

RONDA

COLOMBIA 2021

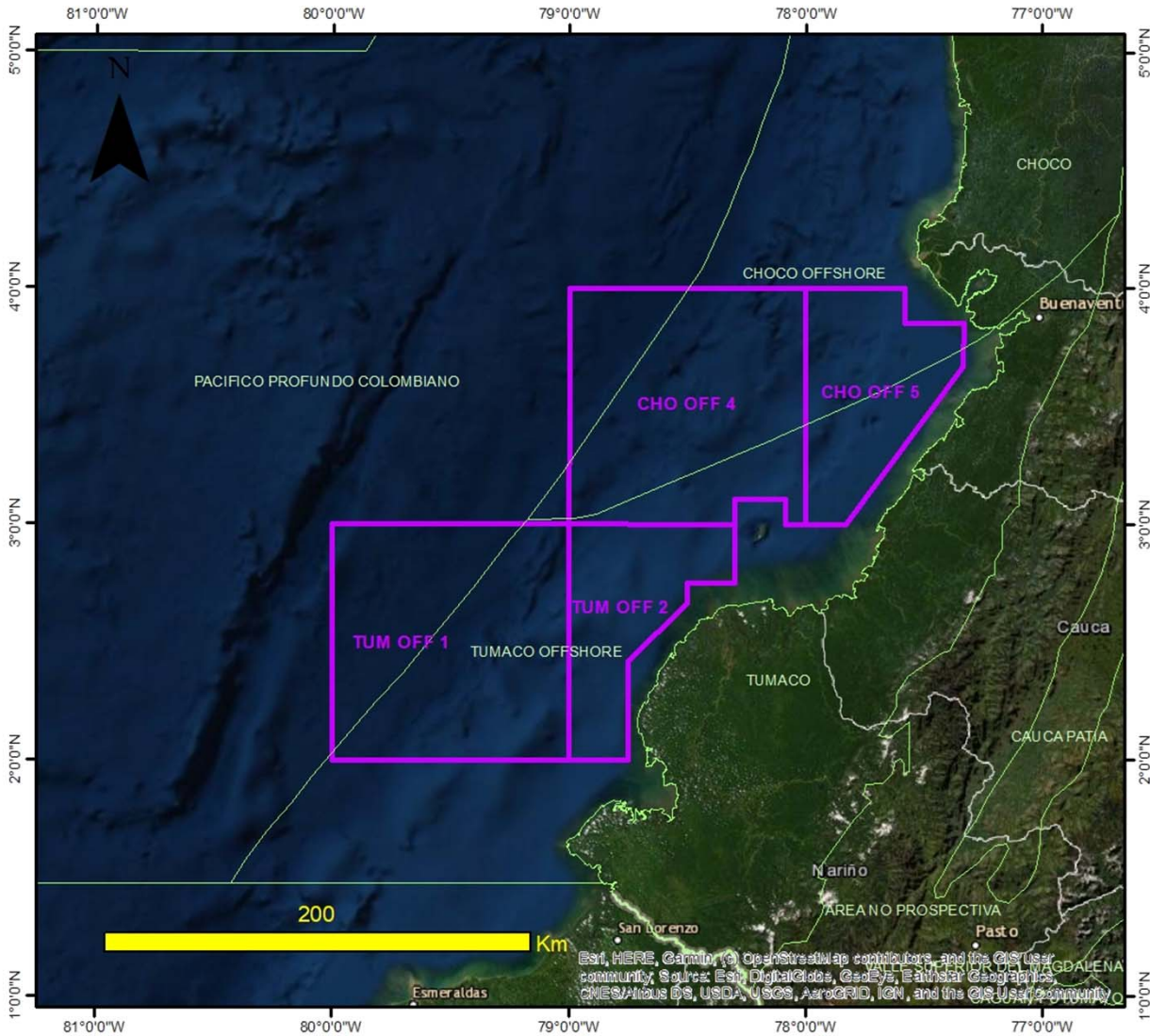
PACIFIC COAST MEGA AREAS

CHO OFF-4, CHO OFF-5, TUM OFF-1 & TUM OFF-2 Areas

JUNE 4TH 2021

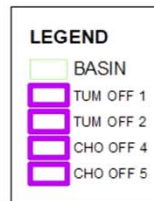
Location
Infrastructure
History of Exploration
Geological Framework
Database
Well Summary
Seismic Interpretation
Prospective Resources
Conclusions
References

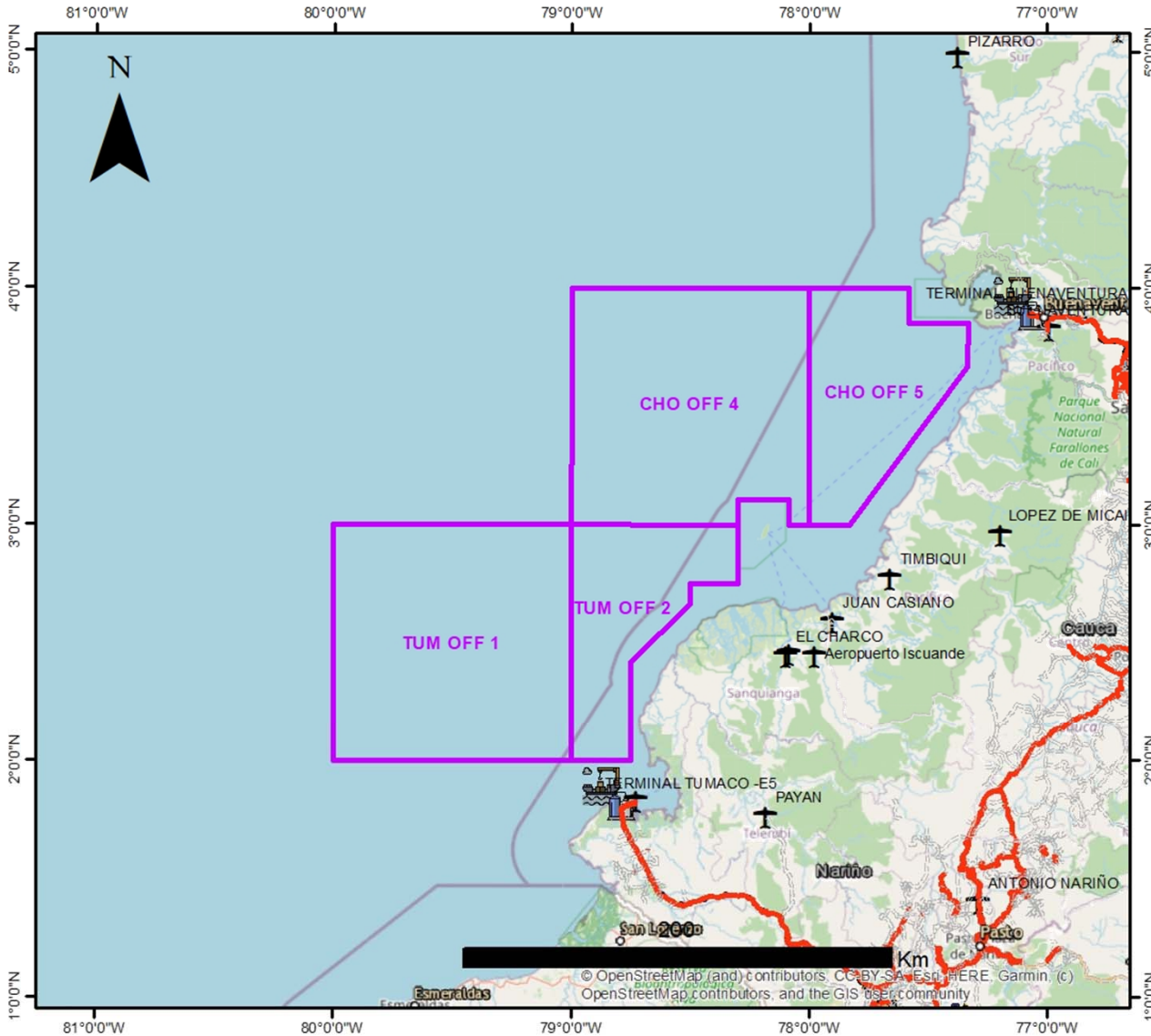
LOCATION



All blocks share Tumaco offshore basin characteristics, and only CHO OFF 4 and 5 blocks belong to the Choco offshore

	AREA (Km2)
TUM OFF 1	12409
TUM OFF 2	5129
CHO OFF 4	12082
CHO OFF 5	5719





Sea ports Buenaventura and Tumaco Average Distance (Km)

SEA PORT	CHO OFF 4	CHO OFF 5	TUM OFF 1	TUM OFF 2
BUENAVENTURA	163	78	292	231

SEA PORT	CHO OFF 4	CHO OFF 5	TUM OFF 1	TUM OFF 2
TUMACO	176	238	113	88

LEGEND

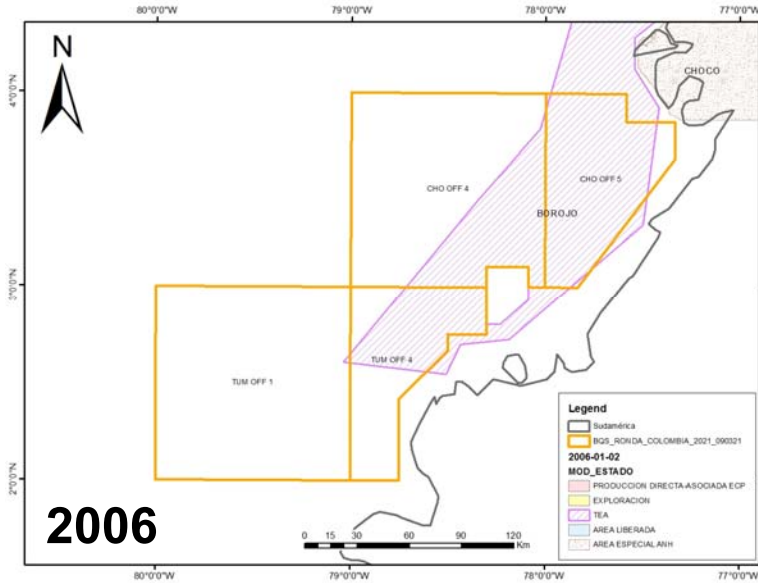
- TUM OFF 1
- TUM OFF 2
- CHO OFF 4
- CHO OFF 5
- ROAD**
- PAVED
- UNPAVED
- Airport
- STORAGE
- PROCESSING FACILITY
- CARRIAGE DRIVING
- SEA PORT
- REFINERY
- PIPELINE

Sea ports of Buenaventura and Tumaco are connected by interdepartmental roads with center of the country.

Both of ports have oil storage infrastructure connected by pipe from production zones.

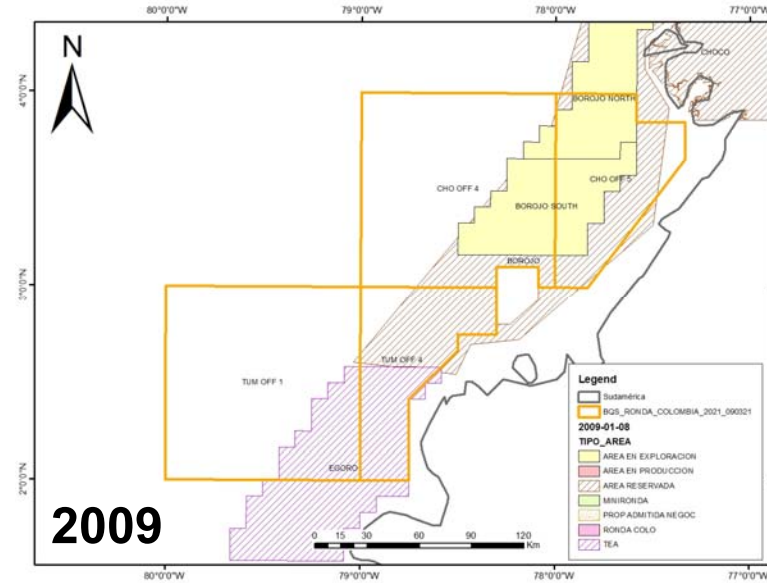
Both of them have airport.

HISTORY OF EXPLORATION



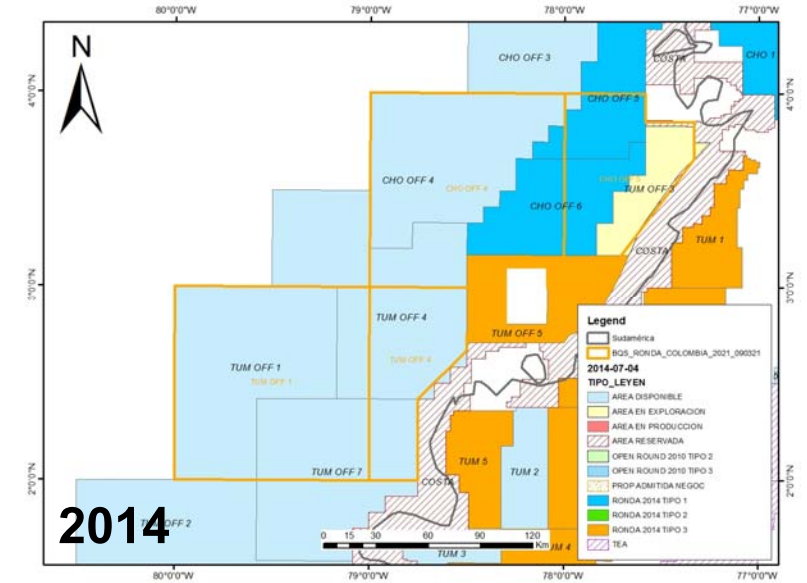
2006

In 2006, Reliance signed the Borojo TEA contract



2009

In 2007, Reliance transformed two blocks of previous TEA in Borojo North and Borojo South E&P.
In 2008, Ecopetrol signed Egoro TEA contract



2014

In 2011, Ecopetrol signed the TUM OFF-3 E&P contract.
In 2013 Reliance returned two blocks Borojo North and South to ANH.
In 2016 Ecopetrol returned TUM OFF 3 block to ANH.

GEOLOGICAL FRAMEWORK

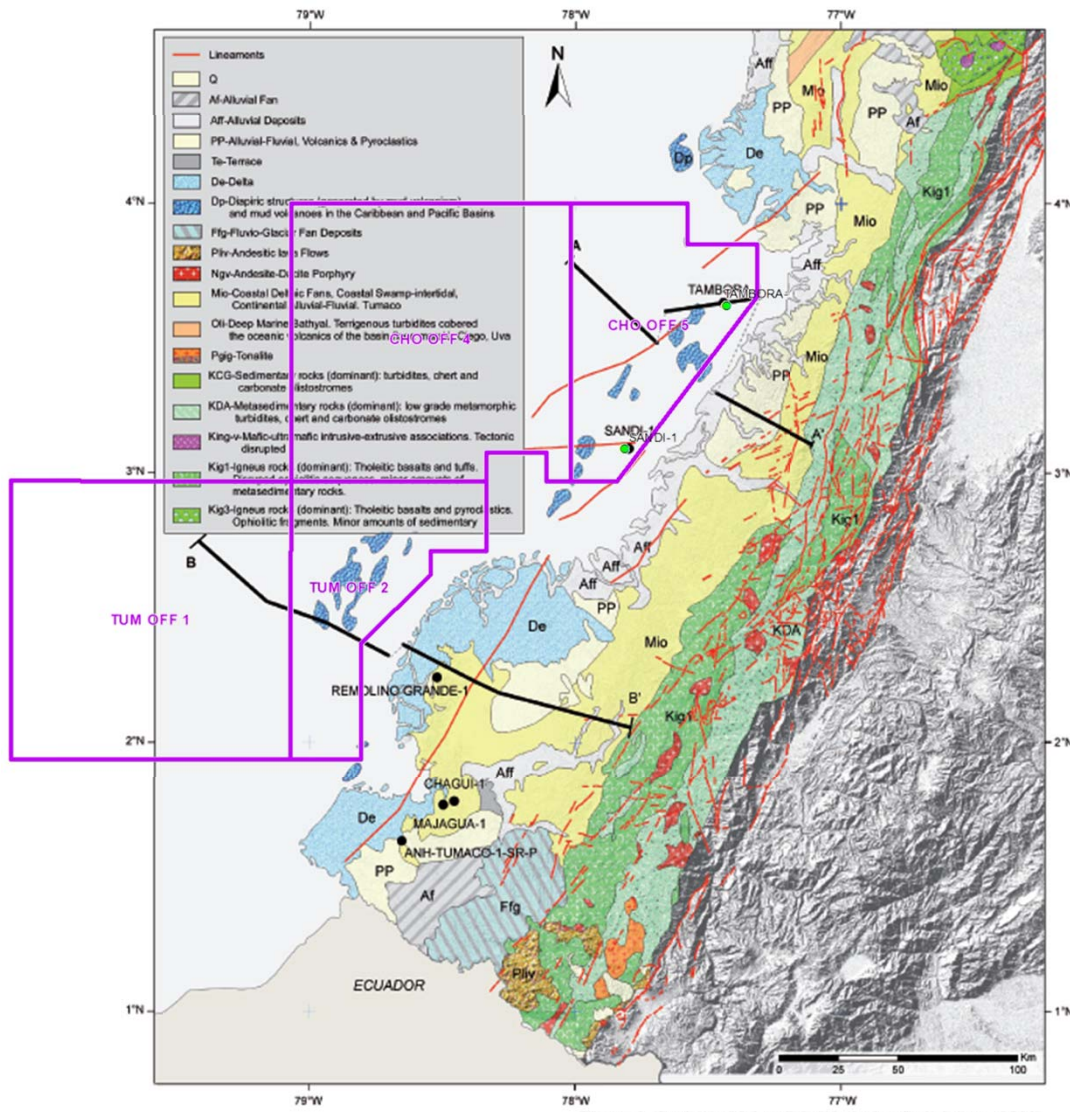
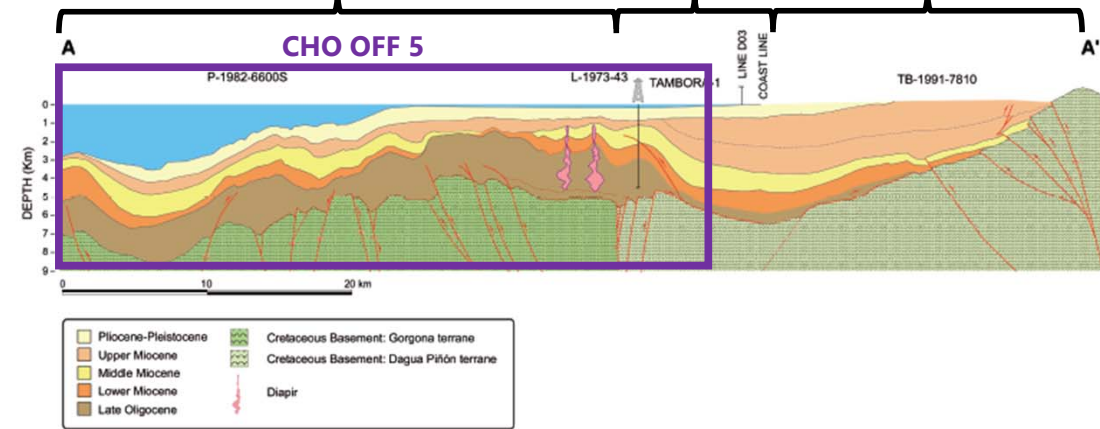


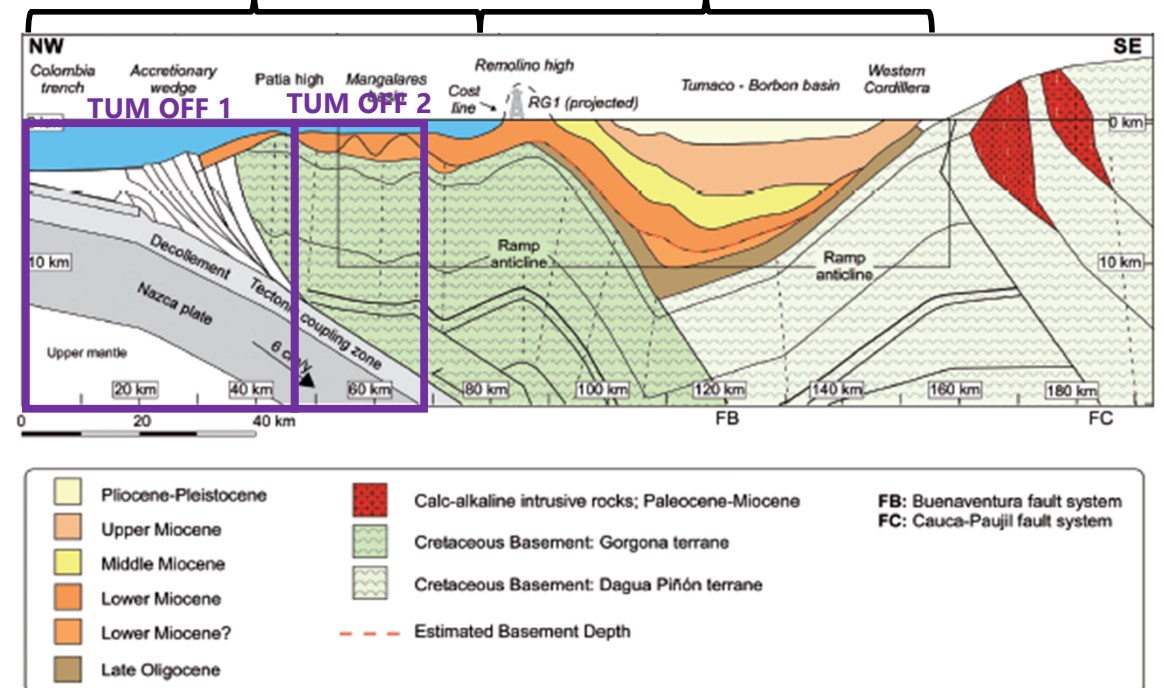
Figure 3. Geological Map. (Modified after Cediel *et al.*, 2000)

Modified after Marín-Cerón, M.I. & Sierra, G. 2011. Tumaco Basin

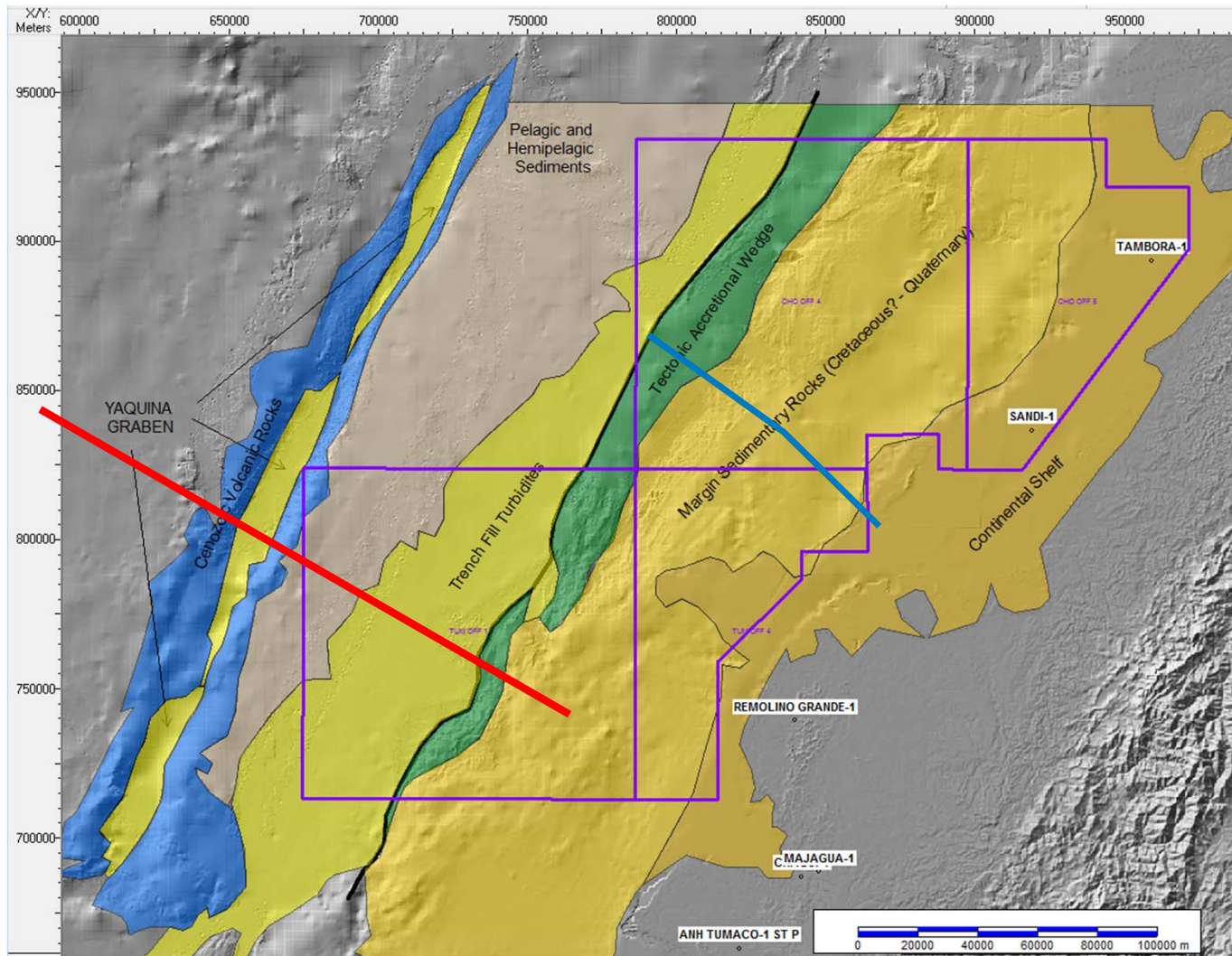
Choco Offshore Basin Offshore Basin Tumaco Basin



Tumaco Offshore Basin Tumaco Basin



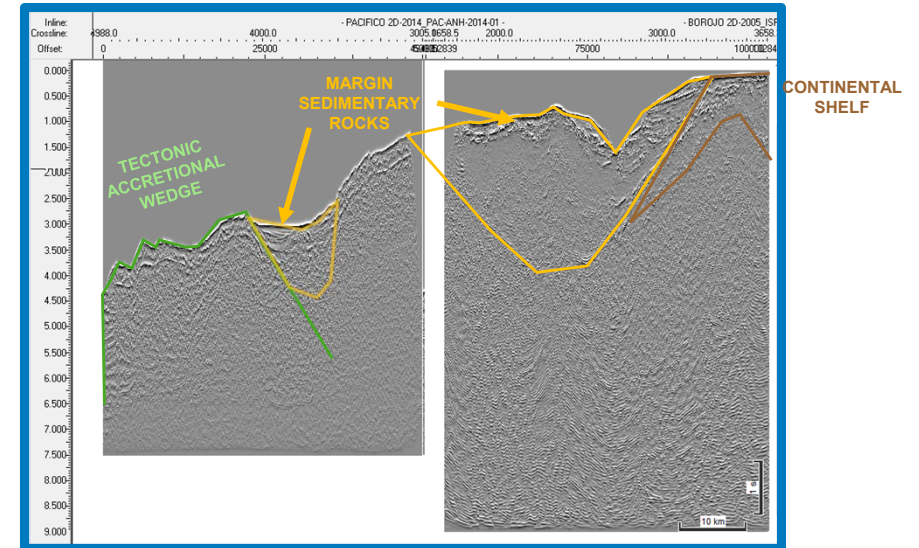
GEOLOGICAL FRAMEWORK



Modified after Collot, J-Y, et al . 2009

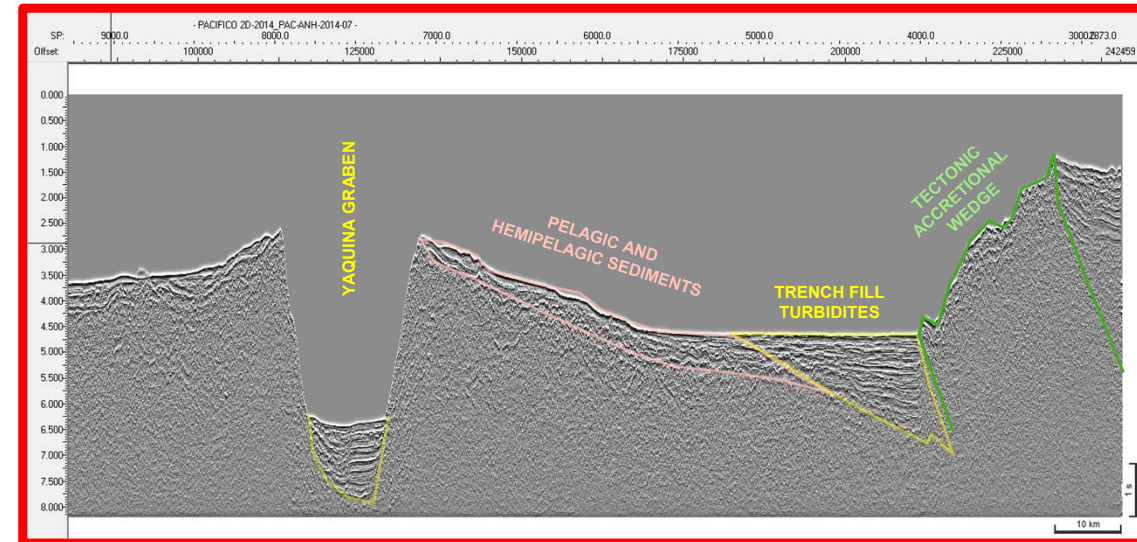
NW

SE

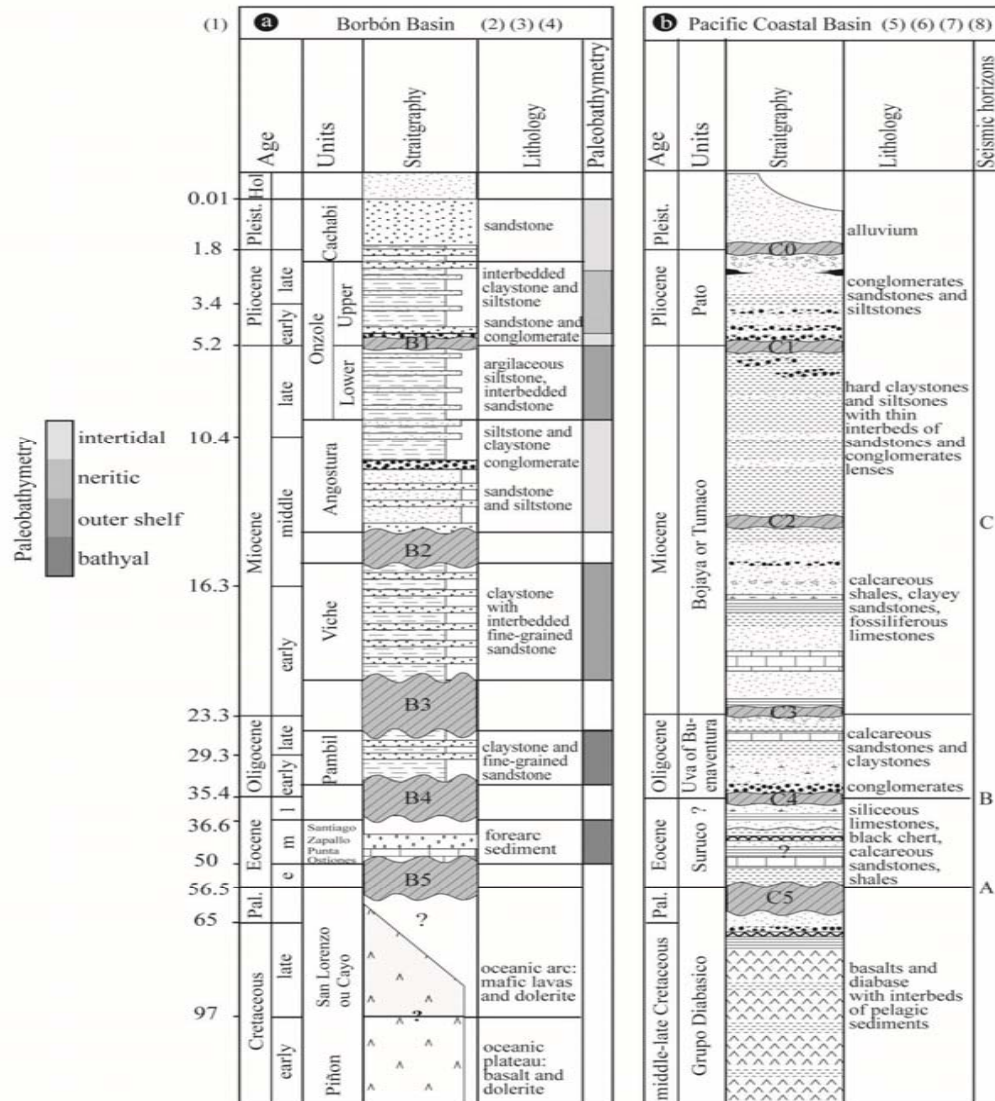


NW

SE



STRATIGRAPHIC COLUMN

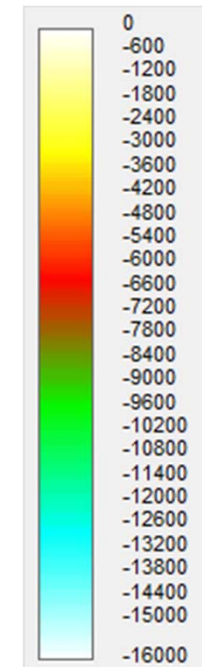
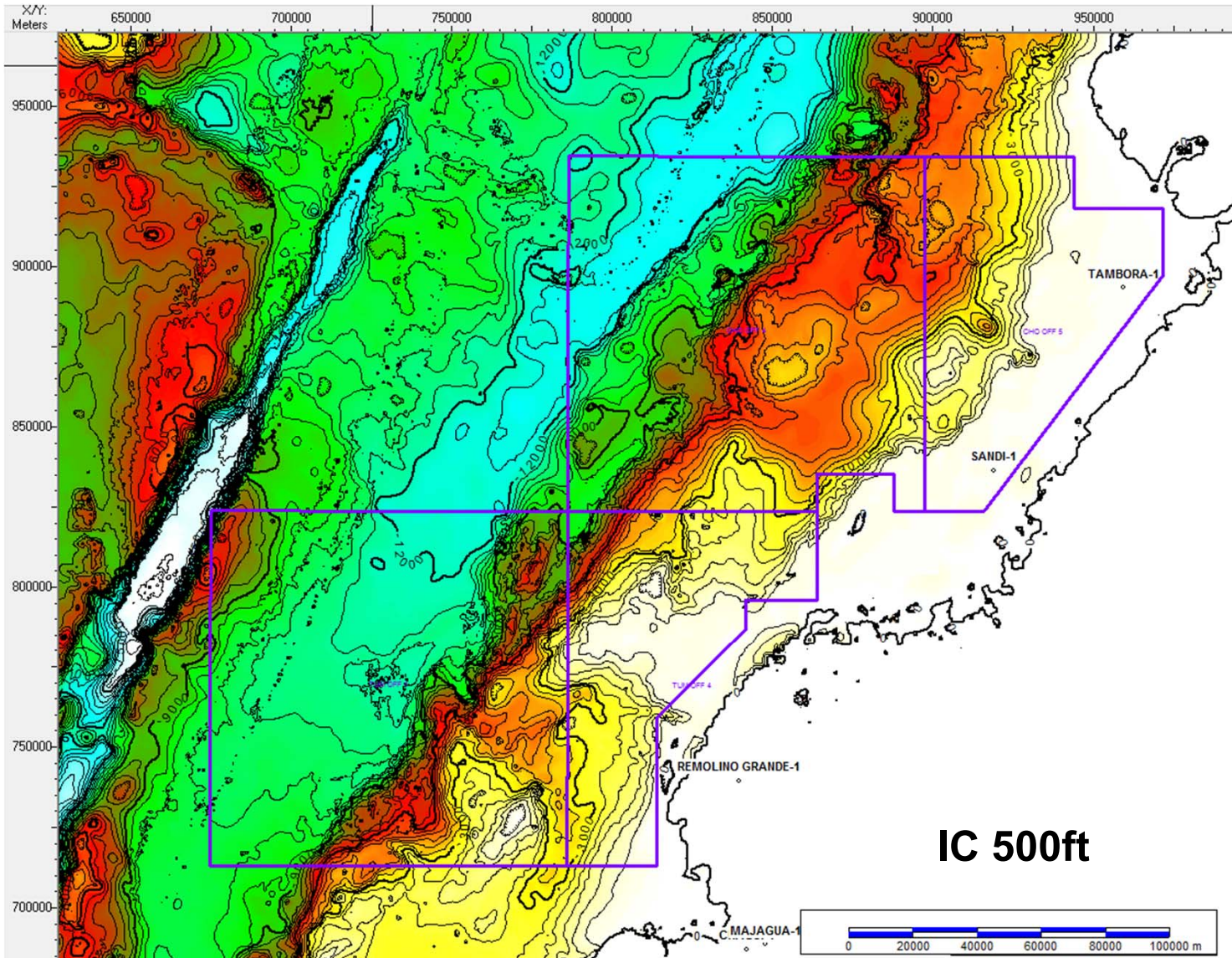


Cronostratigraphic chart of the Borbón basin and Pacific Coastal Basin (Marcaillou, B. et al, 2008)

AGE		Van Der Hammen (1958)	Suarez (1989)	Earthsat (1999)	Duque-Caro (2000)	Marcaillou (2005)	Becerra y Usma (2008)	
QUATERNARY								
PLIOCENE		GUAPI Fm.	GUAPI Fm.	GUAPI Fm.	Sierra Fm.			
MIOCENE	UPPER		San Agustín Chagui			San Agustín	Guapi Fm.	Pliocene
	MIDDLE			San Agustín Chagui	Napipi Sup Fm.	Angostura Fm.	San Agustín Chagui	Miocene Middle Upper
	LOWER	NAYA Fm.	Angostura Fm. Viche Fm.		Napipi Inf. Fm.	Naya Fm.	Viche Fm.	Miocene Middle Lower
OLIGOCENE			Cayapas Fm.	Cayapas Fm.			Cayapas Fm.	Miocene Lower
EOCENE	UPPER	PACIFIC GROUP	Unit 1 South		UVA Fm			
	MIDDLE	???????		Intrusive granite	?		Unit 1 South	Unit 1 South Rocks sedimentary vulcano
	LOWER							
PALEOCENE					PRE-UVA			
CRETACEOUS			DAGUA GROUP			Diabasic Group	Diabasic Group Dagua Group	Diabasic Group Dagua Group

Stratigraphic chart of the Tumaco basin. Comparative chart of the different suggested nomenclatures (Cediel, F., et al, 2009)

BATHYMETRY



CHO OFF 4

above -3000 ft (7.6%)
above -6000 ft (44.1%)

CHO OFF 5

above -3000 ft (76.5%)
above -6000 ft (98.9%)

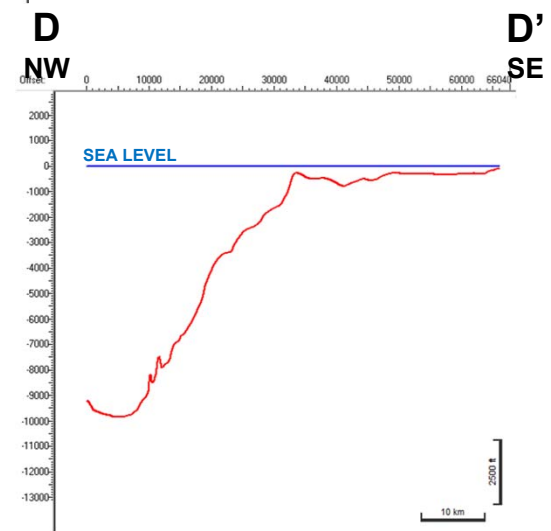
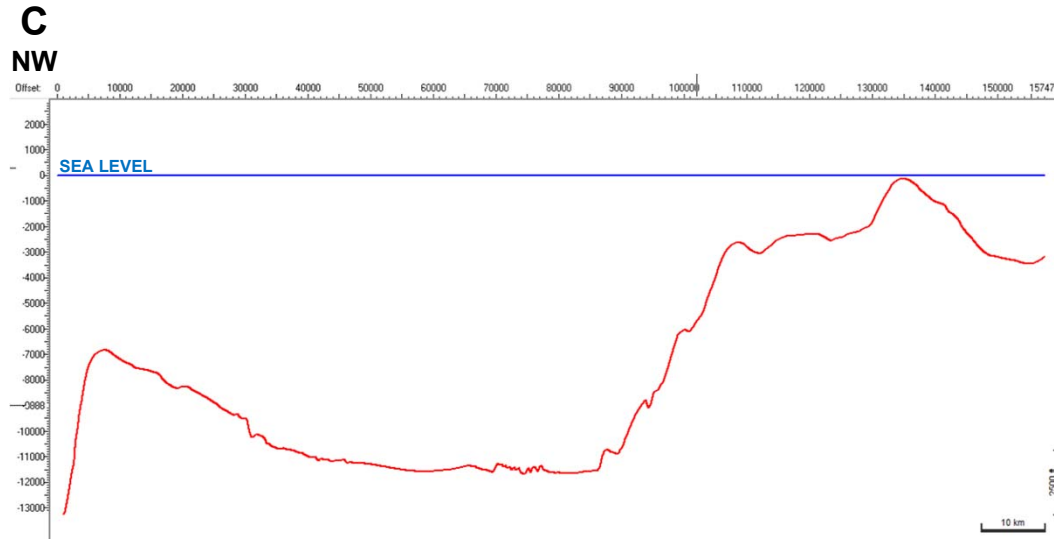
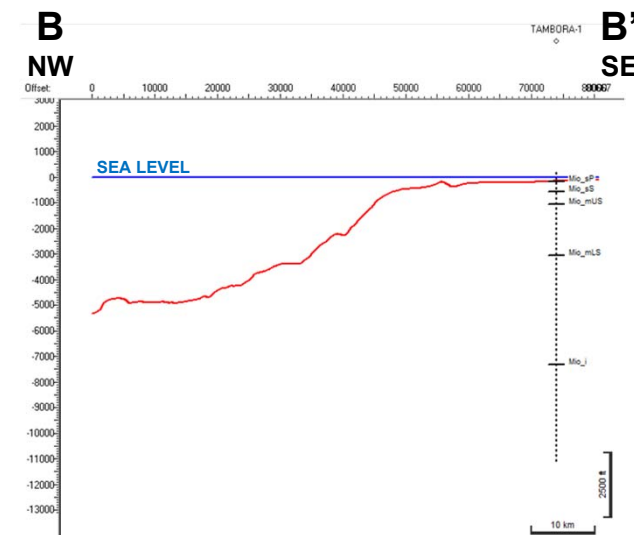
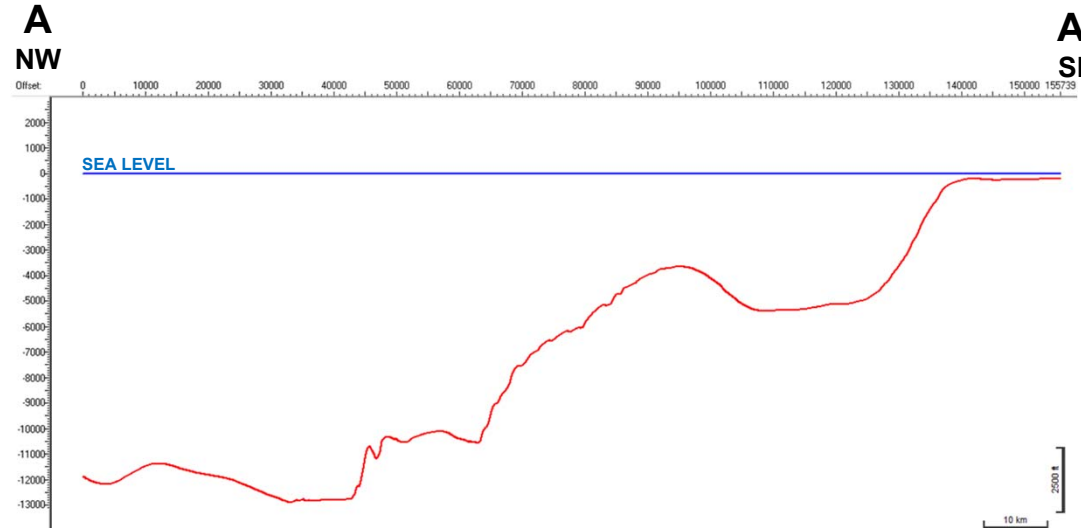
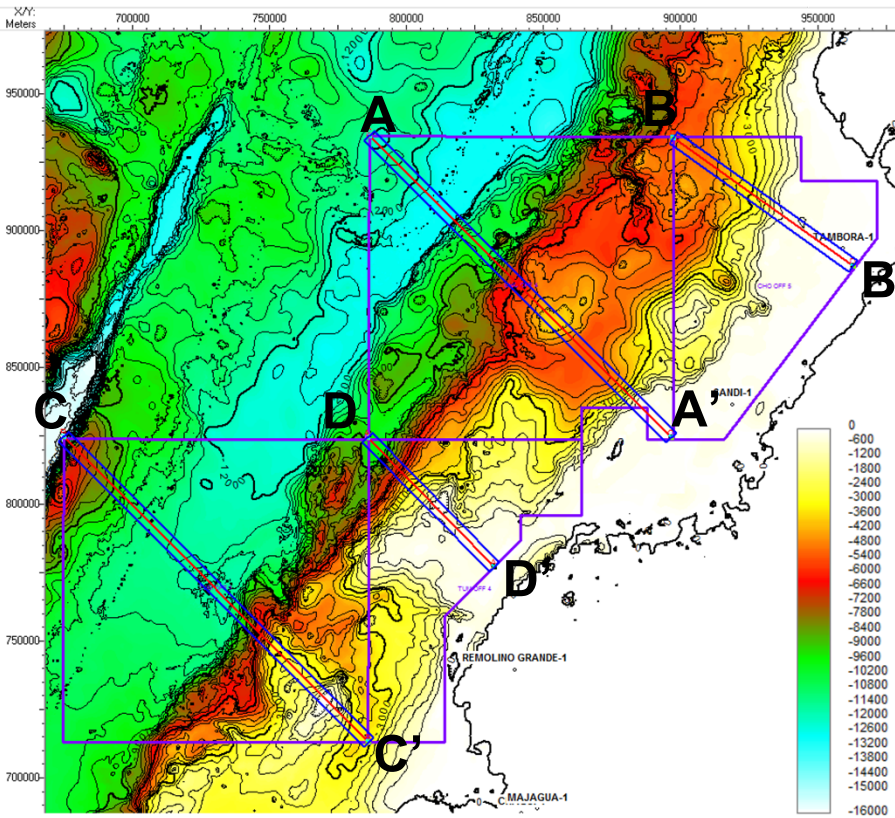
TUM OFF 1

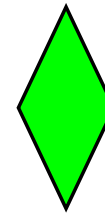
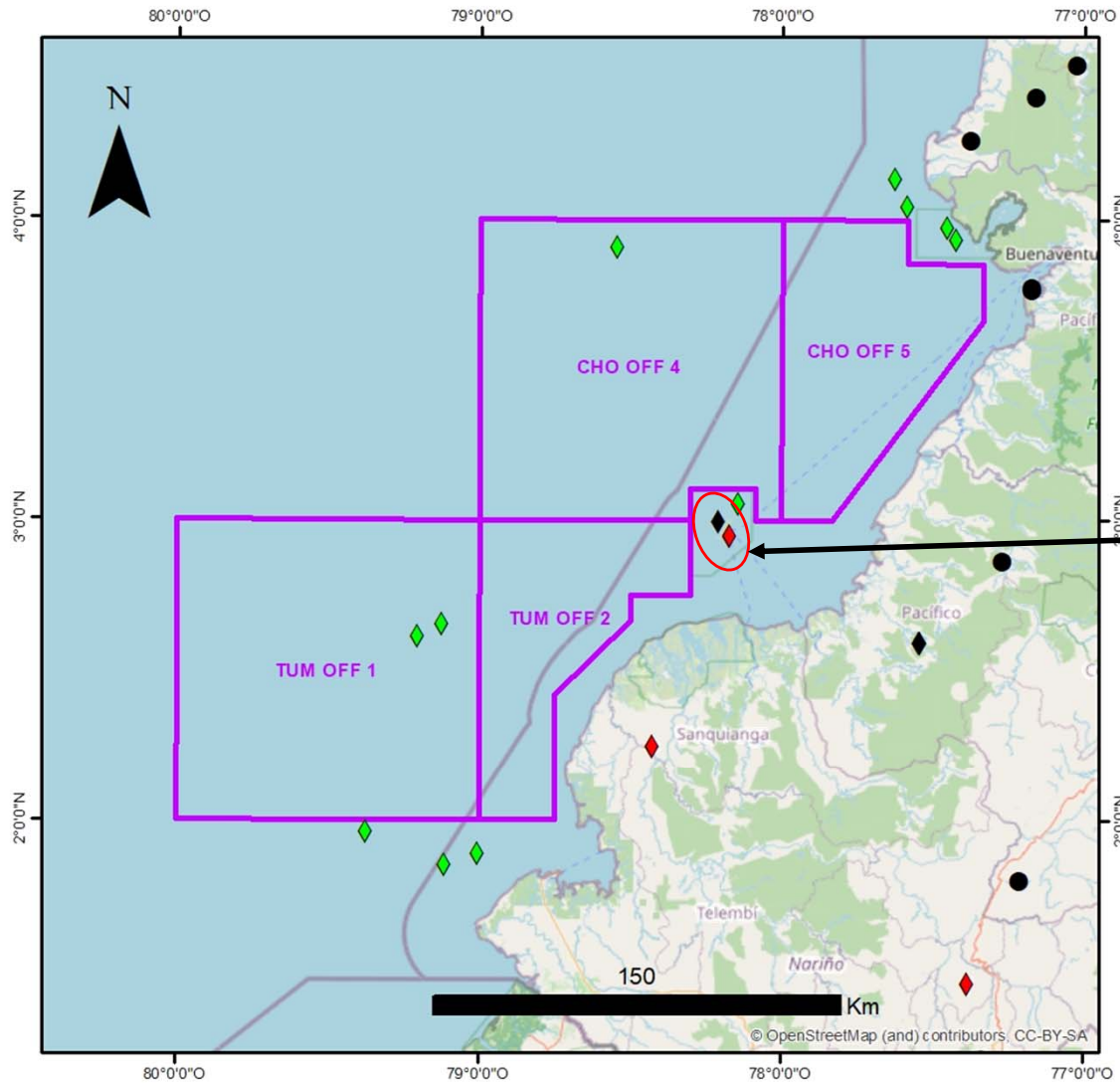
above -3000 ft (7.8%)
above -6000 ft (22.9%)

TUM OFF 2

above -3000 ft (80.2%)
above -6000 ft (94.1%)

BATHYMETRIC PROFILES





Marine oil seep ranked to slick
Discovered by Earth Satellite Corp. (2007)

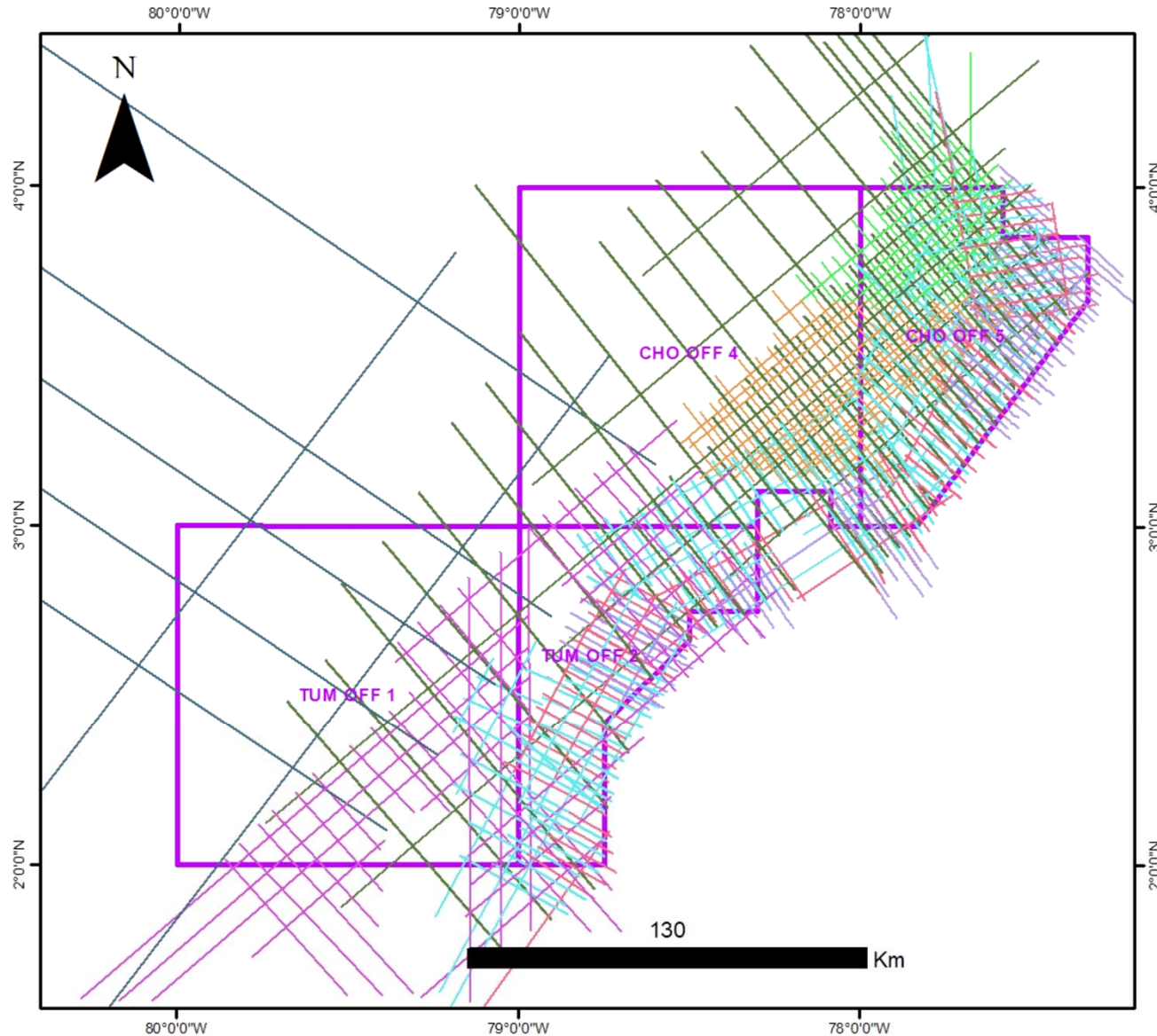
Oil Seeps
Discovered by Shell Condor S.A. (1966) in Gorgona Island

LEGEND

TIPO_SEEP	
◆	ASPHALT
◆	GAS
◆	OIL SLICK
●	OIL
□	TUM OFF 1
□	TUM OFF 2
□	CHO OFF 4
□	CHO OFF 5

DATABASE

Database (2D Seismic Information – EPIS DB)



LEGEND

2D SEISMIC SURVEY_NAM

- BOROJO 2D-2005
- BOROJO NORTH 2D-2009
- BOROJO SOUTH 2D-2009
- PACIFICO 2D-2014
- PACIFICO MC 2D-2009
- PACIFICO-73
- PACIFICO-78
- PACIFICO-82
- TUM OFF 1
- TUM OFF 2
- CHO OFF 4
- CHO OFF 5

• 8 Seismic Program (447 lines) Total coverage 17547 Km

TUM OFF 1

SURVEY	LINES	TOTAL LENGTH	LENGTH INSIDE
BOROJO 2D-2005	7	1222.71	518.76
PACIFICO 2D-2014	6	1592.88	492.33
PACIFICO MC 2D-2009	24	2083.67	1137.79
PACIFICO-73	2	90.39	8.93
PACIFICO-82	16	626.95	259.88
Total general	55	5616.59	2417.69

TUM OFF 2

SURVEY	LINES	TOTAL LENGTH	LENGTH INSIDE
BOROJO 2D-2005	13	2050.61	597.10
PACIFICO 2D-2014	1	282.90	12.88
PACIFICO MC 2D-2009	28	2437.78	857.78
PACIFICO-73	33	1093.65	776.10
PACIFICO-78	23	678.91	468.83
PACIFICO-82	58	2210.03	1271.86
Total general	156	8753.87	3984.54

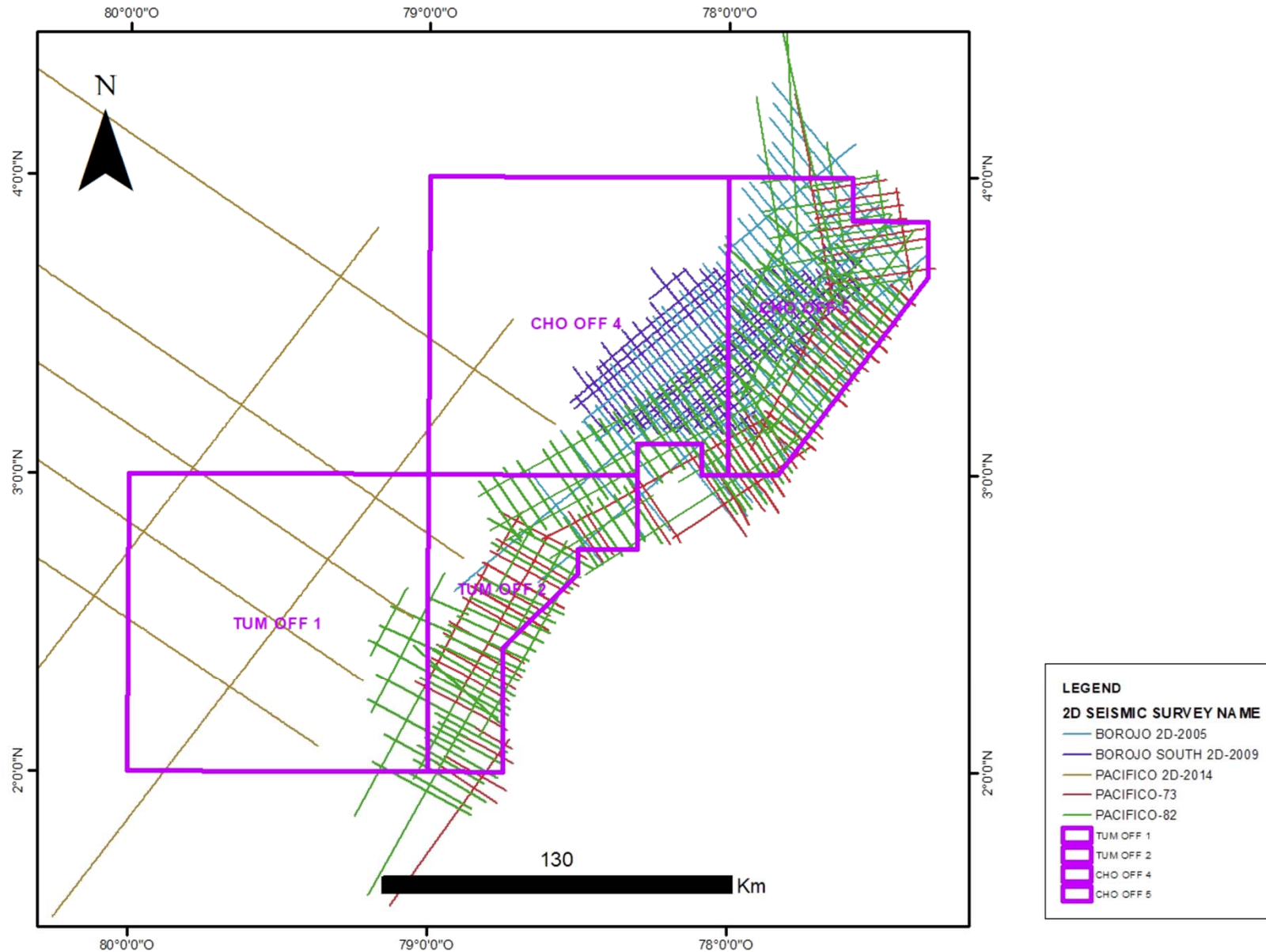
CHO OFF 4

SURVEY	LINES	TOTAL LENGTH	LENGTH INSIDE
BOROJO 2D-2005	34	4275.00	1737.51
BOROJO NORTH 2D-2009	10	347.40	112.97
BOROJO SOUTH 2D-2009	28	1451.82	1052.75
PACIFICO 2D-2014	2	562.46	101.33
PACIFICO MC 2D-2009	11	813.12	263.69
PACIFICO-73	6	274.83	42.53
PACIFICO-78	9	336.16	74.81
PACIFICO-82	32	1190.63	574.84
Total general	132	9251.42	3960.43

CHO OFF 5

SURVEY	LINES	TOTAL LENGTH	LENGTH INSIDE
BOROJO 2D-2005	37	4731.30	2220.79
BOROJO NORTH 2D-2009	24	1070.85	734.99
BOROJO SOUTH 2D-2009	30	1321.51	715.88
PACIFICO-73	34	1183.43	825.10
PACIFICO-78	43	1365.63	937.23
PACIFICO-82	73	2501.65	1750.28
Total general	241	12174.37	7184.26

Database (2D Seismic Information – Loaded Information)



• 5 Seismic Program (269 lines) Total coverage 10165 Km

TUM OFF 1

SURVEY	LINES	TOTAL LENGTH	LENGTH INSIDE
PACIFICO 2D-2014	6	1632.74	501.35
PACIFICO-73	2	92.10	8.56
PACIFICO-82	18	665.61	272.30
Total general	26	2390.45	782.21

TUM OFF 2

SURVEY	LINES	TOTAL LENGTH	LENGTH INSIDE
BOROJO 2D-2005	5	553.11	182.80
PACIFICO 2D-2014	1	288.69	17.12
PACIFICO-73	26	926.86	626.34
PACIFICO-82	57	2159.27	1235.08
Total general	89	3927.93	2061.35

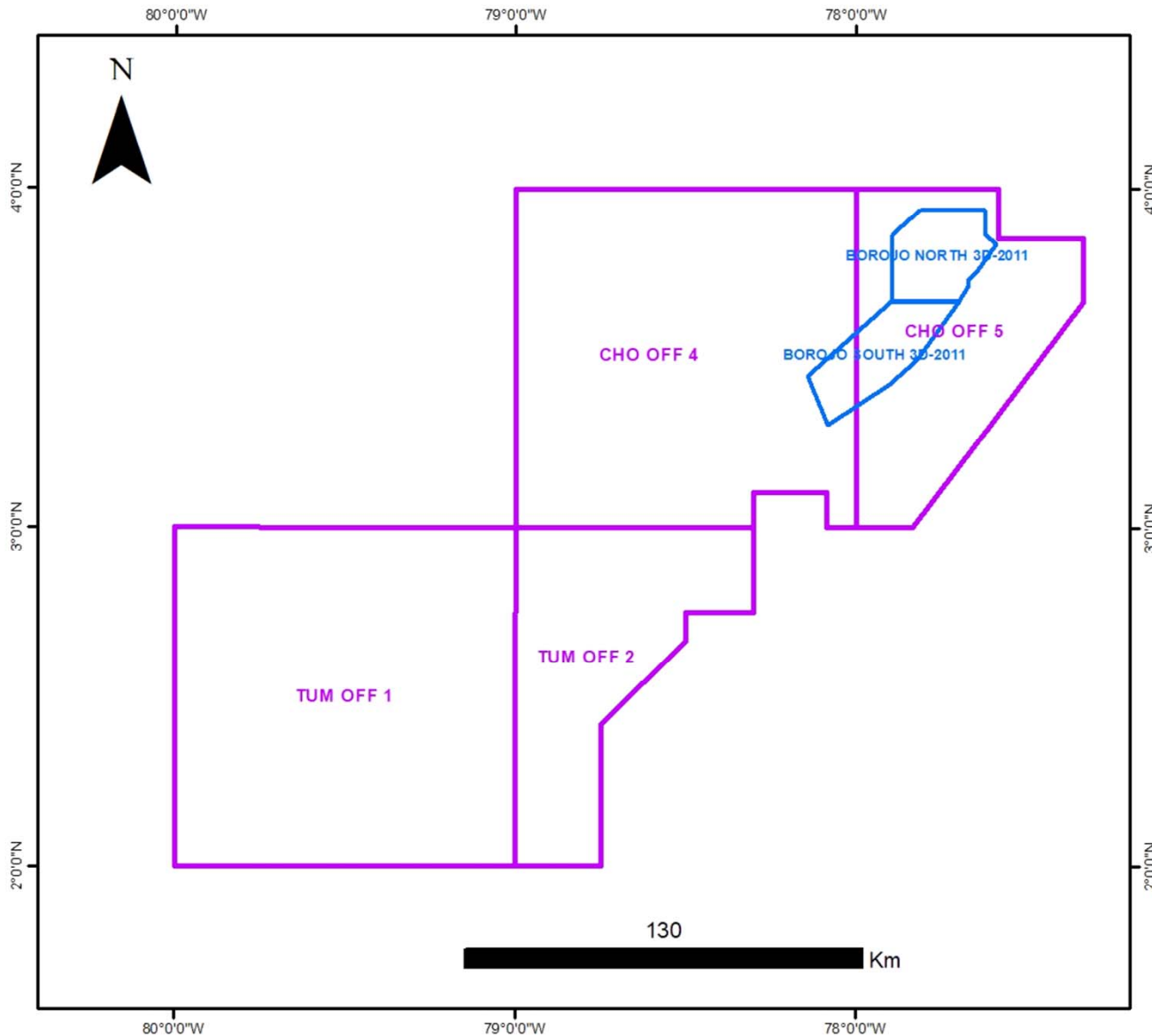
CHO OFF 4

SURVEY	LINES	TOTAL LENGTH	LENGTH INSIDE
BOROJO 2D-2005	25	2050.33	771.61
BOROJO SOUTH 2D-2009	28	1427.22	1035.97
PACIFICO 2D-2014	2	578.89	111.58
PACIFICO-73	6	279.41	43.95
PACIFICO-82	30	1158.65	560.50
Total general	91	5494.51	2523.62

CHO OFF 5

SURVEY	LINES	TOTAL LENGTH	LENGTH INSIDE
BOROJO 2D-2005	30	2568.83	1587.79
BOROJO SOUTH 2D-2009	31	1396.87	761.98
PACIFICO-73	29	1056.82	698.63
PACIFICO-82	62	2504.32	1750.30
Total general	152	7526.85	4798.70

Database (3D Seismic Information)



LEGEND

- ▭ 3D SEISMIC
- ▭ TUM OFF 1
- ▭ TUM OFF 2
- ▭ CHO OFF 4
- ▭ CHO OFF 5

CHO OFF 4

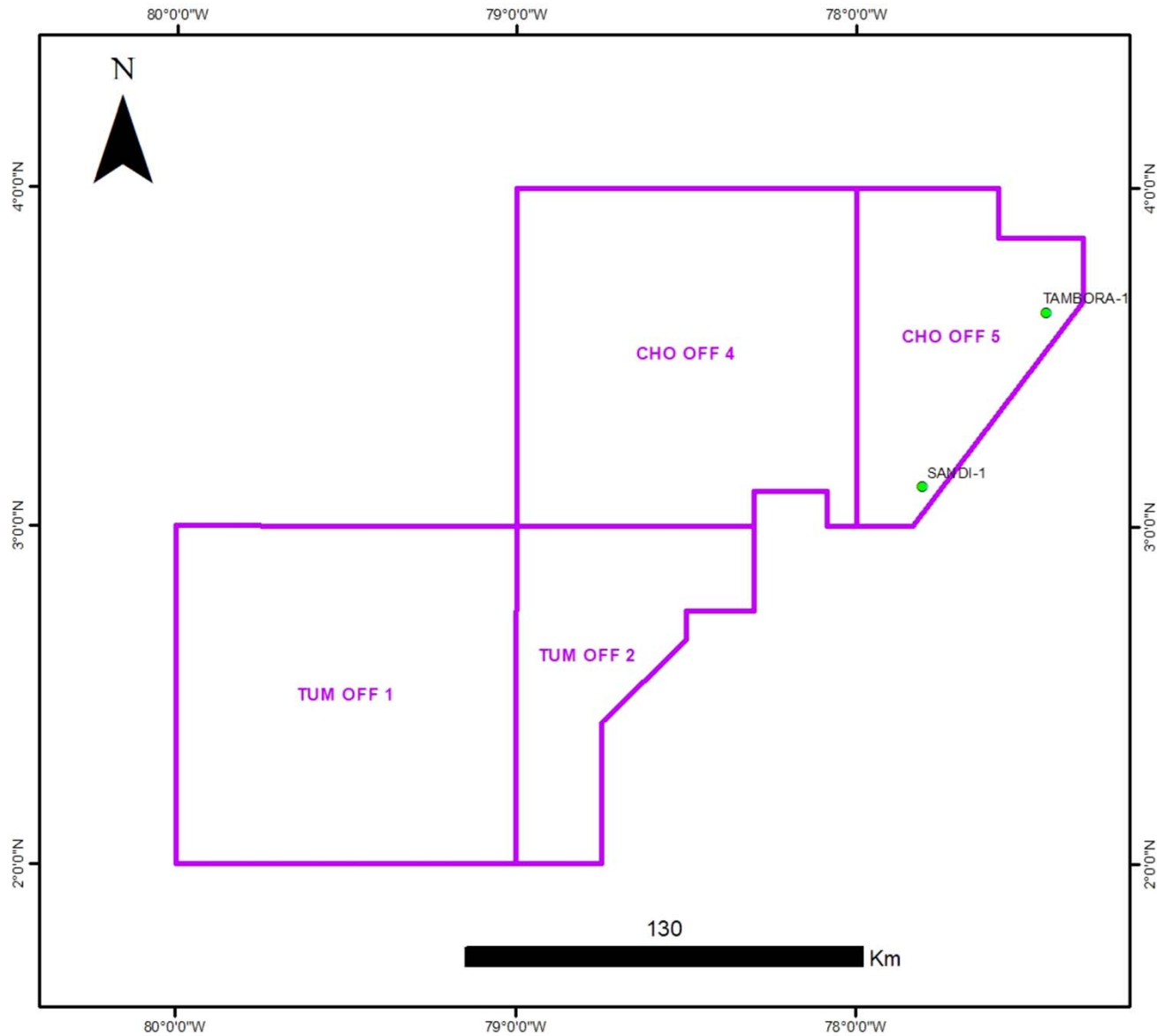
SURVEY	Area (Km2)	
	TOTAL	INSIDE
BOROJO SOUTH 3D-2011	897.36	285.16
Total Coverage	285.2	

CHO OFF 5

SURVEY	Area (Km2)	
	TOTAL	INSIDE
BOROJO NORTH 3D-2011	834.55	831.22
BOROJO SOUTH 3D-2011	897.36	608.27
Total Coverage	1433.3	

- **2 Seismic Program (1725 Km²)**
- **Total coverage 4.9%**
- **CHO OFF 4 (2.3%)**
- **CHO OFF 5 (24.8%)**

Database (Well Information)



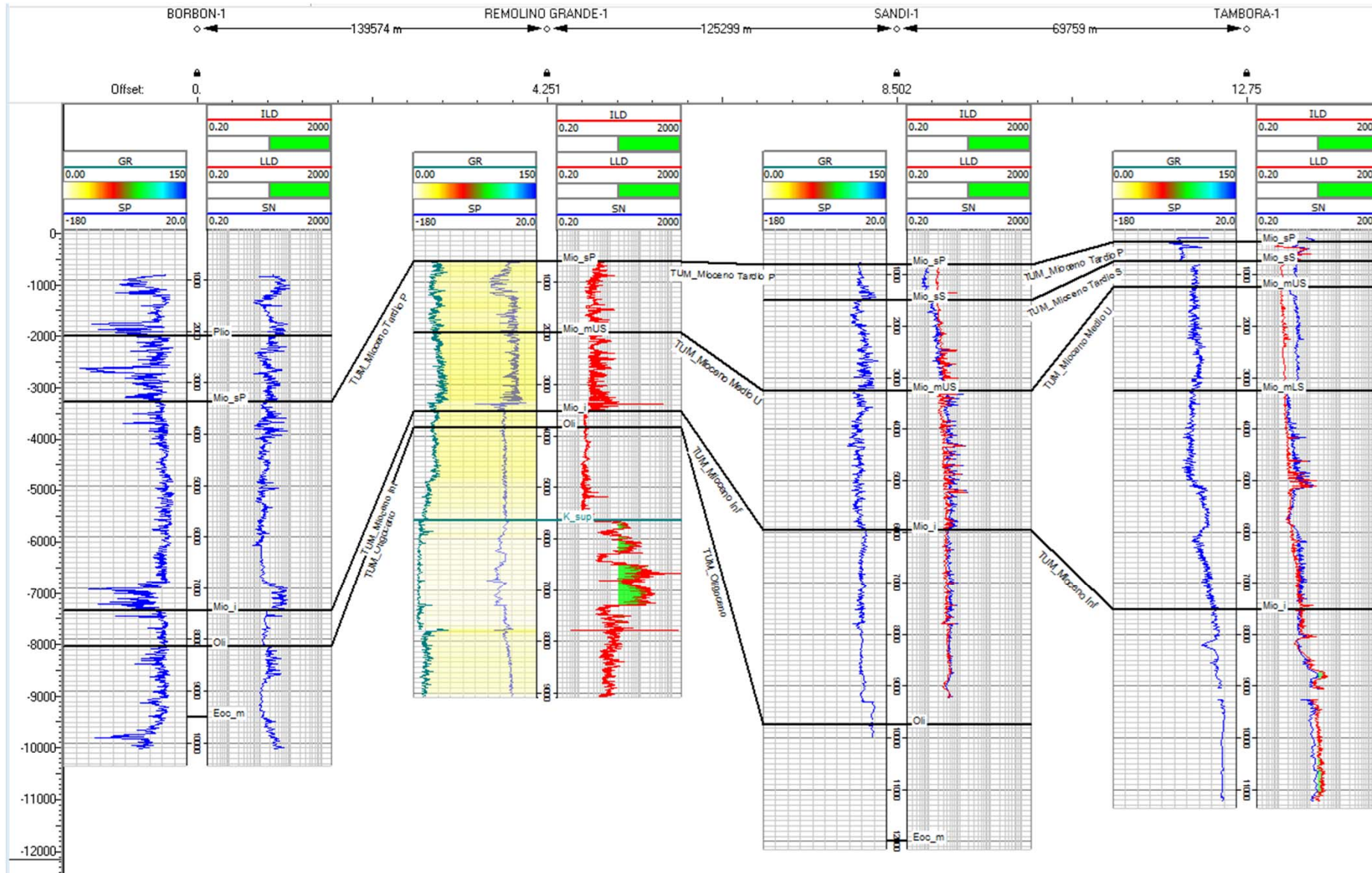
CHO OFF 5

WELL_NAME	SPUD DATE	RTE (ft)	TOTAL DEPTH (ft)
TAMBORA-1	18/02/1967	194	11365
SANDI-1	20/05/1967	194	12161

- **2 Wells drilled only in CHO OFF 5 Area**

WELL SUMMARY

WELL CORRELATION



SANDI-1

The well is drilled along the flank of an anticline, with a dip of 30-35 degrees.

CORE	INTERVAL	REC_FT	REC%	AGE	OBSERVATIONS
1	3222' - 3258'	5	14	Early Miocene	
2	5026' - 5050'	18	75	Early Miocene	
3	5845' - 5863'	11	61	Early Miocene	5% POR
4	6721' - 6746'	15	60	Early Miocene	
5	8655' - 8672'	7	41	Early Miocene	
6	9310' - 9324'	9	61	Early Miocene	No shows 8%POR
7	9891' - 9901'	4	40	Early Miocene	
8	10898' - 10914'	16	100	Early Miocene	
9	11328' - 11342'	11	79	Early Miocene	Some gas along Fractures
10	11860' - 11878'	18	100	Early Miocene	

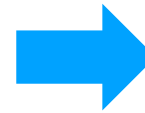
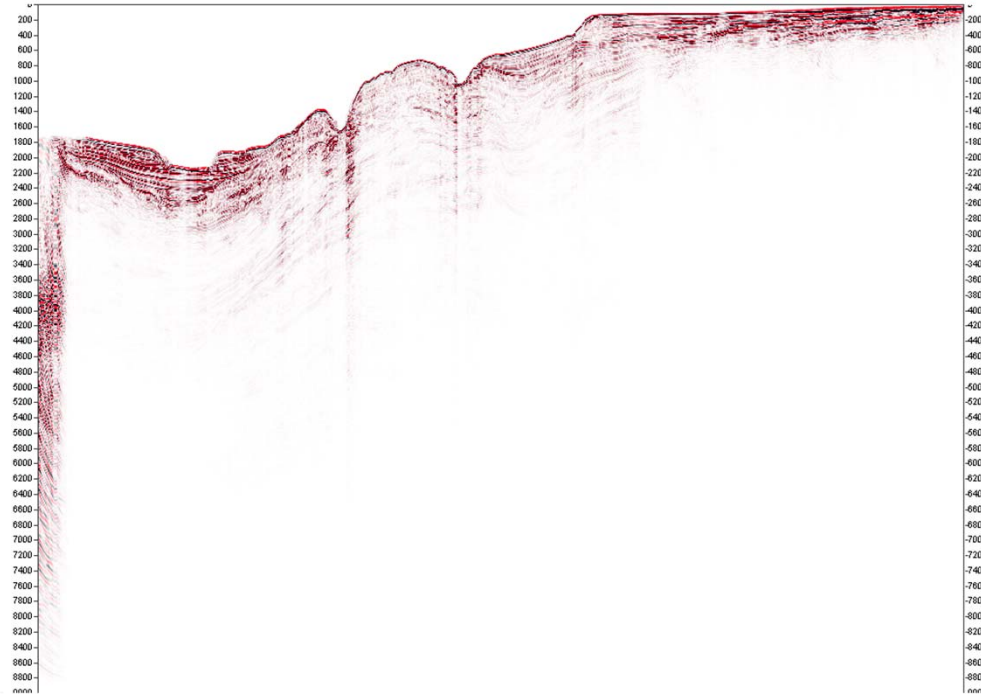
TAMBORA-1

The well was drilled on the flank of an anticline in the inner portion of the Central Basin and High area. Minor shows of gas were encountered throughout the well, and tar (biodegraded (?) residual oil) was found within the La Mojarrá Conglomerate Formation at 9625 feet. It

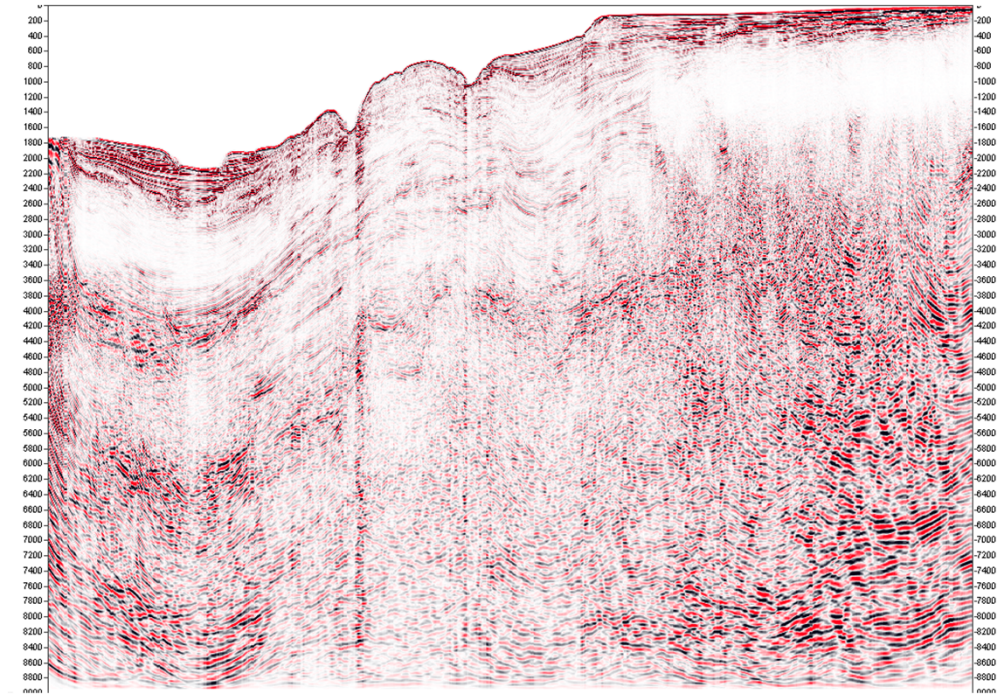
SEISMIC INTERPRETATION

Dip Line ISPBD-2005-422094

Normalized Amplitude

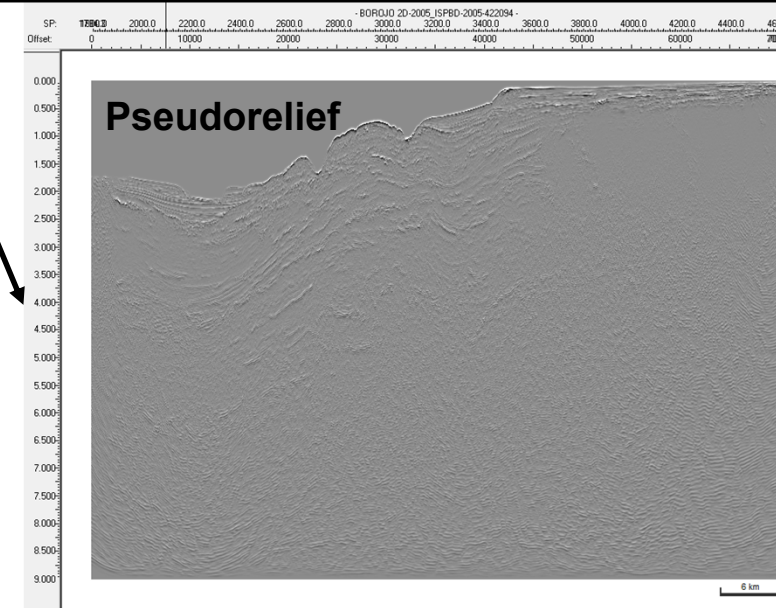
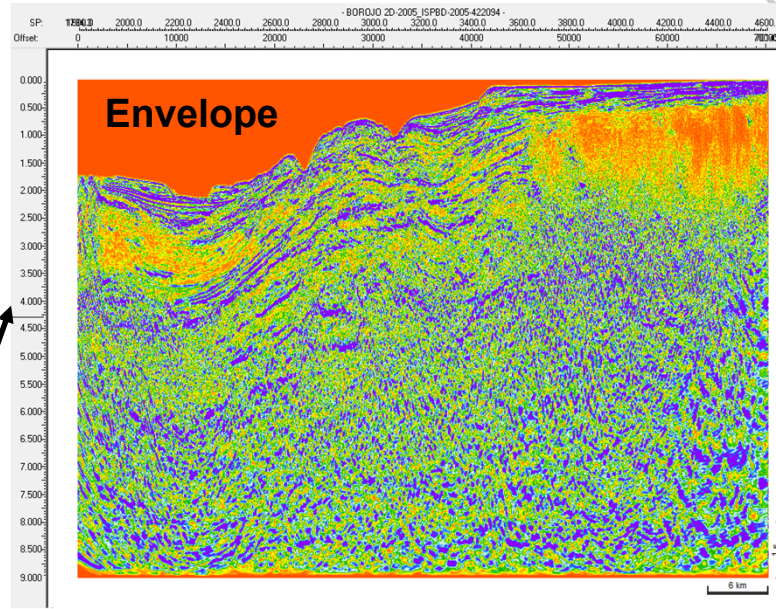
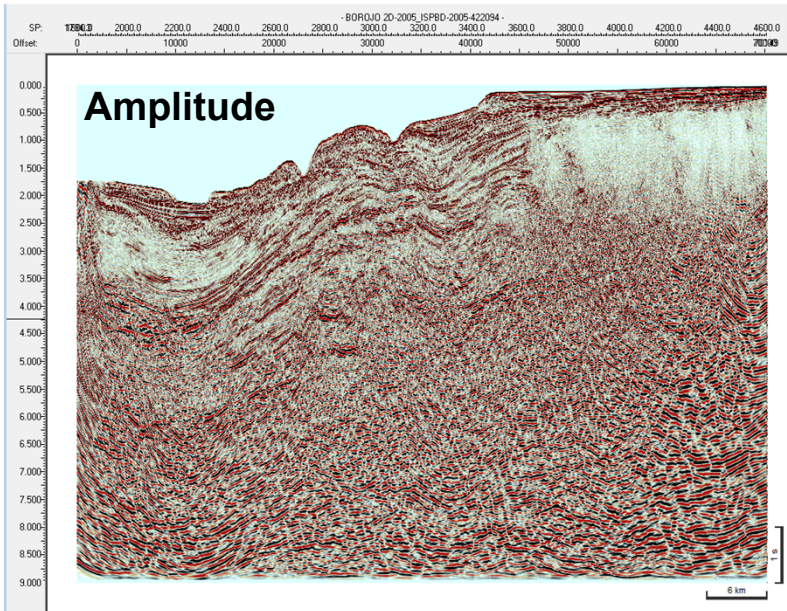


AGC Processing

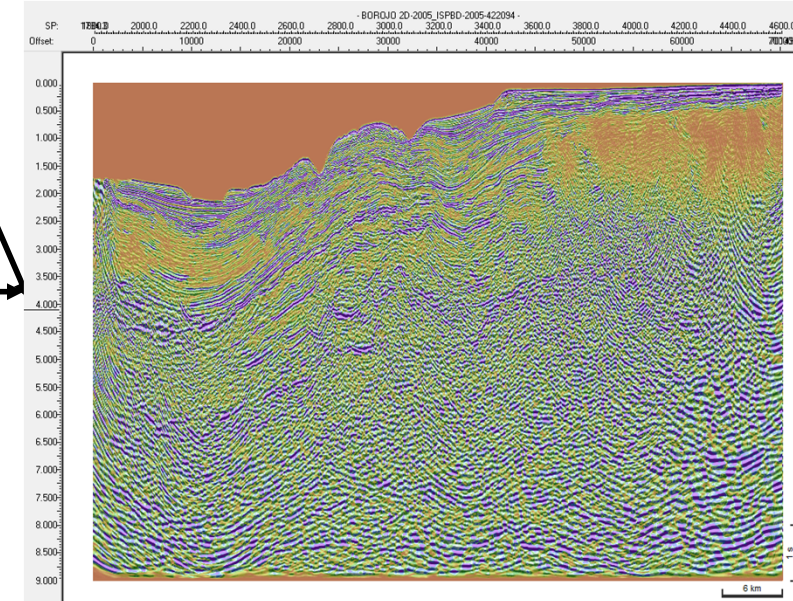


In Borojo 2D-2005 and Borojo South 2D-2009 surveys is necessary apply a AGC Processing for recover reflections occults in a Normalized load of interactive software

Dip Line ISPBD-2005-422094



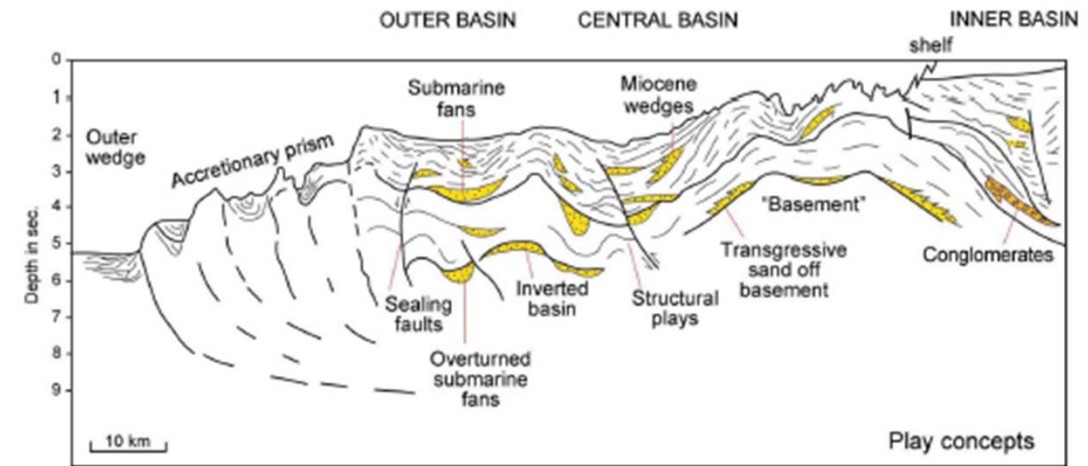
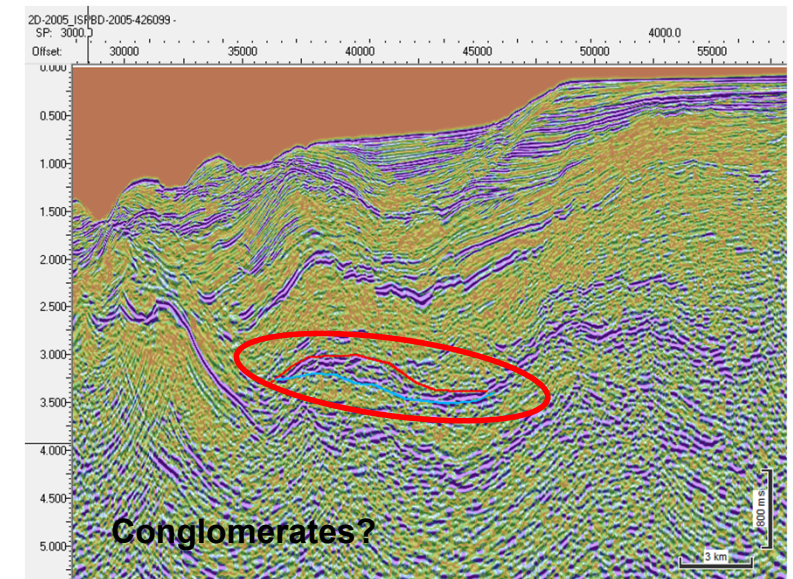
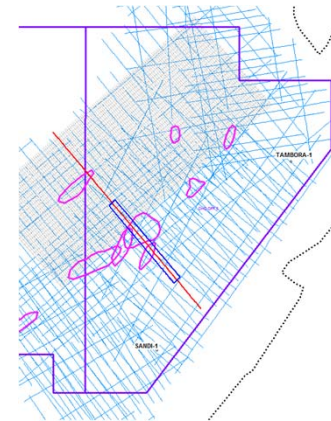
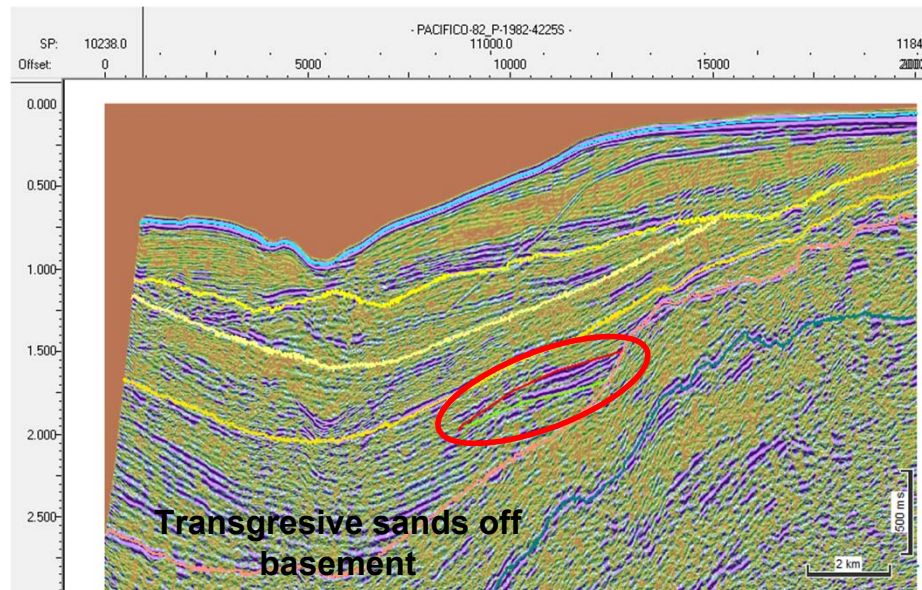
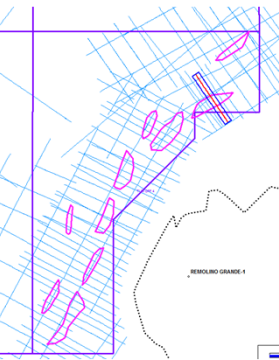
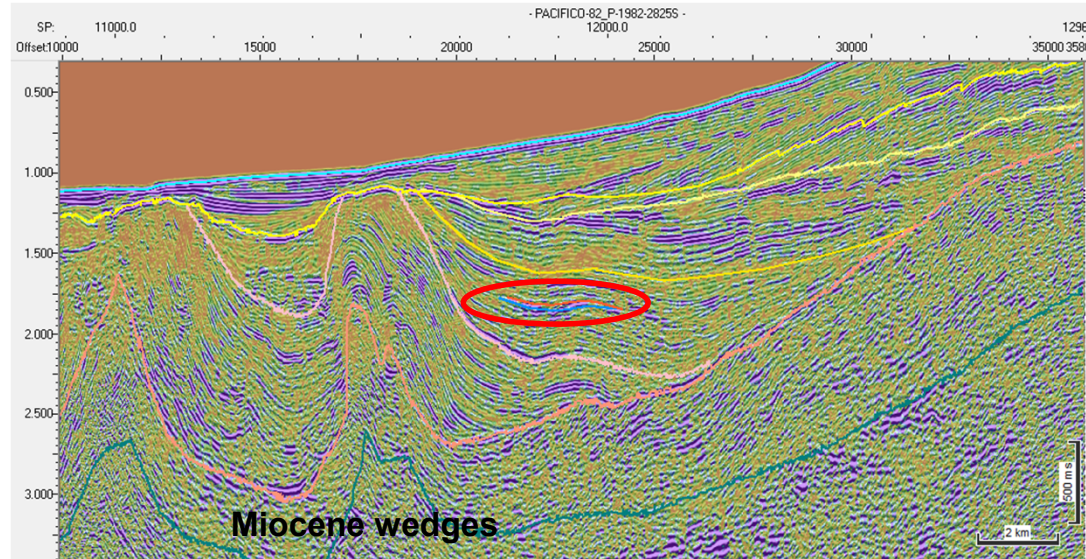
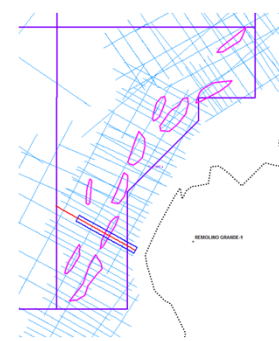
Coblending Amplitude-Envelope



For all seismic programs the envelope and pseudo-relief seismic attributes were calculated.

- Envelope helps define sequence boundaries, unconformities and to some extent lithology changes
- Pseudo relief allows to improve the correlation of stratigraphic and structural features such as faults and channels.

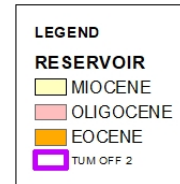
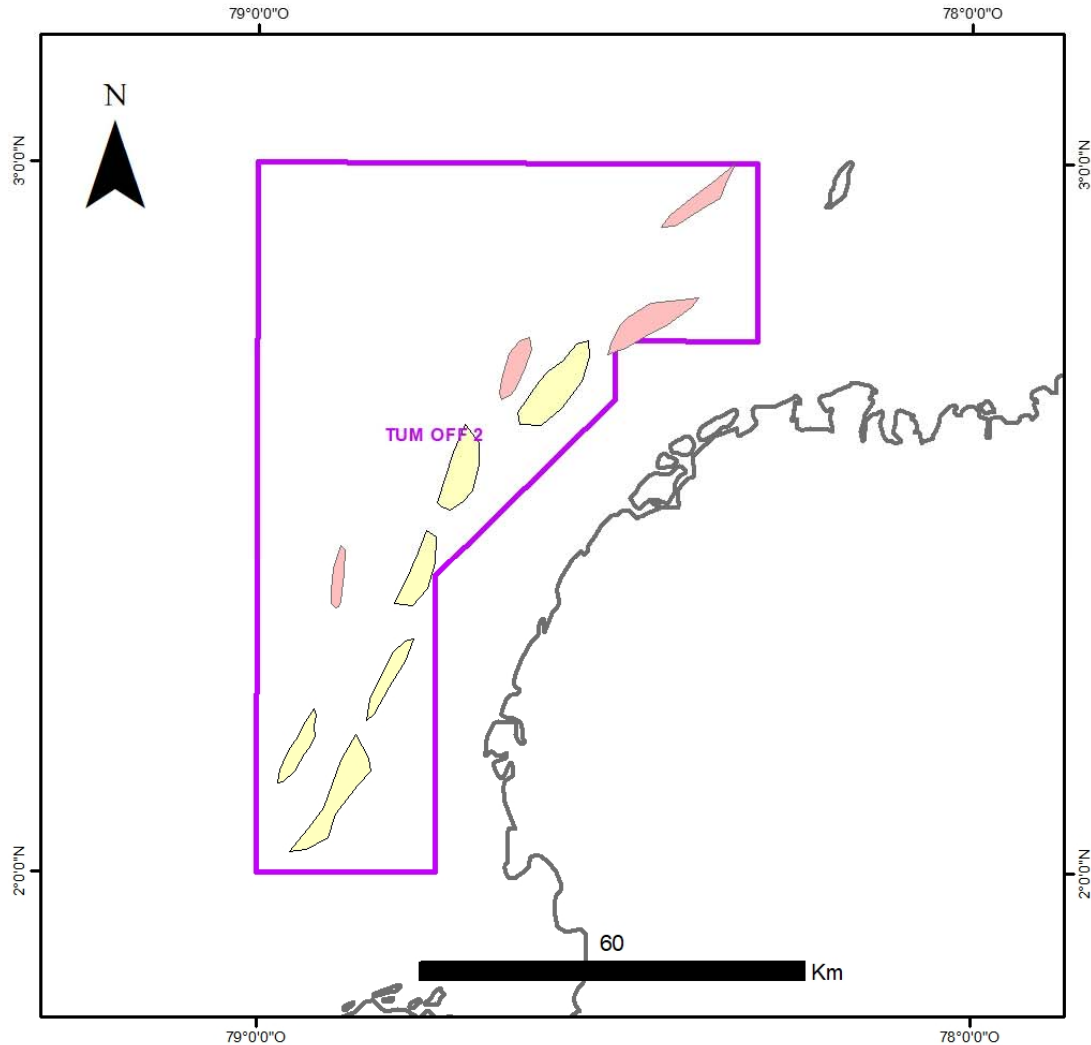
SEISMIC INTERPRETATION



Play Concepts of Pacific Region. Taken from Bockelie, J.F. et al 2007

PROSPECTIVE RESOURCES

TUM OFF-2 - PROSPECTIVITY



PROSPECTIVE RESOURCES

10 LEAD

Prospective Resources

Lead No	AREA (Acres)	OOIP (MMBO)	OGIP (BCF)	Prospective Resources	
				MMBO	BCF
1	6636	367	867	9.17	61
2	11577	640	1513	16.01	106
3	6078	336	794	8.40	56
4	16489	912	2155	22.80	151
5	11943	660	1561	16.51	109
6	8919	493	1165	12.33	82
7	3333	184	436	4.61	30
8	5941	329	776	8.21	54
9	5814	322	760	8.04	53
10	15168	839	1982	20.97	139

OOIP: 5082 MMBO

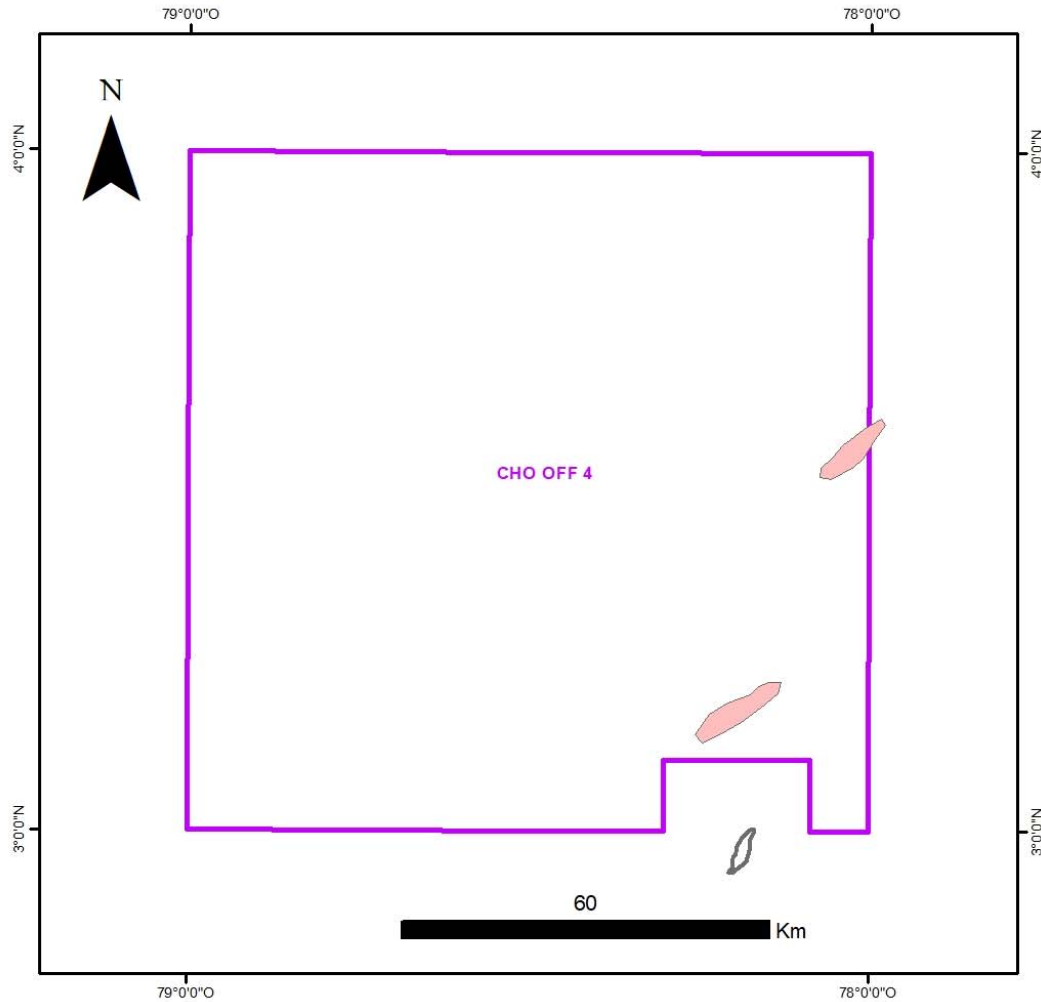
OGIP: 12 TCF

PROSPECTIVE RESOURCES:

127 MMBO

840BCF

CHO OFF-4 - PROSPECTIVITY



LEGEND

	MIOCENE
	OLIGOCENE
	EOCENE
	CHO OFF 4

PROSPECTIVE RESOURCES

2 LEAD

Prospective Resources

Lead No	AREA (Acres)	OOIP (MMBO)	OGIP (BCF)	Prospective Resources	
				MMBO	BCF
1	9217	510	1205	11.5	76
2	12035	666	1573	16.6	110

OOIP: 1175 MMBO

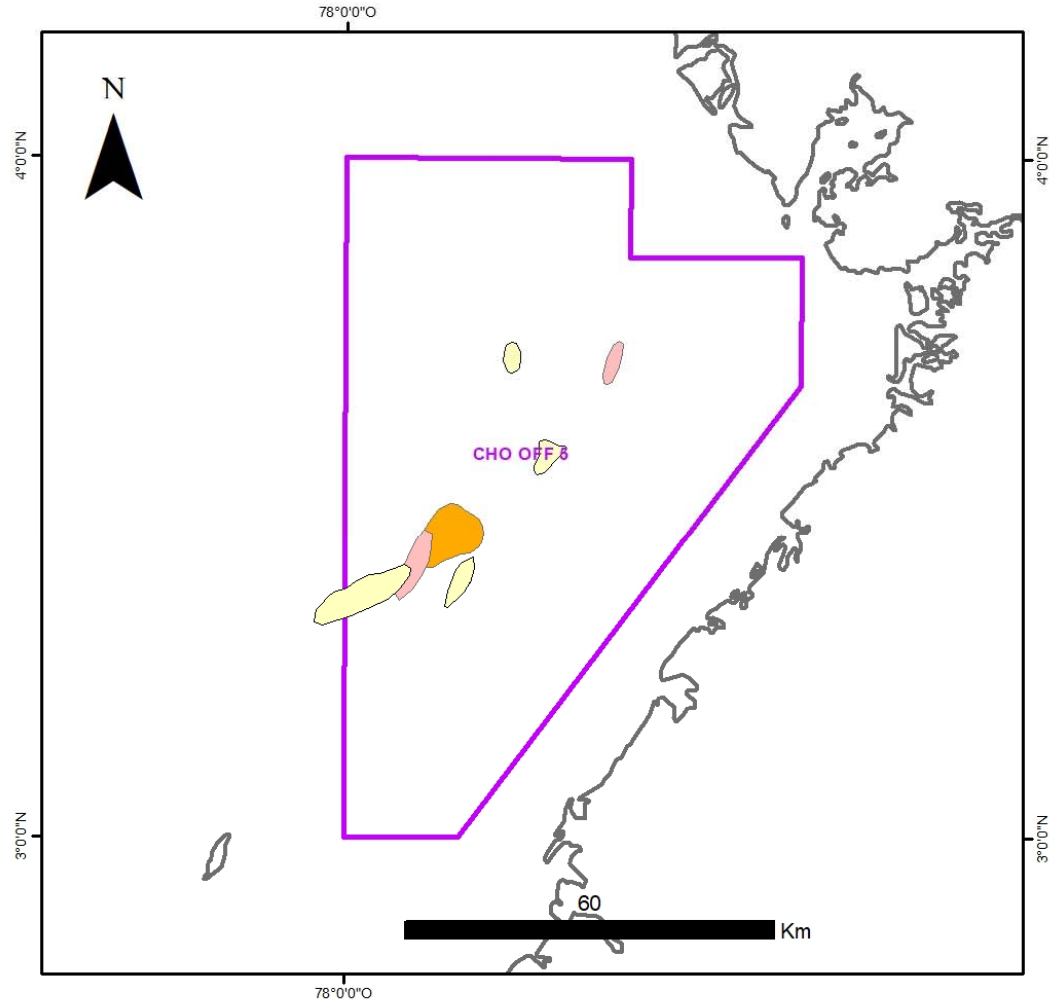
OGIP: 2.7 TCF

PROSPECTIVE RESOURCES:

28.1 MMBO

186 BCF

CHO OFF-5 - PROSPECTIVITY



LEGEND

RESERVOIR

- MIOCENE
- OLIGOCENE
- EOCENE
- S2D_CPE7-1_FALTANTES
- CHO OFF 5

PROSPECTIVE RESOURCES

8 LEAD

Prospective Resources

Lead No	AREA (Acres)	OOIP (MMBO)	OGIP (BCF)	Prospective Resources	
				MMBO	BCF
1	3241	179	424	4.5	29.6
2	2712	150	354	3.7	24.8
3	4046	224	529	5.6	37.0
4	18925	1047	2473	26.2	173.1
5	4546	251	594	6.3	41.6
6	8324	460	1088	11.5	76.1
7	16717	925	2185	23.1	152.9
8	16717	925	2185	23.1	152.9

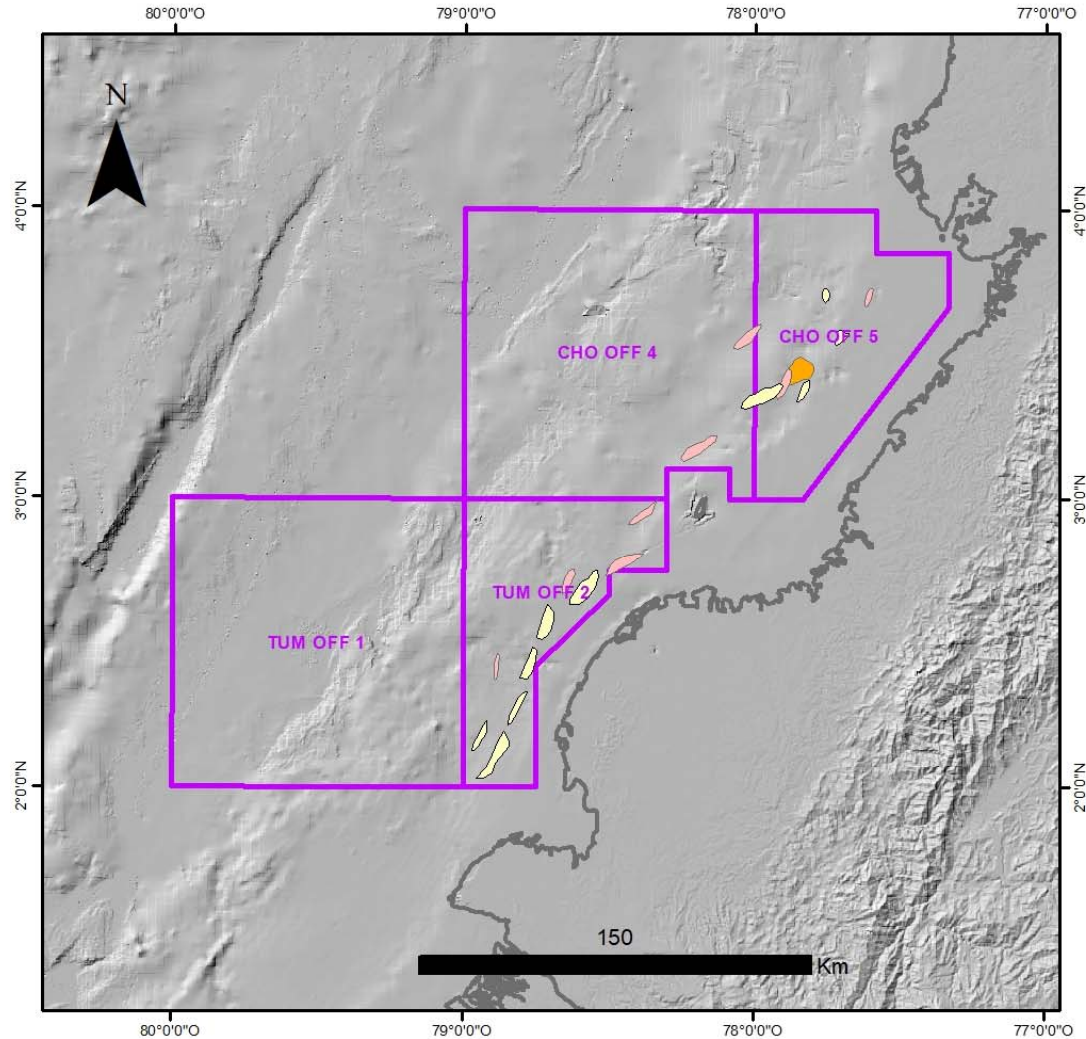
OOIP: 4160 MMBO

OGIP: 9.8 TCF

PROSPECTIVE RESOURCES:

104 MMBO

688 BCF



Oil & Gas (Deterministic)

■ **20 leads in total**

OOIP: 10418 MMBls or OGIP: 24.6 TCF

Recovery factor	OIL (25%)
	GAS (70%)
Chance of success	(10%)

■ **Prospective Resources**

OIL

High Estimate	260 MMBls
Best Estimate	145 MMBls
Low Estimate	29 MMBls

GAS

High Estimate	1723 BCF
Best Estimate	957 BCF
Low Estimate	191 BCF

- The information available for this mega area corresponds to 10,165 linear km of coverage, 1725Km² of 3D seismic coverage and 2 wells drilled on the continental shelf.
- During the seismic acquisition in 2007, numerous oil seeps were discovered in the ocean, although they are poor manifestations, they can interpret the possibility of the existence of liquid hydrocarbons in the area.
- Possible traps correspond to wedges within the Miocene intervals, some transgressive sand off basement from the Oligocene and possibly Eocene conglomerates. A more dedicated interpretation is still needed to define these and other possible traps associated with submarine turbidites.
- The depth of the water table less than 1Km occupies 29% of the total area of the 4 blocks and 53% of the area for a water table less than 2Km.
- Inside the areas offered by the ANH, 20 leads have been mapped using seismic interpretation with a best estimate of recoverable prospective resources of 145 MMBO or 957 BCF.

REFERENCES

- Agudelo, William Mauricio & Ribodetti, Alessandra & Collot, Jean-Yves & Operto, Stéphane. (2009). Joint inversion of multichannel seismic reflection and wide-angle seismic data: Improved imaging and refined velocity model of the crustal structure of the north Ecuador–South Colombia convergent margin. *Journal of Geophysical Research*. 114. <https://doi.org/10.1029/2008JB005690>
- Cediél, F., Restrepo, I., Marín–Cerón, M.I., Duque–Caro, H., Cuartas, C., Mora, C., Montenegro, G., García, E., Tovar, D. & Muñoz, G. 2009. Geology and hydrocarbon potential, Atrato and San Juan Basins, Chocó (Panamá) Arc. Tumaco Basin (Pacific realm), Colombia. Agencia Nacional de Hidrocarburos and Fondo Editorial Universidad EAFIT, 172 p. Medellín, Colombia. https://www.anh.gov.co/Informacion-Geologica-y-Geofisica/Estudios-Integrados-y-Modelamientos/GEOLOGYANDHYDROCARBONPOTENTIALCHOCOANDTUM/libro_eafit.pdf
- Collot, Jean-Yves & Michaud, François & Alvarado, Alexandra & Marcaillou, Boris & Marc, Sosson & Ratzov, Gueorgui & Migeon, Sébastien. (2009). Vision general de la morfología submarina del margen convergente de Ecuador-Sur de Colombia : implicaciones sobre la transferencia de masa y la edad de la subducción de la Cordillera de Carnegie. https://www.researchgate.net/publication/245541740_Vision_general_de_la_morfologia_submarina_del_margen_convergente_de_Ecuador-Sur_de_Colombia_implicaciones_sobre_la_transferencia_de_masa_y_la_edad_de_la_subduccion_de_la_Cordillera_de_Carnegie
- Flueh, Ernst R., Bialas, Jörg and Charvis, Philippe, eds. (2001) FS SONNE Fahrtbericht SO159 = Cruise Report SO159 SALIERI - South American Lithospheric Transects Across Volcanic Ridges ; Guayaquil - Guayaquil, August 21 - September 17, 2001. Open Access . GEOMAR-Report, 101 . GEOMAR Forschungszentrum für marine Geowissenschaften der Christian-Albrechts-Universität zu Kiel, Kiel, 263 pp. https://doi.org/10.3289/geomar_rep_101_2001.
- López-Ramos, Eduardo. (2016). HYDROCARBON GENERATION MODELS ALONG THE BASAL DETACHMENT OF THE ANDEAN SUBDUCTION ZONE IN NORTHERN ECUADOR TO SOUTHERN COLOMBIA. *CT&F - Ciencia, Tecnología y Futuro*, 6(3), 25-52. Retrieved June 03, 2021, from http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0122-53832016000100002&lng=en&tlng=en.
- Marcaillou, Boris & Spence, George & Wang, Kelin & Collot, Jean-Yves & Ribodetti, Alessandra. (2008). Thermal segmentation along the N. Ecuador–S. Colombia margin (1–4°N): Prominent influence of sedimentation rate in the trench. *Earth and Planetary Science Letters*. 272. 296-308. <https://doi.org/10.1016/j.epsl.2008.04.049>.
- Marcaillou, Boris & Collot, Jean-Yves. (2008). Chronostratigraphy and tectonic deformation of the North Ecuadorian–South Colombian offshore Manglares forearc basin. *Marine Geology - MAR GEOLOGY*. 255. 30-44. <https://doi.org/10.1016/j.margeo.2008.07.003>.
- Pardo–Trujillo, A., Echeverri, S., Borrero, C., Arenas, A., Vallejo, F., Trejos, R., Plata, Á., Flores, J.A., Cardona, A., Restrepo, S., Barbosa, Á., Murcia, H., Giraldo, C., Celis, S., & López, S.A. 2020. Cenozoic geologic evolution of the southern Tumaco Forearc Basin (SW Colombian Pacific). In: Gómez, J. & Mateus–Zabala, D. (editors), *The Geology of Colombia, Volume 3 Paleogene – Neogene*. Servicio Geológico Colombiano, Publicaciones Geológicas Especiales 37, p. 215–247. Bogotá. <https://doi.org/10.32685/pub.esp.37.2019.08>
- Ratzov, Gueorgui & Marc, Sosson & Collot, Jean-Yves & Migeon, Sébastien. (2013). Late Quaternary geomorphologic evolution of submarine canyons as a marker of active deformation on convergent margins: The example of the South Colombian margin. *Marine Geology*. s 315–318. <https://doi.org/10.1016/j.margeo.2012.05.005>.
- Bockelie J.F. , Hyldmo I. , Andersson L. , Butenko G. , Christancho J. (2007) The geology of offshore Colombia, Pacifico area, Exploration assessments. ANH Internal Report Contract 2006-32. Confidential
- GEBCO 2020 Gridded Bathymetry Data Download <https://download.gebco.net/#>

Thanks You