CÂMARA DOS DEPUTADOS
COMISSÃO DE MEIO AMBIENTE E DESENVOLVIMENTO SUSTENTÁVEL

OF-CONV N.º 502

"Gás de Xisto": Desafios e Perspectivas

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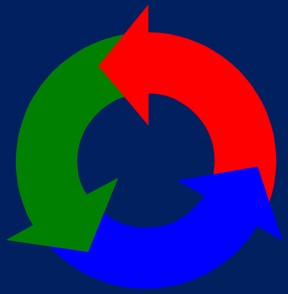
Brasília, DF, 05 de dezembro de 2013

Energia



Alimentos

Ambiente

Água

Pobreza

Popul…

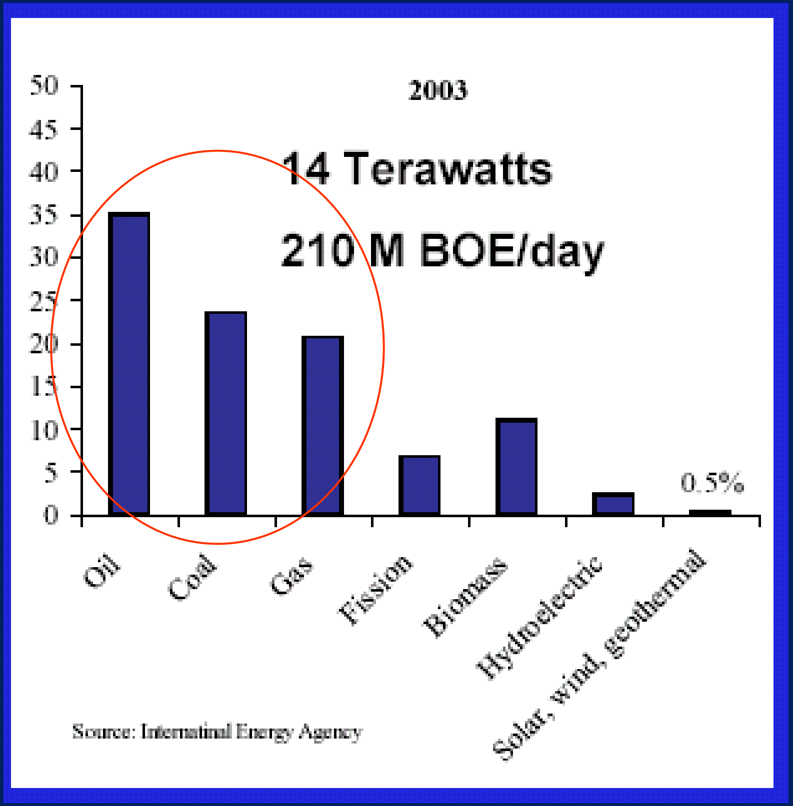
Sustentabilidade

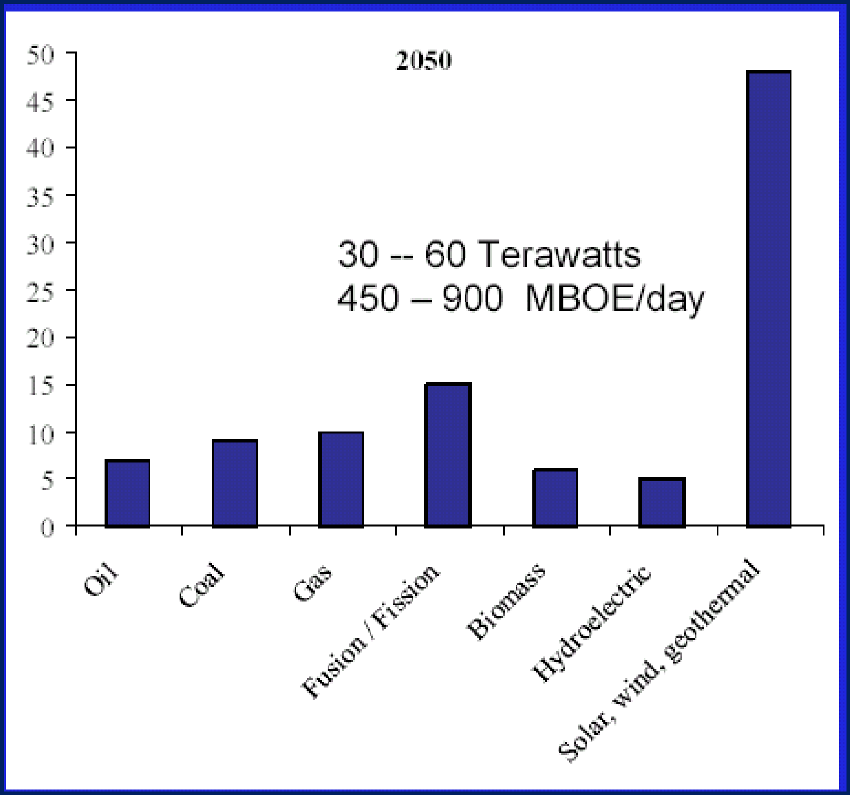
Educação

Democracia

Terrorismo, Guerra, Violência

O Desafio Energético





A Base da Prosperidade

Século XX = Óleo

Século XXI = ???

que significa muito mais do que proteger refinarias e oleodutos contra ataques terroristas.

Segurança energética

pode ser melhor compreendido como a capacidade de manter a máquina global funcionando, isto é, produzindo combustíveis e eletricidade suficientes, a preços acessíveis, para que todos os países possam, pelo menos, manter sua economia operando e o seu povo alimentado.

Segurança energética

Sustentabilidade (quanto tempo o petróleo do mundo, gás natural, urânio e fornecimento de carvão durarão);

Globalização (o impacto do rápido crescimento da demanda de energia nos países em desenvolvimento e as respectivas im... es econômica, política e ambientais);

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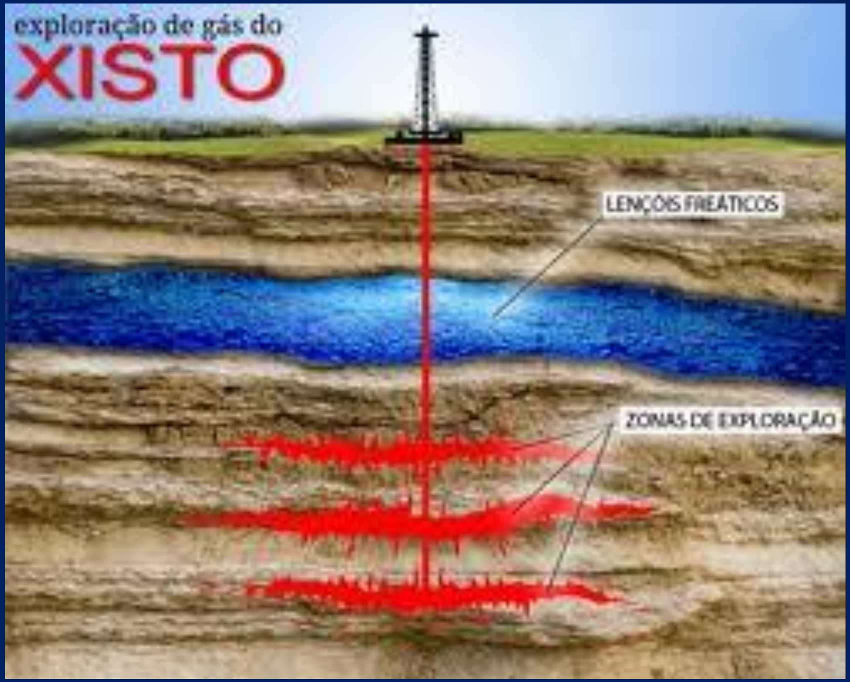
Pr... ...as questões energéticas na qua... de vida, ou o equilíbrio percebido entre con... responsabilidade ambiental), e o

Potencial de desenvolvimento tecnológico (o equilíbrio entre as tecnologias que já estão disponíveis, aqueles que estarão disponíveis em um futuro próximo, e aqueles que podem tornar-se em longo prazo em "mudanças do jogo").

Educação

“Shale Gas” /Gás de xisto

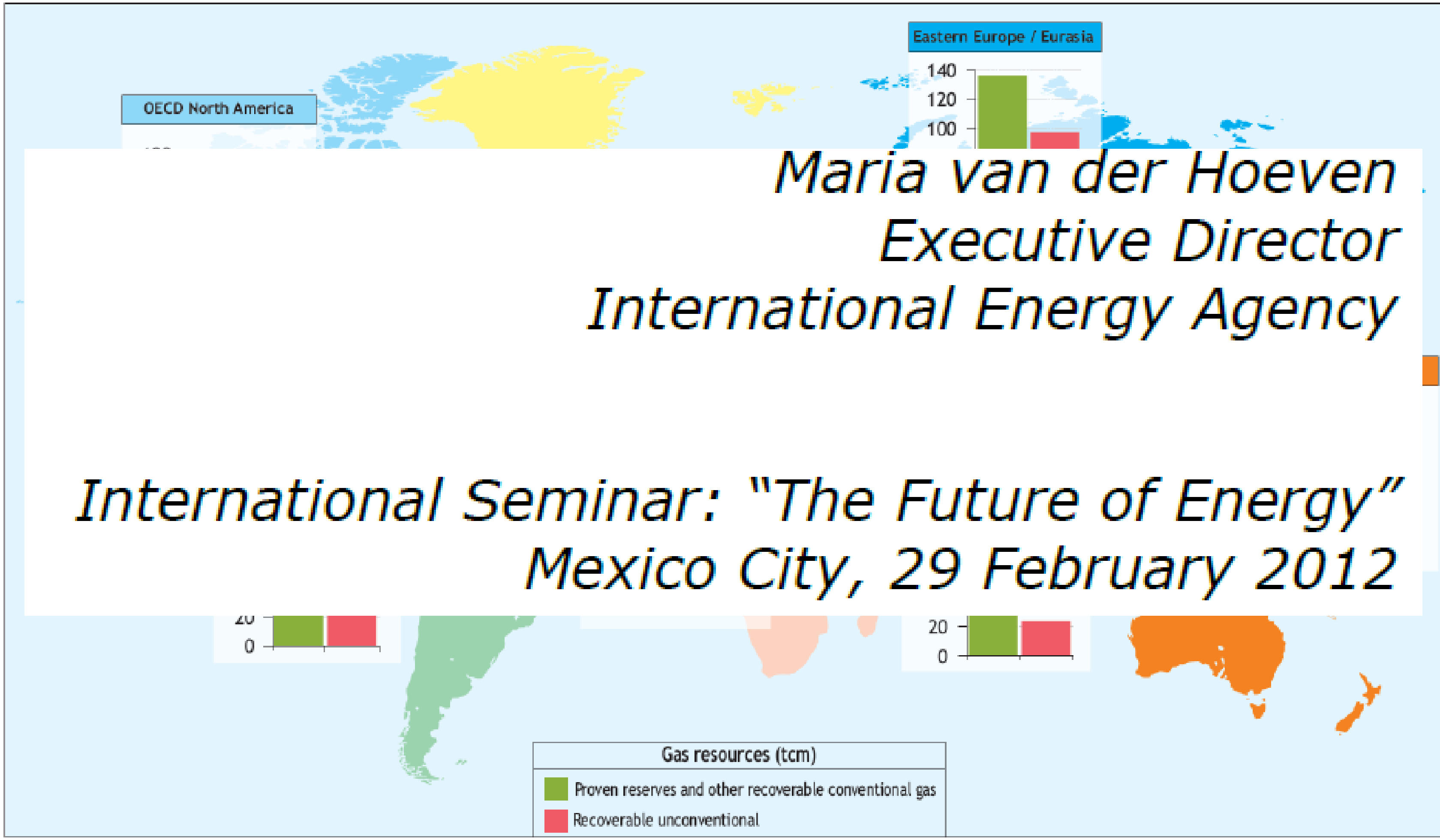
É o gás natural o que pode ser encontrado preso dentro de formações de XISTO, nome genérico de vários tipo de rochas de folhelo.



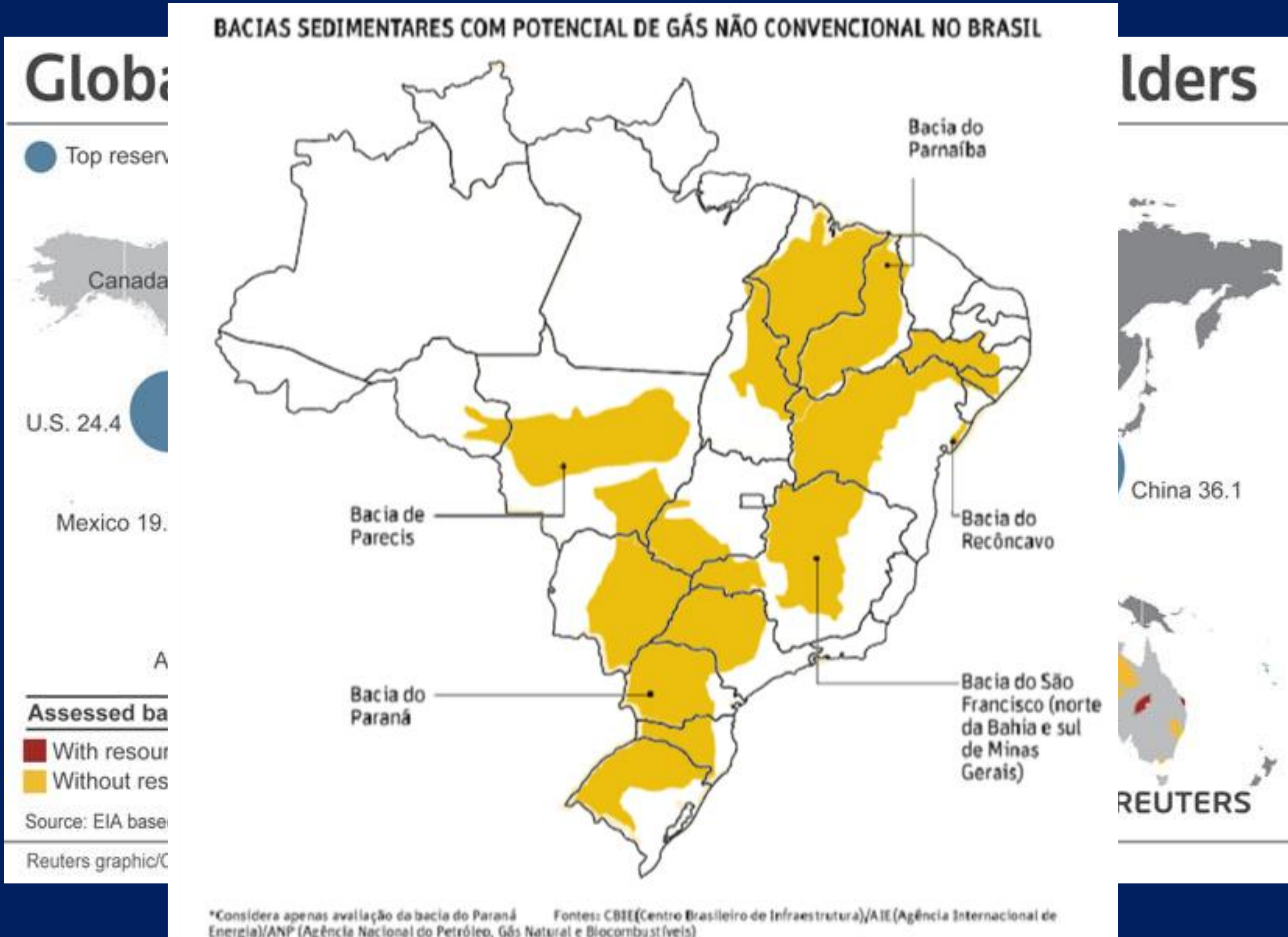
Are we entering a Golden Age of Gas ?

Maria van der Hoeven
Executive Director
International Energy Agency

International Seminar: "The Future of Energy"
Mexico City, 29 February 2012



Natural gas can enhance security of supply: global resources exceed 250 years of current production; while in each region, resources exceed 75 years of current consumption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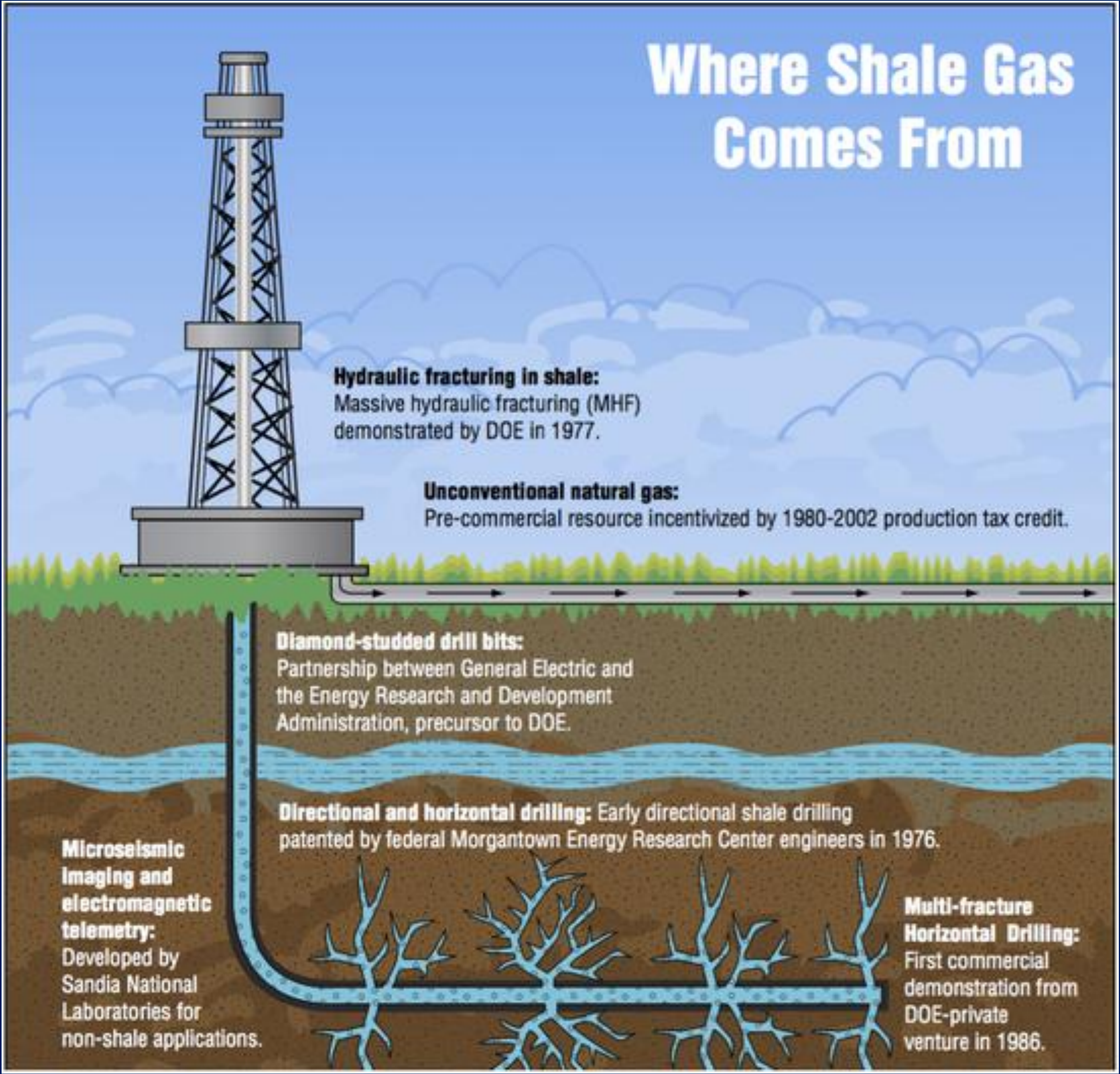
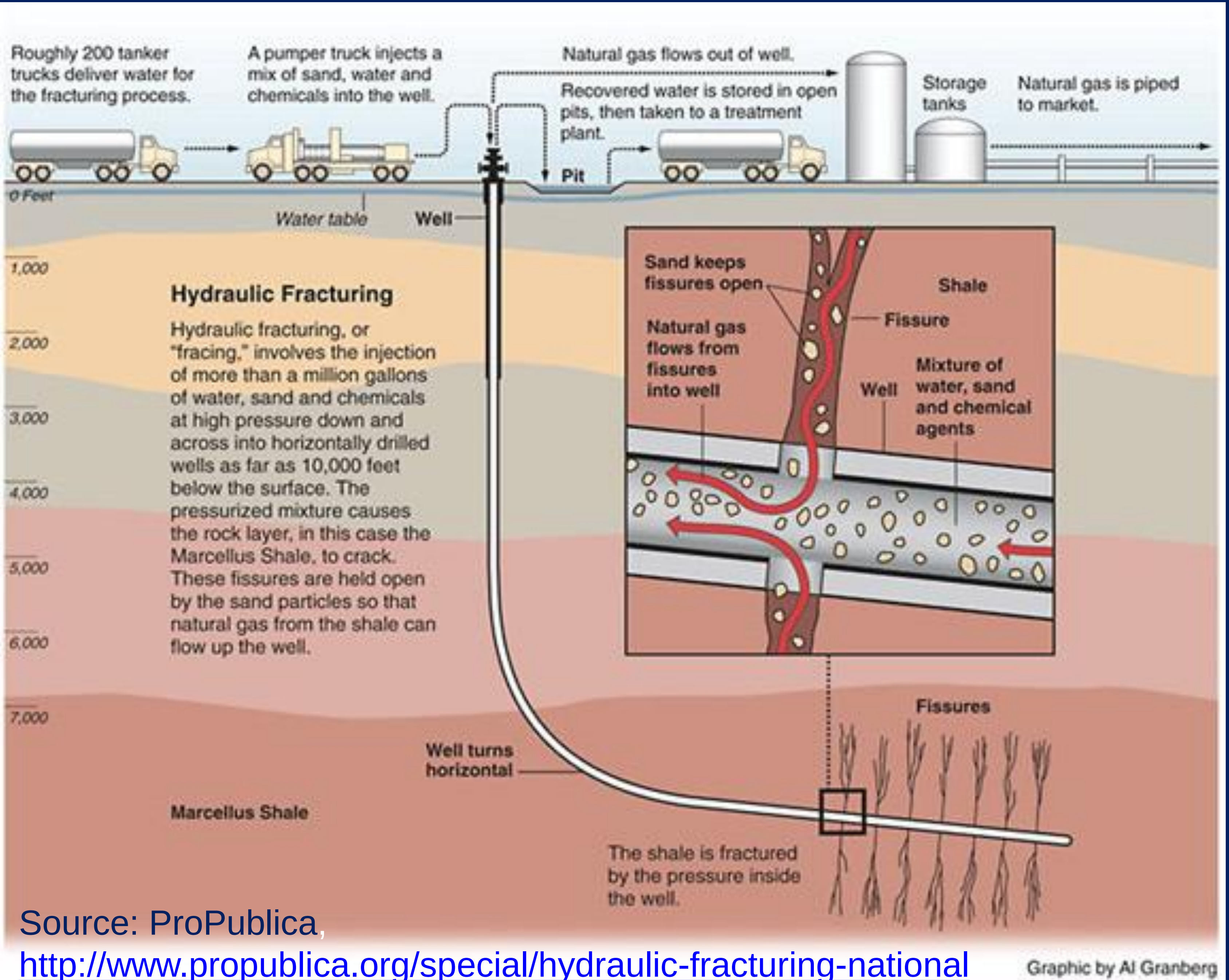
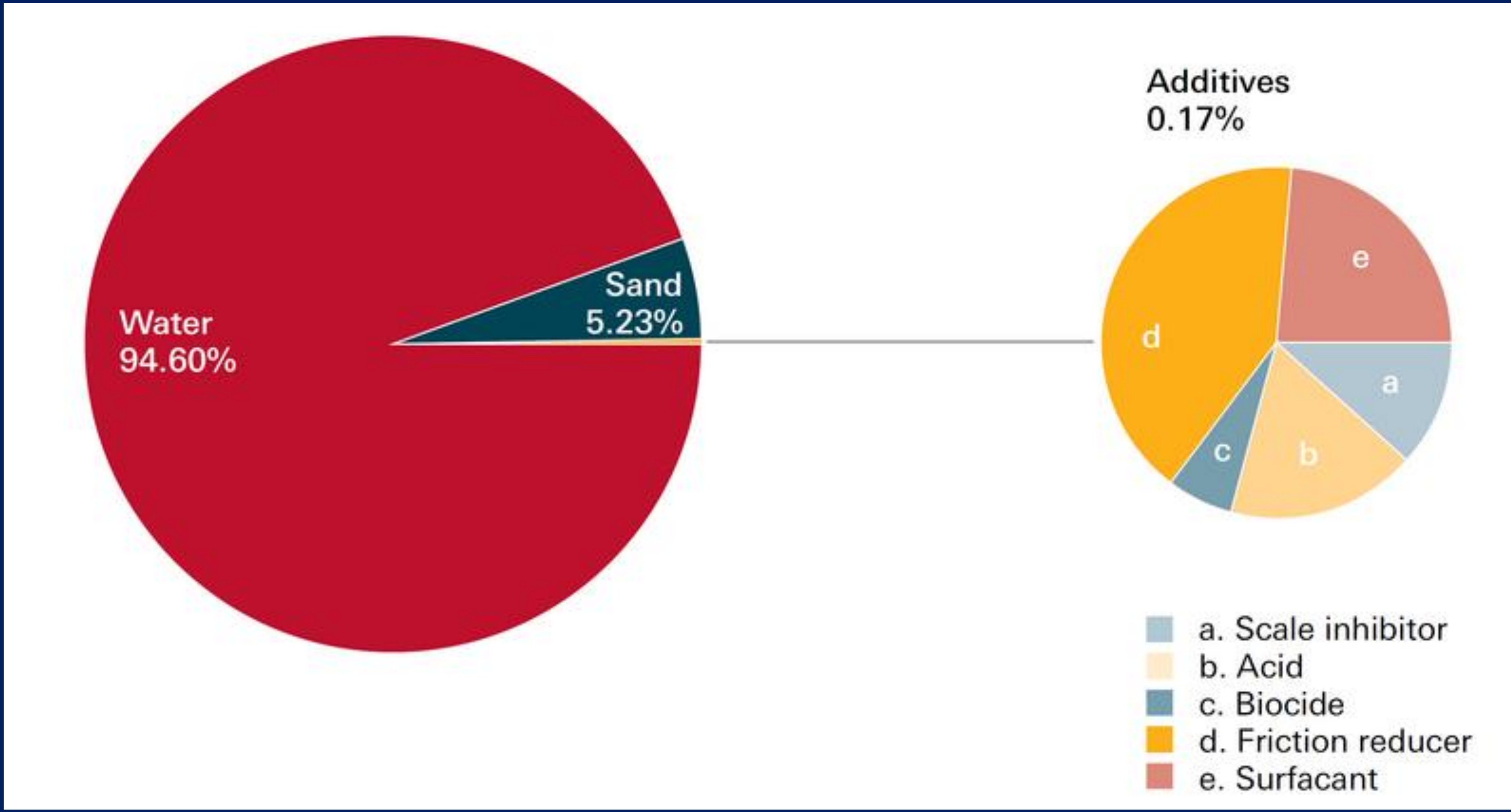
Source: EIA base
Reuters graphic/C
REUTERS
BACIAS SEDIMENTARES COM POTENCIAL DE GÁS NÃO CONVENCIONAL NO BRASIL
Bacia do Parnaíba
Bacia de Parecis
Bacia do Recôncavo
Bacia do Paraná
Bacia do São Francisco (norte da Bahia e sul de Minas Gerais)
*Considera apenas avaliação da bacia do Paraná
Fontes: CBIE(Centro Brasileiro de Infraestrutura)/AIE(Agência Internacional de Energia)/ANP (Agência Nacional do Petróleo, Gás Natural e Biocombustíveis)


Where Shale Gas Comes From
Hydraulic fracturing in shale:
Massive hydraulic fracturing (MHF) demonstrated by DOE in 1977.
Unconventional natural gas:
Pre-commercial resource incentivized by 1980-2002 production tax credit.
Diamond-studded drill bits:
Partnership between General Electric and the Energy Research and Development Administration, precursor to DOE.
Directional and horizontal drilling: Early directional shale drilling patented by federal Morgantown Energy Research Center engineers in 1976.
Microseismic imaging and electromagnetic telemetry:
Developed by Sandia National Laboratories for non-shale applications.
Multi-fracture Horizontal Drilling:
First commercial demonstration from DOE-private venture in 1986.



Source: ProPublica, http://www.propublica.org/special/hydraulic-fracturing-national



www.shale-gas-information-platform.org/categories/water-protection/the-basics/fracturing-fluids.html

Chemical additives: Types and volumes

The numbers and volume of additives used may differ from one shale play to another, depending on the properties and the depth of the target shale, among other things. Therefore, a large variety of fracturing fluid additives exists (Tab.1).

Tab. 1: An overview of common additive classes, their purpose and some examples.

Additive Class	Purpose	Examples
Biocide	Avoiding growth of bacteria and other fauna	Terpenes, isothiazolinones (e.g. 1,2-benzisothiazol-3-(2H)-one or 2-methyl-4-isothiazolin-3-one)
Buffer	pH control	Anorganic acids and bases (e.g. hydrofluoric acid, ammonium bisulfite)
Breaker	Reducing viscosity, enhanced fluid retrieval	Sulfates, peroxides (e.g. Ammonium persulfate, calcium peroxide)
Corrosion Inhibitor	Protect casing and equipment	Acids, alcohols, sulfites, (e.g. 2-butoxyethanol, amine bisulfite)
Crosslinker	Support gel formation, increase viscosity for proper downhole transportation of sand.	Borates, transition metals in combination with complexing agents (e.g. zirconiumoxide, -sulfate)
Friction Reducer	Creates laminar instead of turbulent flow	Polyacrylamide, petroleum distillates, e.g. aromatic hydrocarbons (benzene, toluene)
Gelling Agent	Support gel formation, increase viscosity for proper downhole transportation of sand, ideal proppant carriage	Guar gum, hydroxyethylcellulose, polymers (e.g. acrylamidcopolymers, vinylsulfonates)
Scale Inhibitor	Avoid precipitates from mineralic scalings that may build up at the inner wall of the casing or in the wellhead	Acids, phosphonates, (e.g. dodecylbenzene, sulfonic acid, calcium phosphonate)
Surfactant	Emulsification and salinity tolerance	Amines, glycol ethers, nonylphenol ethoxylates

http://www.shale-gas-information-platform.org/categories/water-protection/the-basics/fracturing-fluids.html

Impact of Shale Gas Development on Regional Water Quality

R. D. Vidic,[1*] S. L. Brantley,[2] J. M. Vandenbossche,[1] D. Yoxtheimer,[2] J. D. Abad[1]

READ THE FULL ARTICLE ONLINE
http://dx.doi.org/10.1126/science.1235009

Cite this article as R. Vidic *et al.*, *Science* 340, 1235009 (2013). DOI: 10.1126/science.1235009

Background: Natural gas has recently emerged as a relatively clean energy source that offers the opportunity for a number of regions around the world to reduce their reliance on energy imports. It can also serve as a transition fuel that will allow for the shift from coal to renewable energy resources while helping to reduce the emissions of CO_2, criteria pollutants, and mercury by the power sector. Horizontal drilling and hydraulic fracturing make the extraction of tightly bound natural gas from shale formations economically feasible. These technologies are not free from environmental risks, however, especially those related to regional water quality, such as gas migration, contaminant transport through induced and natural fractures, wastewater discharge, and accidental spills. The focus of this Review is on the current understanding of these environmental issues.

Advances: The most common problem with well construction is a faulty seal that is emplaced to prevent gas migration into shallow groundwater. The incidence rate of seal problems in unconventional gas wells is relatively low (1 to 3%), but there is a substantial controversy whether the methane detected in private groundwater wells in the area where drilling for unconventional gas is ongoing

ARTICLE OUTLINE

BACKGROUND READING

Groundwater

Vol. 51, No. 4–Groundwater–July-August 2013 (pages 488–510)

Issue Paper/

Groundwater Protection and Unconventional Gas Extraction: The Critical Need for Field-Based Hydrogeological Research

by R.E. Jackson[1], A.W. Gorody[2], B. Mayer[3], J.W. Roy[4], M.C. Ryan[3], and D.R. Van Stempvoort[4]

Abstract

Unconventional natural gas extraction from tight sandstones, shales, and some coal-beds is typically accomplished by horizontal drilling and hydraulic fracturing that is necessary for economic development of these new hydrocarbon resources. Concerns have been raised regarding the potential for contamination of shallow groundwater by stray gases, formation waters, and fracturing chemicals associated with unconventional gas exploration. A lack of sound scientific hydrogeological field observations and a scarcity of published peer-reviewed articles on the effects of both conventional and unconventional oil and gas activities on shallow groundwater make it difficult to address these issues. Here, we discuss several case studies related to both conventional and unconventional oil and gas activities illustrating how under some circumstances stray or fugitive gas from deep gas-rich formations has migrated from the subsurface into shallow aquifers and how it has affected groundwater quality. Examples include impacts of uncemented well annuli in areas of historic drilling operations, effects related to poor cement bonding in both new and old hydrocarbon wells, and ineffective cementing practices. We also summarize studies describing how structural features influence the role of natural and induced fractures as contaminant fluid migration pathways. On the basis of these studies, we identify two areas where field-focused research is urgently needed to fill current science gaps related to unconventional gas extraction: (1) baseline geochemical mapping (with time series sampling from a sufficient network of groundwater monitoring wells) and (2) field testing of potential mechanisms and pathways by which hydrocarbon gases, reservoir fluids, and fracturing chemicals might potentially invade and contaminate useable groundwater.

Environmental Science & Technology

Article

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Source Signature of Volatile Organic Compounds from Oil and Natural Gas Operations in Northeastern Colorado

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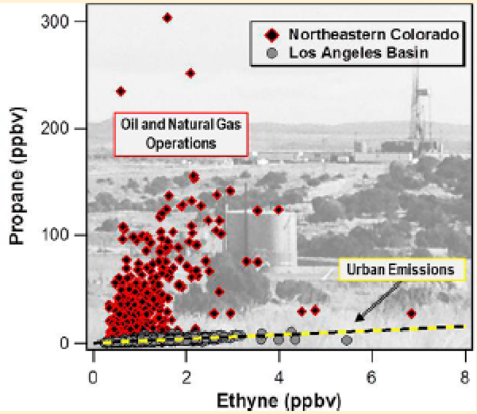
Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, Colorado, United States

NOAA Earth System Research Laboratory, Chemical Sciences Division, Boulder, Colorado, United States

Supporting Information

ABSTRACT: An extensive set of volatile organic compounds (VOCs) was measured at the Boulder Atmospheric Observatory (BAO) in winter 2011 in order to investigate the composition and influence of VOC emissions from oil and natural gas (O&NG) operations in northeastern Colorado. BAO is 30 km north of Denver and is in the southwestern section of Wattenberg Field, one of Colorado's most productive O&NG fields. We compare VOC concentrations at BAO to those of other U.S. cities and summertime measurements at two additional sites in northeastern Colorado, as well as the composition of raw natural gas from Wattenberg Field. These comparisons show that (i) the VOC source signature associated with O&NG operations can be clearly differentiated from urban sources dominated by vehicular exhaust, and (ii) VOCs emitted from O&NG operations are evident at all three measurement sites in northeastern Colorado. At BAO, the reactivity of VOCs with the hydroxyl radical (OH) was dominated by C_2-C_6 alkanes due to their remarkably large abundances (e.g., mean propane = 27.2 ppbv). Through statistical regression analysis, we estimate that on average 55 ± 18% of the VOC−OH reactivity was attributable to emissions from O&NG operations indicating that these emissions are a significant source of ozone precursors.



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An Evaluation of Water Quality in Private Drinking Water Wells Near Natural Gas Extraction Sites in the Barnett Shale Formation

Brian E. Fontenot,[†,⊥,∥] Laura R. Hunt,[†,⊥,∥] Zacariah L. Hildenbrand,[†,⊥] Doug D. Carlton Jr.,[†,⊥] Hyppolite Oka,[†] Jayme L. Walton,[†] Dan Hopkins,[‡] Alexandra Osorio,[§] Bryan Bjorndal,[§] Qinhong H. Hu,[†] and Kevin A. Schug*,[†]

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[§]Assure Controls Inc., Vista, California 92081, United States

Supporting Information

Table 1. Concentrations of Constituents in Barnett Shale Private Water Well Samples[a]

	historical data (1989−99)				active extraction area wells (N = 91)				nonactive and reference area wells (N = 9)			
	N	range	mean ± std error	% ≥ MCL	N	range	mean ± std error	% ≥ MCL	N	range	mean ± std error	% ≥ MCL
TDS	344	129−3302	670.3 ± 21.5	61	91	200−1900	585.1 ± 35.1*	54.9	9	400−600	500 ± 31.6	77.8
arsenic	241	1−10	2.8 ± 0.1	0	90	2.2−161.2	12.6 ± 2.2*	32.2	9	4.7−9.0	6.9 ± 0.7*	0
selenium	329	0.1−50	3.9 ± 0.2	0.3	10	10−108.7	33.3 ± 10.5*	20				
strontium	99	20−16700	1028.9 ± 213.7	N/A[b]	90	66.2−18195	2319.8 ± 330.1*	N/A	9	52.4−7646.2	1610 ± 787.1	N/A
barium	357	0.1−382	57.2 ± 2.9	0	90	1.8−173.7	32.3 ± 3.3*	0	9	2.9−60	22.4 ± 11.3*	0
methanol				N/A	24	1.3−329	33.6 ± 13.3	N/A	5	1.2−62.9	27.4 ± 13.7	N/A
ethanol				N/A	8	1−10.6	4.5 ± 1.2	N/A	4	2.3−11.3	6.8 ± 2.4	N/A

[a]All values are measured in μg/L except total dissolved solids (TDS), methanol, and ethanol in mg/L. Values denoted by asterisks represent statistically significant differences from historical data values (Mann-Whitney U pair wise analysis; $p < 0.05$). Historical data for the counties sampled in this study were obtained online at www.TWDB.state.TX.us/groundwater/. Maximum Contaminant Limits (MCL) obtained from the Environmental Protection Agency's (EPA) National Primary Drinking Water Regulations, 2009. TDS MCL = 500 mg/L, arsenic MCL = 10 μg/L, selenium MCL = 50 μg/L, barium MCL = 2000 μg/L, N/A indicates no MCL has been established. [b]EPA recommends stable strontium values in drinking water do not exceed 4000 μg/L.

accidents such as faulty gas well casings.

Increased st… of drinking water wells … action

Robert B. Jackson[a,b,1], Avn… …vn[a,b], Robert J. Poreda[c],
Stephen G. Osborn[d], Kaigu…

[a]Division of Earth and Ocean Scien… , Durham, NC 27708; [c]Department of Earth and Environmental Scien… …, California State Polytechnic University, Pomona, CA 91768

Edited by Susan E. Trumbore, Max… …ed for review December 17, 2012)

Horizontal drilling and hydraul… production, but their potential … versial. We analyzed 141 drinki… Plateaus physiographic provin… amining natural gas concentr… proximity to shale gas wells. … drinking water samples, wit… higher for homes <1 km from … ane was 23 times higher in … 0.0013); propane was detecte… proximately 1 km distance (P … proposed to influence gas con… (distances to gas wells, valley … tural Front, a proxy for tectoni… was highly significant for met… tiple regression), whereas di…

…consistent with a natural gas …ng <1 km from shale gas wells …ive dataset for natural gas in … Pennsylvania, comparing the …ethane, biogenically derived …tural seeps. We present com- …as wells and ethane and pro- …ons that are not derived from …nly with thermogenic sources. …ta [e.g., $\delta^{13}C\text{-}CH_4$, $\delta^{2}H\text{-}CH_4$, …ic carbon ($\delta^{13}C$-DIC), and …e/CH_4) to distinguish among …ved (14–16).
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ENVIRONMENTAL SCIENCES

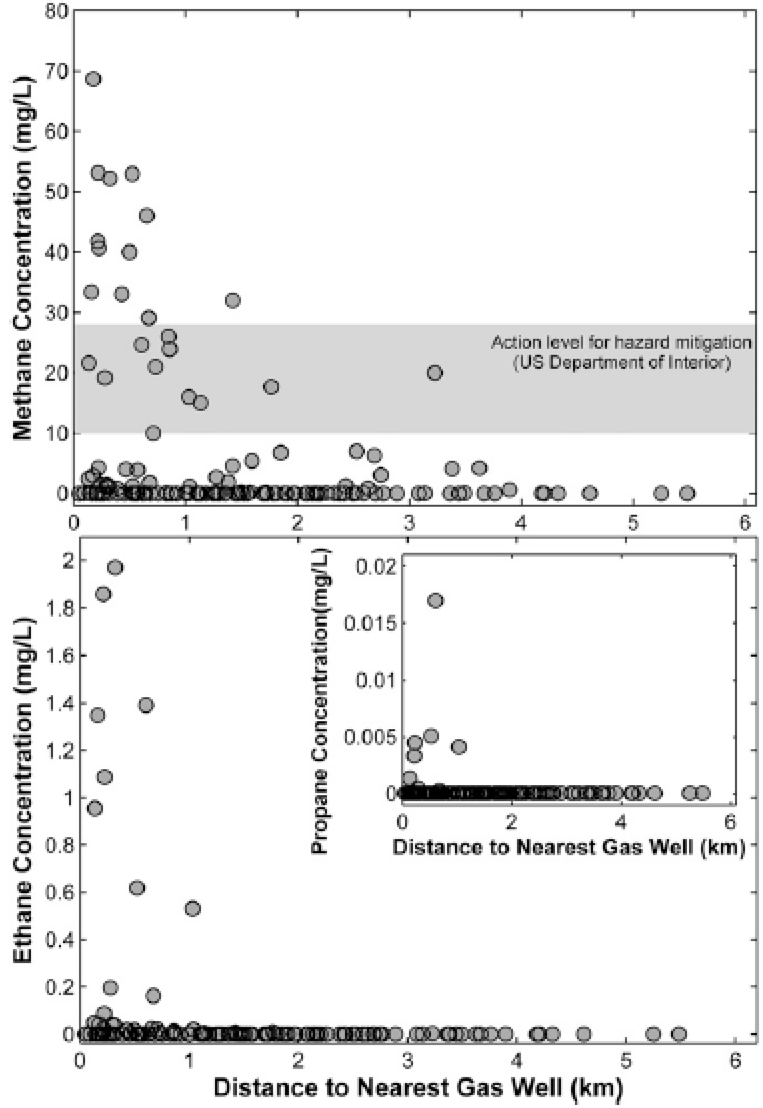

Fig. 1. Concentrations of (*Upper*) methane, (*Lower*) ethane, and (*Lower Inset*) propane (milligrams liter^{-1}) in drinking water wells vs. distance to natural gas wells (kilometers). The locations of natural gas wells were obtained from the Pennsylvania DEP and Pennsylvania Spatial Data Access databases (54). The gray band in *Upper* is the range for considering hazard mitigation recommended by the US Department of the Interior (10–28 mg CH_4/L); the department recommends immediate remediation for any value >28 mg CH_4/L.

www.… 110

Shale-Gas Plans Threaten China's Water Resources

THE IMPACT OF SHALE-GAS DEVELOPMENT ON American water quality has received wide attention ("Impact of shale gas development on regional water quality," R. D. Vidic *et al.*, Review, 17 May, p. 826), but potential impacts of China's accelerating shale-gas exploration on the nation's water crisis have been largely ignored.

China has the world's largest shale-gas reserves, at 36 trillion m^3 (*1*). The country has an ambitious plan to produce 6.5 billion m^3 of shale gas by 2015 (*2*). Thirteen provinces have been selected as priority areas. However, seven of these provinces are already plagued by water shortages, with less than 2000 m^3 available per person, less than one-quarter of the world average. Four of the thirteen provinces are in Southwest China, and two of those have recently experienced severe half-year droughts (*3*). Shale-gas extraction will compete for limited water resources with agricultural, industrial, and domestic sectors. Hydraulic fracturing (fracking), the most widely used extraction method in China, consumes large volumes of water mixed with a range of additives. Due to complex geological conditions, Chinese shale-gas wells each consume 10,000 to 24,000 m^3 of water (*4*, *5*). The target gas production of 1.5 billion m^3 in Sichuan will require 171 million m^3 of water, equal to 10.5% of the province's domestic water demand (*6*).

Some 10 to 90% of fracking fluids are returned to the surface (*7*). Inadequate treatment introduces heavy metals, acids, pesticides, and other hazardous materials to soil and aquatic environments (*8*). This will exacerbate China's polluted water environment (*9*, *10*).

Exploitation of China's shale-gas reserves offers opportunities to satisfy the nation's growing energy demands and reduce carbon emissions, but careful management and legislation will be required to avoid shortages and pollution of already stretched water resources.

HONG YANG,[1*] ROGER J. FLOWER,[2]
JULIAN R. THOMPSON[2]

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China has the world's largest shale-gas

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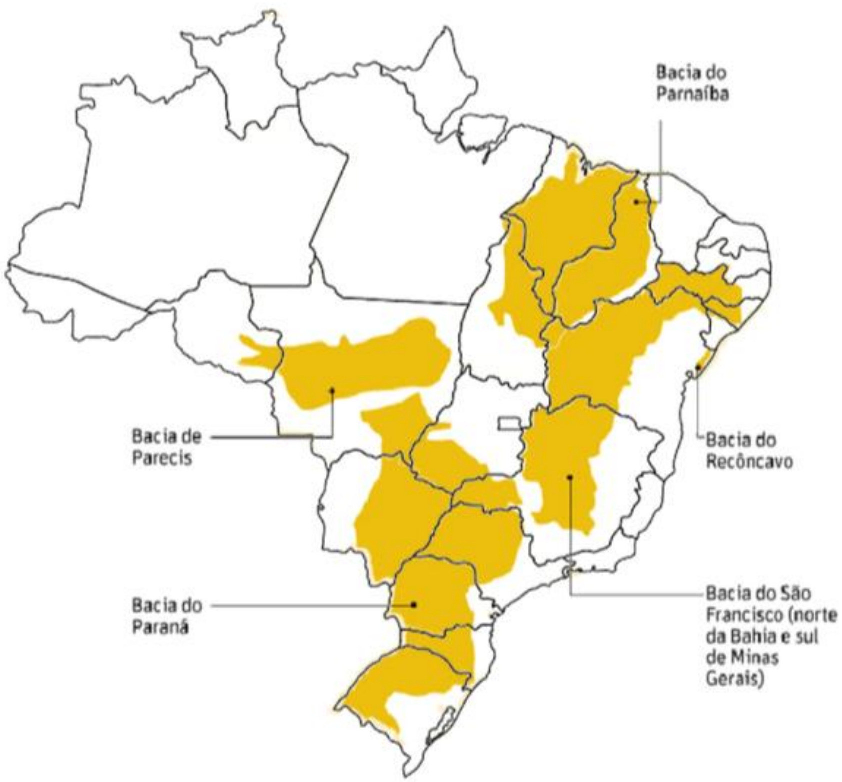
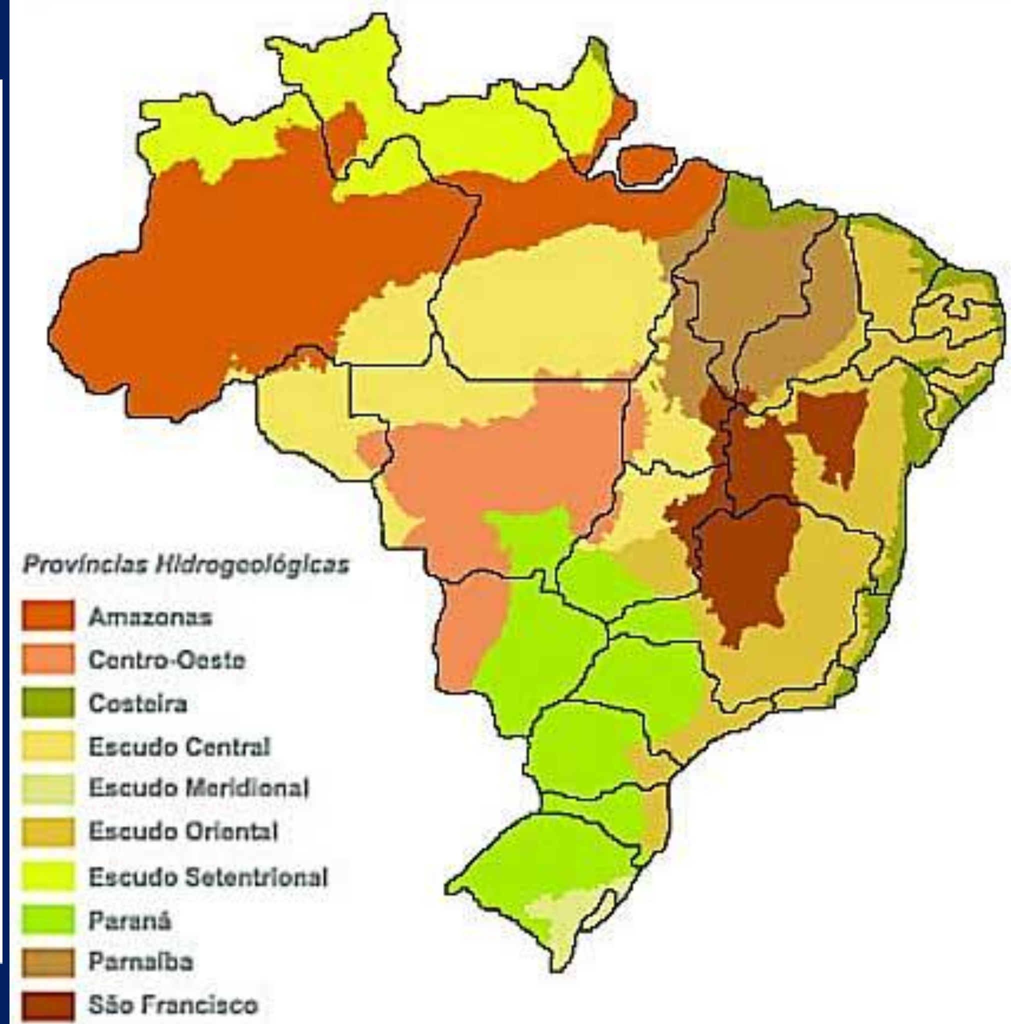
JULIAN R. THOMPSON[2]

BACIAS SEDIMENTARES COM POTENCIAL DE GÁS NÃO CONVENCIONAL NO BRASIL



*Considera apenas avaliação da bacia do Paraná Fontes: CBIE (Centro Brasileiro de Infraestrutura)/AIE (Agência Internacional de Energia)/ANP (Agência Nacional do Petróleo, Gás Natural e Biocombustíveis)



REPRESENTAÇÃO ESQUEMÁTICA DAS PROVÍNCIAS HIDROGEOLÓGICAS DO BRASIL

FONTE: Adaptado de DNPM/CPRM, 1983, citado em MMA, 2003

SBPC e ABC enviam carta à presidente Dilma Rousseff solicitando a suspensão da licitação para a exploração do gás de xisto

A Sociedade Brasileira para o Progresso da Ciência (SBPC) e a Academia Brasileira de Ciências (ABC) enviaram, hoje, carta à presidente da República, Dilma Rousseff, manifestando a sua preocupação com o anúncio da Agência Nacional do Petróleo (ANP) da decisão de incluir o chamado "Gás de Xisto", obtido por fraturamento da rocha *(shale gas fracking)*, na próxima licitação, em novembro, de campos de gás natural em bacias sedimentares brasileiras.

No documento, a presidente da SBPC, Helena Nader, e o presidente da ABC, Jacob Palis, justificam sua preocupação pelo fato de que a exploração econômica do gás de xisto vir sendo muito questionada pelos riscos e danos ambientais envolvidos. Por isso, eles solicitam que a presidente suste a licitação de áreas para explotação de gás de xisto, na 12ª Rodada prevista para novembro próximo, por um período suficiente para aprofundar os estudos, realizados por universidades e institutos de pesquisa públicos, sobre a real potencialidade da utilização do método da fratura hidráulica para a retirada do produto das rochas e os possíveis prejuízos ambientais causados por isso.

Também foi enviada cópia da carta para os presidentes da Câmara e do Senado, a ANP, o Centro Nacional de Pesquisa em Energia e Materiais (CNPEM), o Ministério de Minas e Energia (MME), o Ministério da Ciência, Tecnologia e Inovação (MCTI), o Ministério do Meio Ambiente, o CTPetro, a Financiadora de Estudos e Projetos (Finep), o Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) e as Sociedades Associadas à SBPC.

Leia abaixo, a íntegra da carta:

São Paulo, 5 de agosto de 2013

SBPC-081/Dir.

65ª Reunião Anual da SBPC

Agenda

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