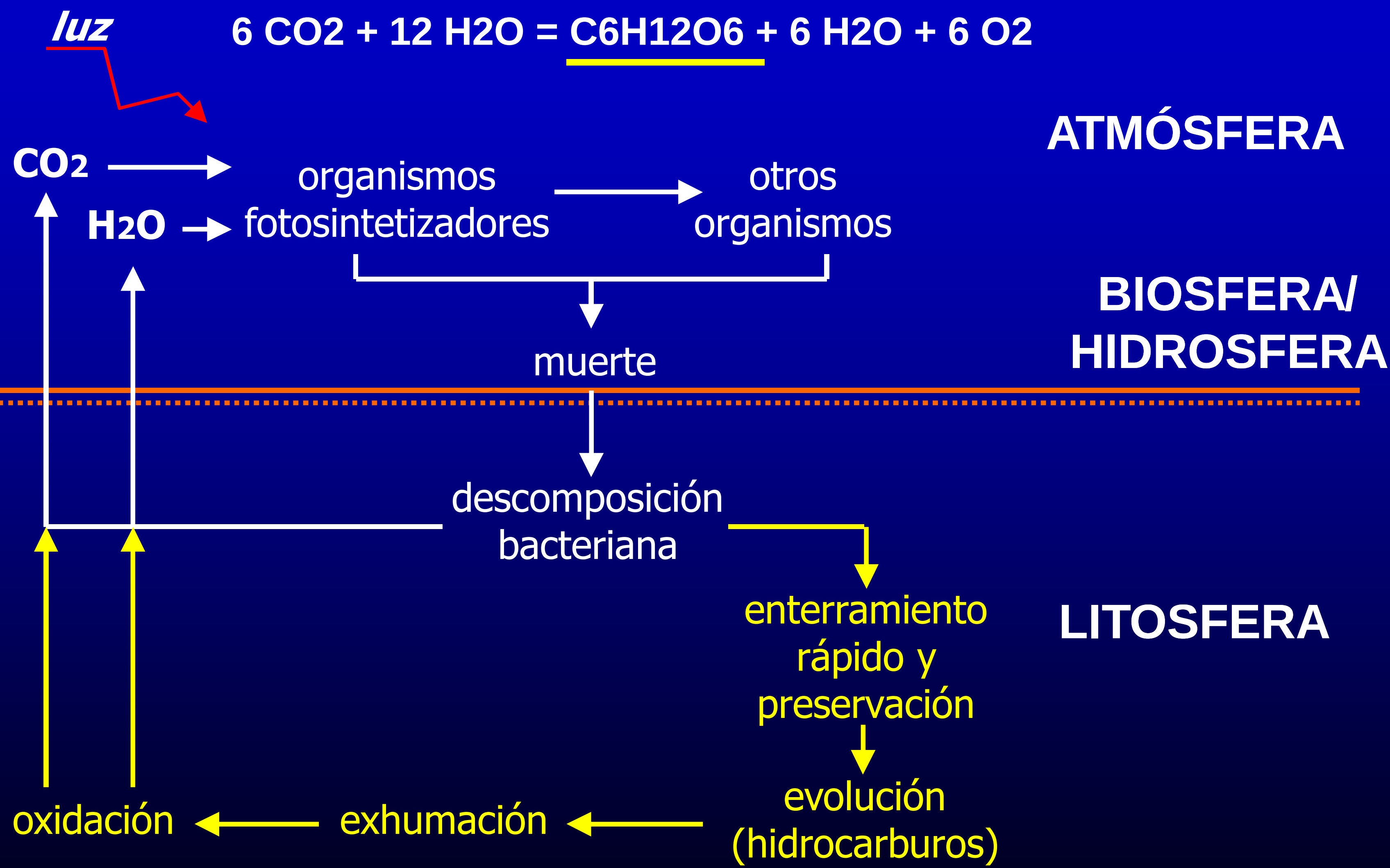

Universitat de Barcelona
Facultat de Geologia
Shale gas? Shale oil? Fracking?
De què estem parlant?
Com s'aplica tot això al cas de Catalunya?
Informació geològica per un debat d'actualitat
Aula Magna Facultat de Geologia/UB
dimecres 20 de març a les 13 hores
a càrrec del Dr. Mariano Marzo

Hidrocarburos: ñla herencia solarò

$$6\,CO_2 + 12\,H_2O = \underline{C_6H_{12}O_6} + 6\,H_2O + 6\,O_2$$



¿Cómo se origina el petróleo y el gas?

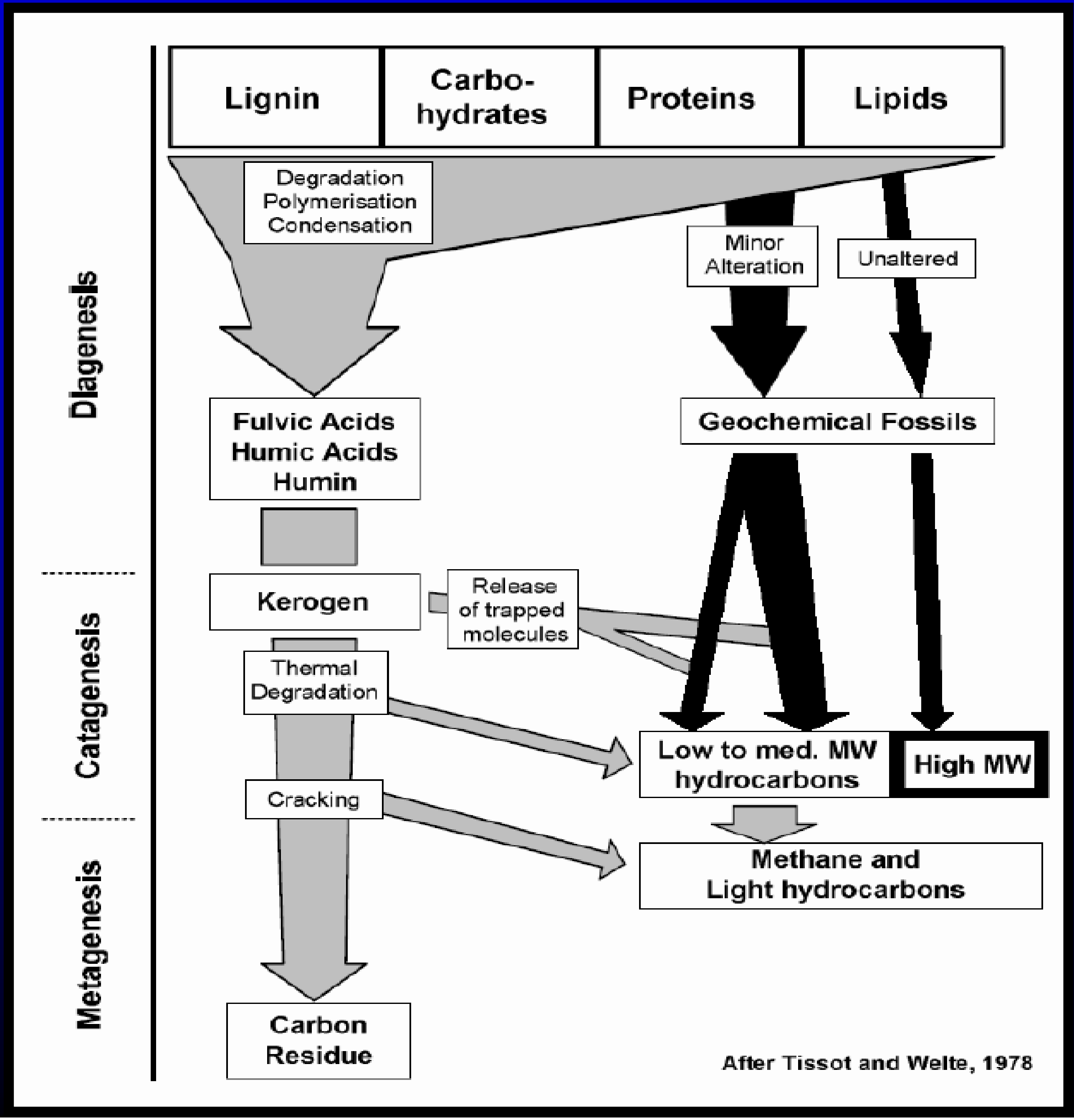
Organismos vivos

Sedimentos ricos en materia orgánica

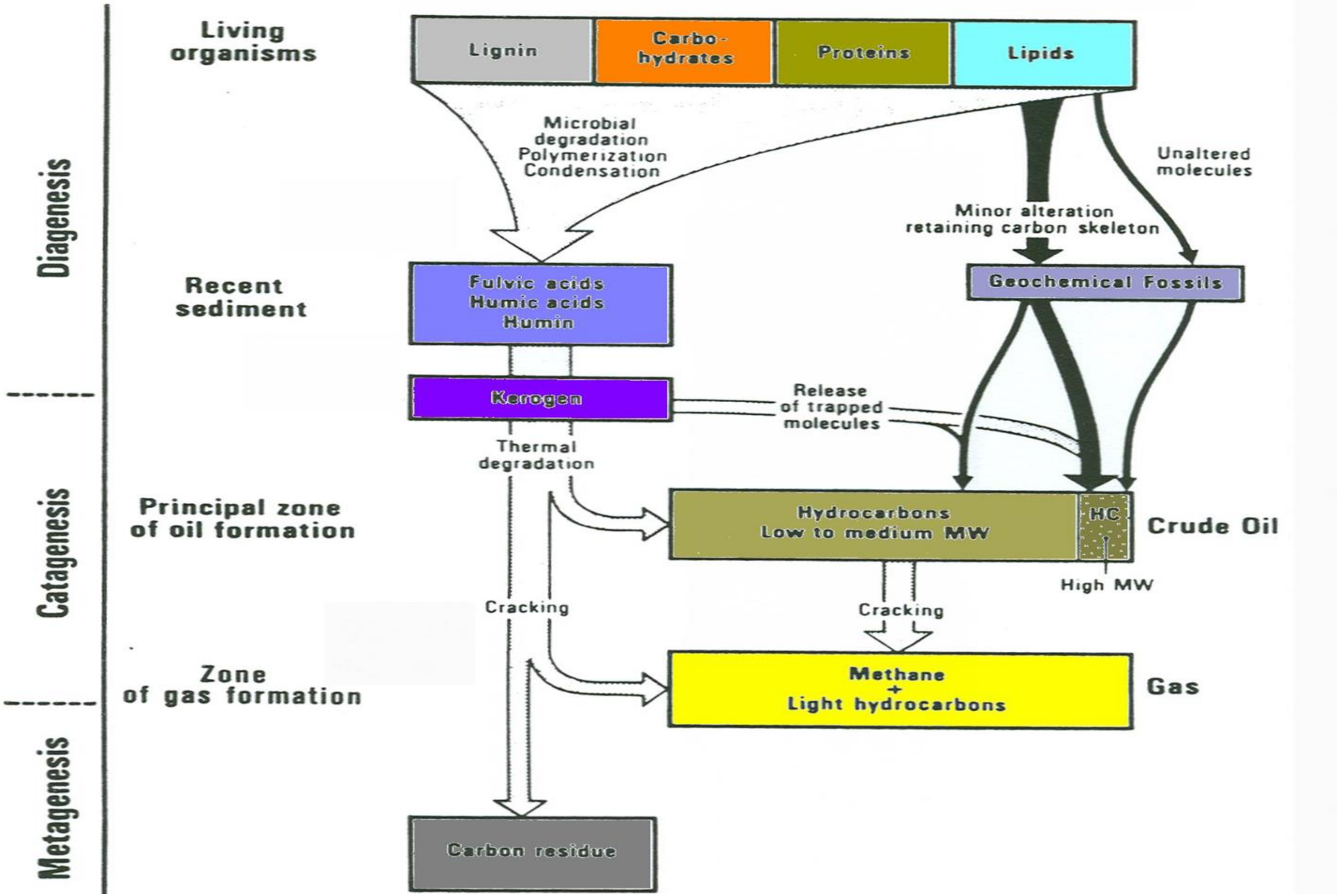
Roca madre

Petróleo

Gas termogénico



¿Cómo se genera el petróleo/gas de las ñshalesò?



Las ventanas del petróleo y del gas

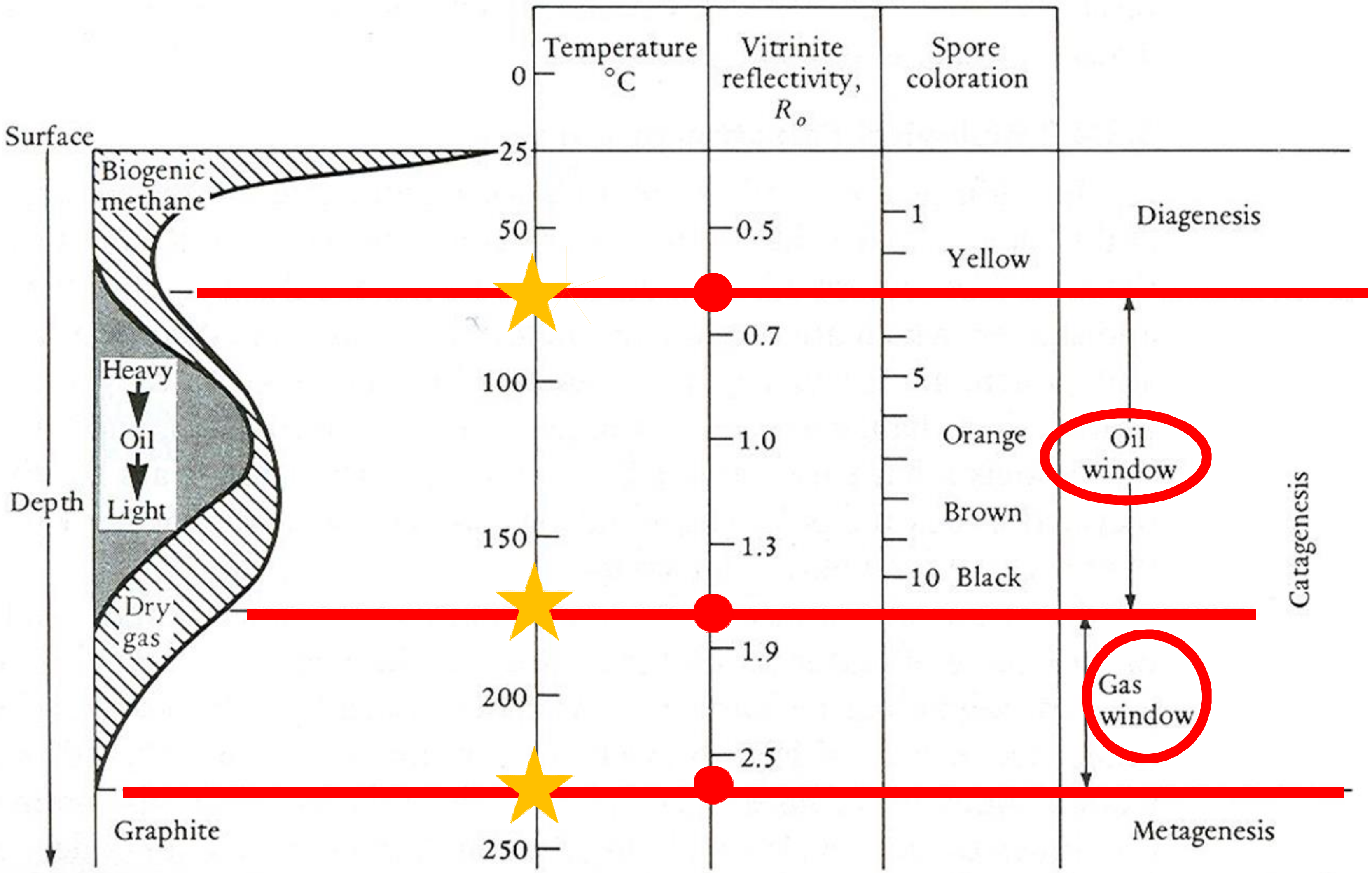
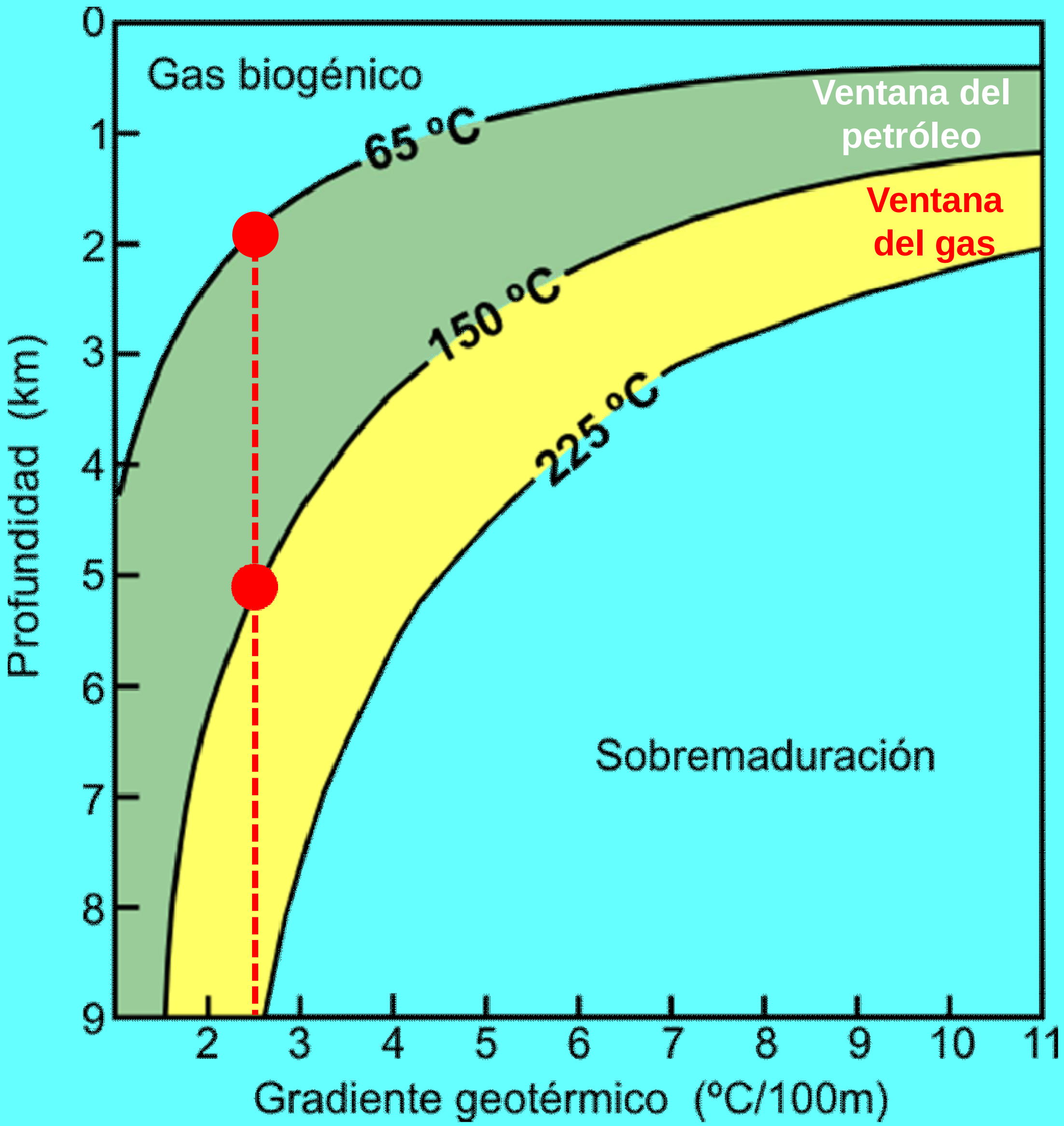


FIGURE 5.19 Correlation between hydrocarbon generation, temperature, and some paleothermometers.

¿A que profundidad se genera el petróleo y el gas?



¿Que son las ñshalesò?

Rocas sedimentarias detríticas de grano fino, mayoritariamente formadas por partículas tamaño arcillaï limo. Pueden ser laminadas o masivas y mas o menos ricas en carbonato. ¡No traducir por pizarras o esquistos (rocas metamórficas)!

ñOil shalesò (ñkerogen shalesò)

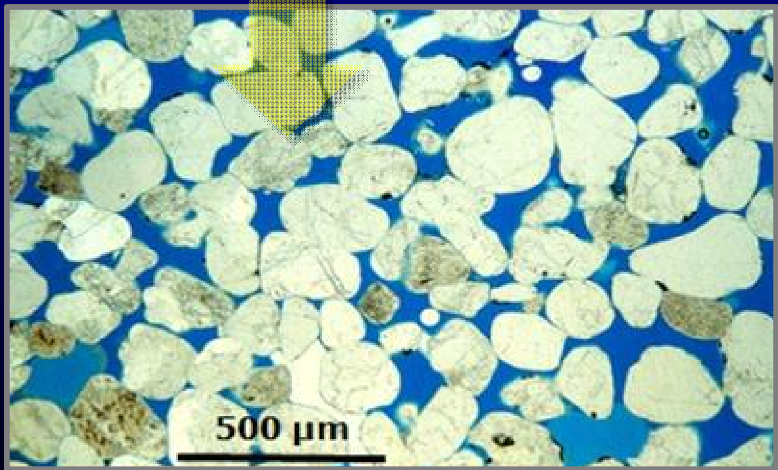
Rocas ricas en kerógeno a partir de las cuales pueden destilarse hidrocarburos líquidos denominados ñshale oilò.

No confundir con el ñligth tight oilò (LTO)

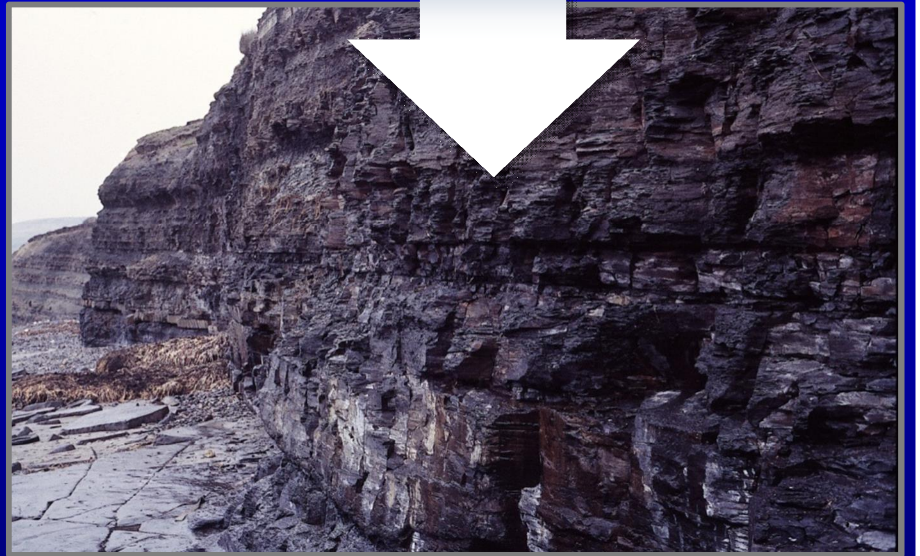
Petróleo natural (o crudo) obtenido de ñshalesò mediante FH

ñShale gasò: gas natural (CH_4) atrapado en ñshalesò

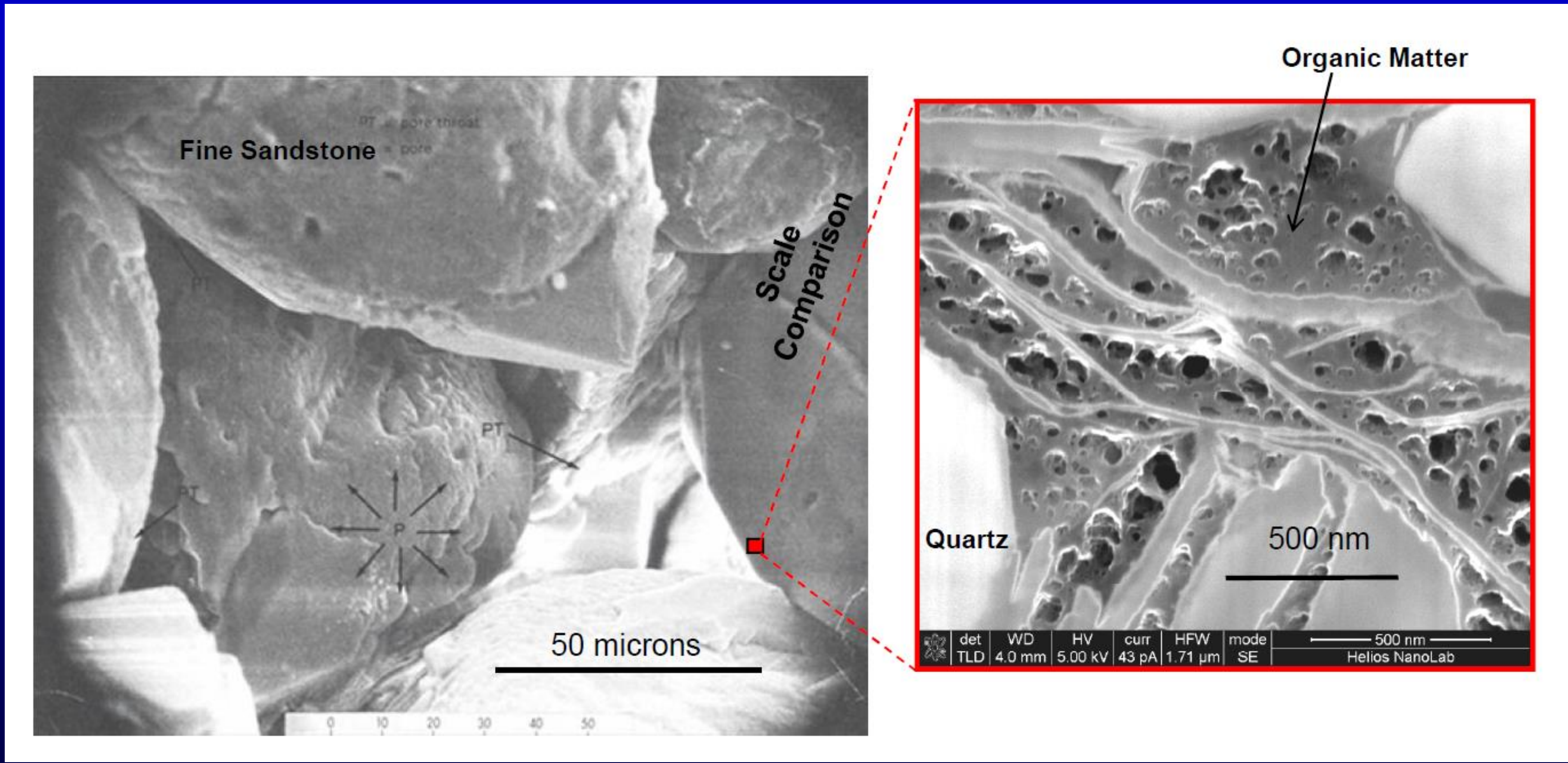
The conventional



The unconventional



Tamaños de poro: gas convencional vs ñgas shaleò

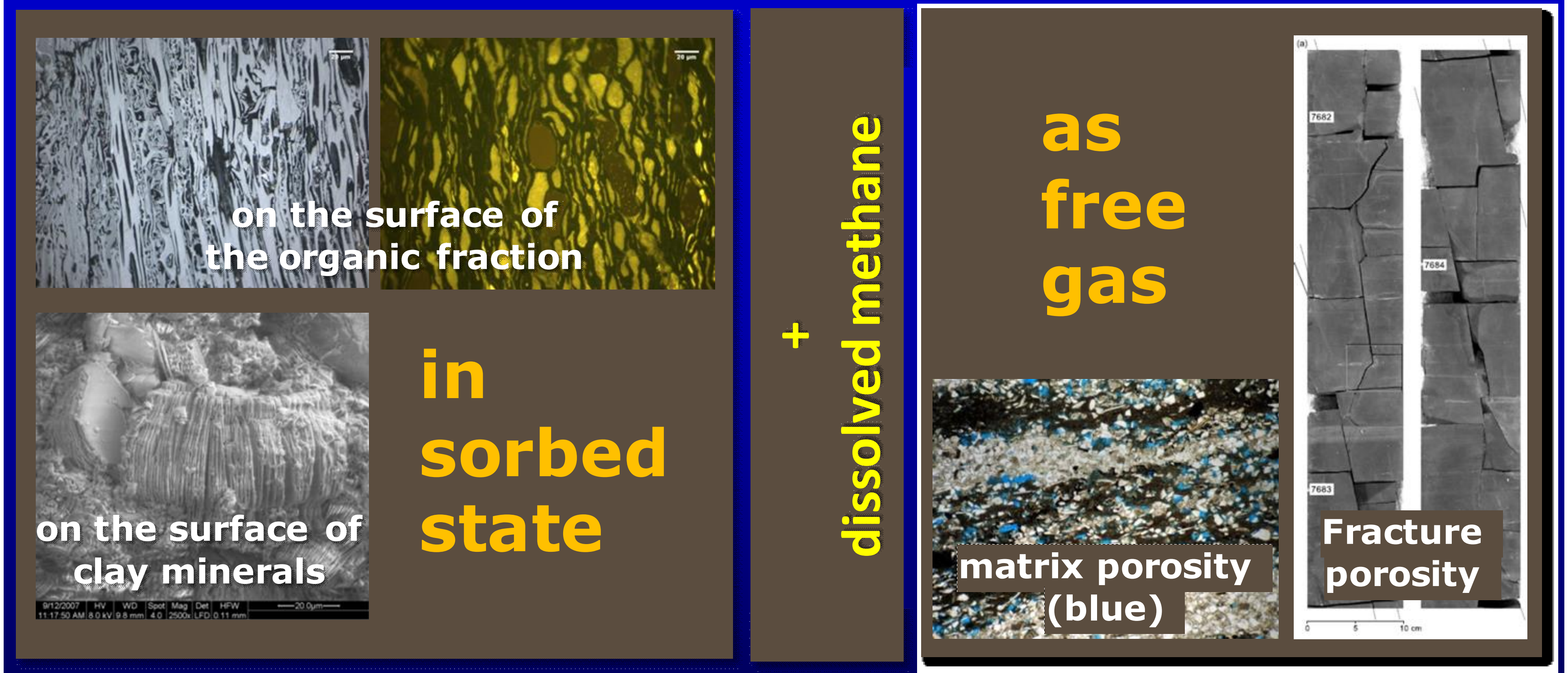


Passey and Bohacs, ExxonMobil

Micra = 10^{-3} mm

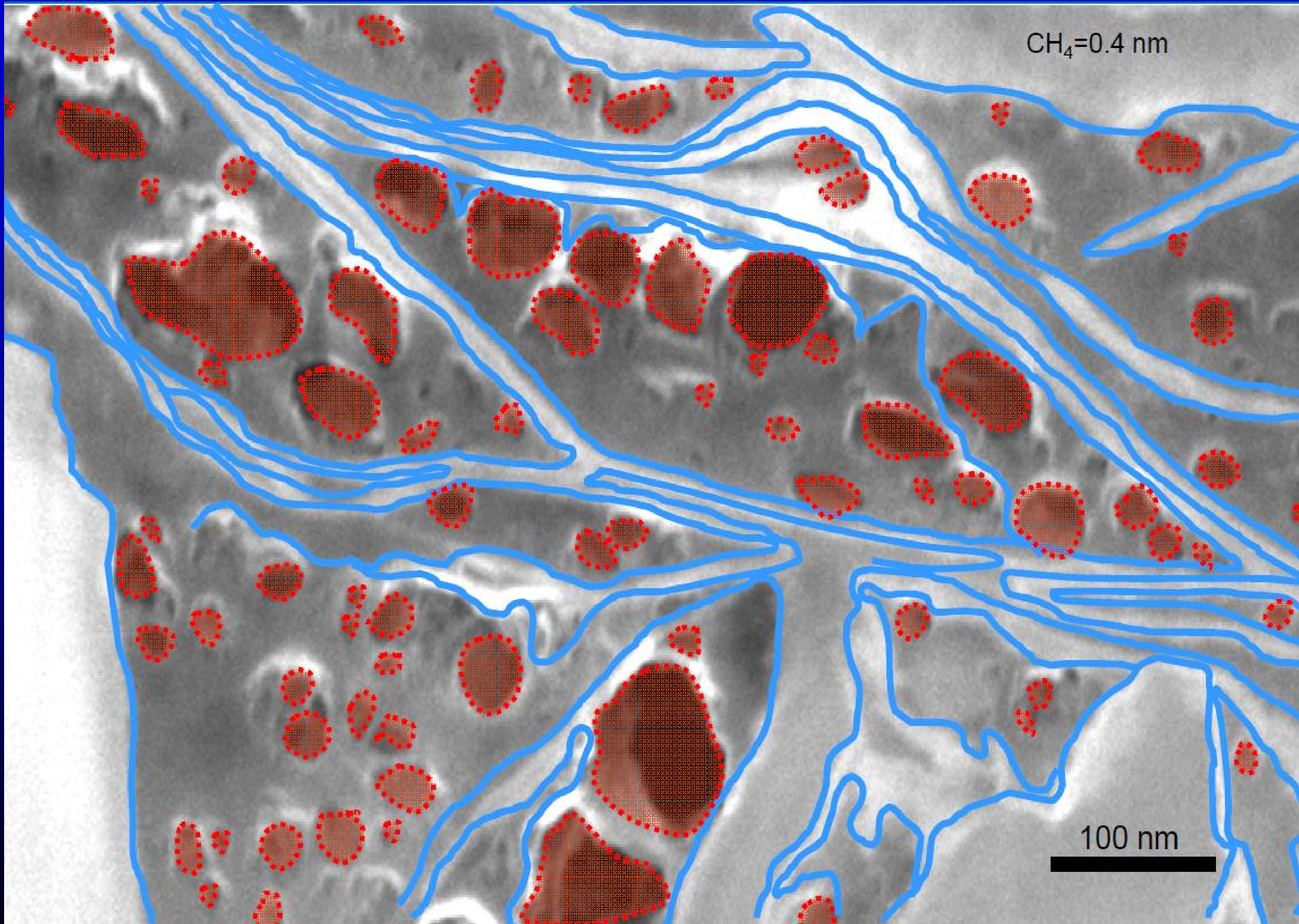
Nano (n) = 10^{-9}

¿Donde está el metano en las ñgas shalesò?



- Fracture gas is produced immediately
- Adsorbed gas is released due to pressure declines

Distribución hipotética de gas y agua.

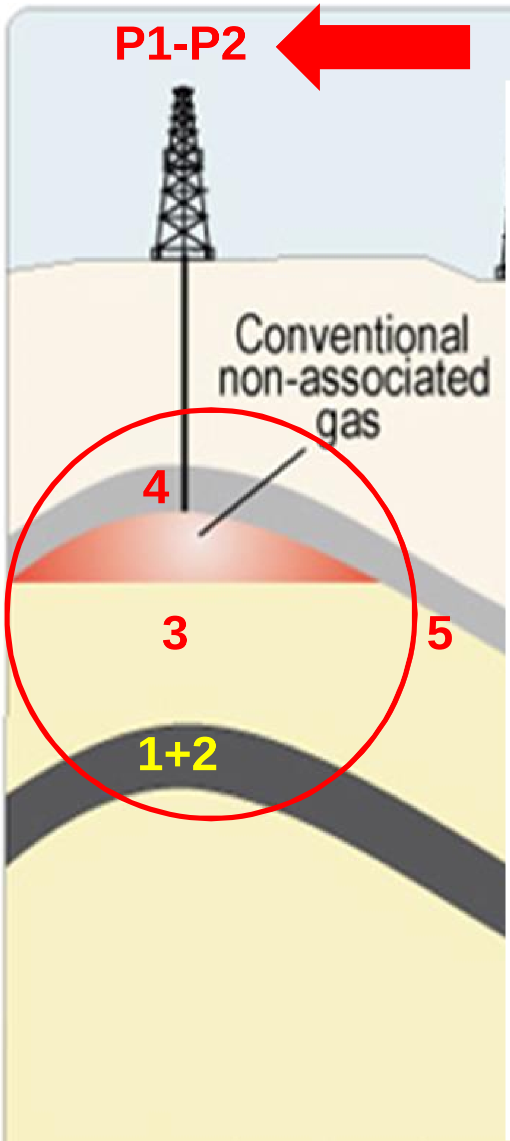


Passey & Bohacs, ExxonMobil

Porosidad y permeabilidad: convencional vs ñgas shaleò

	System	Porosity	Permeability	Reservoir
Conventional	Reservoir rock	up to 30%	10^{-3} Darcy (mD)	Free Gas
Tight Gas	Reservoir Rock	< 5%	10^{-6} Darcy (εD)	Free Gas
Gas shale	Source Rock, organic rich	< 5%	10^{-9} Darcy (nD)	Free + Adsorbed Gas
Coalbed Methane (CBM)	Coal Seams	key challenge is removal of water		natural fractured, filled with water and gas

Extracción : gas convencional vs ñshale gasò

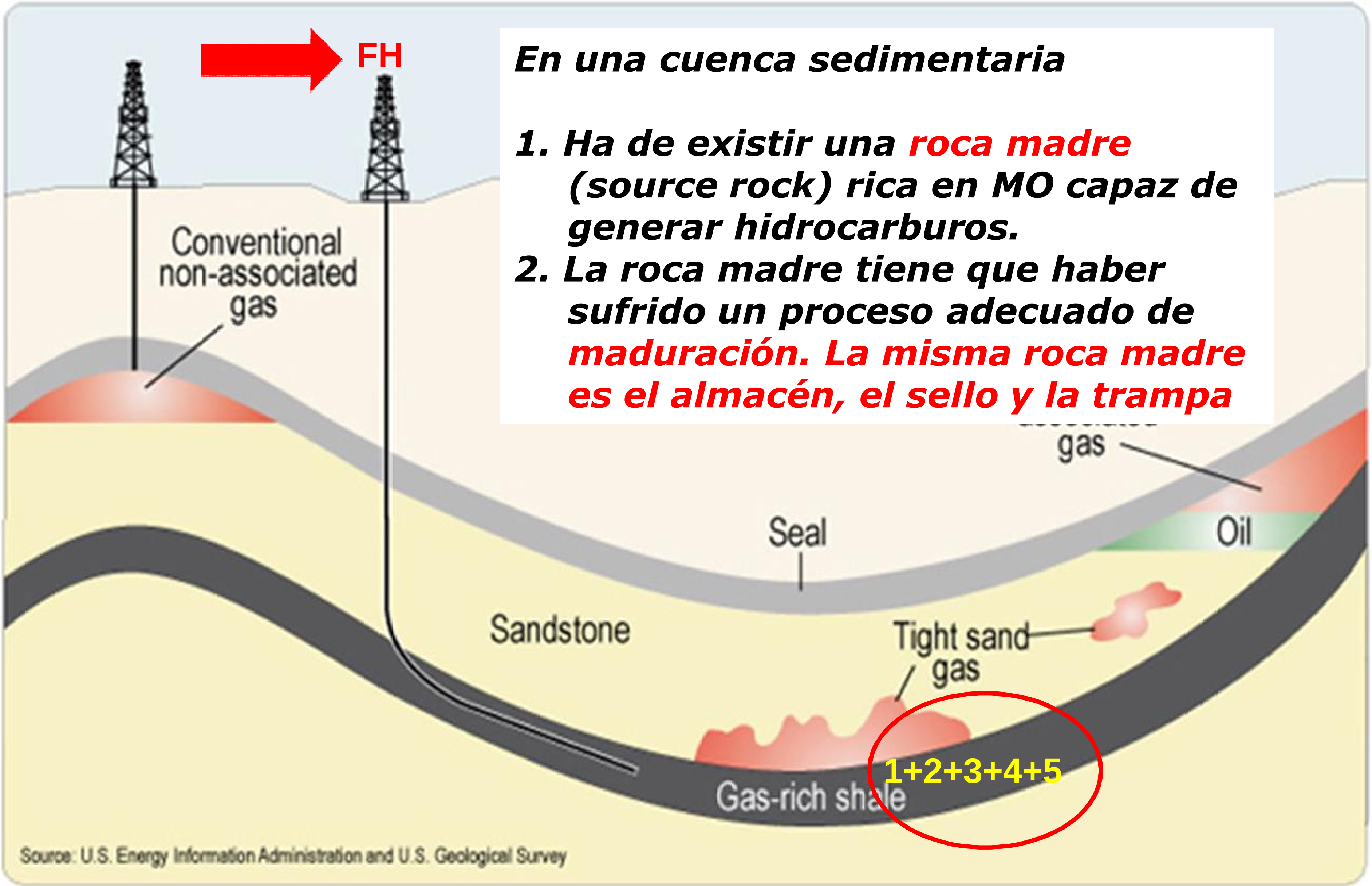


En una cuenca sedimentaria:

1. *Ha de existir una **roca madre** (source rock) rica en MO capaz de generar hidrocarburos.*
2. *La roca madre tiene que haber sufrido un proceso adecuado de **maduración**.*
3. *Ha de existir una **roca almacén** o reservorio (reservoir) conectada con la roca madre, y con valores adecuados de porosidad y permeabilidad.*
4. *Necesidad de una **roca impermeable** (cap rock, seal) que impida el escape de los hidrocarburos.*
5. *Los elementos, ordenados estratigráfica y/o estructuralmente formando **trampas** (traps).*

Source: U.S. Energy Information Administration and U.S. Geological Survey

Extracción : gas convencional vs ñshale gasò



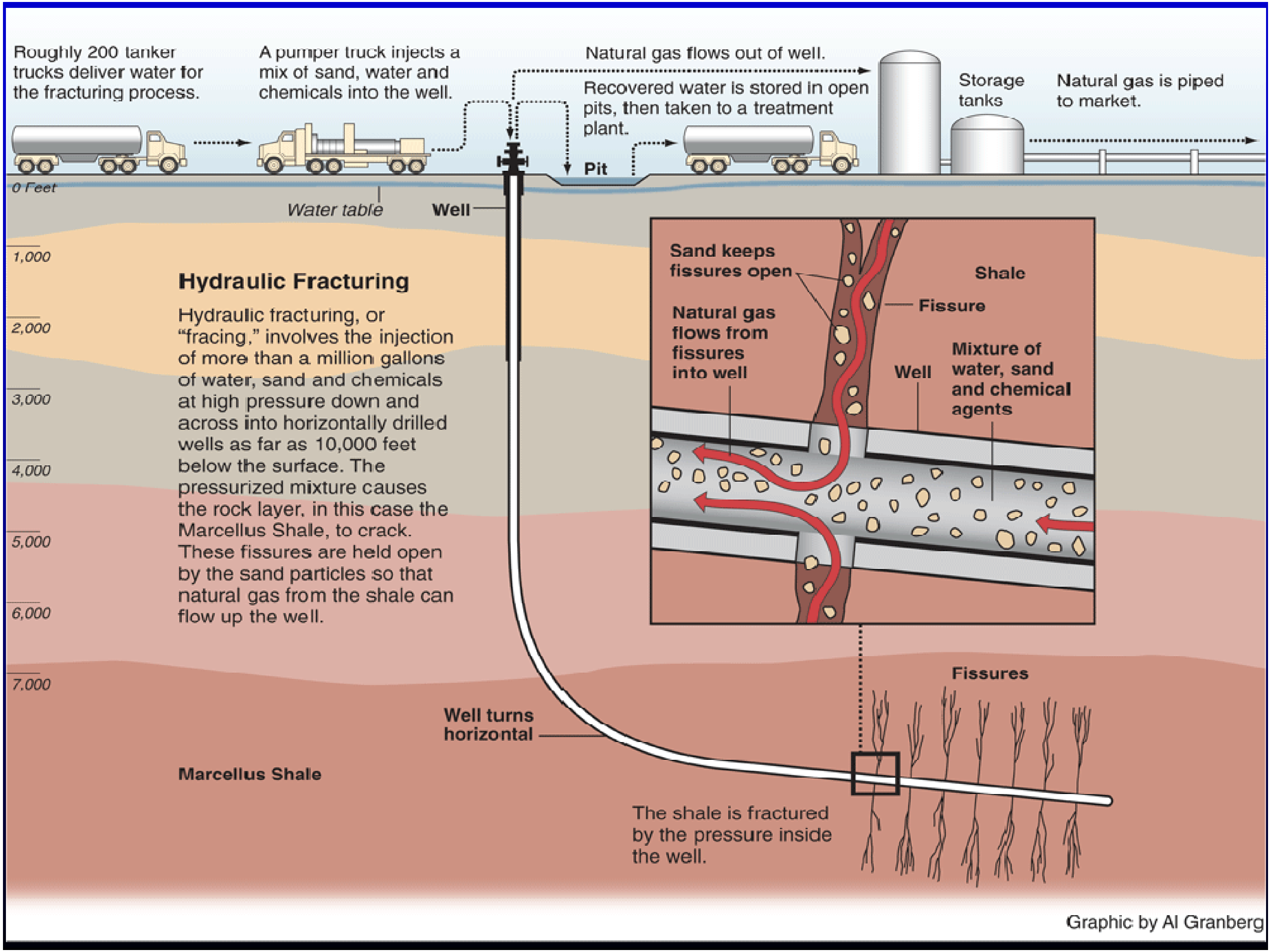
En una cuenca sedimentaria

1. ***Ha de existir una roca madre (source rock) rica en MO capaz de generar hidrocarburos.***
2. ***La roca madre tiene que haber sufrido un proceso adecuado de maduración. La misma roca madre es el almacén, el sello y la trampa***

Fracturación hidráulica o ñfrackingòò

Cambio de paradigma geológico + desarrollo tecnológico

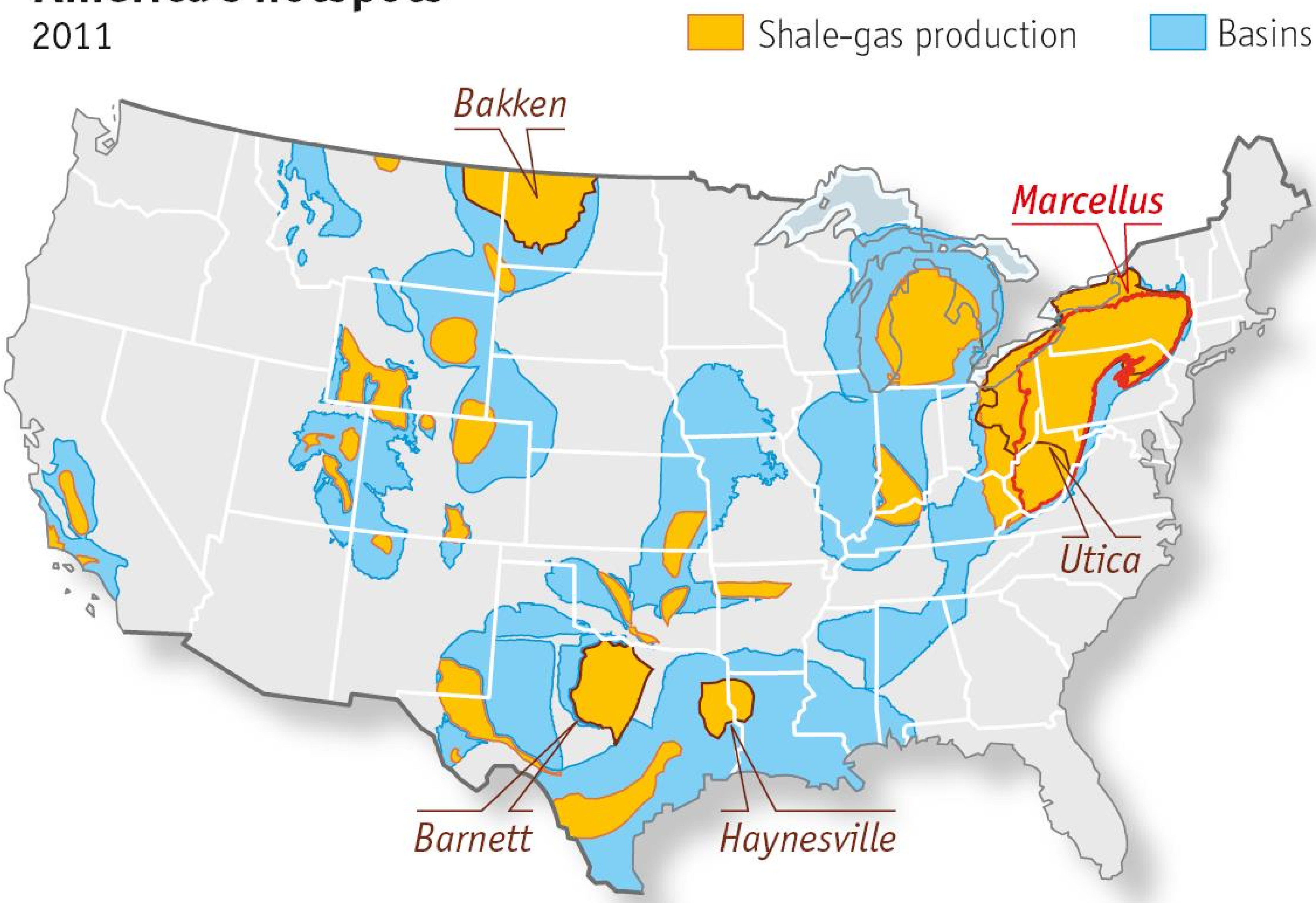
	Conventional	Unconventional
Preferred Trap Type	Structural	Stratigraphic
Common Reservoir Lithology	Sandstones and Carbonates	Shales, Tight Sandstones and Tight Carbonates
Reservoir Permeability	Millidarcies	Nanodarcies
Aerial Trap Size	Small	Huge
Geological Risk	High	Low
Drilling Risk	High	Low
Well Type	Vertical	Horizontal
Completion Expense	Low	High



Roughly 200 tanker trucks deliver water for the fracturing process.
A pumper truck injects a mix of sand, water and chemicals into the well.
Natural gas flows out of well.
Recovered water is stored in open pits, then taken to a treatment plant.
Storage tanks
Natural gas is piped to market.
Pit
0 Feet
Water table
Well
1,000
2,000
3,000
4,000
5,000
6,000
7,000
Hydraulic Fracturing
Hydraulic fracturing, or "fracing," involves the injection of more than a million gallons of water, sand and chemicals at high pressure down and across into horizontally drilled wells as far as 10,000 feet below the surface. The pressurized mixture causes the rock layer, in this case the Marcellus Shale, to crack. These fissures are held open by the sand particles so that natural gas from the shale can flow up the well.
Sand keeps fissures open
Shale
Fissure
Natural gas flows from fissures into well
Well
Mixture of water, sand and chemical agents
Fissures
Well turns horizontal
Marcellus Shale
The shale is fractured by the pressure inside the well.
Graphic by Al Granberg

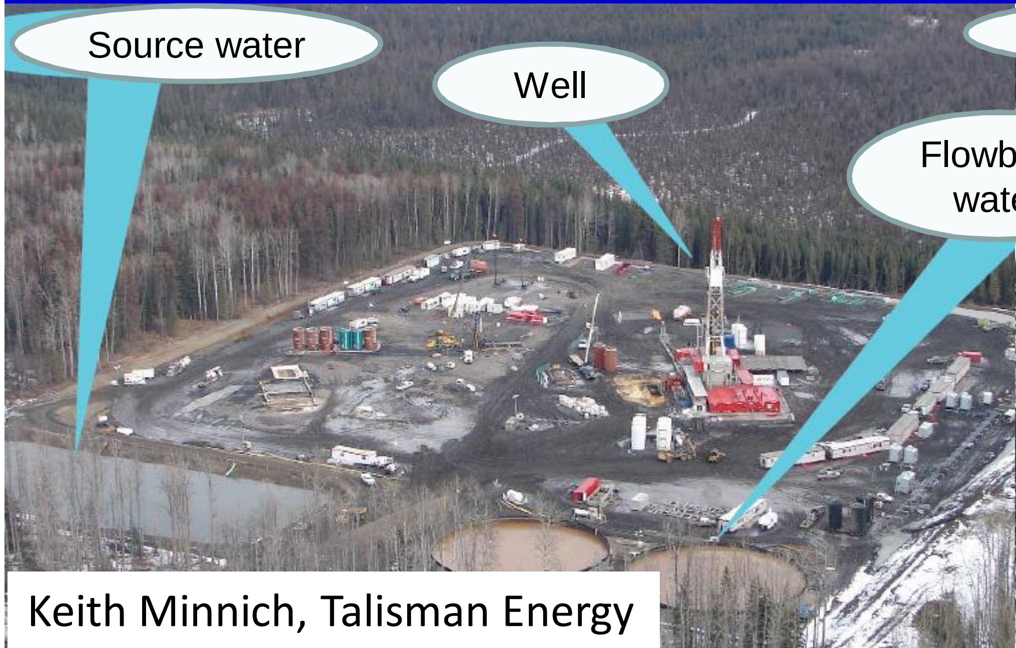
America's hotspots

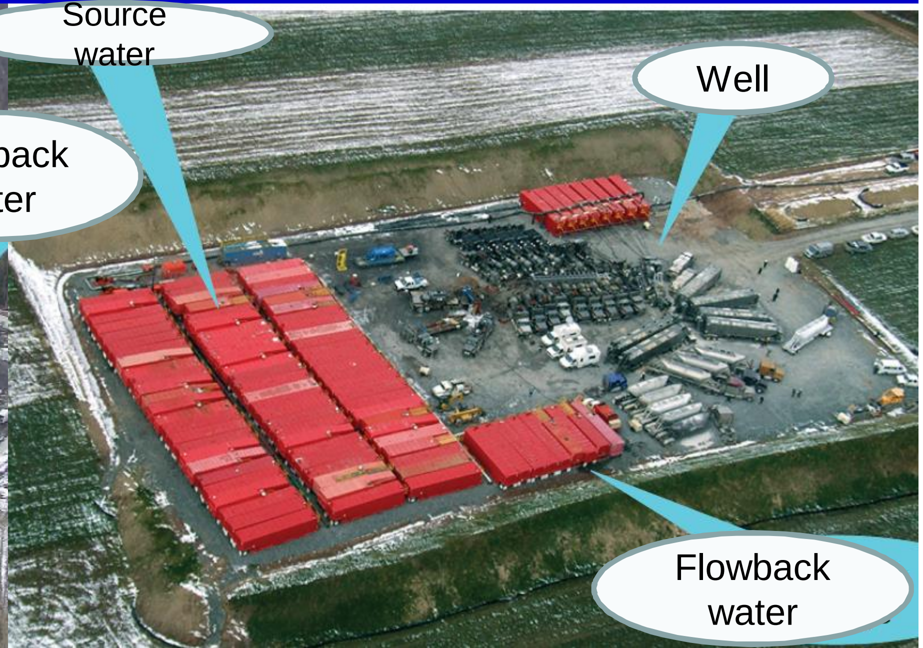
2011



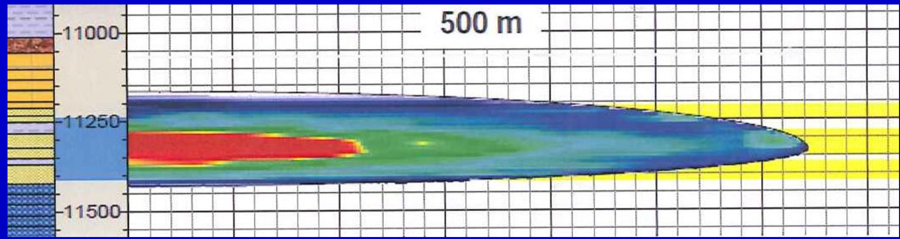
Sources: Energy Information Administration; International Energy Agency

Pozos y operaciones





- Plataforma de operación (ñwell-padò): 1000-4000 m^2 (+/- campo de futbol)
- Se necesitan 15.000-30.000 m^3 de agua por pozo (15-30 millones de litros)
- ~ 35.000 pozos fracturados por año en los EE.UU.
- Uso de agua equivalente al de 1-2 ciudades de 2,5 millones de habitantes
- Transporte de equipo móvil, fluidos y sólidos (~ 1000 viajes de camión / pozo)
- Ampliación de la red de carreteras para conectar todas las bocas de pozo
- Se necesitan gasoductos conectados a la red gasística principal
- Equipos de FH (temporal), equipos de producción (ñpermanenteò)
- Afectación del terreno durante 1-2 generaciones (25-50 años)



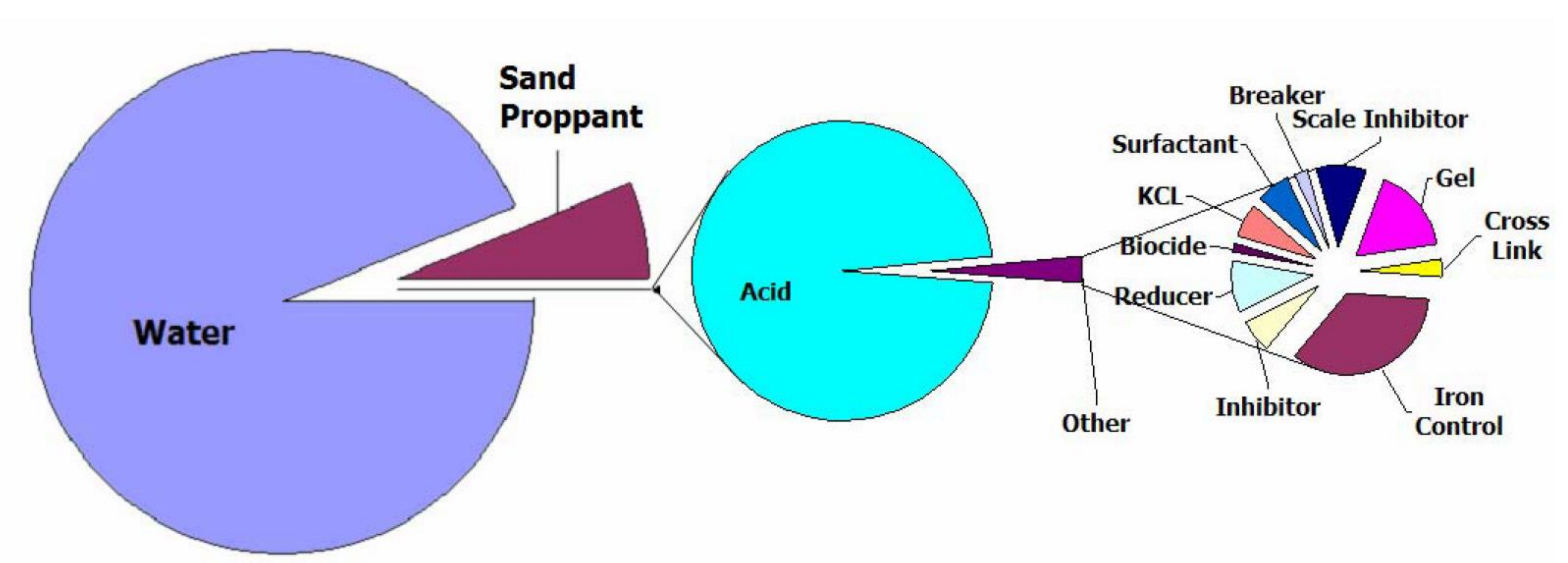
~ 35.000 pozos fracturados por año en los EE.UU

Uso de agua equivalente al de 1-2 ciudades de 2,5 millones de habitantes

Agua subterránea o superficial transportada al lugar del sondeo por camión

El agua se almacena en tanques o en balsas

Porcentaje de agua, sustancias químicas y sólidos



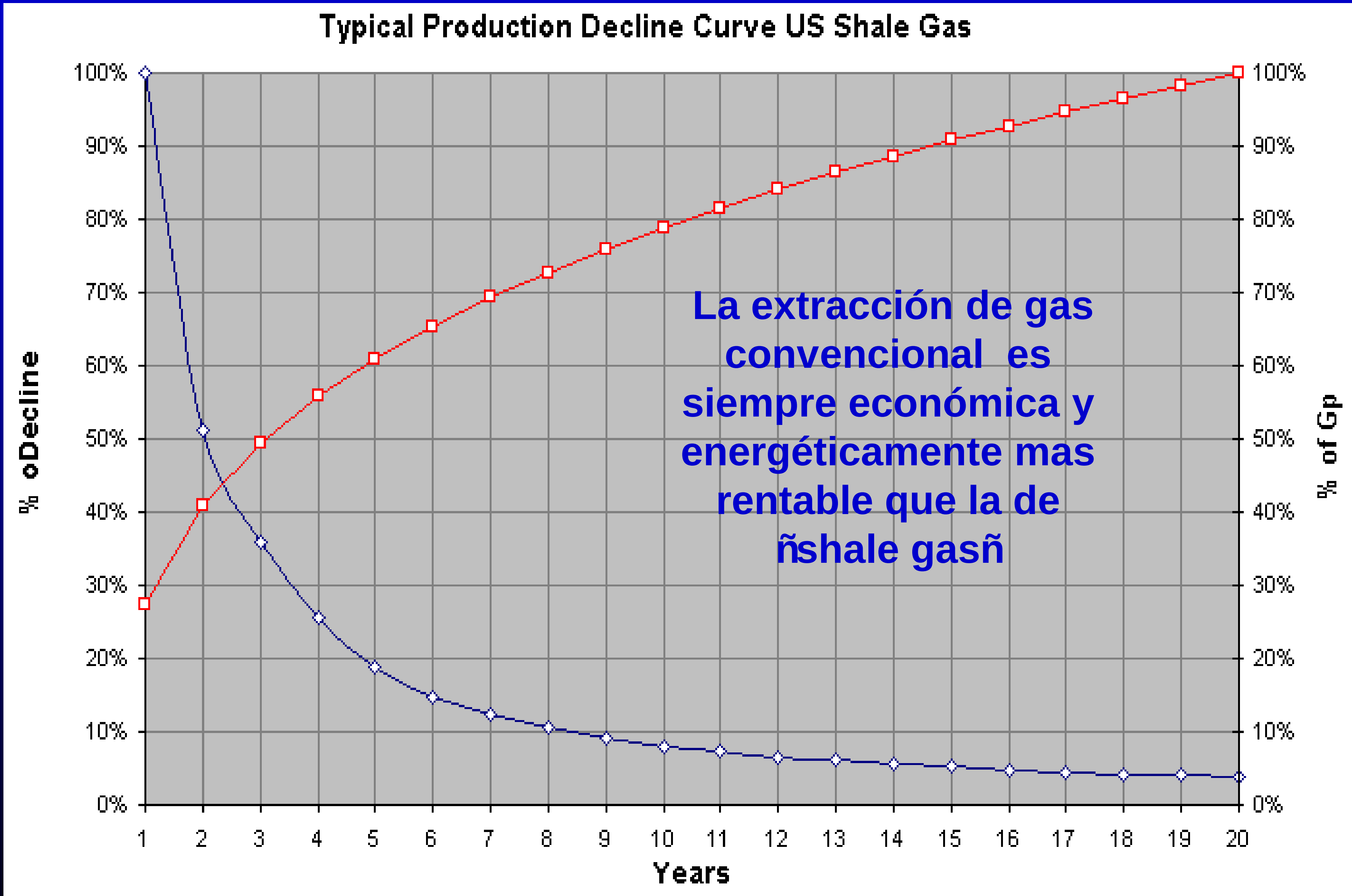
Ingredientes químicos de un fluido de fracturación

TABLE 4. AN EXAMPLE OF THE VOLUMETRIC COMPOSITION OF HYDRAULIC FRACTURING FLUID

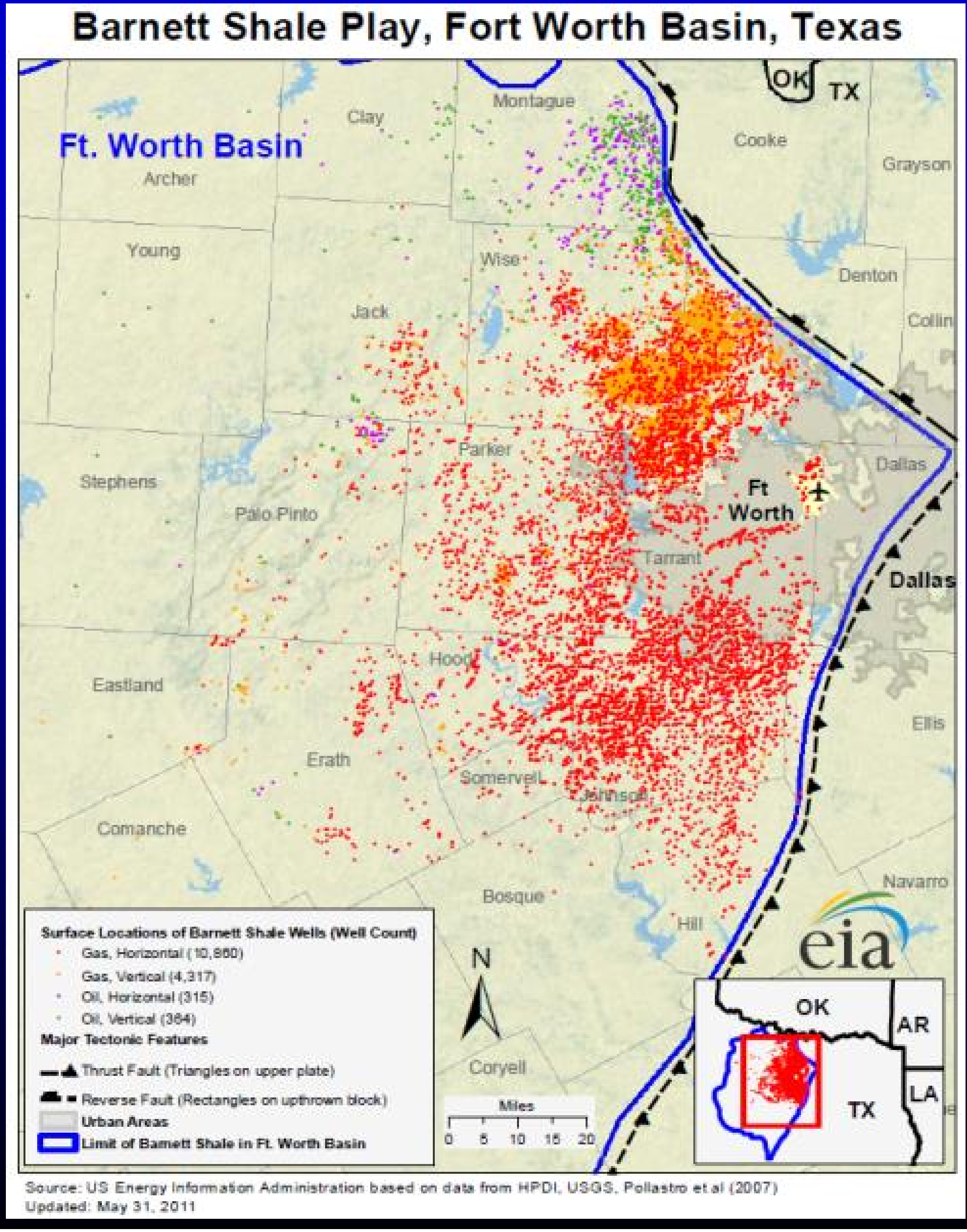
Component/ Additive Type	Example Compound(s)	Purpose	Percent Composition (by Volume)	Volume of Chemical (Gallons)[a]
Water		Deliver proppant	90	2,700,000
Proppant	Silica, quartz sand	Keep fractures open to allow gas flow out	9.51	285,300
Acid	Hydrochloric acid	Dissolve minerals, initiate cracks in the rock	0.123	3,690
Friction reducer	Polyacrylamide, mineral oil	Minimize friction between fluid and the pipe	0.088	2,640
Surfactant	Isopropanol	Increase the viscosity of the fluid	0.085	2,550
Potassium chloride		Create a brine carrier fluid	0.06	1,800
Gelling agent	Guar gum, hydroxyethyl cellulose	Thickens the fluid to suspend the proppant	0.056	1,680
Scale inhibitor	Ethylene glycol	Prevent scale deposits in the pipe	0.043	1,290
pH adjusting agent	Sodium or potassium carbonate	Maintain the effectiveness of other components	0.011	330
Breaker	Ammonium persulfate	Allow delayed breakdown of the gel	0.01	300
Crosslinker	Borate salts	Maintain fluid viscosity as temperature increases	0.007	210
Iron control	Citric acid	Prevent precipitation of metal oxides	0.004	120
Corrosion inhibitor	N,n-dimethyl formamide	Prevent pipe corrosion	0.002	60
Biocide	Glutaraldehyde	Eliminate bacteria	0.001	30

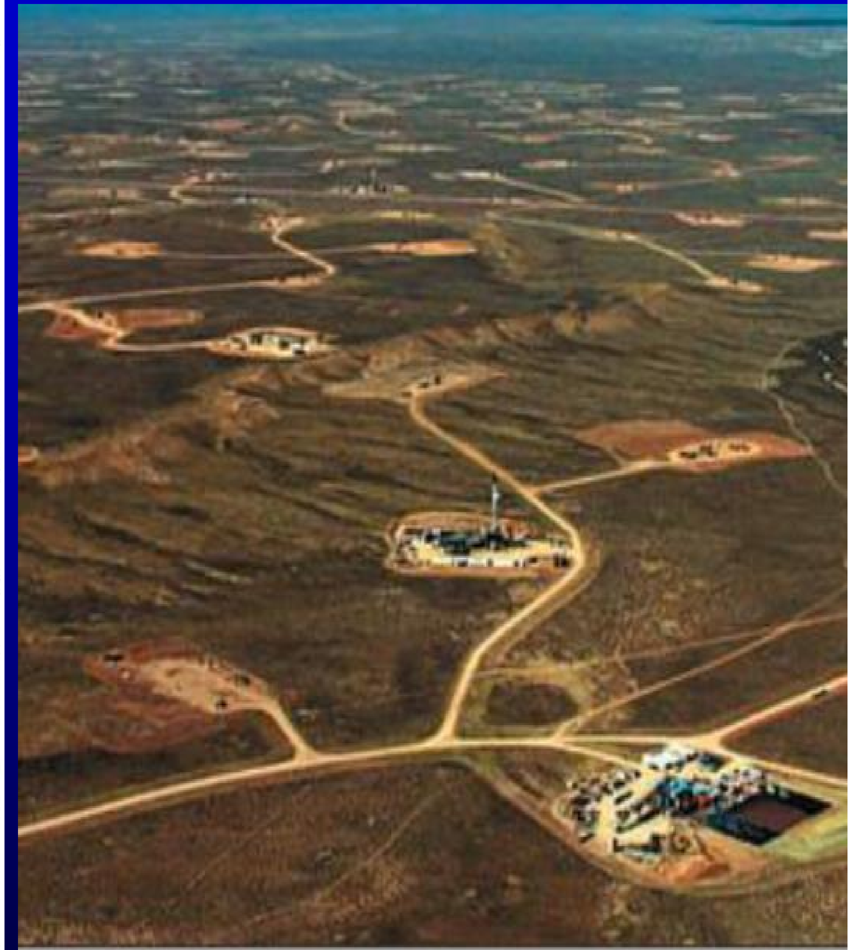
GCWP and ALL Consulting, 2009

Curva típica de declino de la producción del ñshale gasò en los EE.UU



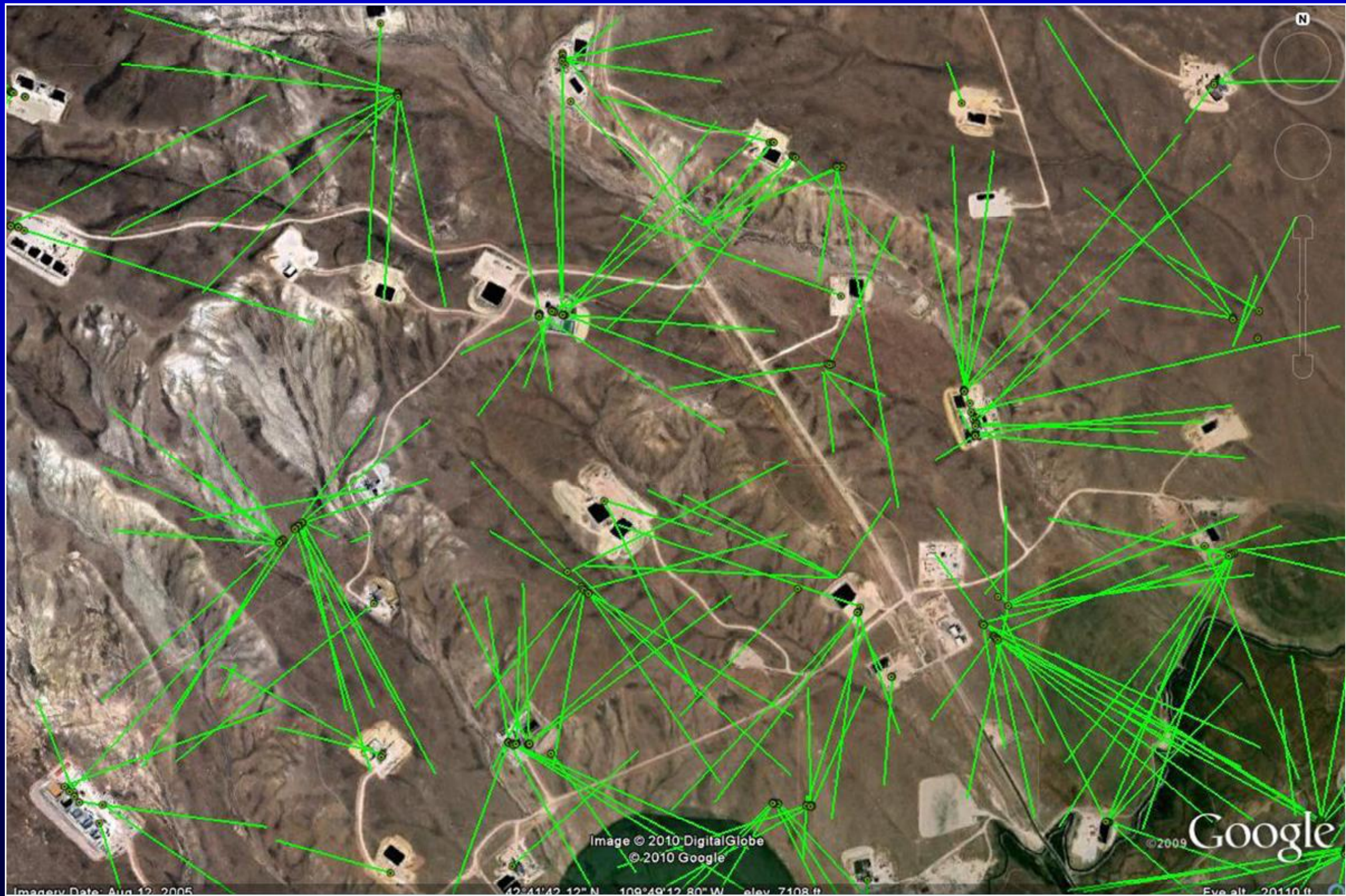
Impacto de la ocupación en superficie





Jonah Gas Field, Pinedale, WY

Ocupacion del terreno → plataformas multi-pozos



… reduces land disruption and drill times

Porter Bennett (2011): The US Natural Gas Revolution: Technology Transforms A Market. #40763.
www.searchanddiscovery.com

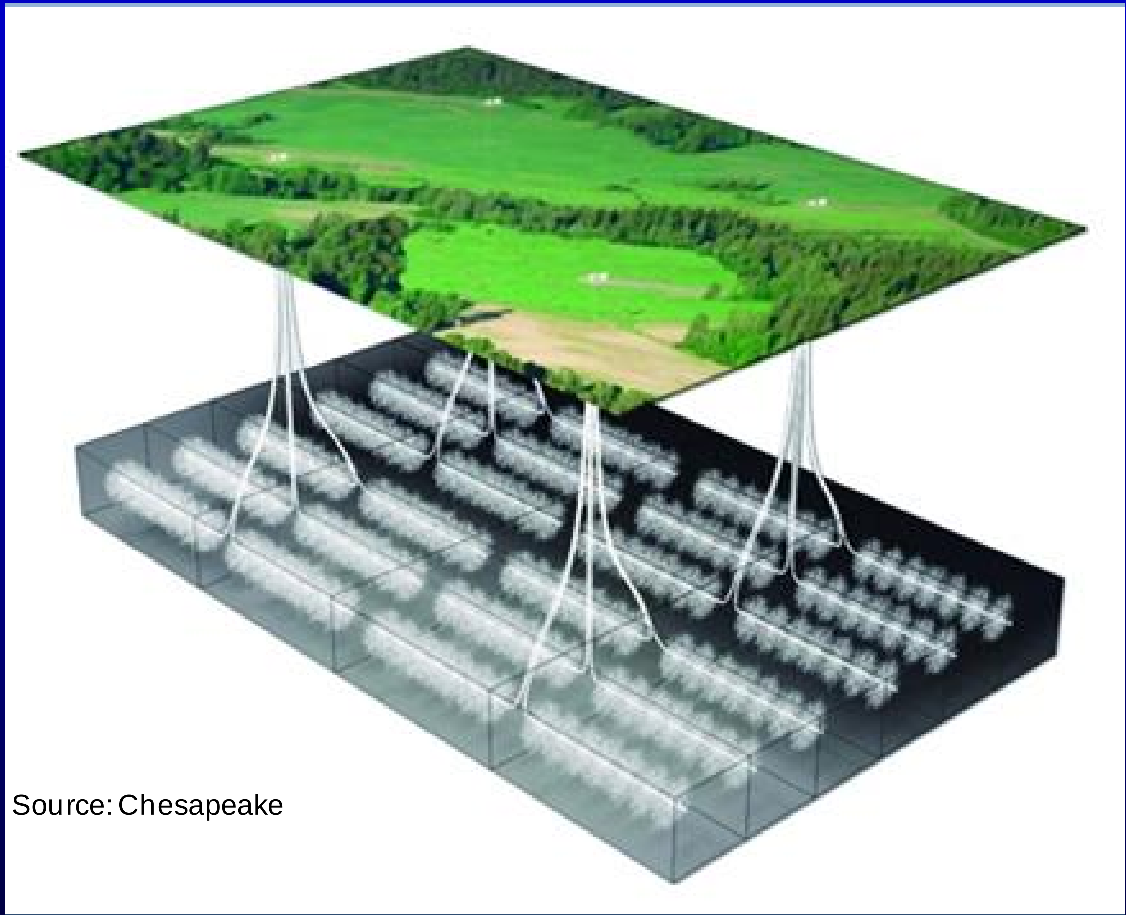
El desarrollo de las técnicas de perforación dirigida, ha permitido perforar en zonas altamente pobladas, alcanzando múltiples objetivos distantes, desde un mismo emplazamiento en superficie

The Barnett Shale underlies much of the Dallas/Ft. Worth area.

Source : Carrizo

Global Unconventional Gas 2010

Plataformas multi-pozos + múltiples fases de FH



Source: Chesapeake

Advances in horizontal drilling have seen the development of steerable drills that can keep drilling while changing direction and sending information back to the operator

Å Objetivo: Maximizar en 3D el volumen de roca estimulado (ñstimulated rock volumeò o SRV = volumen de roca conectado dinámicamente al pozo)

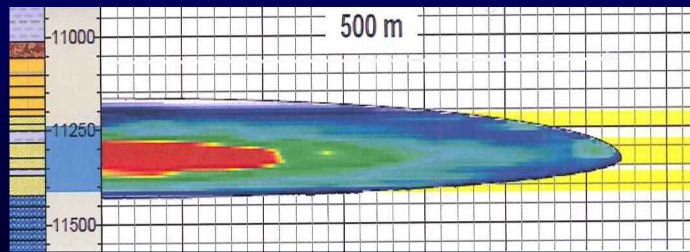
Å Como optimizar:

→ pautas de geométricas de perforación

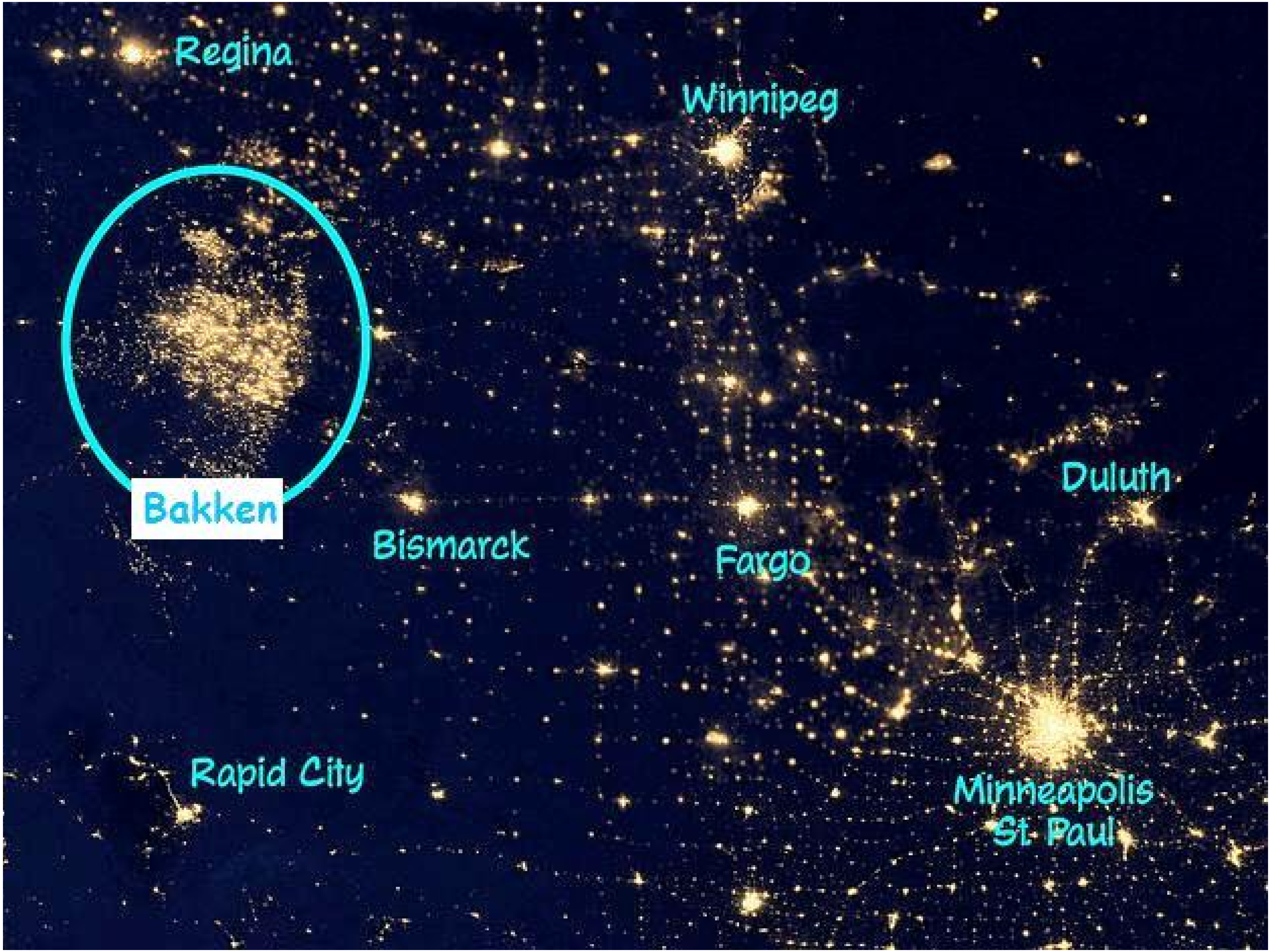
→ optimizar el espaciado entre pozos

→ múltiples fases de FH

→ control por monitorización sísmica




BAKKEN FORMATION
MINNEAPOLIS - ST PAUL
CHICAGO
© NASA

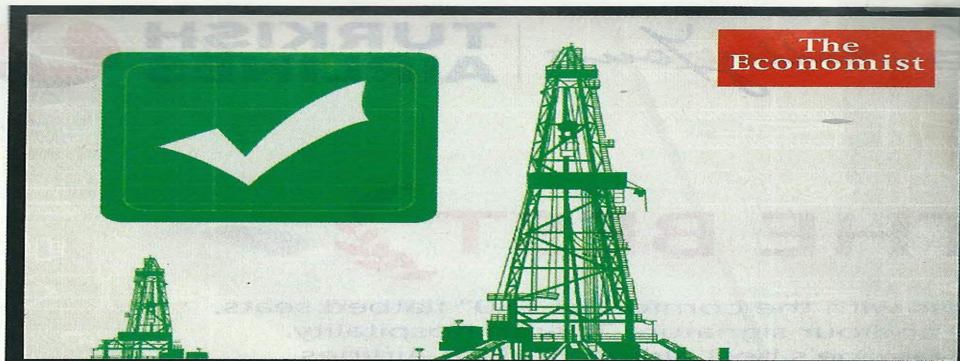

Regina
Winnipeg
Bakken
Bismarck
Fargo
Duluth
Rapid City
Minneapolis
St. Paul


© New York Times / Redux / eyevine

A survey of earthquakes and injection well locations in the Barnett Shale, Texas

Cliff Frohlich, University of Texas at Austin

¿Método intrínsecamente malo o malas practicas? Análisis caso a caso



THE RESULTS

"This house believes that the benefits derived from shale gas outweigh the drawbacks of hydraulic fracturing"

AGREE 49%

"Energy is a fundamental service needed for daily living. Lack of access to fuel is a key driver of poverty and premature mortality. But as essential as energy is to human development, the reality is that all forms of energy production have environmental consequences."

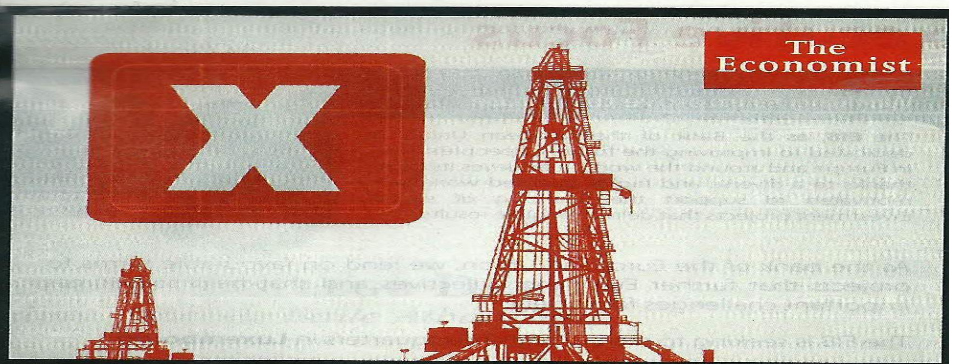
Amy Myers Jaffe
Executive director for energy and sustainability, University of California, Davis

Voting at a glance

DAY	01	02	03	04	05	06	07	08	09	10
YES	40%	41%	44%	46%	47%	47%	46%	45%	46%	49%
NO	60%	59%	56%	54%	53%	53%	54%	55%	54%	51%

50%

To read all statements and comments from the debate in full, go to http://www.economist.com/debate/overview/246



THE RESULTS

"This house believes that the benefits derived from shale gas outweigh the drawbacks of hydraulic fracturing"

DISAGREE 51%

"Fracking currently enjoys exemptions from parts of at least seven major national statutes, including the Clean Air Act, Clean Water Act and Safe Drinking Water Act. If fracking is so safe, why can't the industry be held to the same standards as everyone else?"

Michael Brune
Executive director, Sierra Club

Voting at a glance

DAY	01	02	03	04	05	06	07	08	09	10
YES	40%	41%	44%	46%	47%	47%	46%	45%	46%	49%
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50%

To read all statements and comments from the debate in full, go to http://www.economist.com/debate/overview/246

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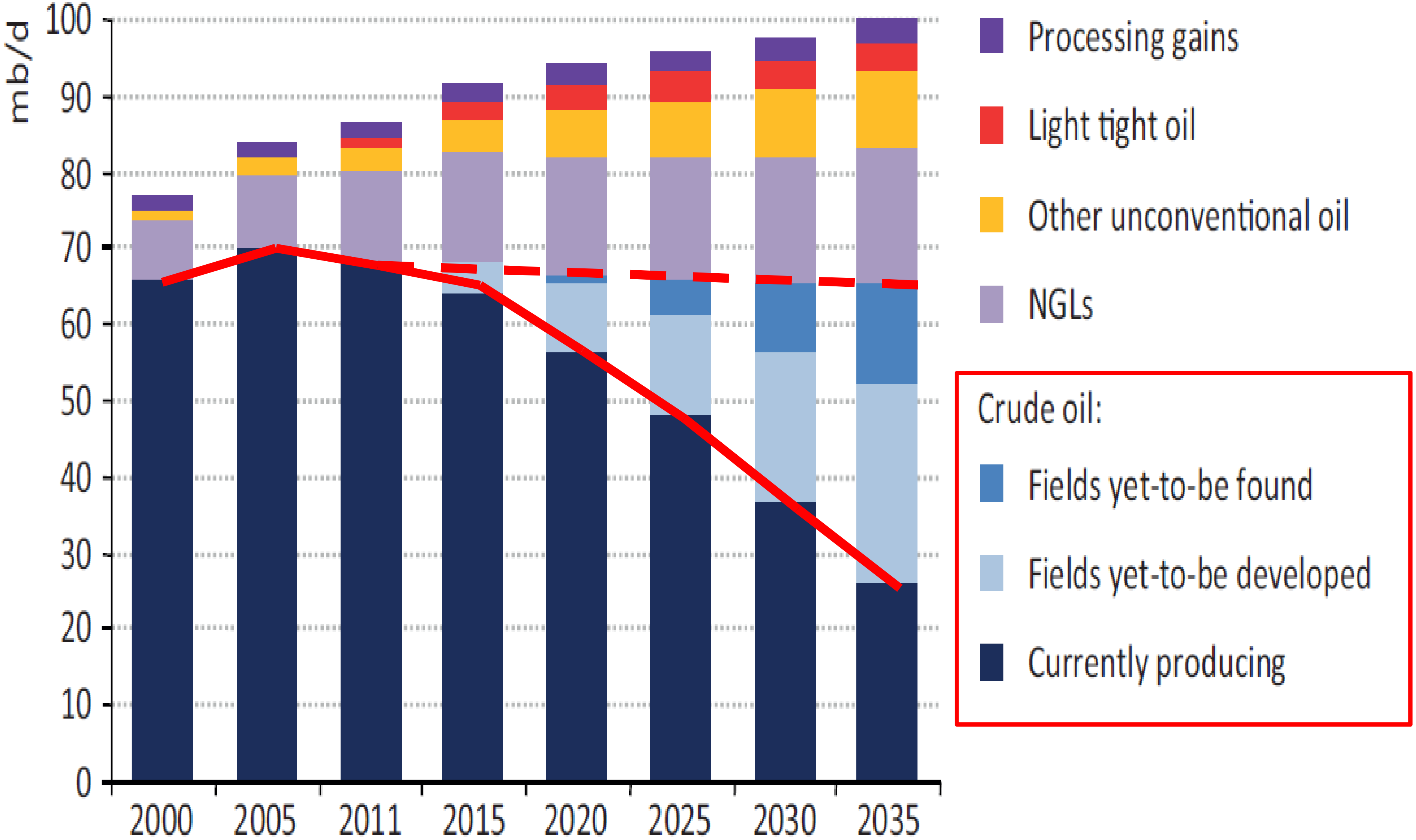
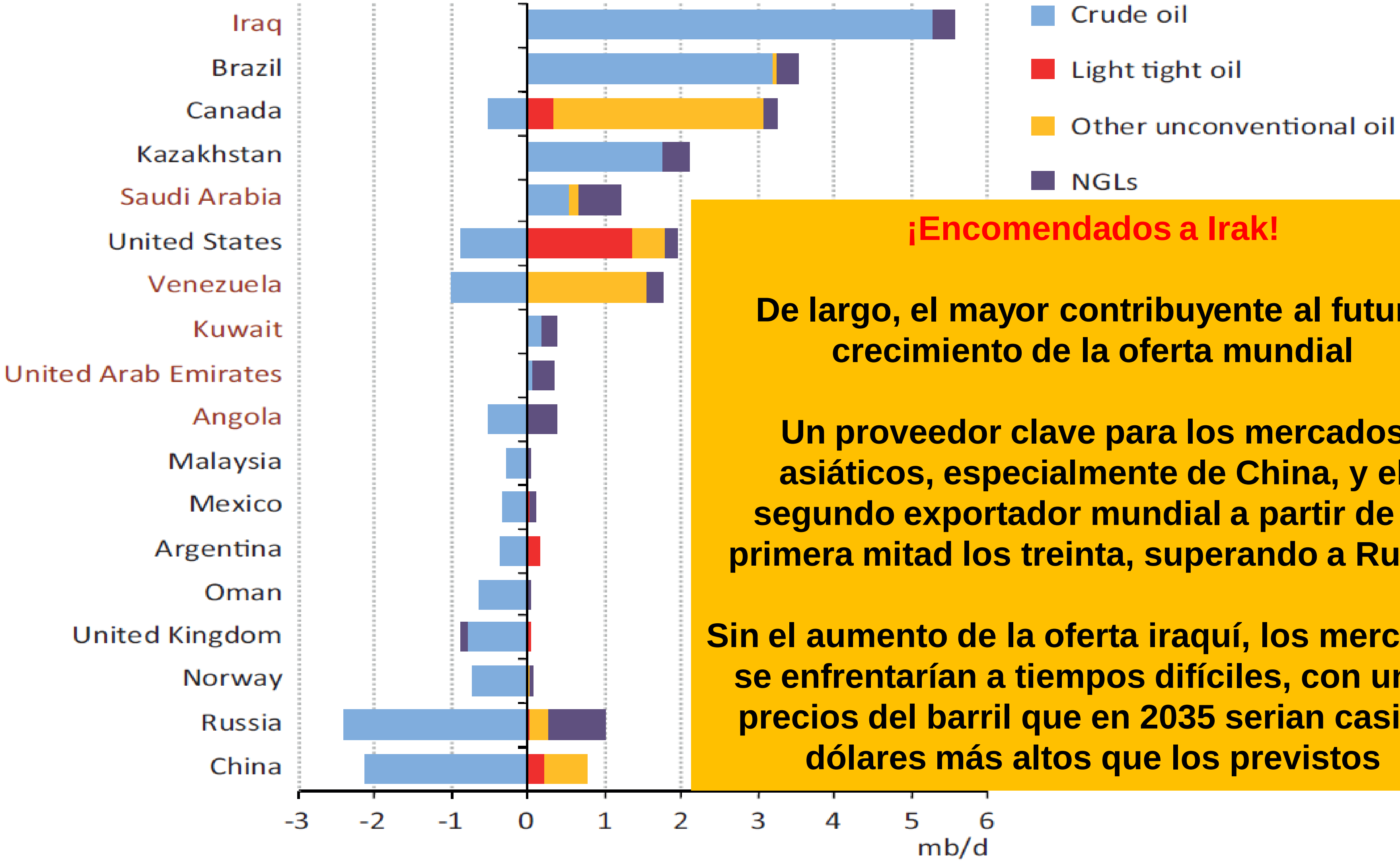
GOOD NEWS!! THE US ECONOMIC RECOVERY IS BUILDING...
LIKE A HOUSE OF CARDS...
WITH BICKERING ARCHITECTS...
SPEND
CUT
ON AN UNCERTAIN FOUNDATION...
OIL
IN A NEIGHBOURHOOD PRONE TO TREMORS...
DOWN WITH QADDAFI!
FREEDOM!
FREE EGYPT!
NO MORE TYRANNY
WITH A GENERAL ELECTION IN THE WIND...
THAT'S THE GOOD NEWS?
OIL
KAL

AIE, WEO 2012 : 4 nuevas Arabias Sauditas en 7 años!

El incremento neto de la producción mundial de petróleo deberá ser cubierto casi en su totalidad por petróleo no convencional y por LNG



Variaciones en la producción de petróleo 2011-2035



¡Encomendados a Irak!

De largo, el mayor contribuyente al futuro crecimiento de la oferta mundial

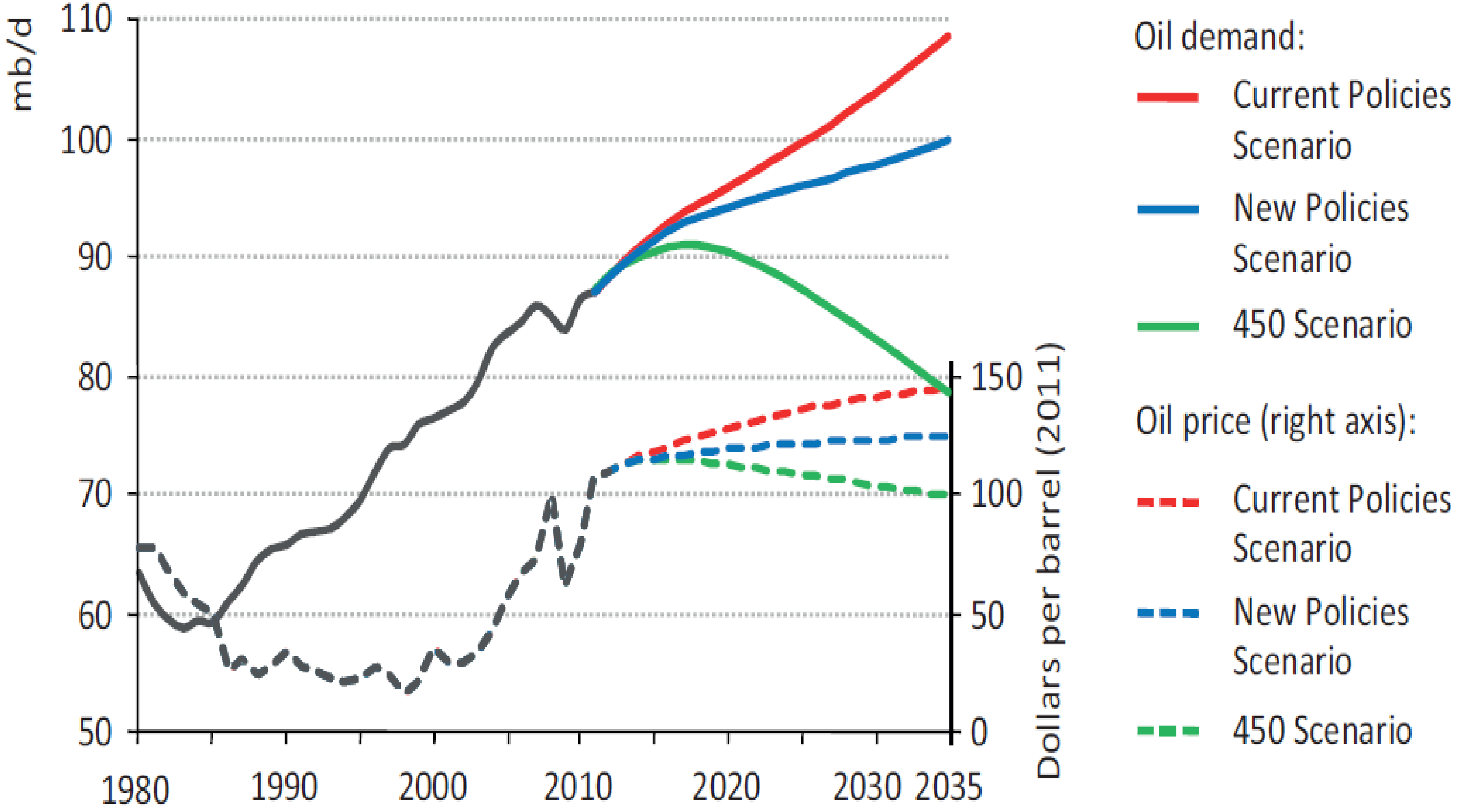
Un proveedor clave para los mercados asiáticos, especialmente de China, y el segundo exportador mundial a partir de la primera mitad los treinta, superando a Rusia.

Sin el aumento de la oferta iraquí, los mercados se enfrentarían a tiempos difíciles, con unos precios del barril que en 2035 serian casi 15 dólares más altos que los previstos

Note: Libya also has a large increase in oil production between 2011 and 2035, as 2011 production was exceptionally low due to the conflict.

KAL's cartoon, The Economist, 5th August 2010

Demanda mundial de petróleo y precios del crudo de importacion de la IEA por escenario



* Average IEA crude oil import price.

Precios nominales 2020: 157, 147, 139
Precios nominales 2035: 250, 215, 177

How resilient is your country?

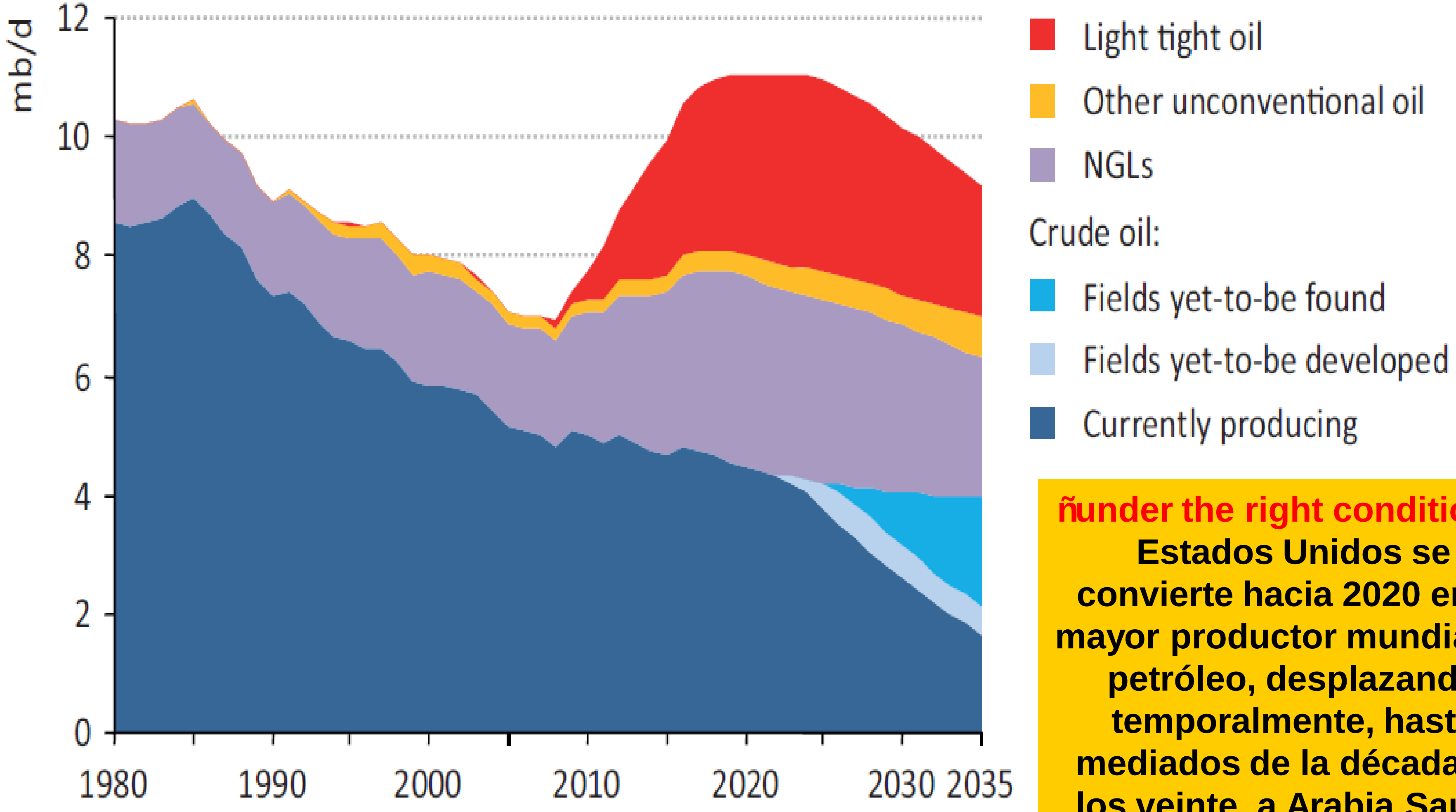
Extreme events are on the rise. Governments must implement national and integrated risk-management strategies, says **Erwann Michel-Kerjan**.

Nature, 22-11-2012

El resurgimiento de la producción de petróleo y gas en los EE.UU. a partir de fuentes no convencionales podría redibujar el mapa energético global

El repunte de la producción de petróleo y gas en EE.UU., basado en el *light tight oil* y el *shale gas*, no solo está impulsando la actividad económica -abaratando los precios del gas y de la electricidad, con la consiguiente mejora de la competitividad de la industria- sino que también está transformando el papel de Norteamérica en el comercio mundial de la energía

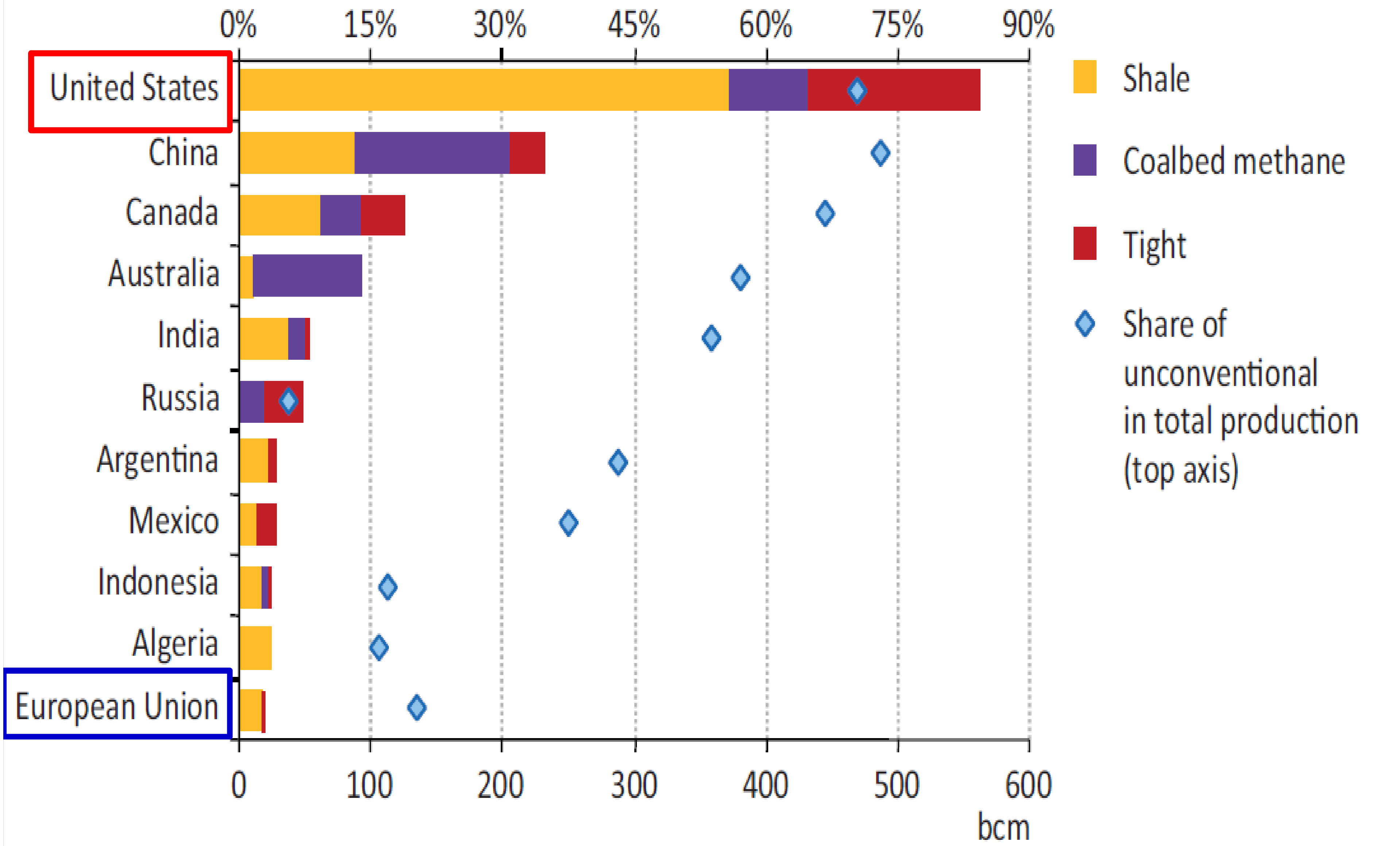
AIE, WEO 2012 : producción de petróleo USA
ñLa joroba del LTOò



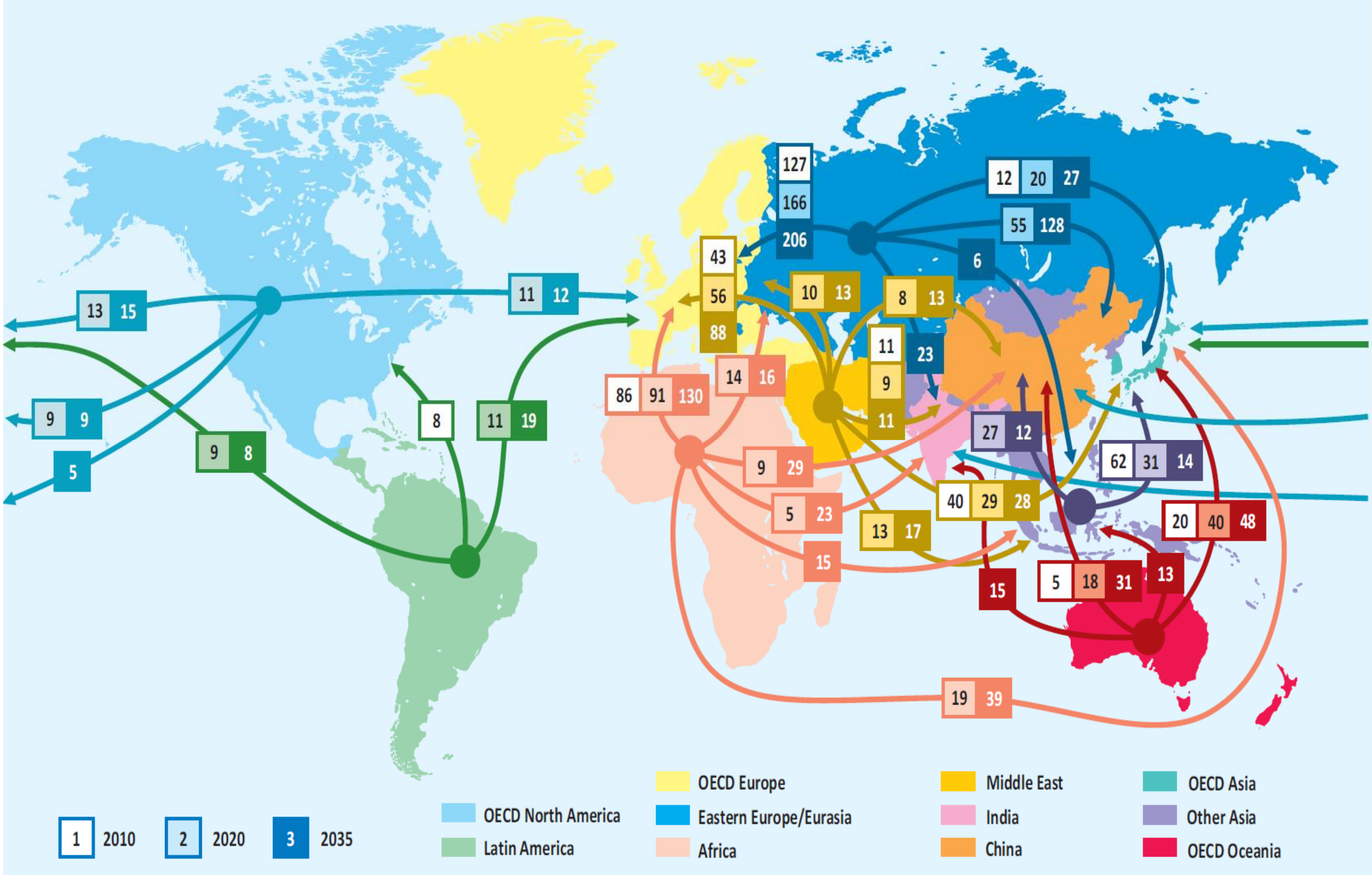
ñunder the right conditionsò
Estados Unidos se convierte hacia 2020 en el mayor productor mundial de petróleo, desplazando temporalmente, hasta mediados de la década de los veinte, a Arabia Saudí.

Note: The World Energy Model supply model starts producing yet-to-find oil after it has put all yet-to-develop fields into production. In reality, some yet-to-find fields would start production earlier than shown in the figure.

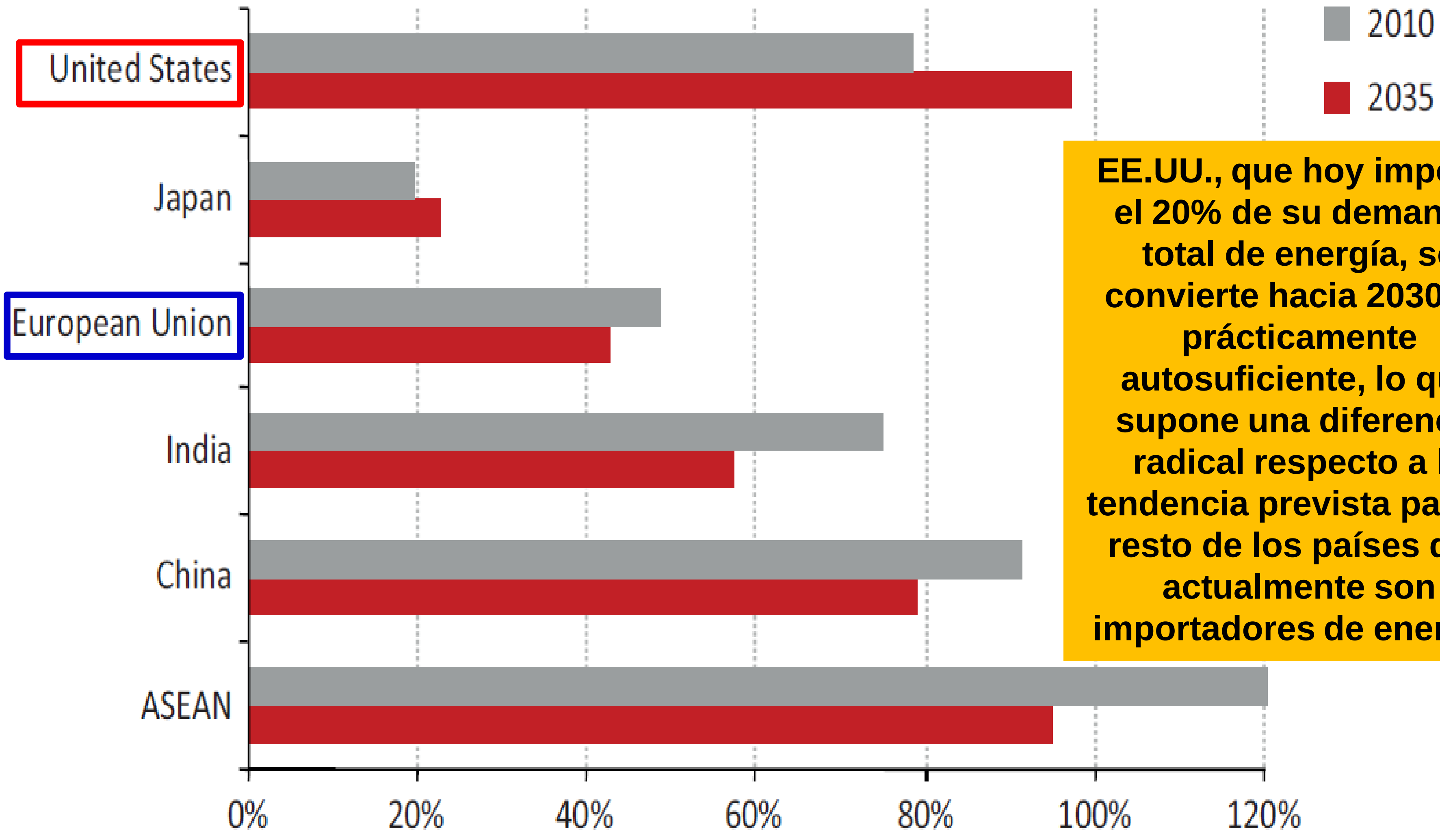
AIE, WEO : producción de gas no convencional (2035)



Flujos netos comerciales de gas natural (bcm)



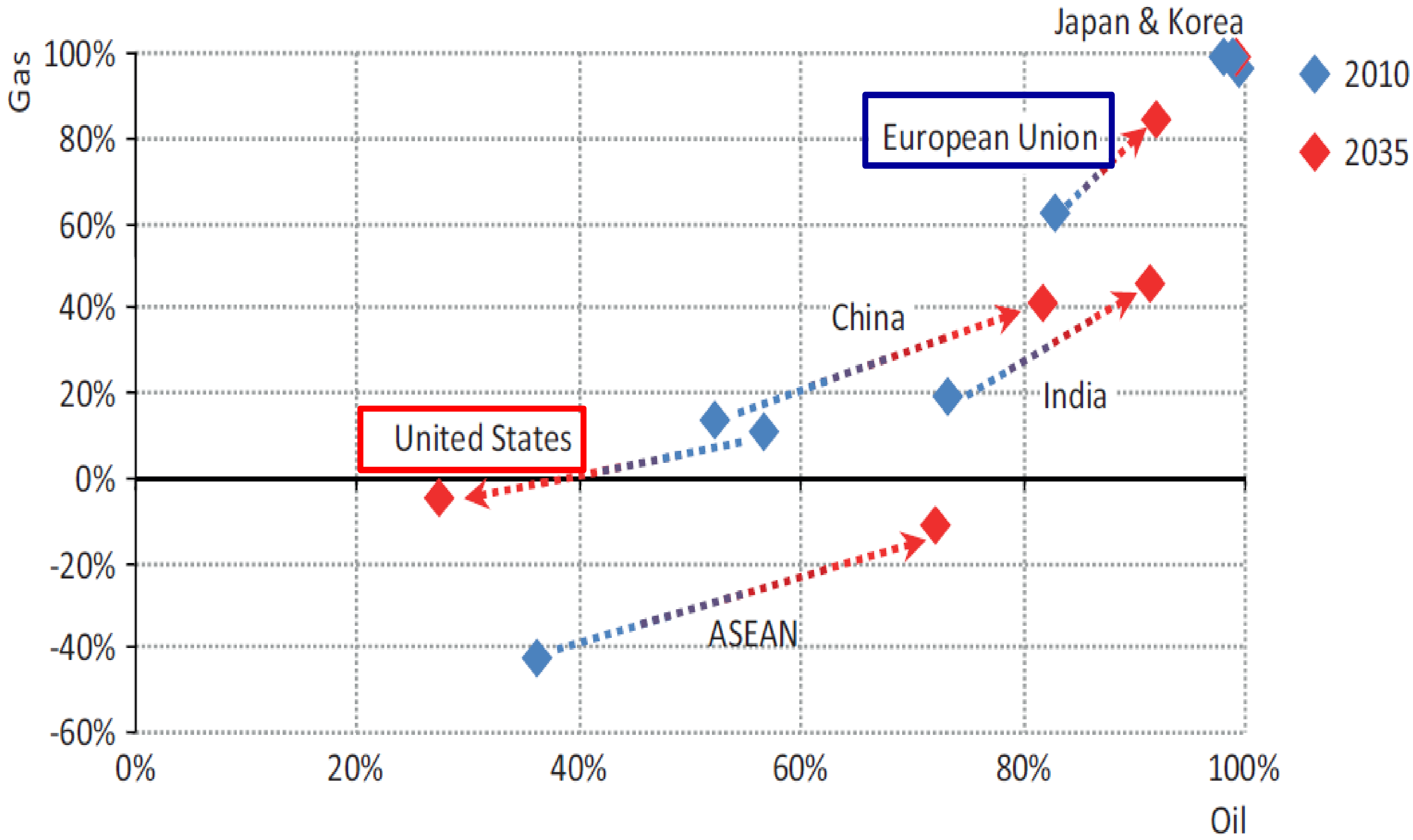
AIE, WEO 2012 : autosuficiencia energética neta



EE.UU., que hoy importa el 20% de su demanda total de energía, se convierte hacia 2030 en prácticamente autosuficiente, lo que supone una diferencia radical respecto a la tendencia prevista para el resto de los países que actualmente son importadores de energía.

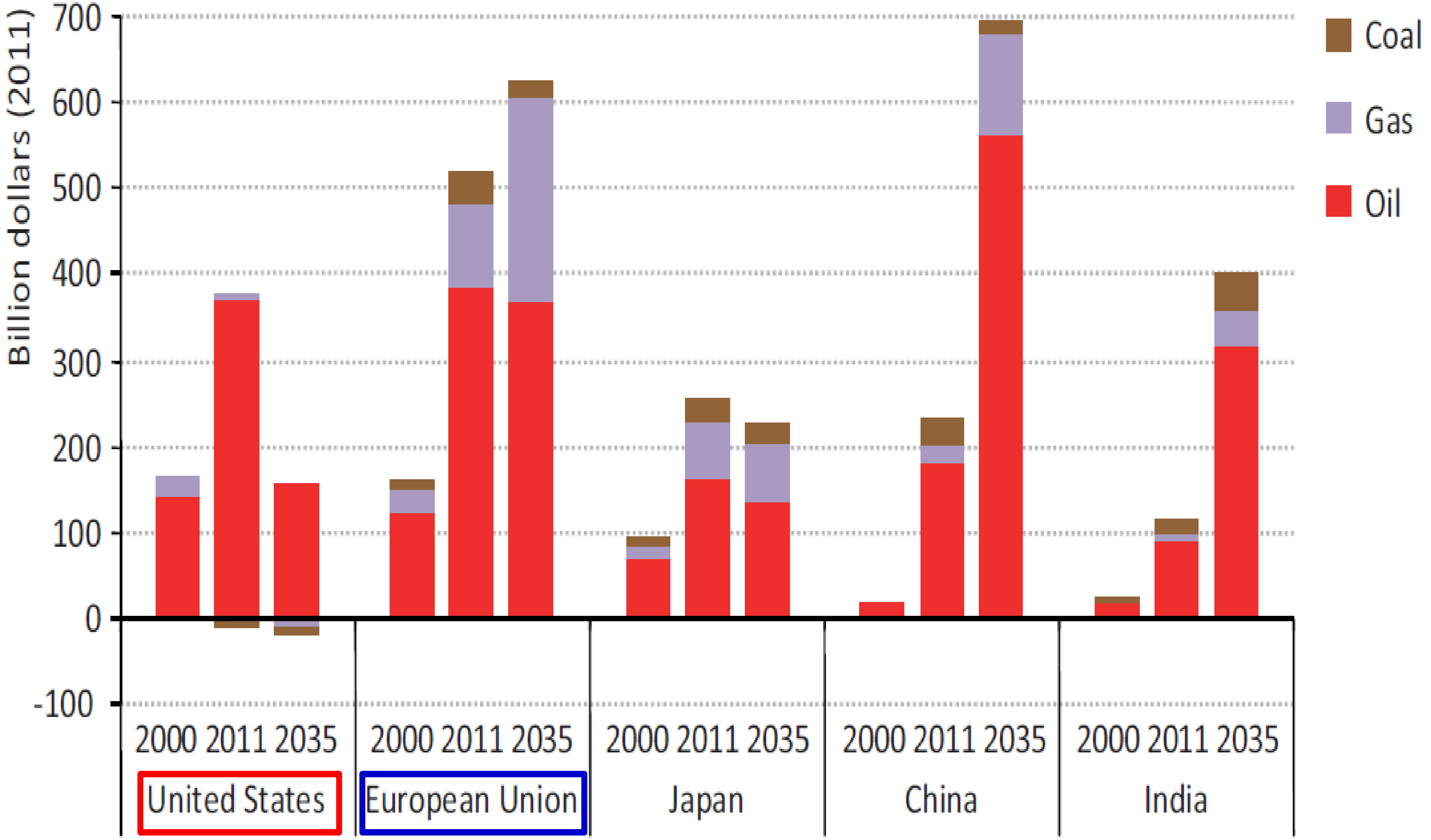
Note: Self-sufficiency is calculated as indigenous energy production (including nuclear power) divided by total primary energy demand.

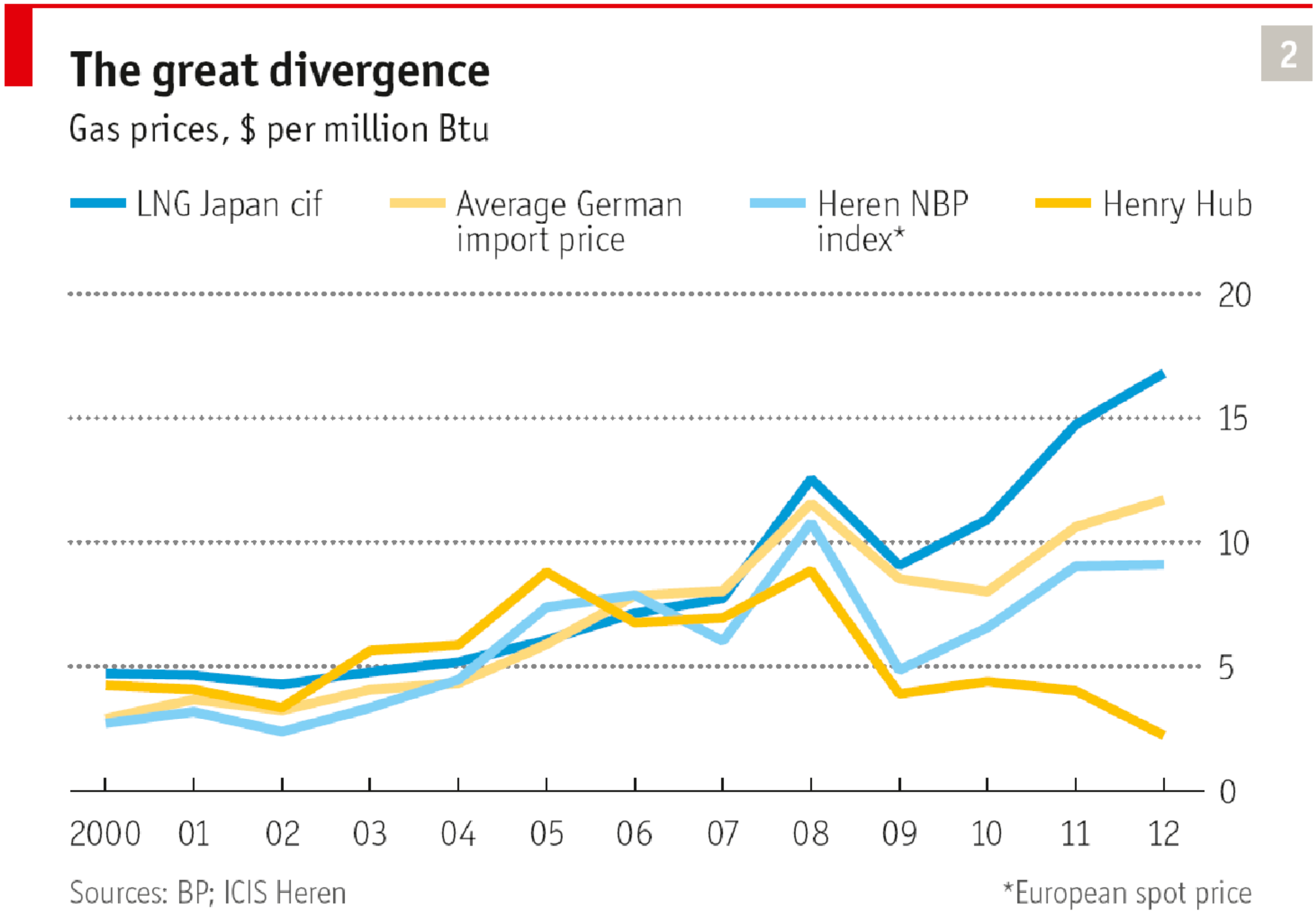
NPS: dependencia de las importaciones de petróleo y gas



Note: Import dependency is calculated as net imports divided by primary demand for each fuel.

Gastos en importaciones de combustibles fósiles

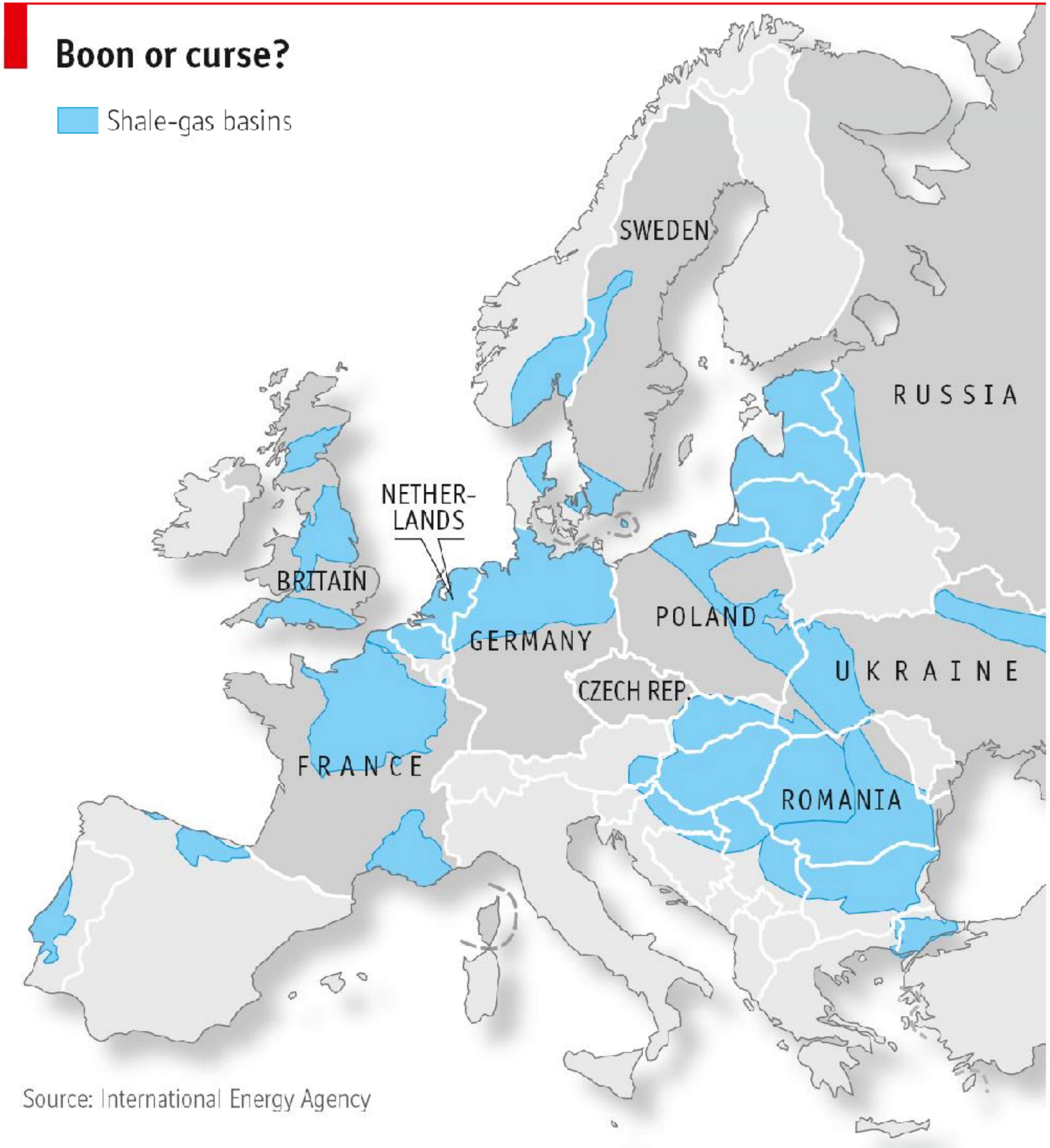




2
The great divergence
Gas prices, $ per million Btu
LNG Japan cif
Average German import price
Heren NBP index*
Henry Hub
20
15
10
5
0
2000
01
02
03
04
05
06
07
08
09
10
11
12
Sources: BP; ICIS Heren
*European spot price

The Economist, 26-11-2011

Boon or curse?



Source: International Energy Agency

Shale gas en Europa: evolución mas que revolución

	Evolution	Revolution
Geology and resource potential	▸ Disappointing well results ▸ Reserves found to be uneconomical to develop ▸ Unsustainable production rates	▸ Early exploration success ▸ Reserves potential proven to be greater than expected ▸ Rapid ramp-up in production
Environmental and social factors	▸ Results of studies into environmental impacts lead to restrictions/bans on use of fracking ▸ Increased public pressure on governments to halt development activity until impact is known	▸ Studies show that fracking is safe to public health and the environment ▸ Public desire for lower energy prices
Fiscal and regulatory regimes	▸ Potential EU-wide regulations on shale gas development ▸ Inclusion of shale gas in EU fuel quality and emissions legislation	▸ Incentives provided by individual countries to shale gas developers ▸ Expedited approvals process for developments ▸ Government support for shale gas R&D
Energy prices	▸ Competition from LNG and pipeline gas from Russia and the Caspian region ▸ Limited spot market liquidity	▸ Deregulation of gas markets ▸ Long-term, oil-indexed contracts not renewed ▸ Improved interconnectivity between markets
Gas demand	▸ Slower growth due to measures to support development of low-carbon economy ▸ Weaker Eurozone economy	▸ Increased demand for gas as a fuel for power generation ▸ Gas positioned as a transition fuel to a low-carbon economy
Infrastructure and service capabilities	▸ Limited supply of suitable equipment or skilled personnel ▸ Lack of funds available to invest in new gas supply infrastructure	▸ Oilfield service industry is fast to adapt to industry needs ▸ Technology developments that drive down costs

Source: Ernst & Young analysis

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AAPG EXPLORER

PRESIDENT'S COLUMN

Ready or Not, Changes Will Keep Coming

By TED BEAUMONT

"My concept of reservoirs has completely changed."

BEAUMONT

I actually heard an engineer say these words – last summer, while attending a technical conference of geologists and engineers – and he was referring to the rapidly evolving concepts of reservoirs generated from shale gas reservoir research.

At the time it struck me that it was very unusual for an engineer to say this because, in my experience, engineers are sometimes more resistant to change than geologists.

Thinking of shales (or more correctly, mudstones) as reservoirs, however, is an example of a significant evolution of thinking – a progression also known as a paradigm shift.

For example, geologists of my generation learned that shales can act as source rocks when they contain abundant organic matter *and* as seals when they cover porous and permeable sandstones or carbonates.

Thinking of a shale as a reservoir, then, is a sometimes-difficult paradigm shift for geologists of my age.

* * *

Paradigm shifts occur from time to time – and, clearly, they can profoundly affect how petroleum geologists work. Exploring for gas shales, oily source rocks or tight oil reservoirs is profoundly different than exploring for more conventional reservoirs.

The accompanying table compares conventional exploration plays to unconventional plays – and as the table shows, exploring for shale gas, shale oil or tight oil reservoirs requires a different mindset.

	Conventional	Unconventional
Preferred Trap Type	Structural	Stratigraphic
Common Reservoir Lithology	Sandstones and Carbonates	Shales, Tight Sandstones and Tight Carbonates
Reservoir Permeability	Millidarcies	Nanodarcies
Aerial Trap Size	Small	Huge
Geological Risk	High	Low
Drilling Risk	High	Low
Well Type	Vertical	Horizontal
Completion Expense	Low	High

This table compares conventional exploration plays to unconventional plays.

Trap areas can cover many thousands of square miles or square kilometers; permeability is measured in nanodarcys – one billionth of a darcy – and the limit of permeability is determined by the size of the pore throats and the size of the molecules that can flow through them.

Not long ago, petroleum geologists were confronted by another non-geologic paradigm shift – using personal computers to manage and map geologic data. In the years since we first started using them, personal computers allowed petroleum geologists to be much more productive. One geologist now does what it used to require several geologists to do. Today, geologists work with more information and process it much more rapidly.

Some geologists, however, refused to make the transition to using computers to do geology. Those geologists are rare today and probably don't work in larger companies! Using computers is not absolutely necessary but it is hard to imagine being competitive and surviving without them.

There are other examples: Sequence stratigraphy, for example, was a revolutionary method for interpreting patterns of strata caused by sea level fluctuation and basin tectonics. It created a prodigious lexicon of "seq-speak" – and inevitably left non-adopters in its wake.

* * *

To survive and prosper, geologists must evolve along with our science. We need to learn more about source rocks – for example, what is the relationship of pore creation to kerogen maturation.

The investigation of tight rocks is being achieved by technology we need to embrace: pulse decay perm, high resolution CT scanning and ion-milled samples with SEM imagery, for example.

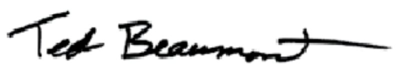
We also need to learn more about completion technology, something that only engineers worried about in the not-too-distant past.

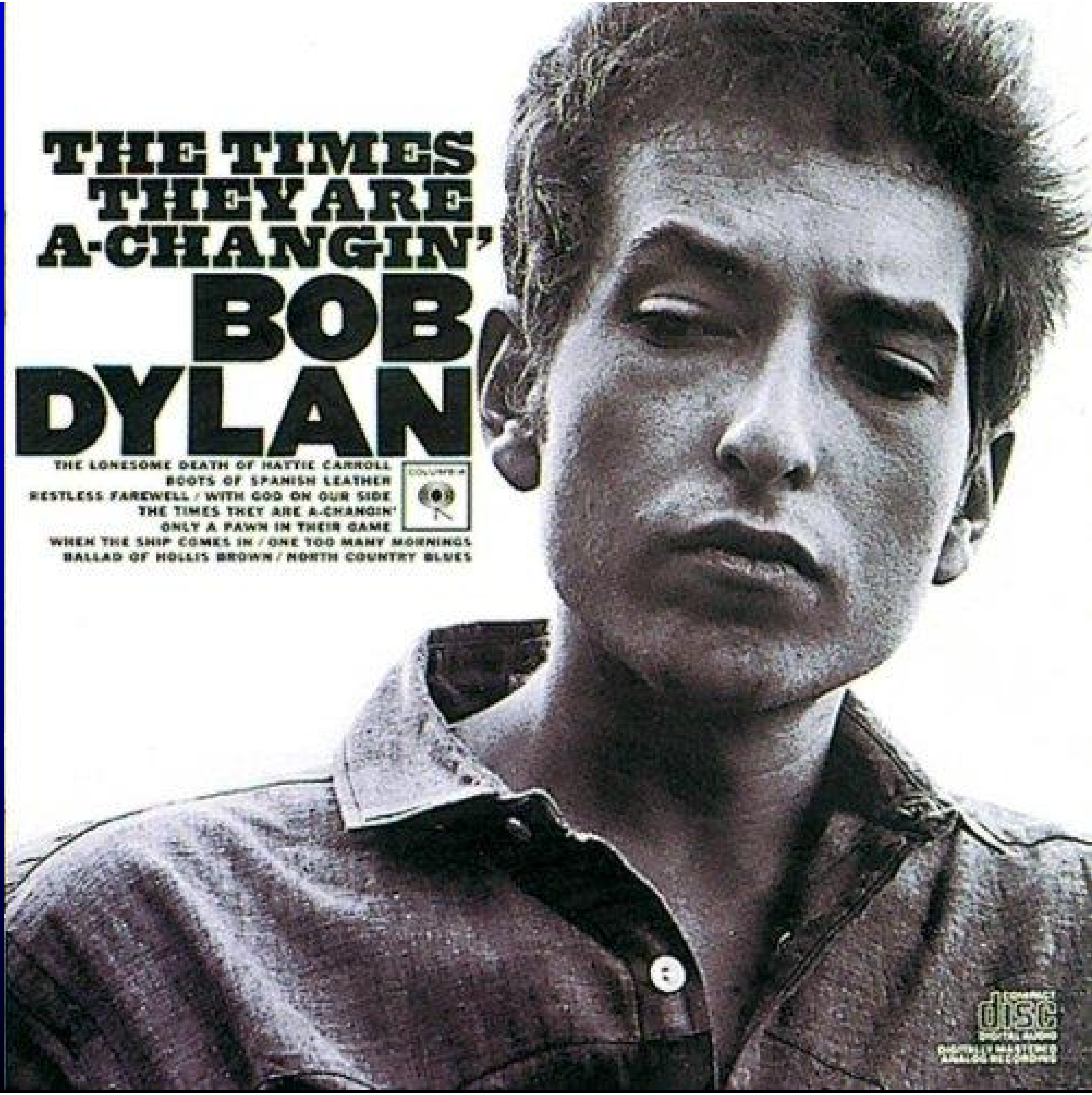
AAPG provides information to help you evolve and you should take advantage of that information. I suggest that during the coming year you consider:

- Attending an AAPG conference or a Geoscience Technology Workshop.
- Taking an AAPG school or online training course.
- Really reading the AAPG BULLETIN or the EXPLORER.
- Surfing *Search and Discovery* or AAPG Datapages.

Paradigm shifts require a response from us. We can refuse to learn about them and become extinct, or we can let our concepts and approaches evolve, allowing us to survive and thrive.

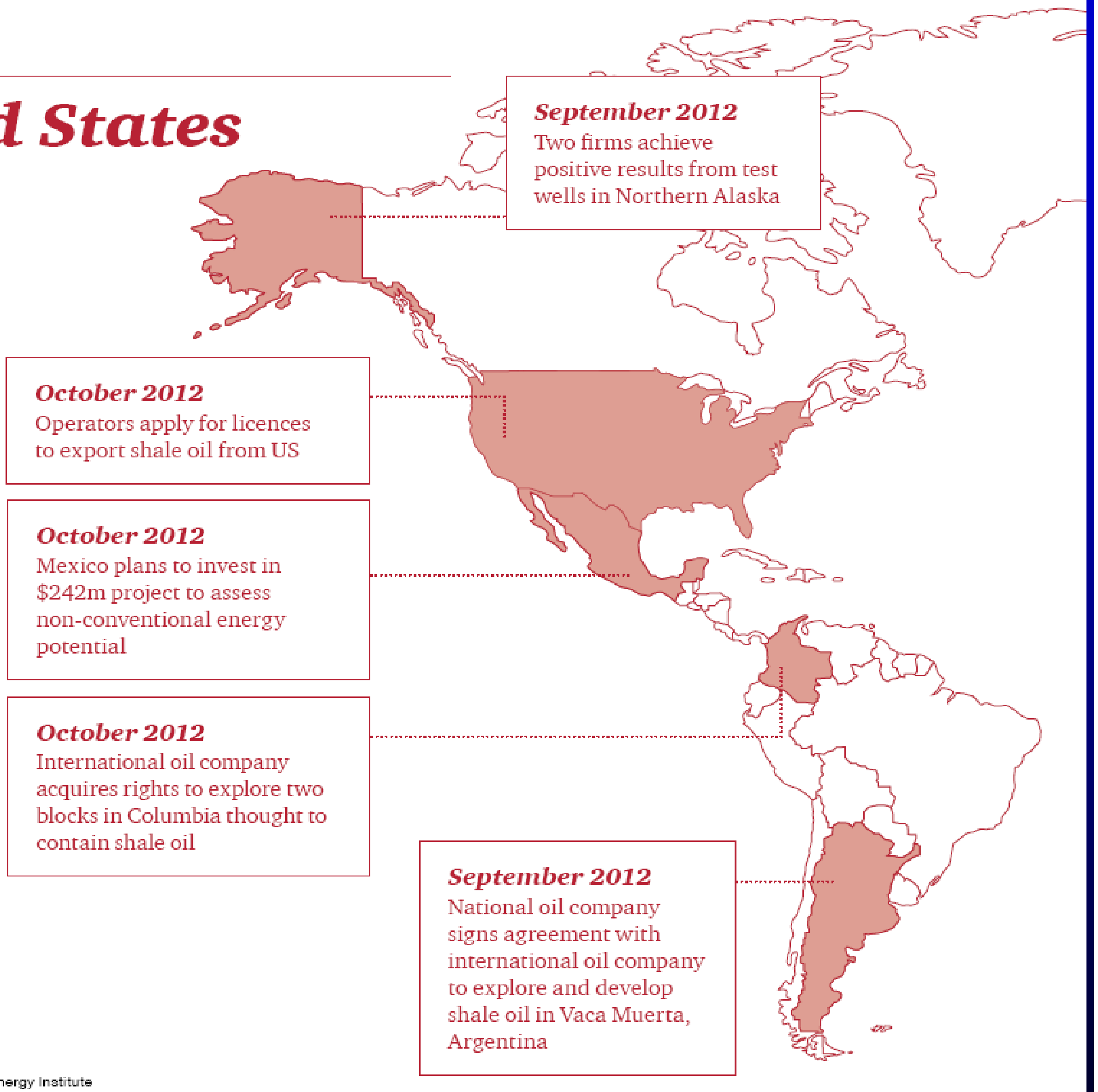
(Special thanks to AAPG member John McLeod, senior geologist for SM Energy Company in Tulsa, for his ideas and edits for this column.)




THE TIMES THEY ARE A-CHANGIN'
BOB DYLAN
THE LONESOME DEATH OF HATTIE CARROLL
BOOTS OF SPANISH LEATHER
RESTLESS FAREWELL / WITH GOD ON OUR SIDE
THE TIMES THEY ARE A-CHANGIN'
ONLY A PAWN IN THEIR GAME
WHEN THE SHIP COMES IN / ONE TOO MANY MORNINGS
BALLAD OF HOLLIS BROWN / NORTH COUNTRY BLUES

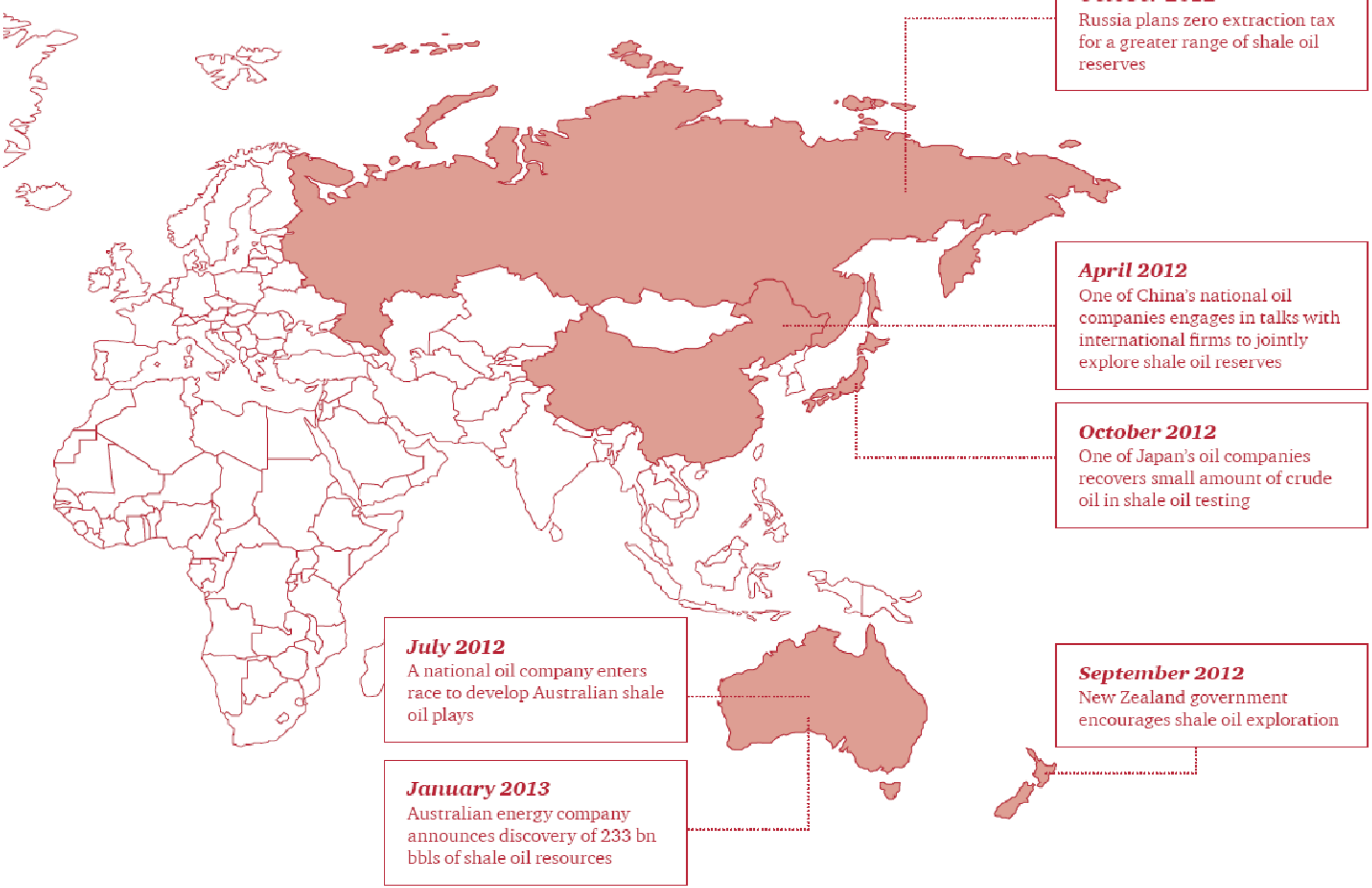
Beyond the United States

- Outside the US, the development of shale oil is still at an early stage. However, there are indications that point to large amounts of technically recoverable resources distributed globally.
- Global shale oil resources are estimated at between 330 billion and 1,465 billion barrels[4]. Investment is already underway to characterise, quantify and develop shale oil resources outside the US, for example, in Argentina, Russia and China[5].
- Since the beginning of 2012, there have been a number of announcements, from Argentina to New Zealand, of discoveries of shale oil resources as well as government initiatives to encourage the exploration and production of shale oil (see Map 1).

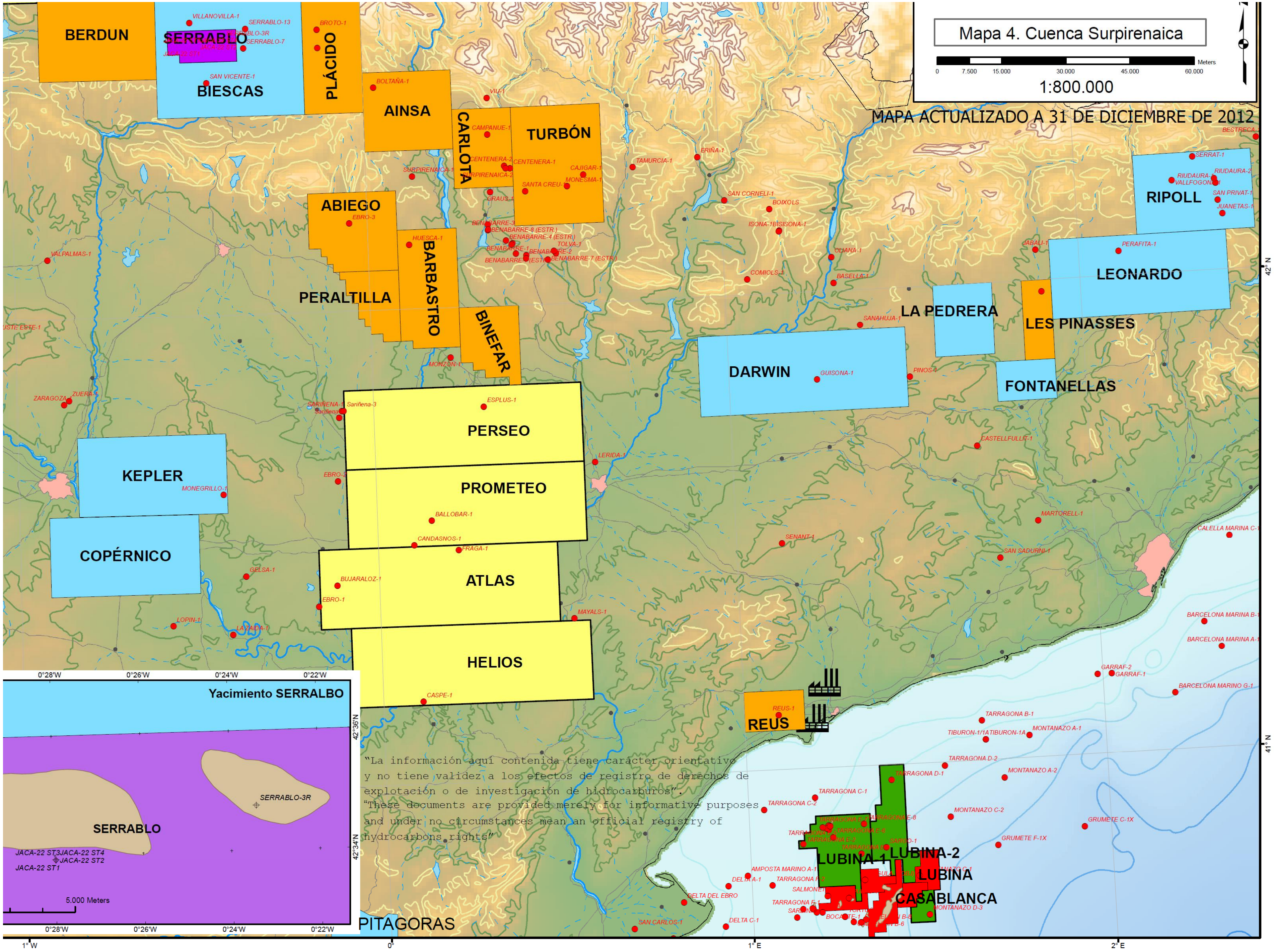


4. "A review of uncertainties in estimates of global oil resources", McGlade, C.E., UCL Energy Institute
5. International Gas Report, Dow Jones, SeeNews, Diamond Gas Report, Platts, Natural Gas Intelligence, EFE, APS Review, Upstream , Oil and Gas news, Oil Daily, Financial Times

Map 1. Shale oil investment is global



Source: PwC research



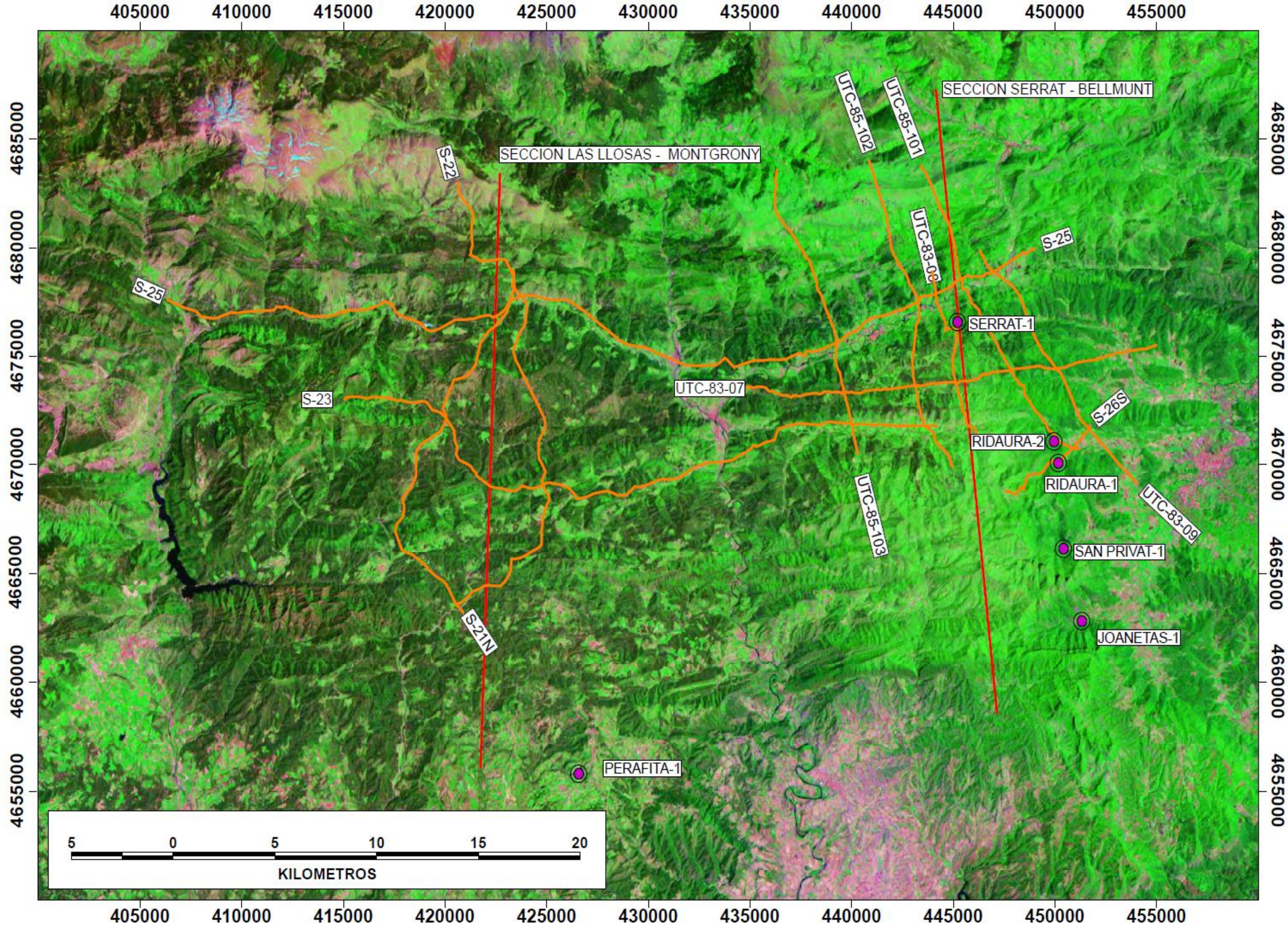
"La información aquí contenida tiene carácter orientativo y no tiene validez a los efectos de registro de derechos de explotación o de investigación de hidrocarburos".
"These documents are provided merely for informative purposes and under no circumstances mean an official registry of hydrocarbons rights"

¿Hay objetivos de ñshale gasò en los permisos concedidos-solicitados?

Extracción económica de ñshale gasò: requisitos

- > 2% TOC
- Kerógeno tipo II, III o ambos (ñgas proneò)
- 1,35<R0<3 (ñdry gasò)
- Potencias mayores a 20-30 metros (para poder perforar correctamente)
- Extensión-continuidad lateral: kilómetros
- Profundidad objetivo entre 1.000 y 4.000 metros
- Porosidad, permeabilidad y fracturación de la roca, adecuadas
- Mineralogía adecuada:
  - Cuarzo: 50-70% (favorece FH)
  - Arcilla: 30-50% (dificulta FH)
  - Carbonatos: Muy pocos (dificulta FH)
- Sobrepresión (ñove rpressureò)
- Disponibilidad de agua
- Factores medioambientales
- Factores comerciales y logísticos
- Factores regulatorios y políticos

b.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4660000
4655000
SECCION SERRAT - BELLMUNT
SECCION LAS LLOSAS - MONTGRONY
UTC-85-102
UTC-85-101
UTC-83-08
UTC-83-07
UTC-85-103
UTC-83-09
S-22
S-25
S-23
S-21N
S-26S
SERRAT-1
RIDAURA-2
RIDAURA-1
SAN PRIVAT-1
JOANETAS-1
PERAFITA-1
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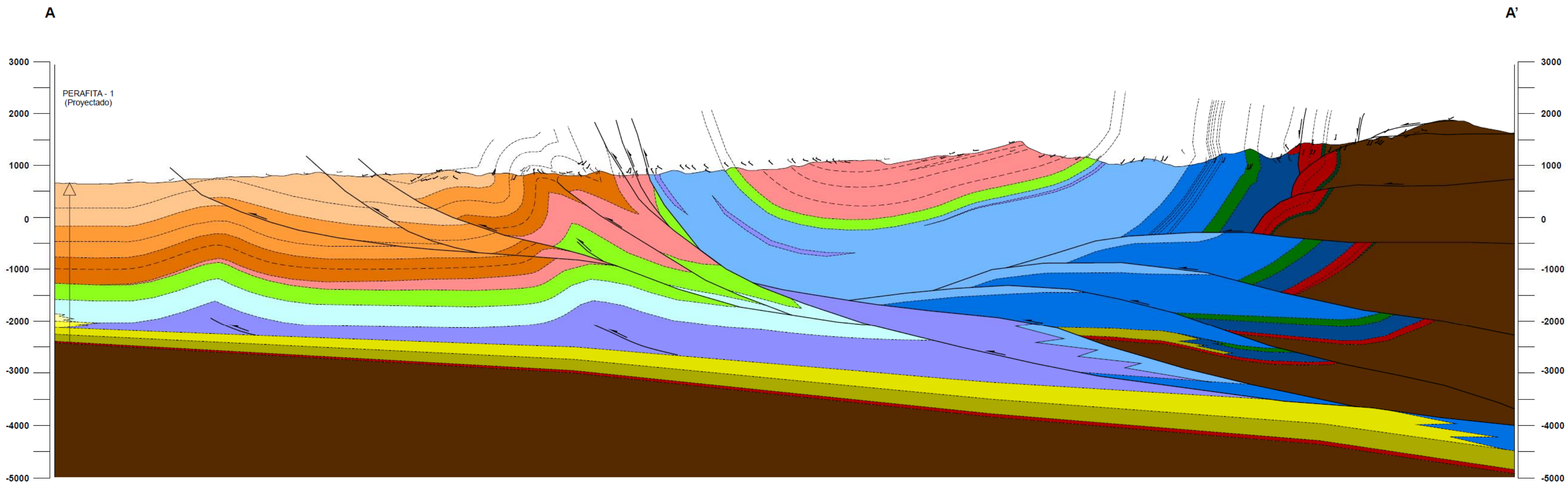
KILOMETROS



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(Proyectado)
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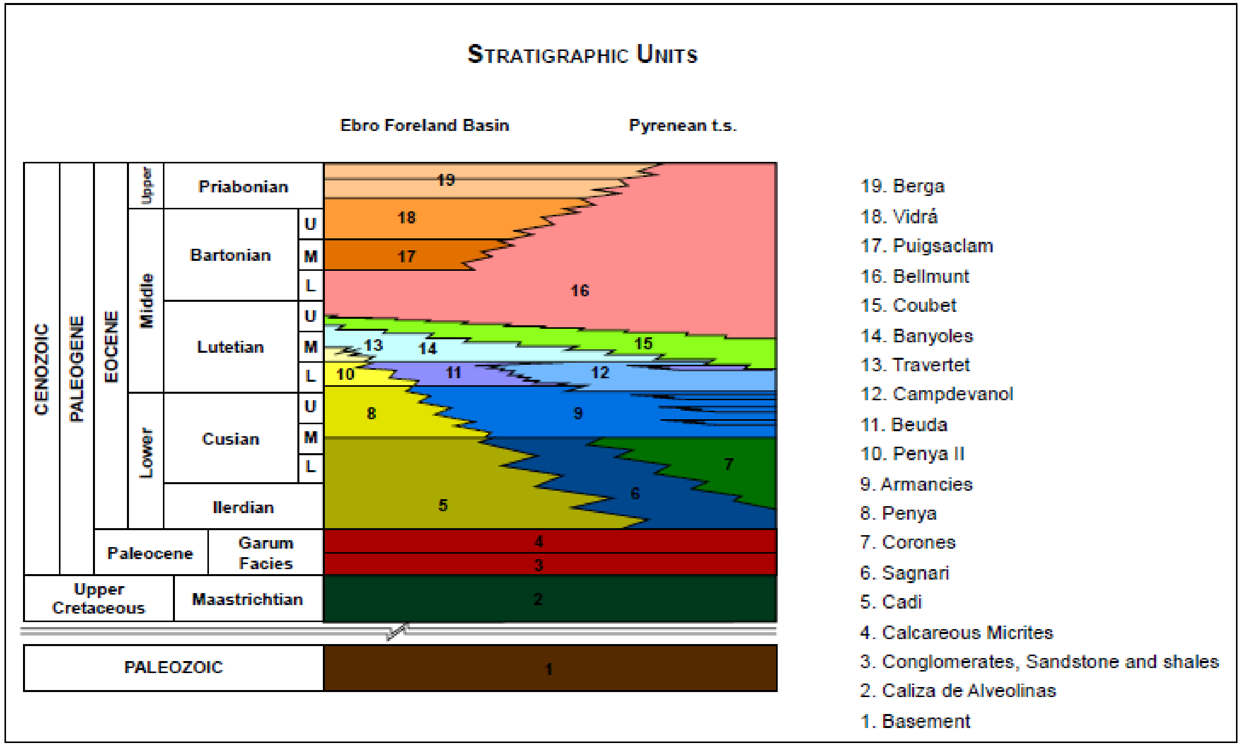
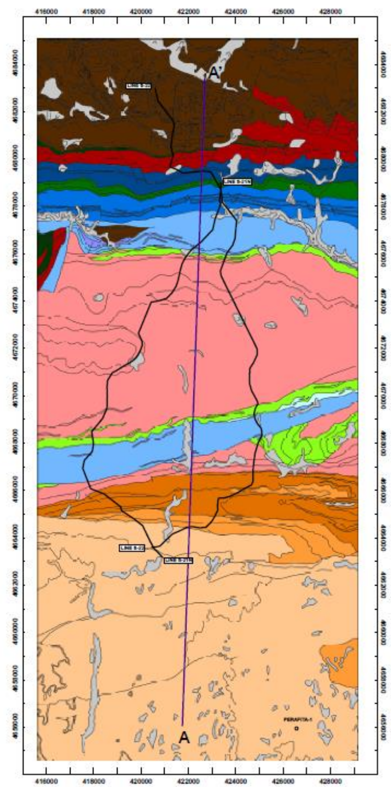
-3000
-4000
-5000



STRATIGRAPHIC UNITS
Ebro Foreland Basin
Pyrenean t.s.
CENOZOIC
PALEOGENE
EOCENE
Upper
Middle
Lower
Priabonian
Bartonian
Lutetian
Cusian
Ilerdian
U
M
L
Paleocene
Garum Facies
Upper Cretaceous
Maastrichtian
PALEOZOIC
19. Berga
18. Vidrá
17. Puigsaclam
16. Bellmunt
15. Coubet
14. Banyoles
13. Travertet
12. Campdevanol
11. Beuda
10. Penya II
9. Armancies
8. Penya
7. Corones
6. Sagnari
5. Cadi
4. Calcareous Micrites
3. Conglomerates, Sandstone and shales
2. Caliza de Alveolinas
1. Basement



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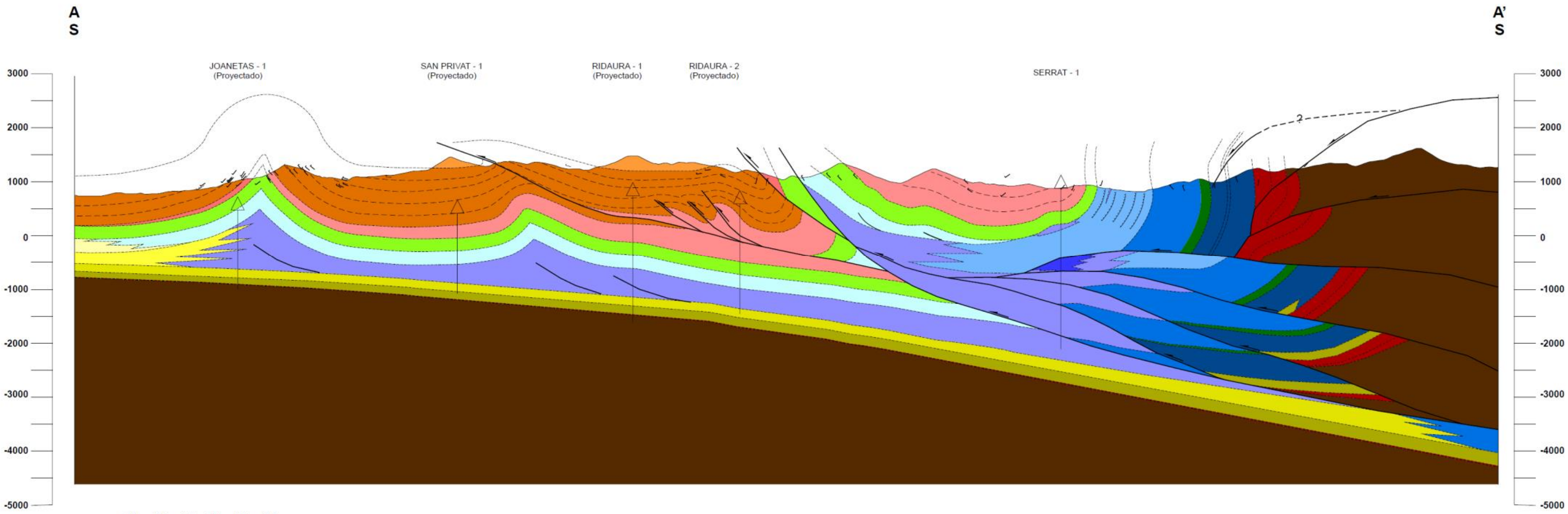
A
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S
JOANETAS - 1
(Proyectado)
SAN PRIVAT - 1
(Proyectado)
RIDAURA - 1
(Proyectado)
RIDAURA - 2
(Proyectado)
SERRAT - 1
3000
2000
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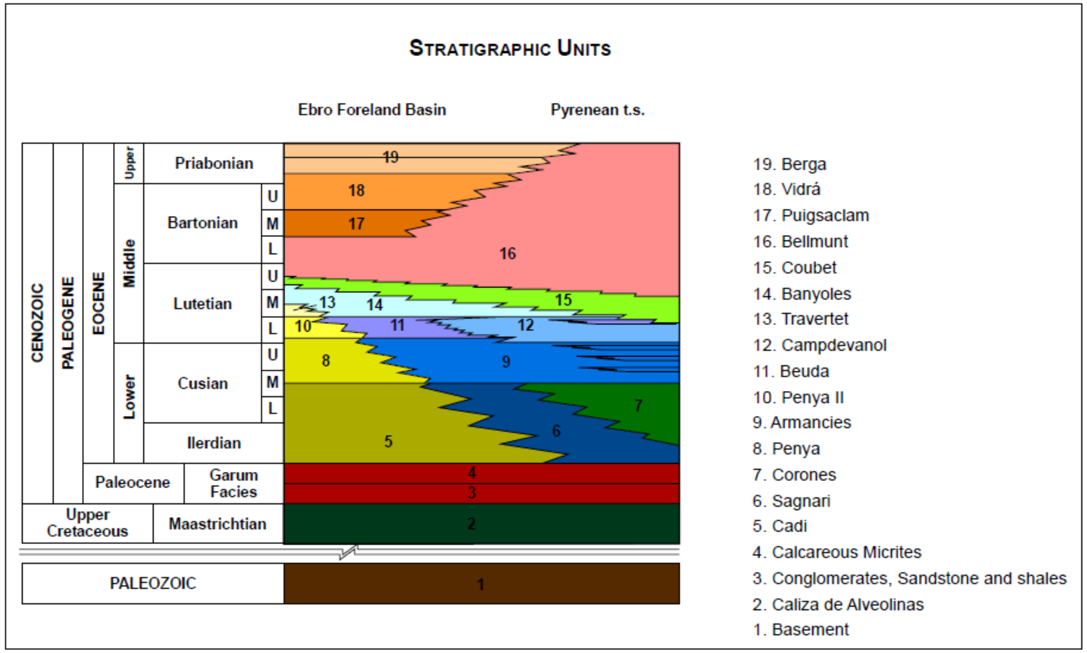
-3000
-4000
-5000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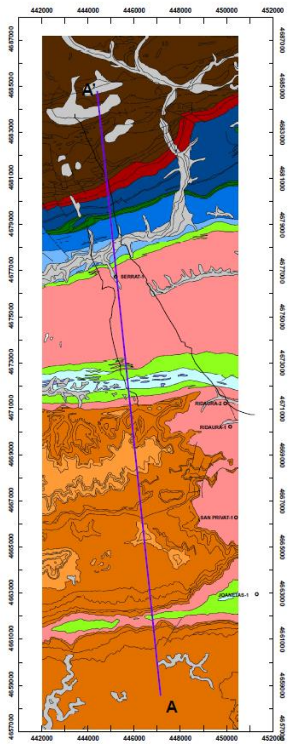
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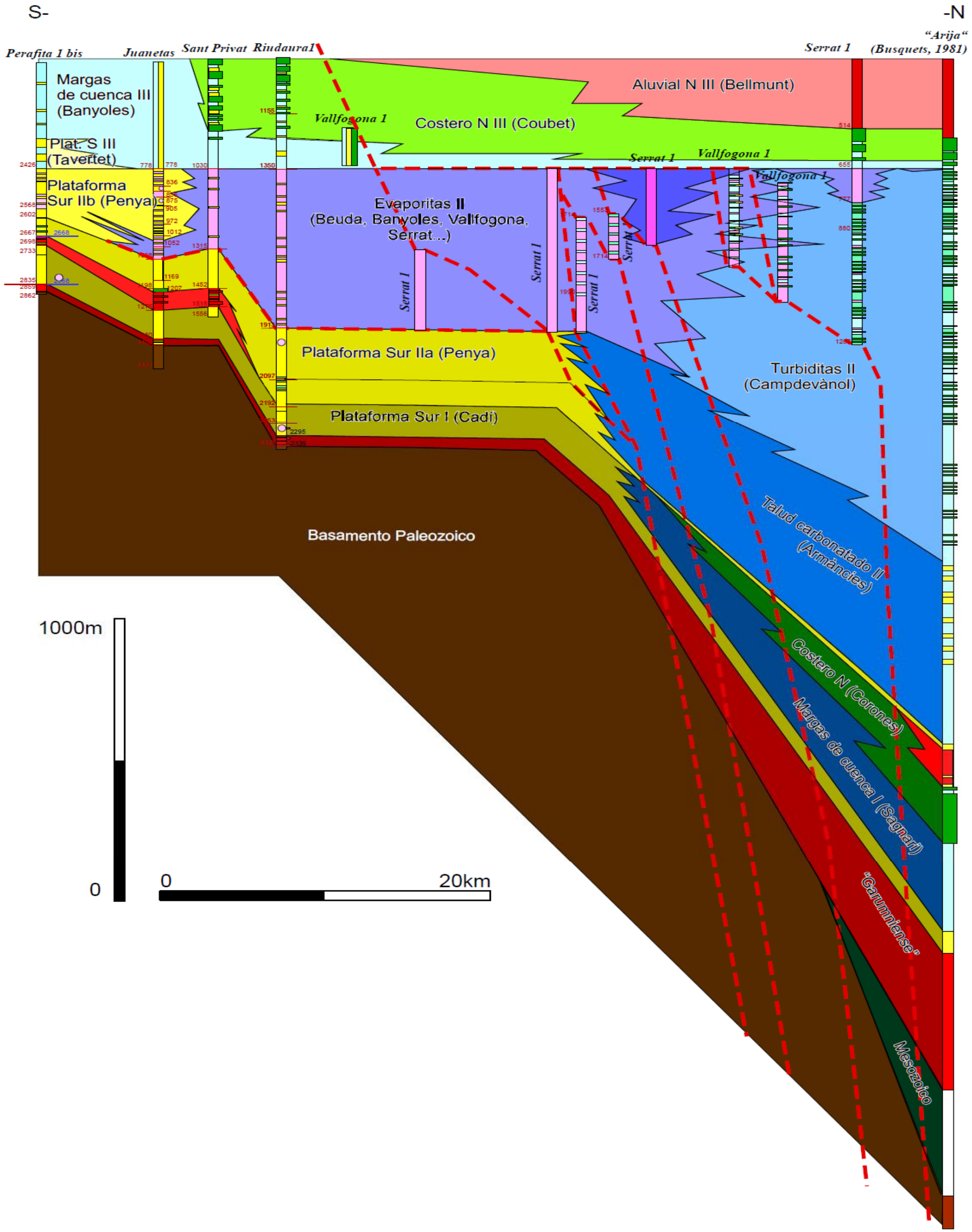
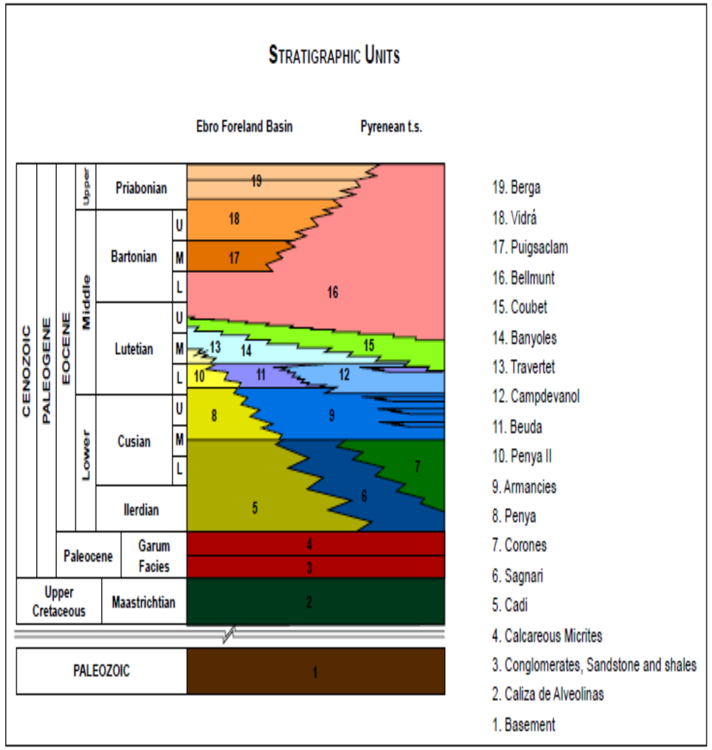


S-
-N
Perafita 1 bis
Juanetas
Sant Privat
Riudaura1
Serrat 1
"Arija" (Busquets, 1981)
Margas de cuenca III (Banyoles)
Plat. S III (Tavertet)
Plataforma Sur IIb (Penya)
Aluvial N III (Bellmunt)
Costero N III (Coubet)
Vallfogona 1
Serrat 1
Evaporitas II (Beuda, Banyoles, Vallfogona, Serrat...)
Plataforma Sur IIa (Penya)
Plataforma Sur I (Cadí)
Turbiditas II (Campdevànol)
Talud carbonatado II (Armàncies)
Costero N (Corones)
Margas de cuenca I (Sagnari)
"Garumniense"
Mesozoico
Basamento Paleozoico
1000m
0
0
20km



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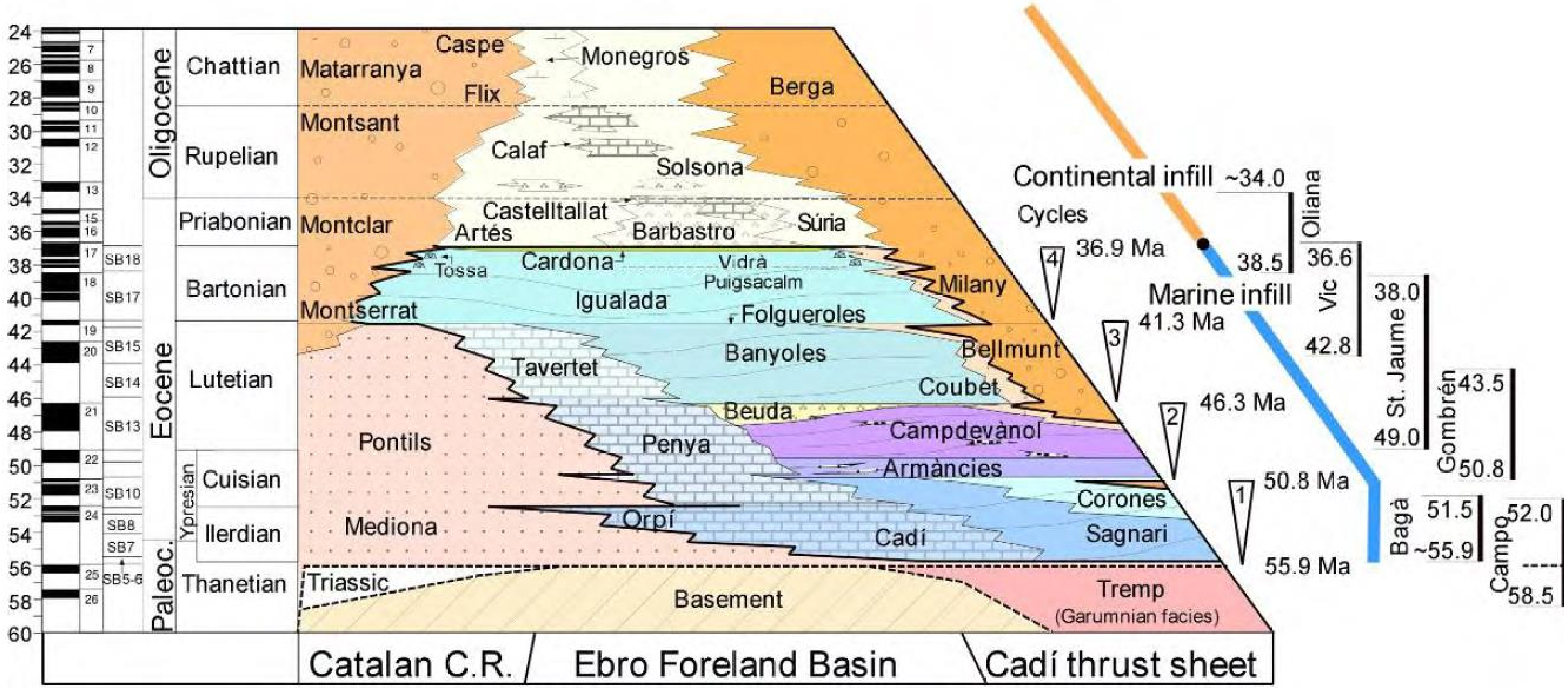


Vergés et al., 1998

ACEPTABILIDAD DE UN PROYECTO
3 condiciones necesarias 3

Evaluación técnica

números, datos y hechos

expertos, instituciones científicasé

Gestión

autorizaciones, regulaciones

Administraciones, empresasé

Argumentos y demandas sociales

opinión y preocupaciones ciudadanas

Instituciones, administraciones, grupos de interésé

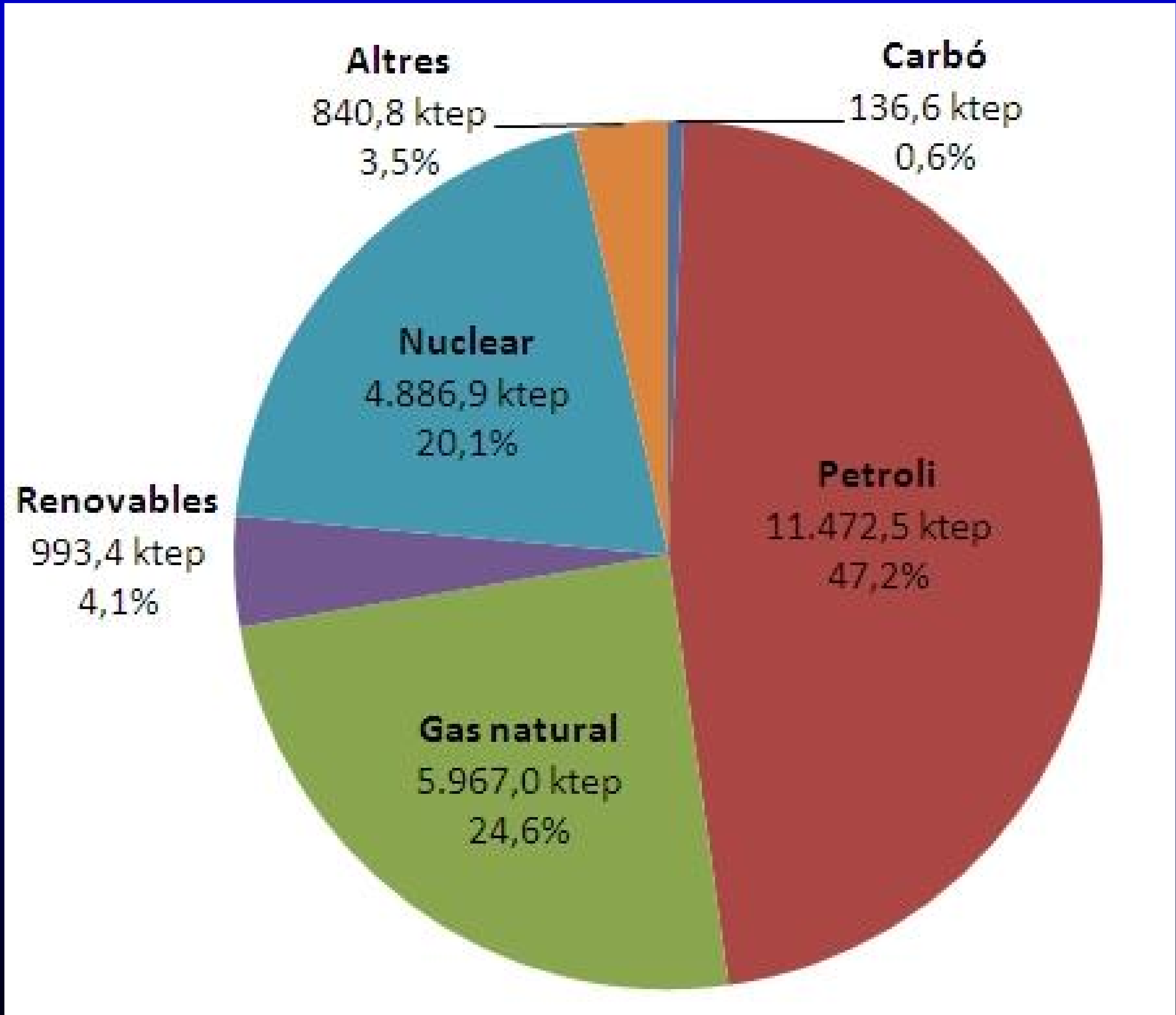
Energía = infraestructura
Infraestructura = agravio-indignación
Gestión de un proyecto = incluye gestionar la indignación

DAD
Decide, Announce, Defend

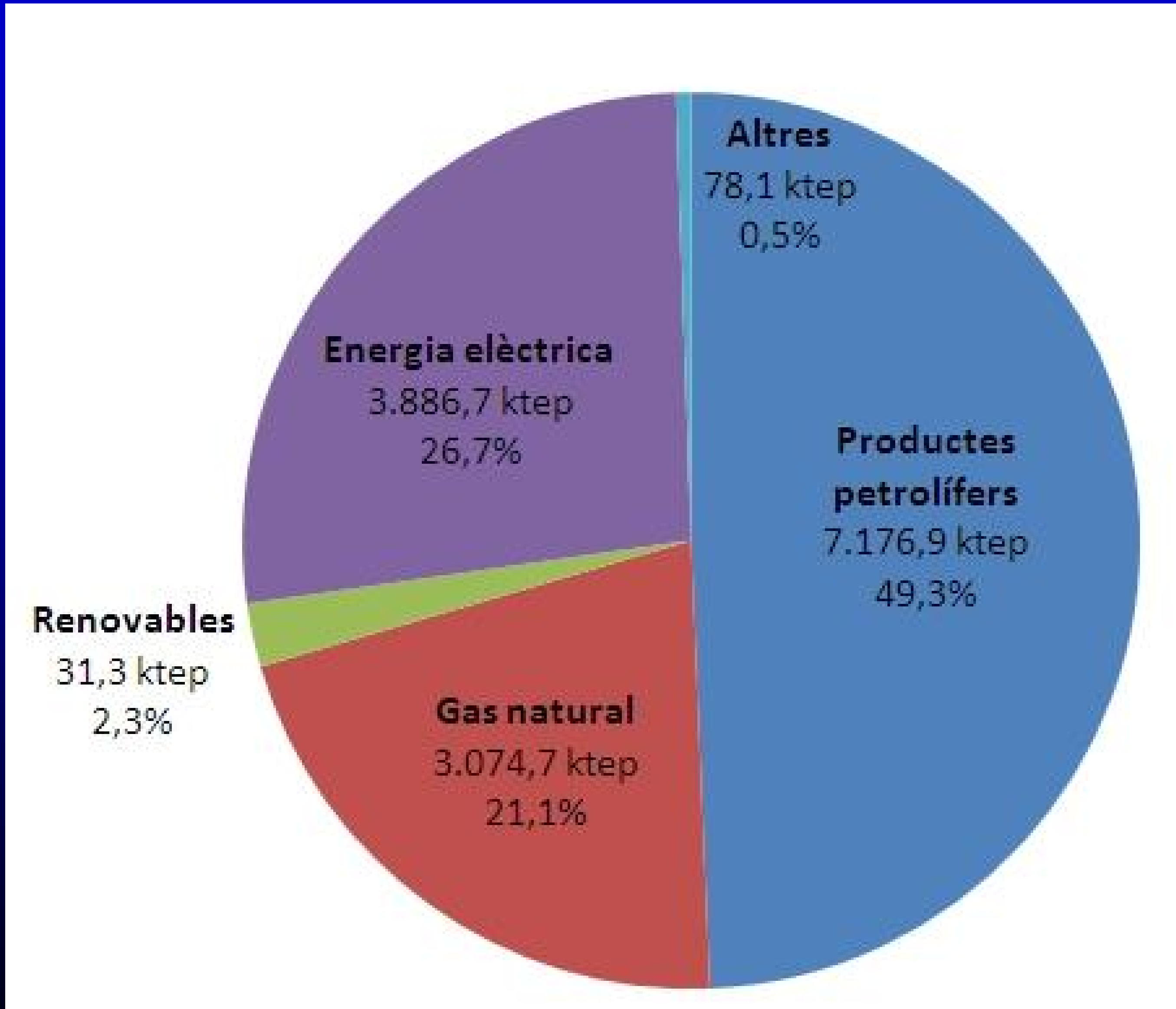
vs

MUM
Meet, Understand, Make a Decission

Catalunya y los hidrocarburos, 2009
72,4% de la energia primaria que entró en el sistema



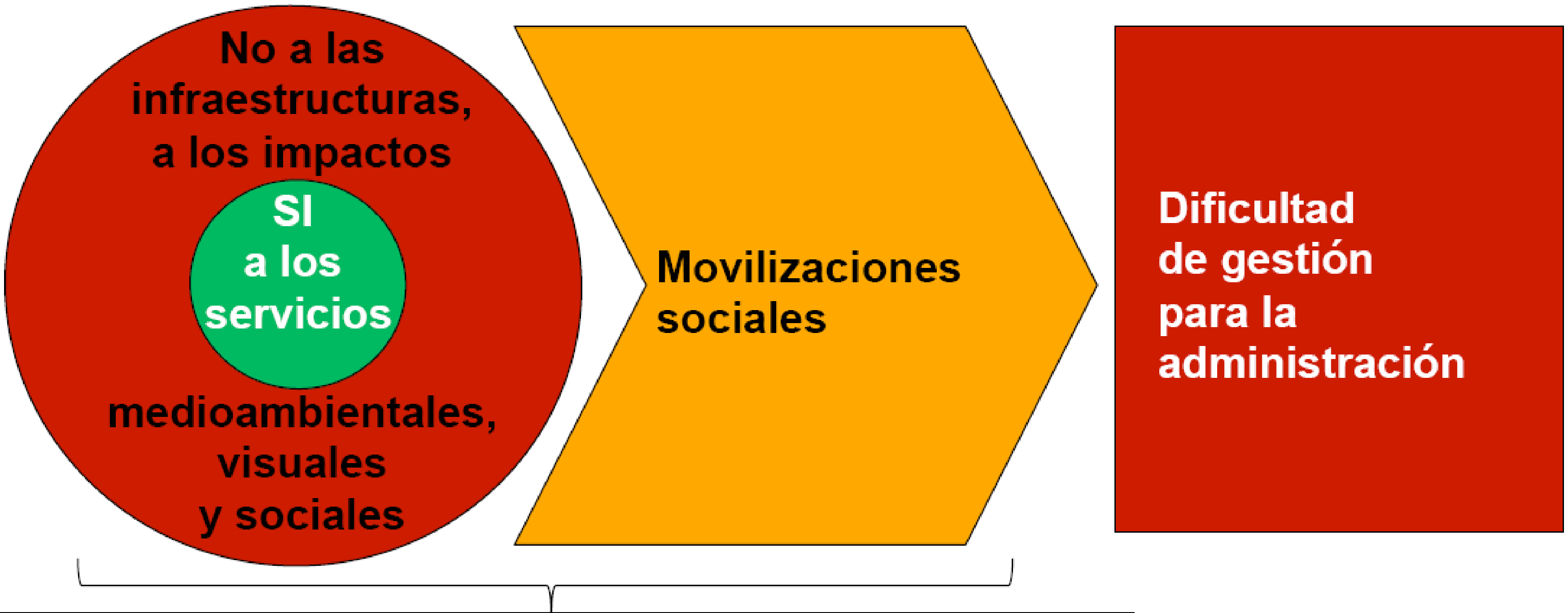
Catalunya y los hidrocarburos, 2009
70,4% de la energia final lista para el consumo



elroto@inicia.es

Generación NIMBY

Not In My Back Yard - No en mi patio



¿Aplicación de un principio de precaución legítimo?
¿Síntoma de una sociedad del bienestar "esquizofrénica"?

Política energética: equilibrio entre las 3 ñesò

Integrar la política energética con las políticas económicas, ambientales, de seguridad, asuntos exteriores y de I+D

Pacto de estado y estados

¡Muchas gracias por su atención!