

# Undeveloped Petroleum Potential of the Offshore Santa Maria Basin, California\*

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Search and Discovery Article #11067 (2018)\*\*

Posted April 23, 2018

\*Adapted from oral presentation given at AAPG Pacific Section Annual Meeting, Innovating the Future: Discovery to Recovery, Anchorage, Alaska, May 21-24, 2017

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## Abstract

Offshore seismic surveys (now in the public domain) and exploration drilling led to the discovery of several potential oil fields in the offshore Santa Maria basin, California. The seismic and well data also help to better understand this tectonically complex area. The current transpressional stress regime has created thrust anticlinal trends extending from onshore, with a long history of oil production, to the offshore discoveries. The anticlinal trends change orientation offshore and merge into the Hosgri fault system. The Hosgri has strike-slip displacement, but the structures are dominantly compressional with strikes sub-parallel to the San Andreas. The offshore wells discovered heavy oil in the Miocene Monterey formation, eight fields north of Point Arguello. Only one of these was developed, Point Pedernales field (106 MMBO). The others were unitized under the federal OCS statutes but became the focus of state political opposition. The wells encountered oil in fractured siliceous rocks and carbonates in the Monterey. These zones have high matrix porosities, but fractures provide most of the permeability. Many of the wells tested relatively low gravity oil (< 15 deg API) at potentially economic rates (100's to 1000's BOPD). Producing this oil offshore has unique challenges. Conservative estimates for the undeveloped fields total 974 MMBO, technically recoverable. They are now on “open acreage”. Politics, and low oil prices, will keep them from being produced for many more years. Note: this is a companion paper to “Undeveloped petroleum potential of the western-most Santa Barbara Channel, offshore California” presented at the PCS and RMS AAPG Joint Meeting in 2016.

## References Cited

Ballard, J.H., 1988, Sword Field, offshore California: challenges in making this giant oil field commercial (Abs.): AAPG Bulletin, v. 72/3, p. 374.

BOEM, 2008, Field reserve estimate summary as of December 2008: Resource Evaluation Program-Pacific Region: Oil and Gas Energy Programs, boem.gov.

Curran, J.F. and Santa Maria Basin Sub-Committee of the A.A.P.G. Committee on Stratigraphic Correlations, 1959, Correlation section across Santa Maria basin from Cretaceous outcrop in the Santa Ynez mountains northerly to Franciscan outcrop north of Santa Maria river California: Pacific Section A.A.P.G.

Dibblee, T.W., 1950, Geology of southwestern Santa Barbara County, California-Point Arguello, Lompoc, Point Conception, Los Olivos, and Gaviota Quadrangles: California Division of Mines Bulletin 150, 95 p.

Graham, S.A., and W.R. Dickinson, 1978, Evidence for 115 kilometers of right slip on the San Gregorio-Hosgri Fault trend: Science, v. 199, P. 179-181.

Jennings, C.W., 1958, Geologic map of California San Luis Obispo sheet: California Geological Survey.

Jennings, C.W., 1959, Geologic map of California Santa Maria sheet: California Geological Survey.

Willingham, R., J.D. Rietman, R.G. Heck, and W.R. Lettis, 2013, Characterization of the Hosgri Fault Zone and adjacent structures in the offshore Santa Maria basin, south-central California: United States Geological Survey Bulletin 1995-CC, 105 p.



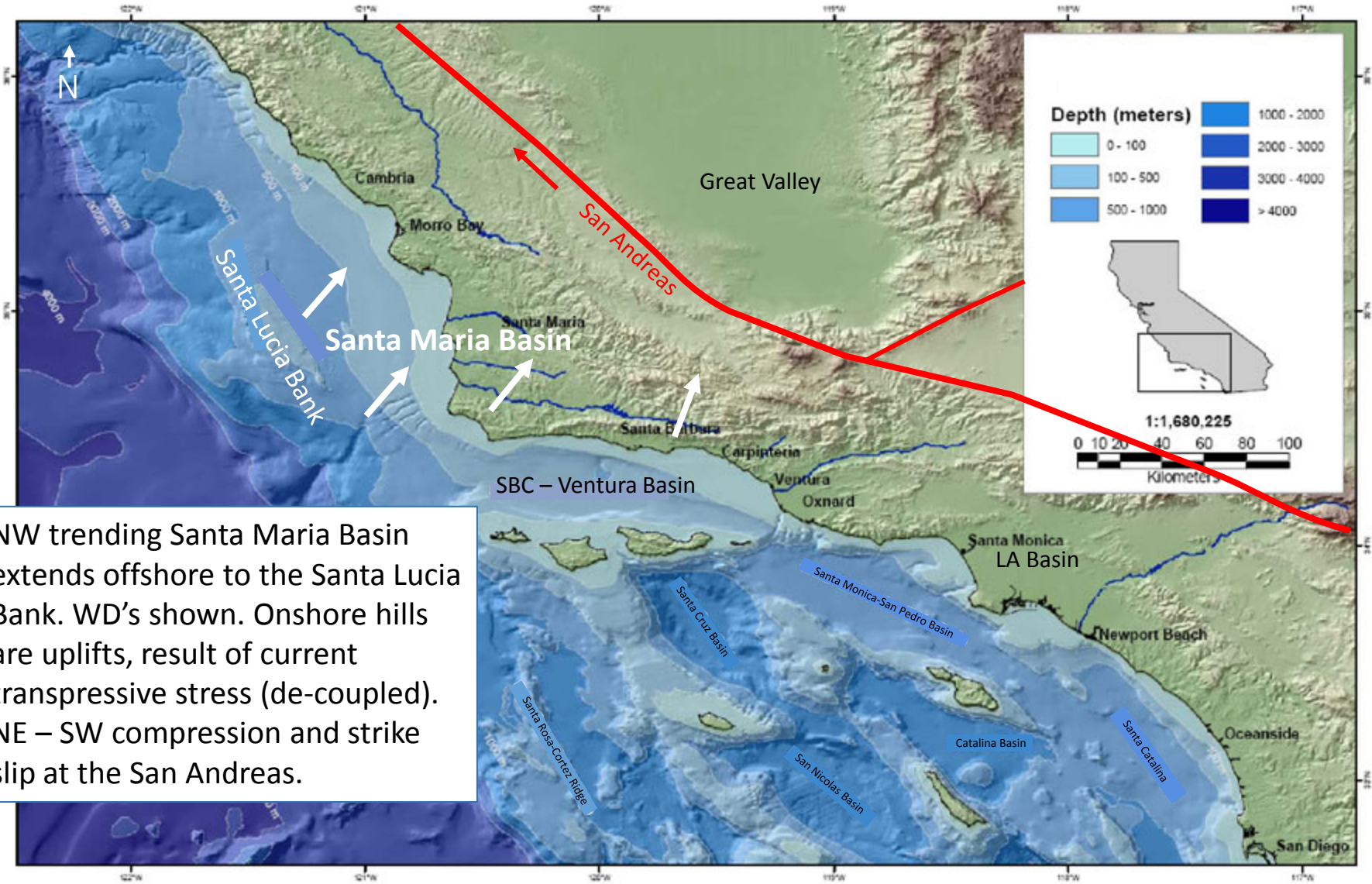
Semi-submersible drilling rig on  
location offshore California

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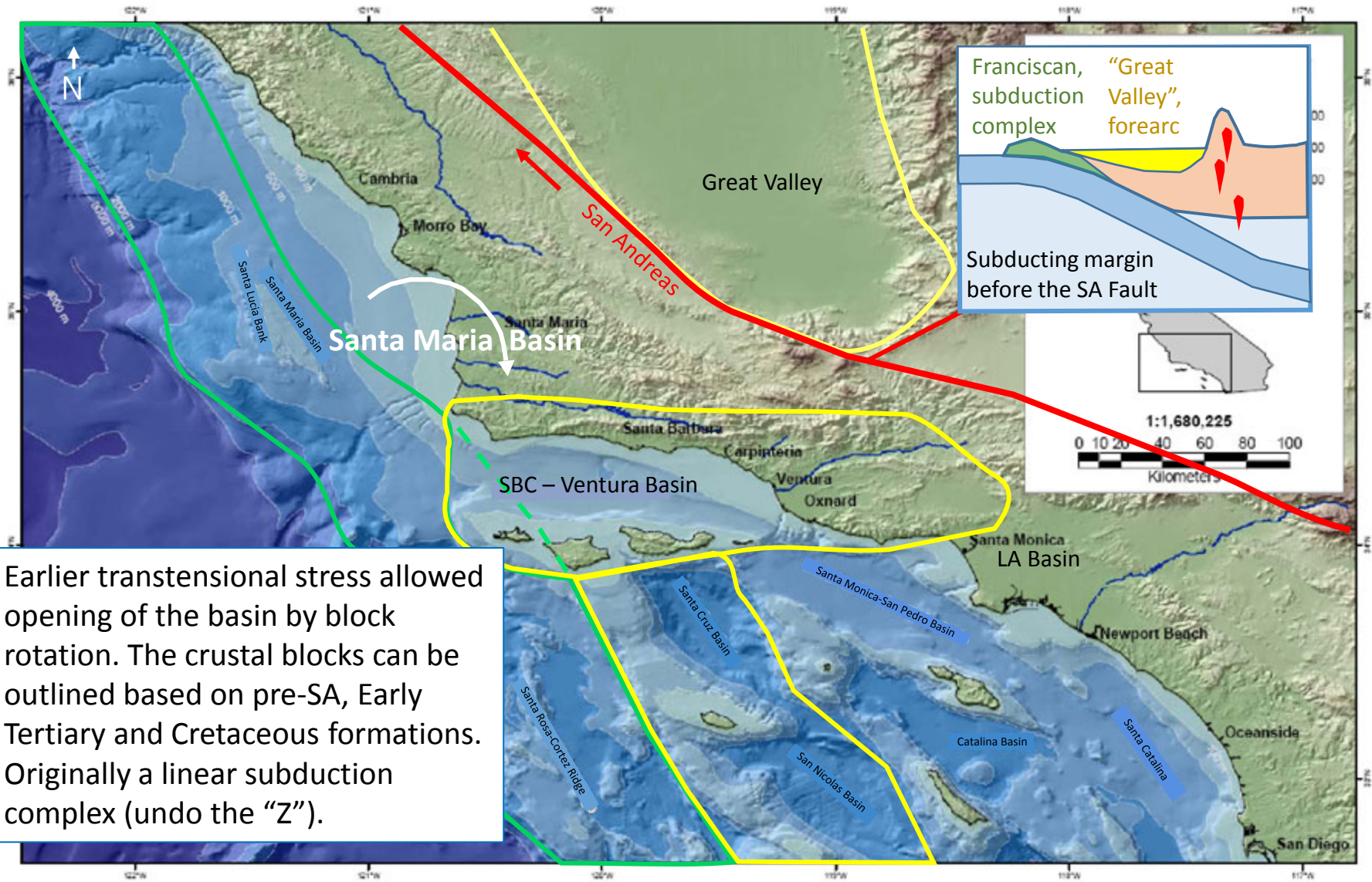
AAPG Pacific Section  
May 21 – 24, 2017  
Anchorage, Alaska

Note, this is a companion paper to  
“Undeveloped petroleum potential  
of the western-most Santa Barbara  
Channel, offshore California”  
presented last year in Las Vegas  
(PS and RMS AAPG Joint Meeting).



NW trending Santa Maria Basin extends offshore to the Santa Lucia Bank. WD's shown. Onshore hills are uplifts, result of current transpressive stress (de-coupled). NE – SW compression and strike slip at the San Andreas.

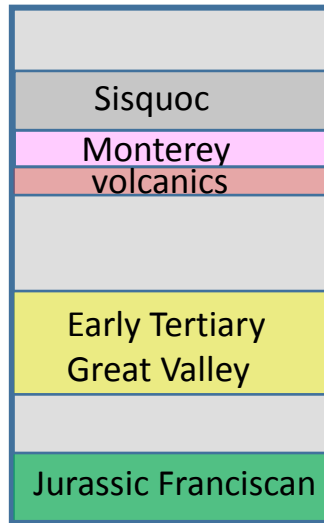




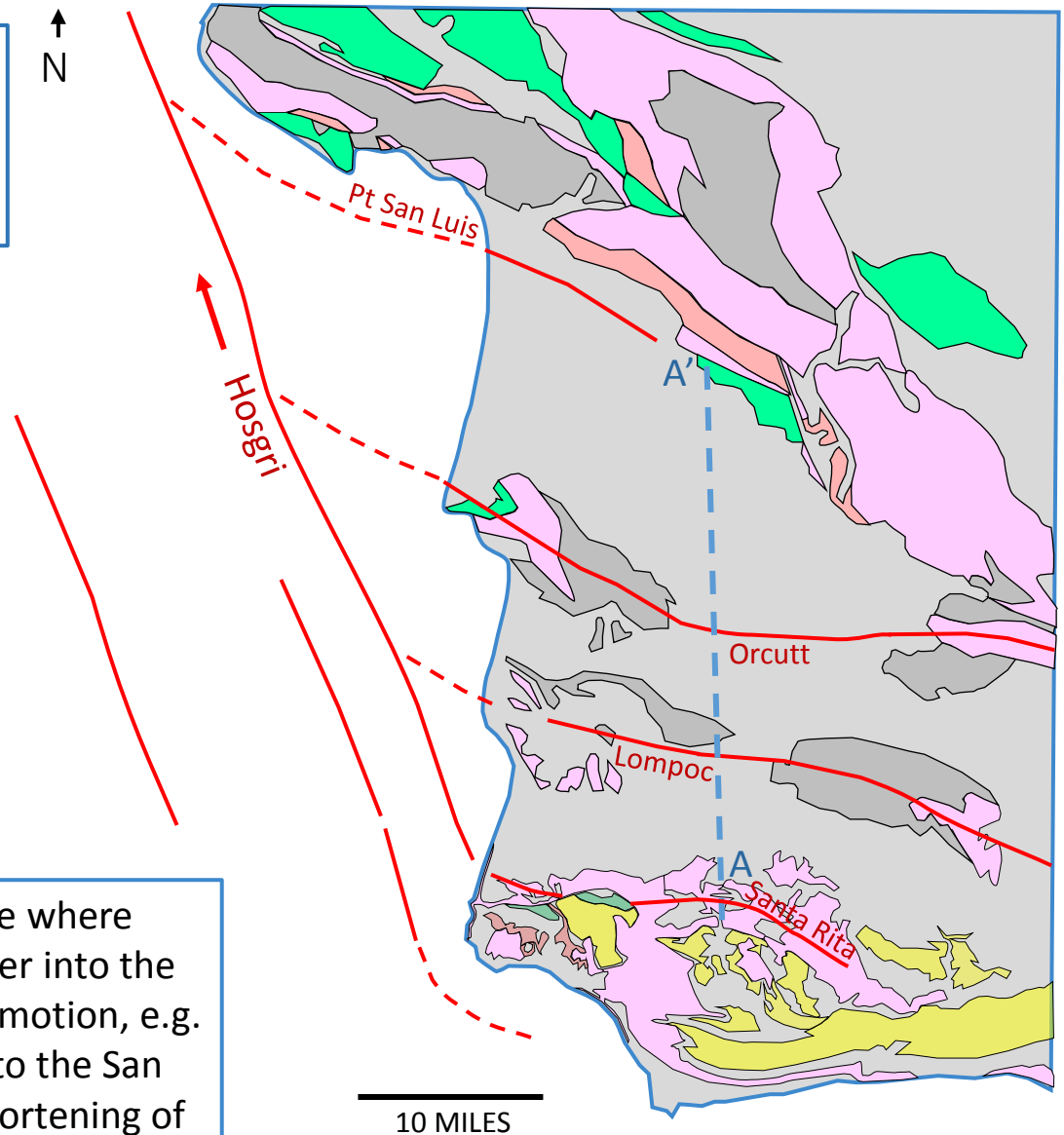
Earlier transtensional stress allowed opening of the basin by block rotation. The crustal blocks can be outlined based on pre-SA, Early Tertiary and Cretaceous formations. Originally a linear subduction complex (undo the "Z").

# Onshore Santa Maria geologic mapping by Dibblee, most compiled by Jennings.

Units of interest in the stratigraphic column; Franciscan, Great Valley (S), Mio. to L Plio. – volcanics (N and S areas), Monterey and Sisquoc.



Anticlinal trends (red) extend offshore where there is a change in direction, a merger into the Hosgri Fault Zone. HFZ has strike slip motion, e.g. Graham and Dickenson, sub-parallel to the San Andreas. Right lateral slip equal to shortening of folds/thrust faults (ocean side not buttressed).



Note location of cross-section for next slide.

# Correlation Section Across Santa Maria Basin - AAPG Pacific Section (generalized)

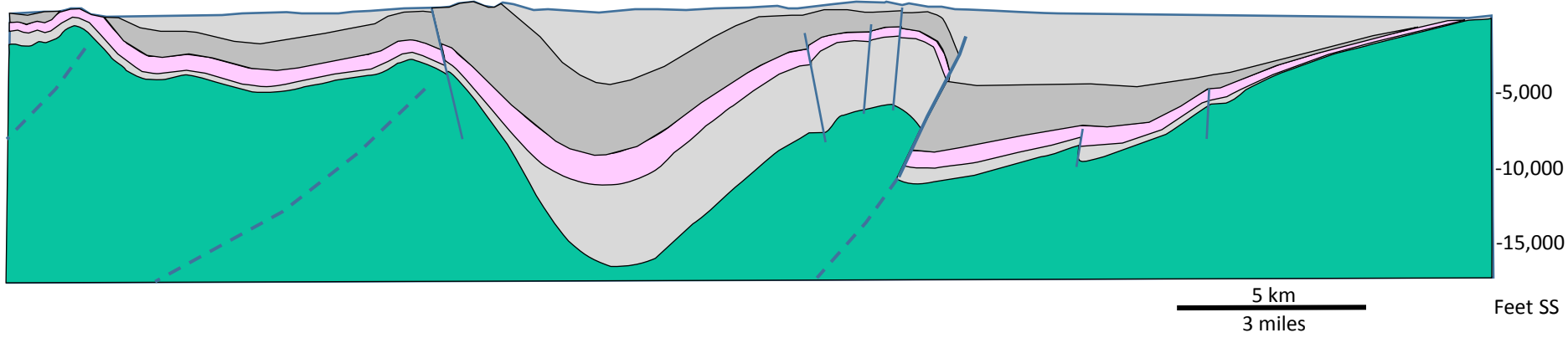
A  
S

A'  
N

Lompoc Field  
50 MMBO; 15-24

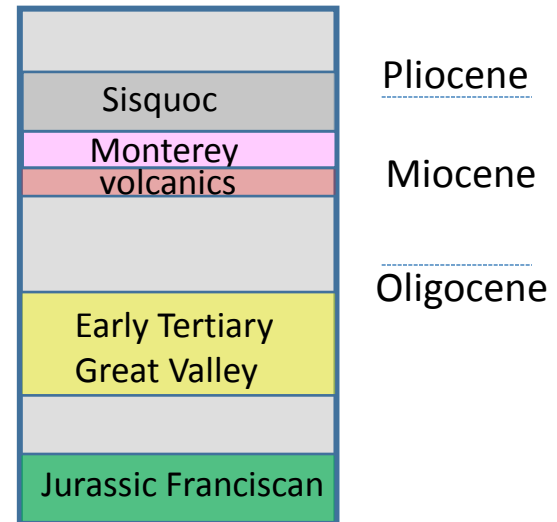
Orcutt Field  
180 MMBO; 16,23

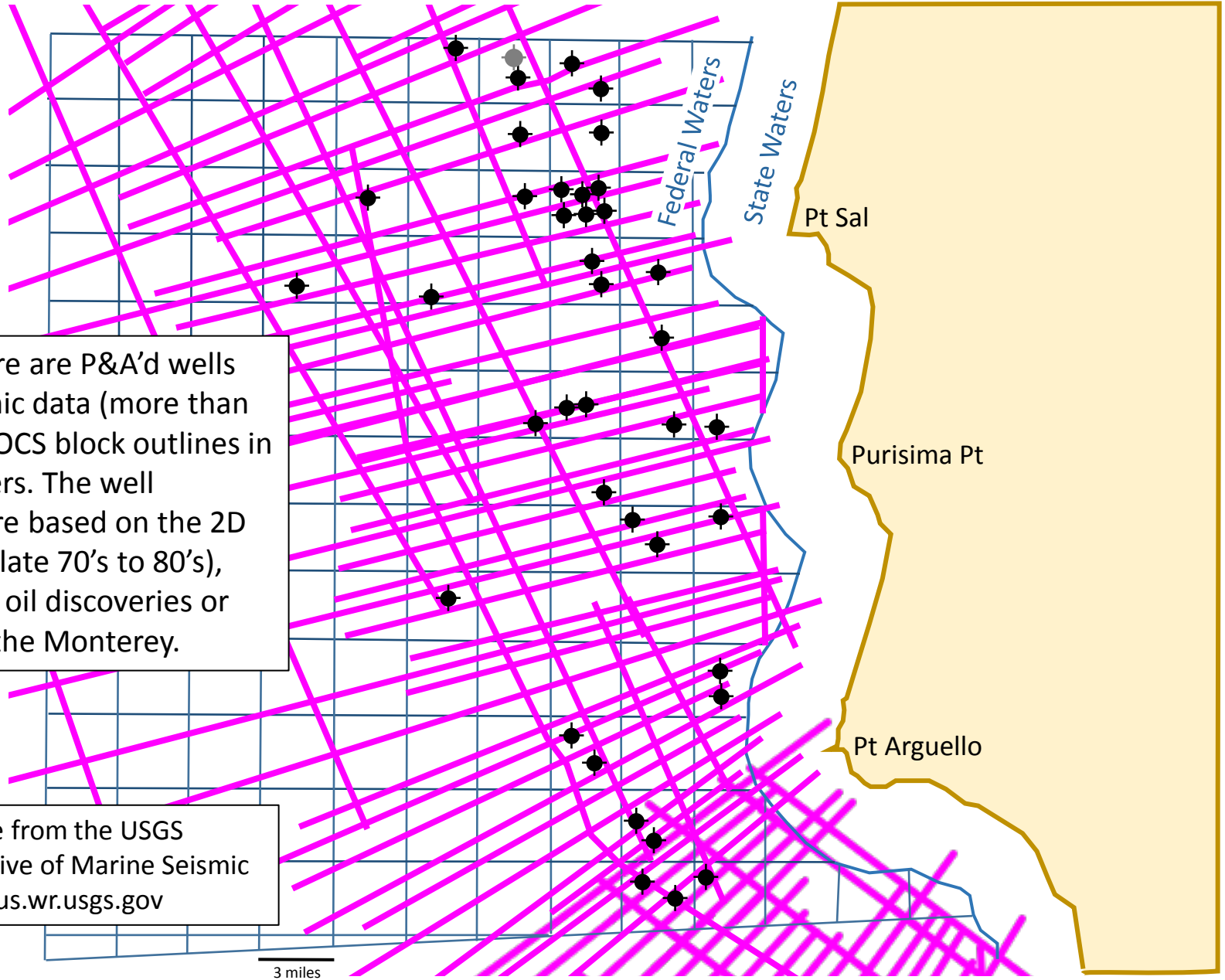
Santa Maria Valley  
230 MMBO; 12-17



Pre-Miocene unconformity, no Great Valley forearc, Jurassic subduction complex, Monterey and other units thickening to the basin center (transtension created space) and late thrust anticlines (transpression).

In the Santa Maria Basin, just about every high is an oil field, mostly in fractured Monterey "shale", also sands above and below. EUR's and API oil gravities shown.



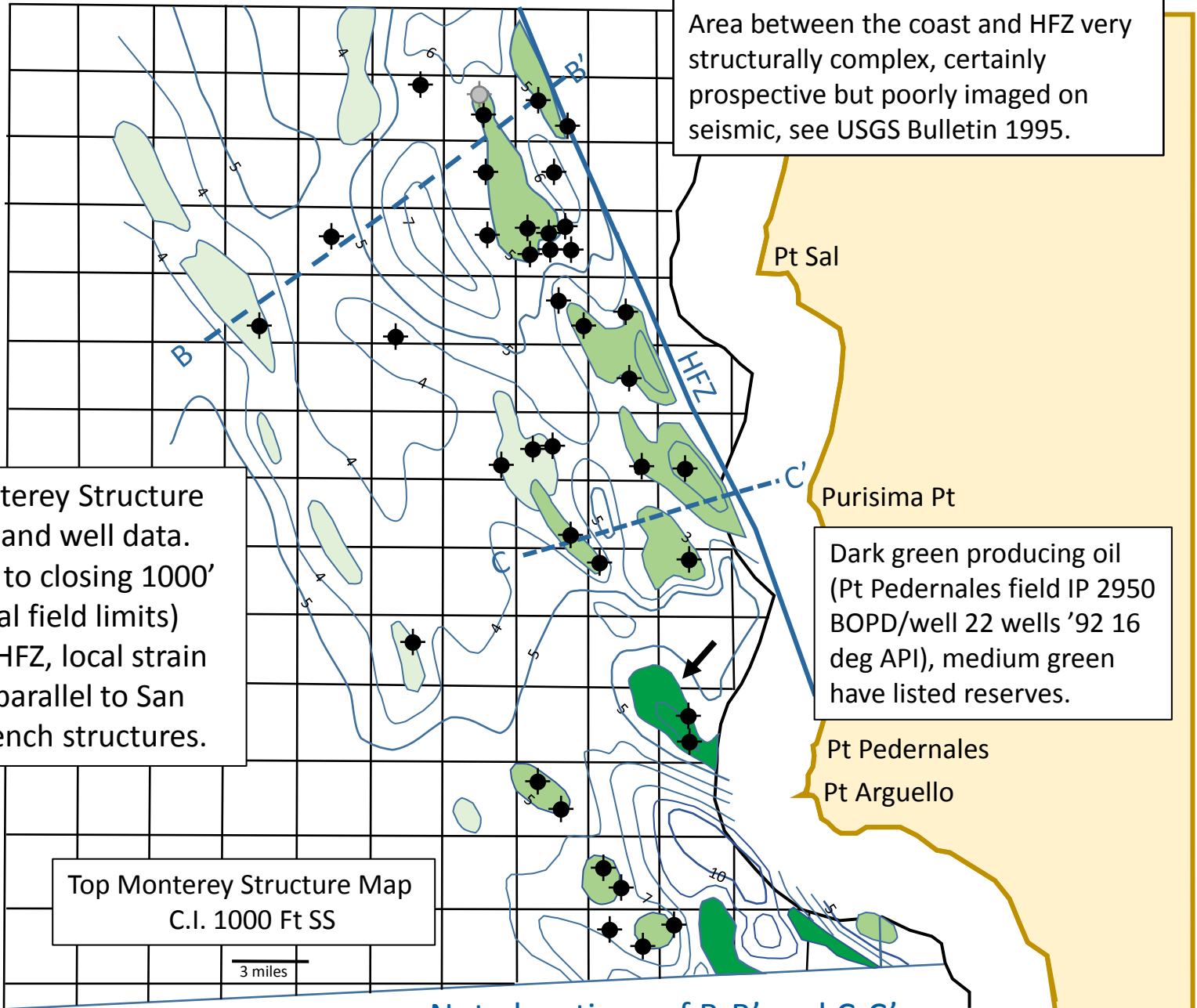


Offshore there are P&A'd wells and 2D seismic data (more than shown) also OCS block outlines in Federal Waters. The well locations were based on the 2D seismic grid (late 70's to 80's), nearly all are oil discoveries or step-outs in the Monterey.

Data available from the USGS National Archive of Marine Seismic Surveys, [walrus.wr.usgs.gov](http://walrus.wr.usgs.gov)

3 miles





Area between the coast and HFZ very structurally complex, certainly prospective but poorly imaged on seismic, see USGS Bulletin 1995.

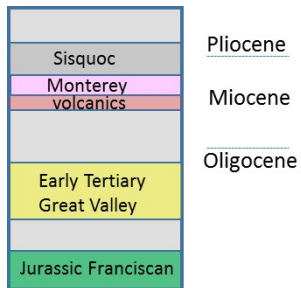
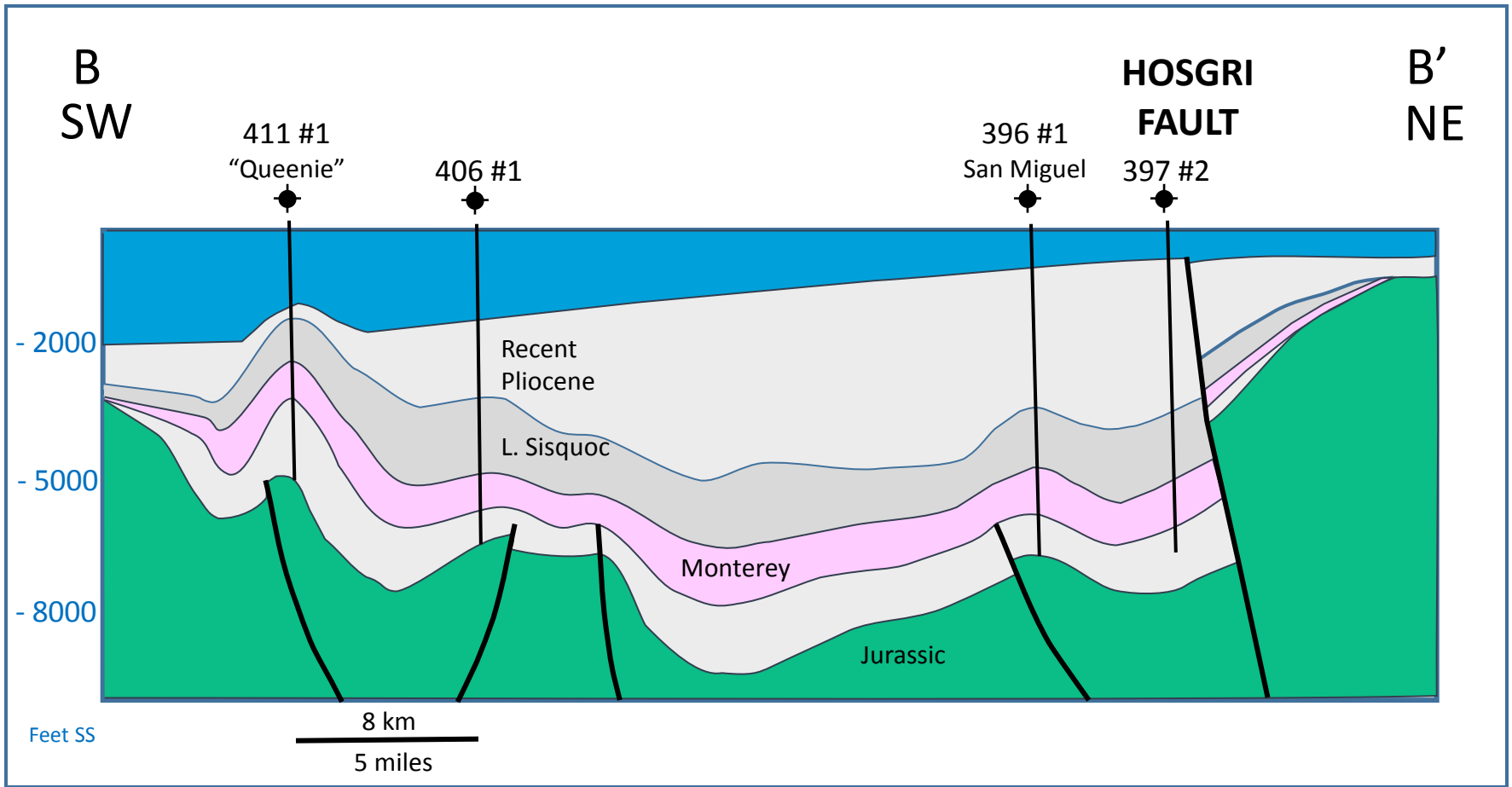
Generalized Monterey Structure from the seismic and well data. Anticlines (green to closing 1000' contours, not total field limits) strike parallel to HFZ, local strain partitioning sub-parallel to San Andreas. Not wrench structures.

Dark green producing oil (Pt Pedernales field IP 2950 BOPD/well 22 wells '92 16 deg API), medium green have listed reserves.

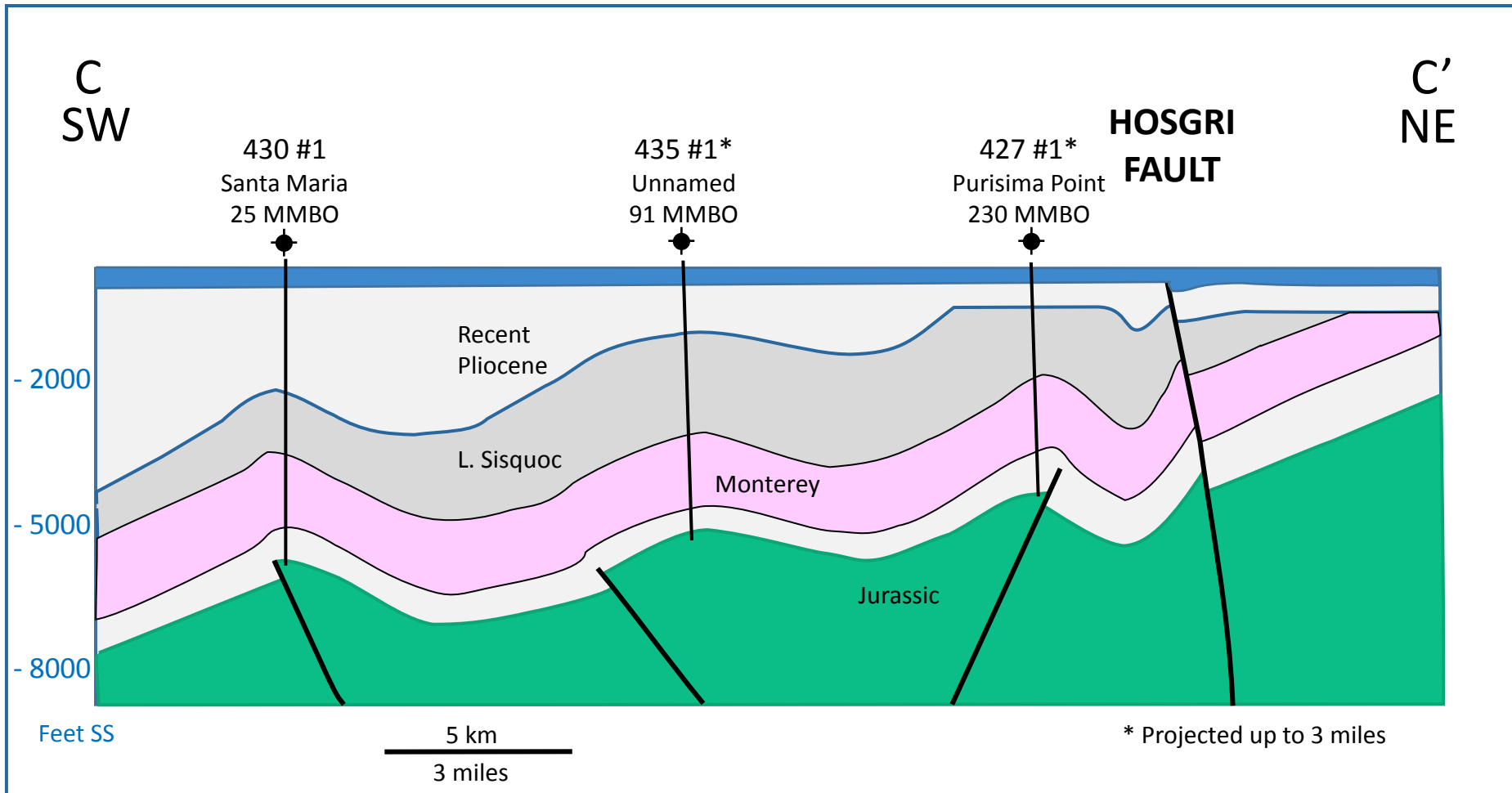
Top Monterey Structure Map  
C.I. 1000 Ft SS

3 miles

Note locations of B-B' and C-C'



Constructed from the 2D seismic and wells. Note recent displacements of the seafloor. Stratigraphy very similar to onshore A – A'. Changing formation thicknesses suggest strike slip on HFZ (there is a nearby well east of the fault). Most of the obvious places drilled, San Miguel a major discovery (256 MMBO). Deepwater wells were not Unitized, probably less economically attractive.



Seismic line along  
a portion of C - C'

SW

NE

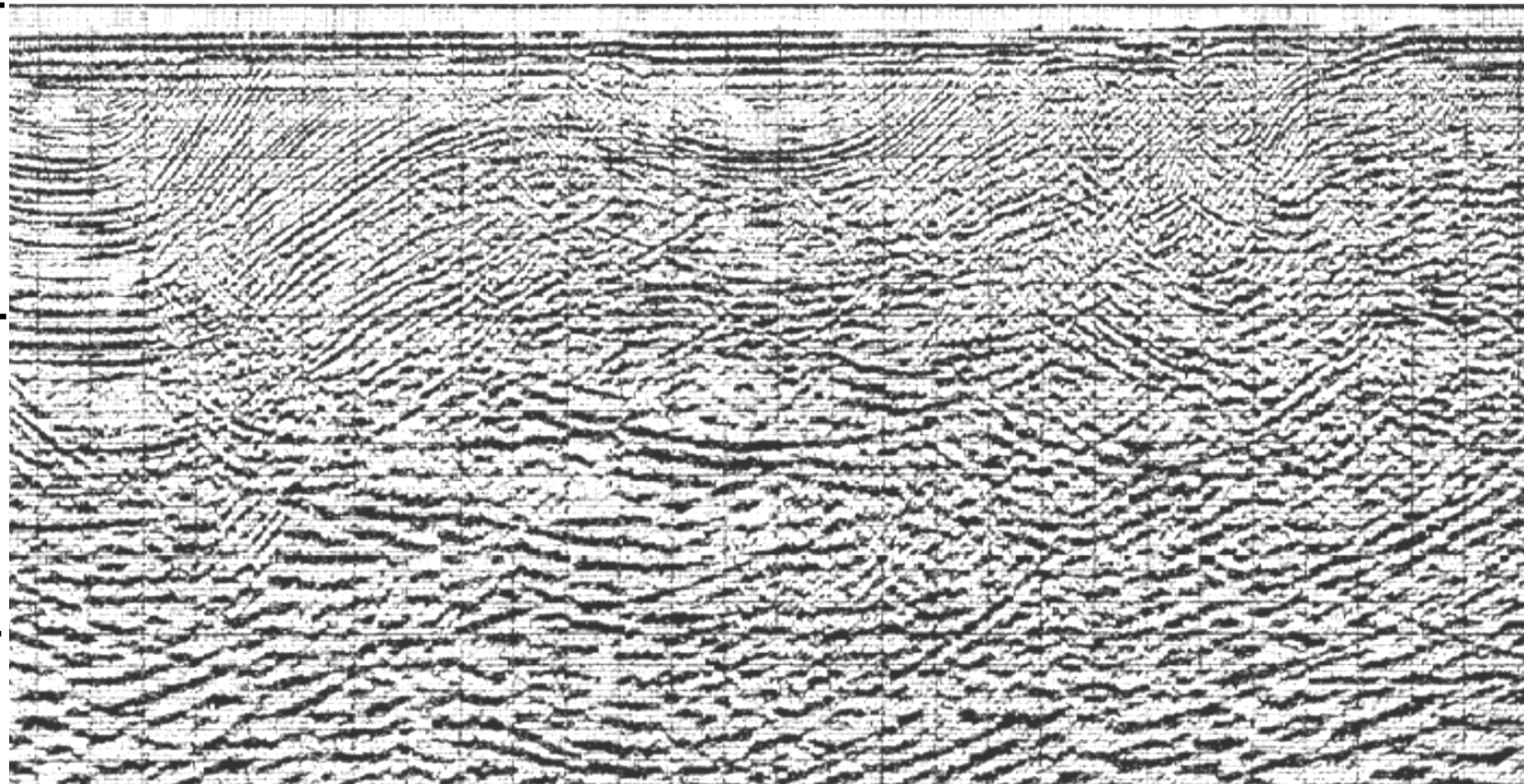
435 #1  
Unnamed

427 #1  
Purisima Point

0

2

3



TWT Seconds

5 km  
3 miles

Data quality is challenging. Note layers versus basement,  
over-steepened limbs, near seafloor angular unconformity.  
Uninterpreted line from USGS Bulletin 1995



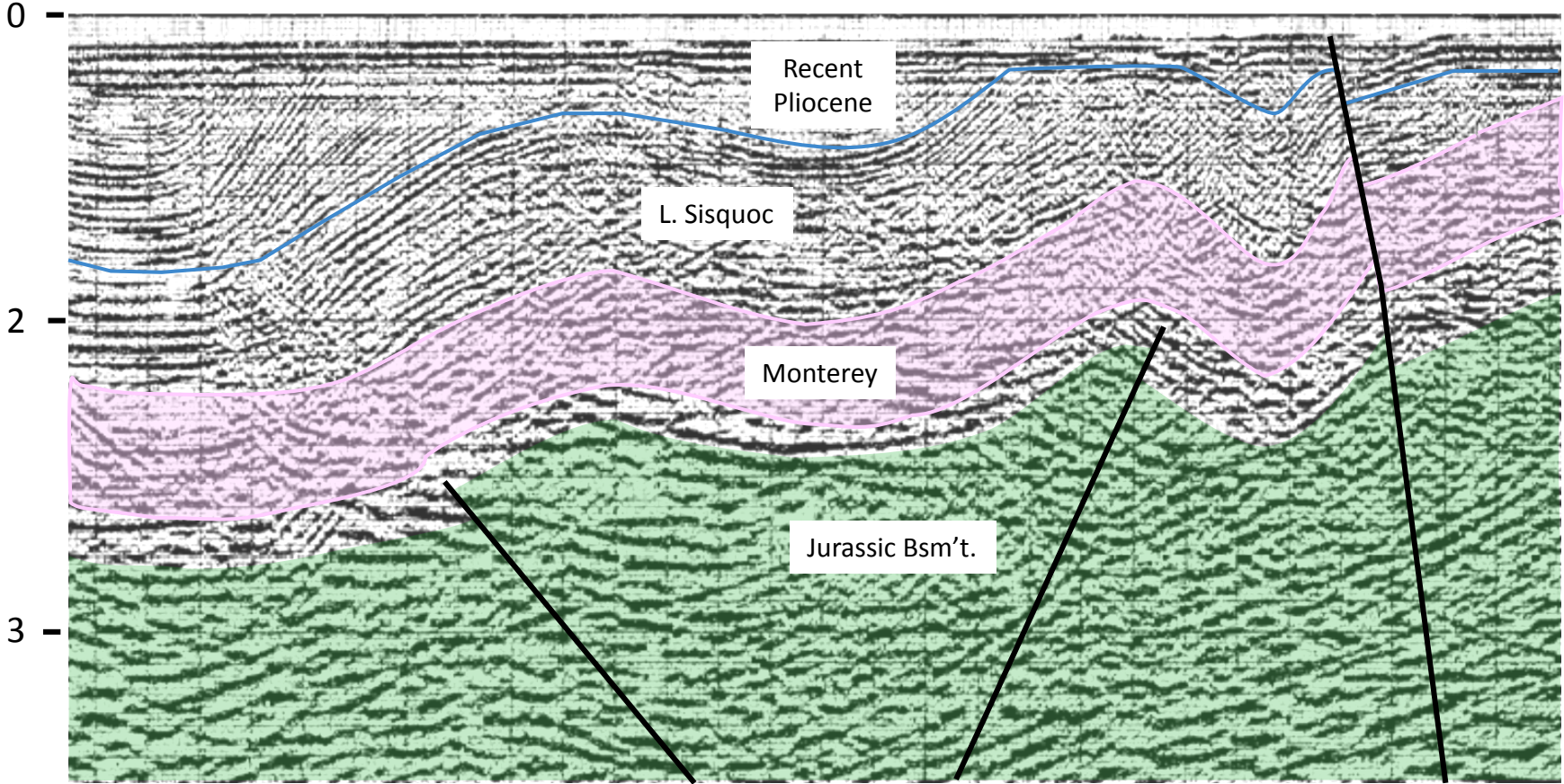
Seismic line along  
a portion of C - C'

SW

NE

435 #1  
Unnamed

427 #1  
Purisima Point



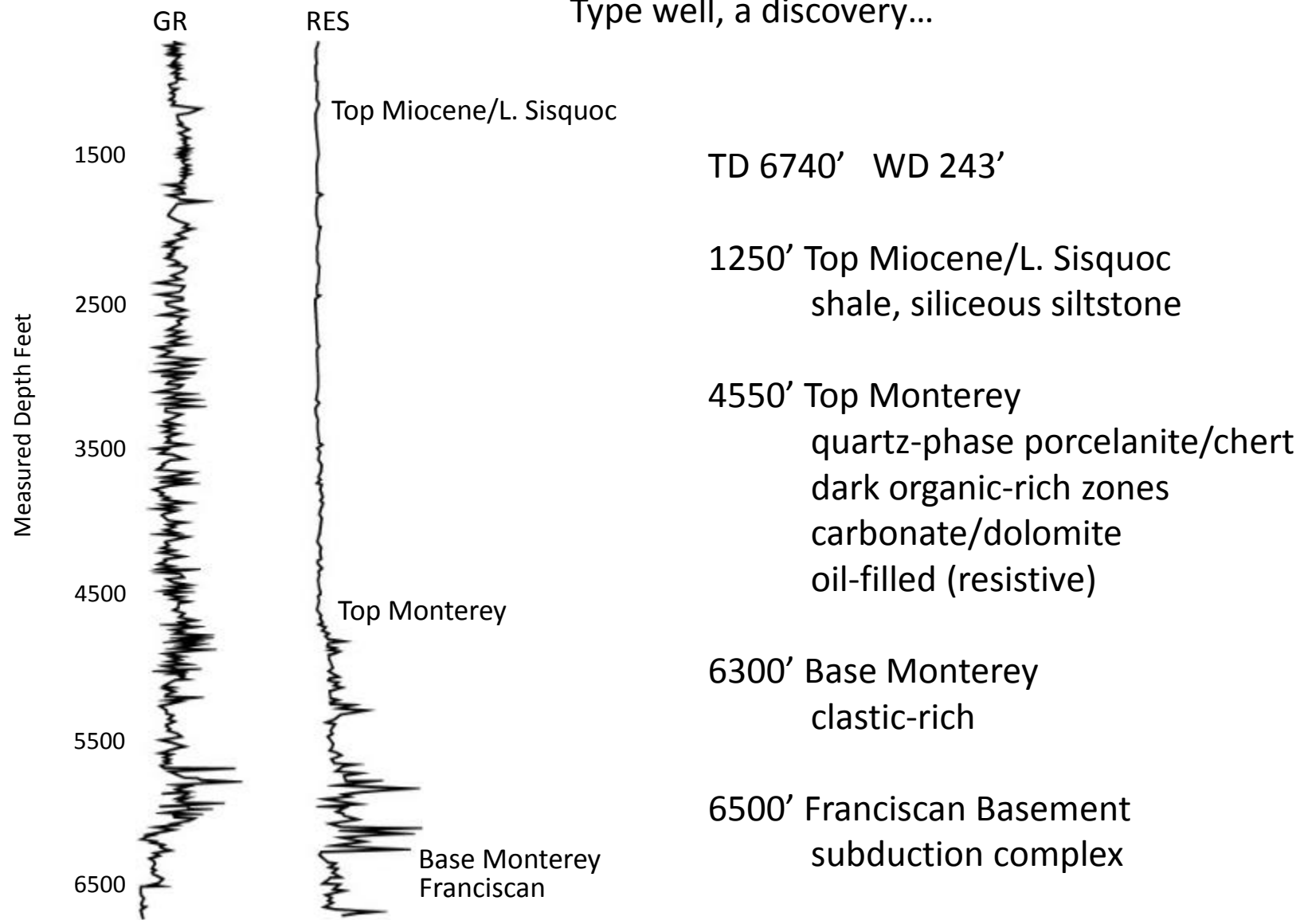
TWT Seconds  
5 km  
3 miles

There are tops from these wells on intersecting lines. Note how shallow thrust faults go is interpretive on this vintage data (limited offsets, "steep" dips not imaged).



# 435 #1

Type well, a discovery...



## Monterey coastal outcrop, Vandenberg AFB

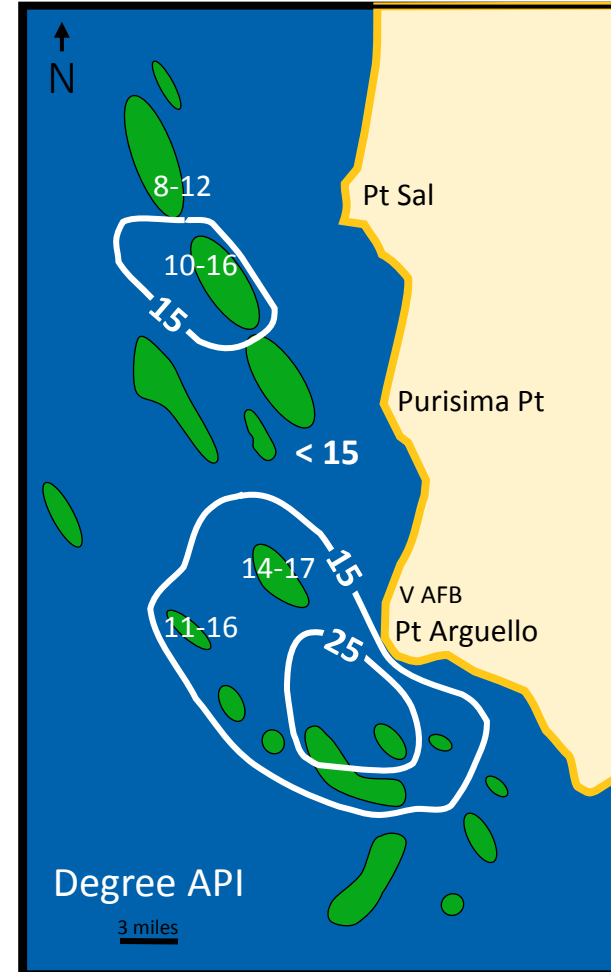


archives.aapg.org

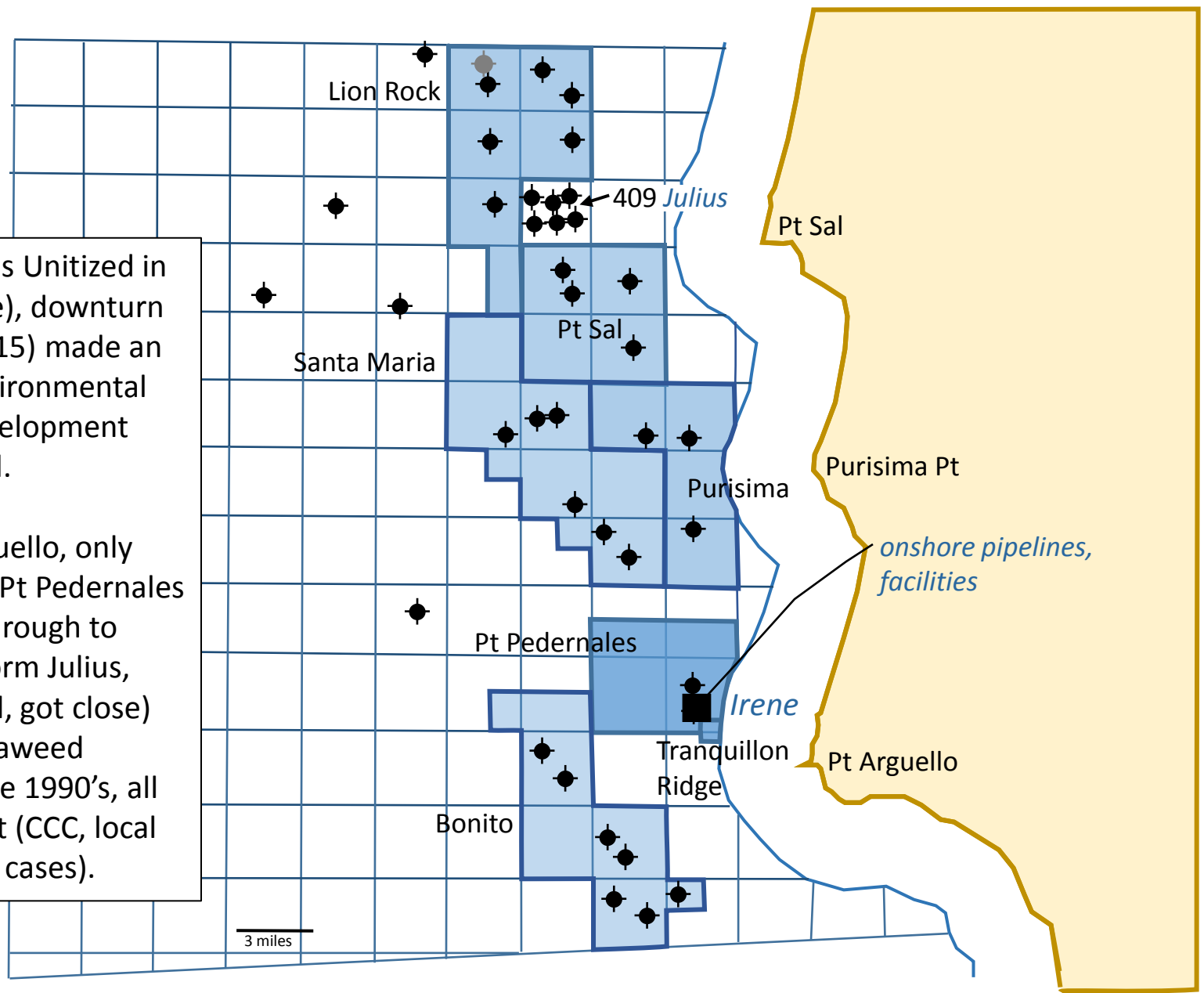
The main reservoir is the bioclastic Monterey porcelanite and chert, also carbonates. Matrix porosities can be very good (20-30%). Matrix permeability is low (.1 md), high flow rates depend on fractures.

Low oil gravities are due to the thermal maturation of the Monterey source rock (and low  $R_o$  generation). The map shows the oil gravity distribution; higher gravity near where the Monterey is more deeply buried.

## Tested Oil Gravities



Modified from JHB 1988



Most discoveries Unitized in the 1980's (blue), downturn in 1986 (like 2015) made an impact, but environmental studies and development plans continued.

North of Pt Arguello, only platform Irene, Pt Pedernales field, made it through to approval (platform Julius, San Miguel field, got close) Then in the "Seaweed Rebellion" of the 1990's, all others were lost (CCC, local elections, court cases).

3 miles

Lion Rock

Santa Maria

Pt Sal

Pt Sal

Purisima

Purisima Pt

Pt Pedernales

Irene

Pt Arguello

Bonito

Tranquillon Ridge

409 Julius

onshore pipelines, facilities



Pacific OCS Region  
2008 "Reserves"  
(boem.gov)

1	A	98	MMBO
2	San Miguel*	256	MMBO
3	Pt Sal*	210	MMBO
4	Purisima Pt*	230	MMBO
5	Santa Maria	25	MMBO
6	435	92	MMBO
7	Pt Pedernales	106	MMBO
8	443	14	MMBO
9	Bonito	49	MMBO

\*BOEM lumps these  
3 fields into "B"

974 MMBO outside  
Pt Pedernales

Fields farther south  
discussed previously.

Top Monterey Structure Map  
C.I. 1000 Ft SS

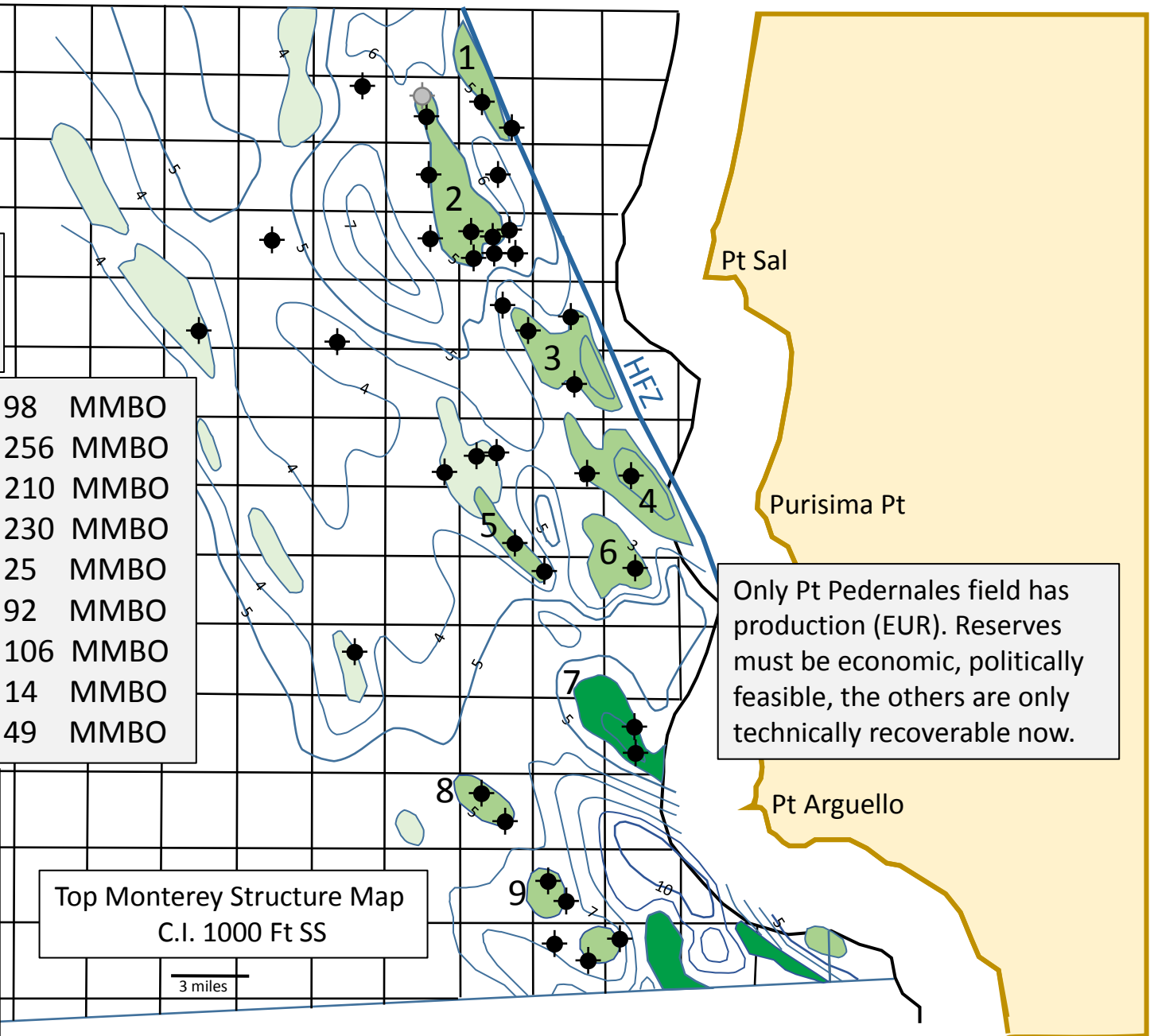
3 miles

Pt Sal

Purisima Pt

Only Pt Pedernales field has  
production (EUR). Reserves  
must be economic, politically  
feasible, the others are only  
technically recoverable now.

Pt Arguello





Low-gravity oil offshore California, pour points can be problematic, as they are onshore.

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