

# AREAS ADVERTISEMENT 2022

**ARJONA 2D-2019 Seismic Program**

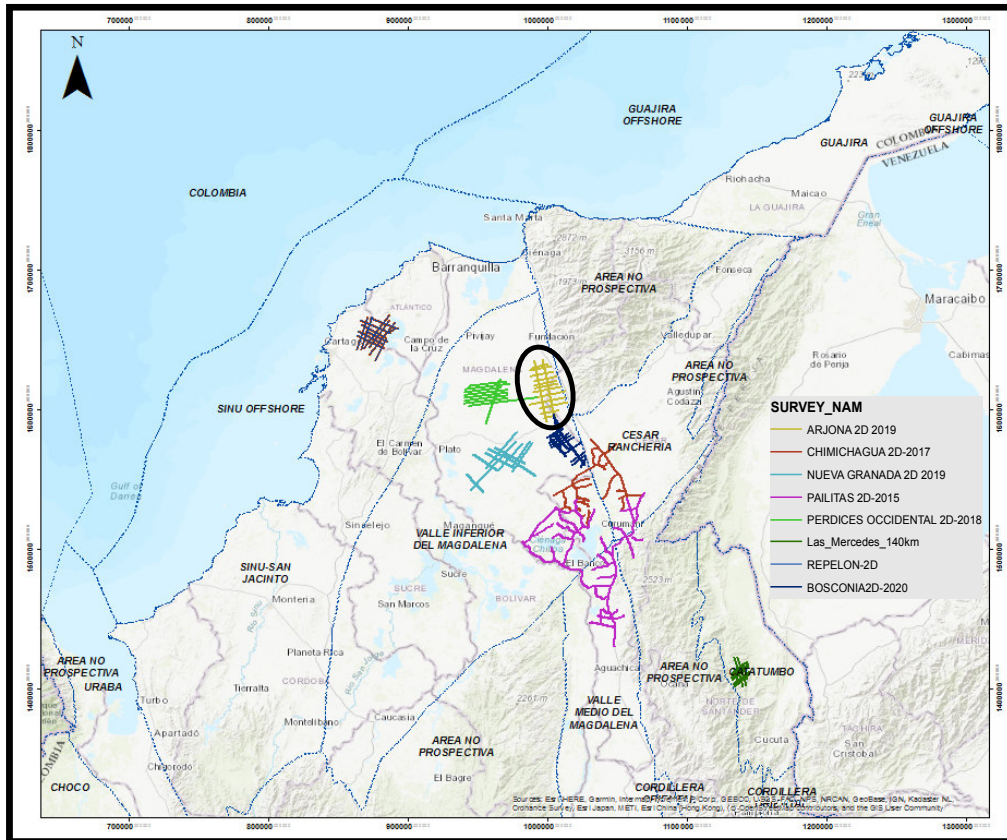
**LOWER MAGDALENA VALLEY BASIN**

March 25, 2022

## Content

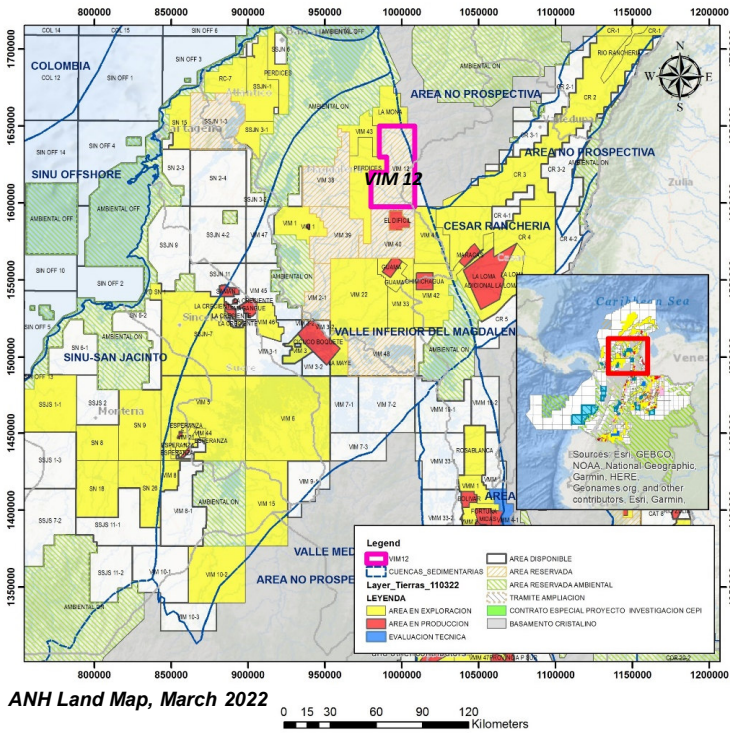
- Introduction
- Infrastructure
- Geological Framework
- VIM 12 - Data Base
- Arjona 2D Seismic Program
- Seismic Interpretation
- VIM 12 - Prospectivity
- Conclusions

## ANH Seismic Surveys



SURVEY	LENGTH (Km)	# LINES
REPELÓN-2D-2021	286	13
PERDICES OCCIDENTAL 2D-2018	295	9
<b>ARJONA-2D-2019</b>	<b>336</b>	<b>14</b>
NUEVA GRANADA 2D-2019	279,8	10
BOSCONIA NORTE 2D-2021	216	16
CHIMICHAGUA 2D -2017	395,56	20
PAILITAS 2D-2015	1317,2	52
LAS MERCEDES 2D-2021	137	9

# Location



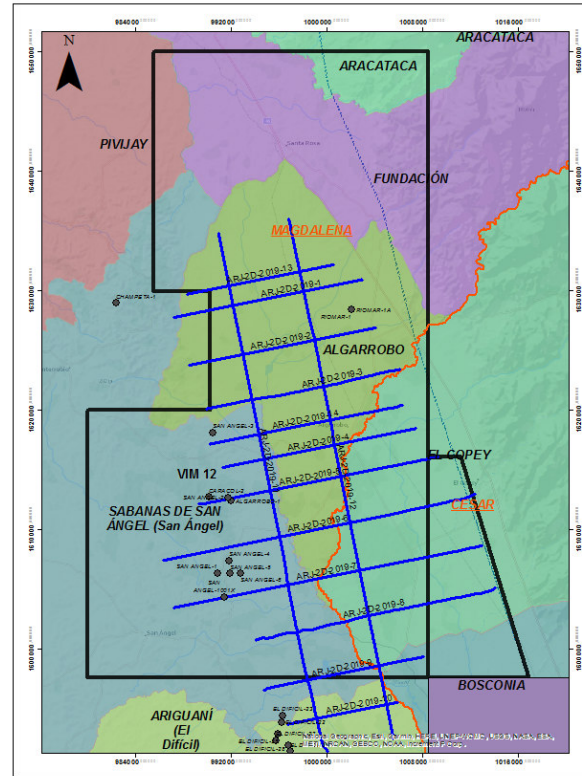
## VIM 12 Block Area: 128052.36 Ha

### VIM 12 Municipalities

Departments	Municipalities
Cesar and Magdalena	Bosconia
	El Copey
	Aracataca
	Fundación
	Pivijay
	Algarrobo
	Sabanas de San Ángel

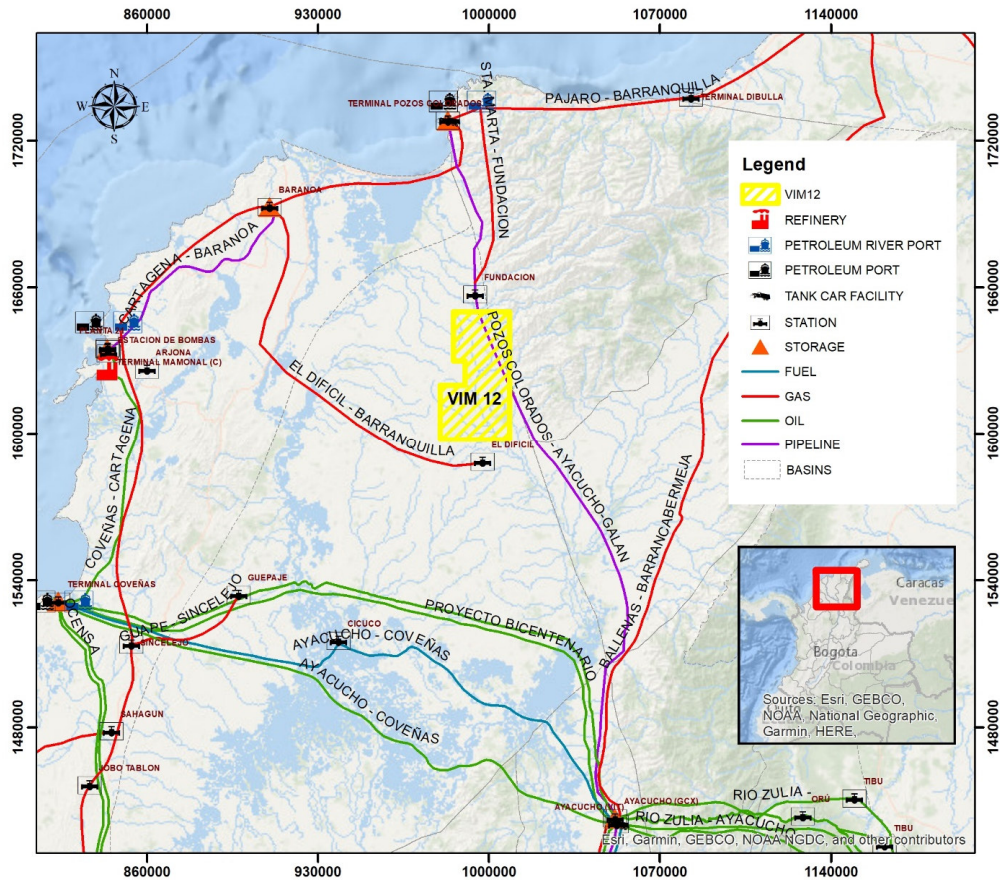
### Seismic Lines Influence

Departments	Municipalities	Influence (%)
Cesar and Magdalena	Bosconia	1
	El Copey	23
	Ariguani	7
	Sabanas de San Ángel	27
	Algarrobo	35





# Infraestructura

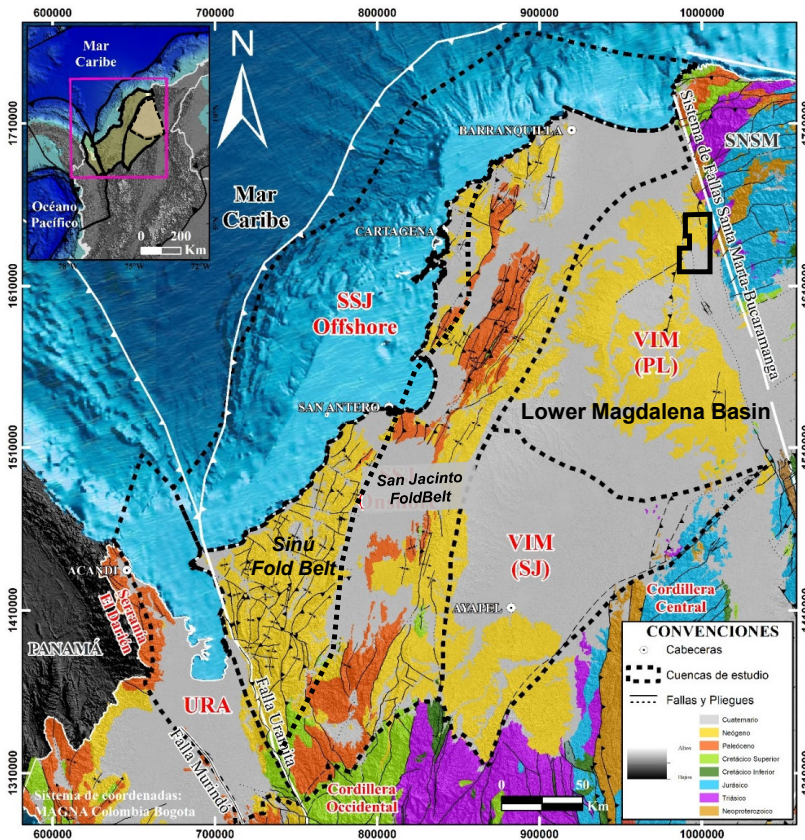


AGENCIA NACIONAL DE **HIDROCARBUROS**

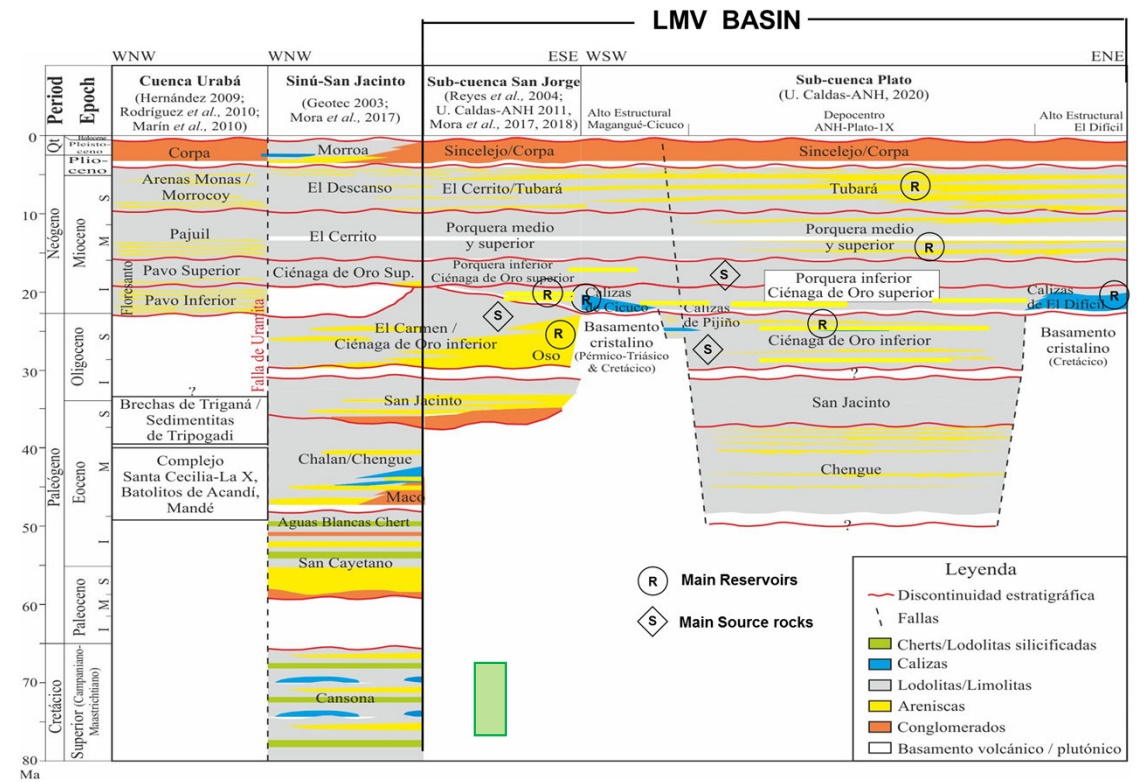
## Main Infrastructure

- **Gas Pipeline**  
El Difícil – Barranquilla  
Santa Marta - Fundación
- **Pipeline**  
Pozos Colorados – Ayacucho - Galán

# Geological Setting and Stratigraphic Chart

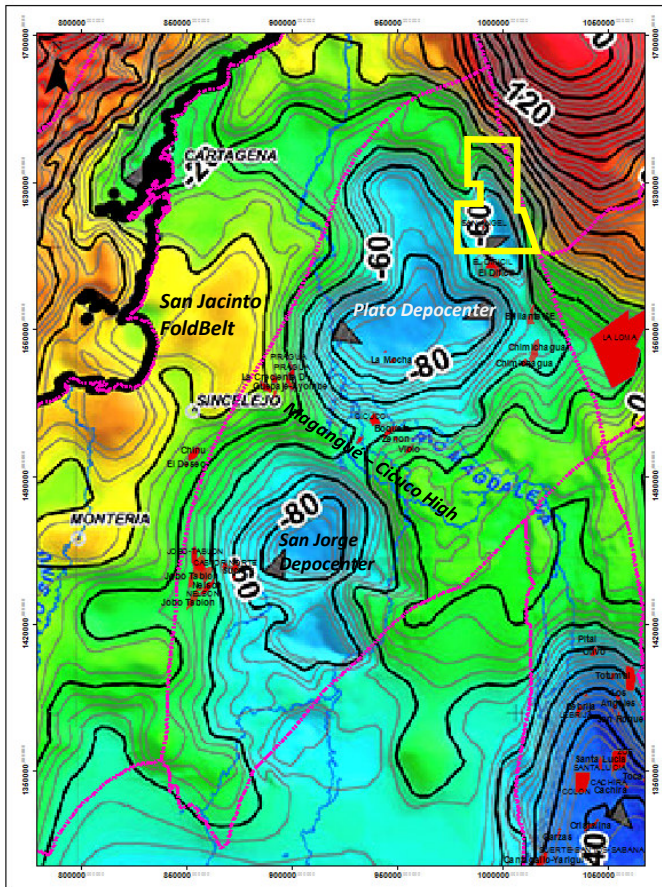


Taken from Universidad de Caldas – ANH, 2020



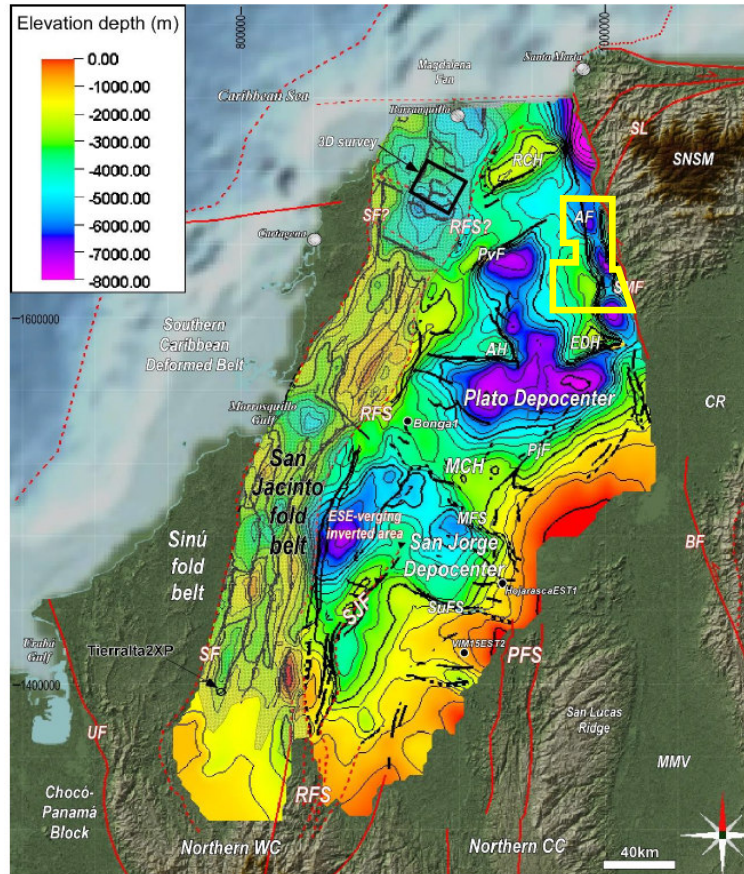


### Bouguer Anomaly Map



SGC – ANH, 2021

### Structural Depth Model of the top of the Basement



AGENCIA NACIONAL DE HIDROCARBUROS

Mora, 2018

### Main Morphological Features in LMV Basin

The positive anomaly representing the San Jacinto Fold Belt

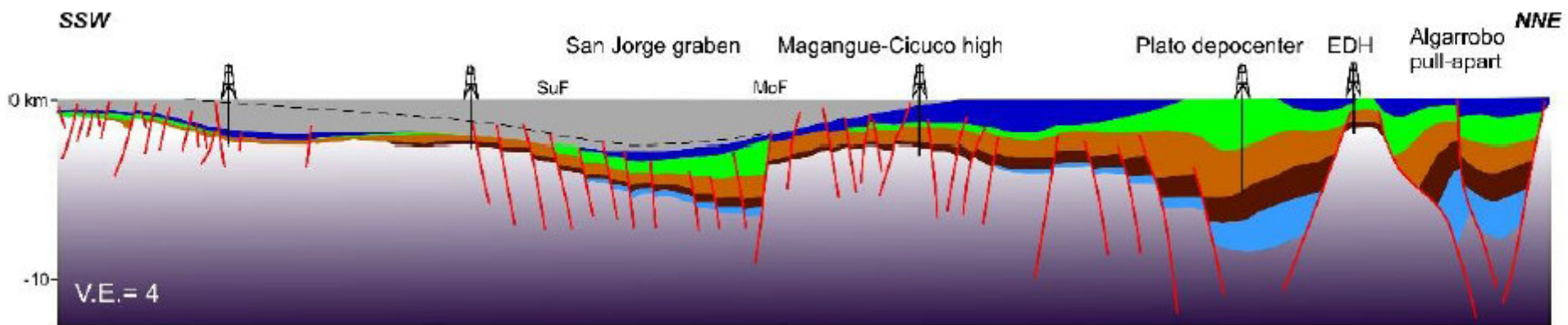
Plato Depocenter – Basement depths > 7000 m

Magangué – Cicuco High (MCH)

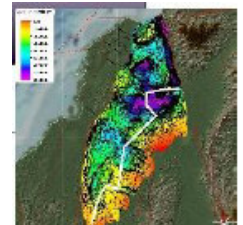
San Jorge Depocenter – Basement Depths > 5000m

**Structural elements.** RFS: Romeral Fault system; PFS: Palestina Fault system; SJF: San Jerónimo Fault; MCH: Magangué-Cicuco High; PjF: Pijiño Fault; AH: Apure High; EDH: El Dificil High; PvF: Pivijay Fault; RCH: Remolino-Ciénaga High; BF: Bucaramanga Fault; SMF: Santa Marta Fault; AF: Algarrobo Fault SL: Sevilla Lineament; UF: Uramita Fault; SF: Sinu Fault; CR: Cesar-Ranchería basin; MMV: Middle Magdalena Valley basin; SNSM: Sierra Nevada de Santa Marta.

## Regional Structural Section



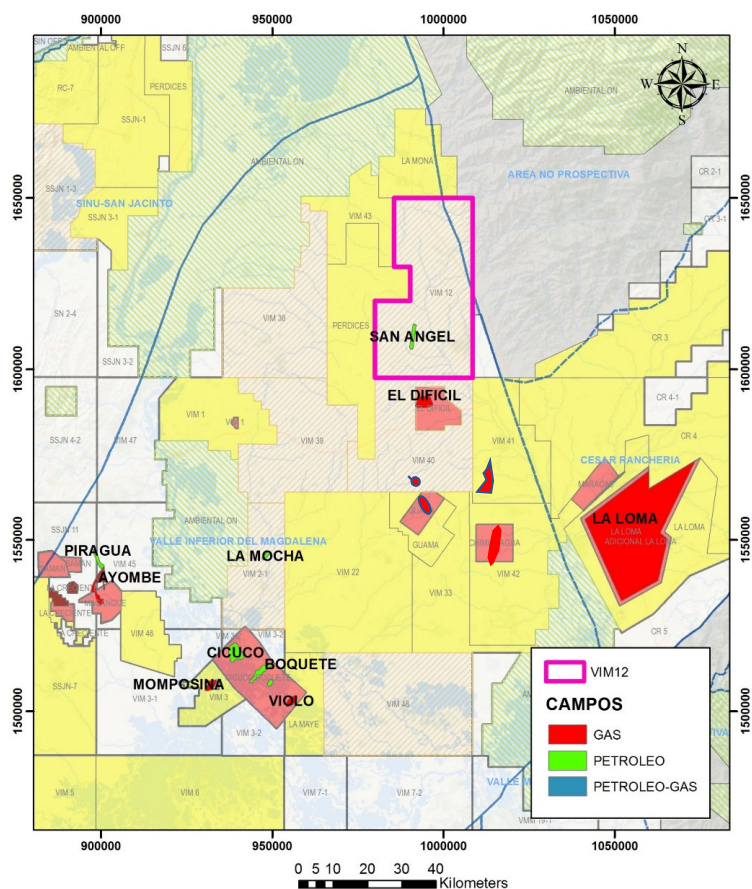
Sequence 5    Sequence 6    Sequences 7 and 8    Sequence 9    Sequence 10



*Taken from Mora, 2019*



## Near Fields

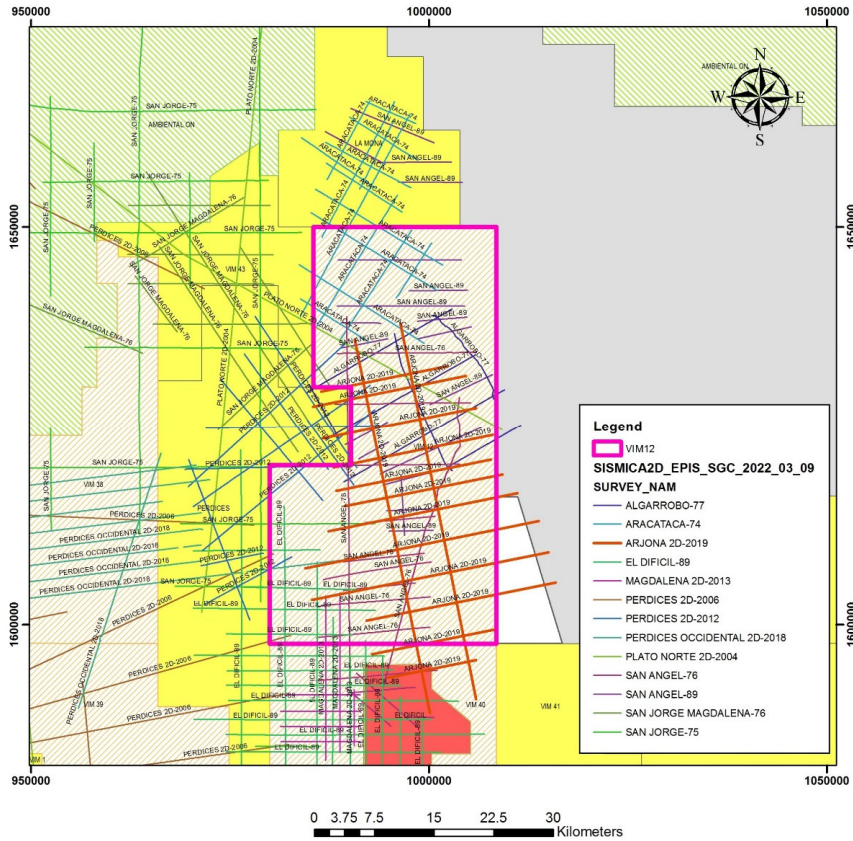


## NEAR FIELDS

FIELD	CONTRACT	RESERVOIR UNIT	PRODUCTION	DISCOVERY YEAR
EL DIFÍCIL	EL DIFÍCIL	CIÉNAGA DE ORO - LIMESTONE	11,5 MMBO, 344 BCF	1943
CICUCO	CICUCO	CIÉNAGA DE ORO	51 MMSTBO & 196 BCF	1956
VIOL	CICUCO	CIÉNAGA DE ORO	2,6 BCF	1958
ZENON	CICUCO	CIÉNAGA DE ORO		1959
BOQUETE	CICUCO	CIÉNAGA DE ORO	18,5 MMSTBO & 41 BCF	1961
ARJONA	CHIMICHAGUA	CIÉNAGA DE ORO		1991
LA MOCHA	ANH	TUBARÁ	632,8 MMscf	1963
LOS ALPES-CONSUELO	ANH	TUBARÁ	4,5 BCF	1963
GUAMITO - LA PINTA	ANH	CIÉNAGA DE ORO, INTRAPORQUERO	13,5 MMscf & 4 MBO	1975
MOMPOSINA	CICUCO MOMPOSINA	CIÉNAGA DE ORO	2.9 BCF	1990
BRILLANTE SE	ANH	CIÉNAGA DE ORO	2,687 MBO & 578 MMscf	2010
CAPURE	GUAMA	INTRA PORQUERO		2013
COTORRA	GUAMA	MIDDLE PORQUERO	149 MMscf	2012
PEDERNALITO	GUAMA	INTRA PORQUERO		2010
LA BELLEZA	VIM-1	CIÉNAGA DE ORO	Tested 2,696 BOPD & 11.8 MMcf/d of gas (4,663 boe/d combined). 43 API crude.	2019



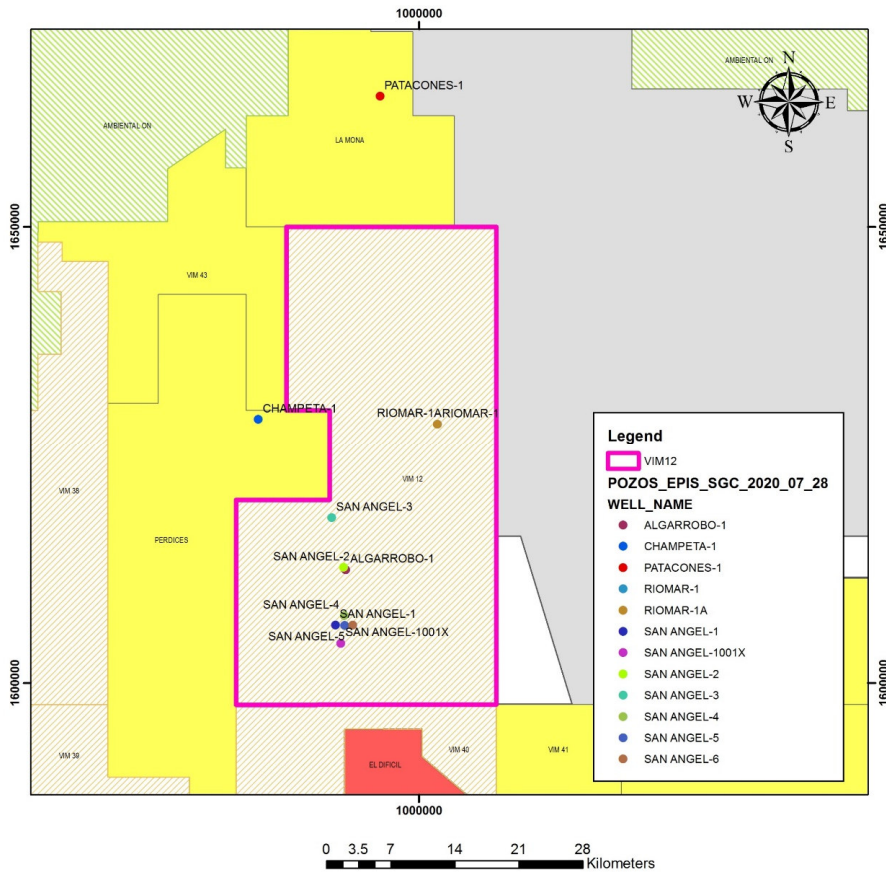
# DATABASE: Seismic



## AVAILABLE 2D SEISMIC: 13 SURVEYS

AREA	SURVEY NAME	TOTAL LENGTH (Km)	LENGTH INTO THE AREA (Km)	# LINES
VIM 12	ALGARROBO-77	110,6	100,7	6
	ARACATACA-74	158,17	99,3	9
	<b>ARJONA 2D-2019</b>	<b>336,16</b>	<b>278,09</b>	<b>13</b>
	EL DIFICIL-89	213,29	72,66	8
	MAGDALENA 2D-2013	40,67	12,4	2
	PERDICES 2D-2006	84,09	3,23	2
	PERDICES 2D-2012	207,87	45,64	10
	PERDICES OCCIDENTAL 2D-2018	49,14	12,23	1
	PLATO NORTE 2D-2004	132,98	26,21	1
	SAN ÁNGEL-76	211,76	184,43	11
	SAN ÁNGEL-89	123,27	122,43	15
	SAN JORGE MAGDALENA-76	37,68	4,25	2
	SAN JORGE-75	126,015	21,366	3
<b>TOTAL LENGTH</b>		<b>1980,7</b>	<b>1065,05</b>	<b>97</b>

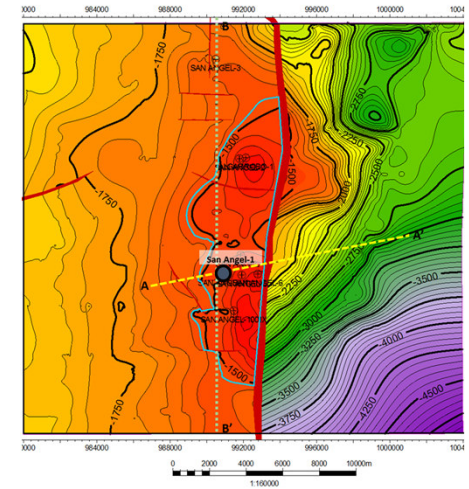
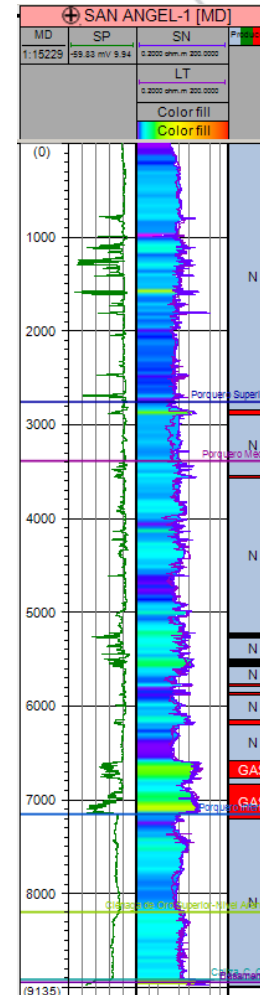
## DATABASE: Wells



WELL NAME	TD DATE	TD (ft)	Ground Elevation (ft)	Well Classification	Well Status	Operator	Observations
ALGARROBO-1	7/1/1969	8329	399	C3	Dry	The Superior Oil Company	The well drilled the FW of a normal fault. Did not find the producers sands. Did not find DST in open hole.
PATACONES-1	12/2/2017	8720	350.5	C3	Dry	Azabache Energy Inc Sucursal Colombia	Abandoned without Formation tests.
RIOMAR-1	8/19/1981	2486.75	400	C3	Abandoned by mechanical damage	Ecopetrol S.A.	
RIOMAR-1A	12/21/1981	13929	400	C3	Dry	Ecopetrol S.A.	Target: Turbidites complex of the Pre-Middle Miocene and platform sandy bodies of the Post-Middle Miocene. Located in the Ariguani Graben
SAN ANGEL-1	6/21/1944	9135	144.4	B3	Gas producer. San Angel-1 tested 0.56b MMcfd for two months	Shell	Gas accumulations in San Angel-1 are present in sands lenses with thicknesses from 10 to 50 ft between 5400-5700 ft. Although, that well had gas show since 2548', where the strong shows were in 6900'
SAN ANGEL-1001X	4/19/2011	7000	351	C3	Abandoned	Petrolifera Petroleum (Colombia) Limited	The well did not find the reservoir. DSTs found formation water in natural flow. The maximum pressure was 4906 psi @PMP
SAN ANGEL-2	11/24/1946	4930	132.5	B1	Abandoned - Gas shows	Shell	Gas shows in 2844'. The mud weight was managed to control the gas shows.
SAN ANGEL-3	1/11/1946	8938	144.4	B3	Abandoned - Gas producer	Shell	The well showed oil stains in surface, and gas shows at the depth of 3088'. In 5254', 6909' and 7798' has strong gas shows.
SAN ANGEL-4	5/14/1946	6747	128.9	C1	Abandoned	Shell	Show gas in 3346' and 3407'
SAN ANGEL-5	1/22/1946	3275	127.6	C1	Dry	Shell	Show gas: 820' and 2696'
SAN ANGEL-6	8/30/1946	3520	120.9	C1	Abandoned by mechanical damage	Shell	show gas: 2840'

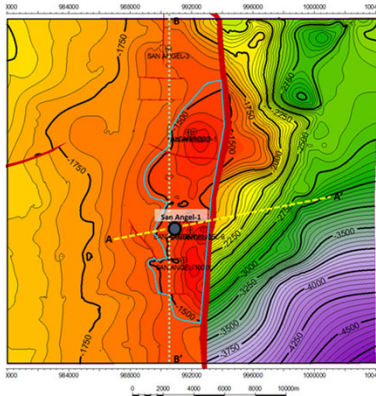
## San Ángel-1 Well

- Company: Shell
- TD: 9132'
- Spud date: April 23rd of 1943
- End date: June 21st of 1944
- Structure: Anticline with three way dip closure and closure against a normal fault at the east.
- Basement: Micaceous schists.
- It presented gas shows initiating at 2548 ft, with the most significant show at 6900 ft.
- Gas accumulations are preserved in sand lenses with thicknesses that vary from 10 to 50 ft in the interval 5400 to 5700 ft, stratigraphically located at the Middle Porquero Formation.
- Initial Production: **Gas: 560 MSCFD and water: 560 BWD, during two months.**
- The well was evaluated for four and a half months, and it was declared as non commercial gas producer.
- Not hydrocarbon production was reported from the Ciénaga de Oro Formation, drilled by the San Ángel-1, San Ángel-3 and Algarrobo-1 wells.

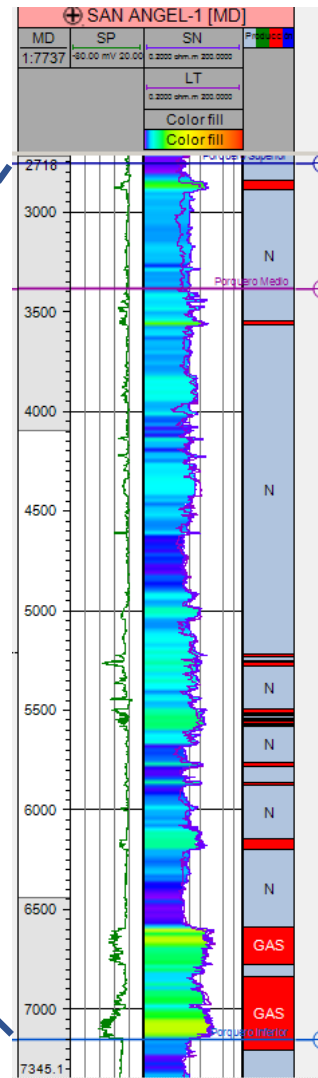
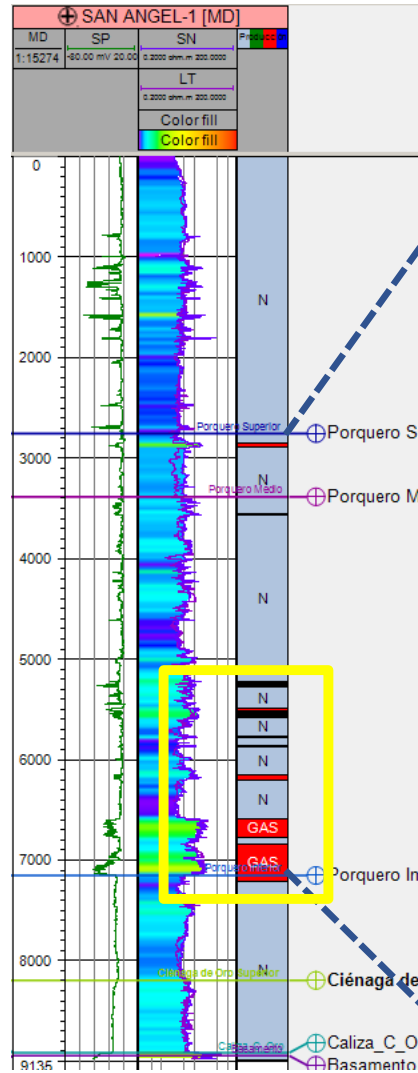


TWT Map Intra Middle Porquero

# San Ángel-1 Tests



TWT Map Intra Middle Porquero



### DST3 May/1944 (2,818ft)

2 hr,20min. Only one or two sporadic puffs at surface, no oil, no gas, no SW. After pumping water into formation, the well flowed M.S.W 900bbl daily Sal Agr/ltr-little gas for 1 ¼ hr

### DST2, May/1944 (3,450ft) Little gas

2-6hr: Slight blow at surface for first hour

### Add. Flow Test (5,219-5,874ft): 500-600 bbl

SW(17gr/ltr) on 7d -> 86 bwpd + 675 MCF gas

### (5538-5547ft): 2d/404-636 bbl SW (16,5gr/ltr)+

799-930 MCF gas

### (6148-6201ft): 7d: little SW (14gr/ltr) + Est. 1,200 MCF

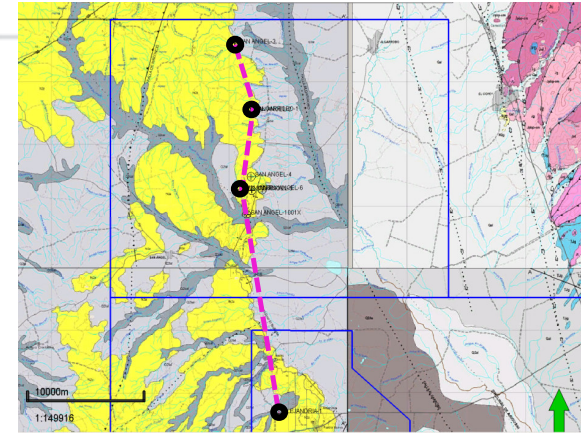
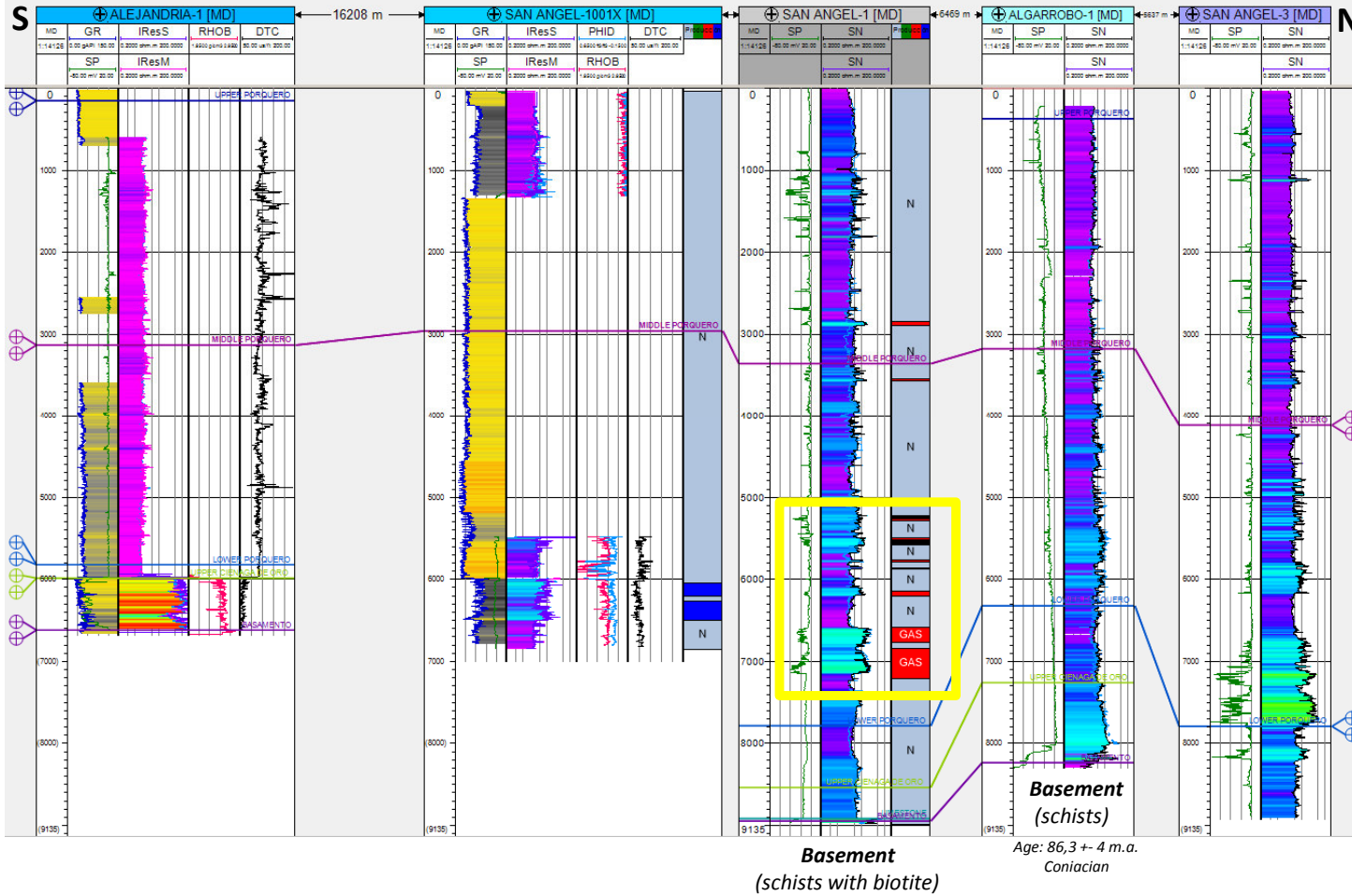
gas

### DST1 (6588-6773, 6868-7207 ft) Jan 1944

11 d/224 bbl SW (19 gr/ltr)+30MCF gas



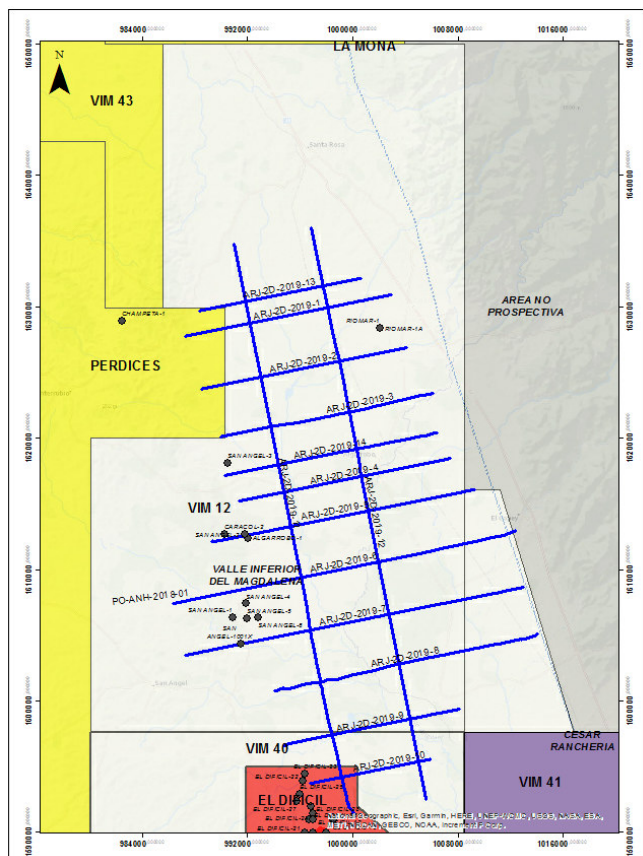
# Structural Correlation





## Arjona 2D Acquisition Parameters

### 14 Seismic lines



#### Acquisition Parameters

Acquired by: Vector Geophysical  
Record Tools: Sercel Unite V3  
Sampling rate: 2ms  
Record Length: 8 s

#### Source:

Source Type: Sismigel  
Charge: 2700 g  
Depth: 10 m  
Interval: 50 m  
SP Distance: 50 m

#### Receivers:

Geophone Type: Single Sensor  
Natural Frequency: 10 Hz  
Channels: 720  
Type of laying: Roll on – Roll off  
Nominal Fold : 150  
Receiver Interval: 25 m  
SP: 5058  
Receiving Stations: 13893

Processed by Inforpetrol (2020), deliverables PSTM

LINE_NAME	Sp's	LENGTH (Km)	LENGTH IN THE VIM12 BLOCK (Km)
ARJ-2D-2019-01	244	19,63	14,74
ARJ-2D-2019-02	244	19,68	16,00
ARJ-2D-2019-03	257	20,35	19,50
ARJ-2D-2019-04	254	20,20	19,41
ARJ-2D-2019-05	334	24,18	21,48
ARJ-2D-2019-06	459	29,92	24,50
ARJ-2D-2019-07	457	30,33	23,61
ARJ-2D-2019-08	336	24,22	16,63
ARJ-2D-2019-09	199	15,53	8,85
ARJ-2D-2019-10	114	11,27	
ARJ-2D-2019-11	804	47,93	39,05
ARJ-2D-2019-12	813	48,15	41,05
ARJ-2D-2019-13	165	16,23	13,44
ARJ-2D-2019-14	253	19,83	0,02
<b>TOTAL</b>		<b>347,43</b>	<b>258,29</b>

# Arjona 2D- Processing Sequence

Geometry check



Noise Attenuation



True Amplitude Recovery



Spike Deconvolution



Static Corrections



Velocity Analysis



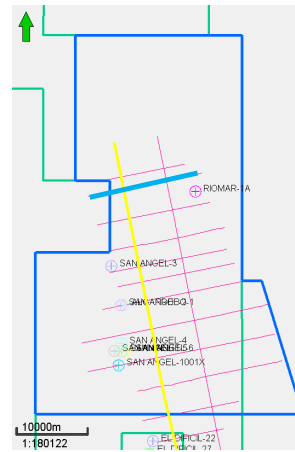
Residual Correction



PSTM Kirchoff (1 It) – Velocity Analysis

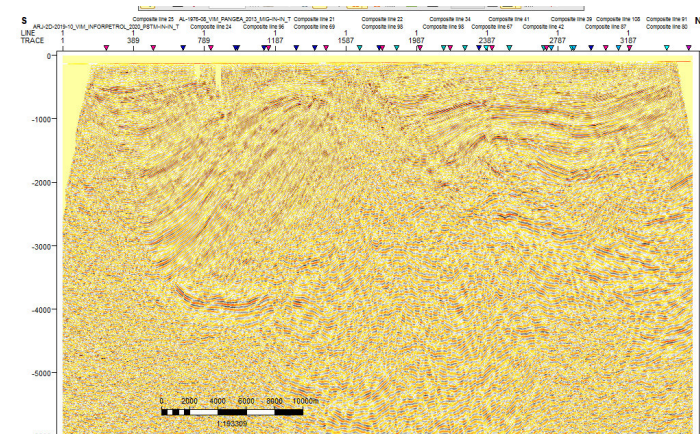
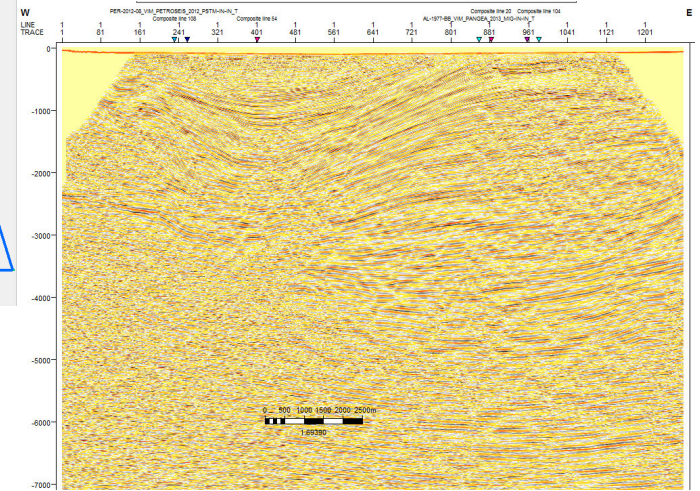


Kirchoff Migration for PSTM



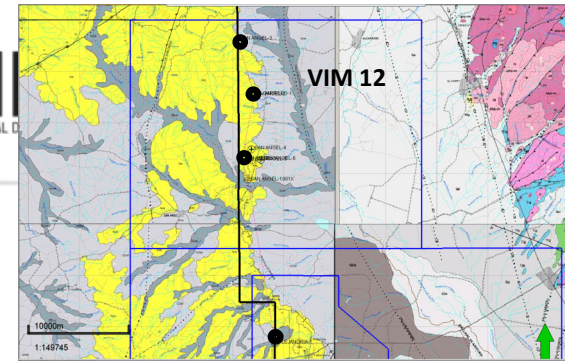
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C 1 LINEA: ARJ-2D-2019-12
C 2 PROCESO: MIGRACION PRE APILADO EN TIEMPO IN-IN.
C 3 PROGRAMA: ARJONA 2D 2019 CUENCA: CESAR-RANCHERIA
C 4 PAIS & AREA: COLOMBIA, EL COPEY-CESAR
C 5 CLIENTE: AGENCIA NACIONAL DE HIDROCARBUROS (ANH)
C 6 FECHA DE REGISTRO: ENERO DE 2020
C 7 REGISTRADO POR: VECTOR GEOPHYSICAL
C 8 PROCESADO POR: INFORPETROL S.A. PROCESADO PARA: ANH
C 9 FECHA DE PROCESAMIENTO: ENERO DE 2020
C10 RANGO DE FUENTES: 1001.5 - 2655.5 NUMERO DE DISPAROS: 830
C11 RANGO DE RECEPTORES: 851 - 2745 RANGO DE CDP: 1852-5400
C12 INTV. FUENTES: 50 m. INTV. RECEPTORES: 25 m.
C13 CANALES: 720 CUBRIMIENTO: 180
C14 RATA DE MUESTREO: 2.0 ms. LONGITUD DE REGISTRO: 8.0 s.
C15 TIPO DE FUENTE: DINAMITA
C16
C17 POSICION BYTES SEG Y HEADERS (SEG-REV 1):
C18 CDP NUMBER: 121 4I NUMERO DE CDP
C19 CDP_X COORD: 181 4I COORDENADA X DE CDP
C20 CDP_Y COORD: 185 4I COORDENADA Y DE CDP
C21 CDP_SLOC: 197 4I LOCALCION DE CDP
C22 CDP_ELEV: 1221 4I ELEVACION DE CDP
C23
C24 SECUENCIA DE PROCESAMIENTO:
C25 DATUM: 200 m.s.n.m VELOCIDAD DE REEMPLAZAMIENTO: 2000 m/s
C26 SISTEMA DE REFERENCIA: BOGOTA-MAGNA.
C27 01. CONVERSION DE DATOS A FORMATO INTERNO SEIS_SPACE. 02. GEOMETRIA.
C28 03. ASIGNACION DE GEOMETRIA. 04. ATENUACION DE RUIDO. 05. PRIMEROS ARRIBOS.
C29 06. RECUPERACION DE AMPLITUDES (TAR). 07. AMPLITUD CONSISTENTE EN SUPERFICIE
C30 08. DECONVOLUCION. 09. ESTATICAS DE REFRACCION.
C31 10. ANALISIS DE VELOCIDAD 1. 11. ESTATICAS RESIDUALES 1.
C32 12. ANALISIS DE VELOCIDAD 2. 13. ESTATICAS RESIDUALES 2.
C33 14. PSTM. KIRCHHOFF (IRA IT.) 15. ANALISIS DE VELOCIDAD PSTM
C34 16. PSTM. KIRCHHOFF (ZDA IT.) 17. APILADO
C35 18. FILTROS Y ESCALARES
C36 DATUM DE ESTE SEG Y: 200 m.s.n.m VELOCIDAD DE REEMPLAZAMIENTO: 2000 m/s
C37
C38
C39 contacto: gerencia@inforpetrol.co.co
    
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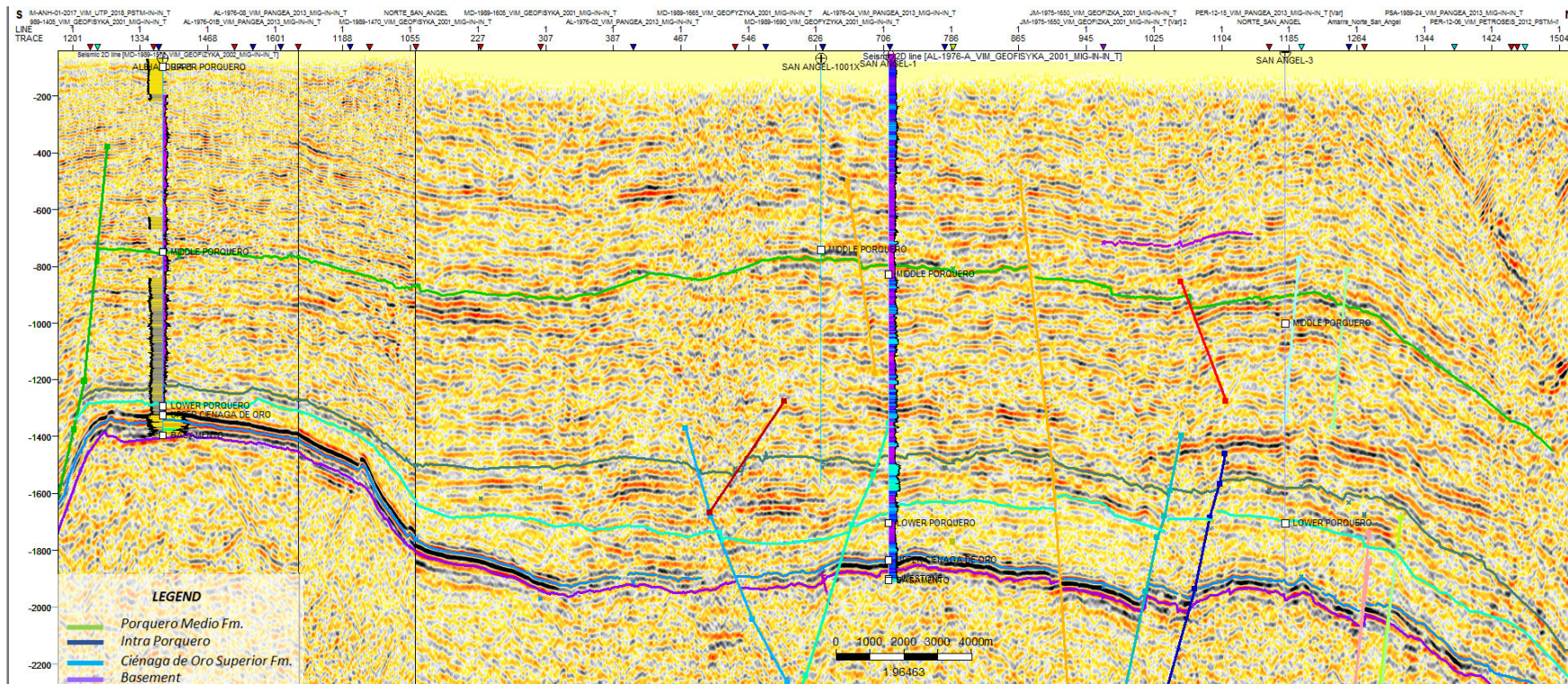




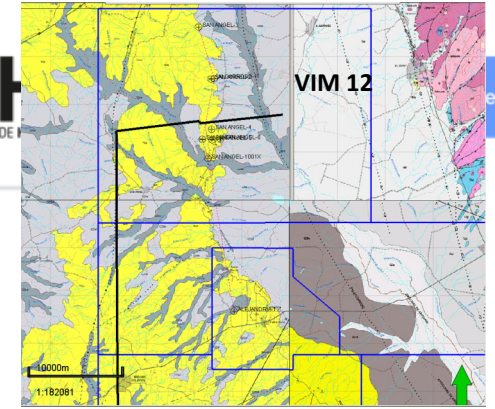
# Seismic Interpretation



Composite section. Alejandría-1 and San Ángel-1 Wells

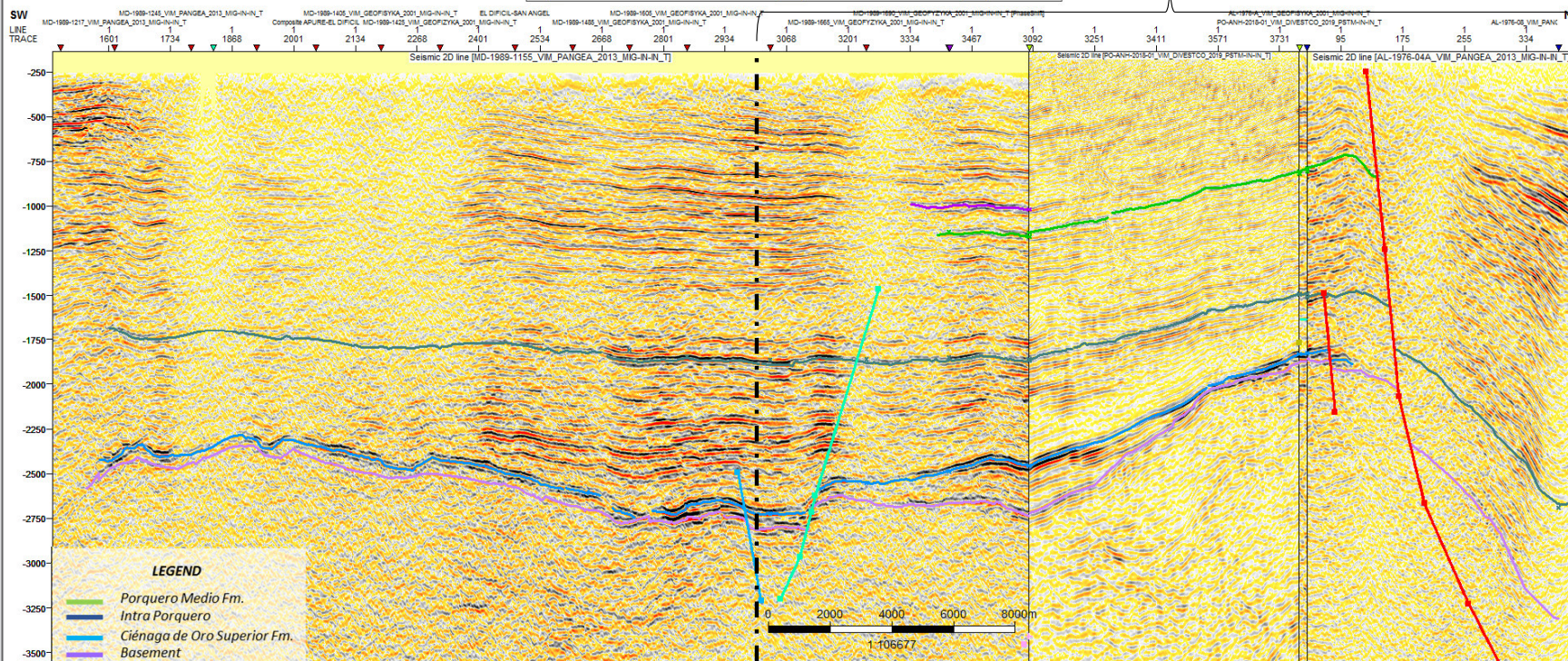






VIM 12 Area

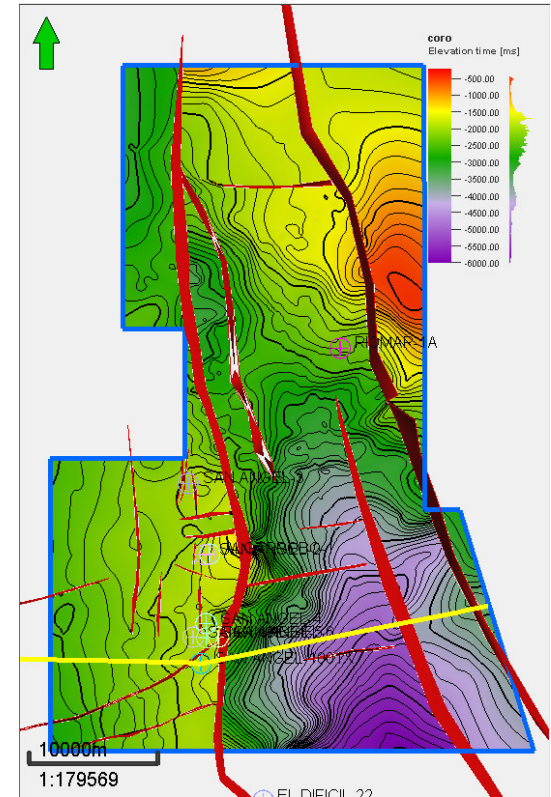
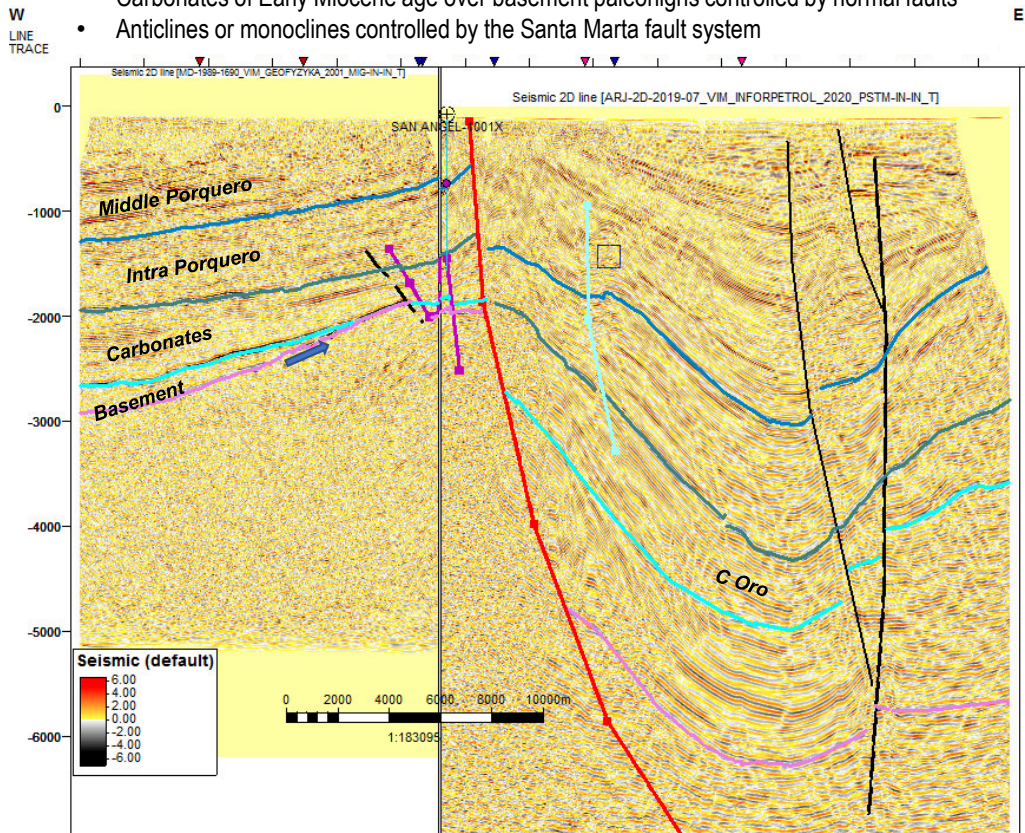
Composite section.





# Seismic Interpretation

- PLAYS
- Stratigraphic traps (onlaps and pinch outs)
- Carbonates of Early Miocene age over basement paleohighs controlled by normal faults
- Anticlines or monoclines controlled by the Santa Marta fault system

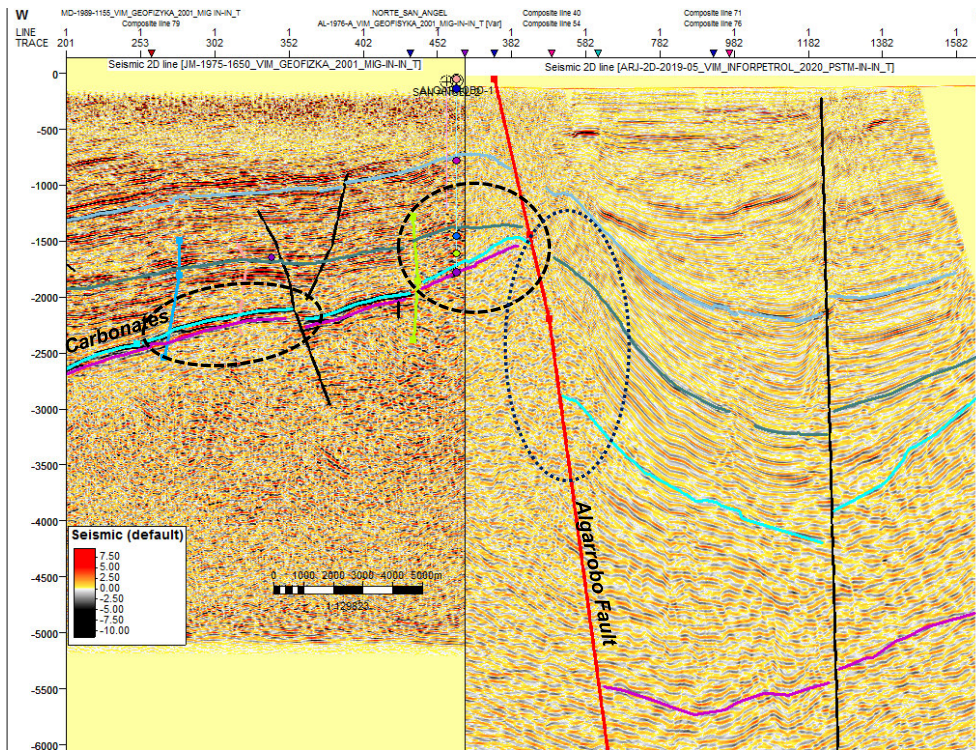


TWT Map Ciénaga de Oro Fm

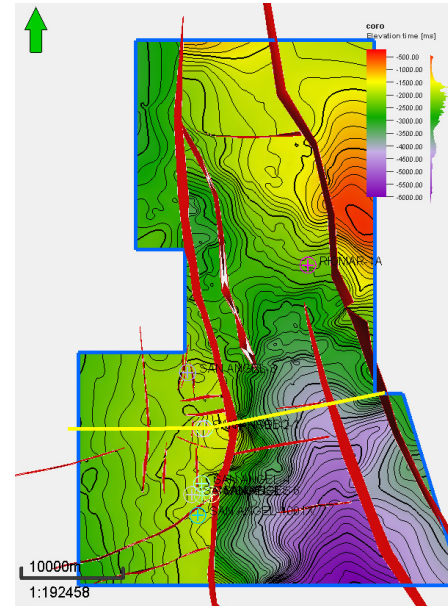


# Seismic Interpretation

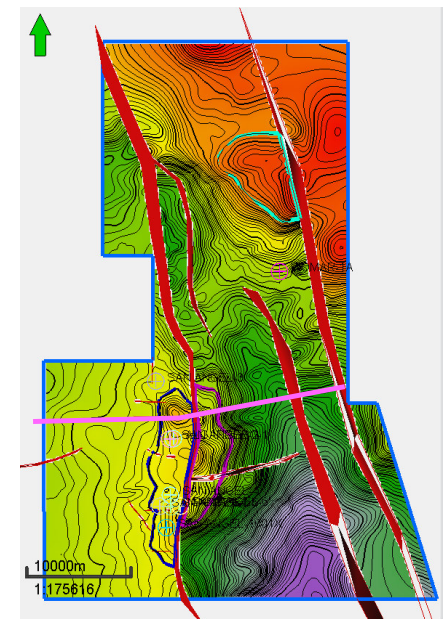
- PLAYS
- Carbonates of Early Miocene age over basement paleohighs controlled by normal faults
- Structural plays associated to faulted anticline



TWT Map Ciénaga de Oro Fm



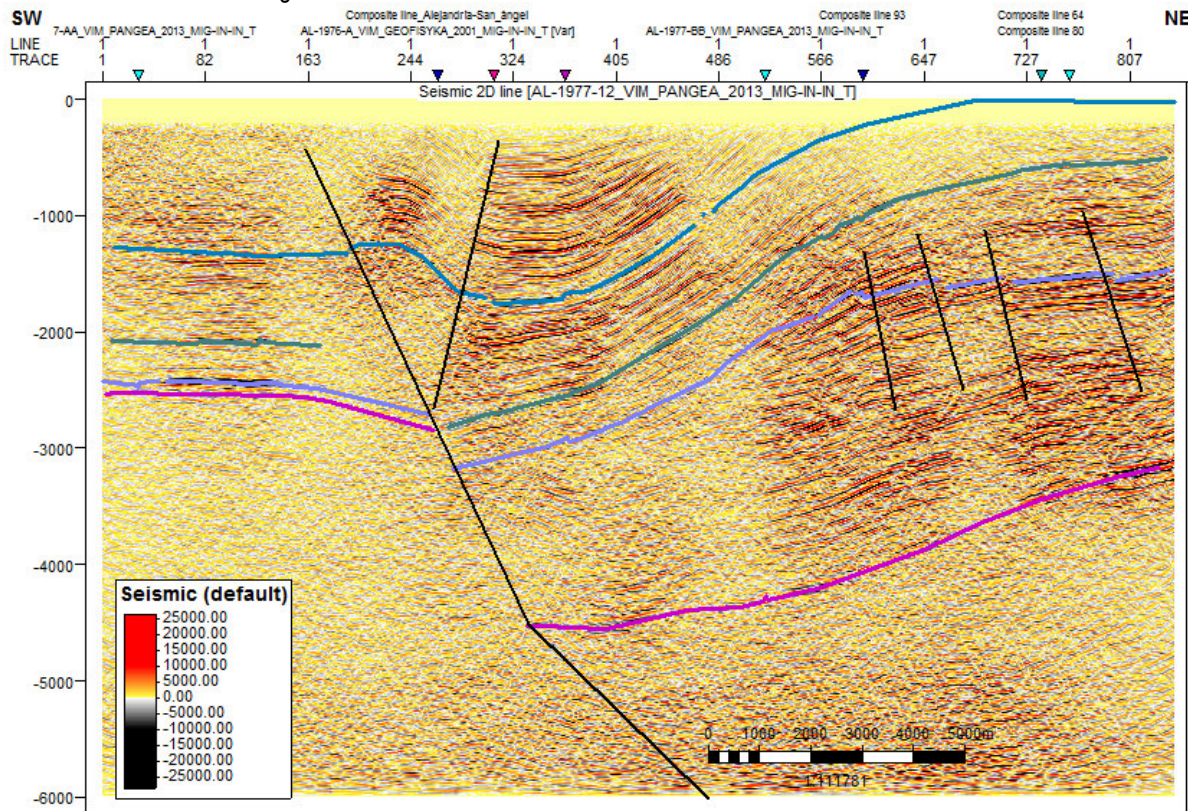
TWT Map Intra Porquero Fm



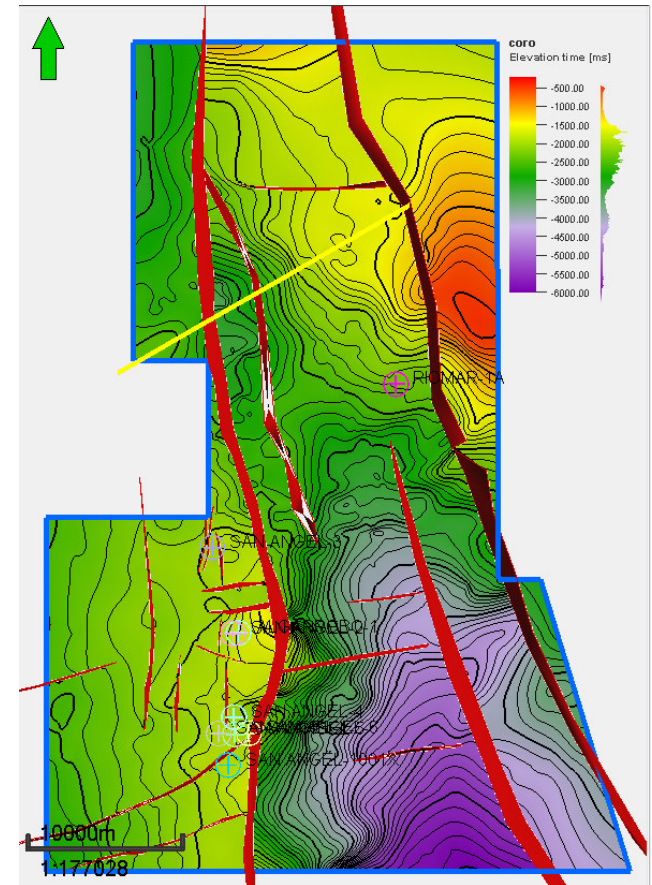


# Seismic Interpretation

- PLAYS
- Structural plays associated to faulted anticline
- Structural closure against fault



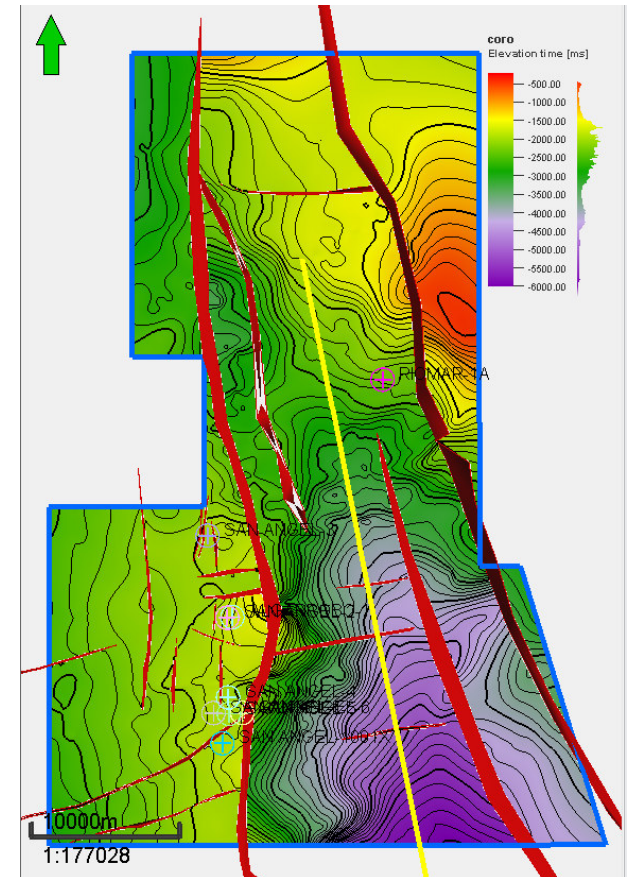
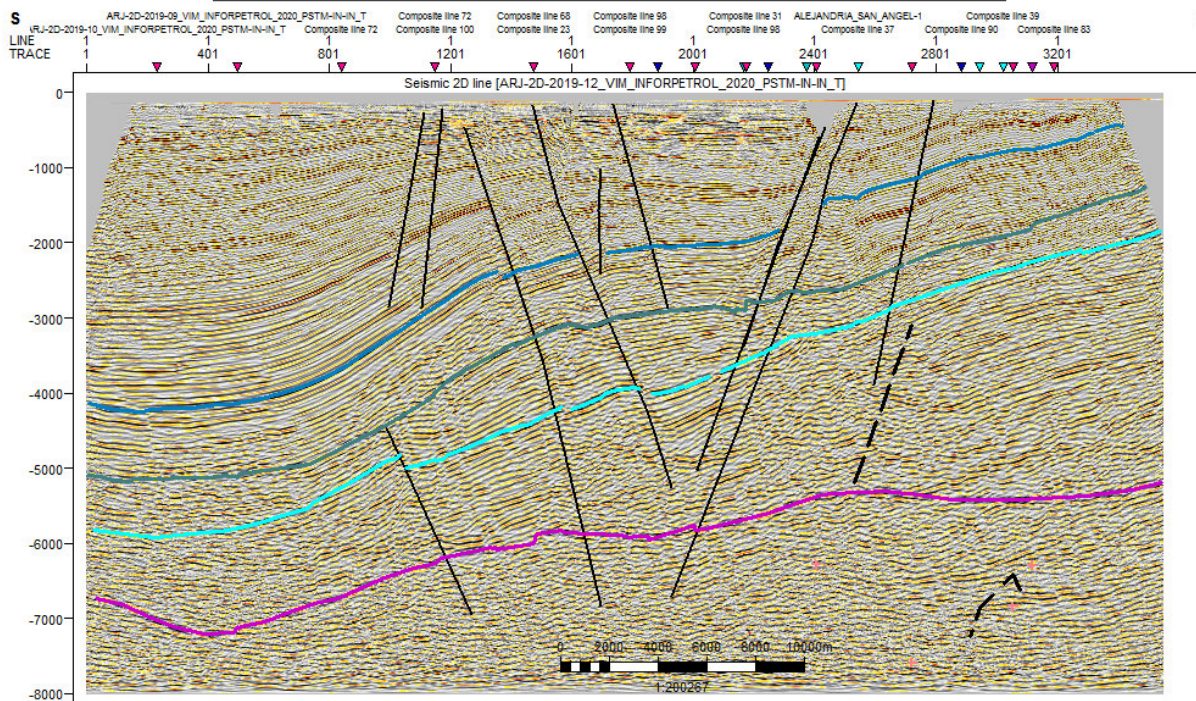
TWT Map Ciénaga de Oro Fm



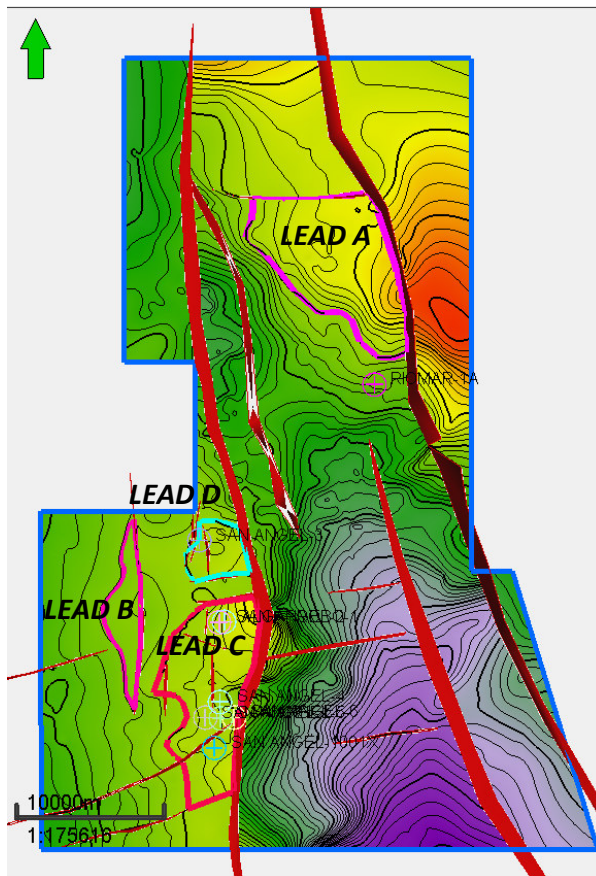


## Seismic Interpretation

- PLAYS
- Structural plays associated to faulted anticline in the Algarrobo Graben



## Prospectivity Ciénaga de Oro Formation



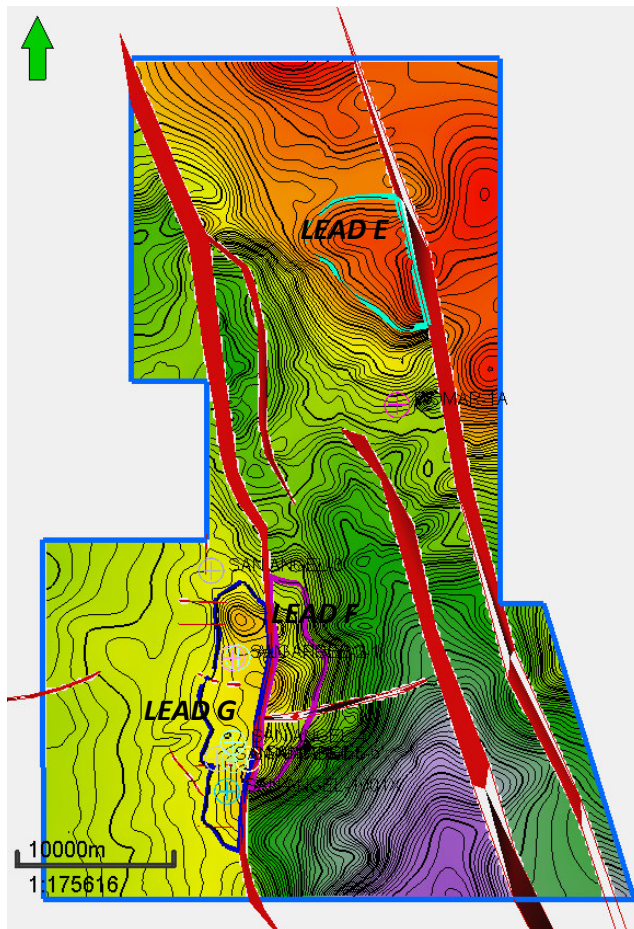
LEAD	HIGH ESTIMATED AREA (Acres)	OGIP (BCF's)
LEAD A (Sandstones)	16800	111,1
LEAD B (Limestones)	3880	35,5
LEAD C (Limestones)	14600	133,8
LEAD D (Limestones)	3000	27,5

### Volumetrics

- Sandstones: Assuming a porosity of 18%, net pay of 30 ft, and Sg of 90%.
- Limestones: Assuming a porosity of 8%, net pay of 30 ft, and SG of 85%.



## Prospectivity Intra Middle Porquero



LEAD	HIGH ESTIMATED AREA (Acres)	OGIP (BCF's)
LEAD E	9100	60,2
LEAD F	7600	50,3
LEAD G	11300	74,7

### Volumetrics

- Sandstones: assuming a porosity of 18%, net pay of 30 ft, and Sg of 90%.



## Conclusions

- The VIM 12 area has thirteen 2D seismic programs, with a total length of 1980 Km. This surveys have been acquired since 1974 and the recent program is Arjona 2D-2019, acquired and processed by Vector Geophysical and Inforpetrol respectively.
- The seismic program Arjona 2D -2019 is located in the northeast of the LMV basin in the Magdalena and Cesar departments, within the area reserved by the ANH, VIM 12 area. Corresponding to 336 Km of length, distributed in 13 seismic lines, 10 dip lines and 2 strike lines, with a 5058 source points and 13893 receiver stations.
- Ten exploratory wells have been drilled in the VIM 12 area, where the well San Ángel-1 drilled in 1944, had gas accumulations in sand lenses in the Middle Porquero Unit. The well had an initial production of 560 MSCFD and water of 560BWD, during two months. It was evaluated for four and a half month and it was declared as non comercial gas producer.
- It was identified different types of plays, related to stratigraphic and structural traps that involve the limestones levels of Ciénaga de Oro Formation and structural traps controlled mainly by the Algarrobo fault and the Santa Marta fault dynamics, involving the Intra Porquero units too.
- A high estimate areas and volumetrics have been calculated for four leads associated to Ciénaga de Oro Formation and three leads for the Intra Middle Porquero Unit.