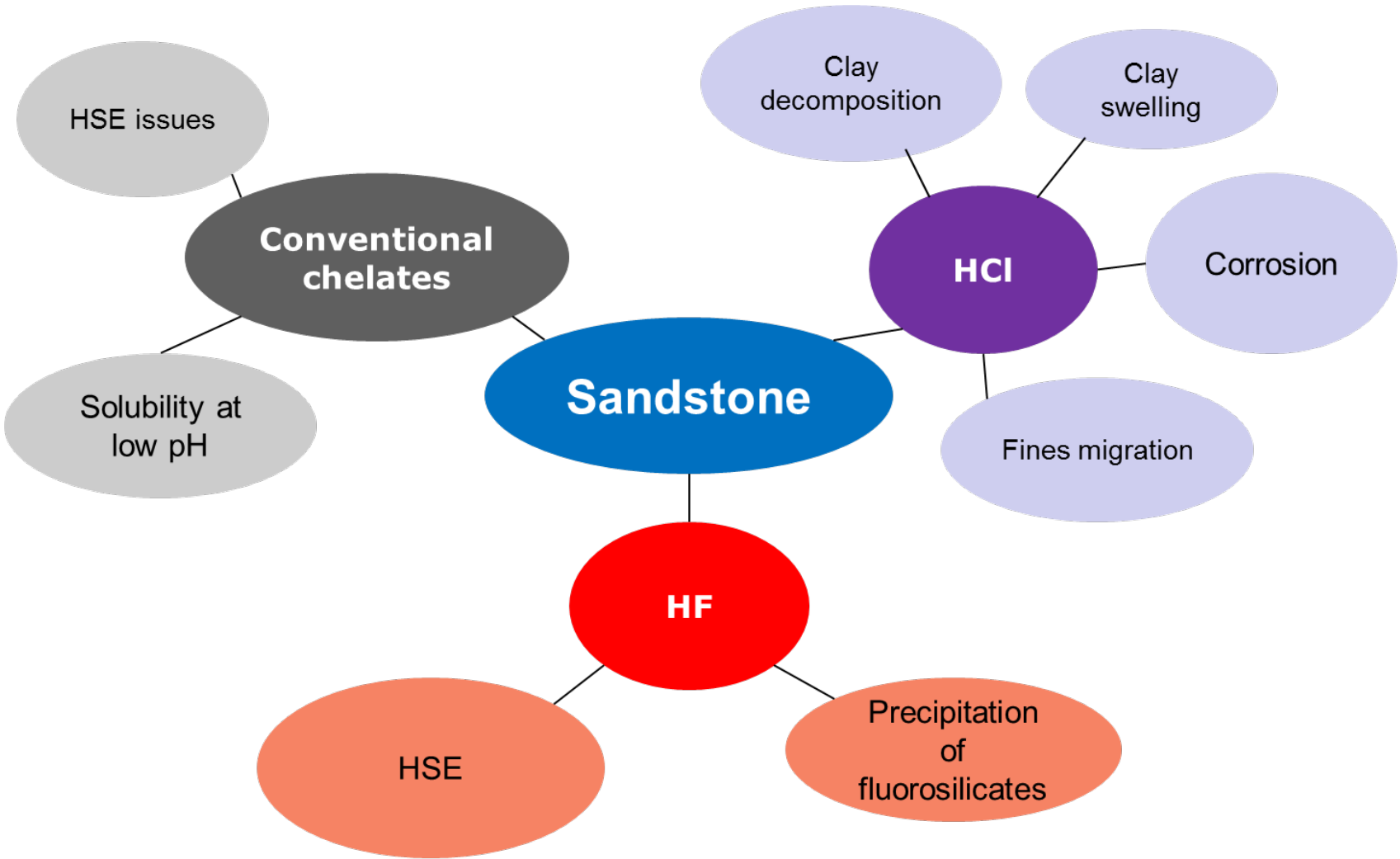
**Amin Ameri**  
**[amin.ameri@akzonobel.com](mailto:amin.ameri@akzonobel.com)**  
**October, 2016**



# Major problems with carbonate acidizing



# Major problems with sandstone acidizing



# Chelates — StimWell Portfolio

Dissolvine StimWell is a chelate based product series

– Dissolvine StimWell HTF (pH 3.8):

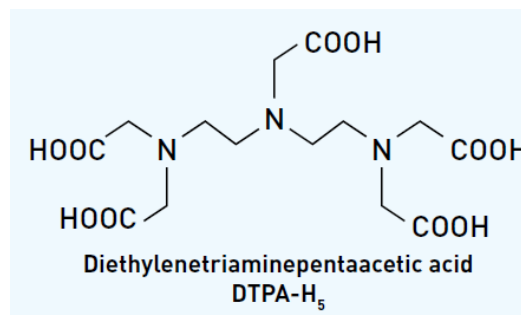
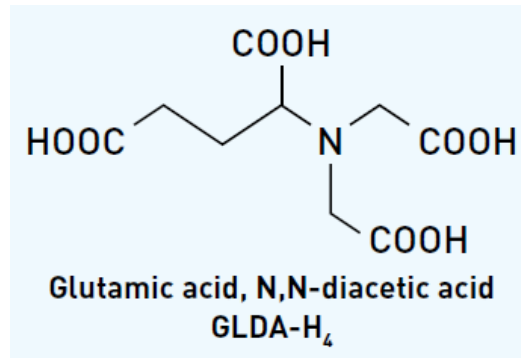
- CaCO<sub>3</sub>
- Iron scales

– Dissolvine StimWell DGH (pH 11.5):

- CaSO<sub>4</sub>

– Dissolvine StimWell DDH (pH 14):

- BaSO<sub>4</sub>
- SrSO<sub>4</sub>

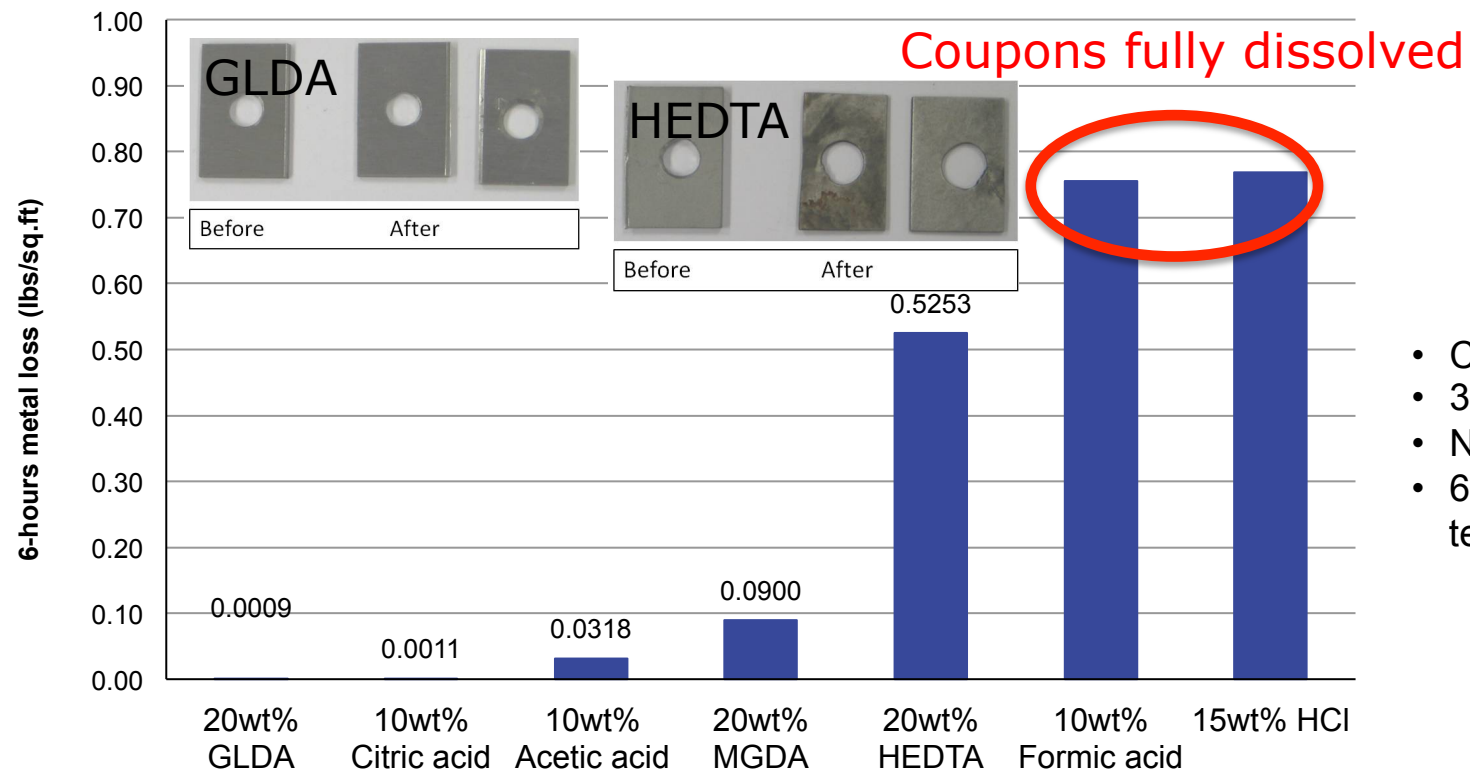


# Summary

	GLDA	<del>ASDA</del>	<del>EDG</del>	MGDA	HEDTA	MSA	HCl
Solubility pH<4	++	+	-	-	+/-	++	++
Calcite dissolution	+	+/-	-	-	+	++	++
Carbonate (300°F, 2cc/min)	++	+	-	-	+	-*	-*
Sandstone	++	+/-	-	-	+	n.d.	-
Thermal stability	+	-	++	++	+	++	++
Corrosion L-80	+	+/-	+/-	+/-	+/-	-	-
Corrosion Cr-13	++	+	+	+	+/-	-	-
Health	++	++	++	++	++	-	-
Biodegradability (OECD 301D)	++	++	++	++	-	++	n.a.
Solubility in 15% HCl	++	-	+	+/-	++	n.d.	n.a.
Iron control	+	+	++	+/-	++	n.a.	n.a.

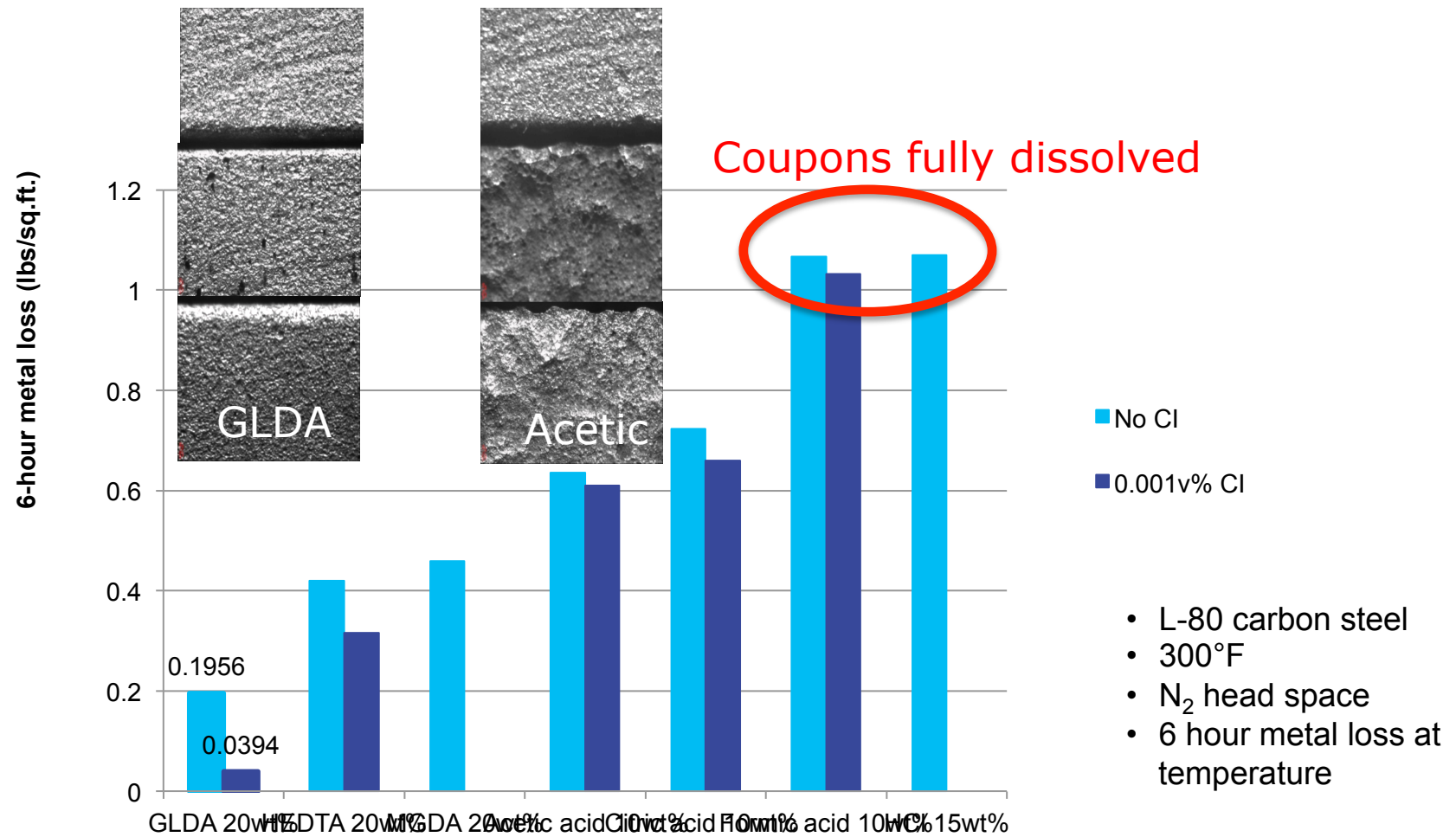
\* Dependent on T and flow rate conditions

# Low corrosion profile



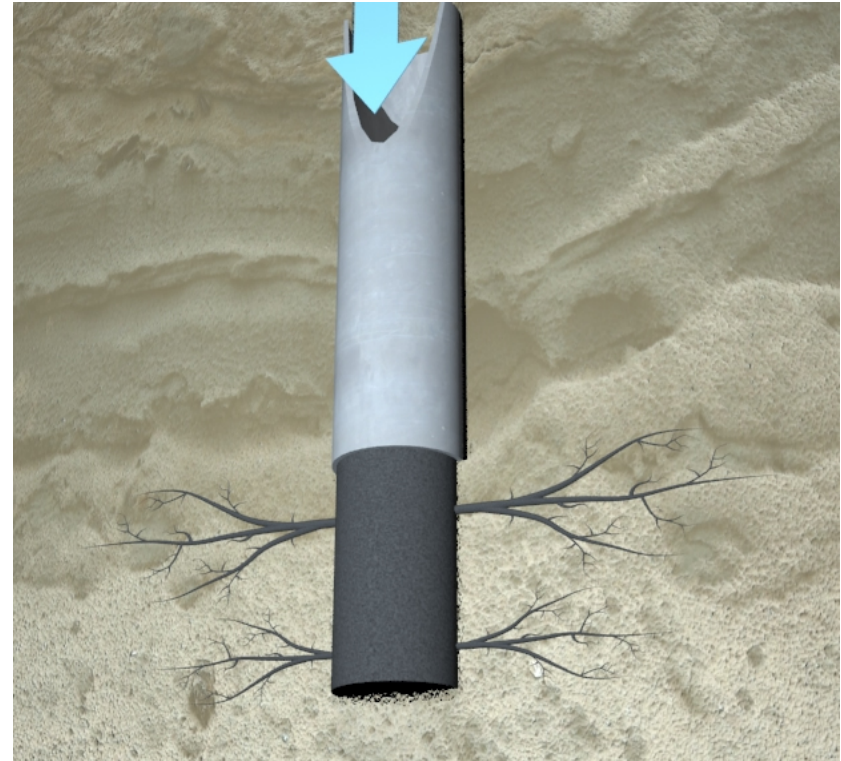
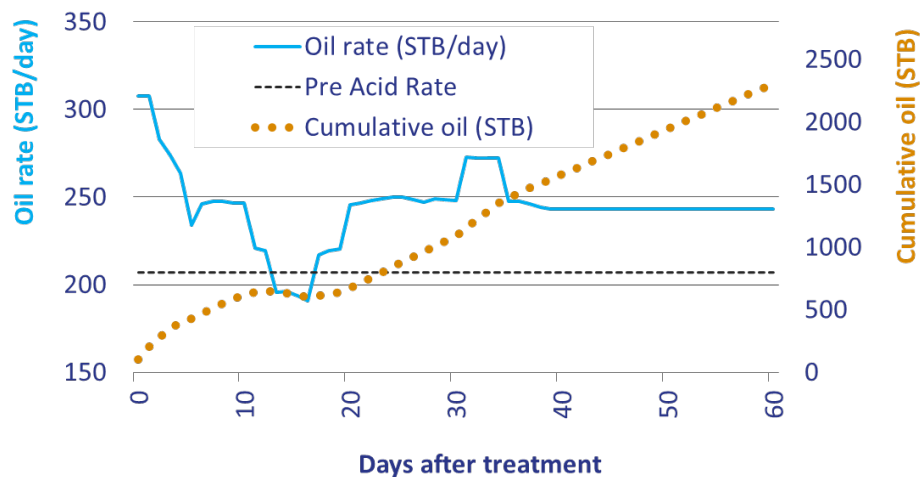
- Cr-13
- 300°F
- N<sub>2</sub> head space
- 6 hour metal loss at temperature

# Low corrosion profile



# Stimulation in carbonate reservoirs

- Acids are used to create wormholes to connect the formation to the wellbore
- Success depends on how deep this acid will penetrate into the formation creating uniform wormholes

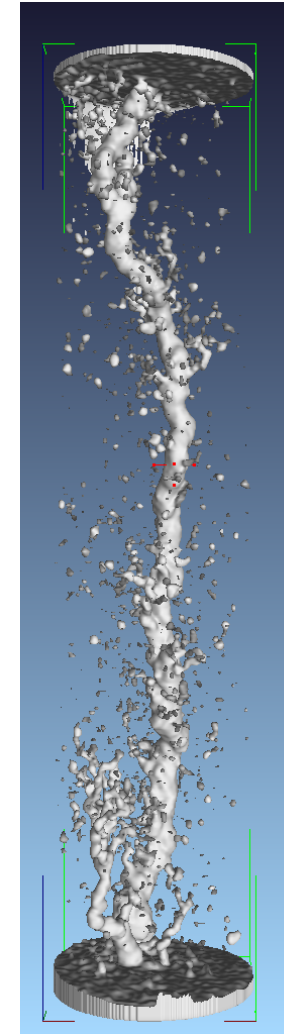
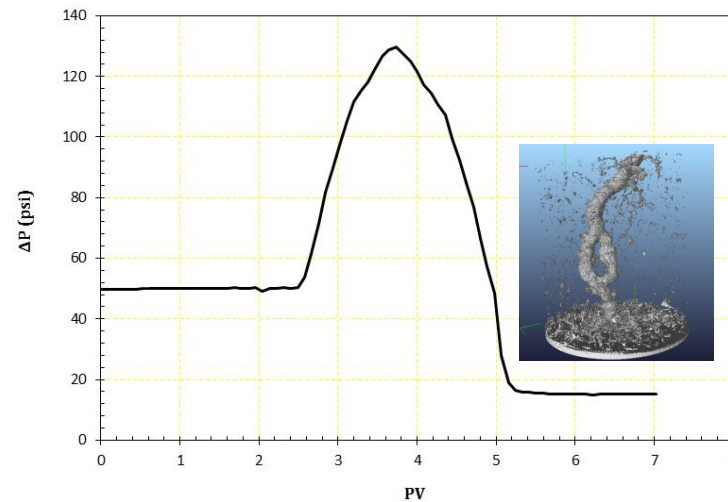
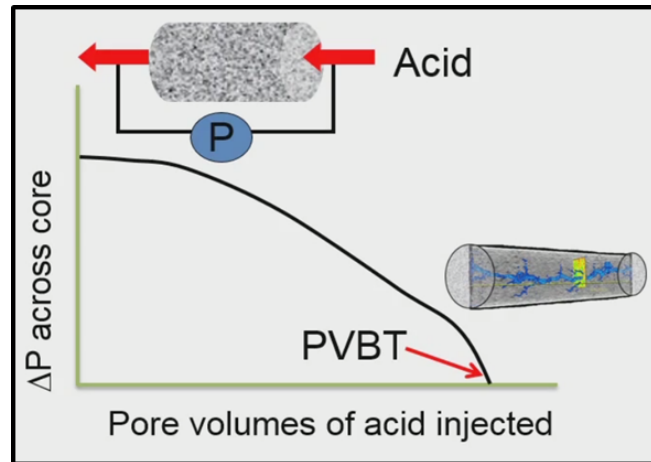
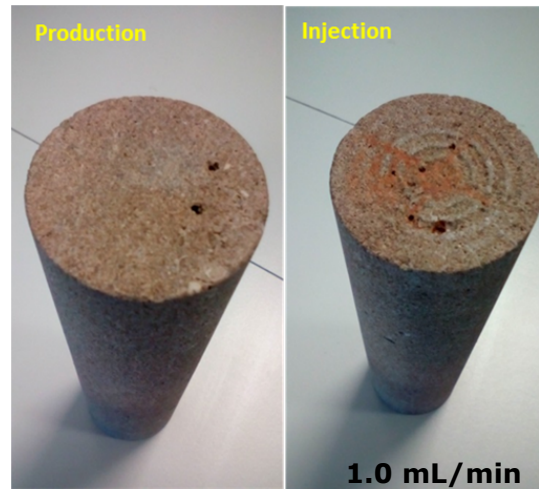




# Lab Study



Coreflood @ T and P



# Stimulation in sandstone formations

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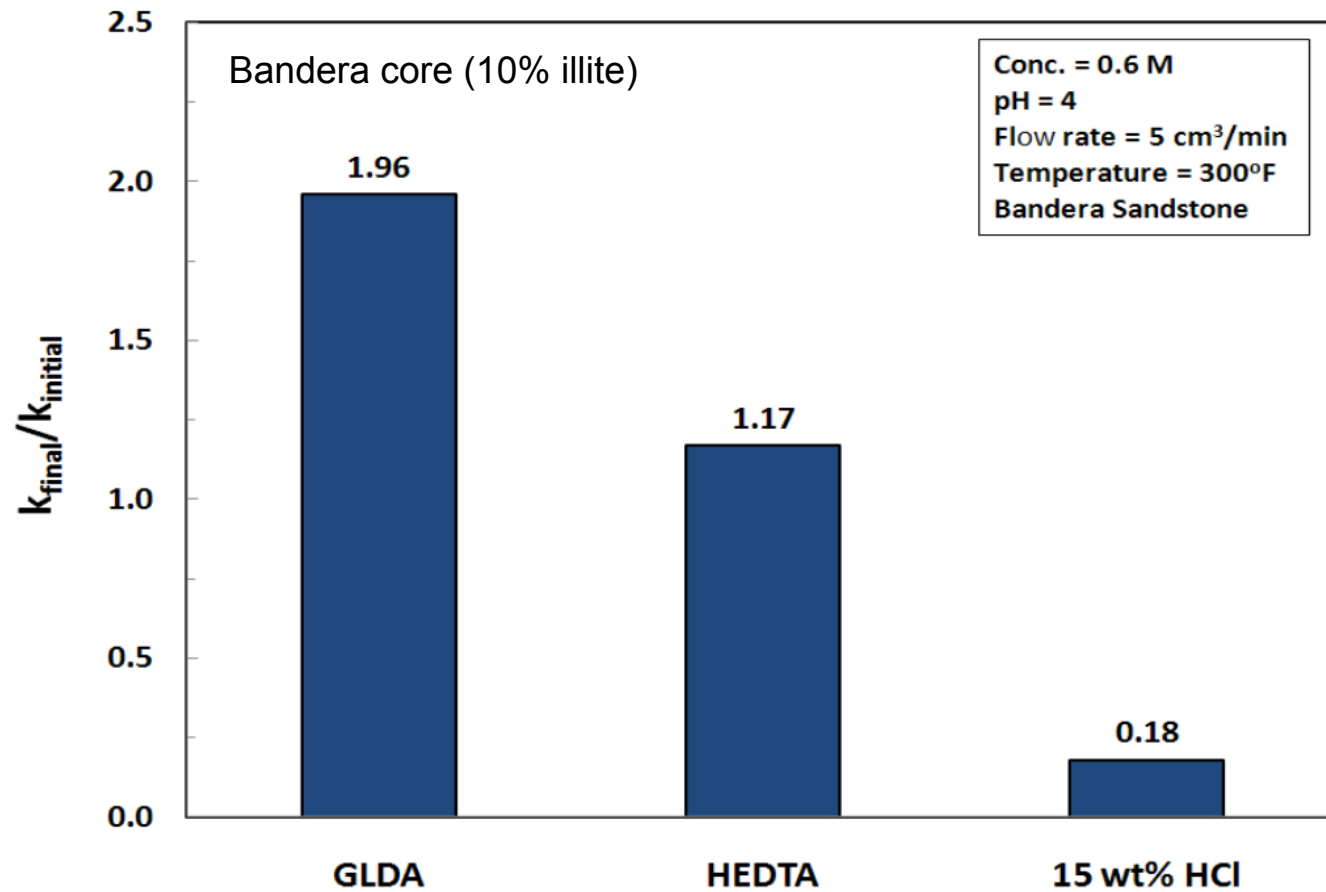
- Acids are used to dissolve the soluble materials
- Solubility tests in the lab (samples from TU Delft - W-1)
  - 100°C for 6 hours

<b>Solvent</b>	<b>Dissolved [%]</b>
SW HTF 50%	9.87
SW DDH 50%	7.55
HCl 15%	14.34

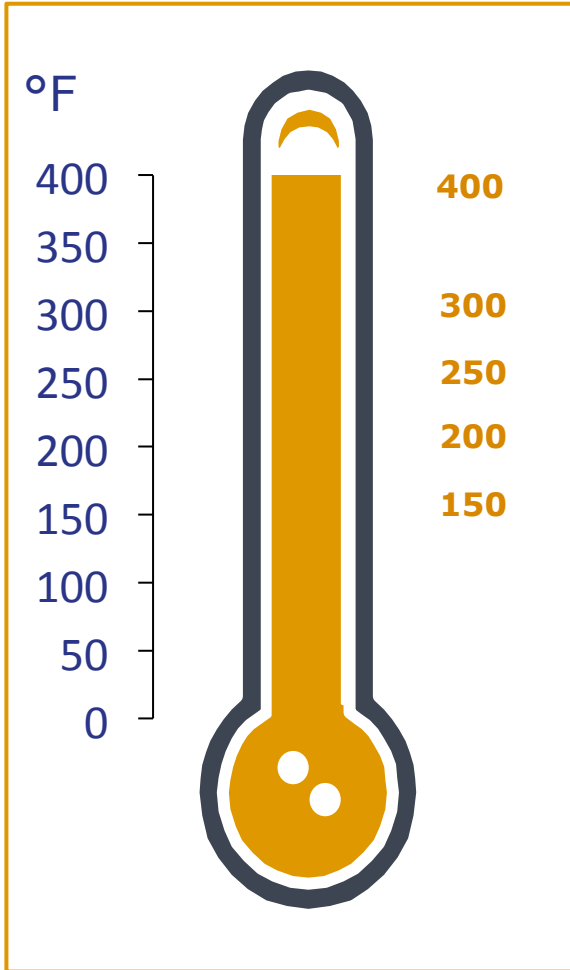


# Stimulation in sandstone formations

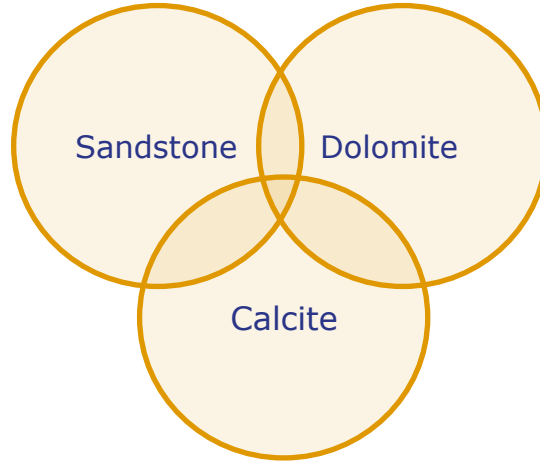
- Coreflood tests with Bandera cores



# Case Histories - Overview



**Temperature**



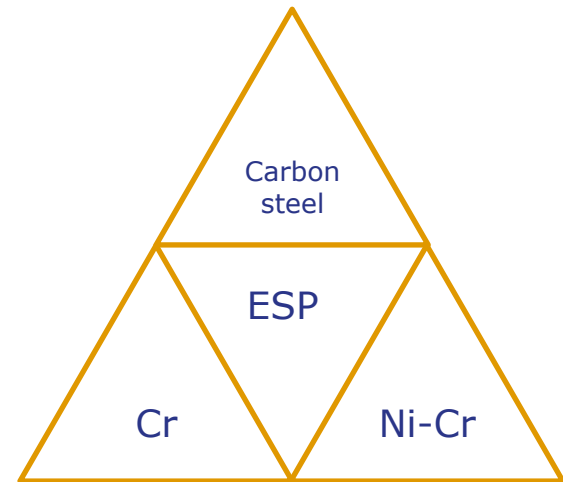
**Formation**



**Geometry**

- Stimulation
- Descaling
- Pickling

## Applications

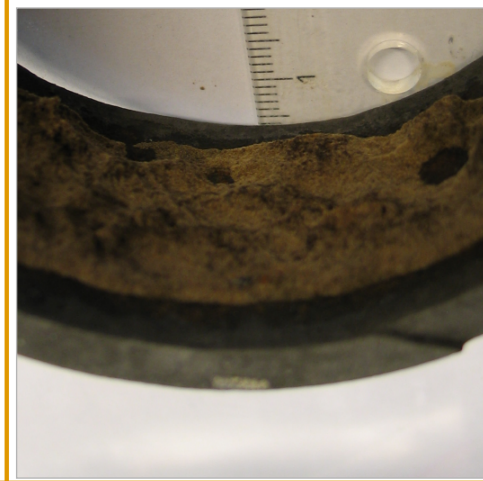
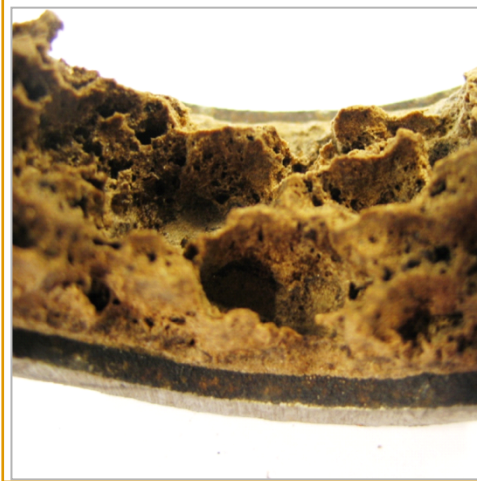


**Materials**

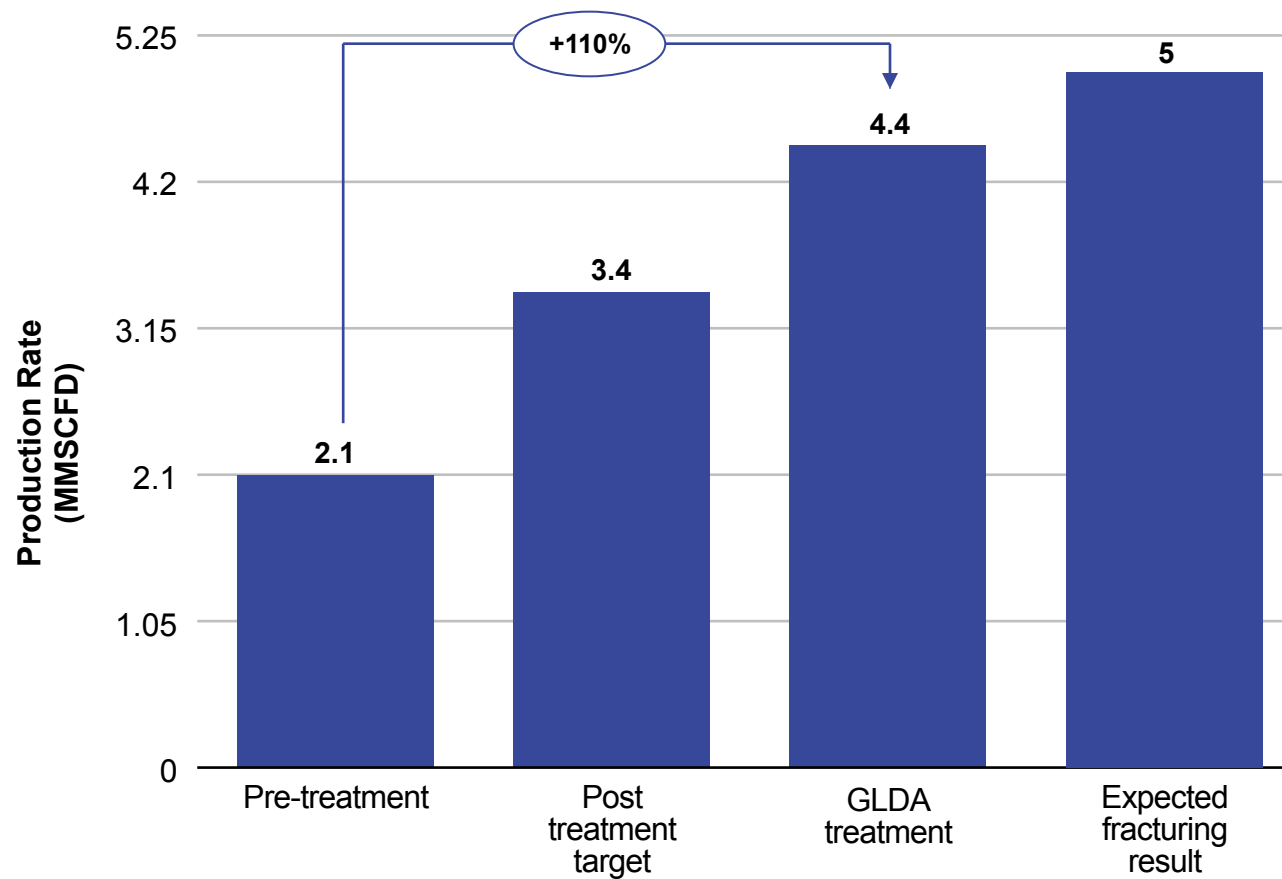
# De-scaling



Descaling using  
StimWell HTF



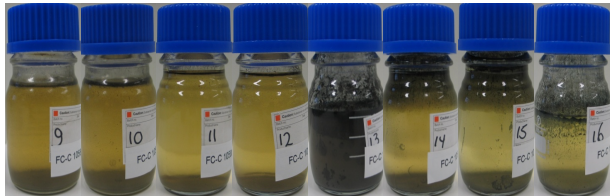
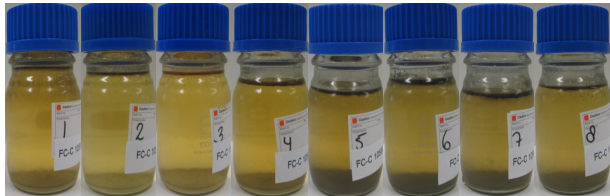
# Field application I: Tight, sour gas well



- 325°F
- 20% H<sub>2</sub>S
- 9% CO<sub>2</sub>
- Carbonate (calcite and dolomite)
- Porosity: 11.5%
- Permeability: 4 mD
- CRA and carbon steel
- 20wt% GLDA at pH=3.4

SPE 163332

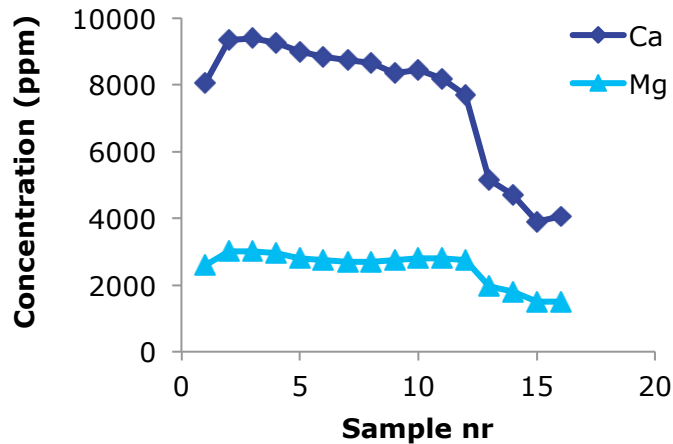
# Field application I: Tight, sour gas well



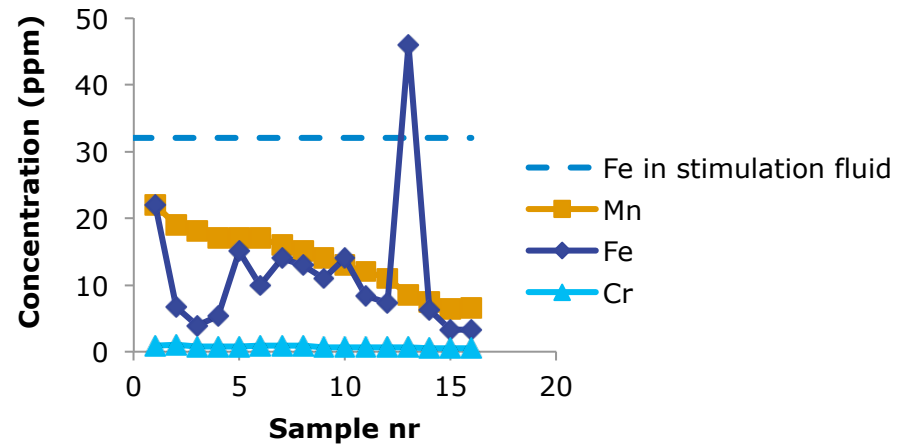
All flowback samples pH>6

No after treatment required

- 325°F
- 20% H<sub>2</sub>S
- 9% CO<sub>2</sub>
- Calcite and dolomite
- Porosity: 11.5%
- Permeability: 4 mD
- CRA and carbon steel
- 20wt% GLDA at pH=3.4



Effective dissolution of calcite and dolomite



No corrosion

SPE 163332

# Field application II: Horizontal well

	Before stimulation		After stimulation	
	Liquid rate (bbl/day)	PI (bbl/day/psi)	Liquid rate (bbl/day)	PI (bbl/day/psi)
Well 1	680	0.8	1215	1.8
Well 2	350	0.4	900	1.6

- 271°F
- 200 ppm H<sub>2</sub>S
- 6mol% CO<sub>2</sub>
- Permeability: 50 mD
- L-80 tubular
- >4500 feet horizontal section completed within 4 hydraulic sliding sleeves
- 20wt% GLDA at pH=3.4 at 0.25 bbl/ft

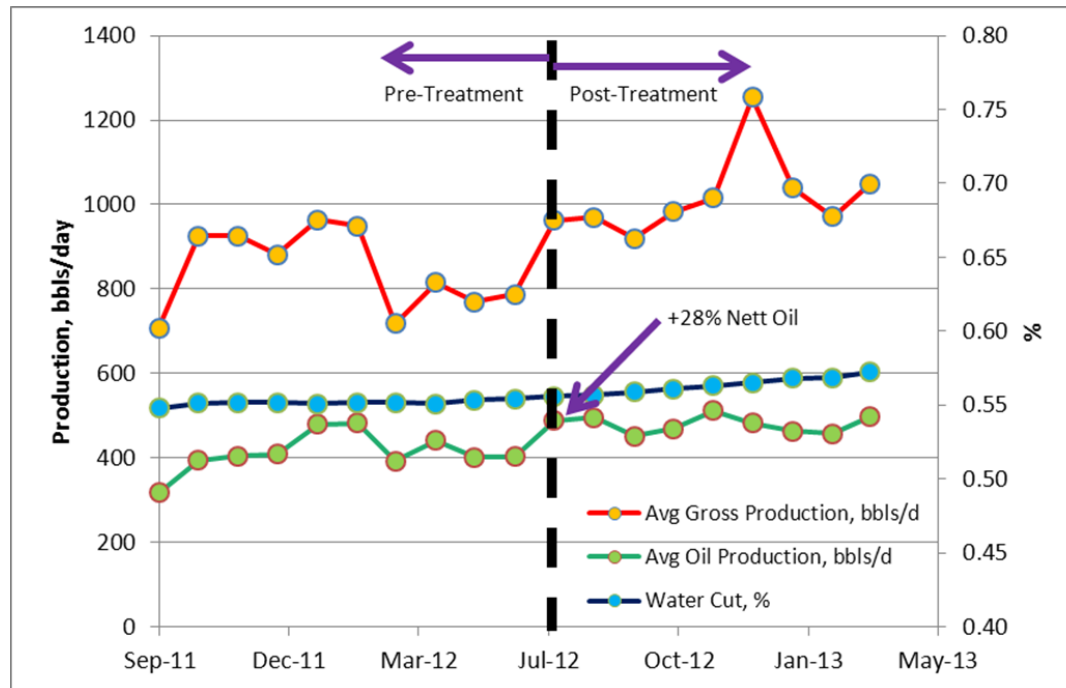
Effective residual filtercake removal and stimulation from heel to toe due to slow reaction rate



# Field application III: Descaling ESP



- 160°F
- $\text{FeCO}_3$  and  $\text{CaCO}_3$  around ESP
- 20wt% GLDA at pH=3.4

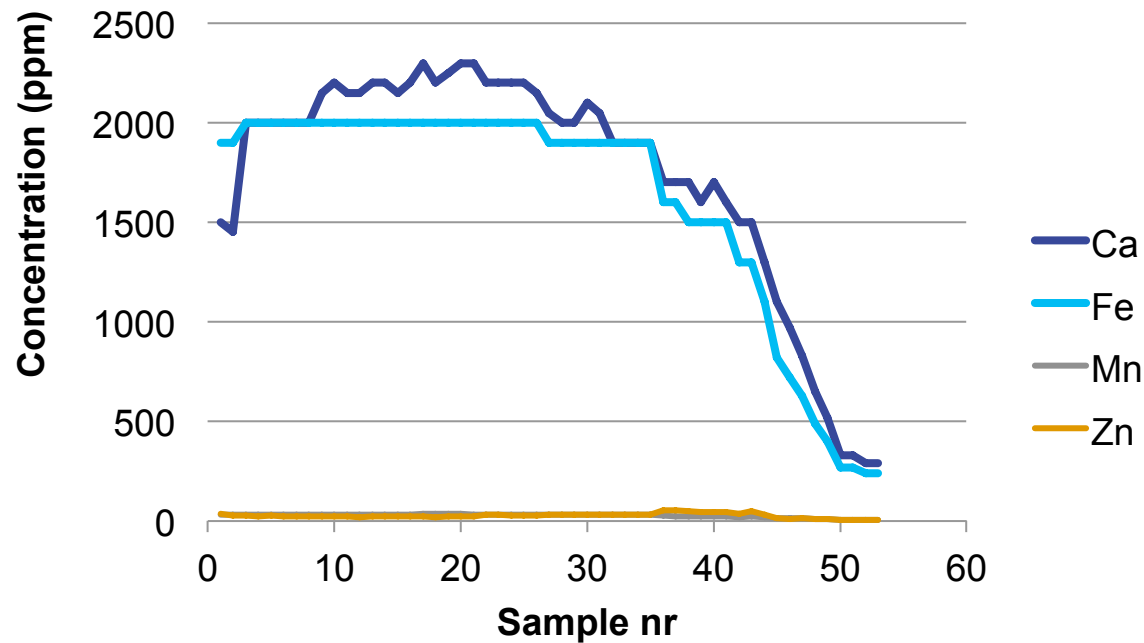


The oil production increased from 400 to 512 STB/day and the PI improvement sustained for 6 months

SPE 166335

# Field application III: Descaling ESP

- 160°F
- FeCO<sub>3</sub> and CaCO<sub>3</sub> around ESP
- 20wt% GLDA at pH=3.4



Analysis of flowback samples proved dissolution of the scales, without any adverse impact on the ESP or well tubular

# References



Subject	Reference	Year
Field applications	SPE 163332: SPE P&O (2013) 28-3, pp277-285	2012
	SPE 166335	2013
	SPE 168163: J. of Can. Pet. Tech., 54-5, pp289-297	2014
	SPE 173774	2015
Carbonate coreflood	SPE 127923: SPEJ (2011), 16-3, pp559-574	2010
	SPE 133497: SPEJ (2011), 16-4, pp968-980	2010
	SPE 140149	2011
Sandstone coreflood	SPE 139815	2011
	SPE 143301	2011
	SPE 147395: SPE P&O (2015), 30-1, pp43-51	2011
Corrosion	SPE 152716	2012
	SPE 160849	2012
HSE	SPE 157467	2012
	SPE 168145	2014
Reaction rates	SPE 139816	2011
	SPE 164480	2013
Filtercake removal	SPE 155426	2012

**Thank you for your  
attention**

**Questions?**