Development of Kern County's Rose Oil Field*

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Abstract

We provide a data-rich update for Kern County's Rose oil field after reviewing the play, reservoir properties and a tiltmeter evaluation of frac propagation, as were documented in a cluster of publications ca. 2003. Our recent synthesis and themed evaluation is drawn from publically accessible online DOGGR data through early 2015. It includes both production information and well histories that include directional surveys, completion information and geologic markers. A "heat map" is presented showing incremental and cumulative production posted over completion intervals and not wellheads. We also present 3-D visualizations showing completion intervals. Decline curves are presented. A discussion of trends in completion and frac programs is presented. The Rose oil field is an unconventional play discovered in 2000. It was indicated by seismic modeling and drill data extrapolated from the nearby North Shafter field. The play is a burial-induced permeability increase attributed to the diagenetic transformation of opal-CT to quartz diatomite within the McLure shale member of the Monterey Formation. The field is structurally simple; the McLure dips gently SW in an apparently unfaulted homocline. The play was confirmed in mid-2000 when EOG Resources recompleted, fraced and flow-tested the Tulare 25-1 in the McLure, previously untested in the area. Shortly after, EOG spudded the discovery well Goodshow 1H to confirm commercial production from the McLure and establish the pattern for developing the field. Rose production wells are vertical drills to approximately 7500 ft TVD, builds of ~86 degrees or ~94 degrees and laterals of ~2500 to ~5500 ft length toward the NNE or SSW. Rose field has a cumulative production >4 Mbbl BOE. Current production is from ~52 wells with a GOR of ~430 cf/stb and watercut of ~70%. Completion of production wells is as follows: ~20 wells in 2000-2003, ~3 wells in 2004-2006, none in 2007-2010 and ~22 in 2011-2014. Produced water is injected at depths of ~2500 to 6000 ft into the Etchegoin and San Joaquin Formations. There are ~15 open permits for new wells of all types within or associated with the field.

References Cited

Ganong, B., C. Hansen, P. Connolly, and B. Barree, 2003, Rose Field: A McLure Shale, Monterey Formation Development Story: SPE International, SPE 83501, presented at SPE Western Regional/AAPG Pacific Section Joint Meeting, Long Beach, CA, 2003, Web Accessed July 12, 2015, https://www.onepetro.org/conference-paper/SPE-83501-MS.

Minner, W., J. Du, B. Ganong, S. Demetrius, and C. Wright, 2003, Rose Field: Surface Tilt Mapping Shows Complex Fracture Growth in 2500' Laterals Completed with Uncemented Liners: SPE International, SPE 83503, presented at SPE Western Regional/AAPG Pacific Section Joint Meeting, Long Beach, CA, 2003, Web Accessed July 12, 2015, https://www.onepetro.org/conference-paper/SPE-83503-MS.

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Overview – Rose field

- Field discovered in 2000, all production has been from hydraulically fractured horizontal completions
- Central Kern County: monotonous, SSW – dipping homocline
- Diagenetic play (opal-CT to quartz) within McLure (Monterey Fm) shale
- Play identified by reprocessed seismic & extrapolated along-trend from drill success ~6 mi SSE in North Shafter field
- Target ~ 30 feet vertical thickness
- Typical completion ~ 3500 ft long

Rose field was presented by EOG Resources team in 2003 publications:

- Two SPE papers
- > 4 conference & meeting presentations
- Topics addressed:
  - The play
  - Drilling & completion including hydraulic fracturing
  - Reservoir characteristics
  - First 3 years production.
  - Microseismic evaluation of hydraulic fracturing

Reservoir Properties (ca. 2002)

RES. PRESSURE	6200-6300 PSI
RES. TEMP	190-195 F
RES. THICKNESS	20-40 FT
PERM	0.04-0.06 mD
POROSITY	0.3
SP. GRAV., OIL	0.8996
INITIAL WATER SAT.	0.45
OIL COMPRESSIBILITY	7.8 E-06 PSI^{-1}
OIL VISCOSISTY	2.8 cP
BHP LIMIT	3360-3800 PSI

Source: *Ganong, et al, 2003 (SPE paper 83501)*

Ownership & Overall Production

- Entire field operated by EOG until transfer to Oxy (a.k.a. Vintage, California Resources Corporation) (October 2009)
- Placed on artificial lift by Oxy (early 2010)
- ~58 wells drilled through spring 2014
- 4.5m BBL total production through end-2014

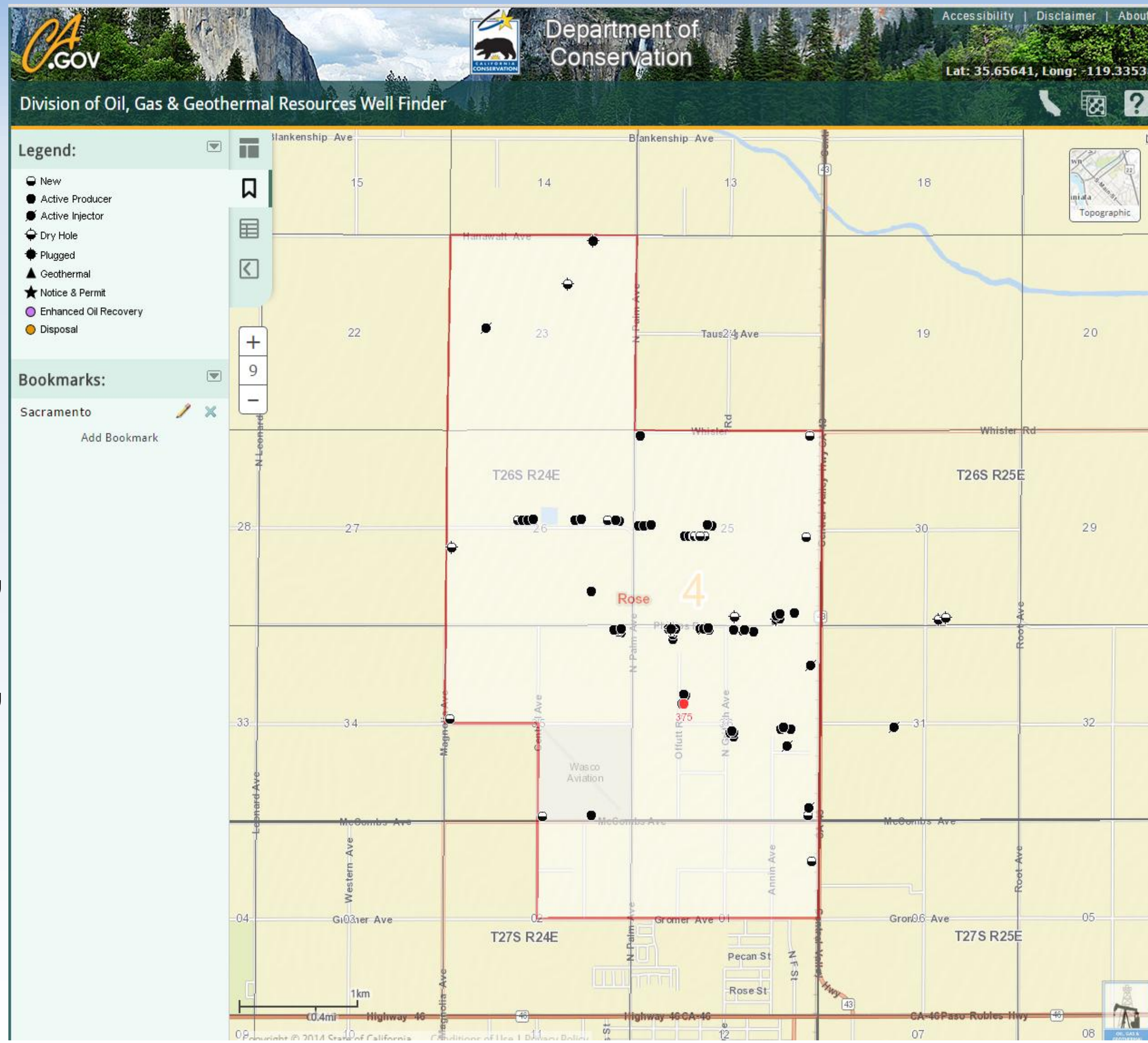
Production & injection wells from DOGGR's Well Finder Web Mapping Application

Feb 2015:

- **37 wells producing oil**
- **7 wells injecting produced water**

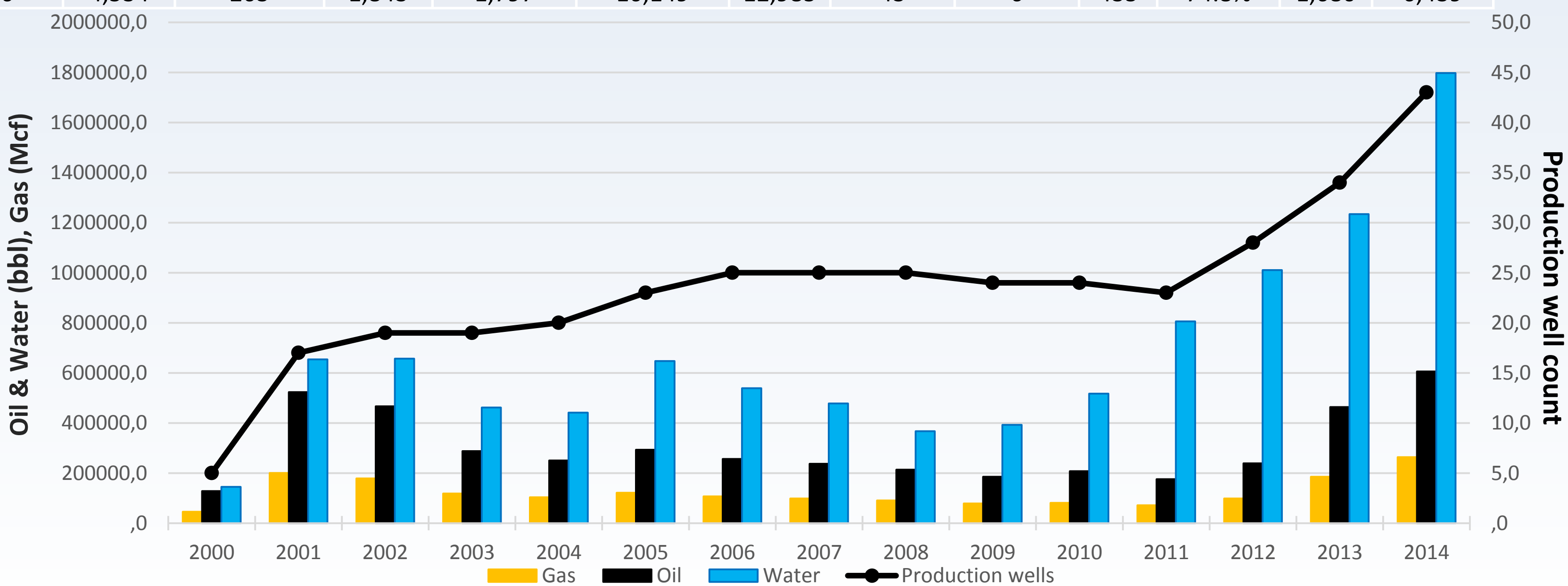
Active & Permitted Wells April 20, 2015:

- **65 "active status" oil & gas wells**
- **14 "active status" water disposal wells**

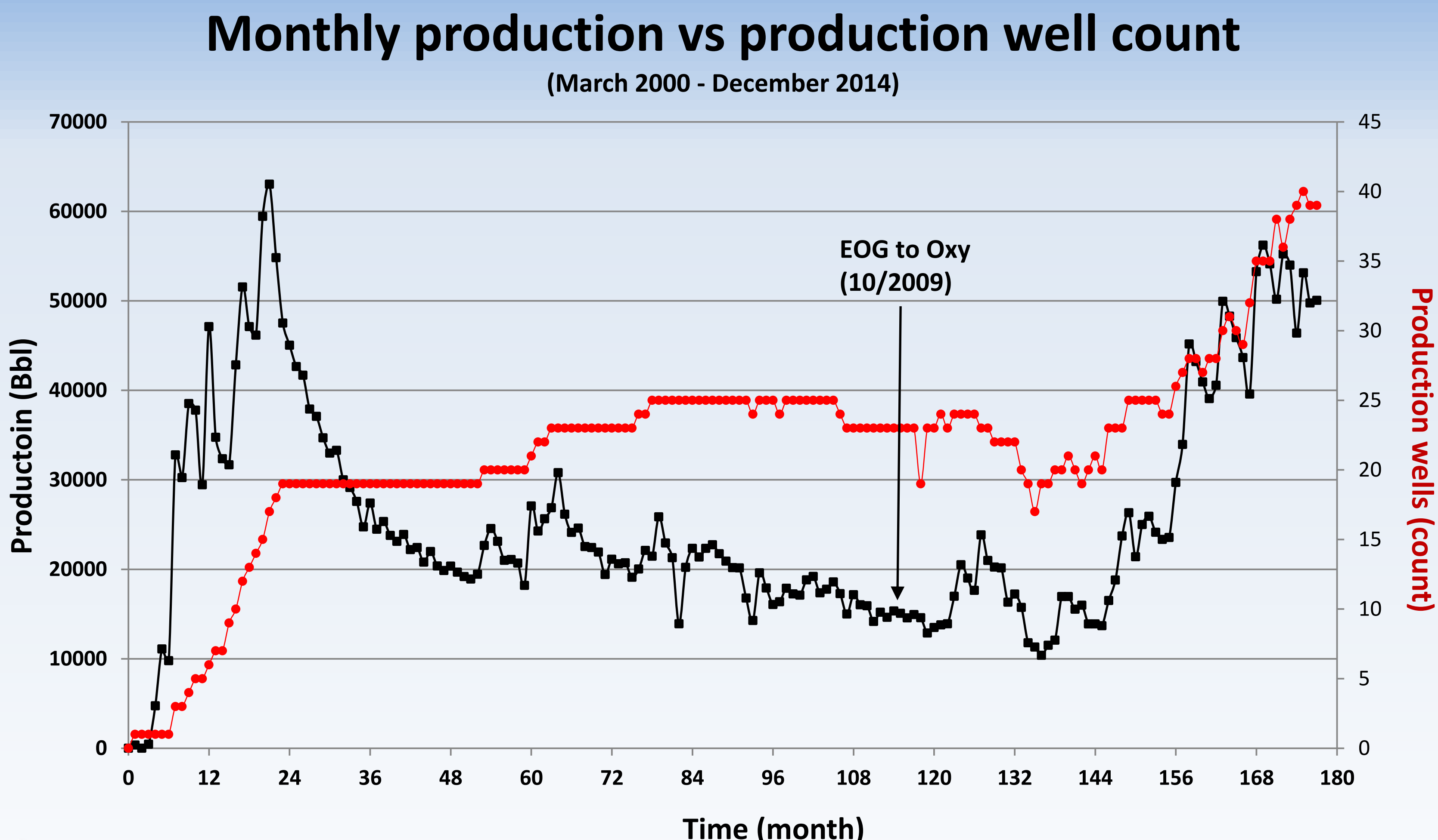


Annual oil, natural gas, and water production

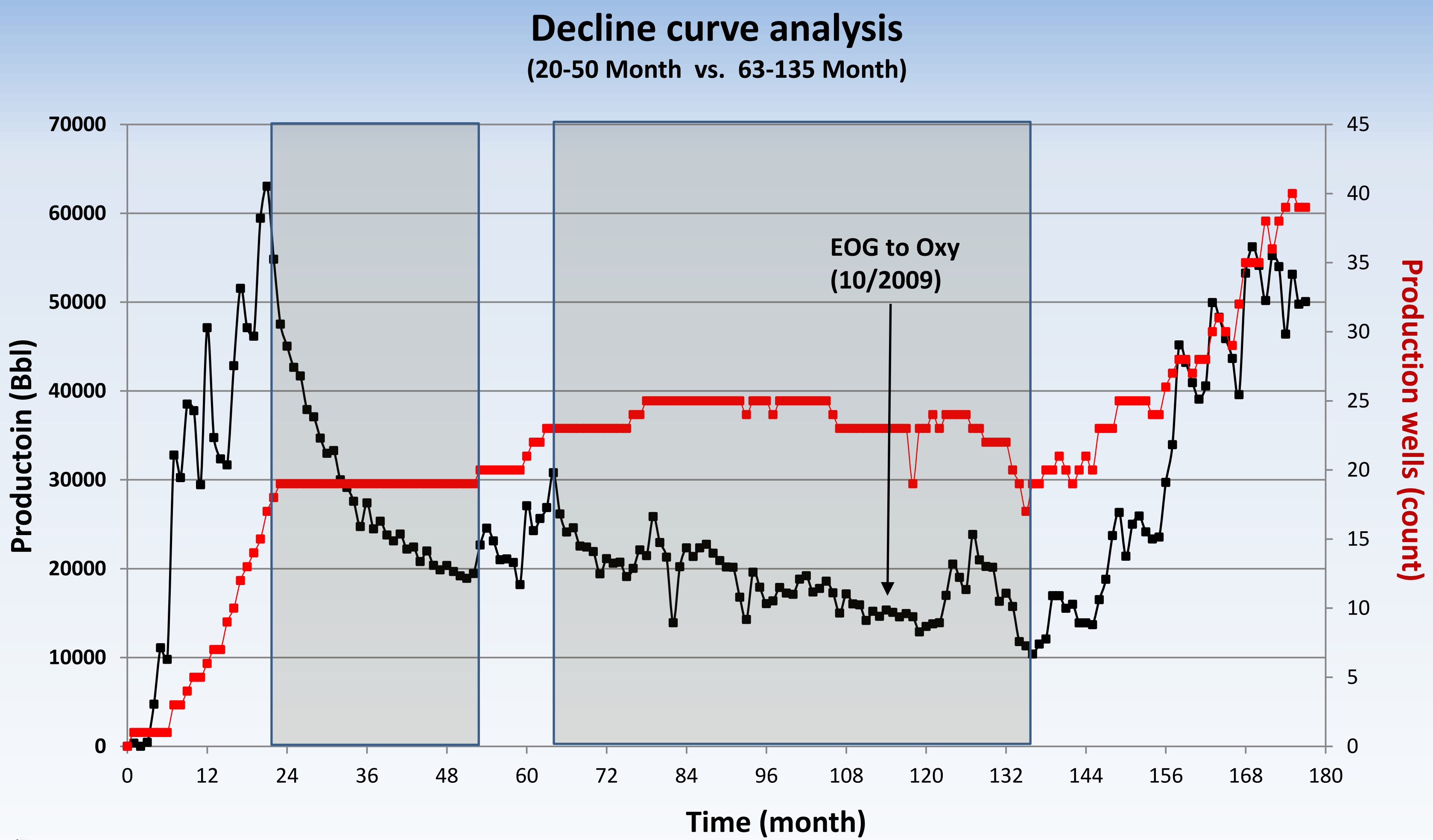
Year	('000's) Oil Production (bbl)	('000's) Cum. Oil (bbl)	('000's) Gas Production (Mcf)	('000's) Cum. Gas (Mcf)	('000's) Water Production (bbl)	('000's) Cum. Water (bbl)	Days Producing	"Production" Wells	"Injection" Wells	GOR (cf/stb)	Water Cut (percent)	('000's) Injection (bbls)	('000's) Cum. Injection (bbl)
2000	128	128	45	45	145	145	384	5		355	53.1%	0	0
2001	523	651	200	245	654	799	3,497	17	2	383	55.6%	598	598
2002	467	1,118	178	424	657	1,456	6,869	19	3	383	58.5%	711	1,309
2003	288	1,405	118	542	462	1,918	6,935	19	3	411	61.6%	511	1,820
2004	250	1,656	103	646	441	2,360	7,089	20	3	413	63.8%	465	2,286
2005	293	1,949	121	767	647	3,007	8,048	23	3	414	68.8%	370	2,656
2006	257	2,206	106	874	539	3,546	8,626	25	2	417	67.7%	213	2,870
2007	237	2,443	98	973	477	4,024	8,589	25	1	416	66.9%	181	3,051
2008	214	2,656	90	1,063	367	4,391	8,996	25	2	424	63.2%	300	3,352
2009	185	2,842	79	1,142	392	4,784	8,357	24	1	427	67.9%	267	3,619
2010	208	3,050	81	1,224	517	5,301	8,289	24	1	392	71.3%	280	3,900
2011	176	3,226	71	1,296	805	6,107	7,037	23	2	407	82.1%	103	4,004
2012	239	3,465	98	1,394	1,010	7,118	8,047	28	2	412	80.9%	318	4,322
2013	464	3,929	185	1,579	1,234	8,352	9,840	34	4	399	72.7%	435	4,758
2014	606	4,534	263	1,843	1,797	10,149	12,985	43	6	435	74.8%	1,680	6,439



Oil Production



Oil Production – Decline Curve Analysis



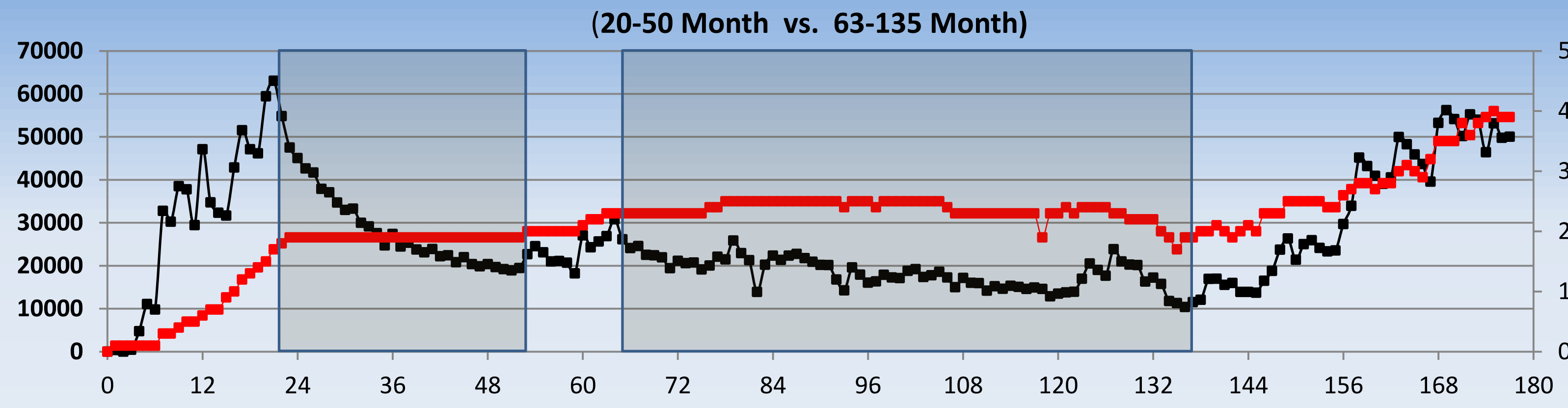
Production decline equations (Arps):

Exponential decline: $q = q_i \exp(-Dt)$

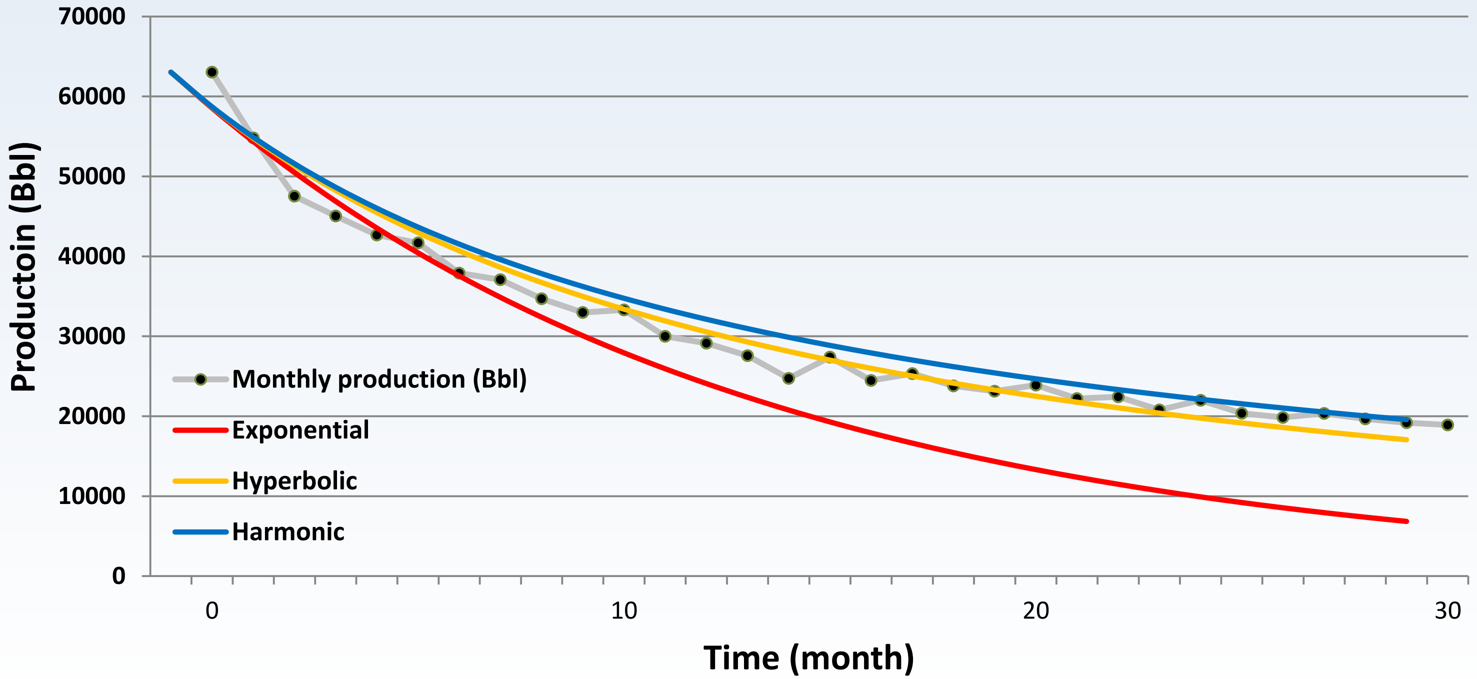
Hyperbolic decline: $q = q_i (1+bD_i t)^{-1/b}$

Harmonic decline: $q = q_i (1+D_i t)^{-1}$

Oil Production – Decline Curve Analysis



7.4% decline rate during 20-50 month time period



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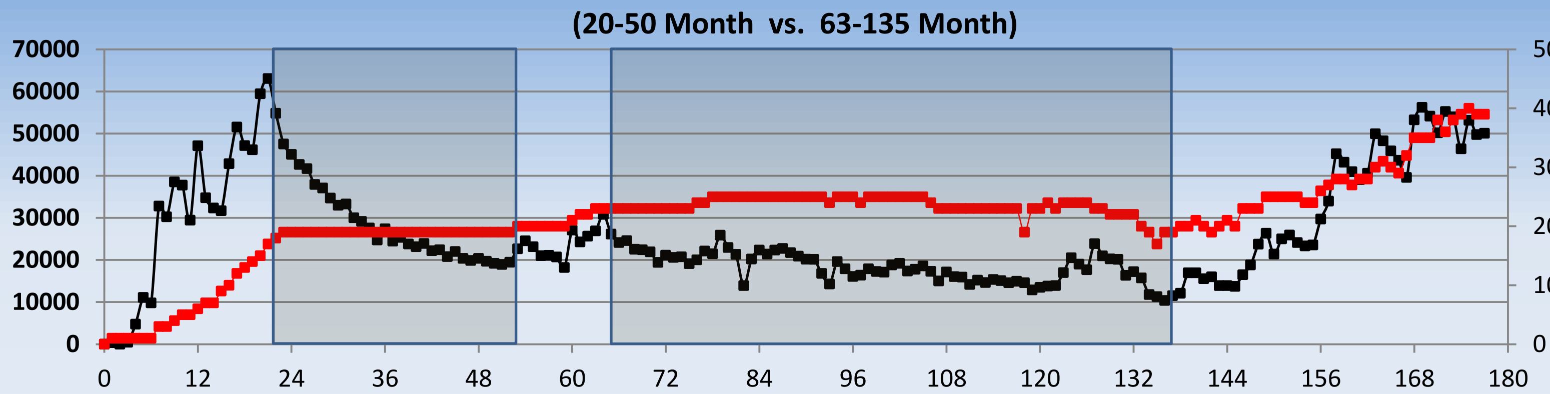
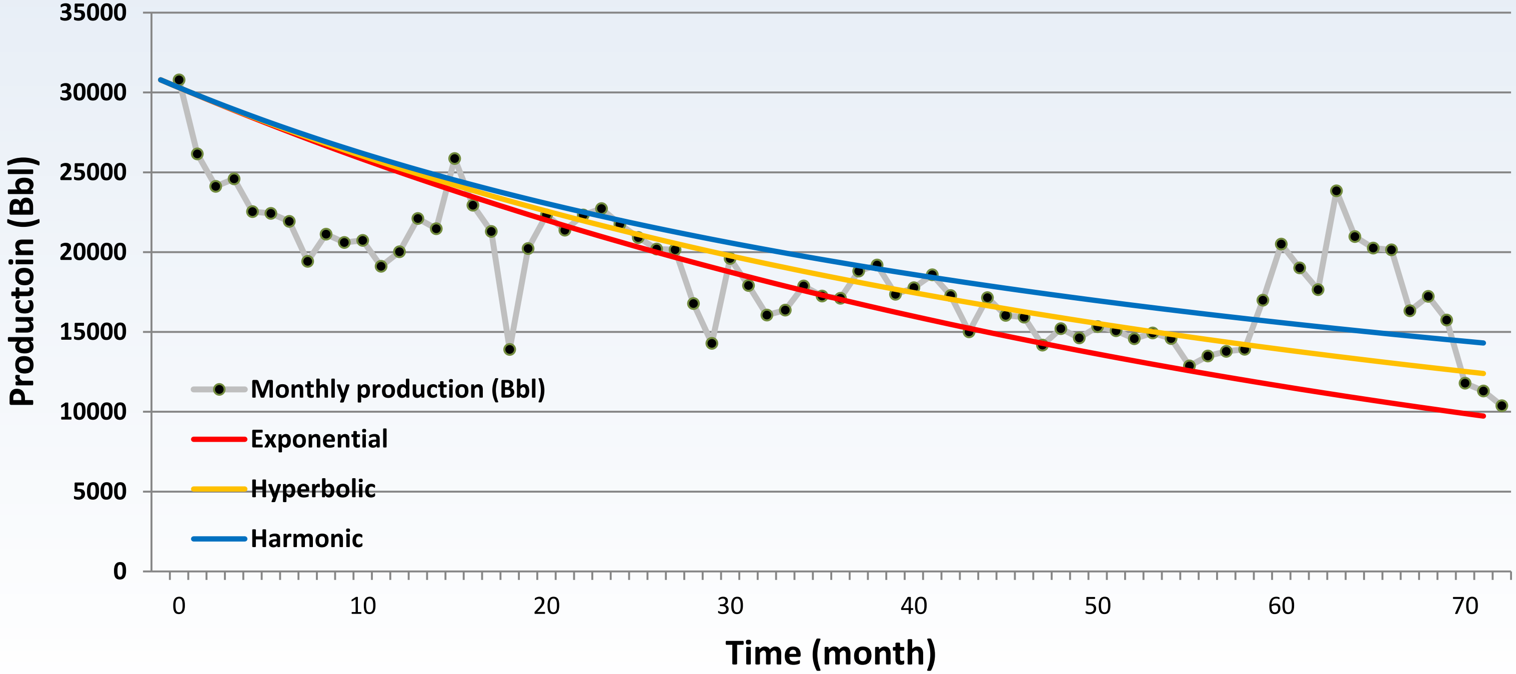


1.6% decline rate during 63-135 month time period



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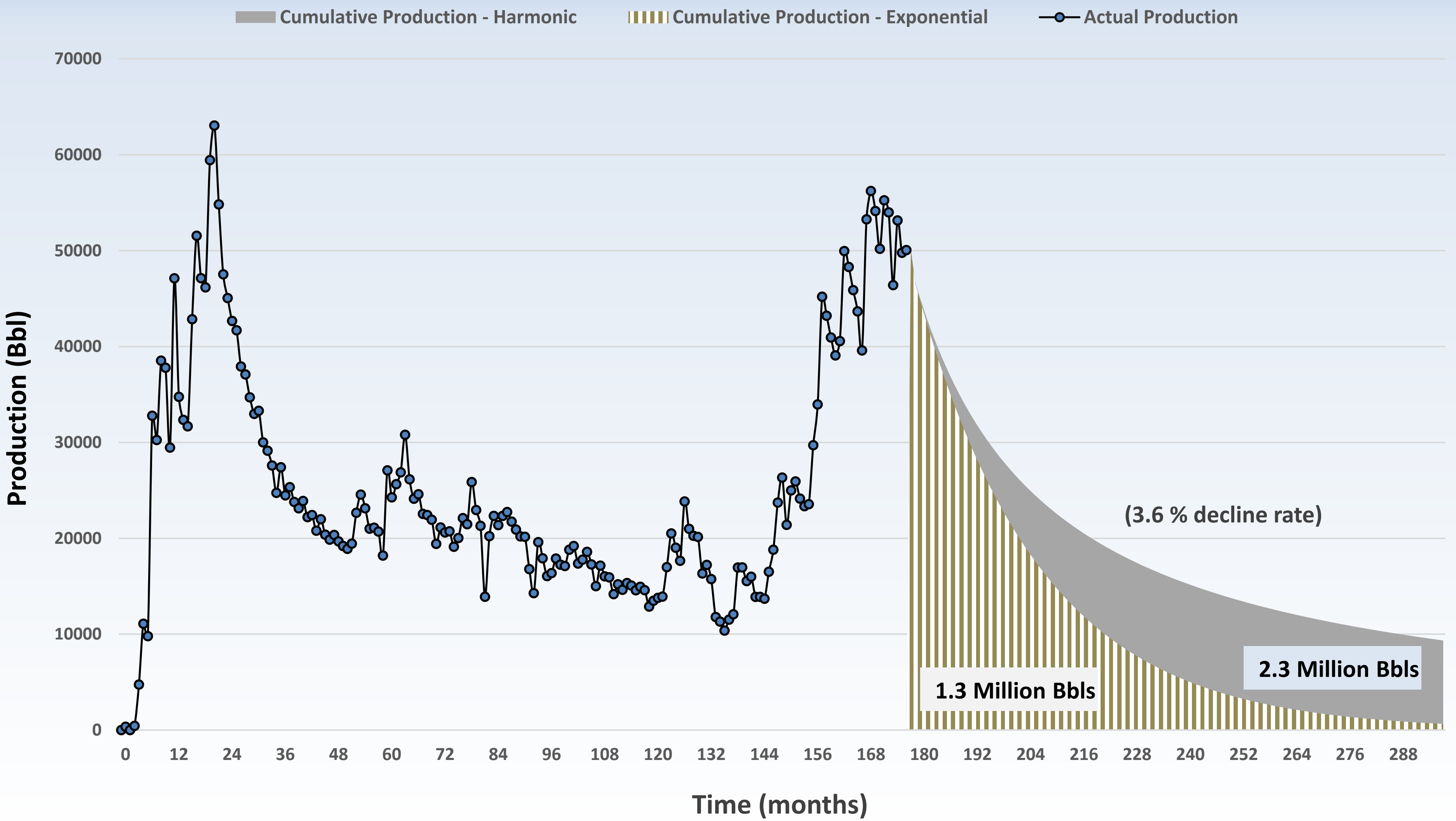
Oil Production – Estimated Ultimate Recovery (EUR) Forecast for 10 years



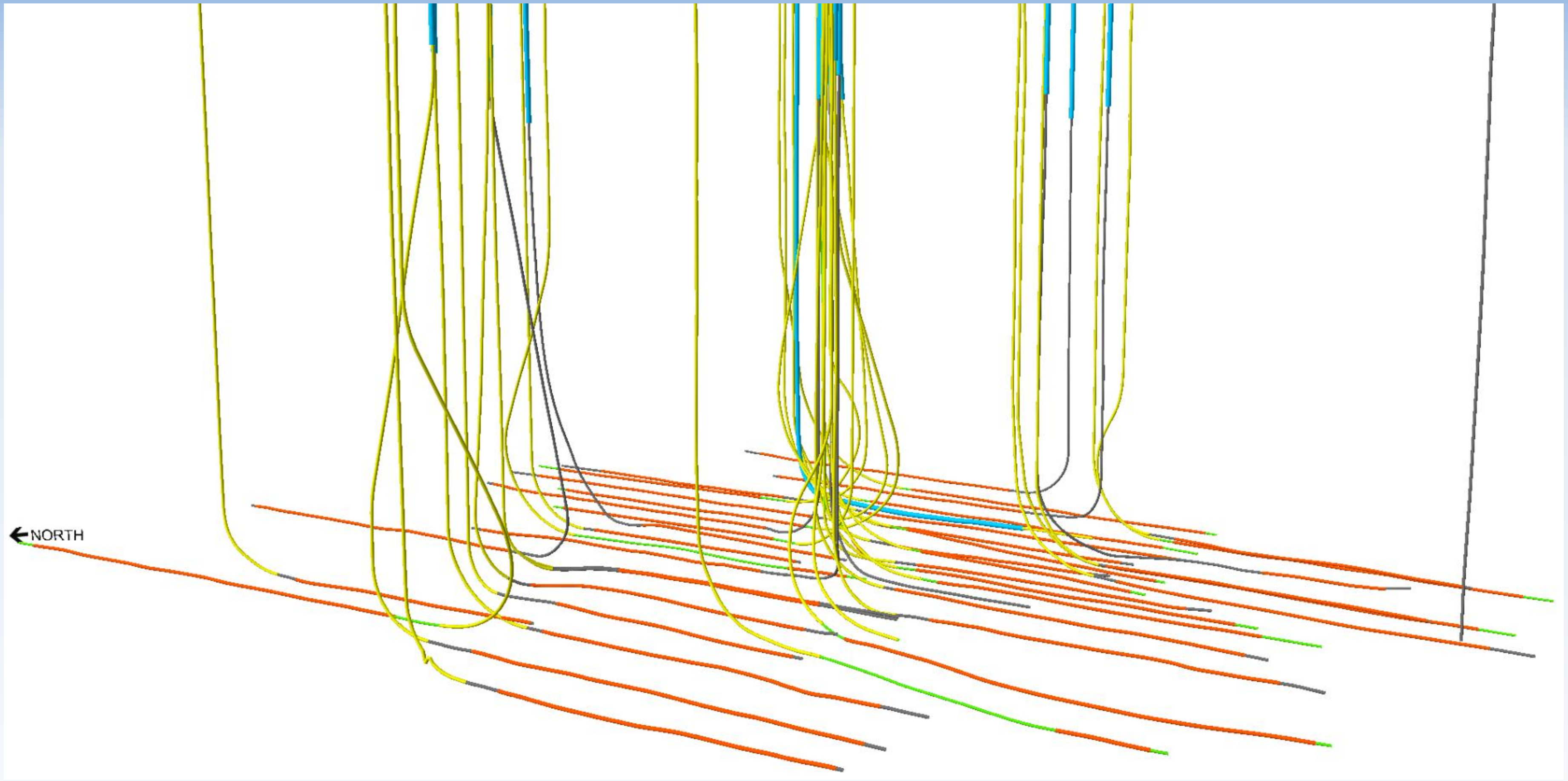
Wellbore surface traces

Directional data from 52 wells:

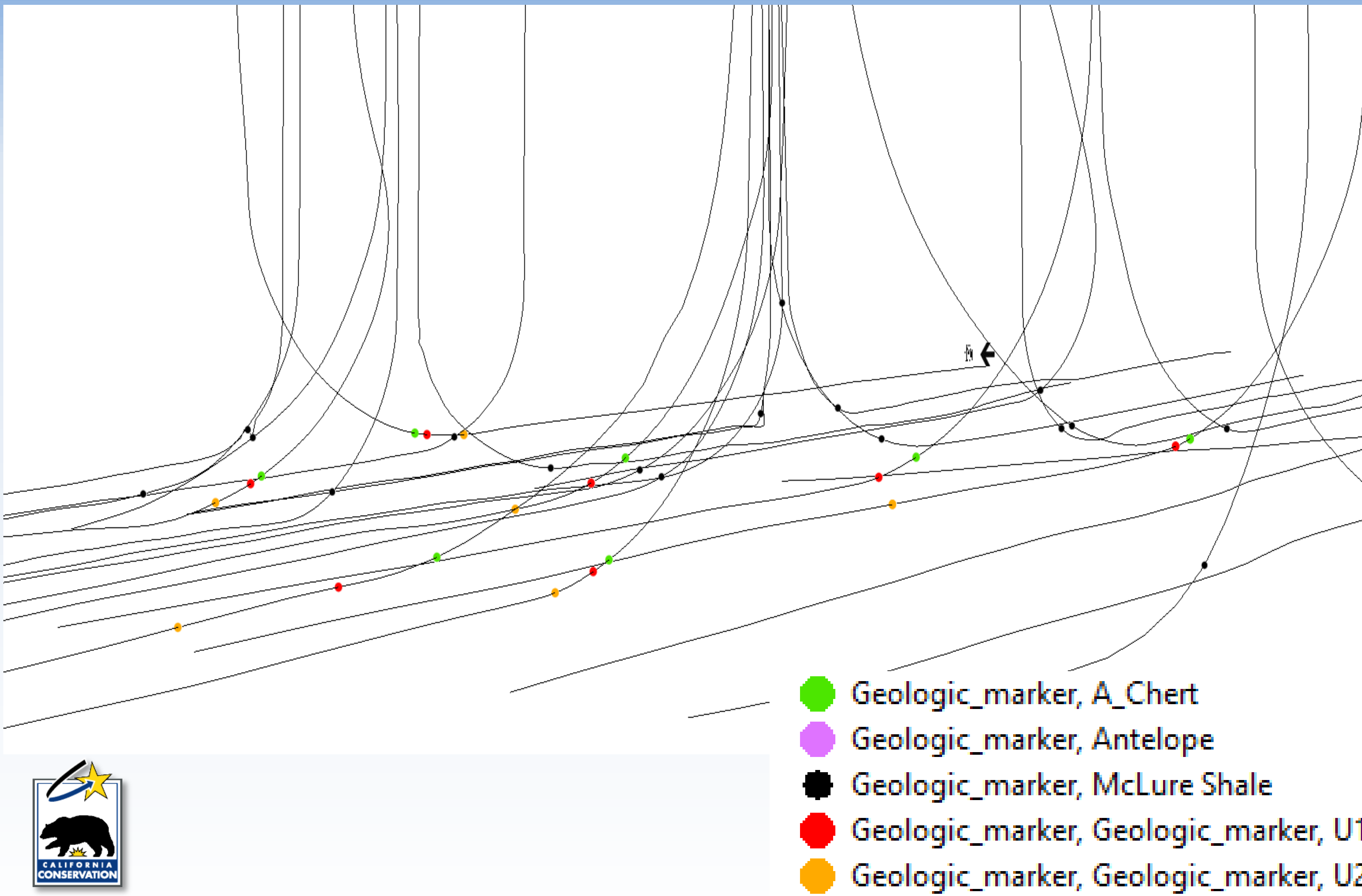
- **EOG Resources – 30 wells**
- **Vintage – 22 wells**

DRAFT (ver. 4/20/15): Well bore surface traces with completion & recompletion intervals along the Eastern edge of Rose Field.
Basemap Imagery: One foot scale Aerial Imagery from Kern County ArcGIS Image Service.

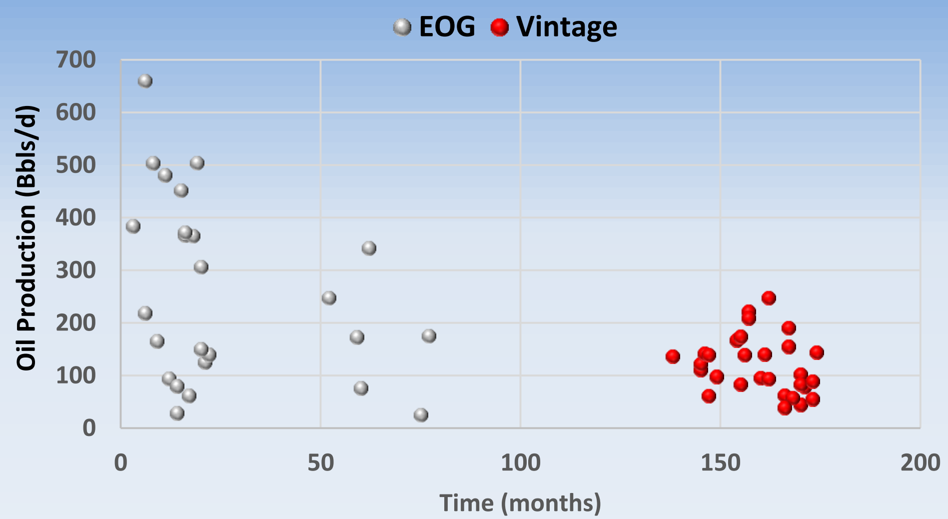
3D image of horizontal completion intervals



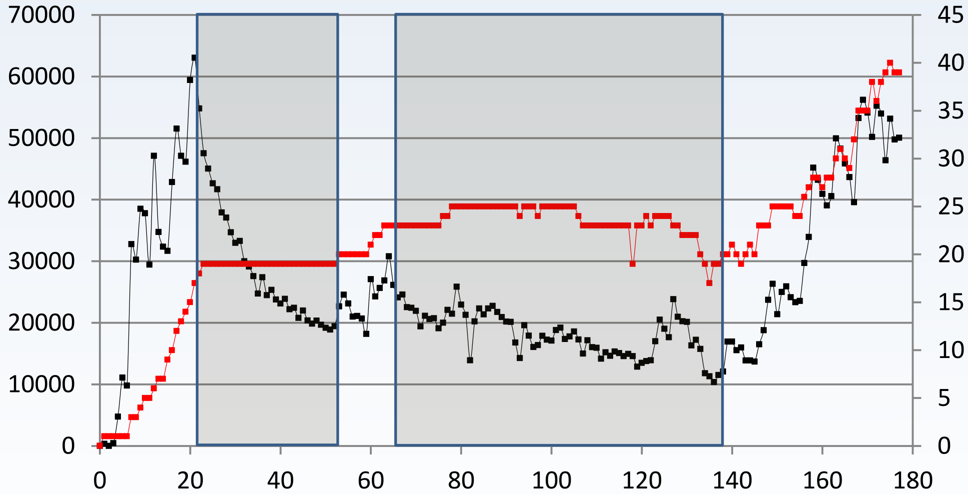
3D image of geologic markers



Initial Production Rates – Chart and Map



(20-50 Month vs. 63-135 Month)



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- **Publically – available DOGGR data:**
  - Well Finder http://www.conservation.ca.gov/dog/Pages/Wellfinder.aspx
  - Online Production & Injection data http://opi.consrv.ca.gov/opi/opi.dll
- **Public – domain publications of others:**

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- Pinnacle Technologies, Inc., 2007. A Rose by Any Other Name…, www.pintech.com: http://www.halliburton.com/public/pinnacle/contents/Case_Histories/web/H08427.pdf.

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our wives

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