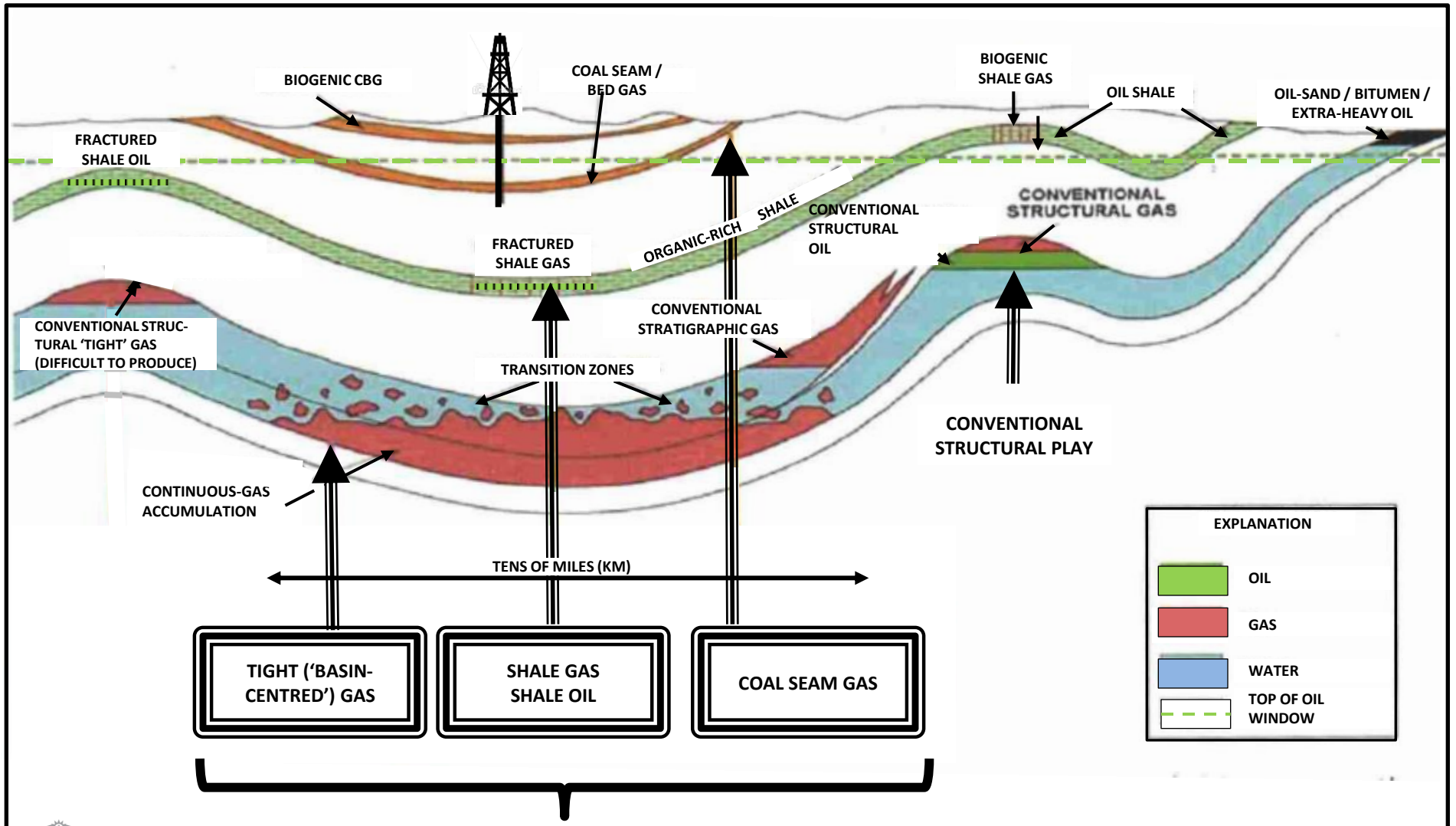
UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Earth and Environmental Sciences

Shale Gas

Unconventional Hydrocarbons



Unconventional Plays

UNCONVENTIONAL GAS – 'HABITAT'

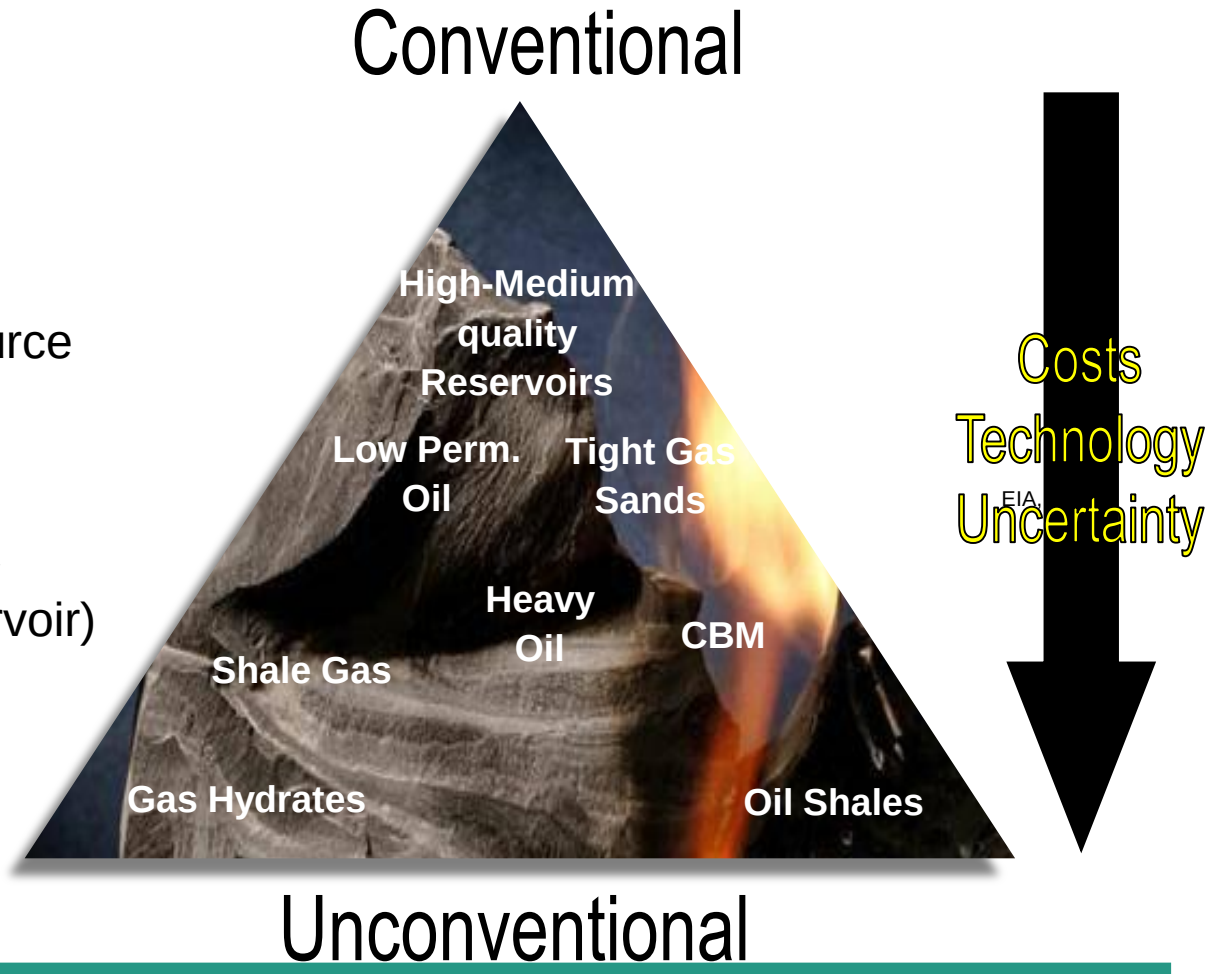
- *CASE FOR DENSE DRLLING PATTERN AND FRACTURING* -

PLAY TYPE	GAS CONTAINMENT PATTERN
COAL SEAM GAS	GAS LARGELY ADSORBED ON SURFACE OF COAL PARTICLES PLUS SOME AS FREE GAS
SHALE GAS	GAS CONTAINED AS FREE GAS IN MICROPORES AND MICROFRACTURES AND ADSORBED ON KEROGEN AND CLAY MINEREALS
TIGHT OR 'BASIN-CENTRED' GAS	GAS CONTAINED AS FREE GAS IN PORES WITHIN 'TIGHT' RESERVOIR

A CASE FOR DENSE DRILLING PATTERN AND FRACTURING

Unconventional hydrocarbons

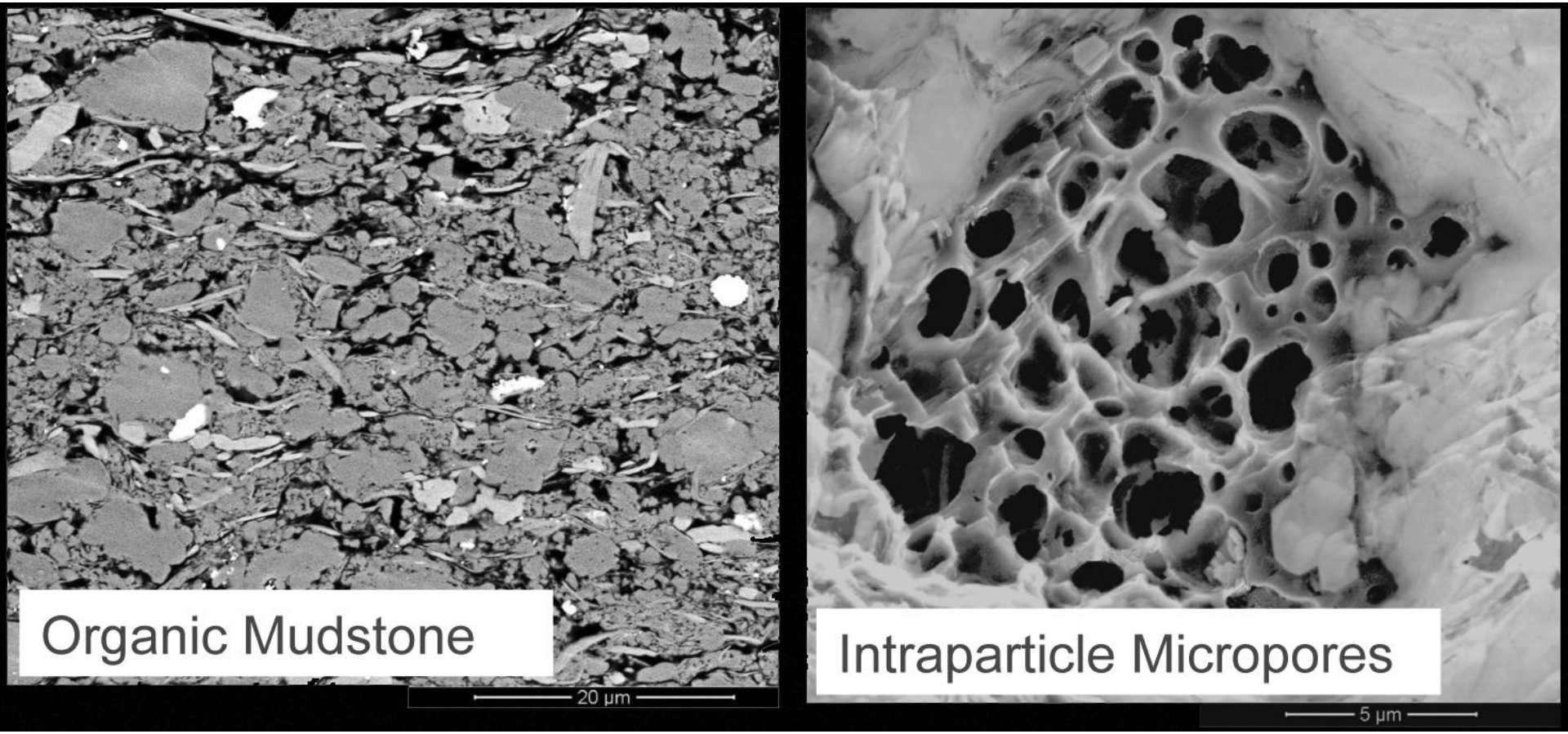
- **Tight Gas**
  - from low porosity sandstone reservoir
- **CBM**
  - from coal seams (source & reservoir)
- **Shale Gas**
  - from low permeability shale (source & reservoir)



Gas Shale

- Source, seal, reservoir and trap in one
- Free gas in pores and fractures
- Absorbed gas on organic matter
- Laterally pervasive
- Insufficient permeability to allow significant flow
- Key: extensive fracture system, rock must be brittle
- Richness estimates for US in-place resources at 17.7 TCF / Gt of shale (Rogner 1997) = 0.5 km3

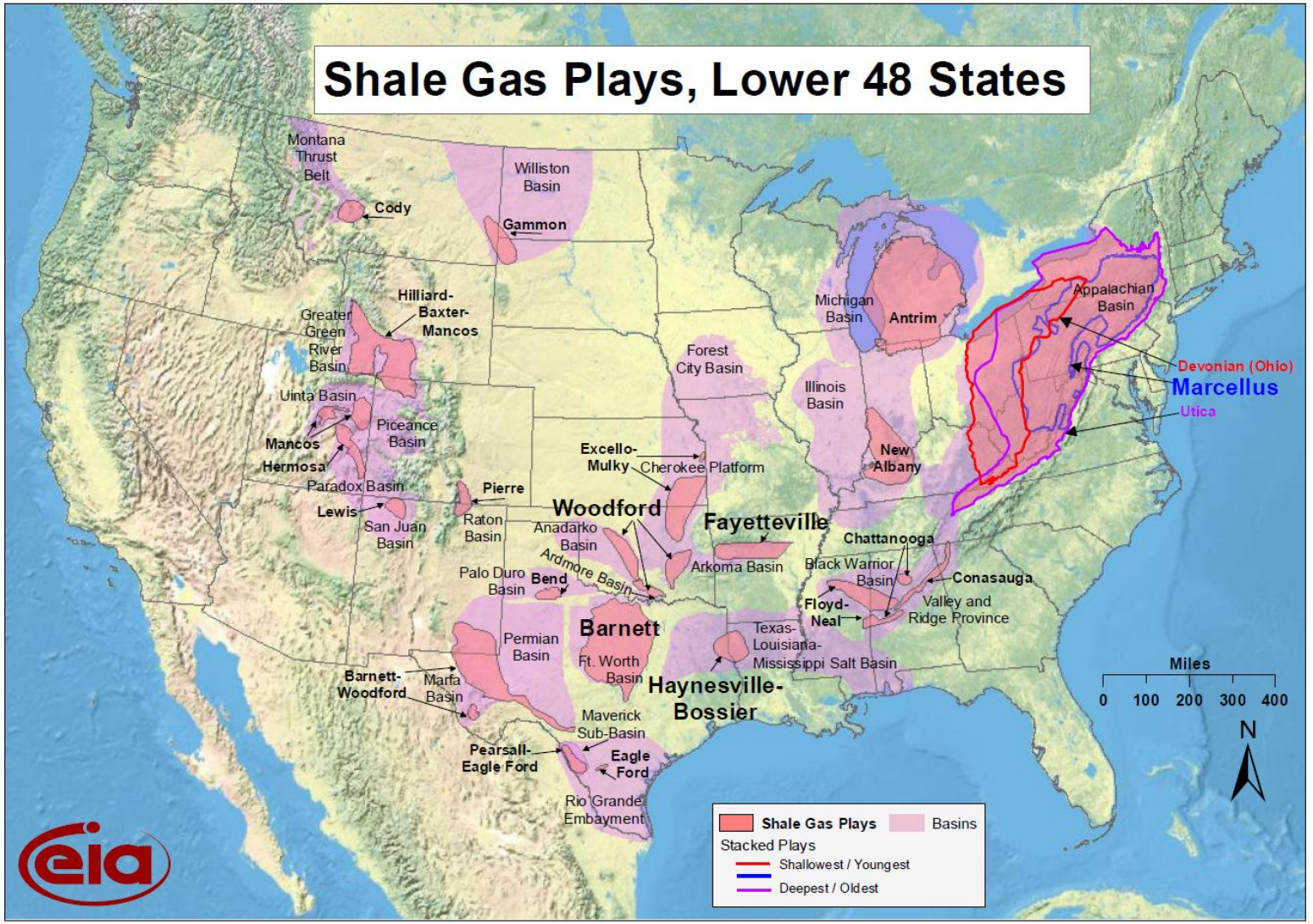
Porosity in gas shales



What Makes a Good Shale Gas Reservoir?

- Organic-rich: TOC > 2.0%.
- Maturity: mature for humic type III SR
  overmature for type II SR
  immature (biogenic gas).
- Thick: > 50m; 30m minimum.
- Lithology: silt laminae desirable
- Brittle: quartz/carbonate > 40%; pure clays < 30%.
- Natural fractures
- Deeper reservoirs are better (high / over-pressured shale favours pore gas over adsorbed gas)

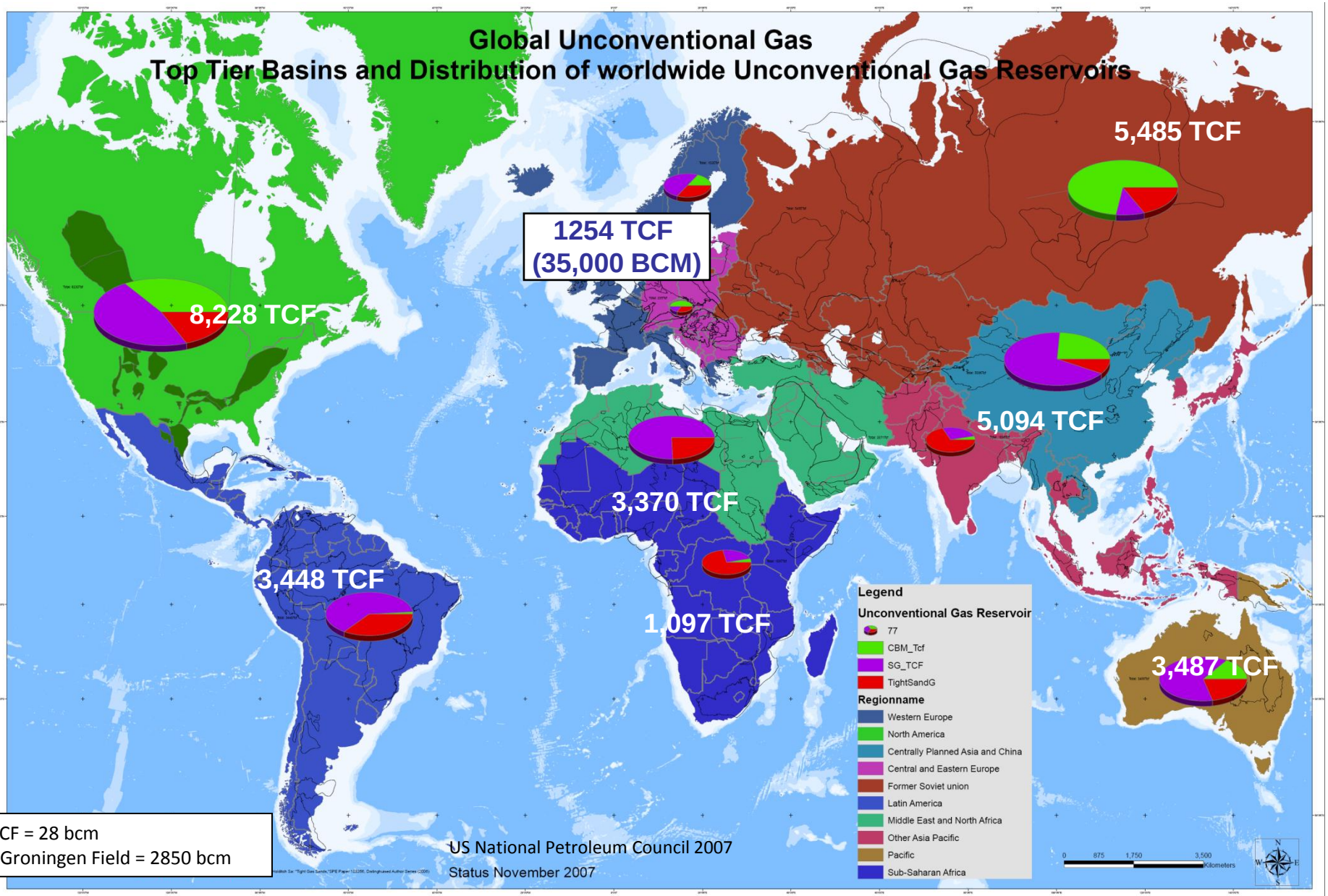
US Shale Gas Plays



Source: Energy Information Administration based on data from various published studies.
Updated: March 10, 2010

First Producing Shale Gas well: 1821, near Fredonia, New York (Devonian shale)

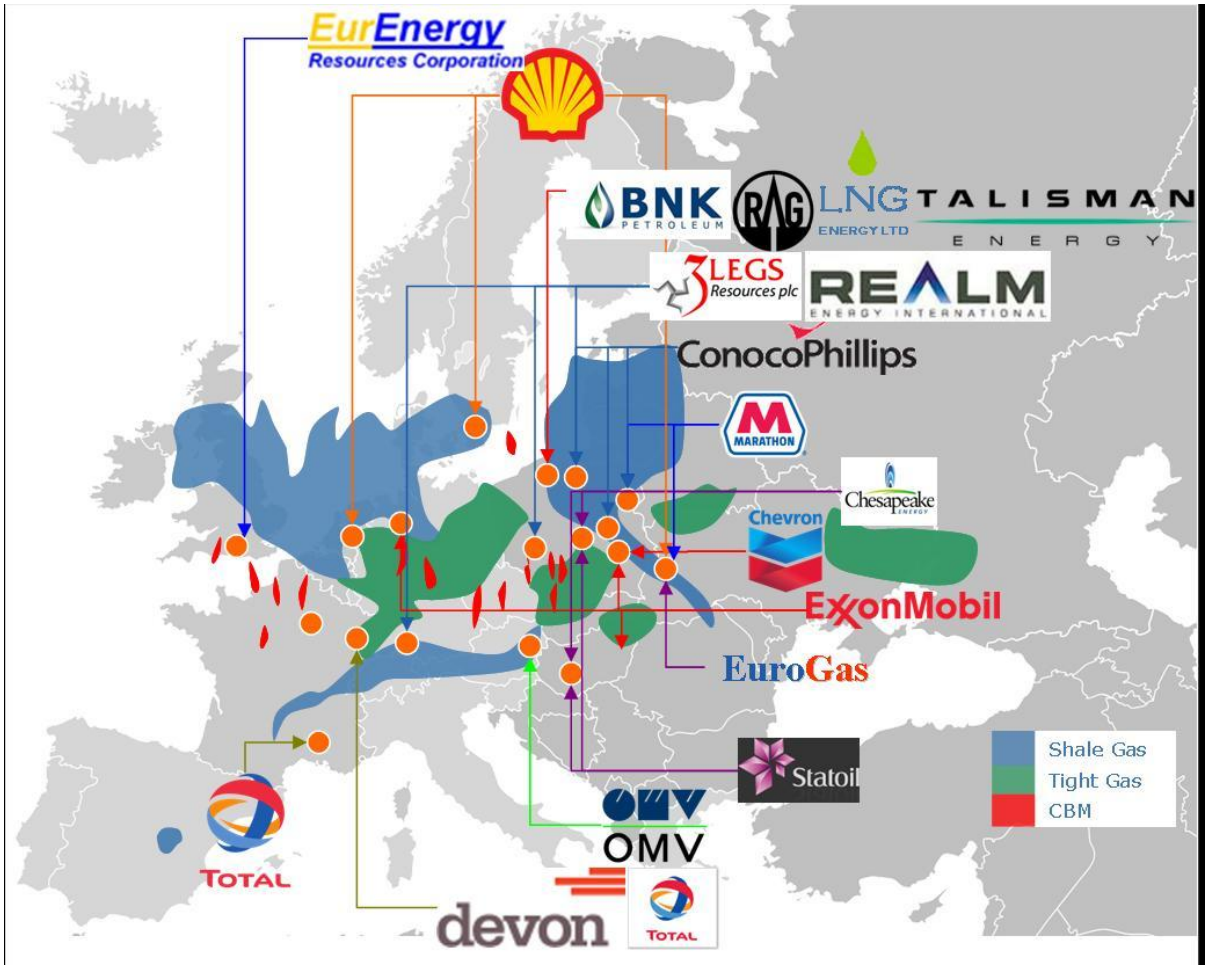
Unconventional Gas global distribution of GIIP



1 TCF = 28 bcm
NL Groningen Field = 2850 bcm

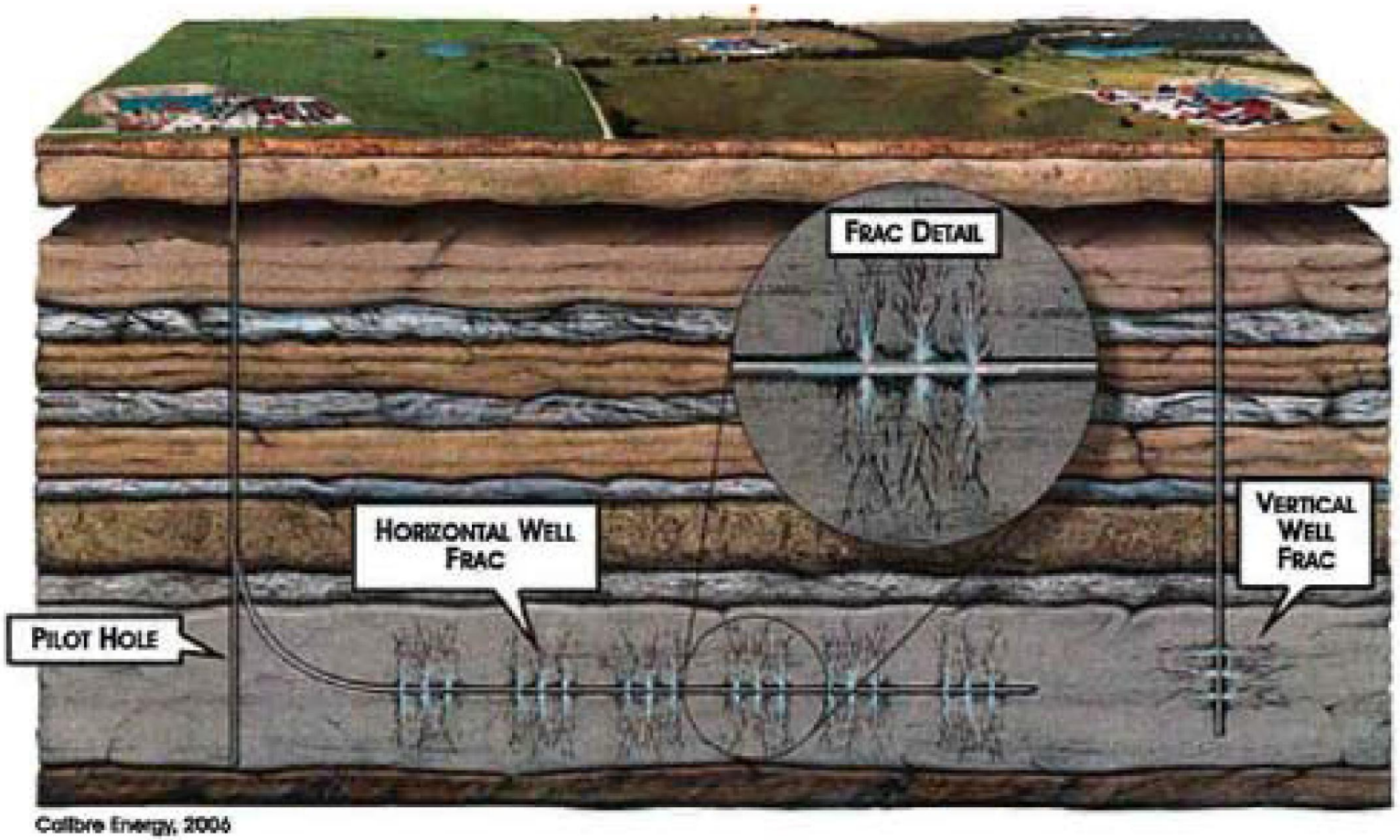
Eart

Unconventional gas activities Europe



Shale gas development

Concept of shale gas development

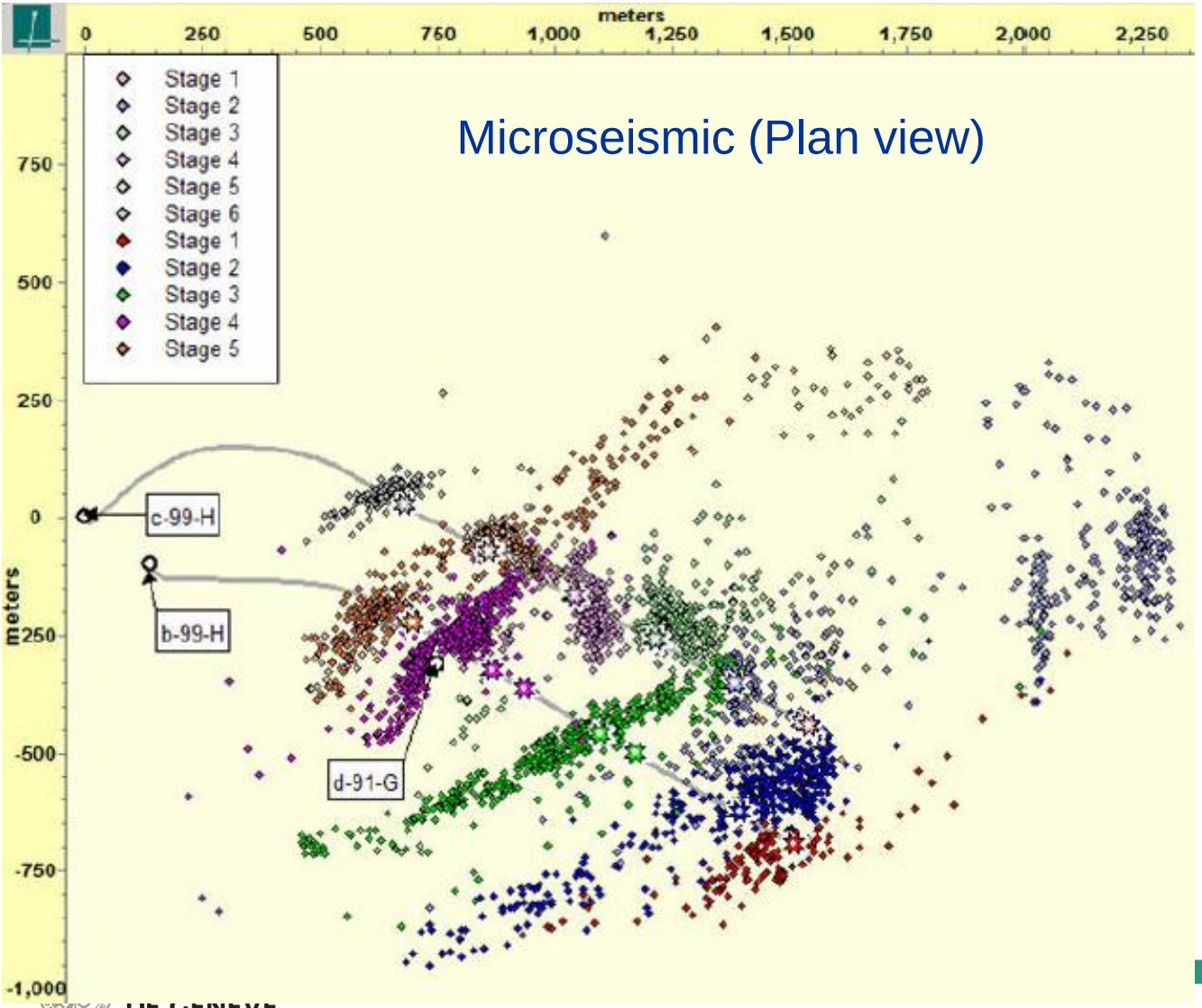


Drill: $3.5 mio (2,600m TVD; 1,650 hor);
Compl: $5.0 mio (14 frac);
Tie-in: $0.2 mio. Total: $ 8.7 mi0

Shale Gas Fraccing

Apache Horn River 10-frac: 2.4 million kg sand; up to 30 000 m3 water

Seismic monitoring of fracs



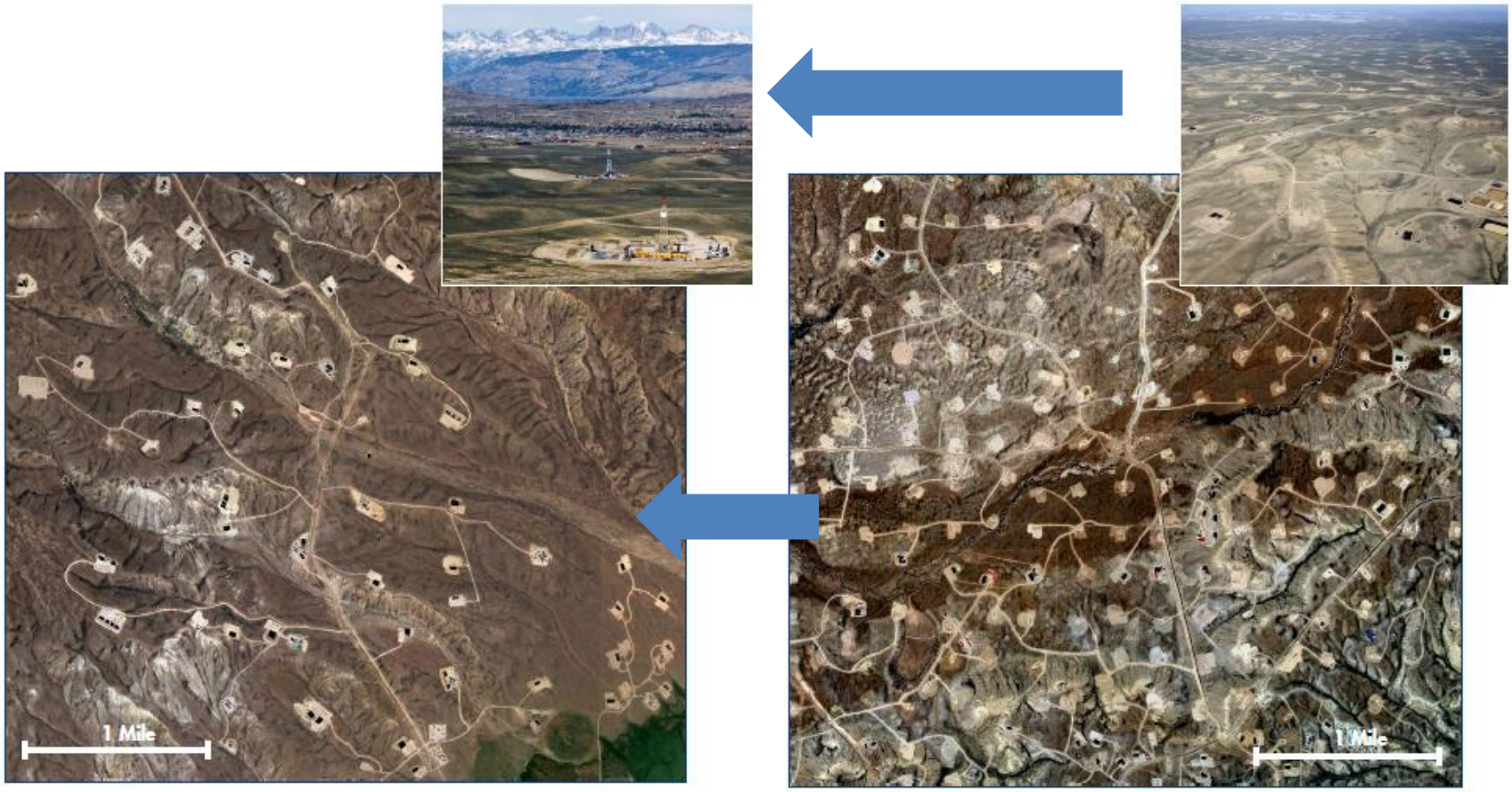
Apache
Fracture Results
Horn River Basin

Fracs: 0.5 - > 1 km

Magnitude:
1.5 – 2.5 Richter =
Large lorry passing by your house

100s K every year

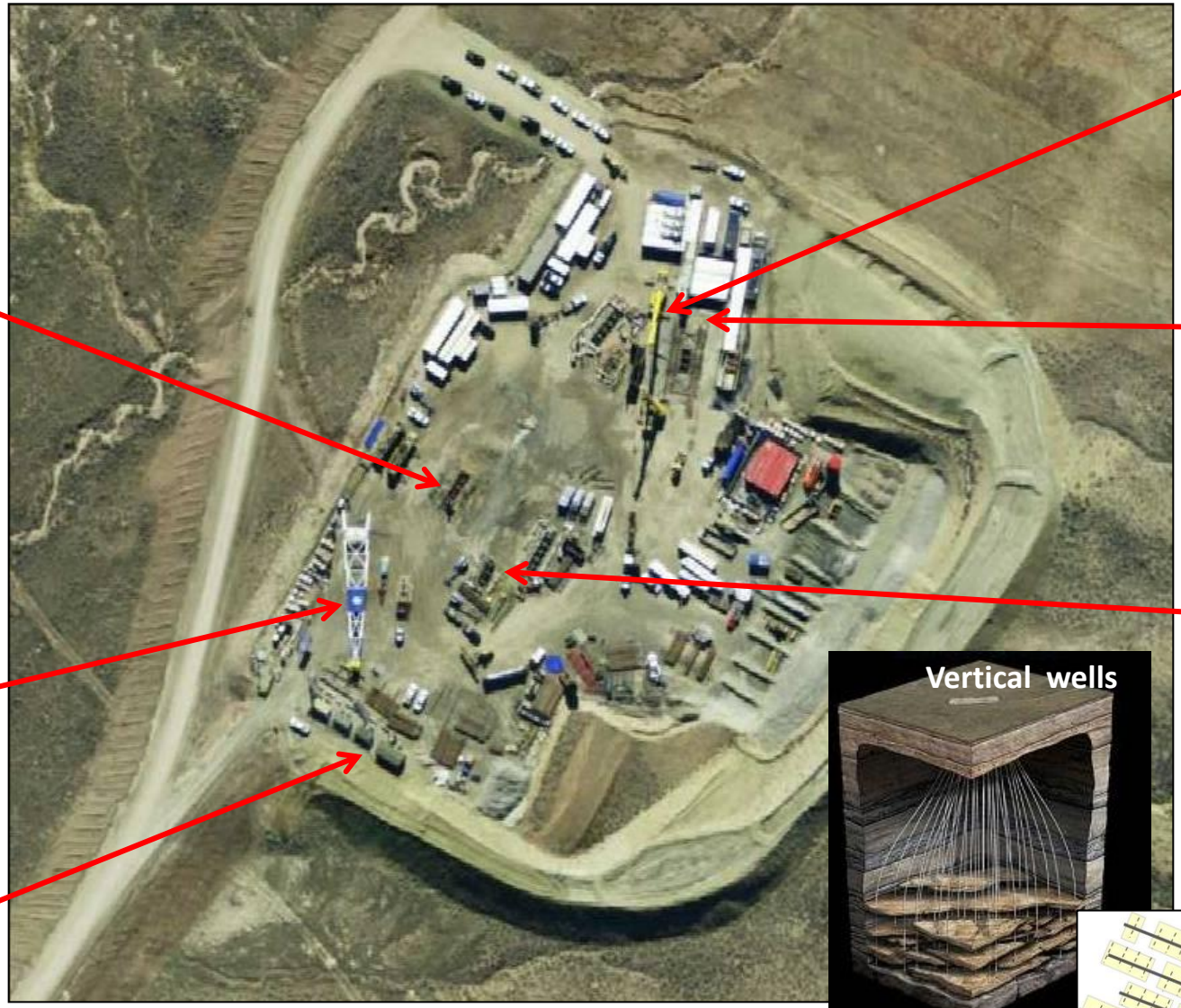
Reducing surface footprint



16 wells per pad, going to 32

- Early US development practices are no longer acceptable.
- Industry is working towards continuous reduction of surface footprint by, for example increasing no. of wells per pad.
- Innovative solutions will be required for many environmentally sensitive areas

Minimizing Environmental Footprint by Maximizing Pad Usage



Active Hydraulic Frac Programme

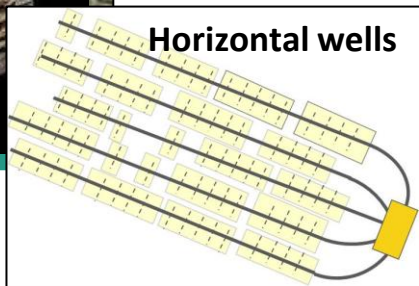
4 Active Producing Wells

11 Active Producing Wells

8 Active Producing Wells

Rigging Up a Drill Rig

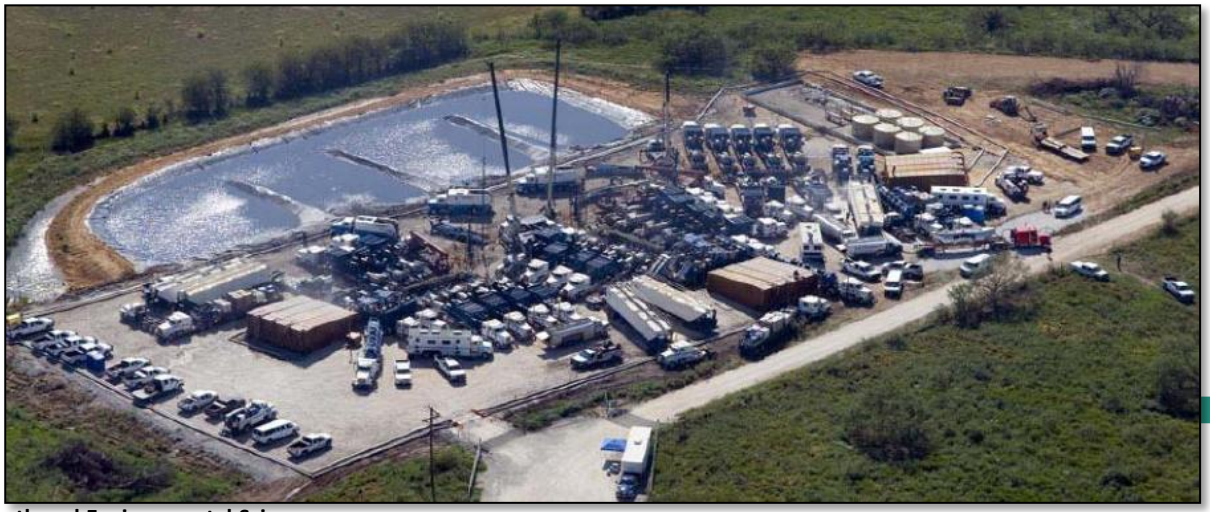
Active Production Facilities



SIMOPS at Shell's Pinedale Warbonnet 13-10 PAD

Water management challenges

- Access
- Transport
- Treatment
- Disposal
- Community Relations

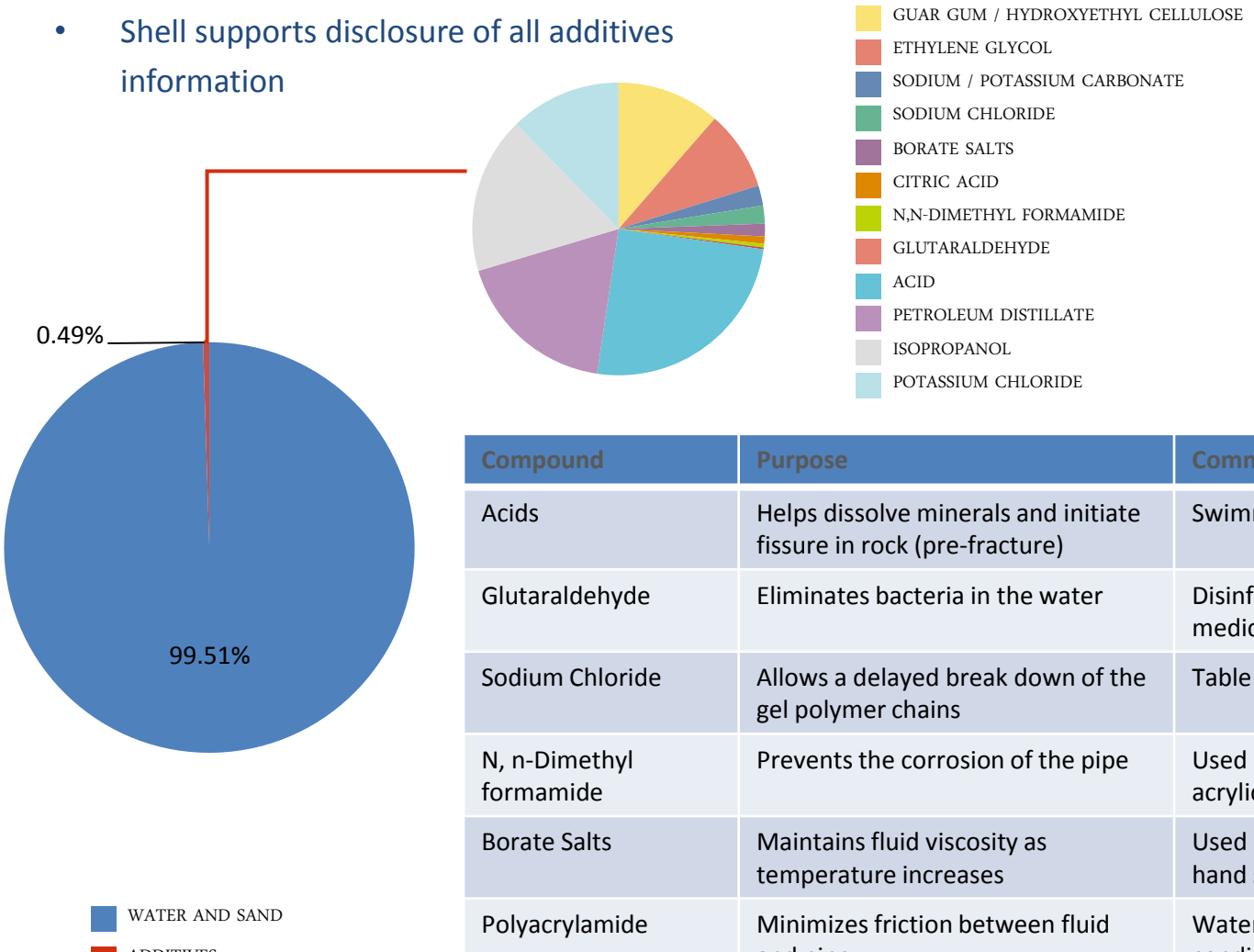


Groundwater protection

- Key is to collect data early …and use the data.
  - Characterize groundwater systems / properties.
  - Determine aquifer vulnerability
  - Identify mitigation for potential sources of impact.
  - Have an aquifer monitoring programme in place.
- Most incidents relate to surface spills of hazardous fluids.
  - Aim for pitless operations.
  - Implement secondary containment barriers.
  - Have spill prevention plans in place and conduct regular inspections.
- Implement appropriate casing design and cement practices
  - Set casing below deepest groundwater.
  - Cement recipe and quality control is critical.
  - Cementing practices and crew competency is key for success.

Fluids used in Slick Water hydraulic fracturing

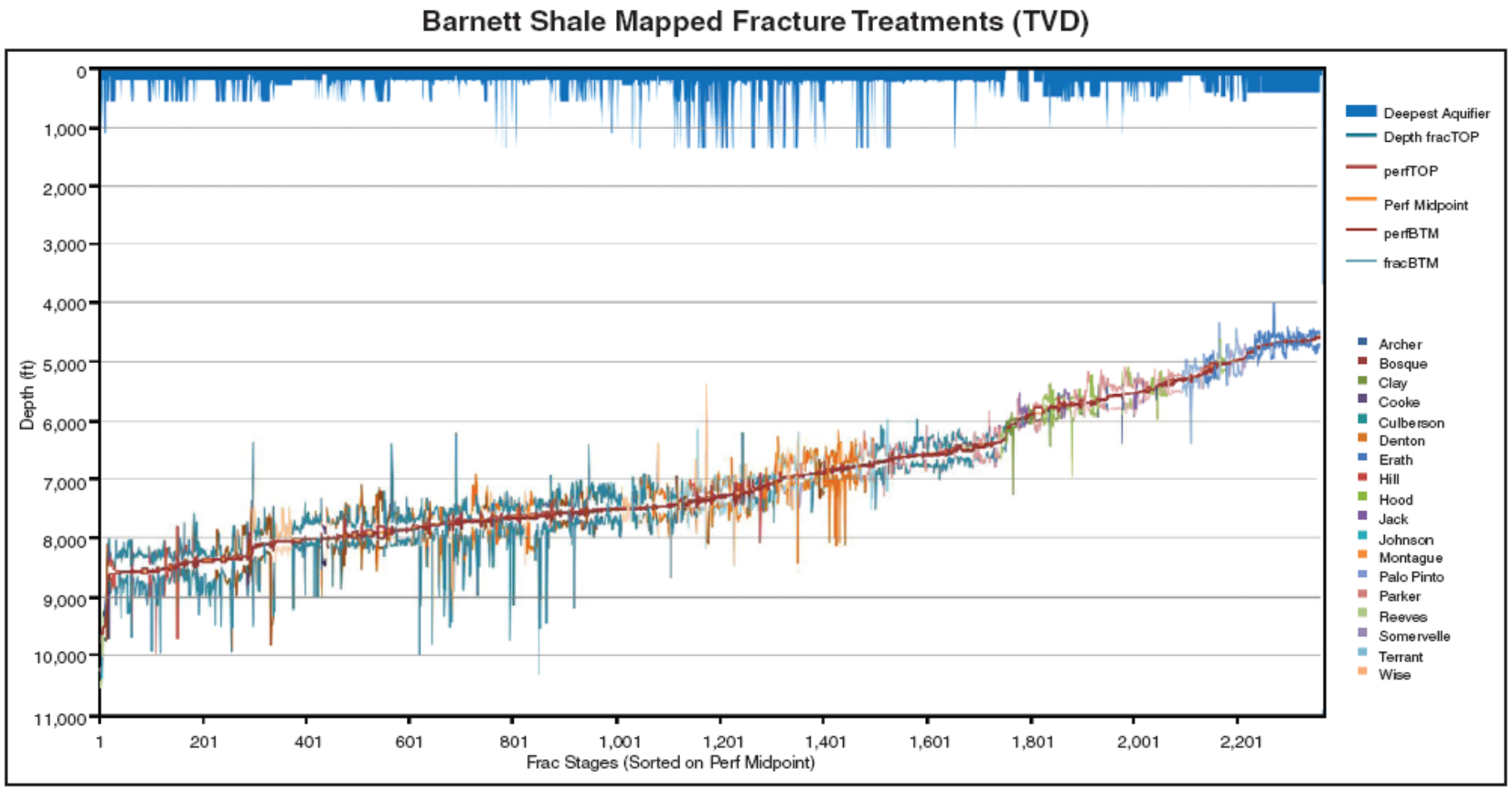
- Shell supports disclosure of all additives information



Compound	Purpose	Common Application
Acids	Helps dissolve minerals and initiate fissure in rock (pre-fracture)	Swimming pool cleaner
Glutaraldehyde	Eliminates bacteria in the water	Disinfectant; Sterilizer for medical and dental equipment
Sodium Chloride	Allows a delayed break down of the gel polymer chains	Table Salt
N, n-Dimethyl formamide	Prevents the corrosion of the pipe	Used in pharmaceuticals, acrylic fibers and plastics
Borate Salts	Maintains fluid viscosity as temperature increases	Used in laundy detergents, hand soaps and cosmetics
Polyacrylamide	Minimizes friction between fluid and pipe	Water treatment, soil conditioner

Source: Energy in Depth

Frac Mapping

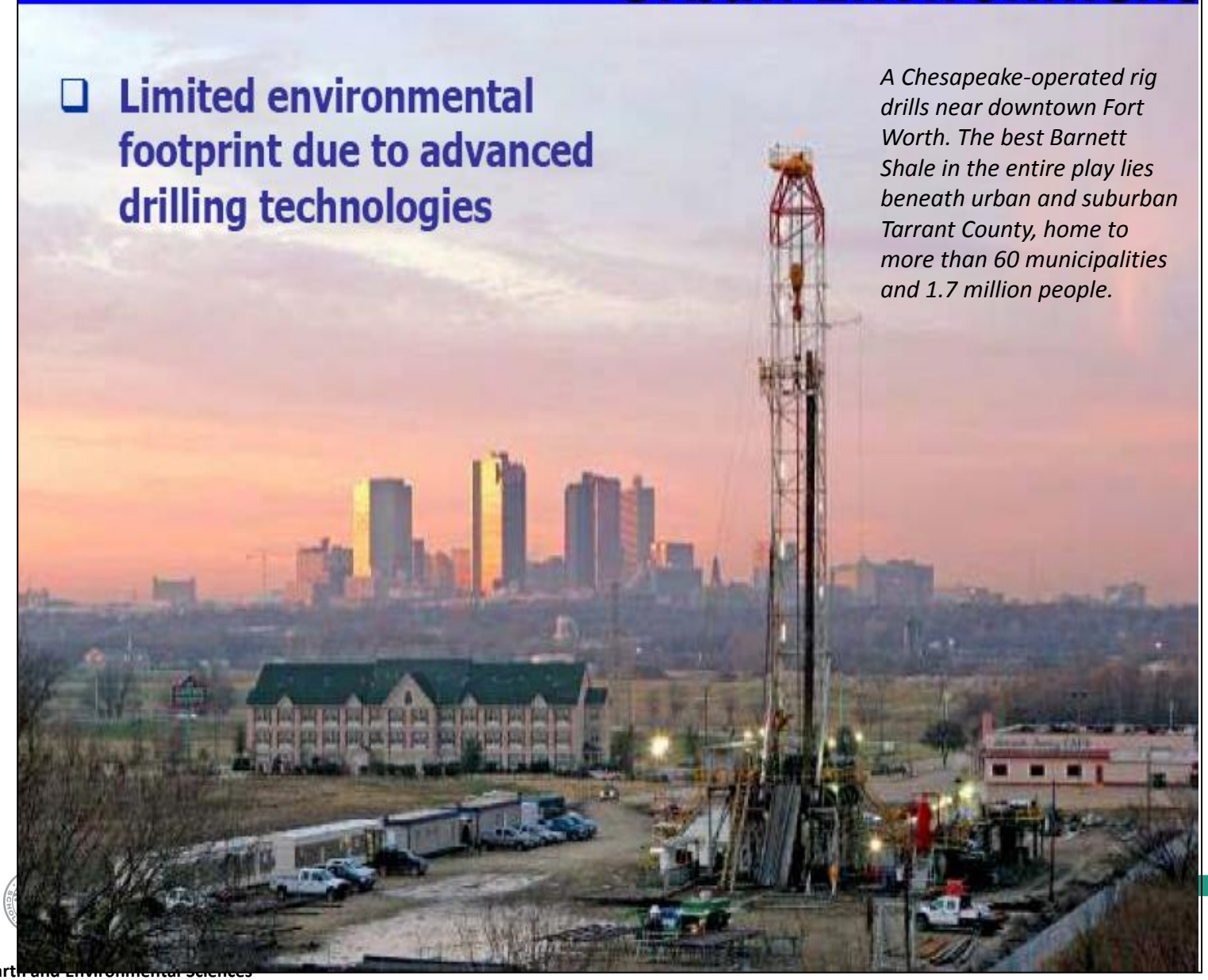


Reproduced for Halliburton Pinnacle with permission from The American Oil & Gas Reporter www.aogr.com

The graph illustrates the fracture top and bottom for all mapped treatments performed in the Barnett since 2001.

Good Neighbors in an Urban Environment

- Limited environmental footprint due to advanced drilling technologies



A Chesapeake-operated rig drills near downtown Fort Worth. The best Barnett Shale in the entire play lies beneath urban and suburban Tarrant County, home to more than 60 municipalities and 1.7 million people.

Data source: Chesapeake Energy Corporation - 2008 Annual Report

Dallas Fort Worth International Airport development

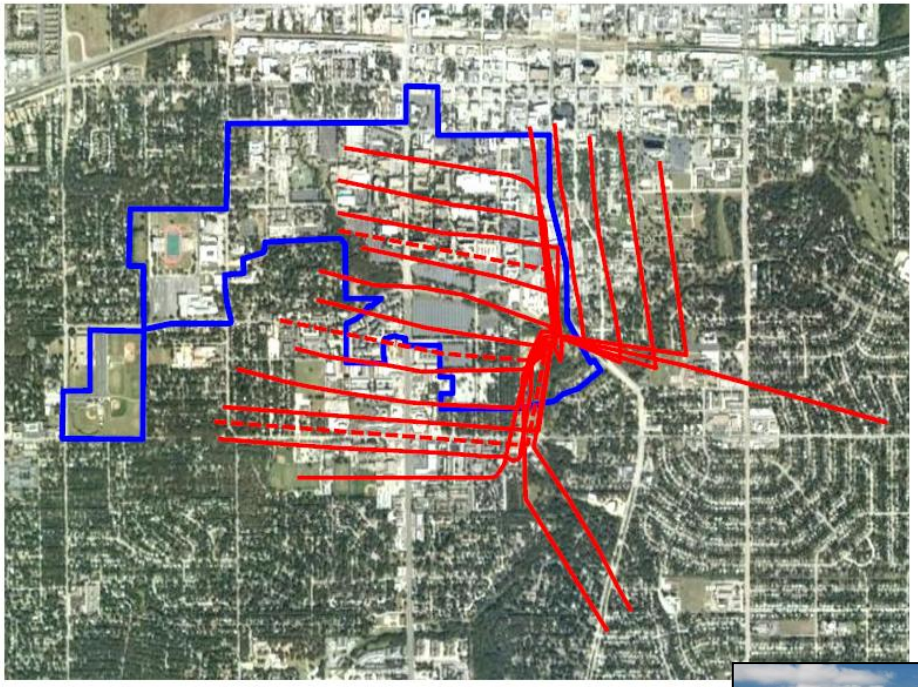
Data source: Chesapeake Energy Corporation - 2008

Urban drilling in Fort Worth

University of Texas - Arlington
Urban Drilling

CARRIZO

- 400 acre lease; 2,500 acre "Halo"
- 22 wells drilled in initial development plan
- Pad on full production
- Producing wells are highest rate CRZO Barnett wells drilled to date
- Infrastructure supports additional expansion



Data source: Johnson Rice Energy Conference
Carrizo Oil & Gas, Inc. October 6, 2010

Moratoria world-wide

Country	Start date	Status
Australia - NSW	In place until April 2012	Election promise of government Applies to fracking only
Bulgaria	January 2012	Parliament vote
Canada - Quebec	March 2011	Cabinet decision
France	2011	Parliament vote
Germany (defacto)	2011	Water study to be completed
Netherlands (defacto)	2011	In place until outcome of study on impacts of UCG development, expected Q3 2012
Northern Ireland	February 2012	Parliament vote
South Africa	March 2011	Cabinet
USA –New York State	2010	Environmental analysis – pending outcome

Key reports & studies

Number and frequency of governments “studying” environmental issues around unconventional gas is increasing. Several critical reports for the Industry being worked at present:

- EU Parliament Energy Committee report
- EU Parliament Environment Committee report
- Dutch government report
- German state reports on water issues
- US EPA report
- UK Royas Society of Engineers
- New Zealand Parliamentary commission


NON AU
GAZ DE SCHISTE
L'exploitation des hydrocarbures non conventionnels
(couramment appelés gaz de schiste)
impacte gravement l'environnement et compromet la transition énergétique.
«Non au gaz de schiste»
le 11 février 2012
9h30 - meeting
13h30 - rassemblement
NON AU GAZ DE SCHISTE
ce n'est pas fini !
Saint-Julien-en-Genevois (Arande)
Renseignements sur www.ngds74.info
La mobilisation est notre seul moyen de lutte
Collectif NON AU GAZ DE SCHISTE HAUTE-SAVOIE
www.nonaugazdeschistelyon.org/74

Shale gas extraction | Royal Society

Shale gas extraction | Royal Soc...

royalsociety.org/policy/projects/shale-gas-extraction/

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Shale gas extraction

Project details

The Royal Society carried out a short review jointly with the Royal Academy of Engineering of the major risks associated with hydraulic fracturing (also known as 'fracking'); including, geological risks, such as seismicity, and environmental risks, such as groundwater contamination.

The extraction of shale gas in the UK has been the subject of recent debate, with many concerned over potential risks associated with the process. This project reviewed the scientific and engineering

Working Group

The study w
by Professor

Shale ga

Final report
published Ju

Project det
announced

Policy news

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Statement on hydraulic fracturing report » Taranaki Regional Council

Statement on hydraulic fracturi...

www.trc.govt.nz/statement-on-hydraulic-fracturing-report/

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Statement on hydraulic fracturing report

27 November 2012

The Taranaki Regional Council welcomes the release of the Parliamentary Commissioner for the Environment's interim report on hydraulic fracturing.

The Council will study this report carefully and make a detailed response in due course, with a view to informing her second report. In the meantime, the Council makes the following initial observations:

The Commissioner concludes that the environmental risks associated with hydraulic fracturing can be managed effectively provided, to quote the UK Royal Society, *"operational best practices are implemented and enforced through regulation"*. This has been, and continues to be, the Taranaki Regional Council's position. This Council also notes the Commissioner's view that a moratorium on hydraulic fracturing is not presently justified.

The Council's monitoring of oil and gas activities is extensive. In the past 30 years, there have been thousands of site visits and inspections, analyses of thousands of air and water samples, and hundreds of bio-monitoring surveys associated with oil and gas activities. The Council has detected no significant adverse environmental effects attributable specifically to hydraulic fracturing.

The Council notes the Commissioner's statement (p44) that "to date, there is no evidence that fracking has caused groundwater contamination in New Zealand, and at the current scale of operations, the risk appears low".

The Council also notes the Commissioner's statement (p47) that although the most common method of disposing of liquid waste, deep well injection, could result in the wastewater migrating into aquifers, "there does not appear to be any evidence that this has occurred in New Zealand".

The Commissioner also refers to the landfarming of waste solids, saying these may contain heavy metals and hydraulic fracturing fluids. In Taranaki, landfarming is a consented and monitored activity, with operators required to meet specified loadings and concentrations to comply with recognised environmental standards and guidelines. For example, levels of any heavy metals must and do meet New Zealand agricultural guidelines at time of application.

News

- News 2010
- News 2009
- News 2008
- News 2007
- News 2006

Browse by Date

- December 2012
- November 2012
- October 2012
- September 2012
- August 2012
- July 2012
- June 2012
- May 2012
- April 2012
- March 2012
- February 2012
- January 2012
- December 2011
- November 2011
- October 2011
- September 2011
- August 2011
- July 2011

CYCLE DE FORMATION ÉNERGIE – ENVIRONNEMENT
SÉMINAIRE 2012-2013
Université de Genève

Le sous-sol comme ressource au service de la ville.

Le projet Deep City

•Prof. Aurèle PARRIAUX

EPFL

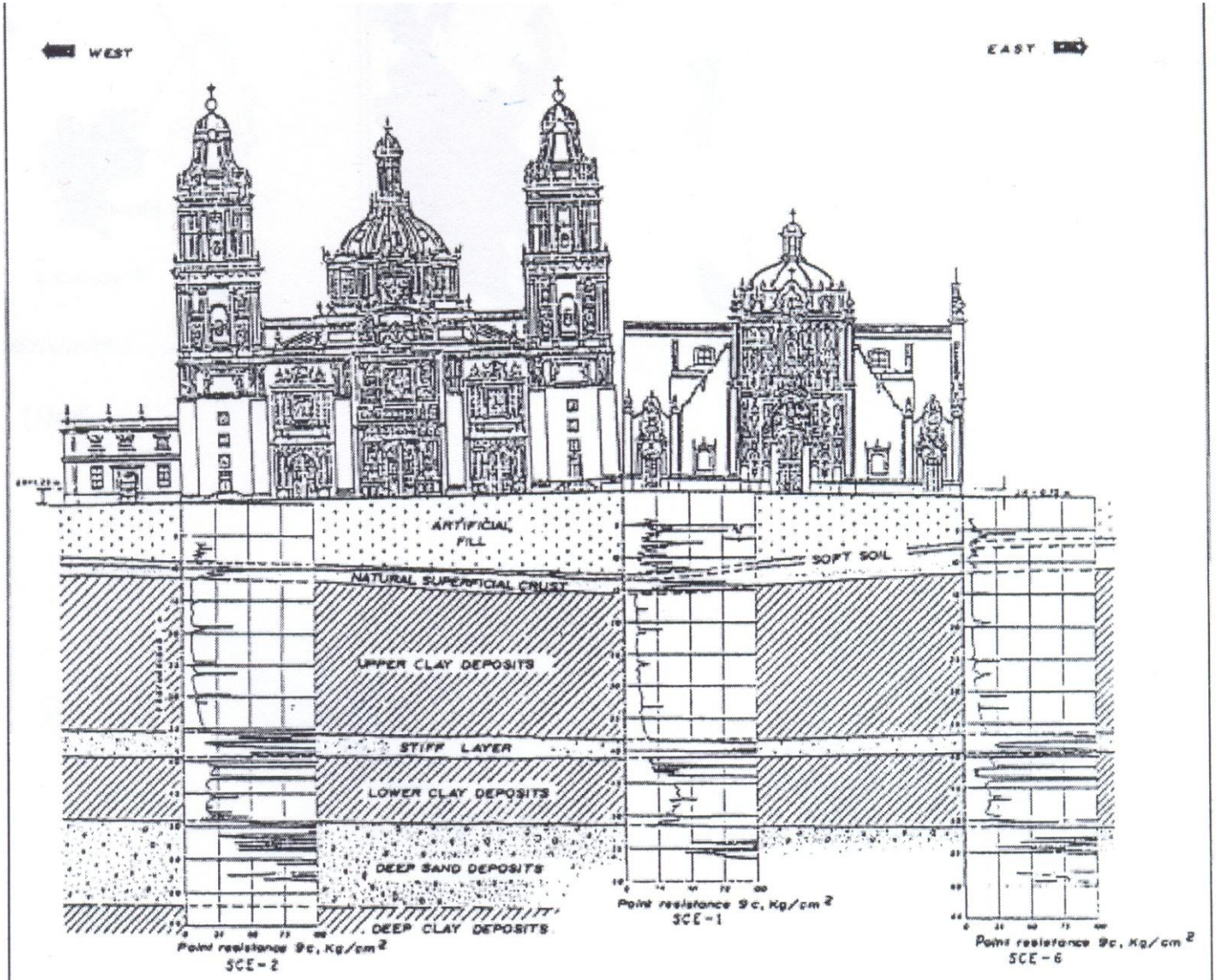
Notre thèse

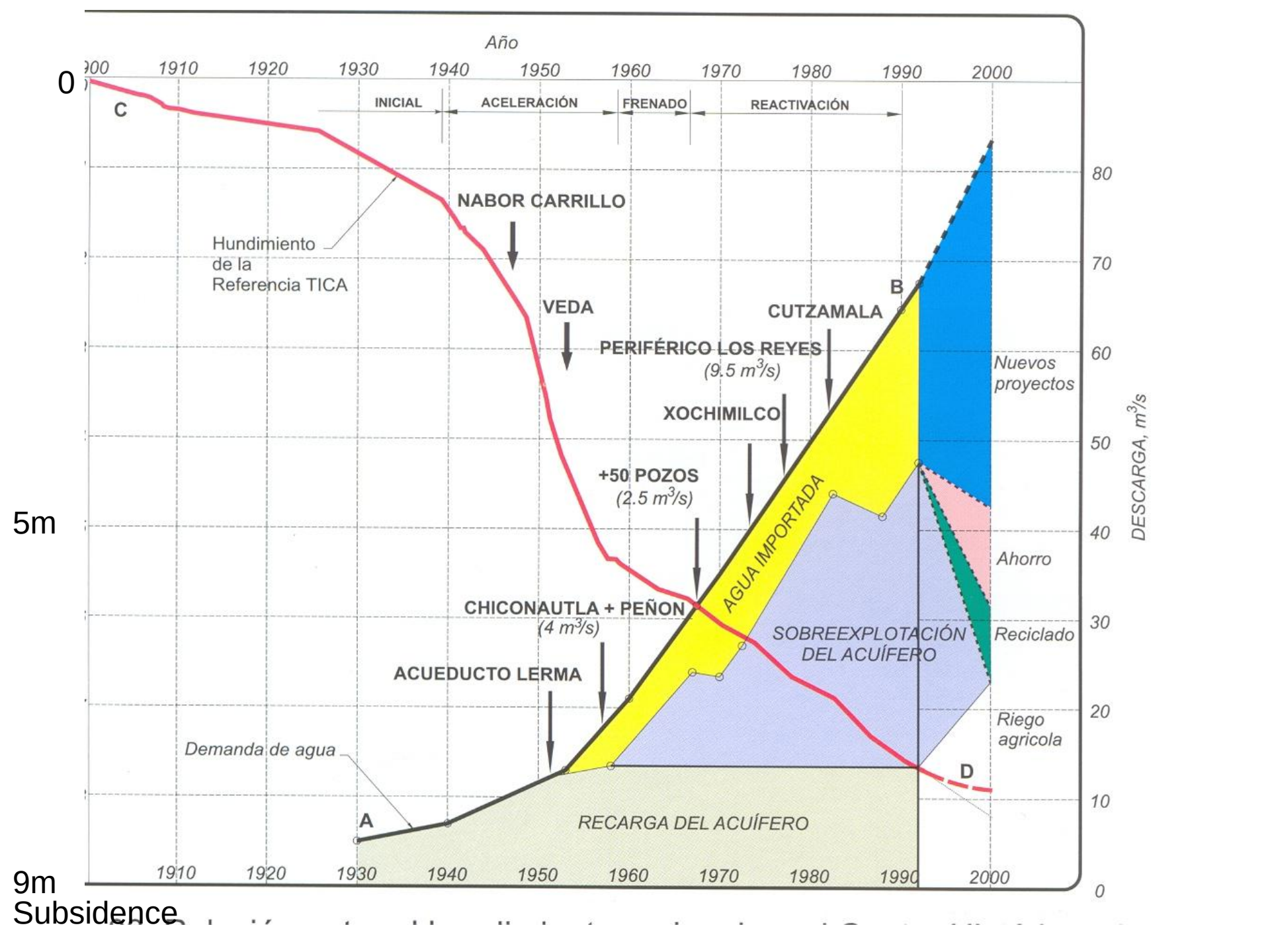
“Le développement durable des villes ne pourra être atteint sans avoir recours de plus en plus à la 3e dimension en profondeur”

Leçons du passé

- Exemple de Mexico-City

Affaissement de la ville




0
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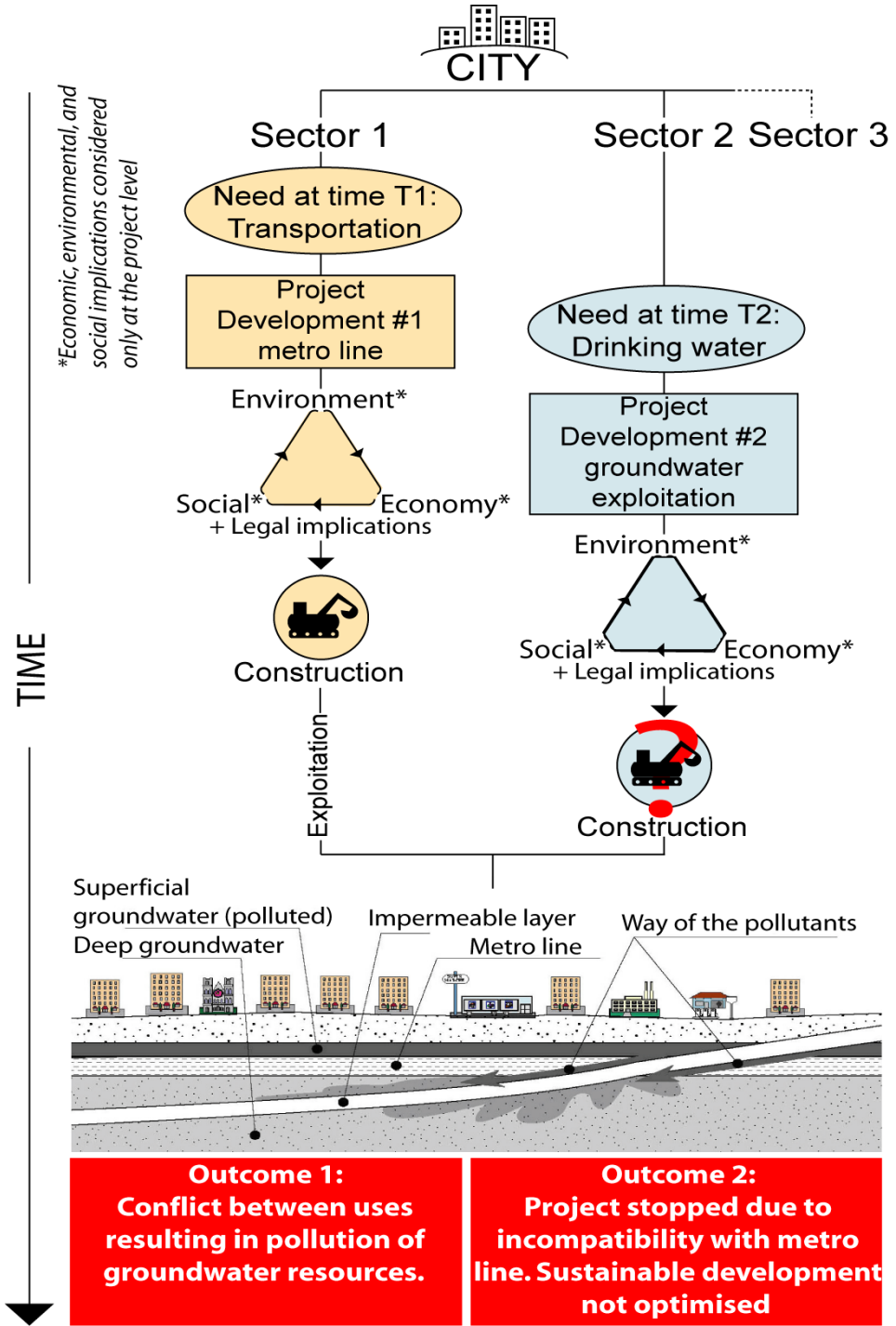
FRENADO
REACTIVACIÓN
C
B
A
D
NABOR CARRILLO
Hundimiento
de la
Referencia TICA
VEDA
CUTZAMALA
PERIFÉRICO LOS REYES
(9.5 m3/s)
XOCHIMILCO
+50 POZOS
(2.5 m3/s)
CHICONAUTLA + PEÑON
(4 m3/s)
ACUEDUCTO LERMA
AGUA IMPORTADA
SOBREEXPLOTACIÓN
DEL ACUÍFERO
RECARGA DEL ACUÍFERO
Demanda de agua
Nuevos
proyectos
Ahorro
Reciclado
Riego
agricola
DESCARGA, m3/s
80
70
60
50
40
30
20
10
0

Conclusion principale du volet “Leçons du passé”

- “L’approche sectorielle” est la principale raison de la non-conformité avec les principes du développement durable.

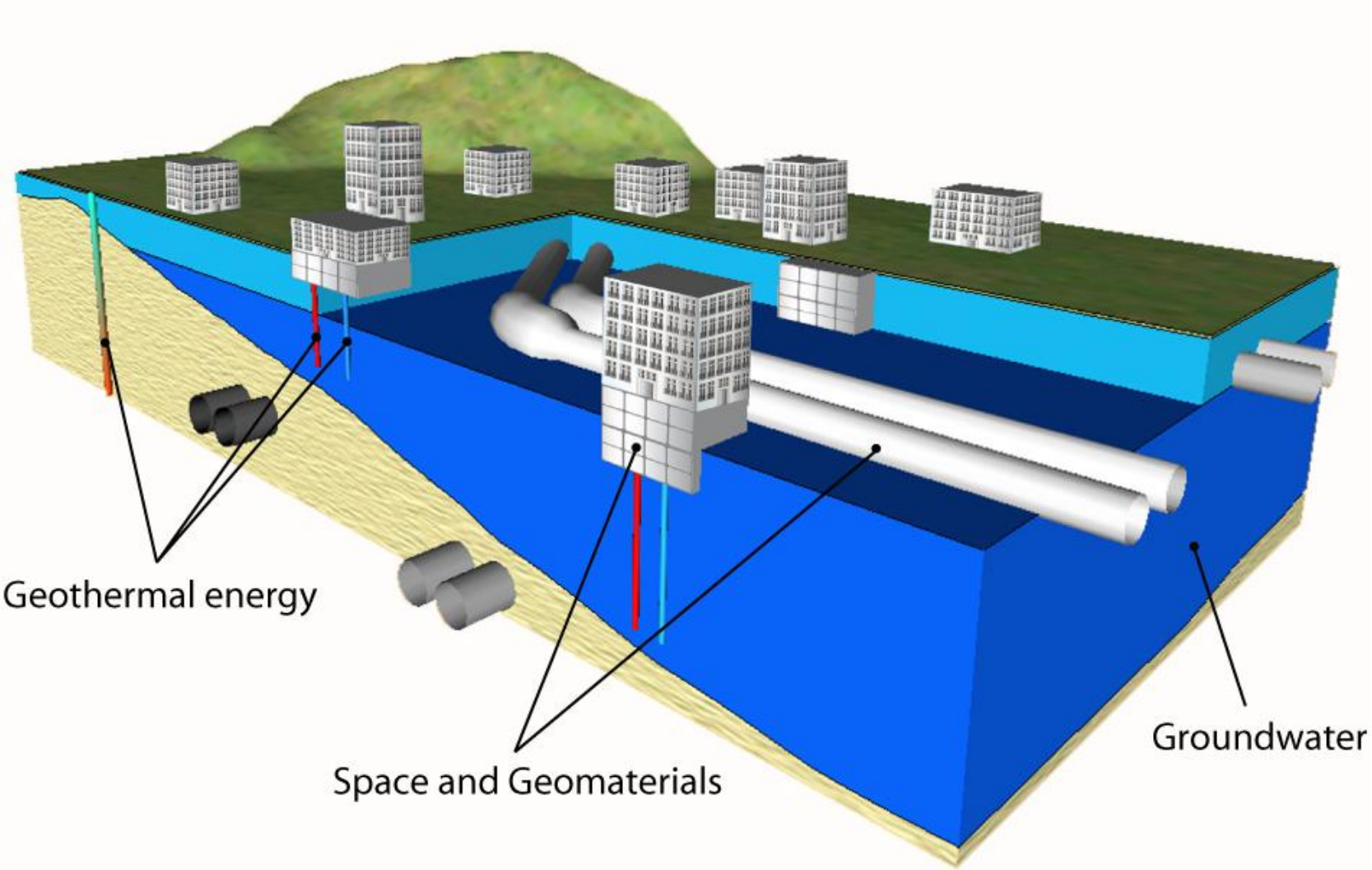
Approche sectorielle dans l'usage du sous-sol : *Exemple d'un cas typique*



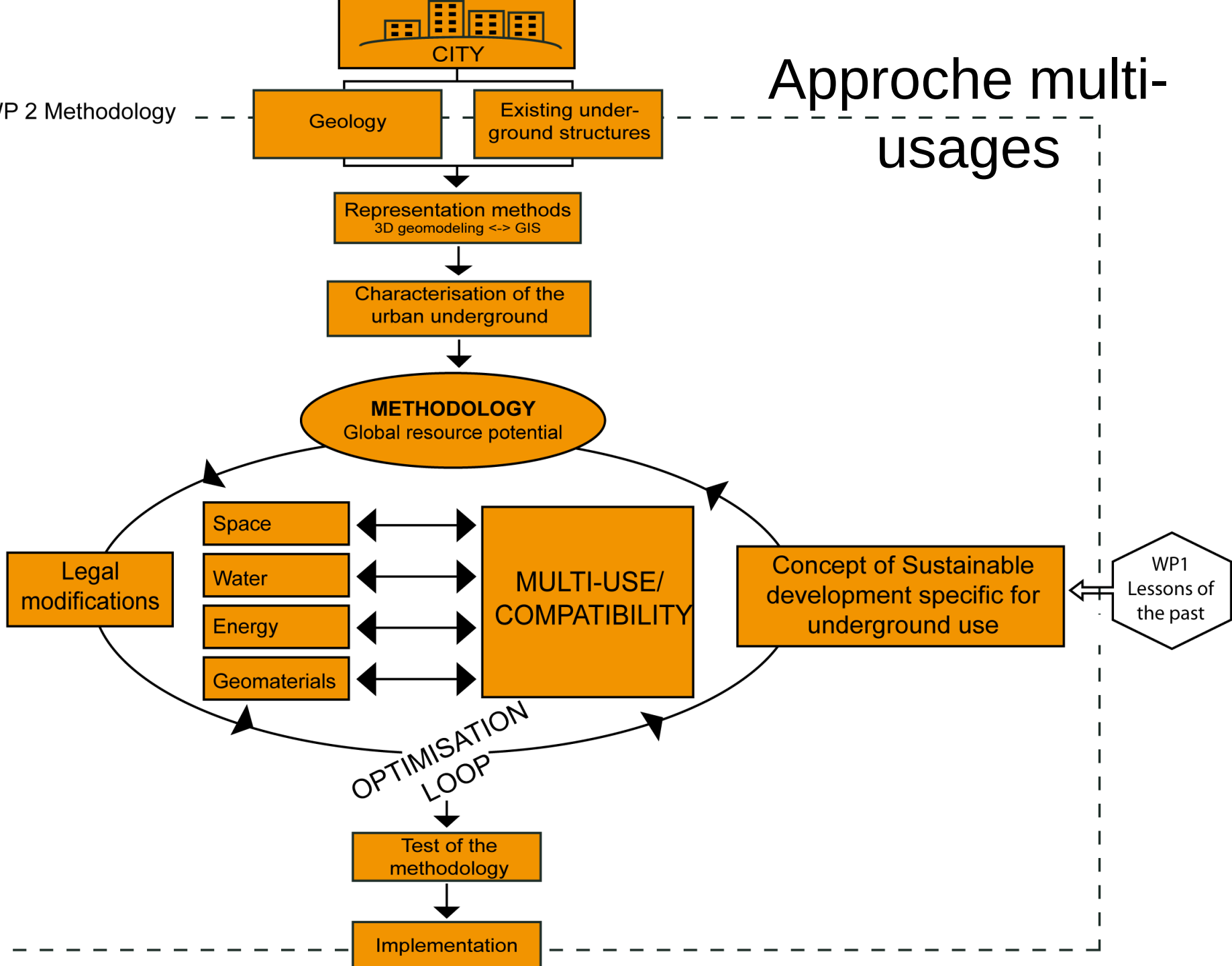
Principe du projet DEEP CITY

“Seule une approche planifiées multi-usage permet d’exploiter l’entier du potentiel de ressources du sous-sol de manière durable”

Les quatre resssources principales du sous-sol urbain



Approche multi-usages

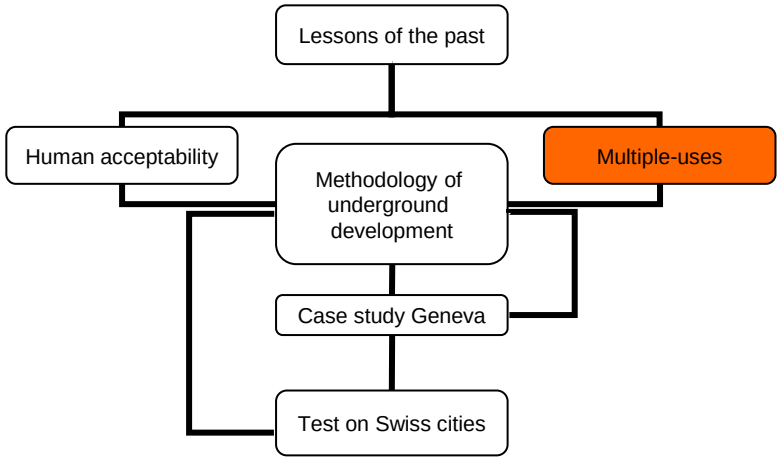


Concept multi-usages

Analyses des interactions à long terme selon le concept multi-usage des ressources (interactions positives ou négatives) =>

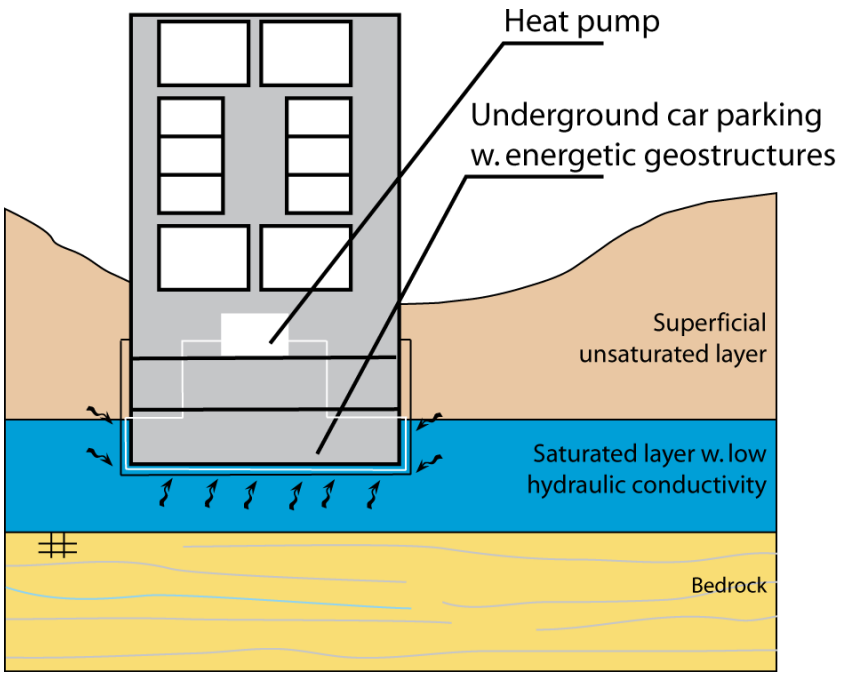
Qu'est ce qui est compatible avec quoi et ceci selon quelles conditions aux limites

=> Règles générales

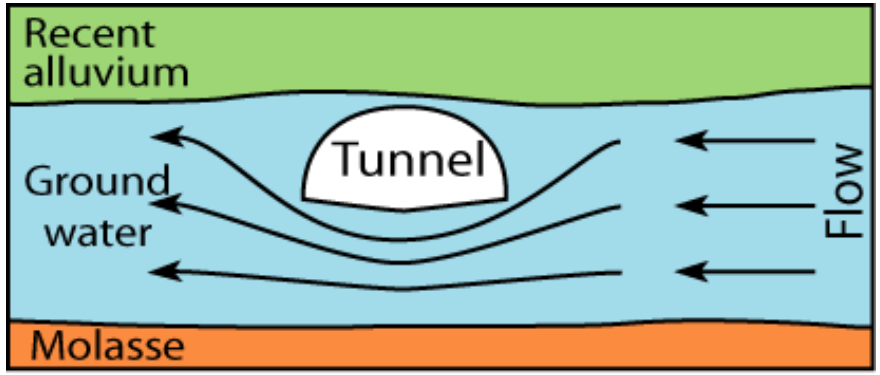


Synergies et conflits

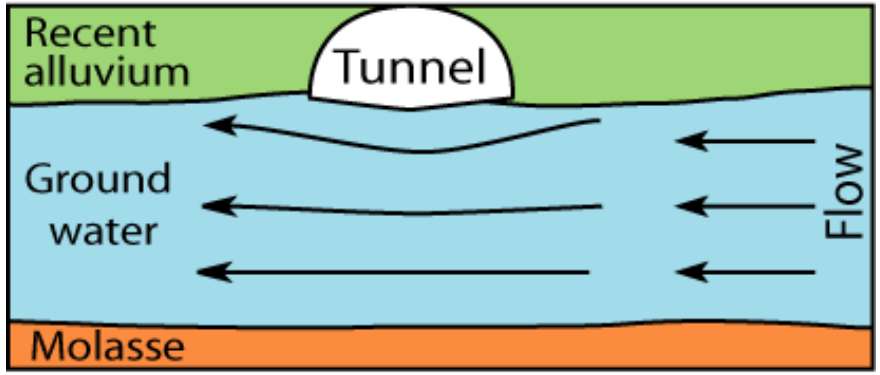
Espace et géothermie



Espace et ressource en eau
2 variantes pour le RER CEVA (Genève)



a) Tunnel is below the groundwater table



b) Tunnel is above the groundwater table

Matrice des interactions

AGENT IMPACTANT \ AGENT IMPACTÉ	Espace	Eau Souterraine	Géothermie	Géomatériaux
Espace	-Conflit d'espace -Subsidence +Mise en réseau	-Concurrence hydrogéologique -Effet barrage -Pollution des eaux[1] -Court-circuits entre aquifères +Captages dans les ouvrages souterrains	+Géostructures énergétiques +Valorisation thermique des flux techniques	-Élimination des matériaux d'excavation +Valorisation des géomatériaux
Eau Souterraine	-Infiltration dans les ouvrages -Poussée d'archimède -Subsidence et soulèvement -Corrosion et détérioration des ouvrages	-Concurence hydrogéologique	-Dessaturation des terrains	
Géothermie	-Conflit d'espace -Modifications thermo-mécaniques -Gel du terrain -Impact des prélèvements	-Concurence hydrogéologique -Effet barrage -Pollution des eaux[1] -Modifications de l'activité biologique -Modification des paramètres physico-chimiques	-Interaction des plumes de froid ou de chaud -Surexploitation du flux thermique	
Géomatériaux	+Coordination extractions-constructions	-Modifications du bilan hydrogéologique -Effet barrage -Court-circuits entre aquifères -Pollution des eaux[1]		D'après Blunier

Rapport complet DEEP CITY

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De la théorie à la pratique

- Plan légal : contacts avec l'Office fédéral du développement territorial afin d'introduire la 3e dimension souterraine dans l'aménagement du territoire

Nouvelle mission pour l'Aménagement du territoire

A l'échelle du pays :

Principes dans une loi

A l'échelle des agglomérations :

L'introduction de la 3e dimension implique de nouvelles tâches pour les professionnels de l'aménagement

4 étapes principales

Etape 1 : le modèle 3D

- Collection des données géologiques
- Collection des infrastructures souterraines existantes
- Stockage sous une forme utilisable
- Etablissement du modèle 3D du sous-sol

Etape 2 : management à long terme des ressources

- Potentiel propre de chaque ressource possible prise isolément (espace, géomatériaux, géothermie, eau de boisson)
- Potentiel intégral multi-usages par optimisation des synergies et minimisation des conflits (selon la méthodologie Deep City)

C'est l'étape principale!

Etape 3 : Evaluation des ouvrages existants

- Les ouvrages existants sont-ils compatibles avec le développement durable ?
- Si non, planification de leur abandon ou leur adaptation (on ne peut pas simplement détruire comme en surface)

Etape 4 : Evolution dynamique

- Evolution dynamique de l’aménagement du sous-sol selon :
- - de nouvelles données
- - de nouveaux besoins
- - de nouvelles technologies
- - de nouvelles conditions socio-économiques etc.

Conclusion

Cette manière plus holistique de considérer le sous-sol sous la ville devrait être adoptée sans délai par les urbanistes et tous les acteurs de son futur.

C’est urgent !

Tard risque d’être trop tard !

Deep City : et après ?

- Achèvement du projet Deep City China (2013)
- Nouveau doctorat (2012-2016) sur l'application de la méthodologie Deep City sur des grandes villes de la Planète dans des contextes très différents (géologie, taille, niveau socio-économique, gouvernance etc.).

La gestion du sous-sol a besoin de la Géologie.

Peut être vous aussi …

Nouvelle édition

http://ppur.epfl.ch/