

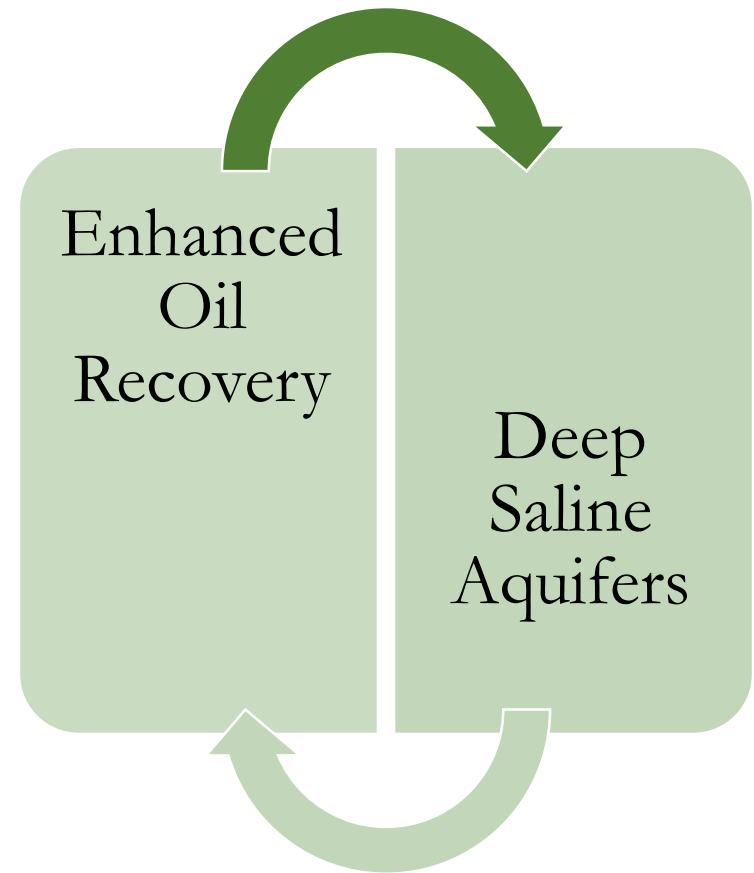


Overview of Mexico's storage potential

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SENER

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STORAGE POTENTIAL



CO₂ Storage

Geologic traps

Deep enough sandstone or carbonate porous and permeable rock formations sealed on top by a non-permeable formation

Saline Aquifers

Knowledge of geologic features is usually limited: sealing integrity uncertain. Additional characterization needed to reduce the risk of CO₂ leakage

Oil and Gas Fields

Well known geologic features. Sealing integrity proven over millions of years before discovery and production: Drilled wells are the potential sites for CO₂ leakage

Abandoned

Producing

Zonas de Exclusión

- A** Conformada de rocas ígneas extrusivas, metamórficas, plutónicas y vulcano-sedimentarias, además de presentar hidrotermalismo de bajo a alto, actividad sísmica fuerte, así como estructuras volcánicas y fallas activas.
- B** Constituida de rocas volcánicas ácidas y básicas, metamórficas y vulcanosedimentarias, también presenta actividad sísmica media, hidrotermalismo de bajo a medio, y algunas estructuras volcánicas y fallas activas.



Zonas de Inclusión

- C** Conformada principalmente de rocas terrígenas continentales, volcánicas y carbonatadas. También presenta hidrotermalismo bajo, actividad sísmica menor o nula, y ausencia de información sobre fallas activas.
- D** Consiste de una litología terrígena que corresponde a diferentes edades y ambientes de depósito. Hay también hidrotermalismo esporádico, actividad sísmica menor o nula, y ausencia de información sobre fallas activas.
- E** Conformada de una litología mayormente evaporítica, en asociación con calizas, lutitas, areniscas, dolomías y conglomerados de diferentes edades y orígenes, además de actividad sísmica nula y ausencia de fallas activas.
- F** Compuesta principalmente de sedimentos terrígenos marinos del Plio-Cuaternario, actividad sísmica casi nula, e incompleta información sobre fallas activas.
- G** Constituida de sedimentos principalmente de tipo terrígeno asociados con ambientes marinos recientes, actividad sísmica intensa y tectónica activa permanente.

DEEP SALINE AQUIFERS

From the inclusion zones, we found 9 from 11 basins, with a theoretical capacity of 100 Gt, spread out in 111 sectors.

Estimación de la capacidad teórica de almacenamiento de CO ₂ para acuíferos salinos profundos en México		
Provincia	Potencial de almacenamiento teórico de CO ₂ (Gigatoneladas)	Sectores
Chihuahua	<1	5
Coahuila	13	12
Central	<1	1
Burgos	17	31
Tampico-Misantla	9	12
Veracruz	15	21
Sureste	24	17
Yucatán	14	7
Chiapas	6	5
Total	100	111

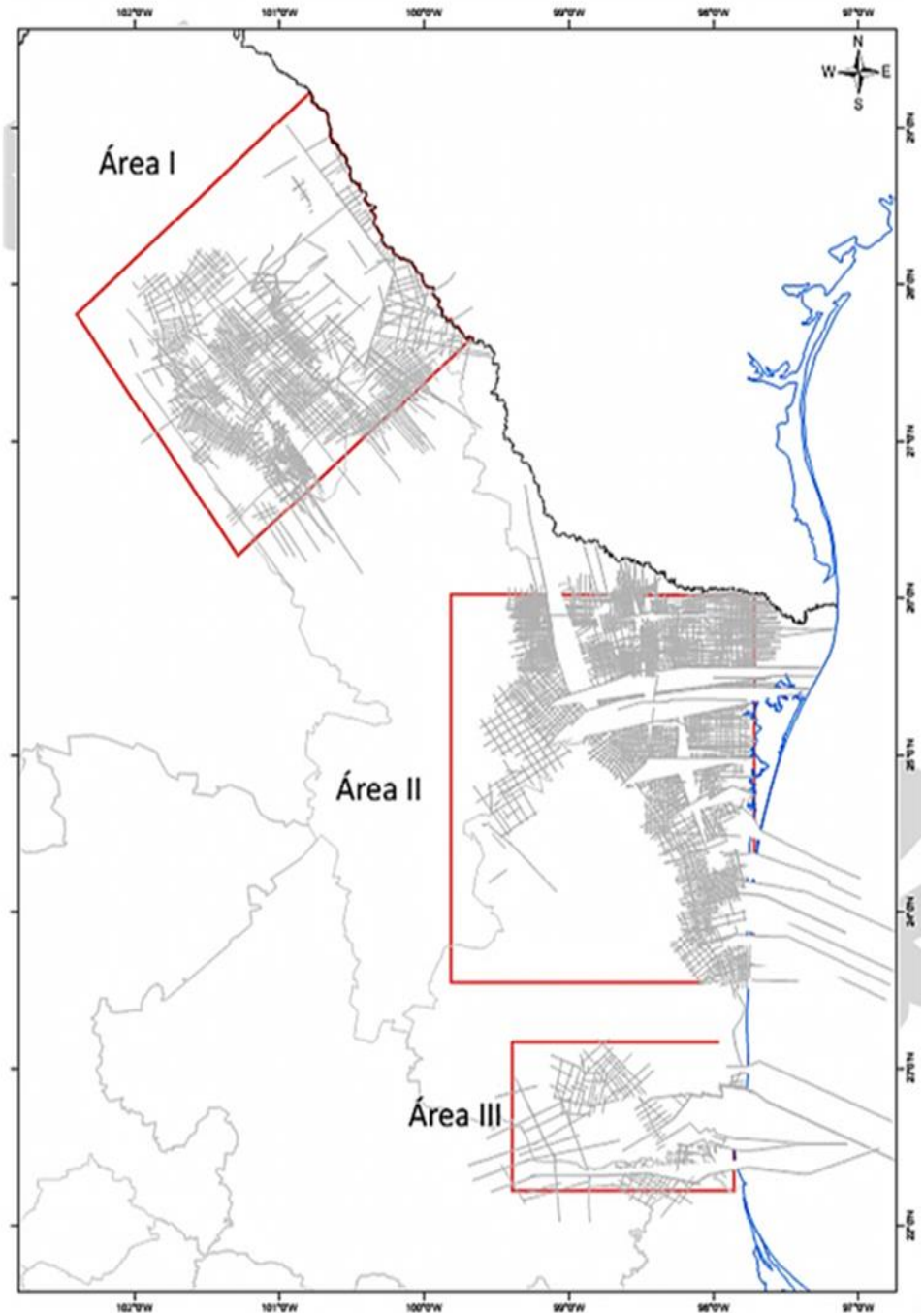
Information

Collaboration between CFE
and PEMEX for key
information sharing,
knowledge transfer and
terminology standardization to
facilitate the understanding.

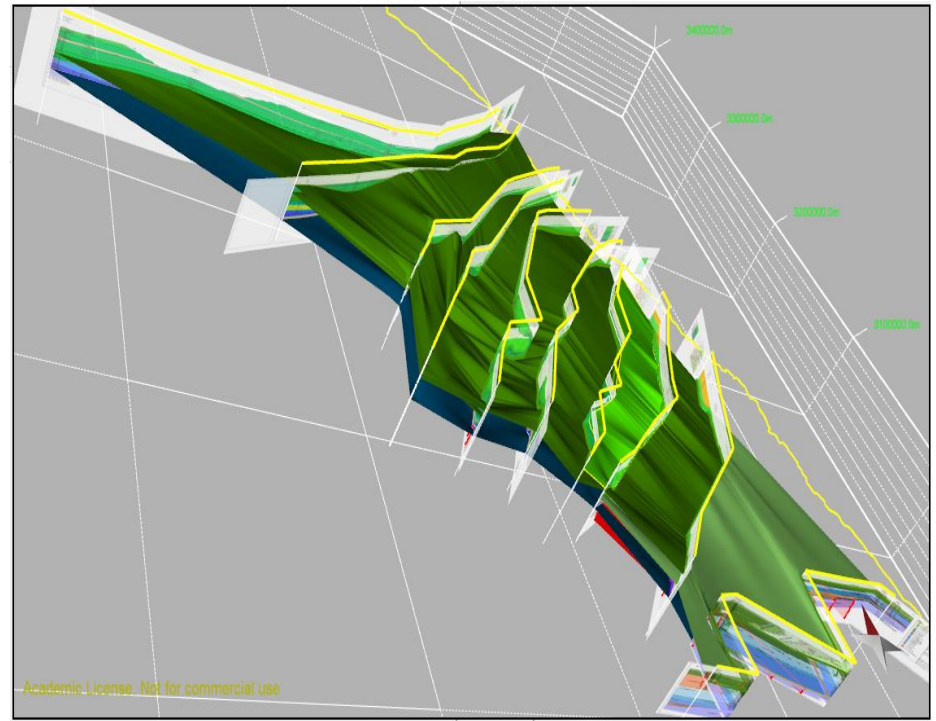
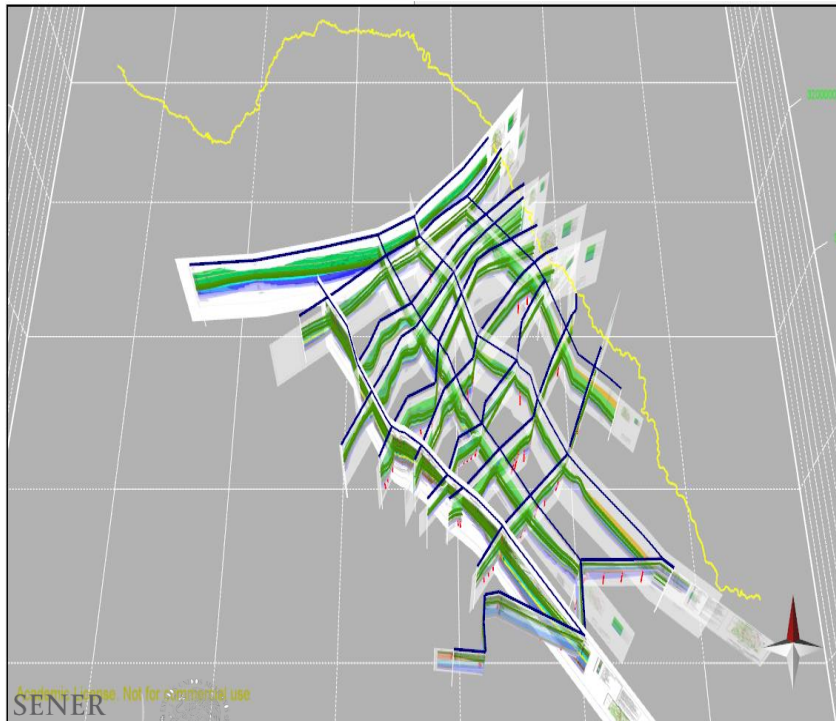
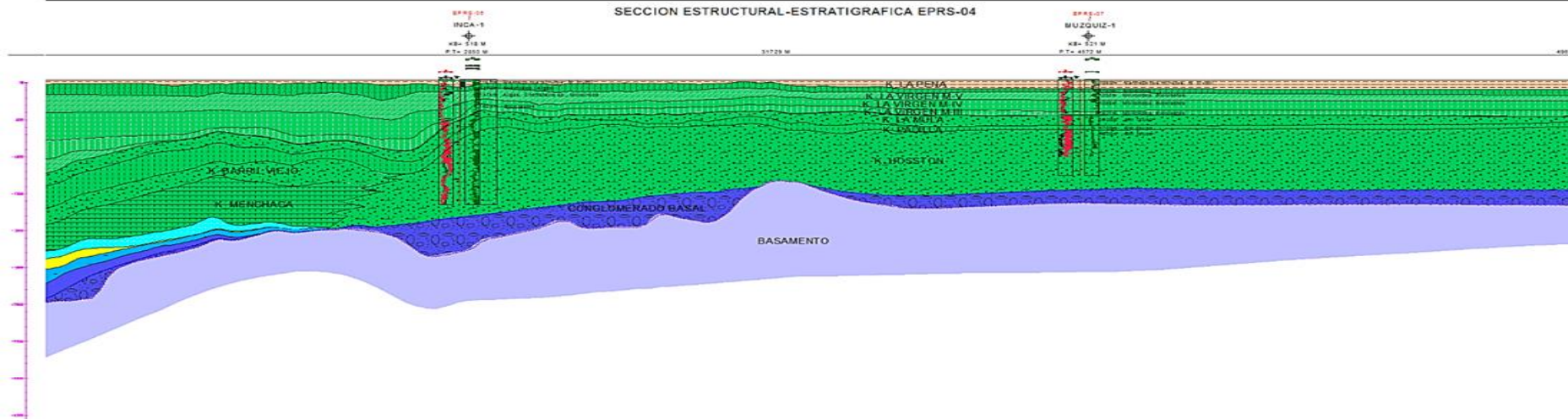


- Geological Reports
- Well bore files
- 2d seismic sections
- Geological cross sections
- Structural configurations
- Geophysical sections

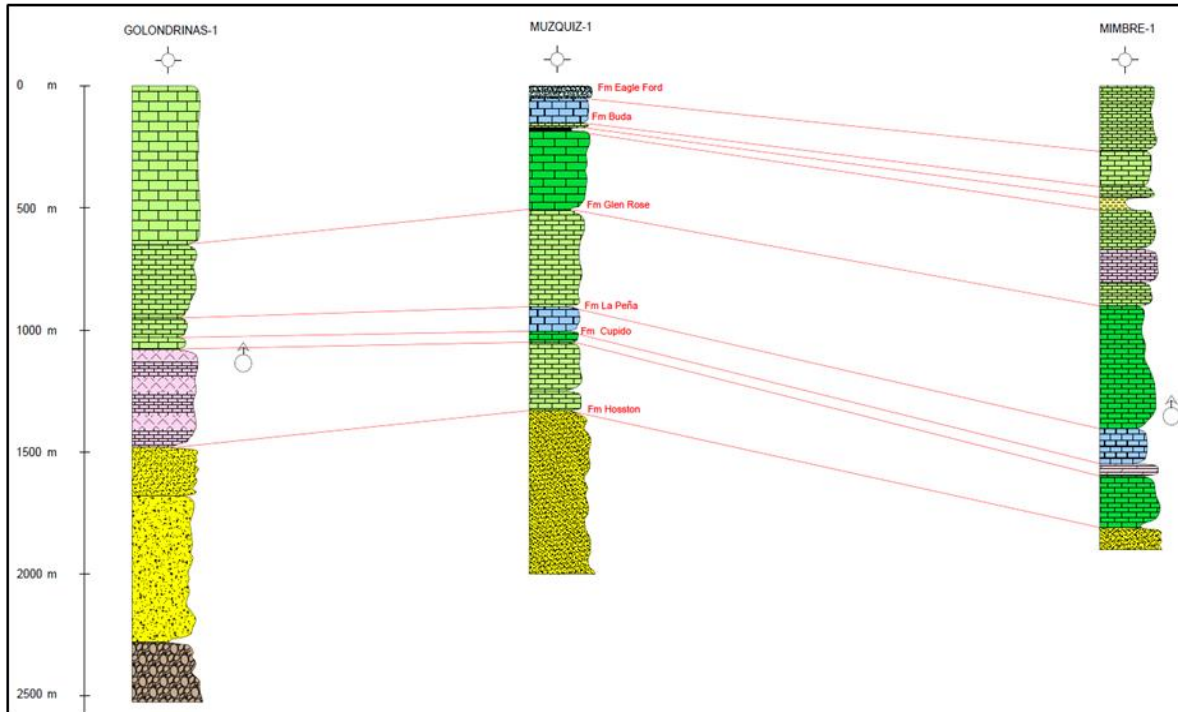
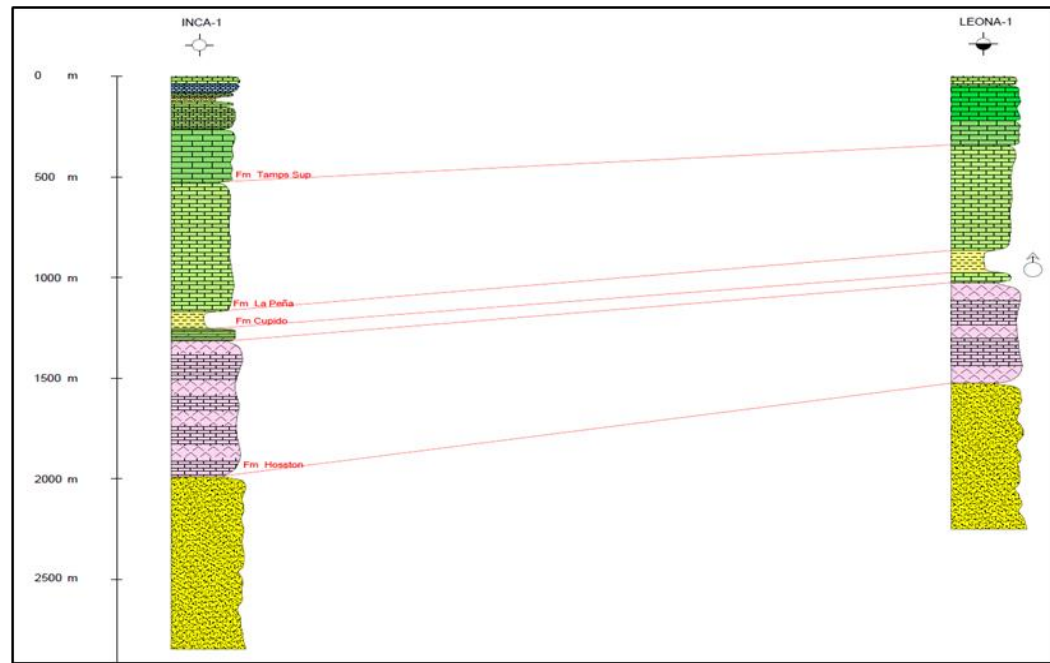
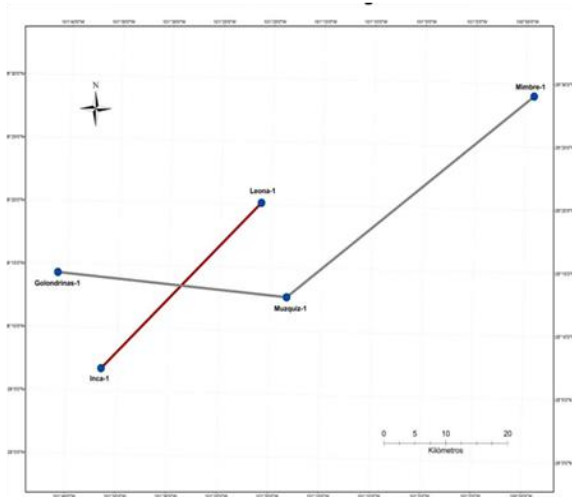
* Quality of Information



3D conceptual geological model

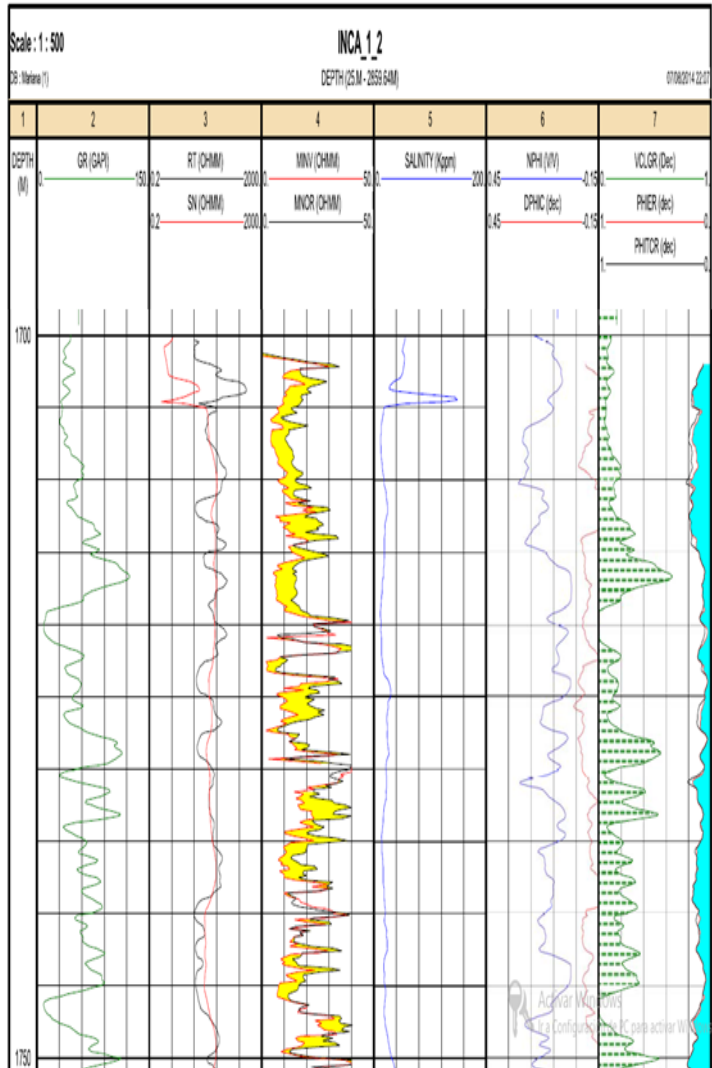


POZOS TIPO: INCA-1; MUZQUIZ-1



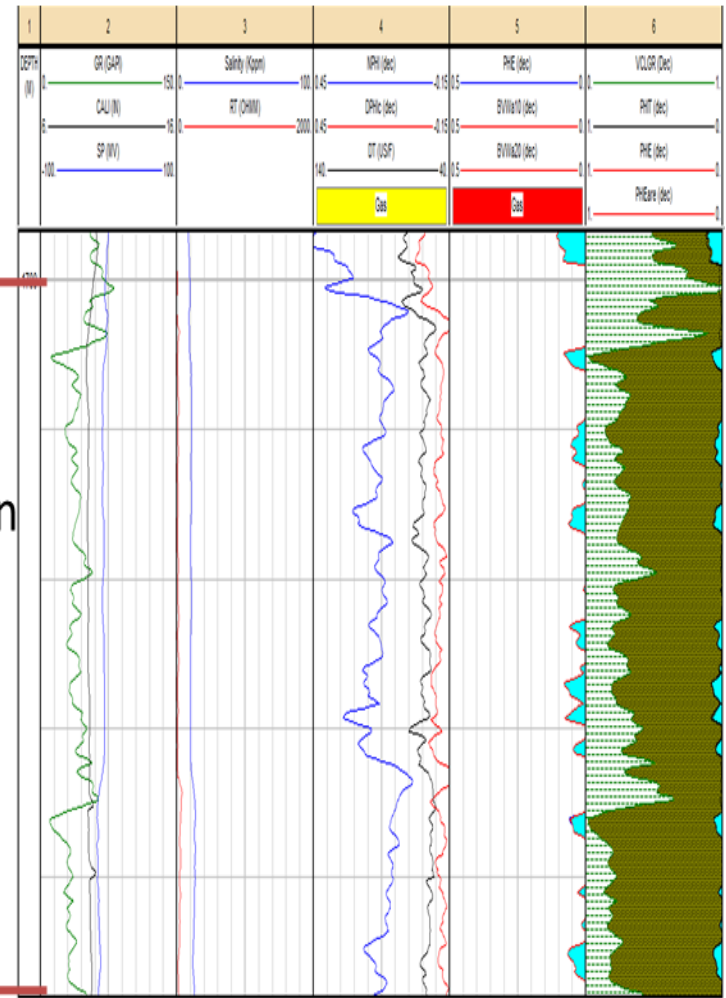
INCA-1		
Fm	Cima	Litología
Austin	Aflora	mudstone
Eagle Ford	35	mudstone arcillo-carbonoso
Buda	84	mudstone a wackestone
Del Río	100	lutitas
Georgetown	127	mudstone a wackestone
Glen Rose	150	mudstone
Arrecife El Burro	260	boundstone
Tamps Sup	525	mudstone
La Peña	1169	lutitas calcáreas
Cupido	1253	mudstone arcilloso-dolomítico calcáreo-evaporítica
La Virgen	1315	areniscas
Hosston	1990	areniscas
P.T.	2847	

MUZQUIZ-1		
Fm	Cima	Litología
Austin	Aflora	marga arenosa
Eagle Ford	50	mudstone arcillo-carbonoso
Buda	150	mudstone
Del Río	170	lutitas
Georgetown	185	packstone
Glen Rose	505	mudstone
La Peña	905	mudstone arcillo-carbonoso
Cupido	1005	mudstone a grainstone
La Virgen	1050	mudstone
Padilla	1250	mudstone a wackestone
Hosston	1330	arenisca
P.T.	2000	



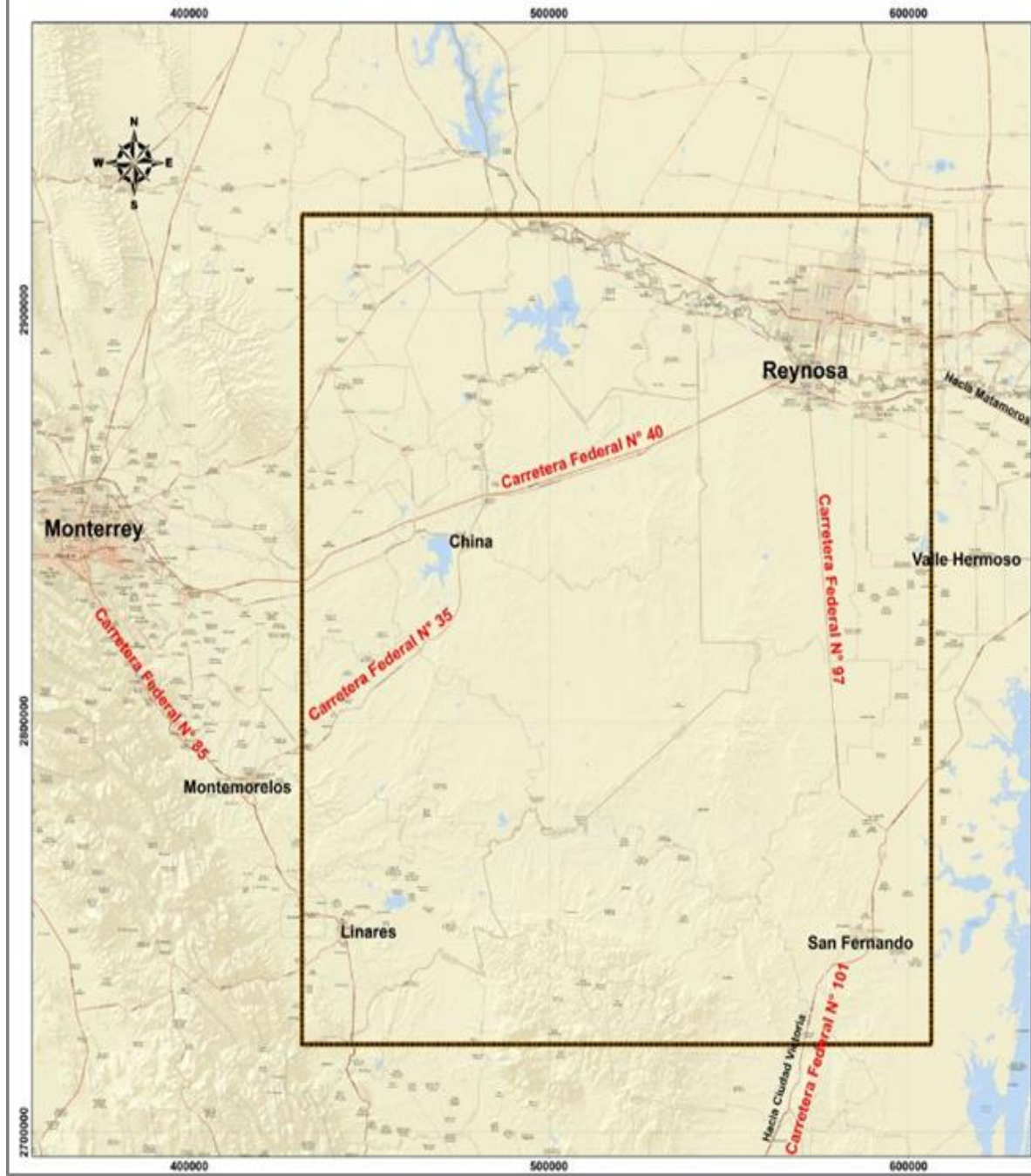
Fm. Hosston
Intervalo almacén
1700 -1750 m.

MUZQUIZ-1



INCA-1			MUZQUIZ-1		
1700 - 1750 m	Espesor 50 m	ϕ 19%	1700 - 1745 m	Espesor 45 m	ϕ 8%

Plano de Localización



Localización

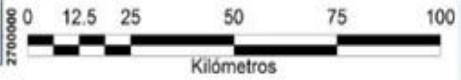


Símbolos

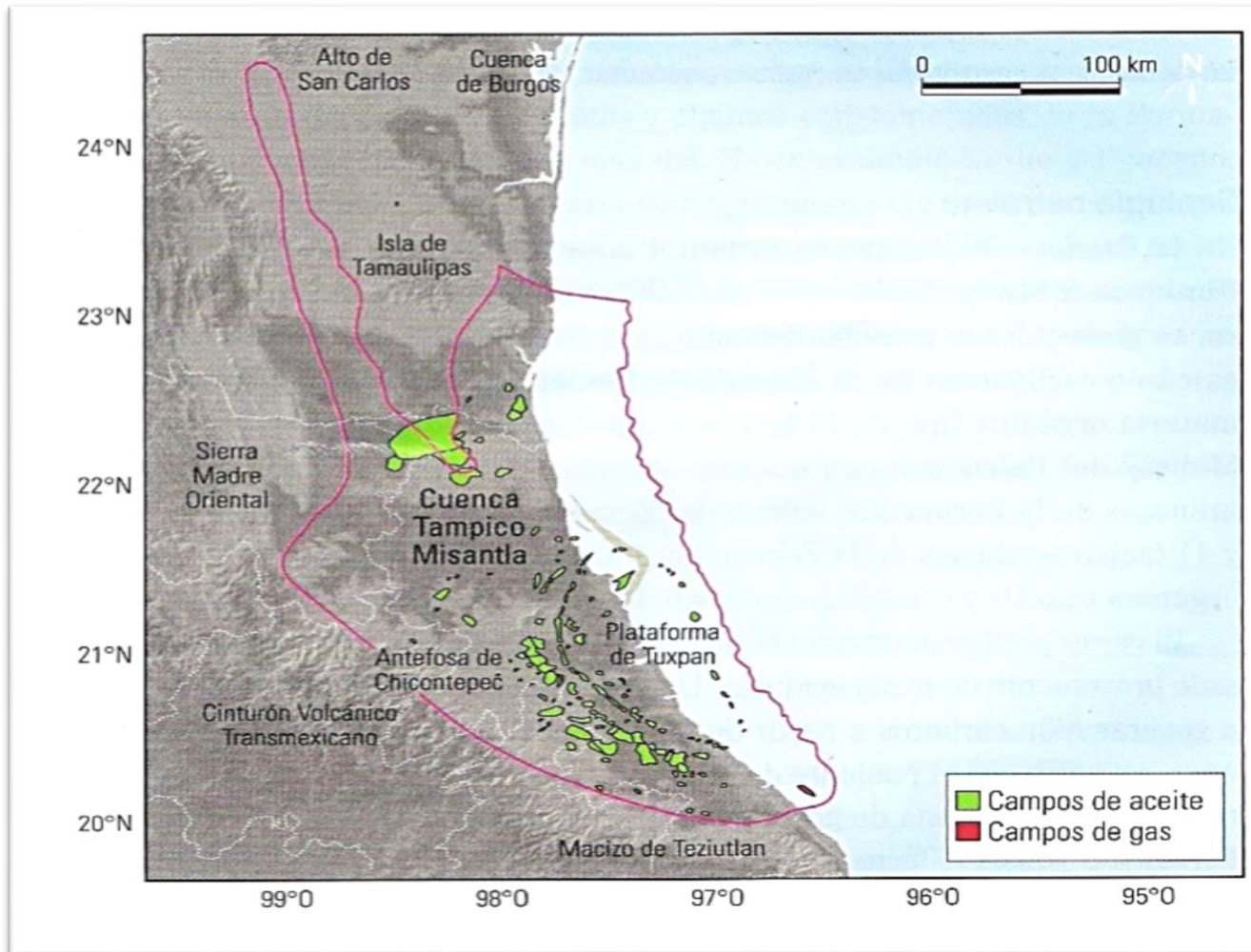
 Área de estudio

Elipsoide: GCS_WGS 1984
Proyección: Transversa de Mercator
Datum: WGS 1984 UTM zona 14

1:250,000

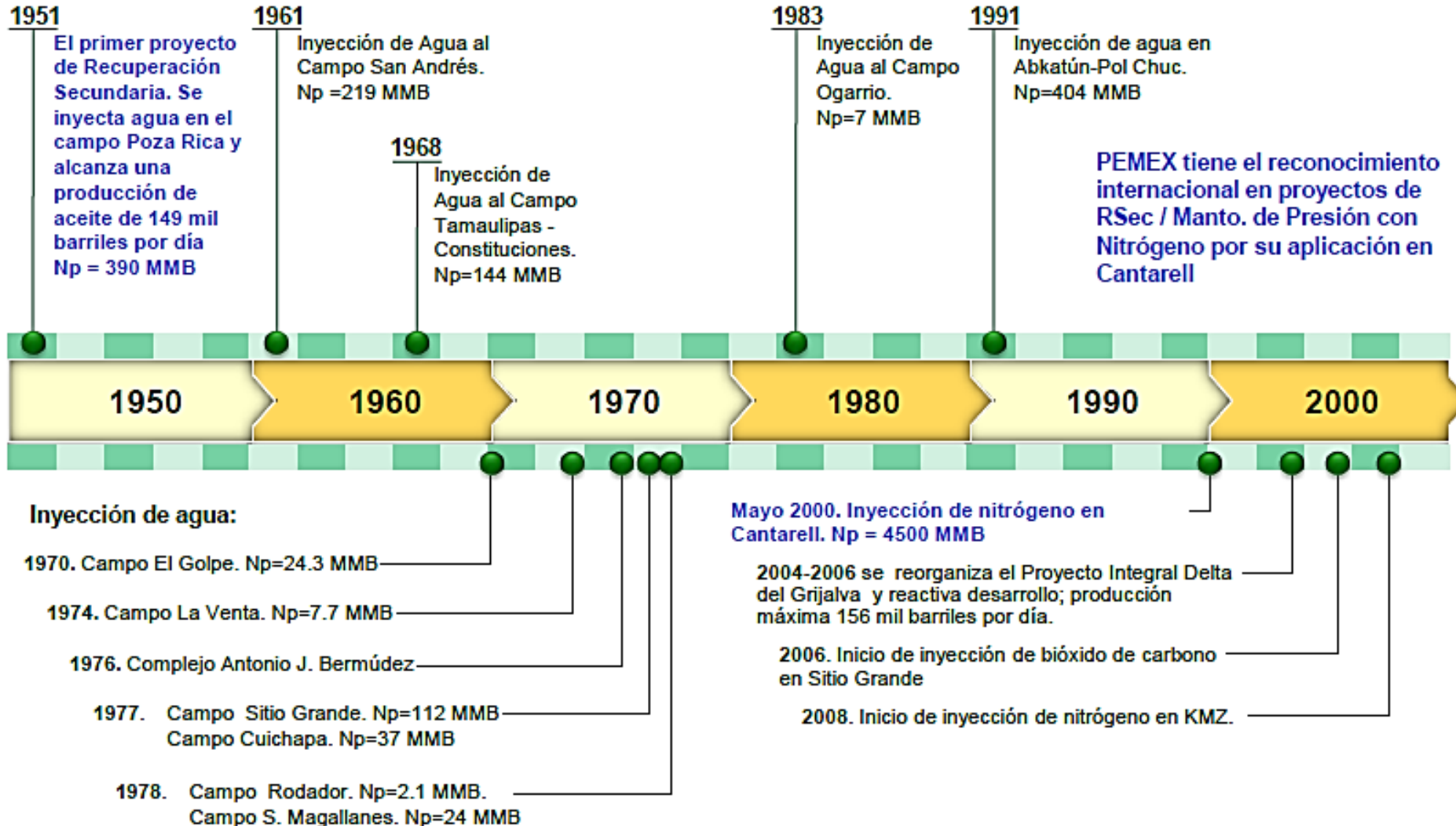


TAMPICO – MISANTLA BASIN



Next steps

ENHANCED OIL RECOVERY



19 campos prioritarios



POTENTIAL FIELDS ANALYSIS SELECTION AND PRIORITATION

- CINCO PRESIDENTES ASSET – BRILLANTE OIL FIELD
- NORTH APPRA ASSET – TAMAULIPAS CONSTITUCIONES OIL FIELD
- SOUTH APPRA ASSET – POZA RICA OIL FIELD

CCUS – EOR PROJECTS

- CINCO PRESIDENTES ASSET – BRILLANTE OIL FIELD

Huff & Puff pilot (1week)

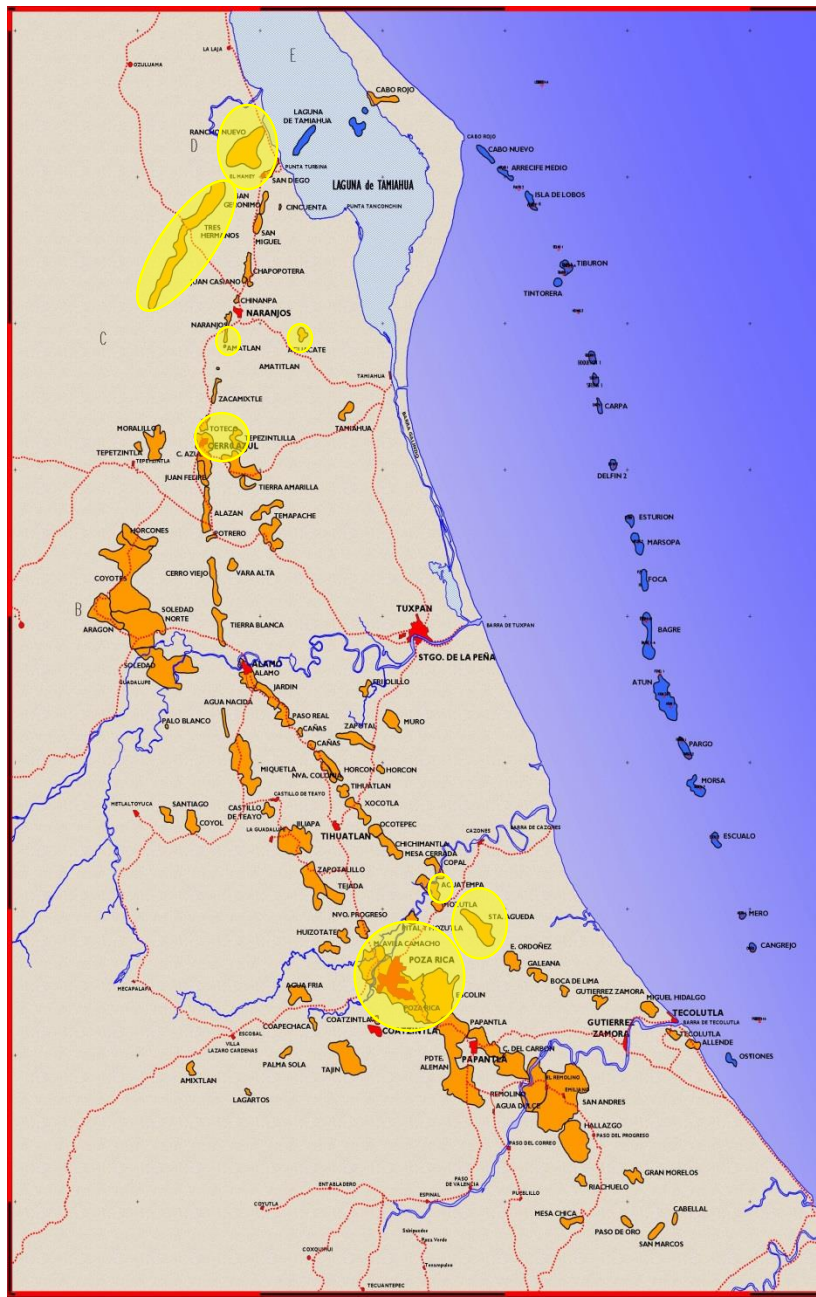
Pilot Test (6months, WAG)

CO₂-EOR CONSIDERATIONS

- CO₂-EOR is proven technology that applies in oil sandstone and carbonate reservoir:
Miscible conditions
- The CO₂ injected through selected wells will eventually show up in the producer wells, mixed with the hydrocarbon:
CO₂ separation and recycling is needed
- At closure of the projects:
 - A fraction of the total injected CO₂ will remain stored in the reservoir.
 - A large amount of the oil (with CO₂ in solution) will remain in the reservoir (~ 50% of the OOIP)
 - Advanced EOR technology developments may allow in the future to recover additional oil from the subject reservoir, with the inevitable production of some of the stored CO₂



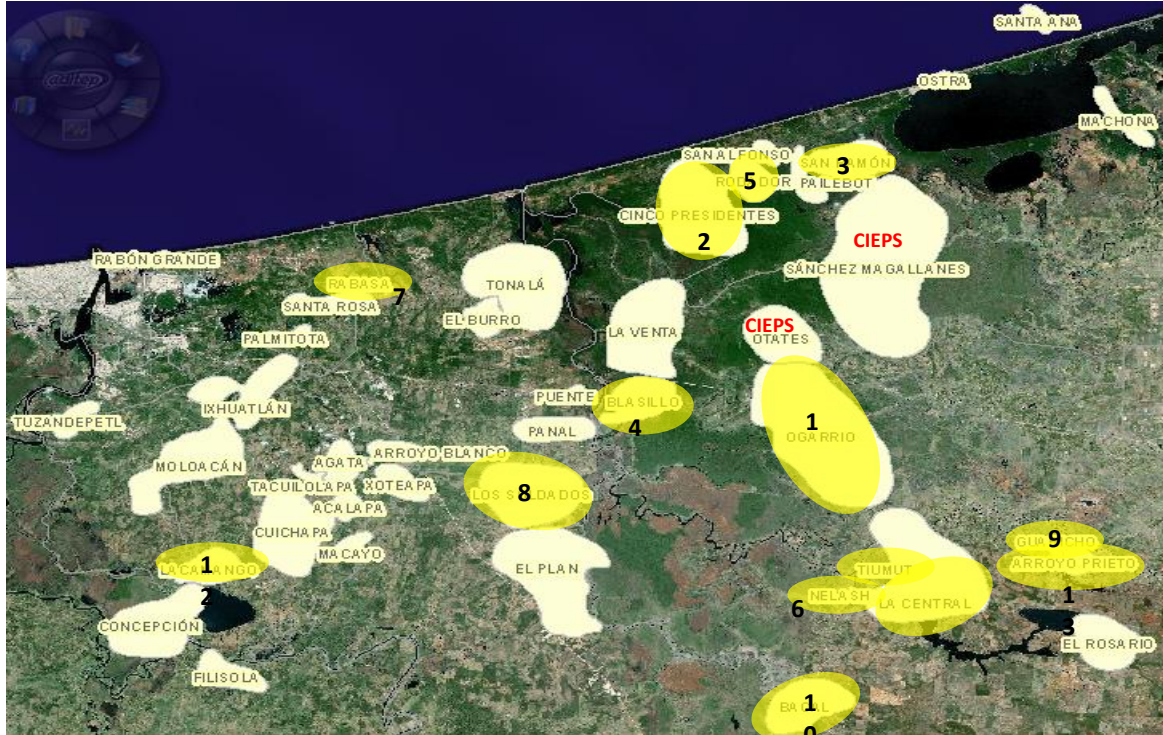
Analysis and Field Selection



Campo	Volumen Original MMstb	Reserva Original MMstb	Np MMstb	Recurso Remanente MMstb	Reserva Remanente MMstb
Poza Rica	4,810	1,571.0	1,418.0	3,392	153
Tamauilipas Constituciones	2,608	348.4	274.7	2,333	74
Toteco Cerro Azul	1,257	379.6	376.1	881	3
Sur de Amatlán	452	137.2	134.9	317	2
Tres Hermanos	423	144.2	138.5	285	6
Santa Águeda	386	127.8	123.0	263	5
Jiliapa	134	43.2	39.6	94	4
Acuatempa	102	32.6	29.7	72	3
Rancho Nuevo	53	18.2	14.6	39	4
Aguacate	31	17.0	4.0	27	13

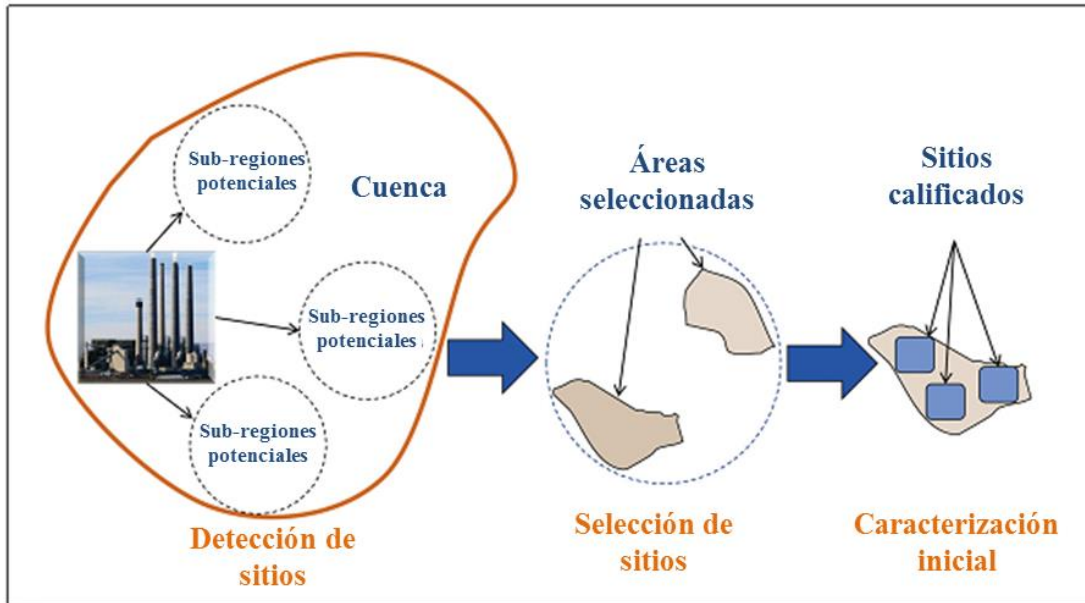
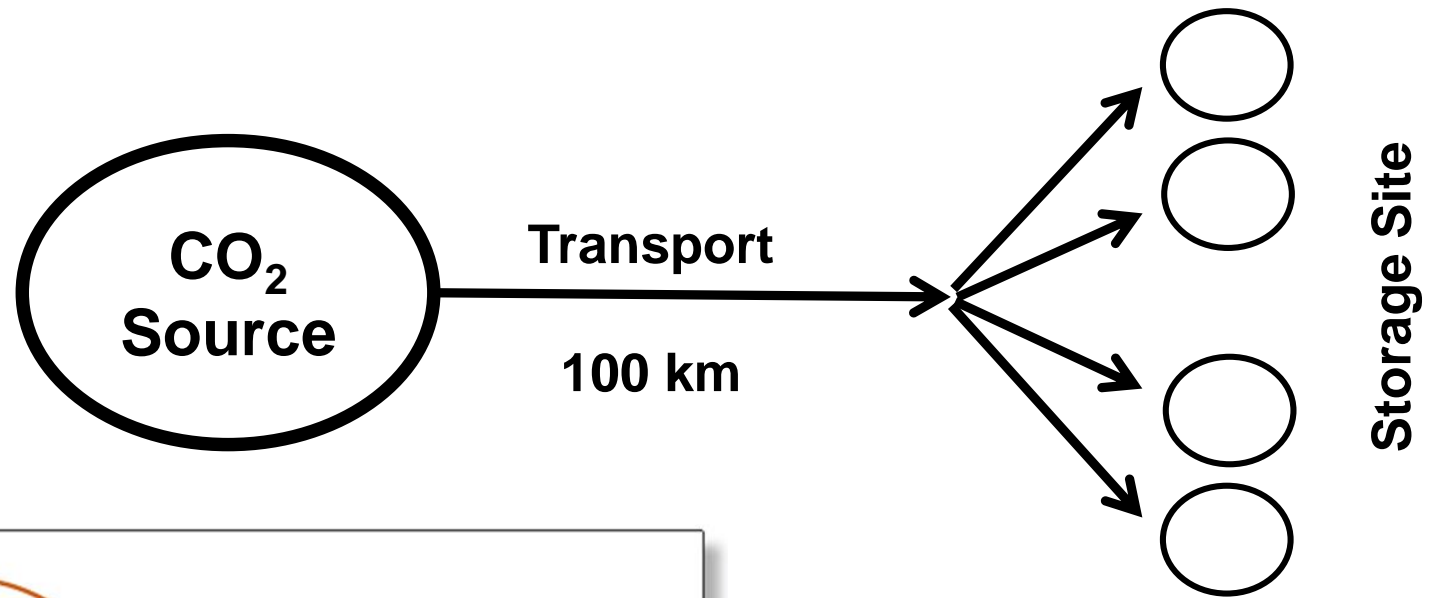
Campo	CO ₂	Surfactante	Vapor
Poza Rica	●	●	●
Tamauilipas Constituciones	●	●	●
Aguacate	●	●	●
Tres Hermanos	●	●	●
Santa Águeda	●	●	●
Jiliapa	●	●	●
Rancho Nuevo	●	●	●
Acuatempa	●	●	●
Toteco Cerro Azul	●	●	●
Sur de Amatlán	●	●	●

Analysis and Field Selection



Campo	Volumen Original MMStb	Reserva Original MMStb	Np MMStb	Recurso Remanente MMStb	Reserva Remanente MMStb
Ogarrio	1,006	258	208	798	50
Cinco Presidentes	1,044	339	314	730	24
San Ramón	476	126	98	379	28
Blasillo	299	81	67	232	14
Nelash	161	10	4	157	6
Bacal	230	111	106	124	5
Rodador	163	61	43	120	18
Los Soldados	133	48	37	96	11
Guaricho	116	49	36	80	13
Lacamango	107	35	31	76	4
Rabasa	95	42	24	72	18
Brillante	40	14	7	33	8
Arroyo Prieto	31	4	2	29	2

SOURCE-SINK MATCH STRATEGY



Atlas Nacional de Emisiones de CO₂

Fuentes Fijas que Emiten CO₂

- Generación de Energía Eléctrica
- Industria del Gas, Petróleo y Petroquímica
- Industria del Cemento y la Cal
- Industria Metalúrgica, Siderúrgica y Metalmeccánica
- Industria Química
- Bebidas Fermentadas y Alimentos
- Industria de la Celulosa y el Papel
- Industria del Vidrio
- Industria Automotriz
- Industria de Pinturas y Tintas
- Explotación de Minerales no Metálicos
- Textiles Plásticos e Impresos
- Agropecuaria
- Centros Logísticos y de Atención Hospitalaria
- Eléctricos, Electrónicos y Electrodomésticos
- Tratamiento de Residuos Peligrosos
- Industria del Asbesto
- Industria Maderera

Emisiones de CO₂ Anuales (Toneladas)

- 0 - 250,000
- 250,001 - 500,000
- 500,001 - 750,000
- 750,001 - 1,000,000
- > 1,000,000



SOURCES SELECTION

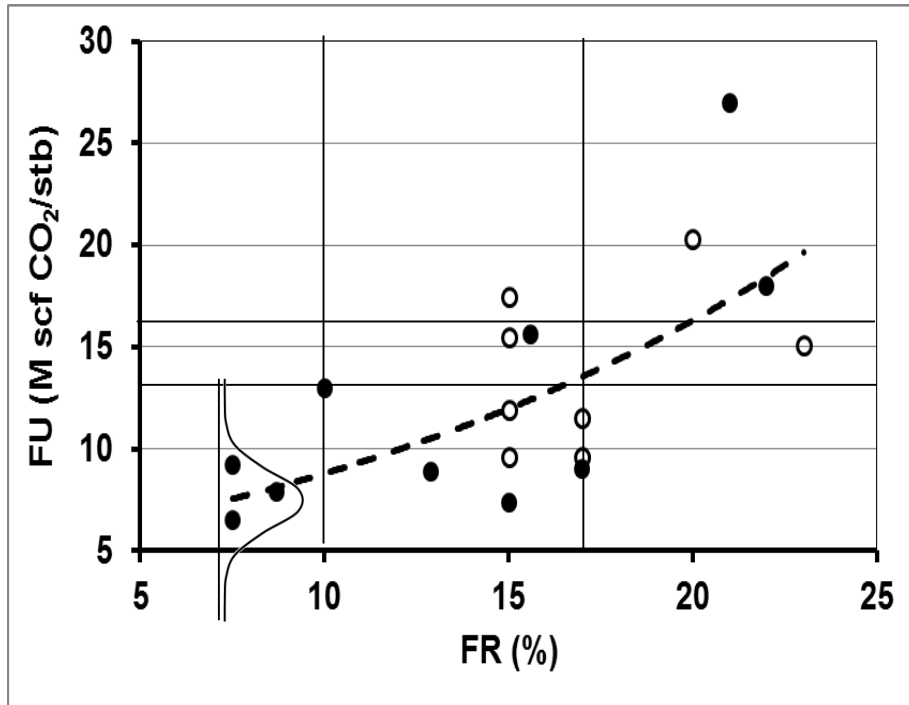
Source	Fuel	Units/ Facilities	CO ₂ emissions (MM ton/yr) / (MM scf/d)	Distance (km)	Cost of CO ₂ (usd/M scf)
Altamira	Petcoke	2	2.00 (110)	9.0	2.5
Tuxpan	Fuel Oil	3	7.30 (400)	65.0	2.5
Cosoleacaque	Natural Gas	3	0.77 (42.2)	65.0	0.5

Criteria:

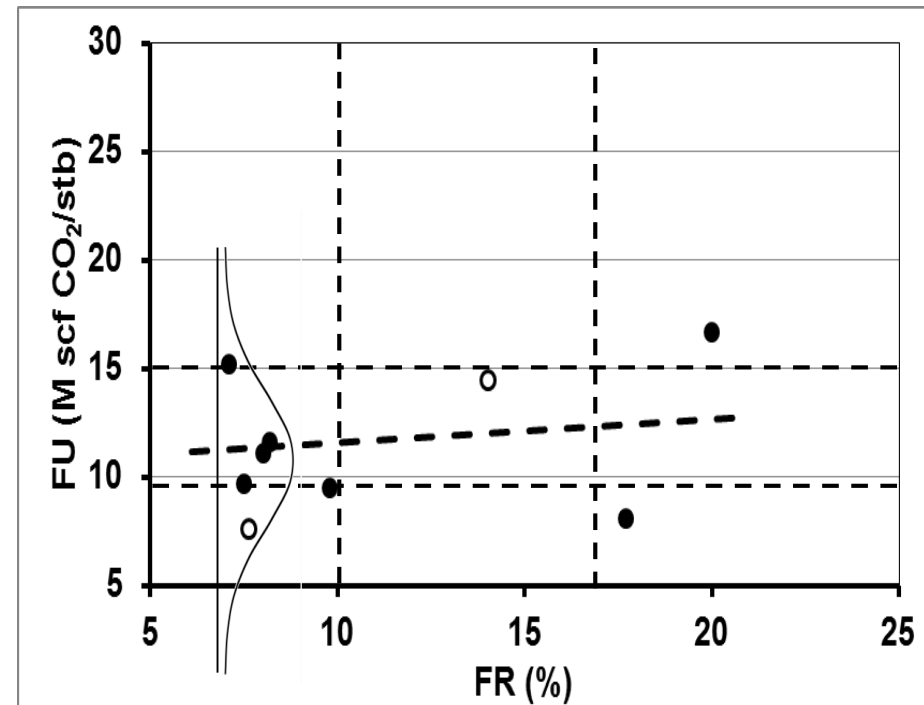
- Type of fuel : coal, fuel oil, natural gas
- CO₂ emissions: 1.00 Mton CO₂/yr
- Distance to the sink: 100 km

Analogous Projects

Areniscas (Permian Basin)



Carbonatos (Permian Basin y Golfo de México)



● Valor de utilización reportado

○ Valor de utilización inferido de función de regresión



Atlas Nacional de Emisiones de CO₂

Fuentes Fijas que Emiten CO₂

- Generación de Energía Eléctrica
- Industria del Gas, Petróleo y Petroquímica

- Sitios potenciales para EOR
- Acuíferos Salinos

Emisiones de CO₂ Anuales (Toneladas)

- 0 - 250,000
- 250,001 - 500,000
- 500,001 - 750,000
- 750,001 - 1,000,000
- > 1,000,000



STRATEGY

- Short-Term:
 - COSOLEACAQUE REFORMER PLANTS – CINCO PRESIDENTES ASSET (Brillante Field)
- Medium Term:
 - COSOLEACAQUE REFORMER PLANTS - Extend to other CINCO PRSIDENTES FIELDS (Rabasa Field)
- Medium to long Term:
 - ALTAMIRA - TAMAULIPAS CONSTITUCIONES FIELDS
 - TUXPAN – POZA RICA FIELD

FINAL THOUGHTS

- Even when all the feasible projects considered for CO₂ storage are on-shore, the off-shore potential is huge.
- Mexico has many fields off-shore becoming on a mature stage and applying some EOR processes currently.
- The main challenge is around the CO₂ supply the projects, additional to the transport and cost.
- Once the CO₂ sources are identified, the analysis of the fields and deep saline aquifers is needed to make a selection and prioritization.
- Other potential projects are been analyzing: capture on methane hydrates on the seabed