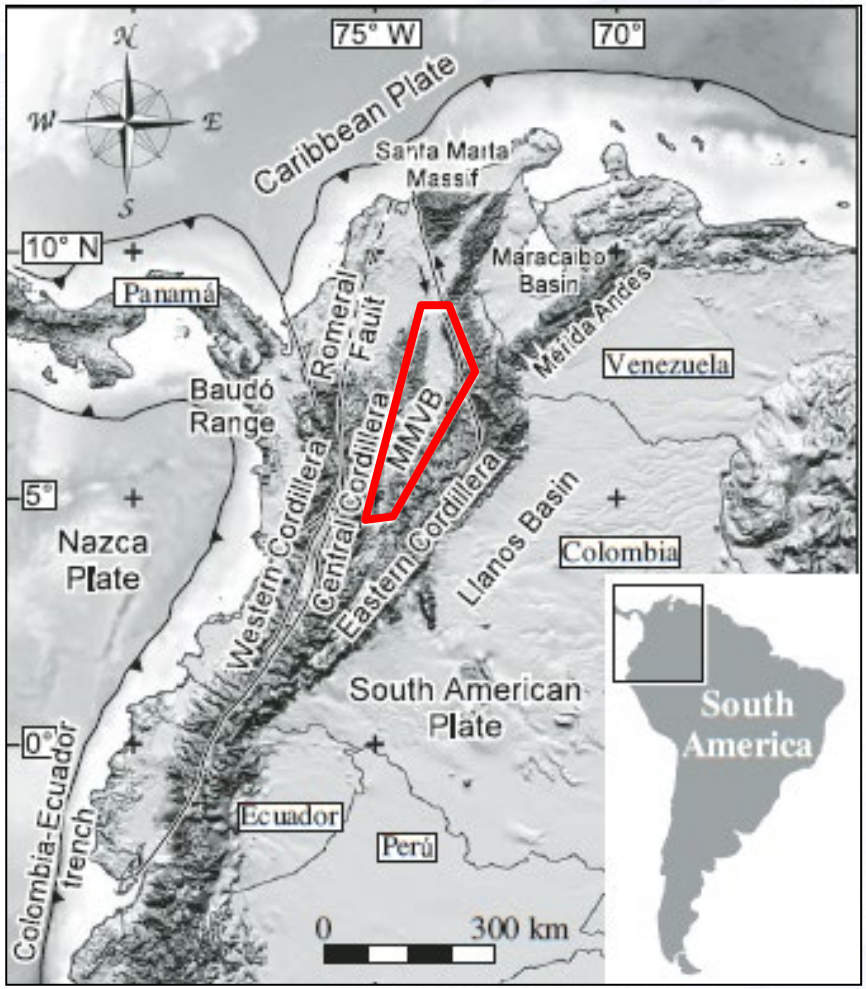
Unconventional Oil Potential in the Cretaceous Shales of the Middle Magdalena Basin Colombia

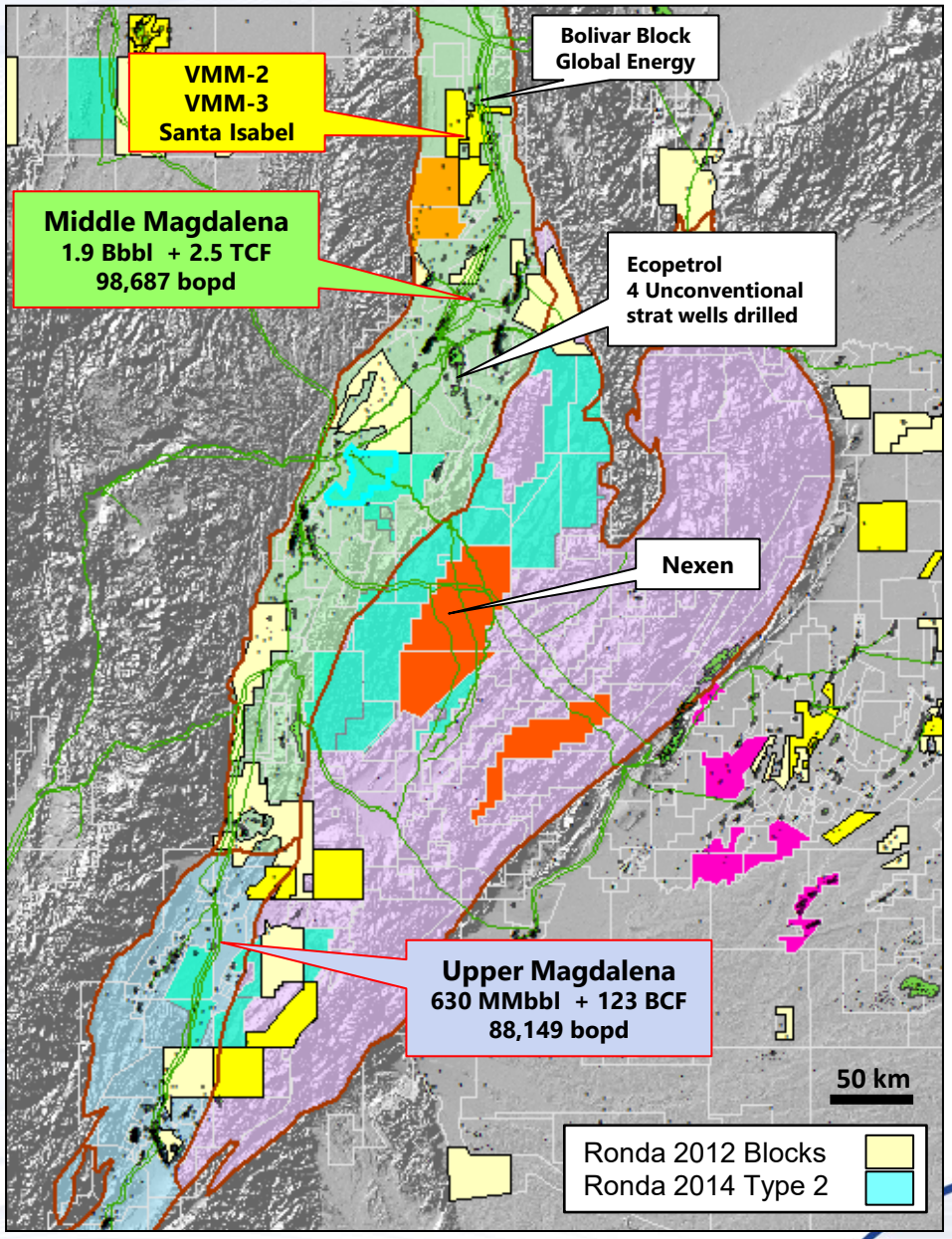
Andrew Willis & Nilanjan Ganguly

May 12th 2014

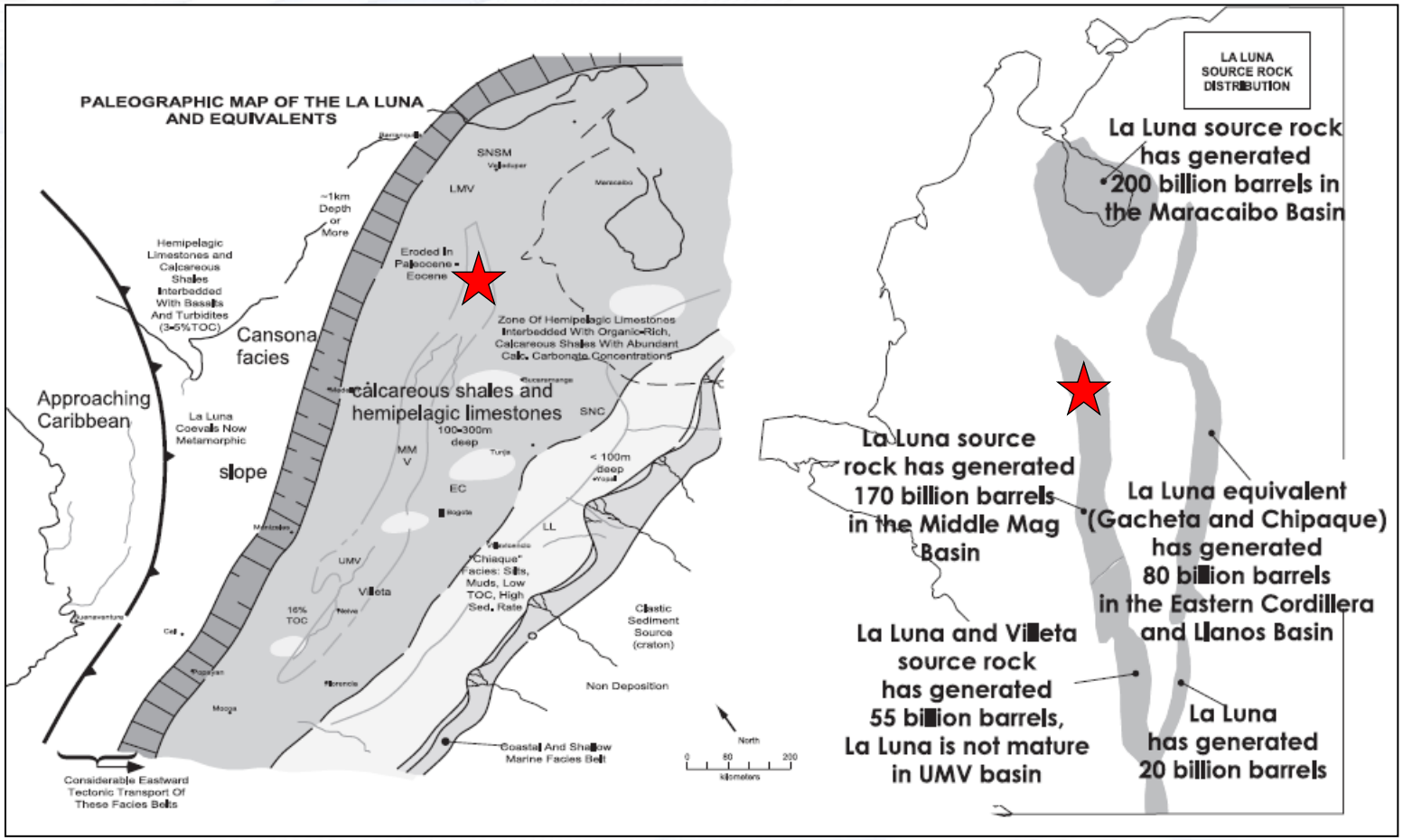
Middle Magdalena Valley Basin Location



Gomez et al. (2012)

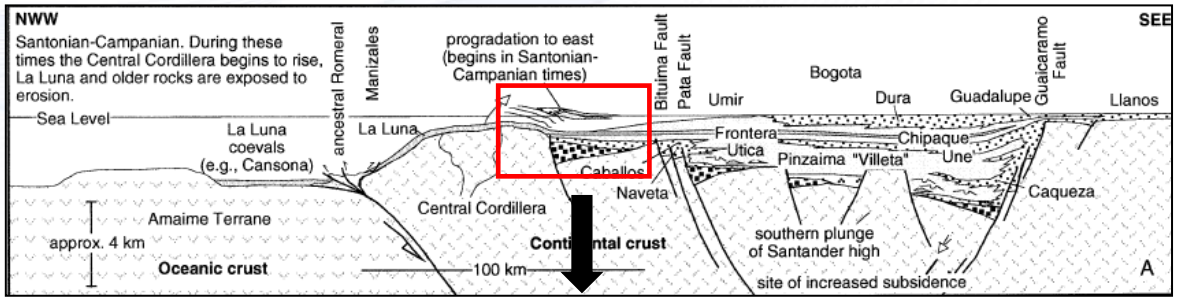


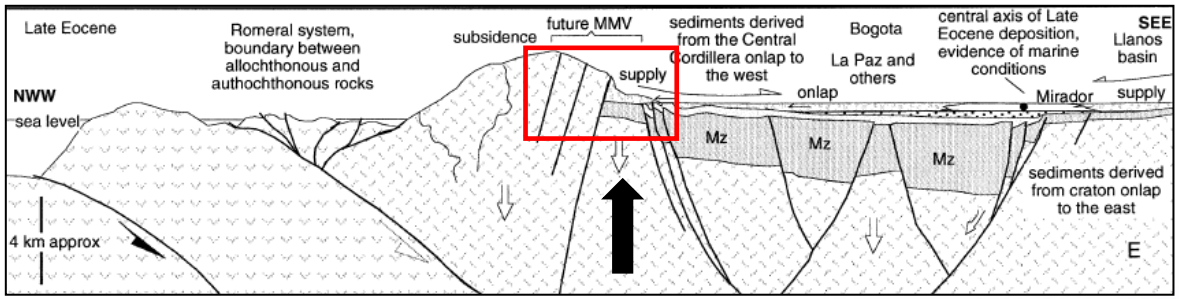
Middle Magdalena Valley Basin
La Luna Source Rock

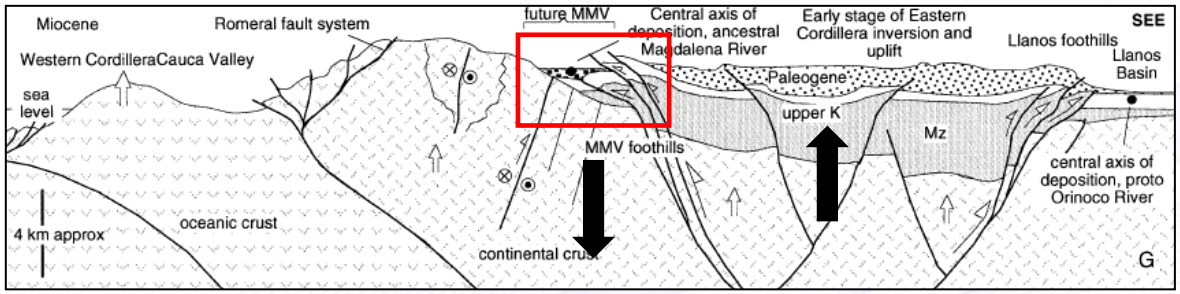


Villamil 2003

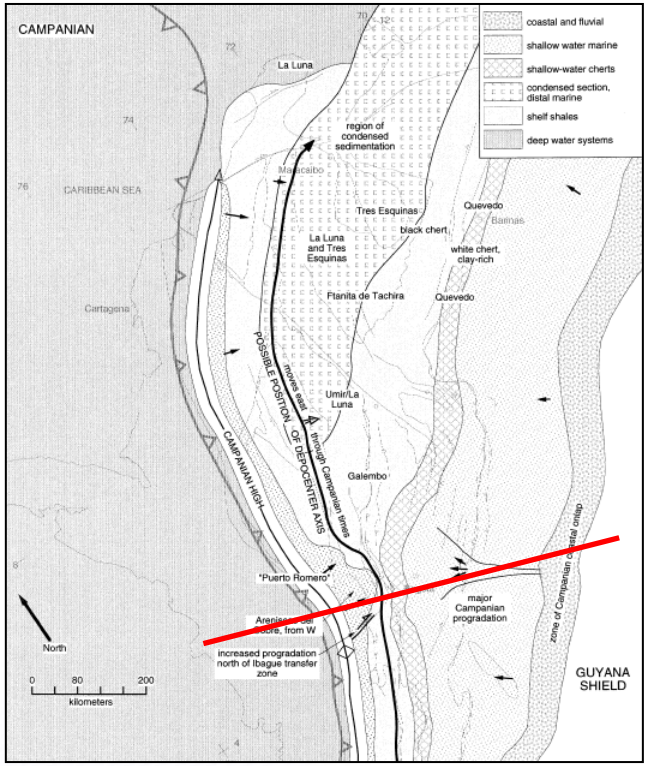
Middle Magdalena Valley Basin
Tectonic History





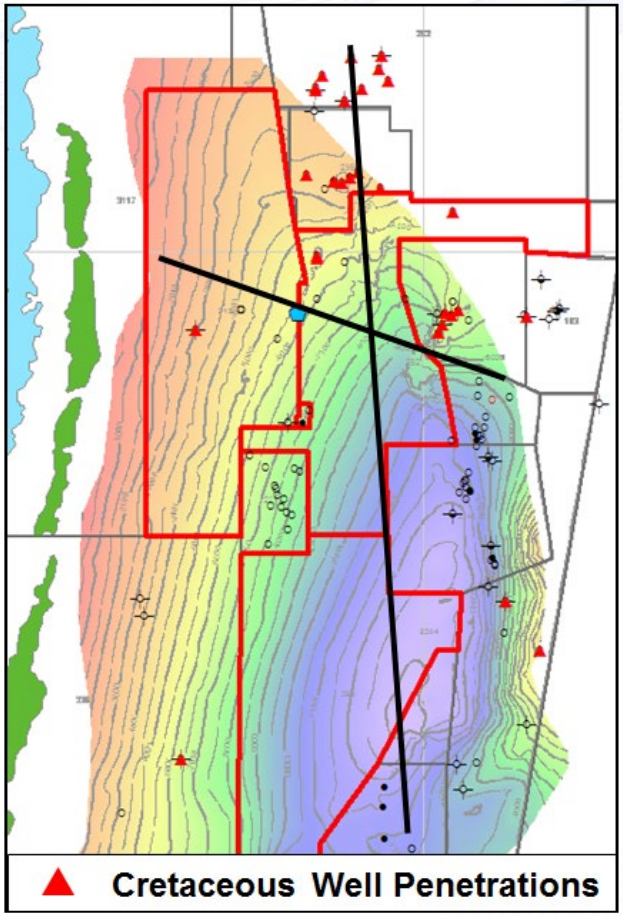


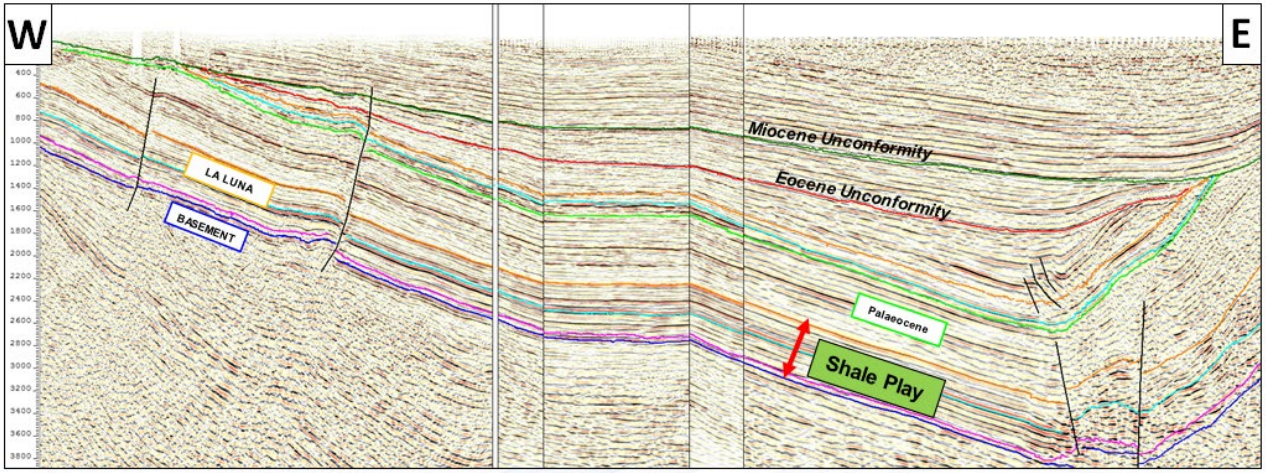
Villamil 1999.

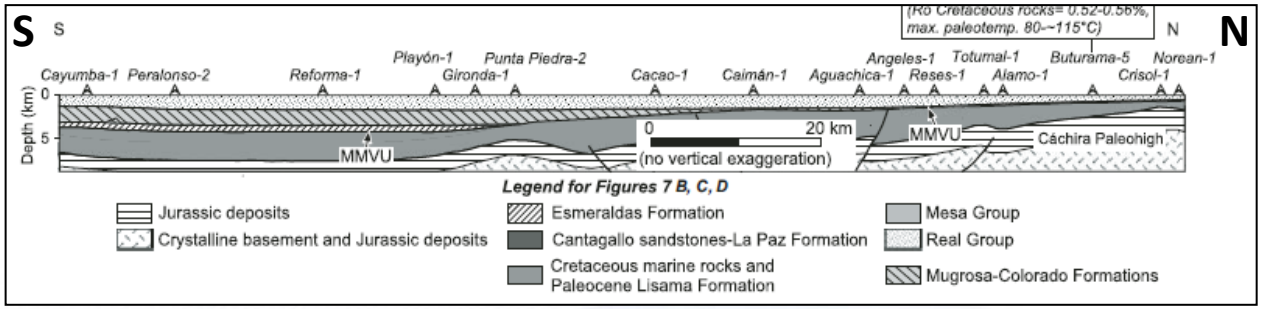


Villamil 1999.

Middle Magdalena Valley Basin
Present Day Structure

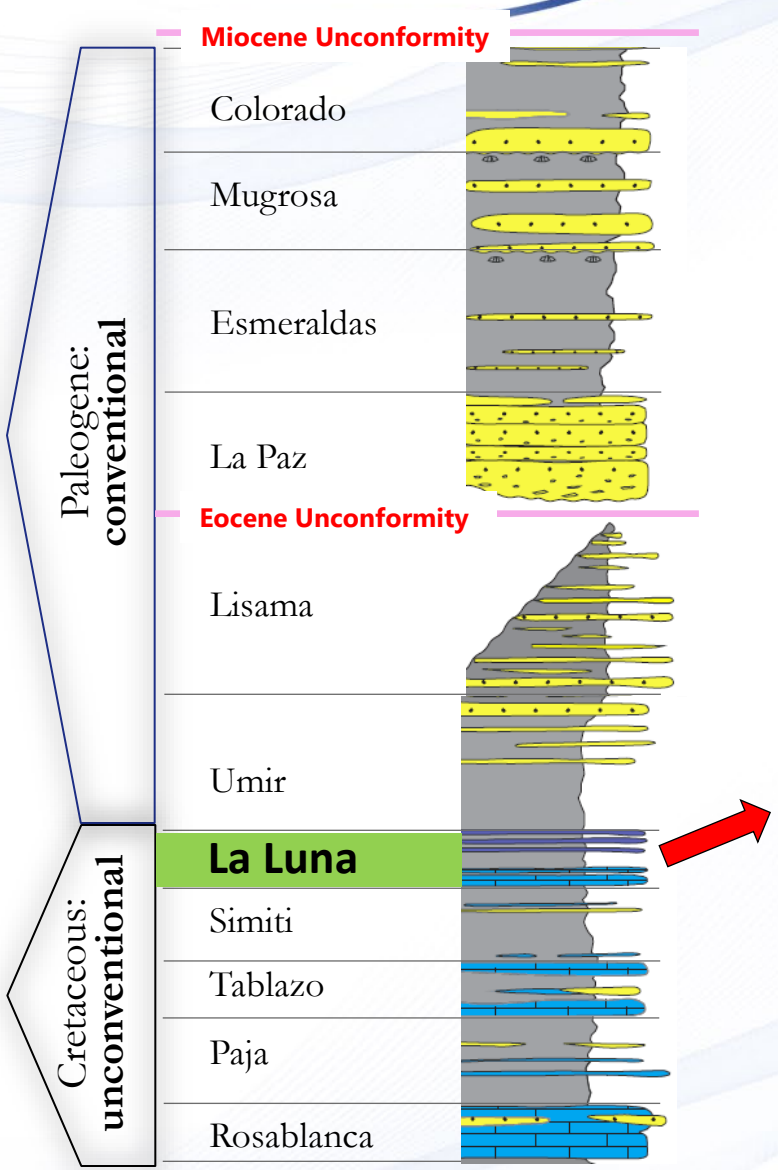


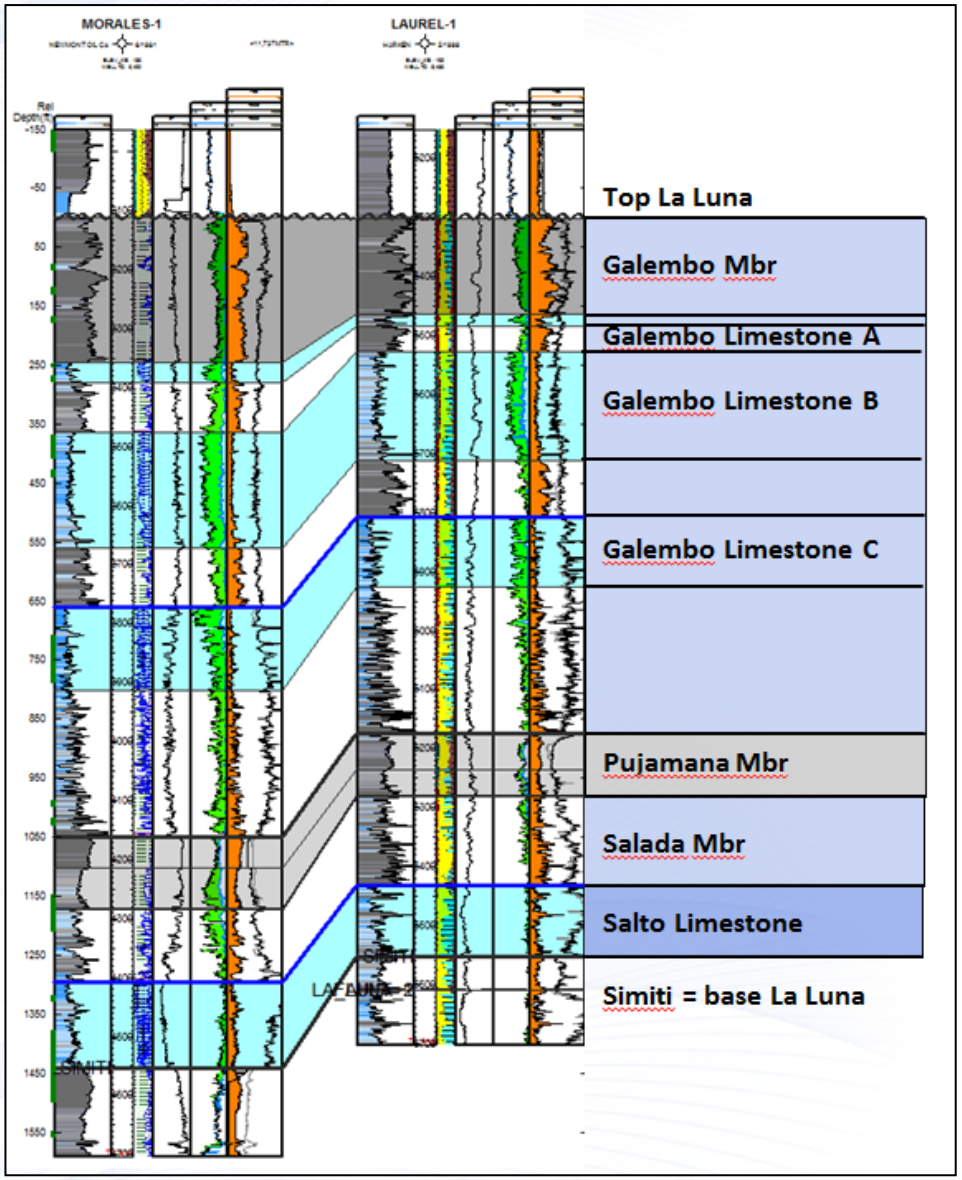




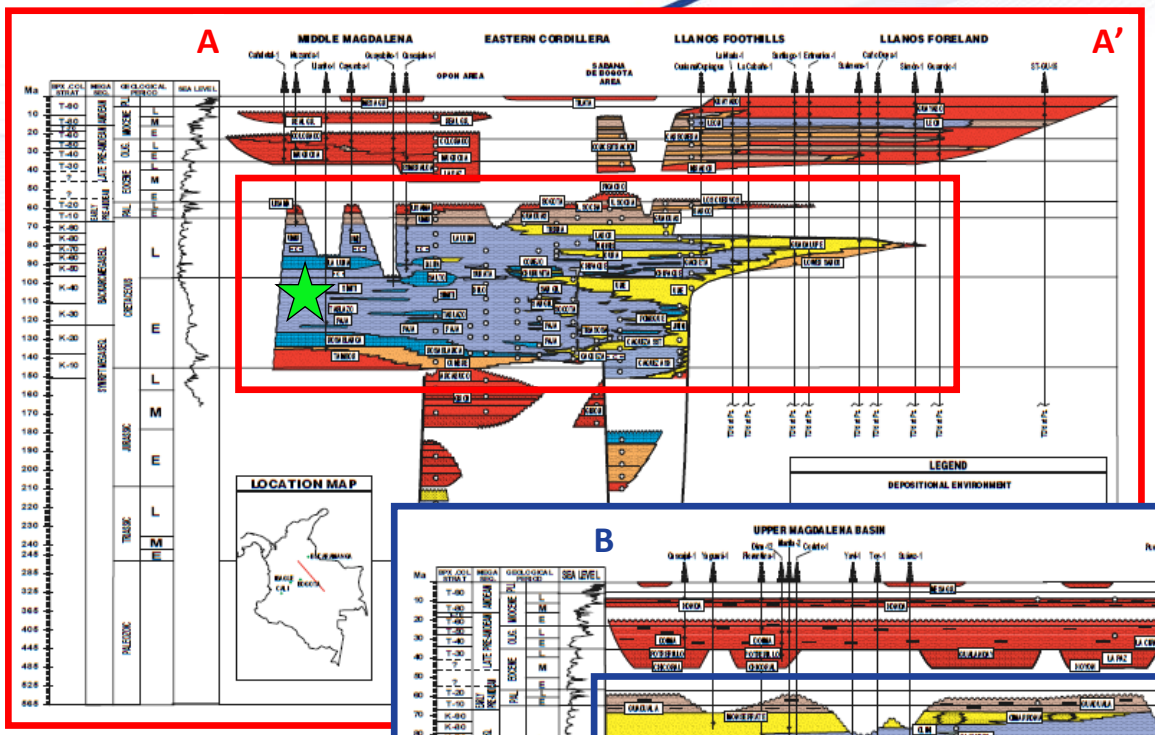
Gomez et al. (2012)

Middle Magdalena Valley Basin Stratigraphy

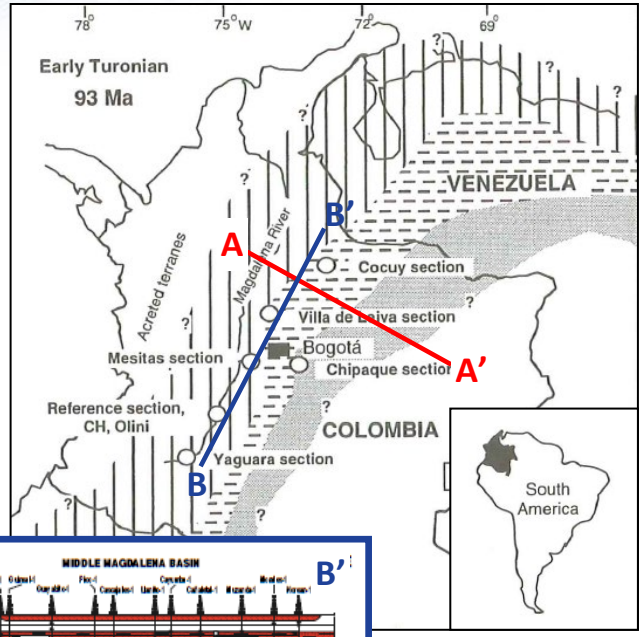




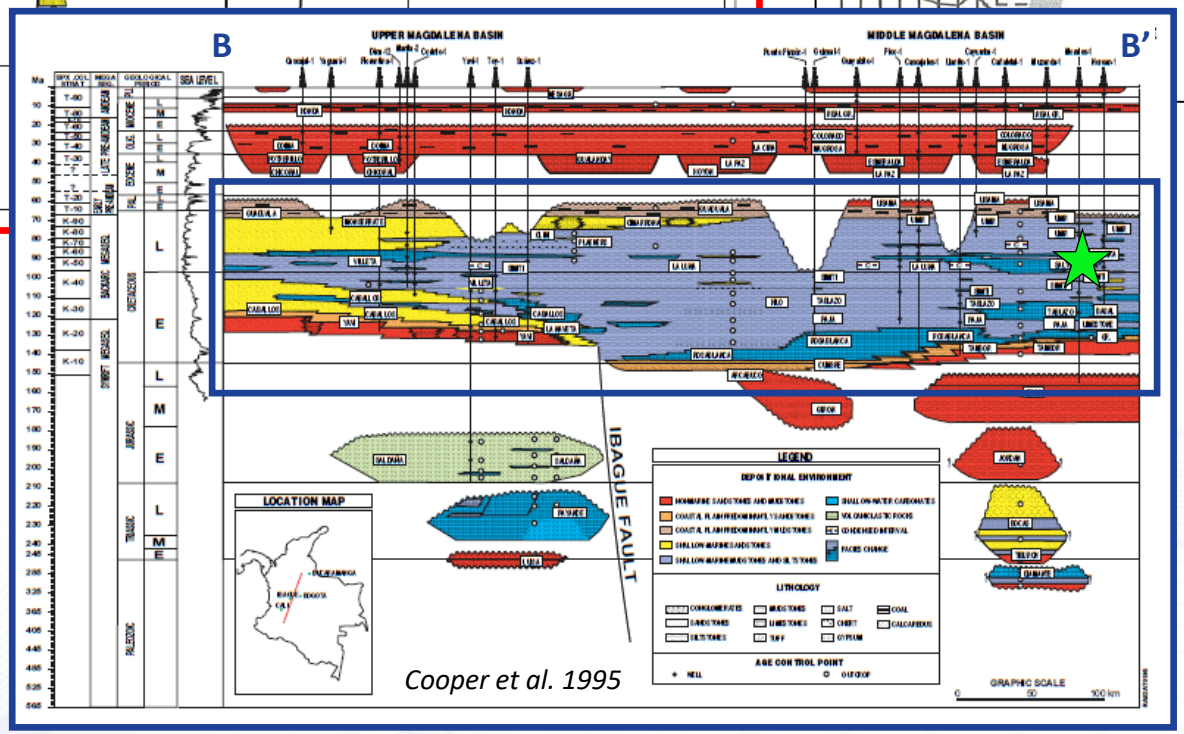
Middle Magdalena Basin
Stratigraphy & Palaeogeography



Cooper et al. 1995



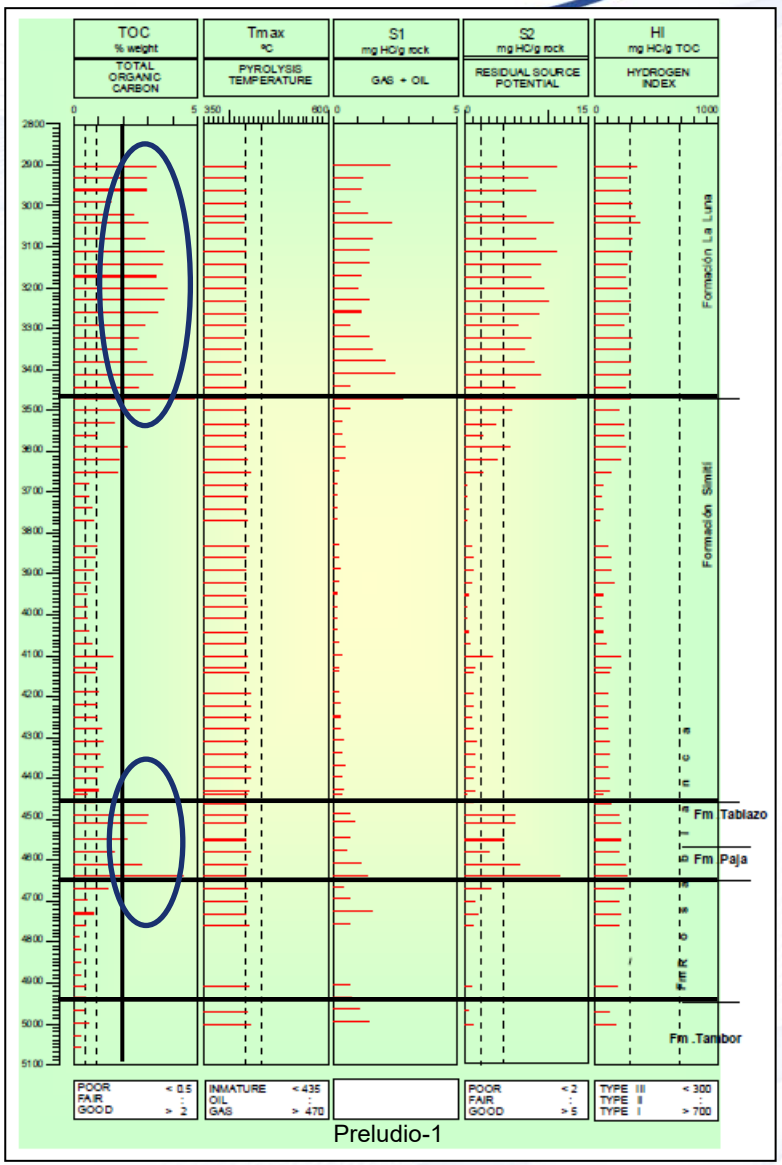
Villamil & Arango 1998.



Cooper et al. 1995

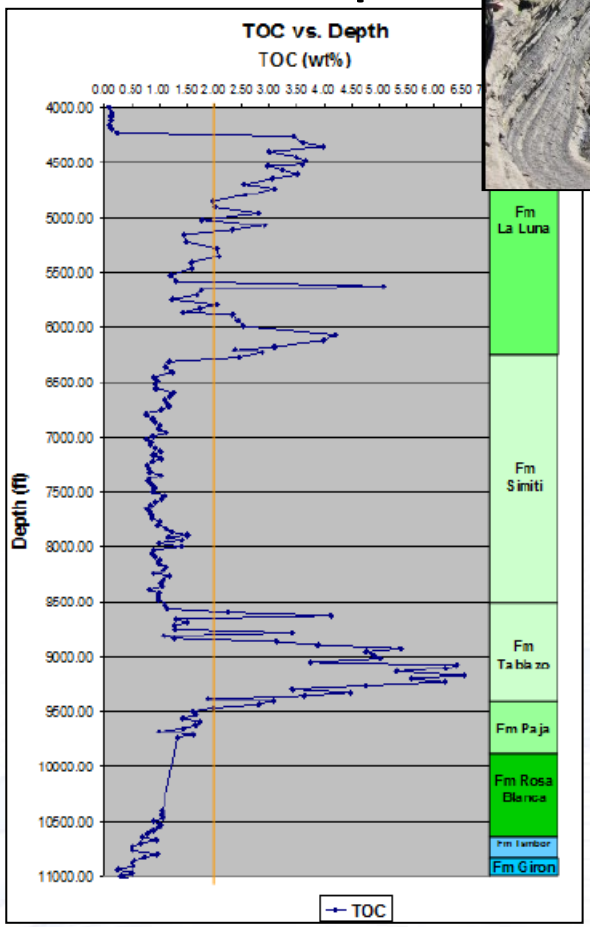
Middle Magdalena Valley Basin
Source Rock Quality

Subsurface



Preludio-1

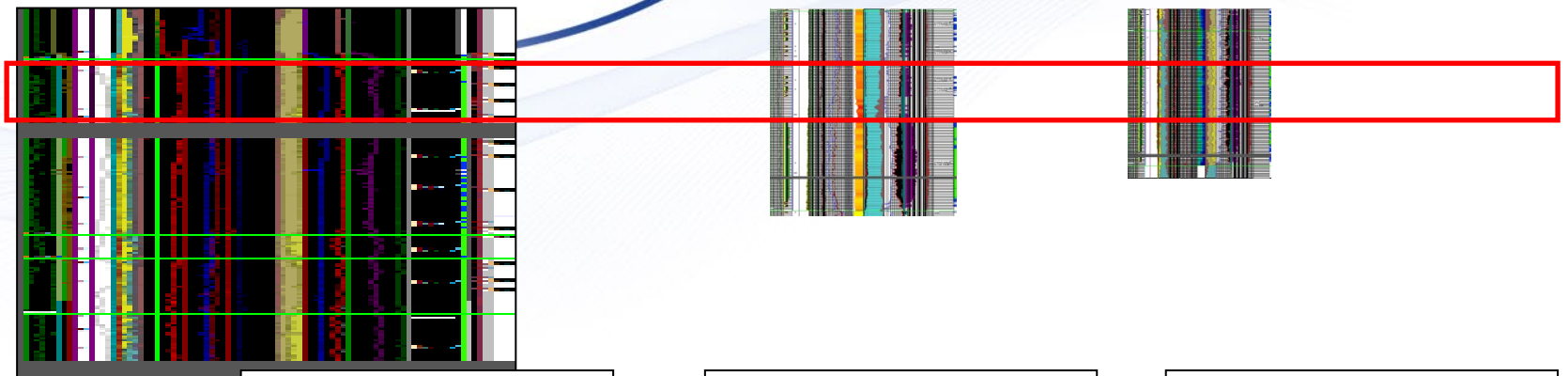
Outcrop





Torres et al. (2013)

Middle Magdalena Valley Basin
La Luna versus other Mesozoic Shale Plays



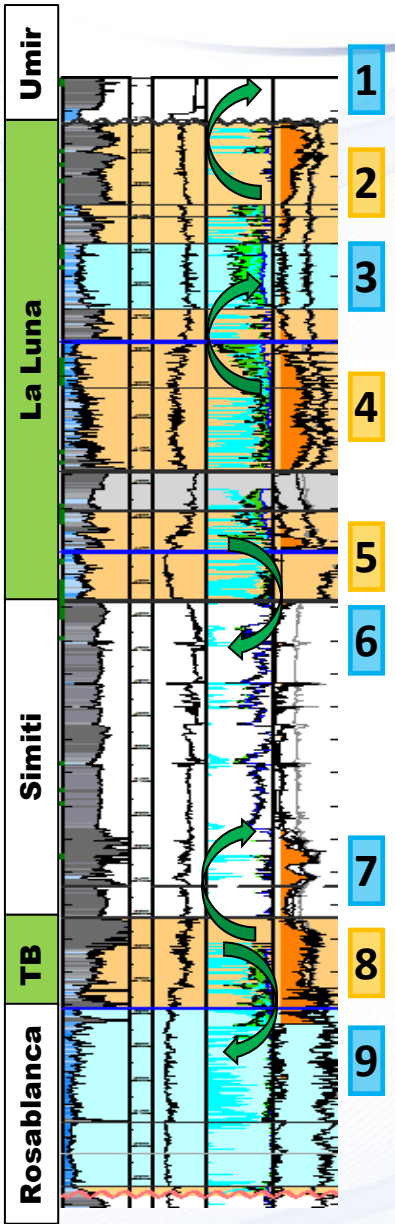
La Luna	
Thickness (Ft):	1500
Porosity (%):	13
Permeability (µD):	1.1
OIIP (MMbo/sec):	509

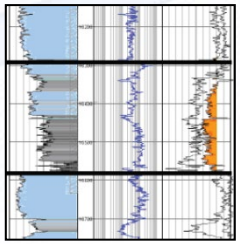
Eagle Ford	
Thickness (Ft):	100-400
Porosity (%):	6-11
Permeability (µD):	0.8-2
OIIP (MMbo/sec):	50

Haynesville	
Thickness (Ft):	200-300
Porosity (%):	8-10
Permeability (µD):	0.1-1
GIIP (BCF/sec):	125-250

Data Source: NuTech Unconventional Catalogue 2014

CANACOL ENERGY LTD.





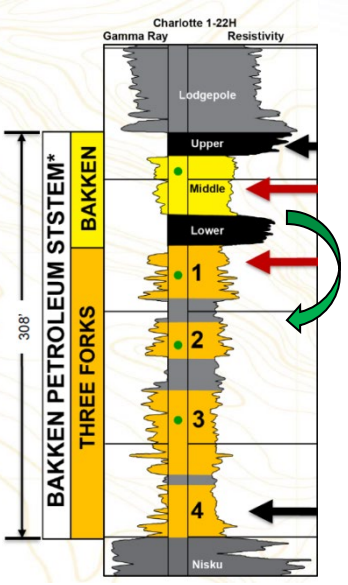
Eagle Ford at same scale as La Luna

Cretaceous Oil Plays

Middle Magdalena

4 **Within-source shale plays (La Luna, Tablazo)**

5 **Explusion tight oil plays (Umir, Simiti, Rosablanca)**

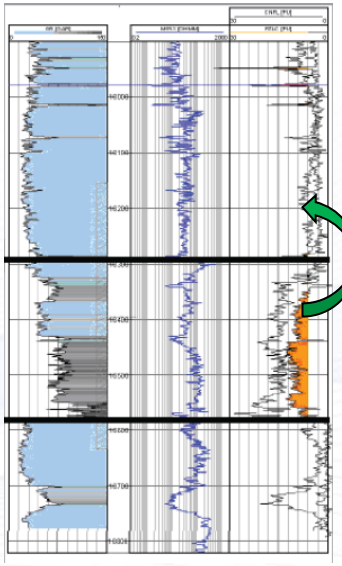


Bakken: 577 BB oiip

Expulsion

Three Forks: 326 BB

Continental Resources Nov 2013



Austin Chalk

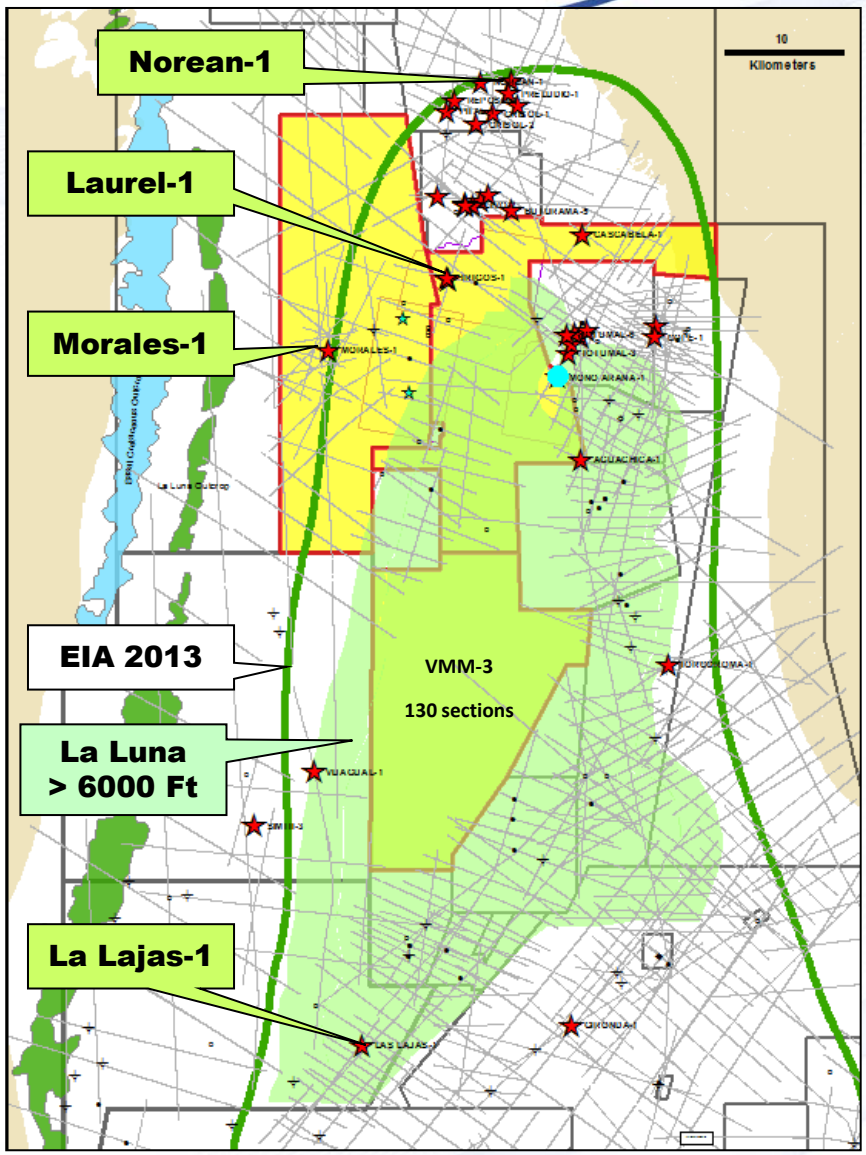
Expulsion

Eagle Ford

Buda Limestone

Nutech 2013

Middle Magdalena Valley Basin
Well & Seismic Database



LA LUNA

45 La Luna Well Penetrations (38 in public domain)

4 wells with sufficient modern logs over the whole La Luna:
Morales-1, Norean-1*, Las Lajas-1, Laurel-1

2 wells with geochemical calibration form cuttings:
Norean-1*, Morales-1

TABLAZO

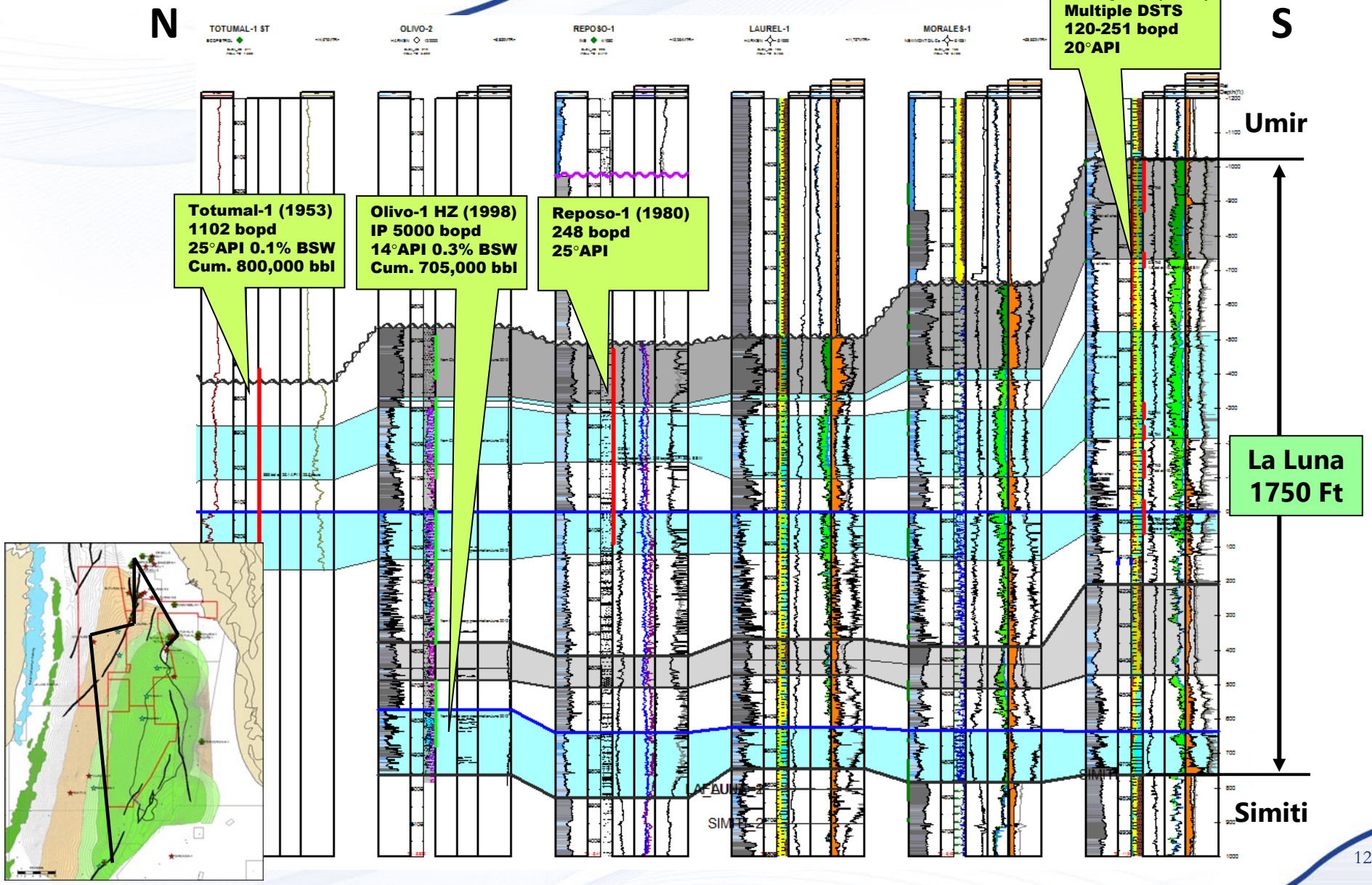
27 Tablazo well penetrations (25 public domain)

5 wells with sufficient modern logs over the whole Tablazo:
Morales-1, Norean-1*, Laurel-1, Bandera-1, Preludio-1

1 well with geochemical calibration form cuttings:
Morales-1

*Norean-1 is structurally thickened (drilled down a fold limb) and cannot be corrected to TST

MMV Unconventional
La Luna Fm.



MMV Unconventional Tablazo Fm.

CANACOL ENERGY LTD.

Buturama-2 (1953)
Tablazo/Rosablanca
1418 bopd
37°API

Catalina-1 (1997)
Tablazo Shale
533 bopd
38°API

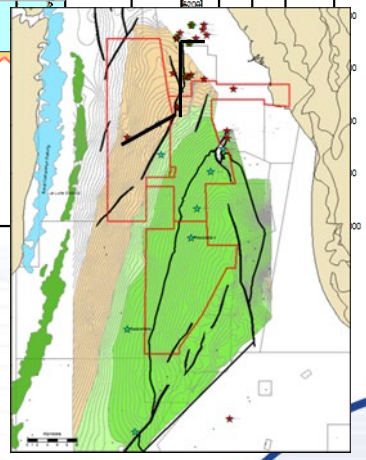
Norean-1 (1981)
Tablazo Shale
5 DSTs
5.7 bbl oil
27°API

Catalina-1 HZ
Rosablanca
7500 bopd
38°API
Cum. 613,000 bbl

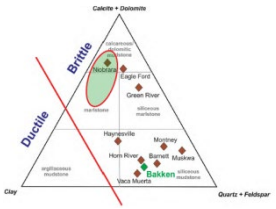
Simiti

Tablazo

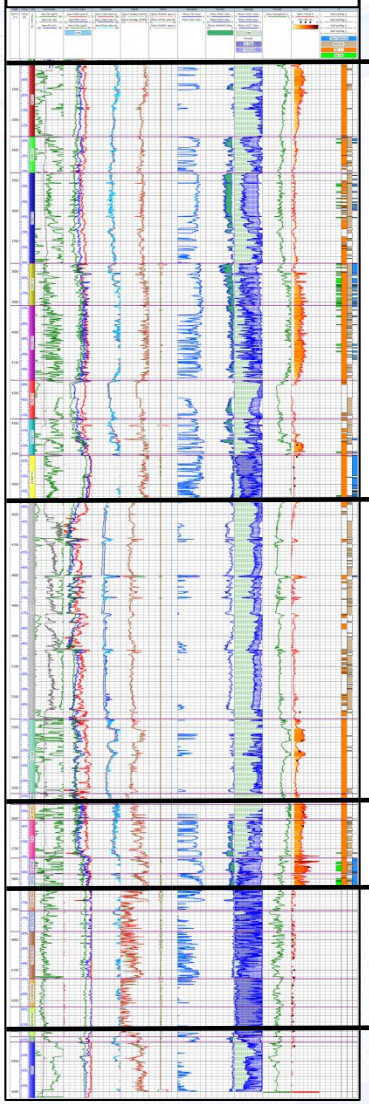
Rosa-Blanca



MMV Unconventional Scoping Pay Summary



Morales-1



ClnRck Summary V*shale* < 30%

Zn #	Zone Name	Top	Bottom	Gross	Net	N/G	Av Phi	Av Vcl Ari	Av Toc Ari
1	LA_LUNA	3112.50	4554.00	1441.50	309.50	0.215	0.093	0.179	1.849
2	SIMITI	4554.50	5518.50	964.00	4.50	0.005	0.026	0.193	3.167
3	TABLAZO	5518.50	5828.50	310.00	91.75	0.296	0.072	0.152	4.480

Reserv5 Summary Porosity > 5%

Zn #	Zone Name	Top	Bottom	Gross	Net	N/G	Av Phi	Av Vcl Ari	Av Toc Ari
1	LA_LUNA	3112.50	4554.00	1441.50	711.00	0.493	0.122	0.401	1.936
2	SIMITI	4554.50	5518.50	964.00	454.50	0.471	0.094	0.646	0.618
3	TABLAZO	5518.50	5828.50	310.00	145.25	0.469	0.097	0.370	4.144

TOC Summary TOC > 1%

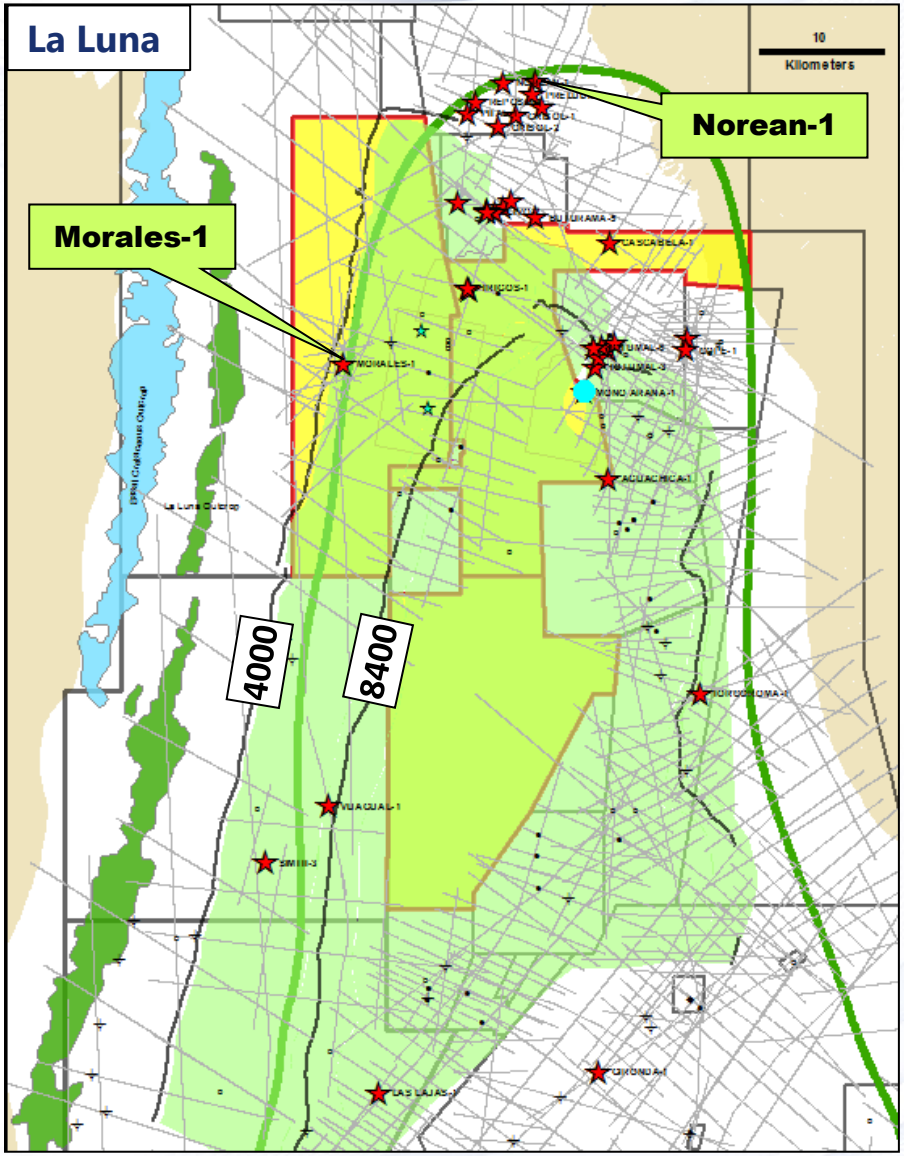
Zn #	Zone Name	Top	Bottom	Gross	Net	N/G	Av Phi	Av Vcl Ari	Av Toc Ari
1	LA_LUNA	3112.50	4554.00	1441.50	1136.00	0.788	0.059	0.534	2.460
2	SIMITI	4554.50	5518.50	964.00	415.00	0.430	0.033	0.760	2.115
3	TABLAZO	5518.50	5828.50	310.00	302.25	0.975	0.055	0.574	3.993

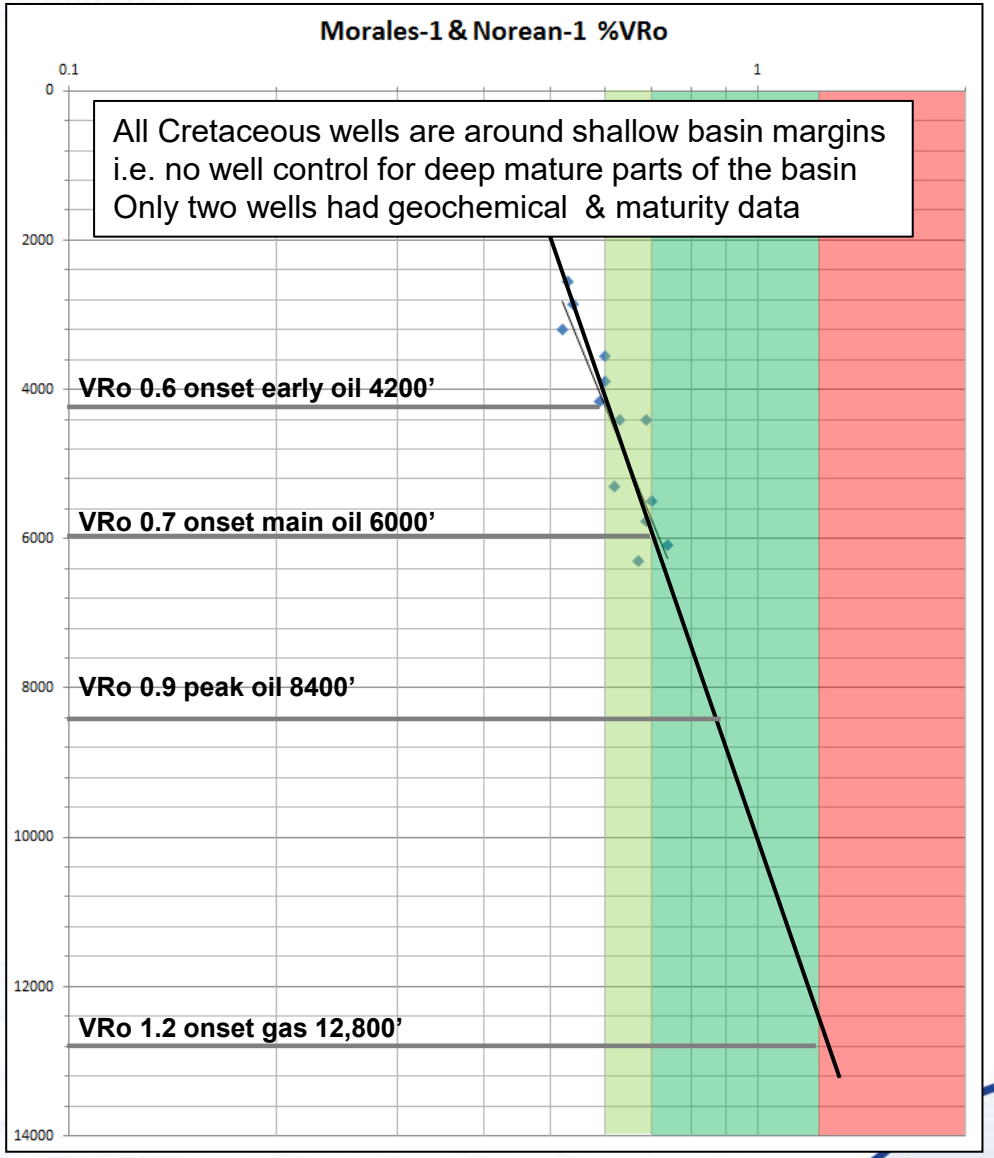
Pay Summary V*shale* < 30% + Porosity > 5% + TOC > 1%

Zn #	Zone Name	Top	Bottom	Gross	Net	N/G	Av Phi	Av Vcl Ari	Av Toc Ari
1	LA_LUNA	3112.50	4554.00	1441.50	127.00	0.088	0.126	0.198	2.762
2	SIMITI	4554.50	5518.50	964.00	0.00	0.000	---	---	---
3	TABLAZO	5518.50	5828.50	310.00	56.25	0.181	0.090	0.151	4.831

Even in the most pessimistic case with all cutoffs applied, we still see 183 Ft of net pay

MMV Unconventional
La Luna Maturity

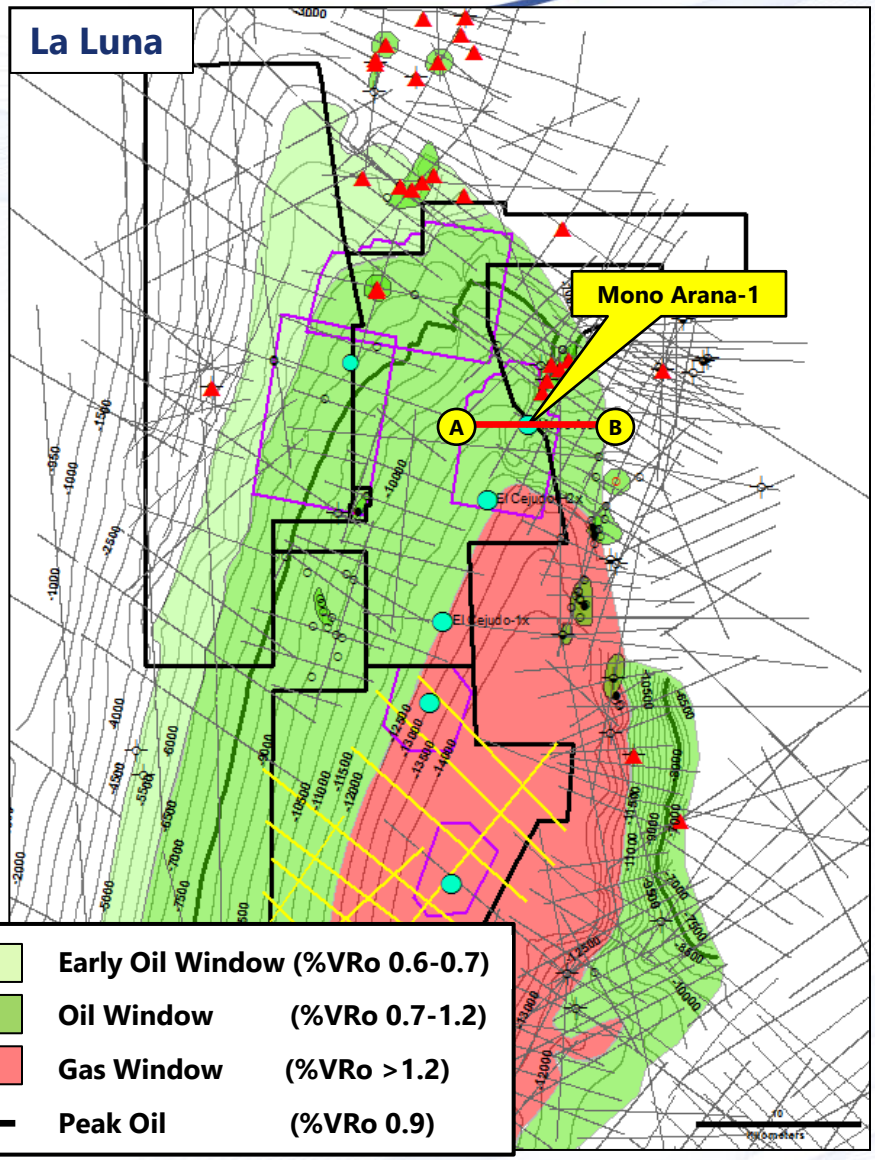


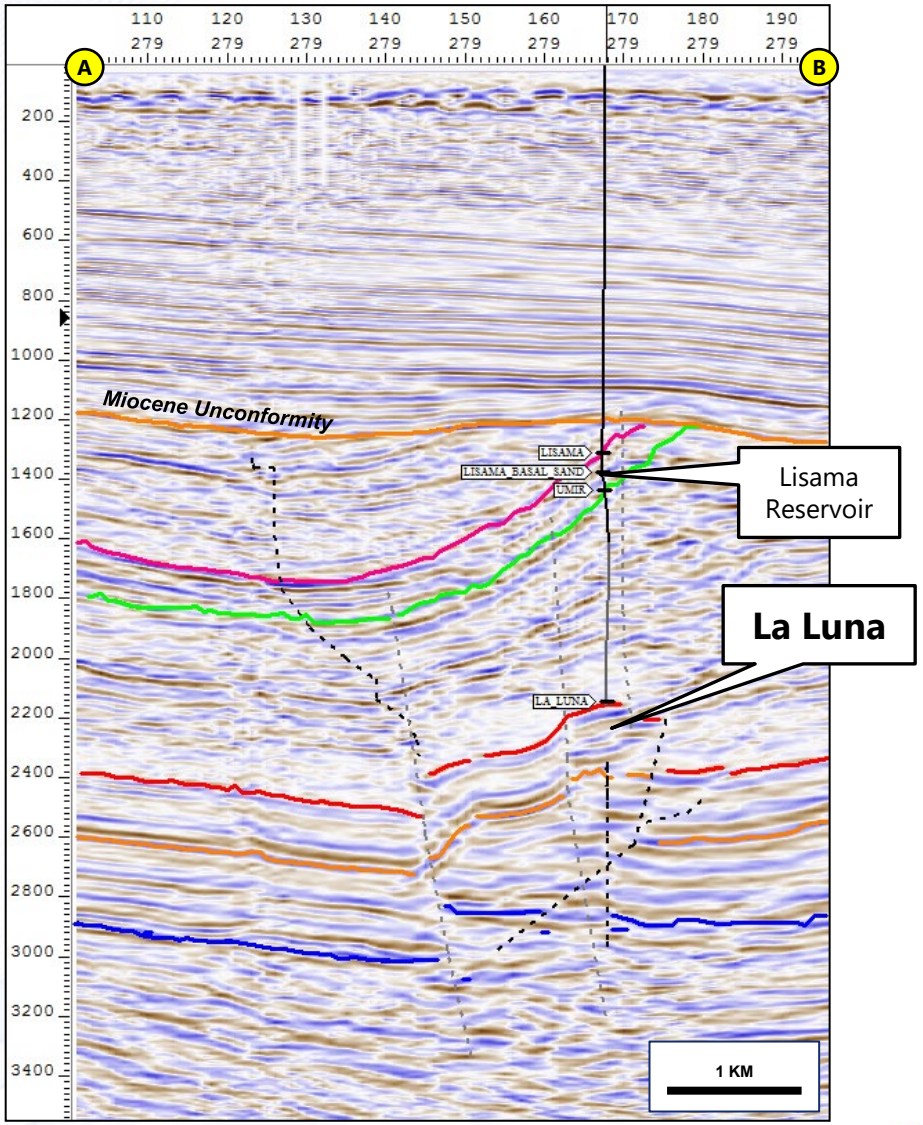


MMV Unconventional
Scoping UPIIP Volumes (MMbbl)

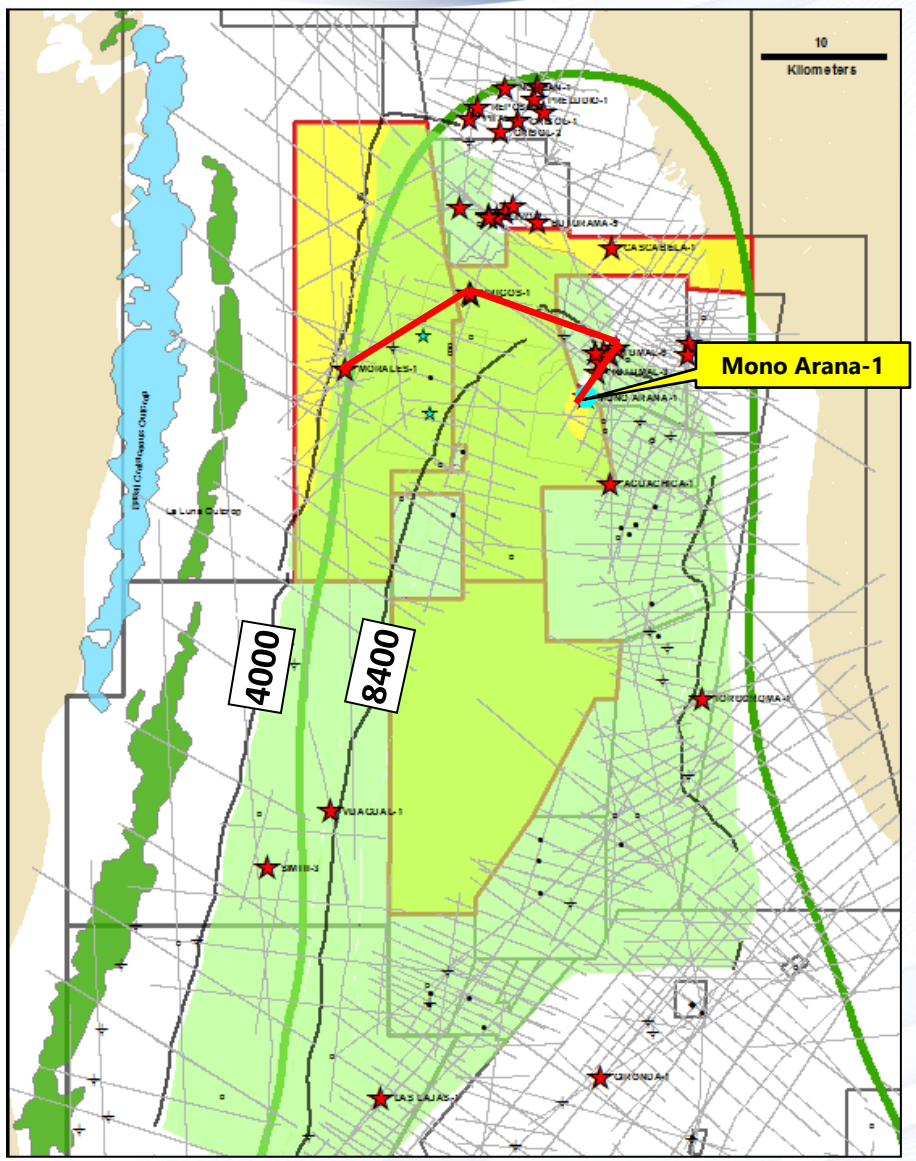
Block WI		Gross p90	Gross p50	Gross p10	Net p90	Net p50	Net p10
Santa Isabel	La Luna	126	1,099	9,549	38	330	2,865
0.3	Tablazo	1,030	2,464	5,894	309	739	1,768
	Total	**1,156**	**3,563**	**15,443**	**347**	**1,069**	**4,633**
VMM2	La Luna	1,425	4,229	12,548	285	846	2,510
0.2	Tablazo	678	1,480	3,229	136	296	646
	Total	**2,103**	**5,709**	**15,777**	**421**	**1,142**	**3,155**
VMM3	La Luna	981	3,270	10,893	196	654	2,179
0.2	Tablazo	51	224	987	10	45	197
	Total	**1,032**	**3,494**	**11,880**	**206**	**699**	**2,376**
				TOTALS	**974**	**2,910**	**10,164**

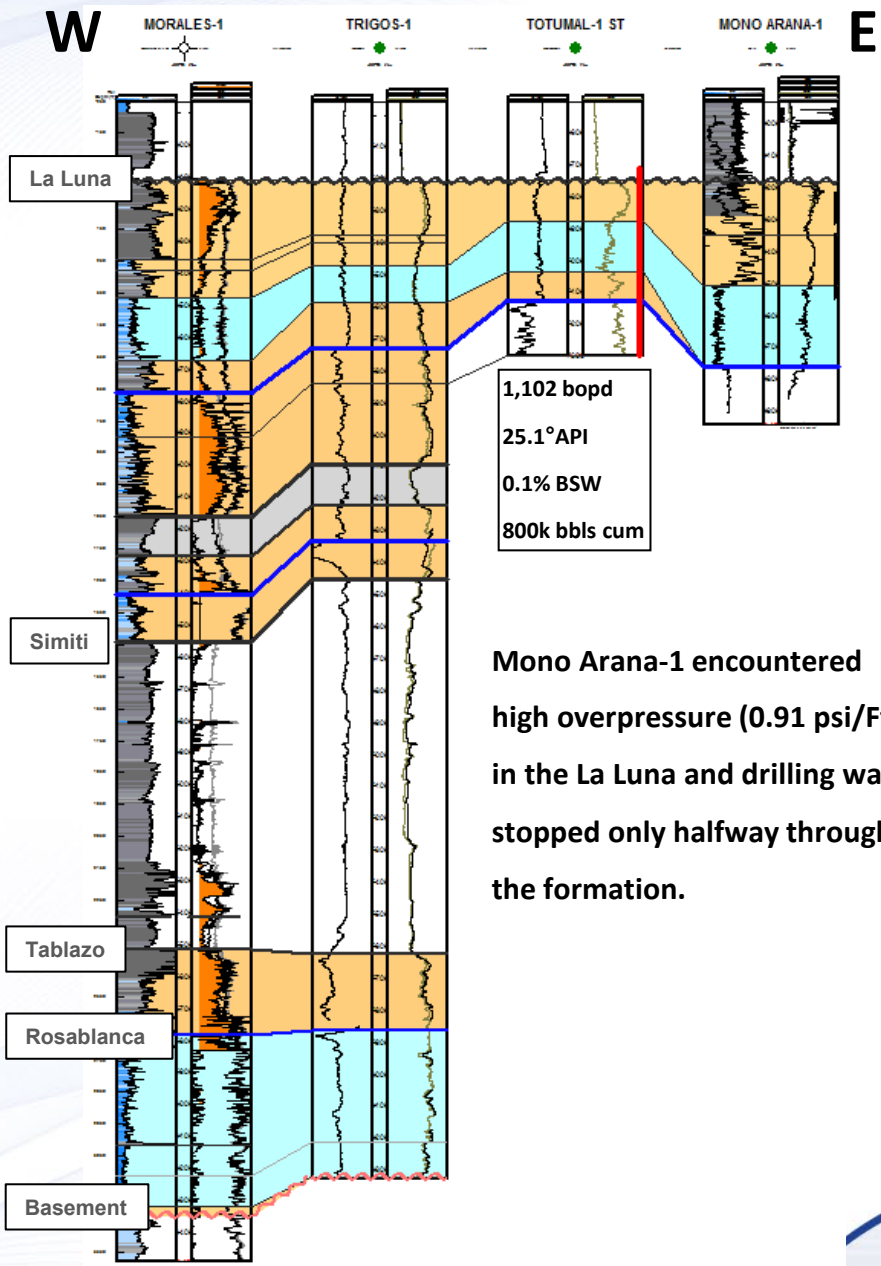
MMV Unconventional
Mono Arana-1 Well



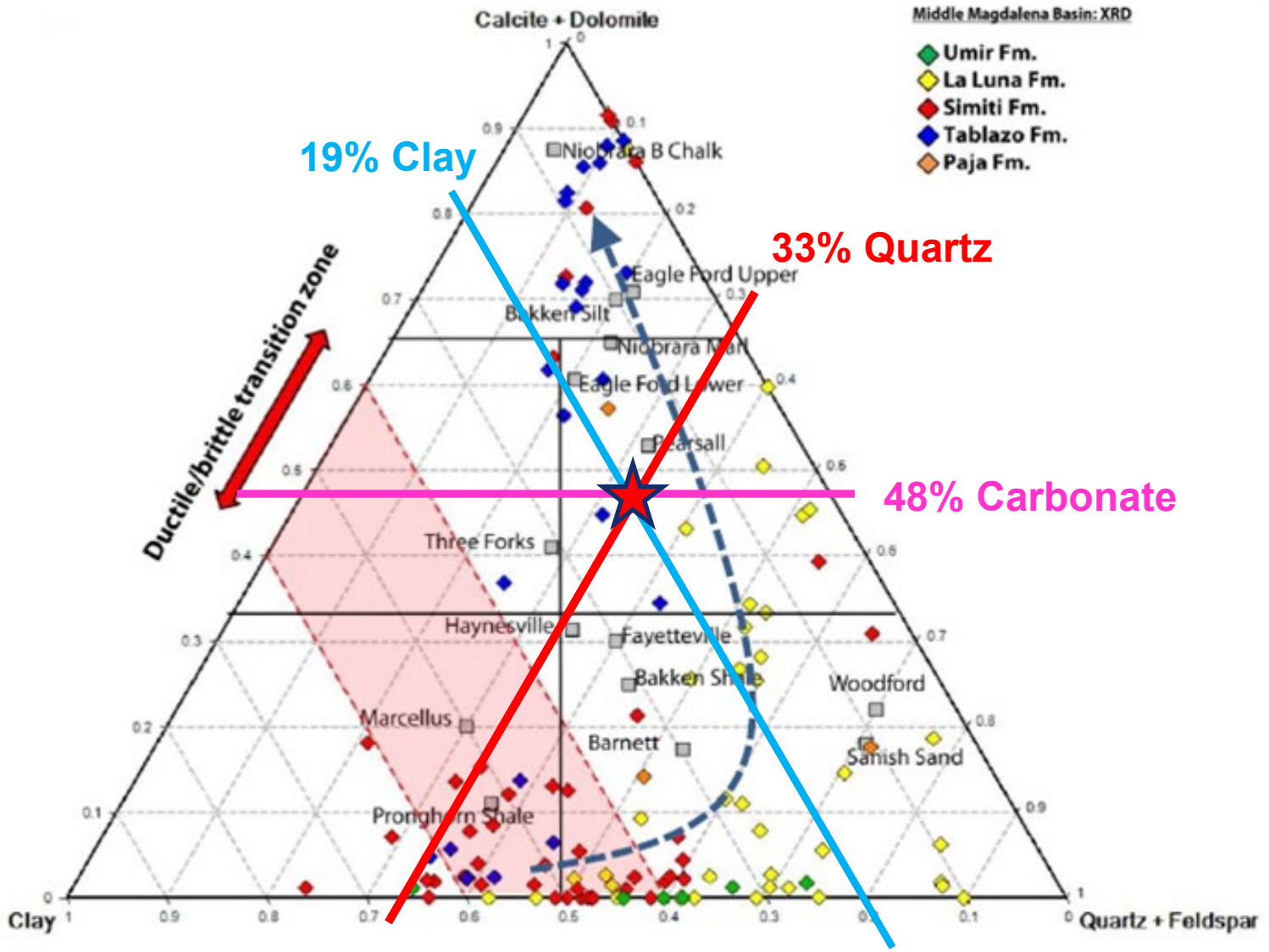


MMV Unconventional
Mono Arana-1 Well



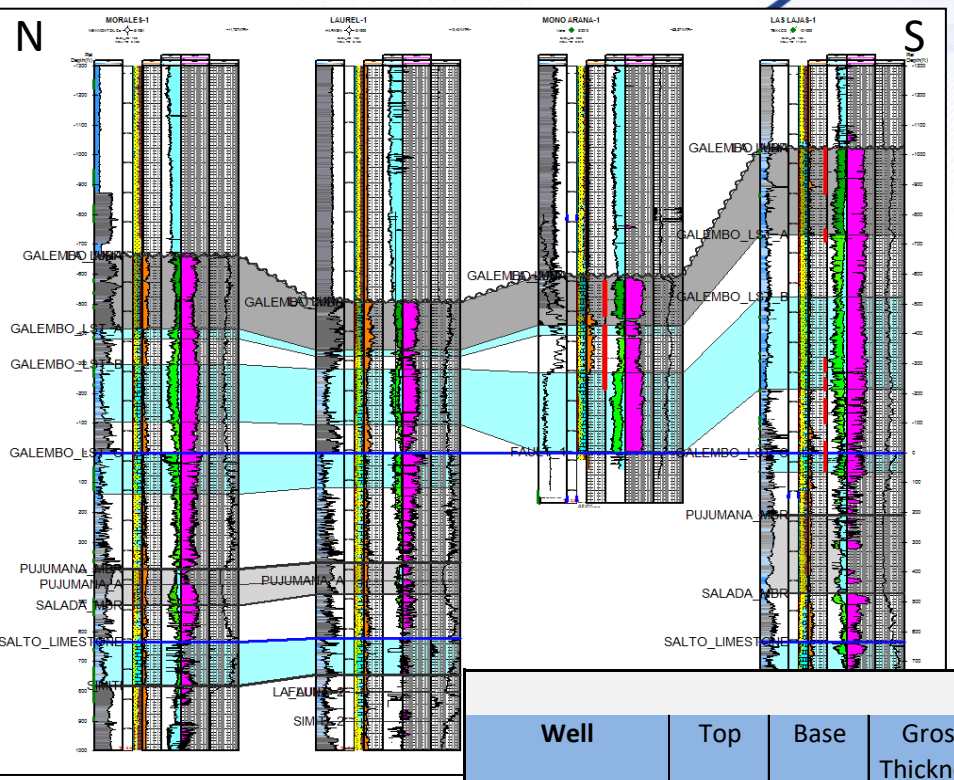


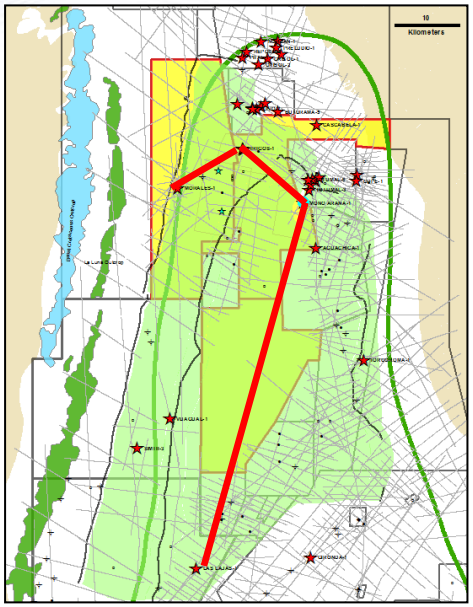
Mono Arana-1 encountered high overpressure (0.91 psi/Ft) in the La Luna and drilling was stopped only halfway through the formation.



Background Plot: ANH Ronda 2014 Brochure

MMV Unconventional
La Luna Petrophysics

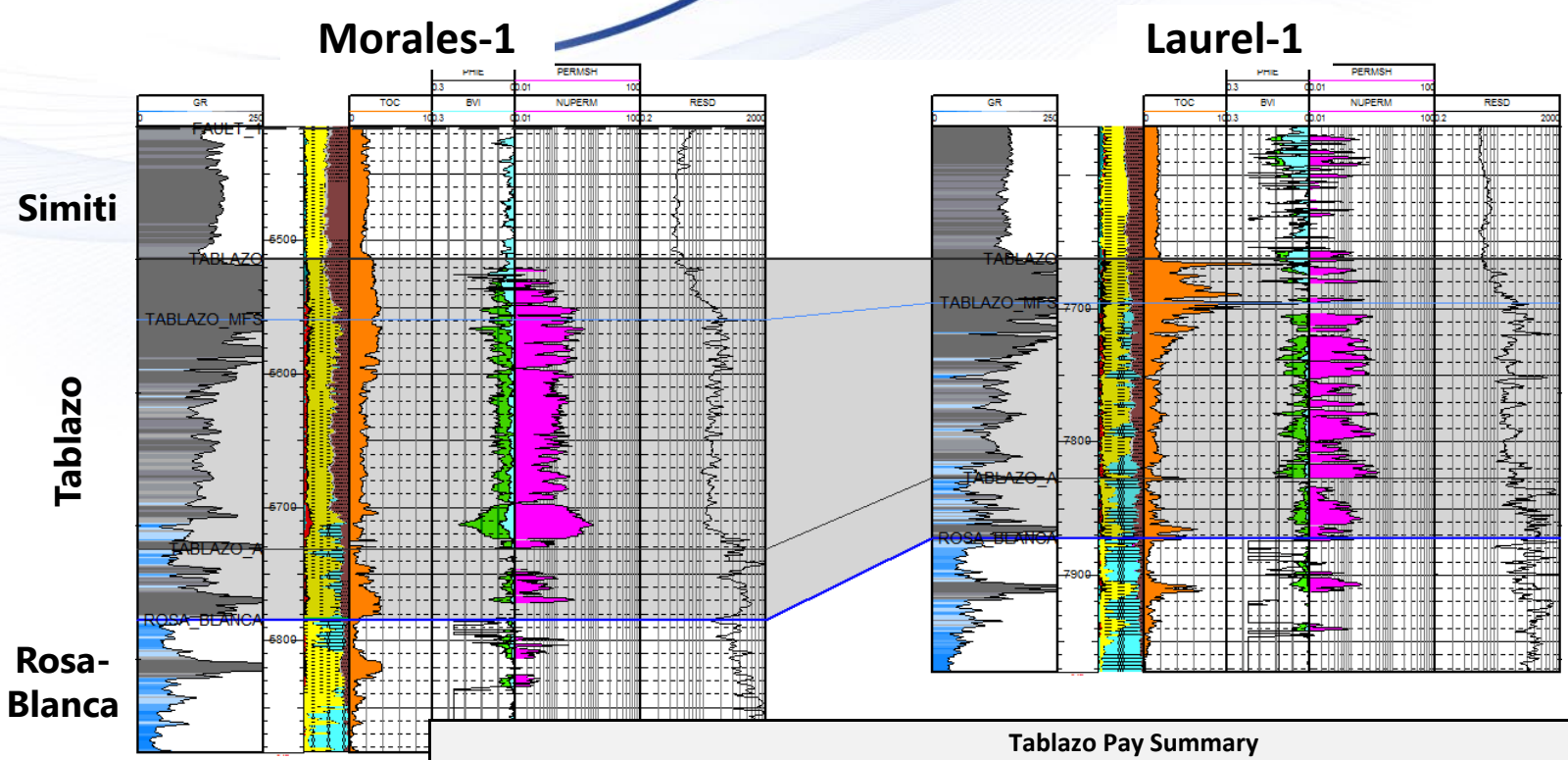


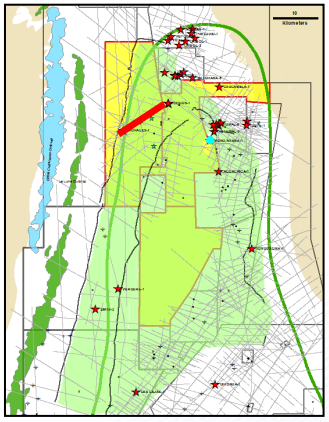


La Luna Pay Summary

Well	Top Ft MD	Base Ft MD	Gross Thickness Ft	Net Pay Ft	N:G dec	Average PHIE dec	Average Vclay dec	Average Sw dec	Perm K mD	Average TOC %	OIP MMBO/Mi2
Tier 1 Wells											
Las Lajas-1	8947	10733	1786	1387	0.78	0.14	0.18	0.38	0.00164	1.21	653
Mono Arana-1*	9180	9774	594	567	0.95	0.16	0.18	0.27	0.00191	1.30	259
Tier 2 Wells											
Laurel-1	5301	6552	1251	950	0.76	0.08	0.19	0.36	0.00084	2.09	398
Morales-1	3111	4554	1443	1274	0.88	0.12	0.25	0.24	0.00012	1.54	477

MMV Unconventional Tablazo Petrophysics



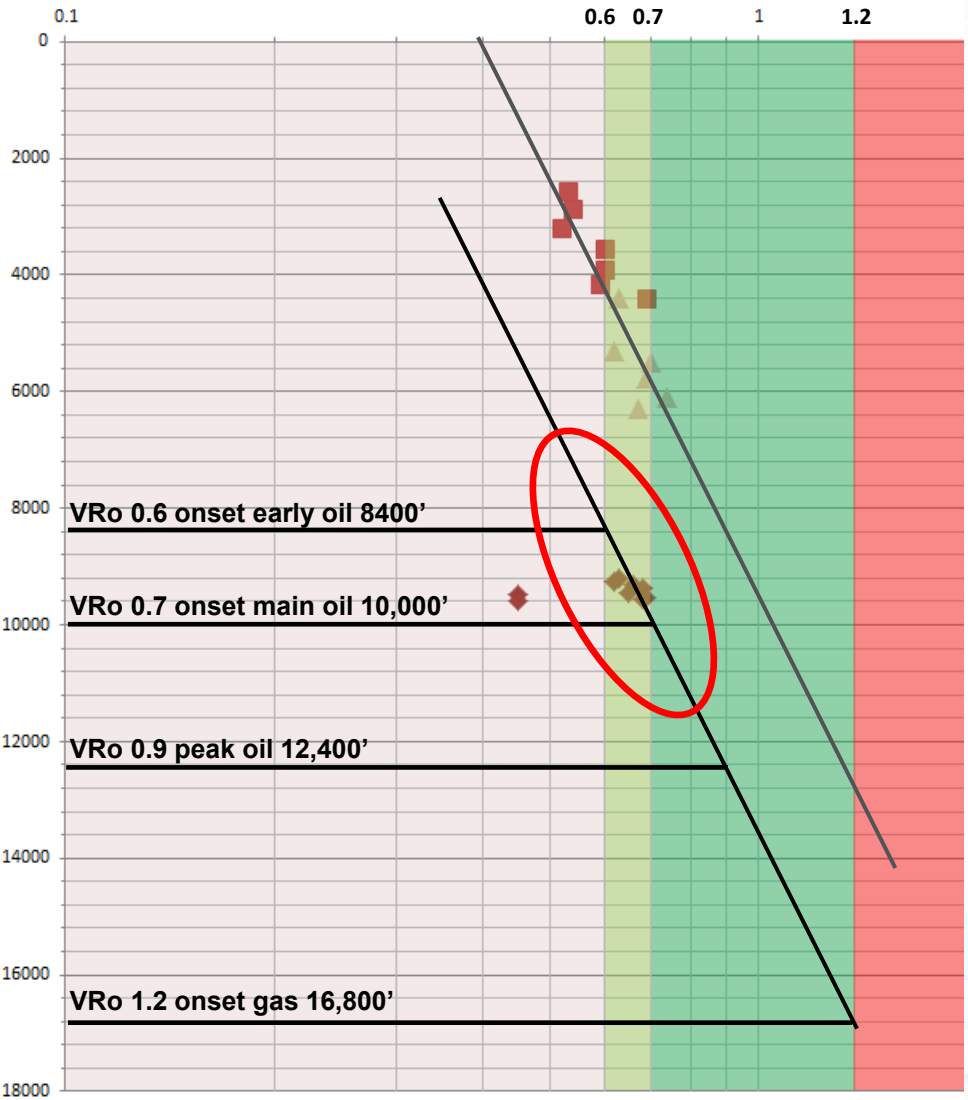


Tablazo Pay Summary

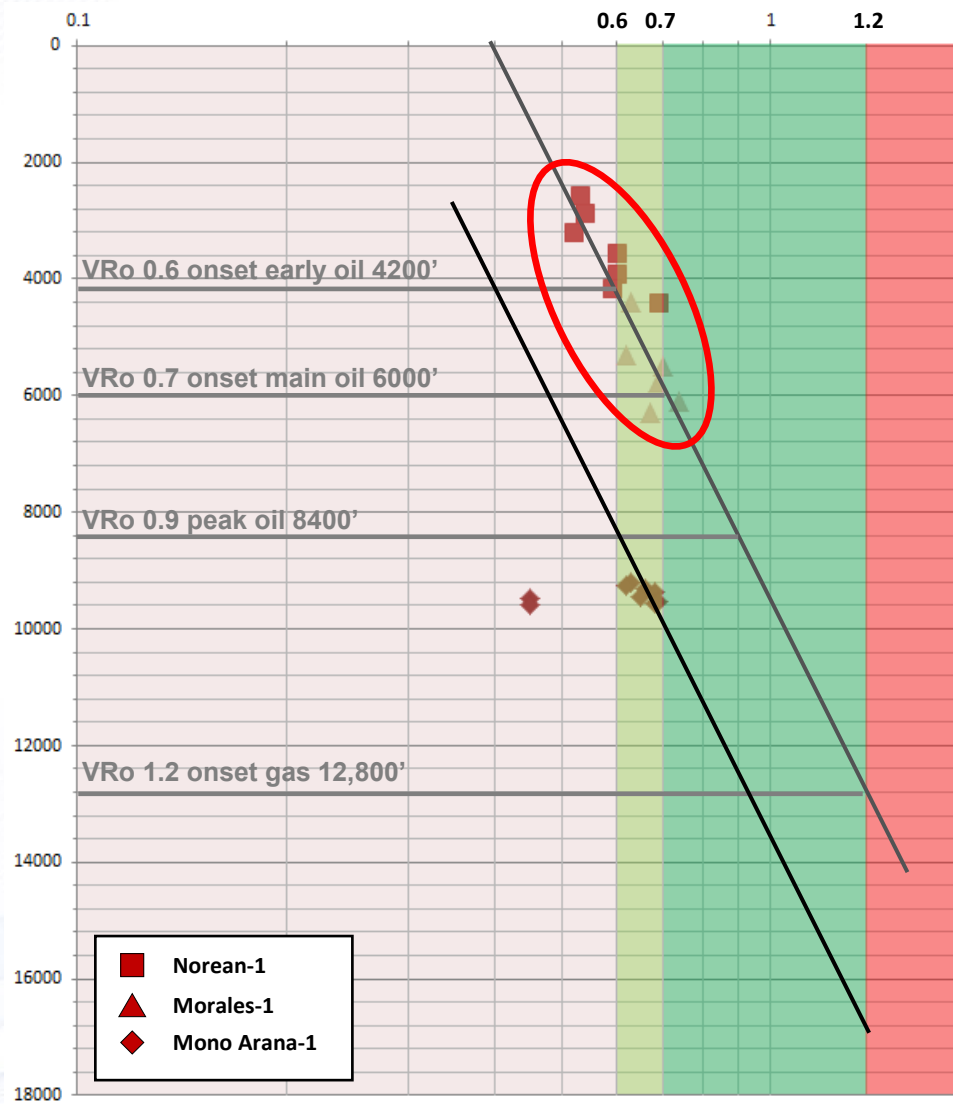
Well	Top Ft MD	Base Ft MD	Gross Thickness Ft	Net Pay Ft	N:G dec	Average PHIE dec	Average Vclay dec	Average Sw dec	Perm K mD	Average TOC %	OIP MMBO/Mi2
Tier 1 Wells											
Tier 2 Wells											
Laurel-1	7663	7874	211	125	0.59	0.05	0.23	0.43	0.00022	3.03	34
Morales-1	5514	5784	270	194	0.72	0.06	0.29	0.43	0.00029	2.24	42

MMV Unconventional Source Rock Maturity

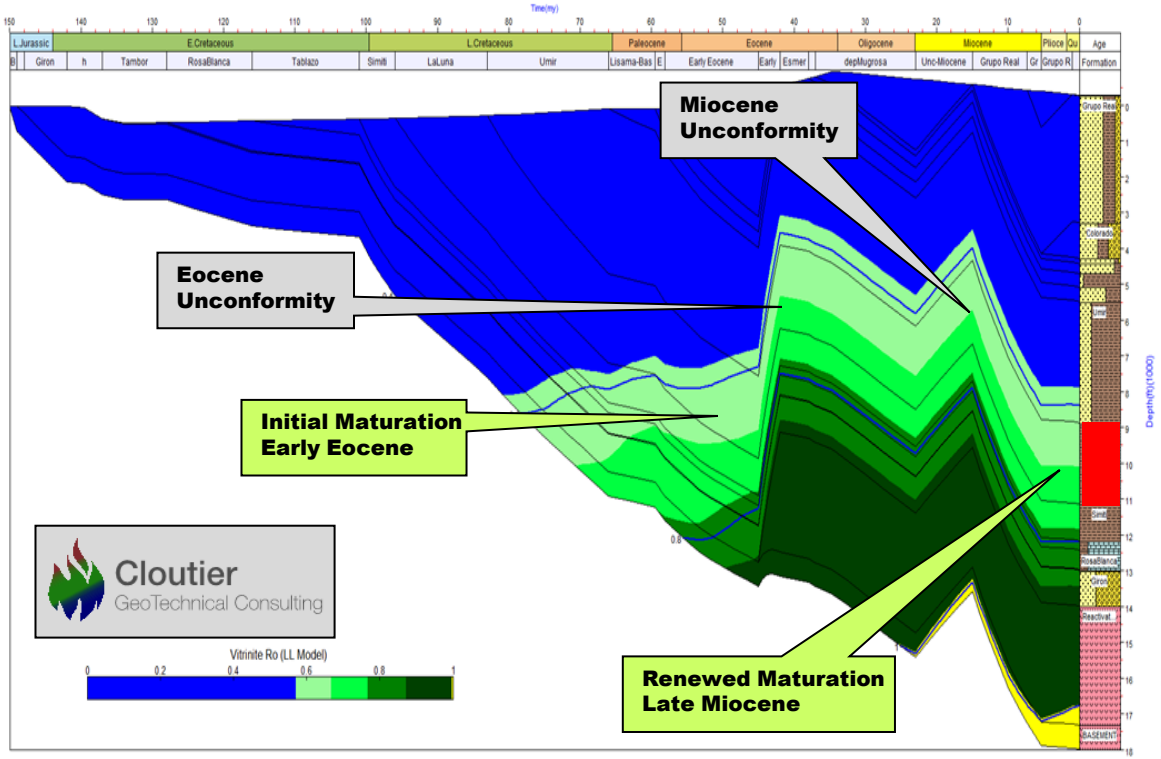
Tier 1: Present maturity / Overpressured

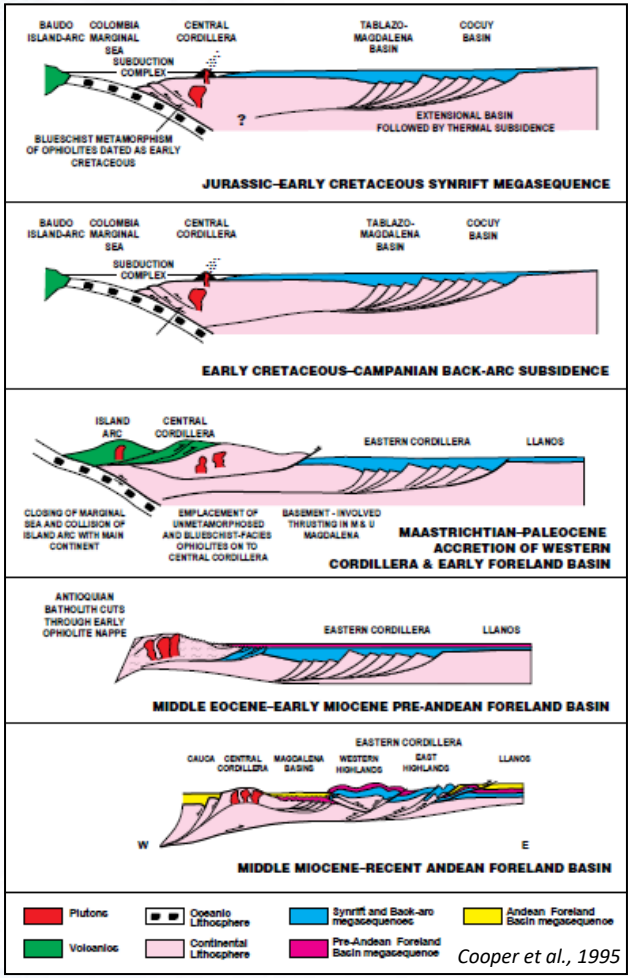


Tier 2: Palaeomaturity / Normally Pressured



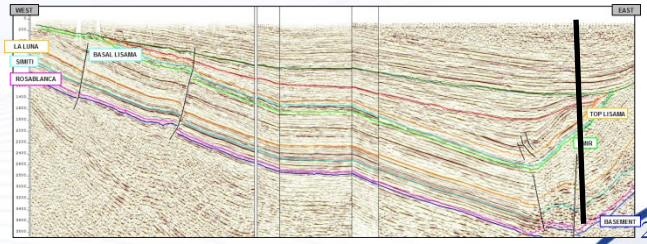
MMV Unconventional Burial History



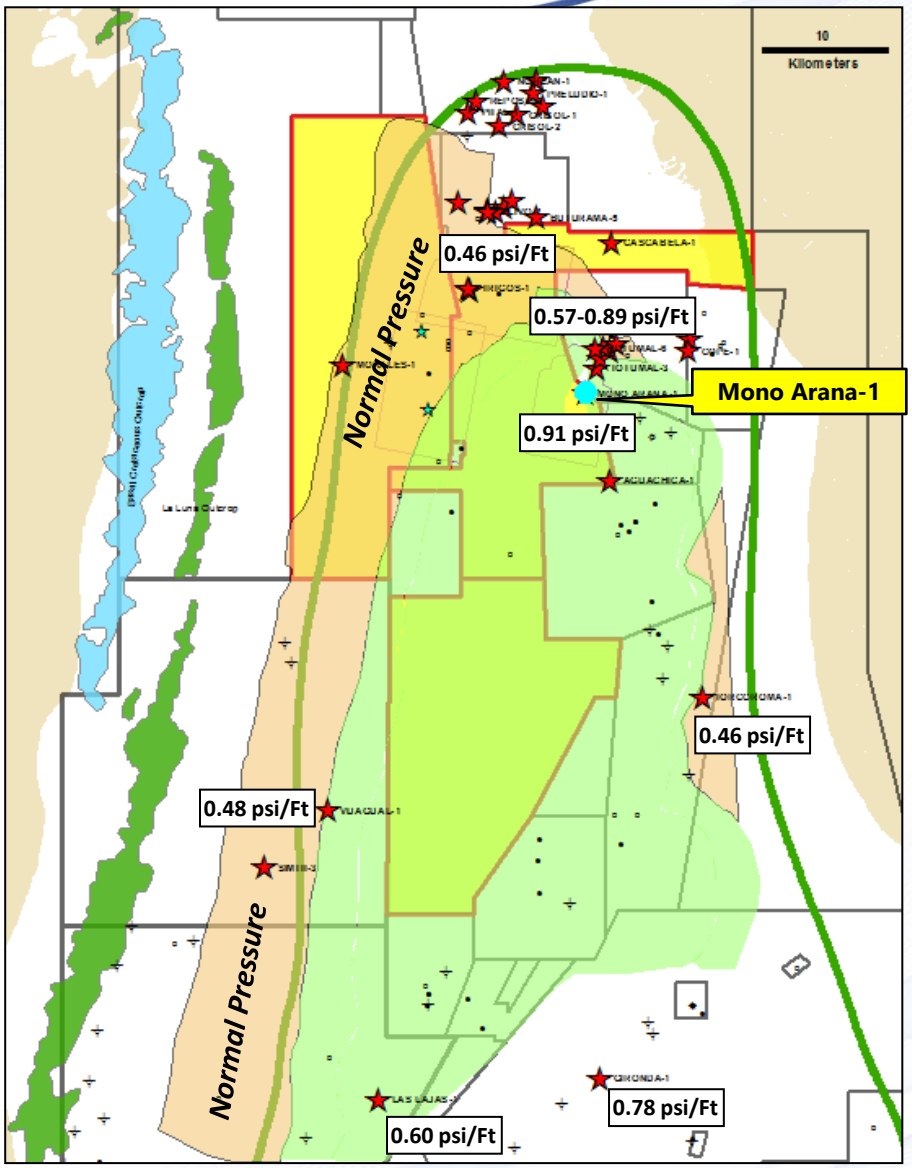


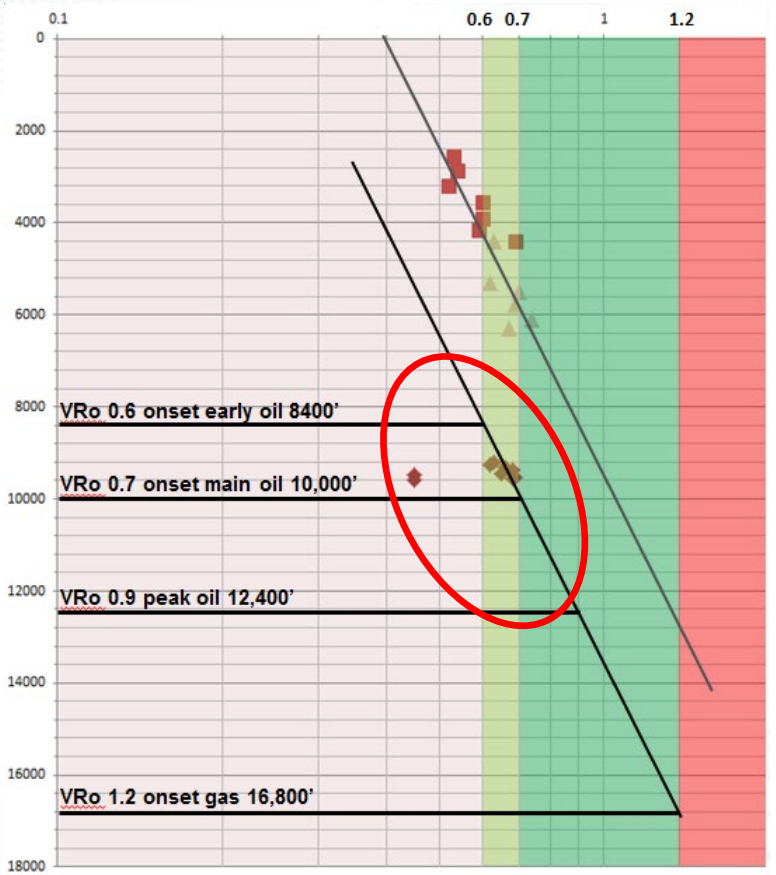
Cooper et al., 1995

- Initial maturation of La Luna in early Eocene
- Uplifted and generation shut down Eocene to mid Miocene
- Renewed burial and generation mid Miocene- present in basin centre



MMV Unconventional
Source Rock Maturity- Base La Luna





Tier 2: Normal Pressure
- Oil Window (%VRo >0.6)

Tier 1: Over Pressure
- Early Oil Window (%VRo 0.6-0.7)
- Oil Window (%VRo 0.7-1.2)
- Peak Oil (%VRo 0.9)

- Norean-1
- Morales-1

Quick-look deterministic assessment of gross La Luna UPIIP on CNE land:

$$UPIIP = \frac{7758 \times acres \times thickness \times Phi \times (1-Sw)}{FVF}$$

$$= \frac{7758 \times 155{,}265 \times 1204 \times 0.13 \times (1-0.31)}{0.925}$$

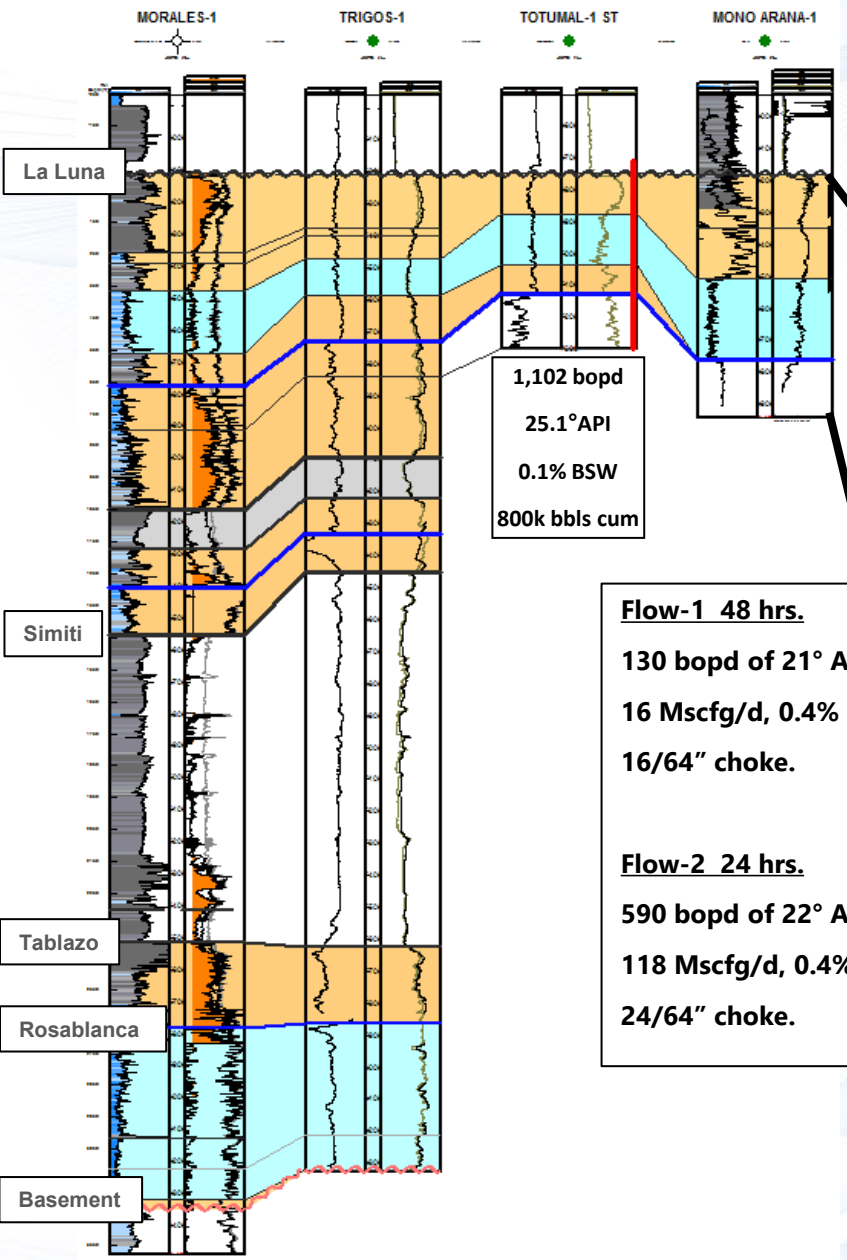
= 140,637,306,492 bbl (140 billion barrels)

242 sections of prospective La Luna area

589 million barrels in place /section

(Tablazo: 8.5 Bbbl UPIIP and 30 MMbbl/sec)

MMV Unconventional
Mono Arana-1 Testing



Flow-1 48 hrs.

130 bopd of 21° API oil,

16 Mscfg/d, 0.4% BSW

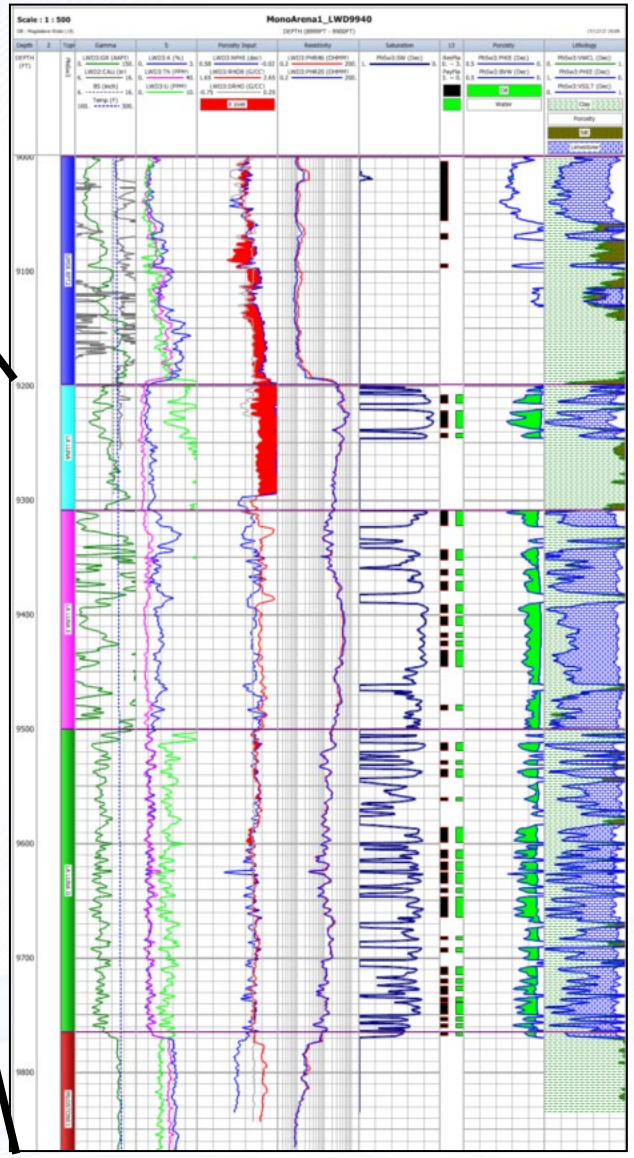
16/64" choke.

Flow-2 24 hrs.

590 bopd of 22° API oil,

118 Mscfg/d, 0.4% BSW

24/64" choke.



9215 - 9315 Ft

9345 - 9550 Ft

Interval cannot be tested due to operational constraints