HAS OIL AND GAS COLLAPSE SEALED FATE OF PEAK OIL?

Society of Petroleum Engineers, Gulf Coast Chapter
Houston Racquet Club

by
Matthew R. Simmons, Chairman
Simmons & Company International
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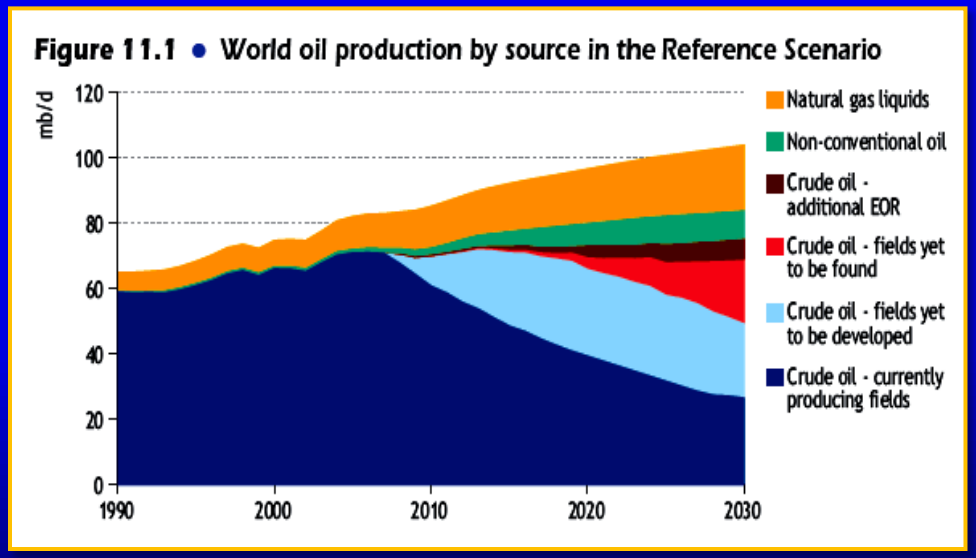
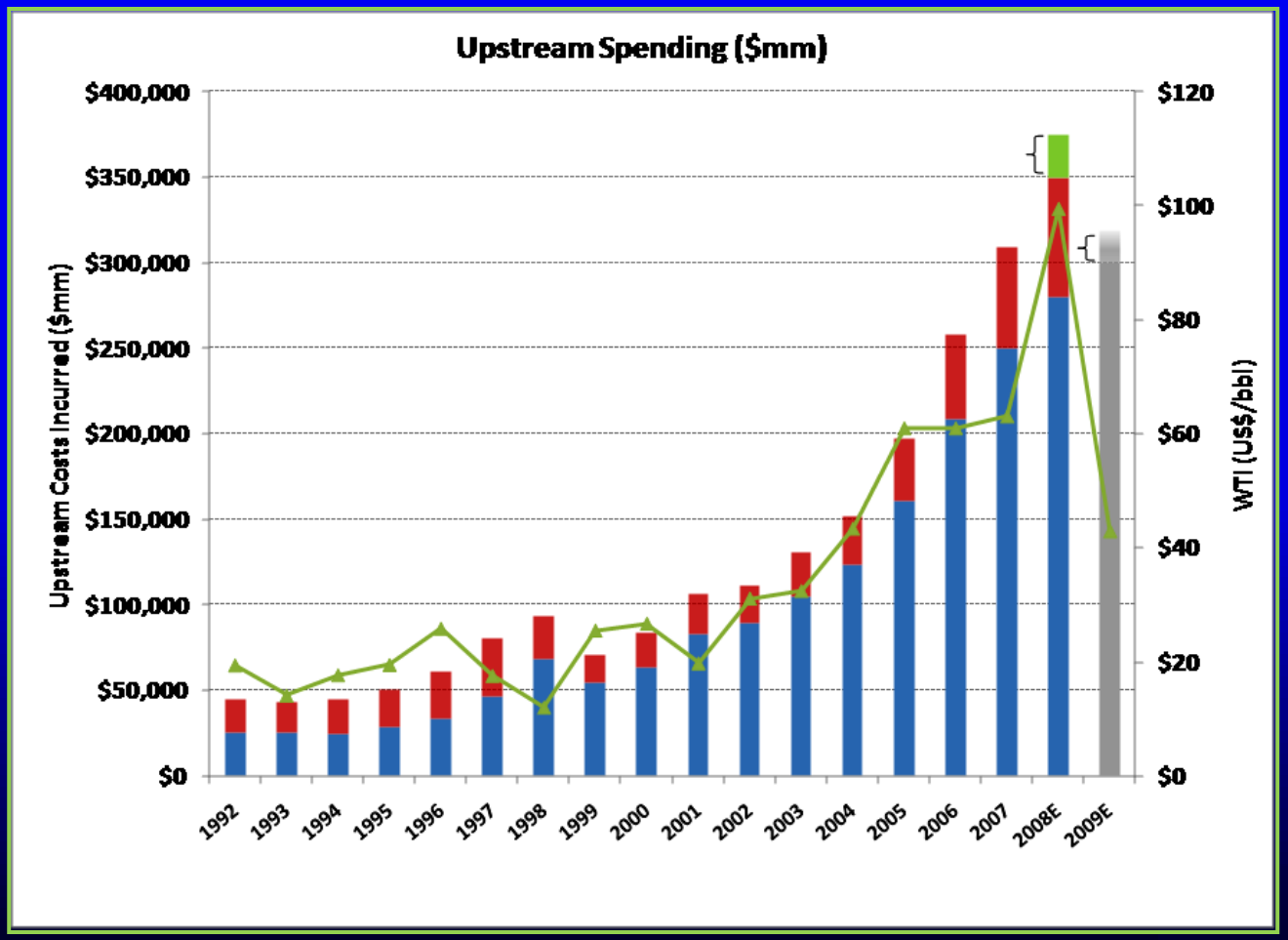
Crude Supply Struggled To Grow With High Oil Prices

- 2005 – 2008 crude oil supply struggled to stay in 72 – 74 MMB/D range.
- Flatness occurred despite soaring prices and record spending.
- Flatness continued despite using last spare drilling rigs.



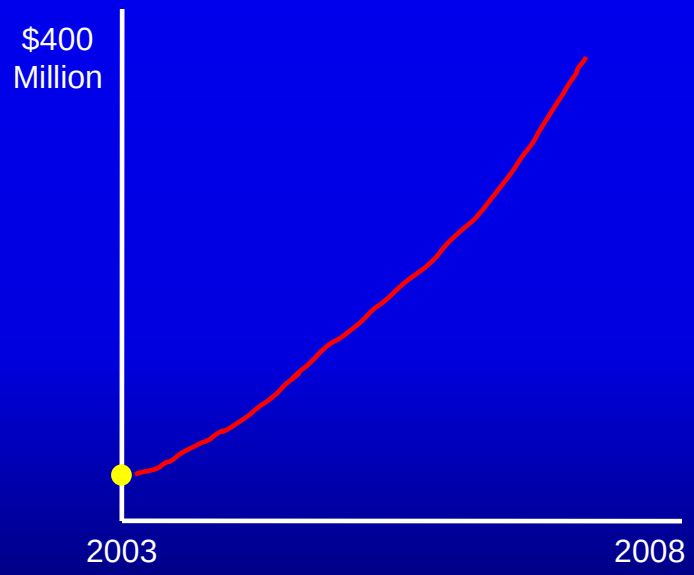
Upstream Spending



Average Spending	
1992 - 1999 =	$60 Billion
2000 - 2004 =	$115 Billion
2005 - 2008 =	$285 Billion

Staggering Contrast Between Spending And Production Growth

Global E&P Spending



Global Crude Oil Production*

	'000 Bbls/Day
2003	69,434
2004	72,493
2005	73,737
2006	73,461
2007	73,006
2008	73,791

*Source: March 2009 EIA Monthly Energy Report

$1.5 trillion spent to keep supply flat.

2008 Crude Output Estimates Might Be Too High

- Bounce in EIA's global crude model assumes Persian Gulf OPEC production ramped up oil in 2Q/3Q 2008.

	2007	1Q-2008	2Q-2008	3Q-2008	4Q-2008	Peak 2nd/3rd Q 2008 Vs. 2007
			-----'000 Bbls/Day -----			
Saudi Arabia	8,722	9,200	9,320	9,570	9,000	+848
Rest of Persian Gulf	11,950	12,490	12,943	12,844	12,371	+993
						+1,841

If some of this jump was "rhetoric", then 2008 production was overstated.

SOURCE: EIA International Petroleum Monthly. April 2009

Why Didn't Increases Show Up In IEA Imports

- Table 6 of IEA Oil Monthly Report details real imports into all IEA member countries.
- Reported IEA member country imports capture increased output.
- World has no idea whether such increases were real or simply "jaw-boning" to dampen high oil prices.

Imports Into IEA Countries
Latest Saudi Arabian Data Through January 2009

2007	1Q-2008	2Q-2008	3Q-2008	4Q-2008	Jan-09
		-----'000 BBL/Day -----			
3.98	4.09	4.05	4.25	4.01	3.75

OPEC's 1st Announced Production Cuts Might Not Be Real

- To extent "production increases" were boasts, September 2008 announced cuts might not have been real either.
- December 2008 OPEC cuts seem real.
- Big question: Has OPEC now cut too deep? How fast can supply crank back up?

Many Key Oil Producing Countries Are Now In Decline

- The key driver to why global crude supply growth waned: Rising decline rates of mature production base.

	2005	2008	▲
		---- 000 B/D ----	
Argentina	704	661	(42)
Denmark	377	287	(91)
Ecuador	532	505	(27)
Egypt	658	603	(56)
Equatorial Guinea	363	337	(26)
Gabon	266	248	(18)
Indonesia	1,067	974	(93)
Iran	4,139	4,025	(113)
Malaysia	631	609	(22)
Mexico	3,334	2,792	(542)
Nigeria	2,627	2,165	(462)
Norway	2,698	2,182	(516)
Oman	774	757	(17)
Saudi Arabia	9,550	9,261	(289)
Syria	432	390	(42)
United Kingdom	1,649	1,390	(258)
United States	5,178	4,955	(223)
Venezuela	2,565	2,394	(171)
Vietnam	375	276	(99)
Yemen	400	298	(102)
“Other Countries”	2,599	2,512	(87)

These declines are hard to offset by new oil fields.

Source: EIA International Petroleum Monthly, April 2009

2005 – 2008 Crude Oil Change

- Largest crude increases offset by 8 largest declines:

Best Performers:	MMB/D
Angola	+590
Azerbaijan	+437
Russia	+314
Canada	+181
Sudan	+171
UAE	+146
30 "Other Countries"	+313
	+2,152

Biggest Declines:	MMB/D
Mexico	(542)
Norway	(516)
Nigeria	(462)
United Kingdom	(259)
USA	(223)
Venezuela	(166)
Iran	(114)
Yemen	(102)
	(2,384)

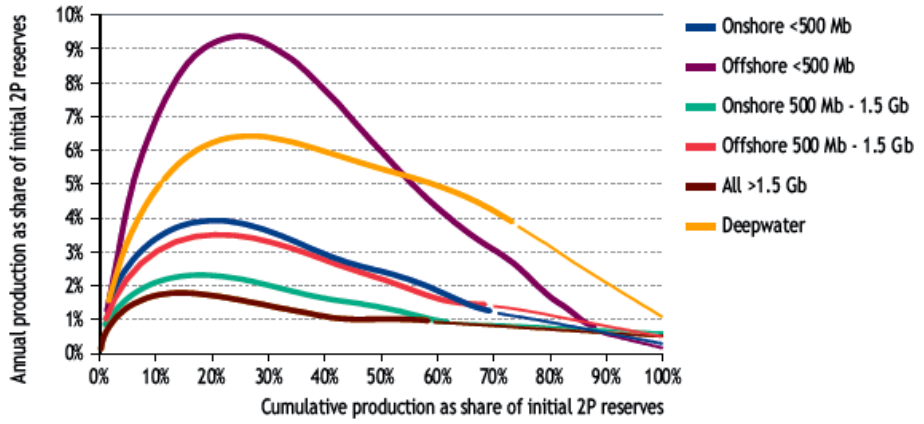
19 smaller producers: 5 grew; 14 declined.

Source: EIA International Petroleum Statistics – April 2009

Why Many Countries' Oil Output Now In Decline

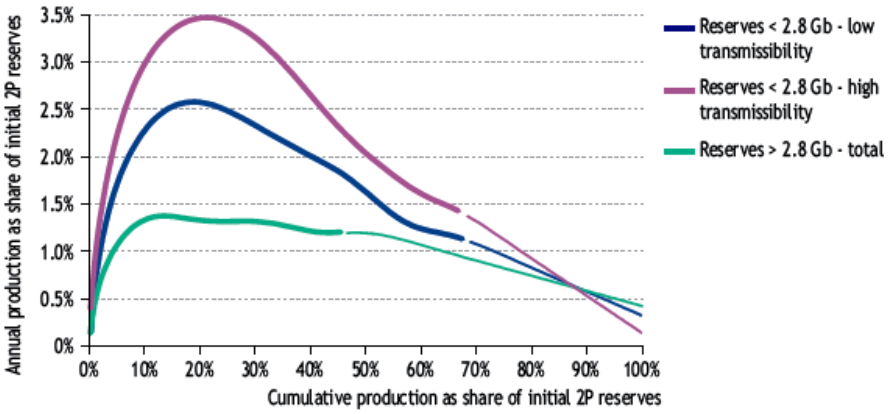
- Too many key oil fields in steep decline.
- New oil fields generally smaller.
- Stable oilfields largely depleted.

Figure 10.3 • Standard oilfield-production profiles by category of field



Source: IEA World Energy Outlook 2008

Figure 10.4 • Standard oilfield-production profiles of giant fields

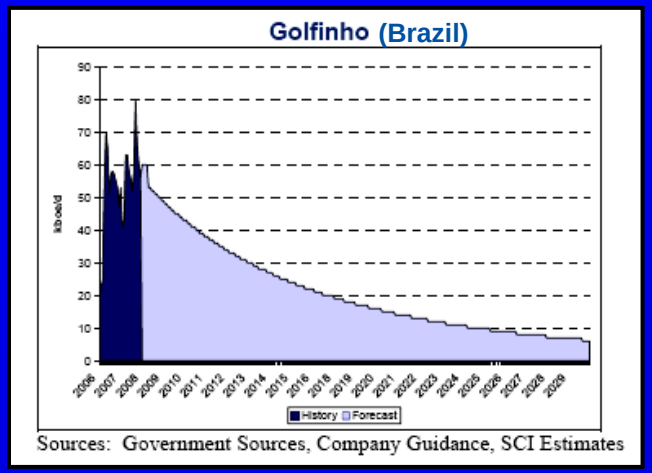


Source: IEA World Energy Outlook 2008

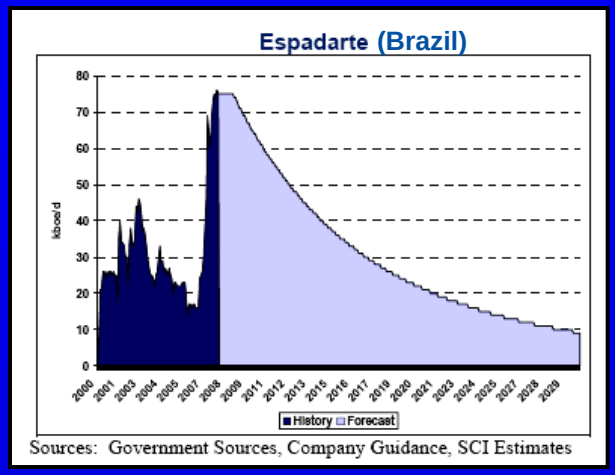
Profiles of key oil fields' declines and projected future declines are enlightening.

Sample Of Key Oil Field Production Profiles

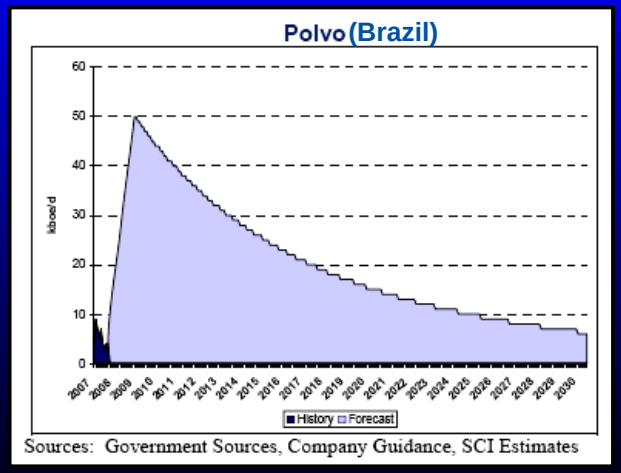
Sources: Government Sources, Company Guidance, SCI Estimates



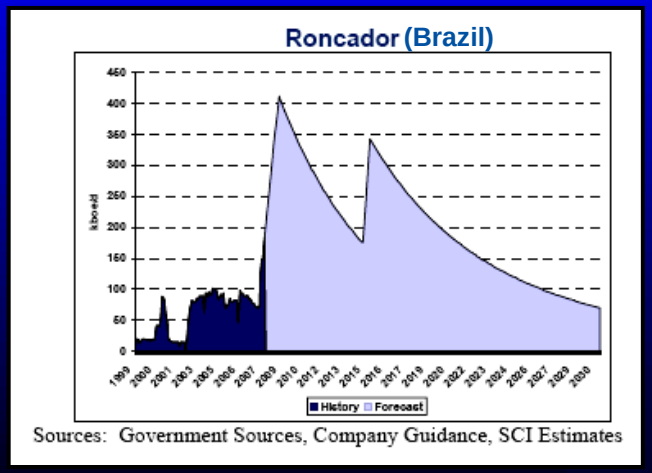
Sources: Government Sources, Company Guidance, SCI Estimates



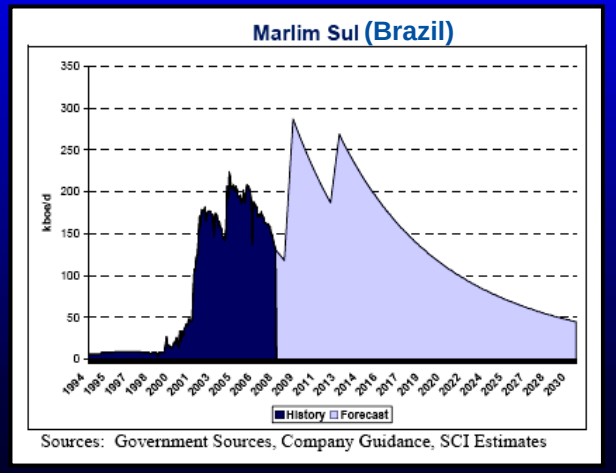
Sources: Government Sources, Company Guidance, SCI Estimates



Sources: Government Sources, Company Guidance, SCI Estimates



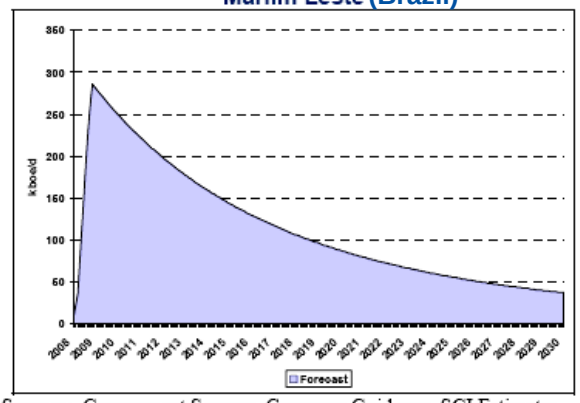
Sources: Government Sources, Company Guidance, SCI Estimates



Sources: Government Sources, Company Guidance, SCI Estimates

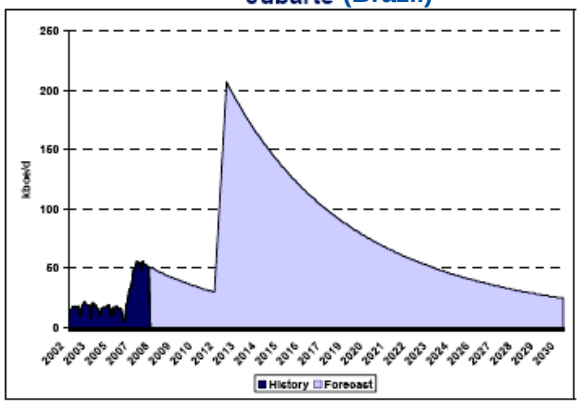
Sample Of Key Oil Field Production Profiles Part II

Marlim Leste (Brazil)



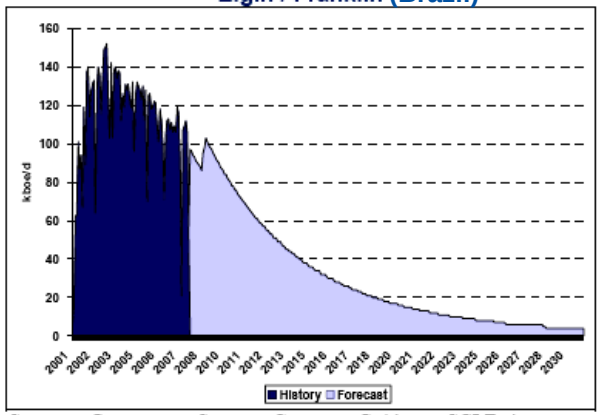
Sources: Government Sources, Company Guidance, SCI Estimates

Jubarte (Brazil)



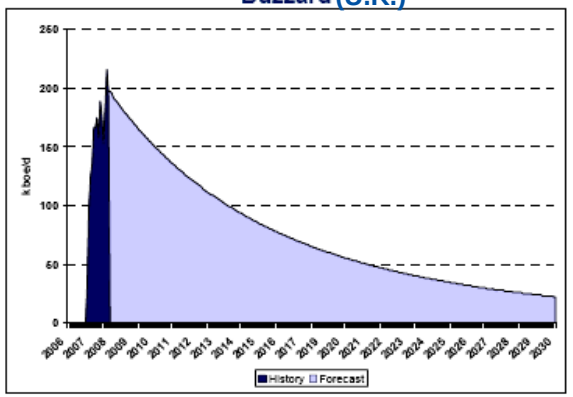
Sources: Government Sources, Company Guidance, SCI Estimates

Elgin / Franklin (Brazil)



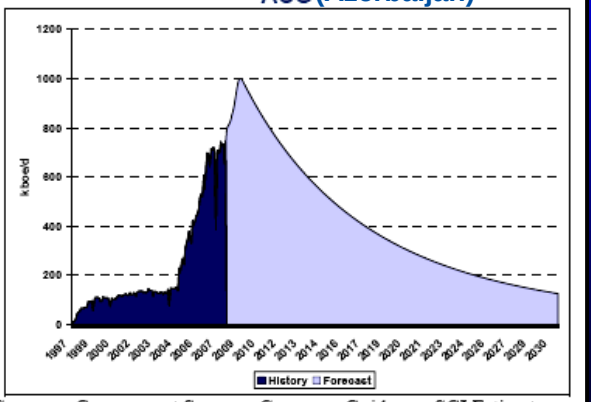
Sources: Government Sources, Company Guidance, SCI Estimates

Buzzard (U.K.)



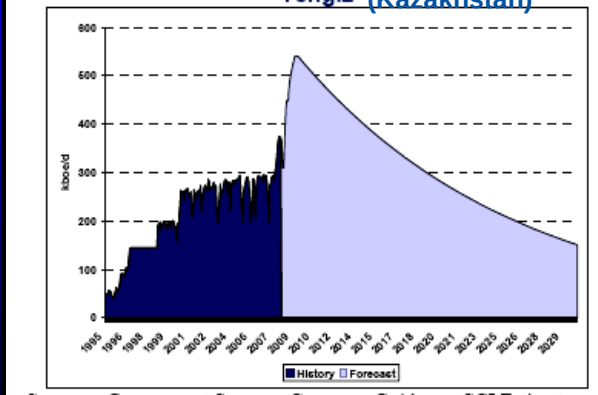
Sources: Government Sources, Company Guidance, SCI Estimates

ACG (Azerbaijan)



Sources: Government Sources, Company Guidance, SCI Estimates

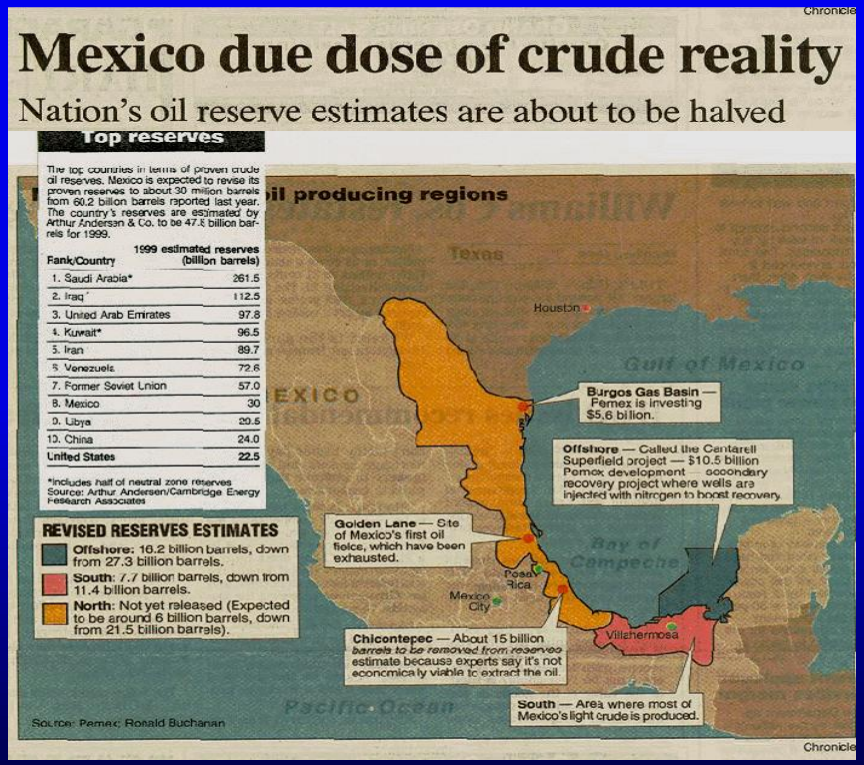
Tengiz (Kazakhstan)



Sources: Government Sources, Company Guidance, SCI Estimates

Gulf Of Mexico's Oil Is Classic Mature Case Study

- Shallow GOM oil production peaked in 1970/71.
- Then came deeper water oil development.
- Today, GOM produces 1.4 MMB/D (still 26% of USA's total supply).
- Handful of deepwater fields create half this output.
- All have rapid decline rates.



Chronicle

Mexico due dose of crude reality

Nation's oil reserve estimates are about to be halved

Top reserves

The top countries in terms of proven crude oil reserves. Mexico is expected to revise its proven reserves to about 30 billion barrels from 60.2 billion barrels reported last year. The country's reserves are estimated by Arthur Andersen & Co. to be 47.8 billion barrels for 1999.

Rank/Country	1999 estimated reserves (billion barrels)
1. Saudi Arabia*	261.5
2. Iraq	112.5
3. United Arab Emirates	97.8
4. Kuwait*	96.5
5. Iran	89.7
6. Venezuela	72.6
7. Former Soviet Union	57.0
8. Mexico	30
9. Libya	29.5
10. China	24.0
United States	22.5

*Includes half of neutral zone reserves
Source: Arthur Andersen/Cambridge Energy Research Associates

REVISED RESERVES ESTIMATES

- **Offshore:** 16.2 billion barrels, down from 27.3 billion barrels.
- **South:** 7.7 billion barrels, down from 11.4 billion barrels.
- **North:** Not yet released (Expected to be around 6 billion barrels, down from 21.5 billion barrels).

il producing regions

Texas
Houston
Gulf of Mexico
EXICO
Bay of Campeche
Mexico City
Villahermosa
Pacific Ocean

Burgos Gas Basin — Pemex is investing $5.6 billion.

Offshore — Called the Cantarell Superfield project — $10.5 billion Pemex development — secondary recovery project where wells are injected with nitrogen to boost recovery.

Golden Lane — Site of Mexico's first oil fields, which have been exhausted.

Chicontepec — About 15 billion barrels to be removed from reserves estimate because experts say it's not economically viable to extract the oil.

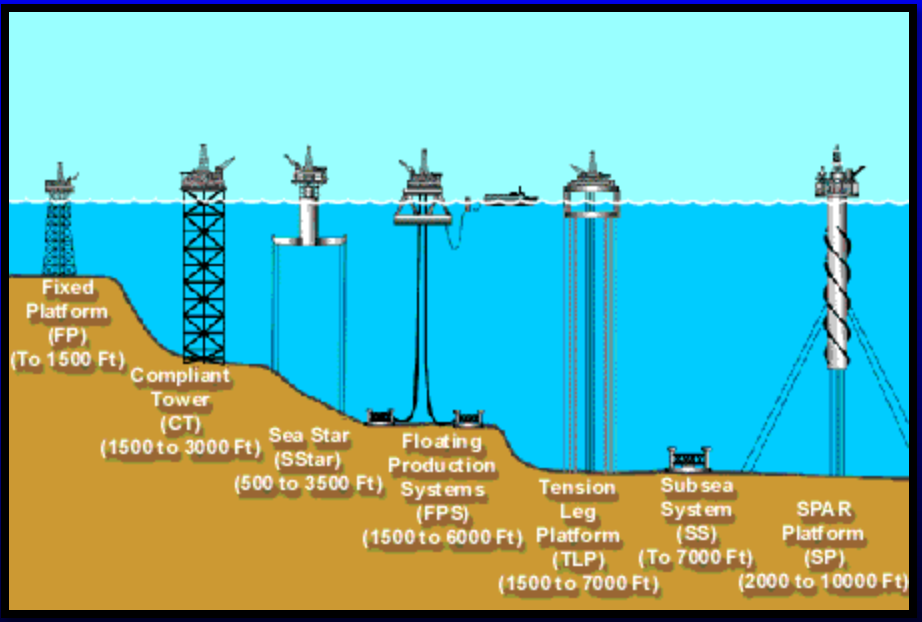
South — Area where most of Mexico's light crude is produced.

Source: Pemex; Ronald Buchanan

Chronicle

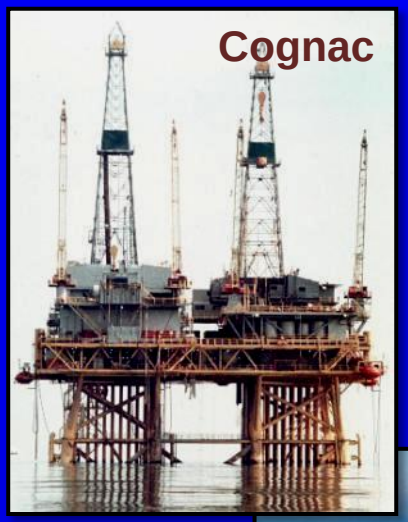
The Evolution Of Deepwater Oil And Gas

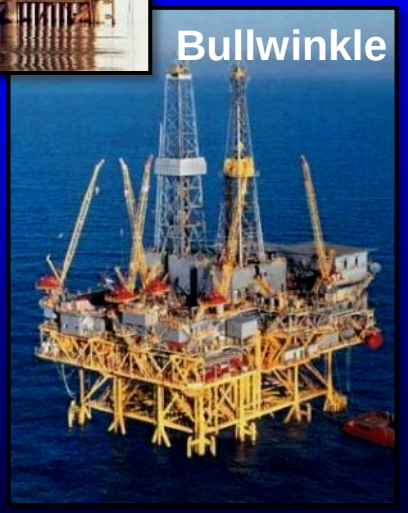
- The first edge of Continental Shelf oil and gas began in GOM:
  - Cognac was the pioneer
  - Bullwinkle and Amber/Amberjack were 2nd and 3rd
- By 1995, 7 deepwater projects produced 183,000 B/D.
- By 2000, 16 deepwater projects produced 596,000 B/D.
- By 2003, 20 deepwater projects produced 737,000 B/D (record).
- By 2007, deepwater flow fell back to 595,000 from 24 fields.



Deepwater Projects Have Astonishing Decline Rates

- To economically recover costs associated with deepwater production, all formations need to be drained fast.
- This created decline profiles never seen before.
- Even early fields exhibited this profile:
  - Cognac peaked 5 years after first production at 72,000 B/D
  - 10 years later, its output was 17,000 B/D
  - Bullwinkle peaked 4 years after first production at 51,000 B/D
  - 5 years later, production was under 10,000 B/D





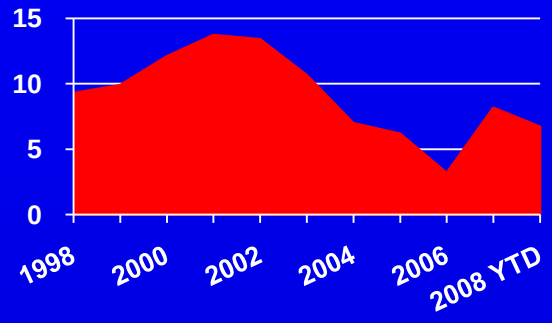
The GOM's Deepwater Score Card

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008 YTD
				---------- '000 Bbls/day ----------							
AMBERJACK	9	10	12	14	13	11	7	6	3	8	7
Atlantis									0	4	95
Auger	79	64	64	60	34	17	12	12	14	16	9
Baldpate	1	43	50	43	25	18	13	9	8	10	15
Brutus	0	0	0	14	55	51	24	14	31	30	14
Bullwinkle (GC 65)	9	8	6	5	4	4	2	2	6	6	4
COGNAC	8	9	7	7	4	6	6	3	0	2	2
Devils Tower (MC 773)							8	15	40	34	26
Gunnison						0	11	17	17	10	7
Holstein							1	45	31	34	10
Hoover	0	0	4	31	44	22	18	15	11	7	7
Horn Mountain / King	0	0	0	0	15	93	85	63	62	46	44
K2								4	24	30	22
KEPLER								46	47		35
Llano (GB 387)	4	1	0	0	0	1	29	37	30	14	13
LOBSTER/OYSTER	49	50	32	28	25	22	18	22	20	14	11
Mad Dog								24	30	45	62
Mars-Ursa	118	164	230	265	254	266	272	170	169	206	167
Medusa						3	28	28	27	16	14
Nansen (EB 602)	0	0	0	0	18	30	32	25	21	14	12
Neptune (VK 825)	21	25	18	13	16	13	9	6	6	5	4
PETRONIUS						53					23
PHOENIX	0	0	0	12	28	17	16	6	0	0	0
Pompano	49	41	35	28	29	21	12	8	10	10	5
Ram-Powell (VK 956)	45	46	30	22	22	17	14	10	11	8	5
SALSA	1	3	1	22	22	24	25	21	16	12	8
Troika (GC 244)	51	96	86	74	59	34	14	13	7	4	4
TOTAL	**444**	**561**	**576**	**637**	**666**	**721**	**657**	**621**	**643**	**587**	**628**

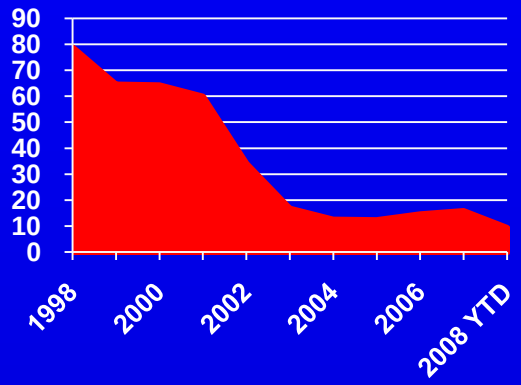
These Were Not Anomalies

A Picture Is Worth A Thousand Words

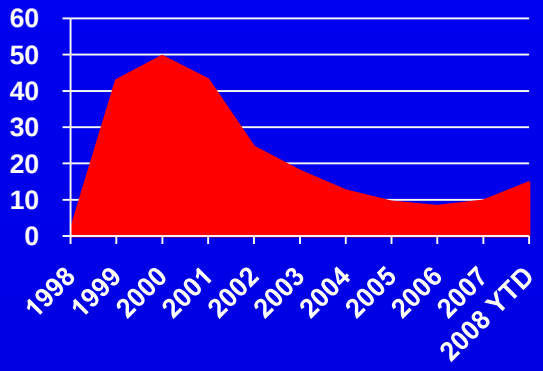
Amberjack



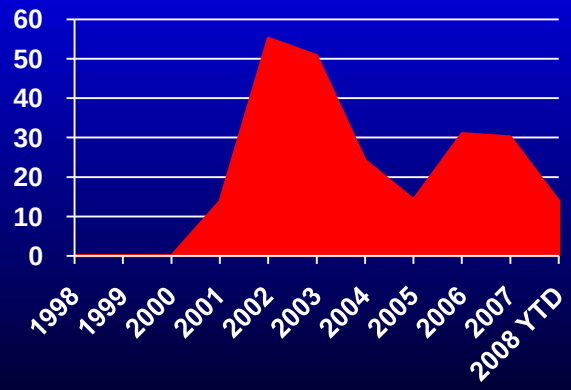
Auger



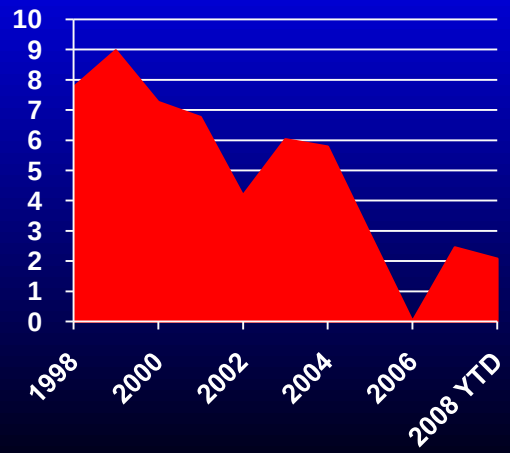
Baldpate



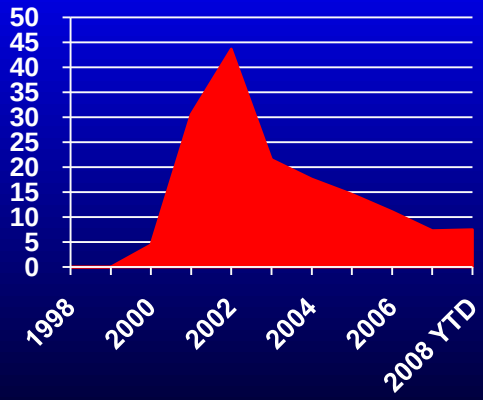
Brutus



Cognac



Hoover



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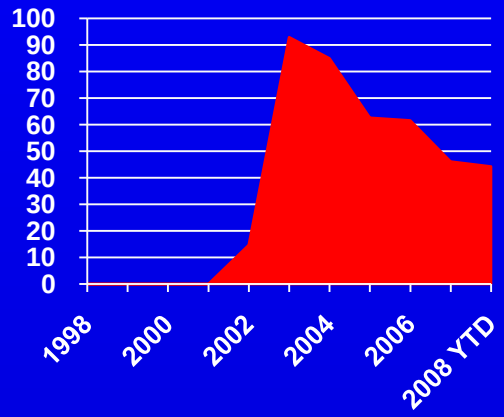
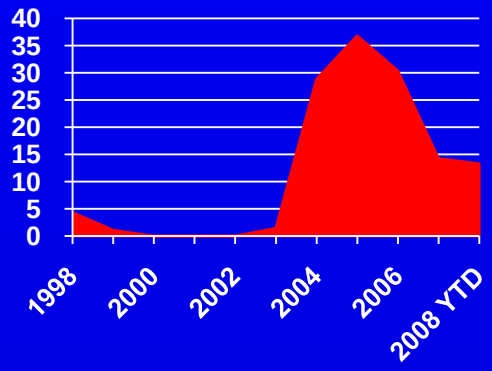
These Were Not Anomalies (Part II)

A Picture Is Worth A Thousand Words

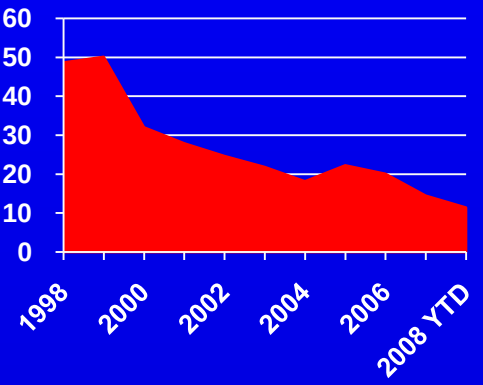
Horn Mountain / King



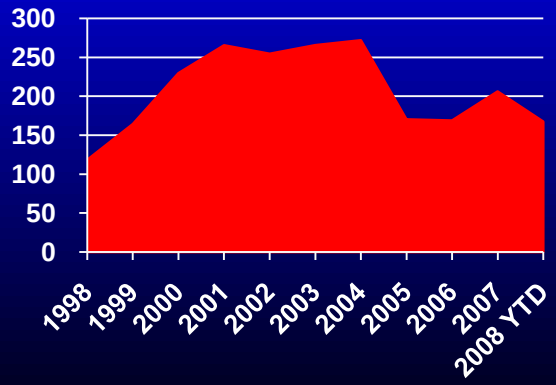
Llano (GB 387)



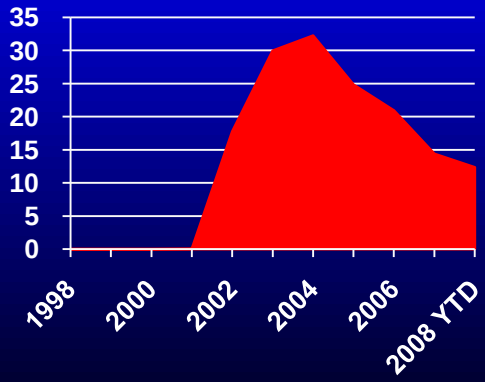
Lobster/Oyster



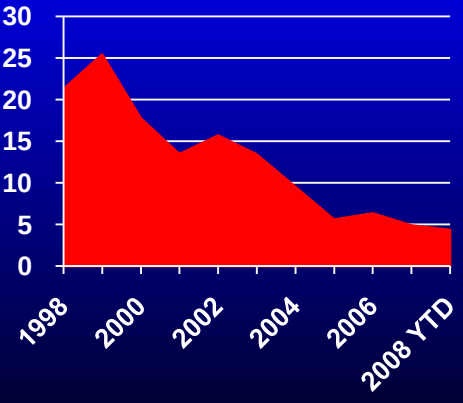
Mars-Ursa



Nansen (EB 602)



Neptune (VK 825)



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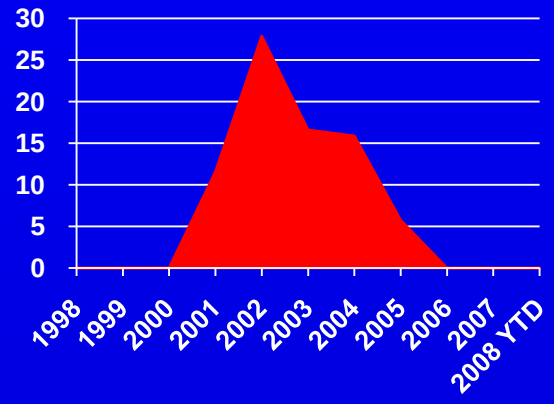
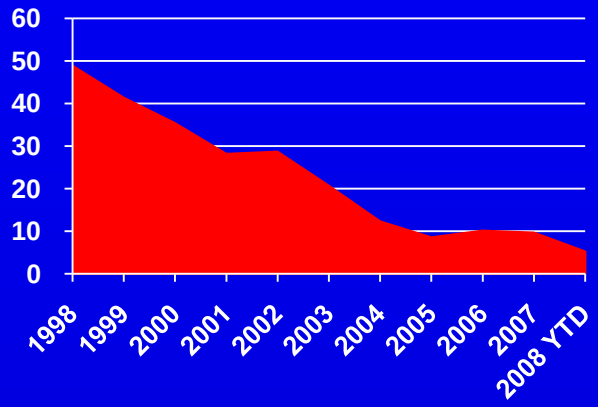
These Were Not Anomalies (Part III)

A Picture Is Worth A Thousand Words

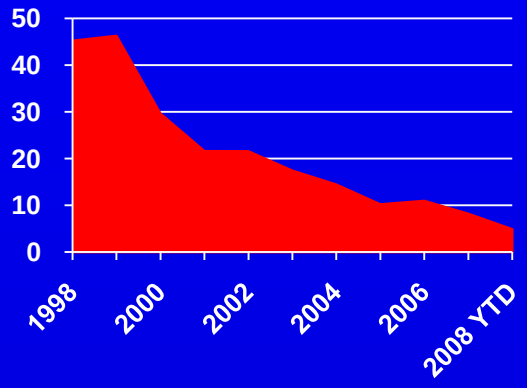
Phoenix



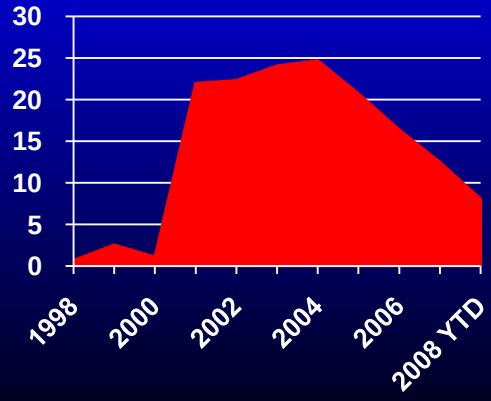
Pompano



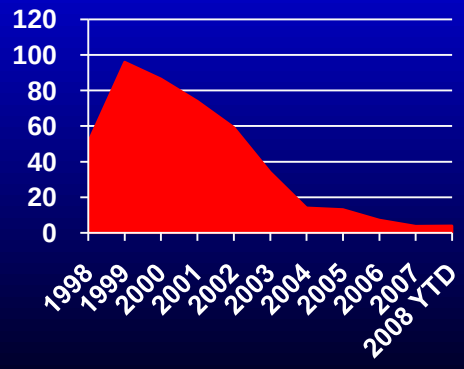
Ram-Powell (VK 956)



Salsa



Troika (GC 244)



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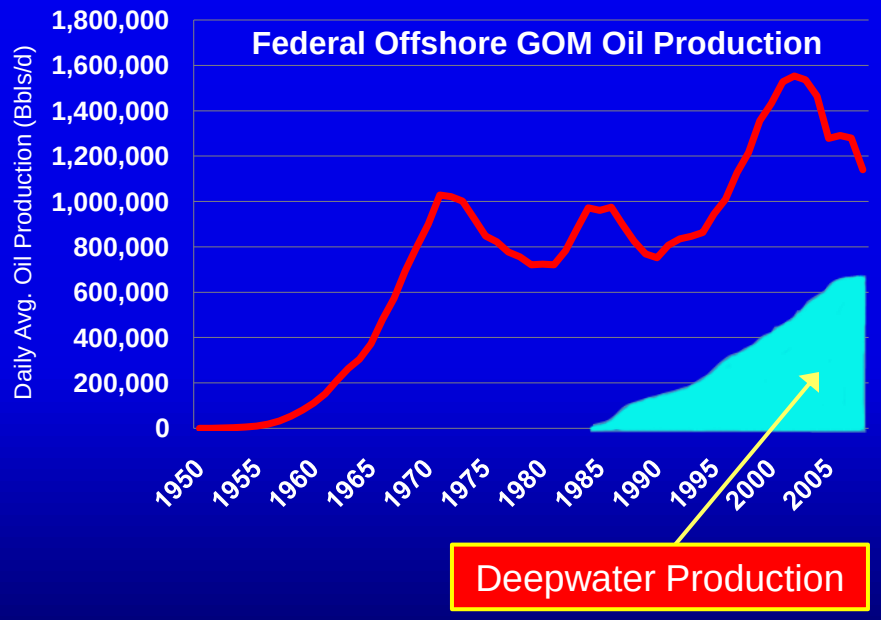
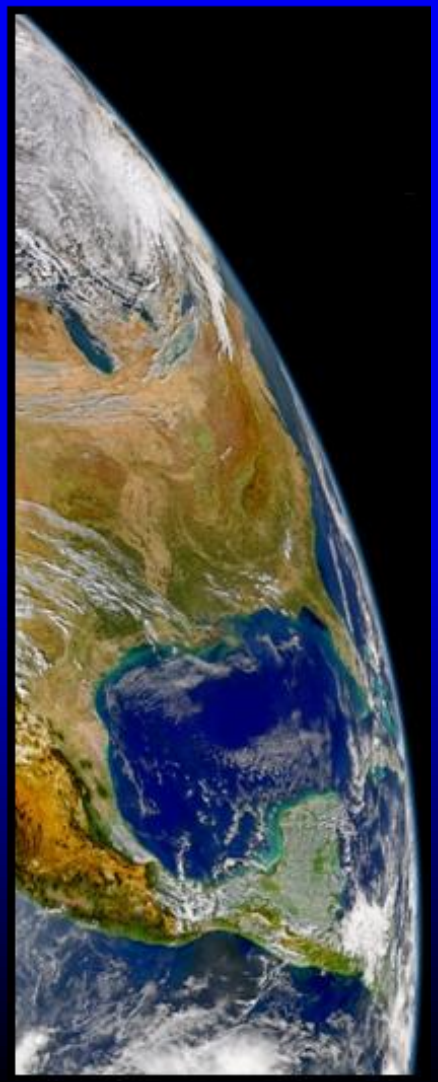
Non-Deepwater GOM Fields Are Now All Small

- Hundreds of other GOM fields produce the rest of GOM oil.
- Most comes from very mature fields and extremely old platforms.
- Abandonment costs are many times the remaining value of recoverable oil.



Gulf Of Mexico's Oil Fields: 15 Are Large, 595 Fields Are Small To Tiny



GOM - Tier 1	'000 B/D	Avg. B/D	% GOM
Top 15 oil fields	565	37.7	48%
Next 30	235	7.8	21%
Next 50	186	3.6	16%
Remaining 51	173	0.3	15%

Source: MMS

Offshore Oil Production In Federal Gulf Of Mexico Waters

- There are 835 oil and gas fields in production:
  - 225 are gas fields only
  - Other 610 are primarily oil producing

	2008 Production		Ave/Field
	------'000/Day ------		---'000/Day ---
Mars-Ursa	169	15%	
Atlantis	80		
Mad Dog	56	18%	
Horn Mountain/King	43		
Thunderhorse	34		
Top 5	382	33%	76,400
Next 10	187	18%	18,706
Top 15	569	51%	963
595 "Others"	588	49%	0.3
Total	1,157	100%	1.4

GOM's Natural Gas Supply Also A Pyramid

	Total Production MMCF/Day	% of Total NGLs	Avg./Field MMCF
Top 5 Fields	735	12%	147
Next 12 Fields	673	11%	56
Next 7 Fields	272	4%	39
Next 44 Fields*	1,206	19%	27
Remaining 157 Fields	3,415	54%	22
222 Fields Total	6,301	100%	28

*19 in production from 1953 - 1969

Source: MMS

Like GOM, World Crude Base Anchored Super Giant Fields

- All super-giants are old.
- All have passed their peak.
- Some are just starting into decline.
- They will all meet this fate.

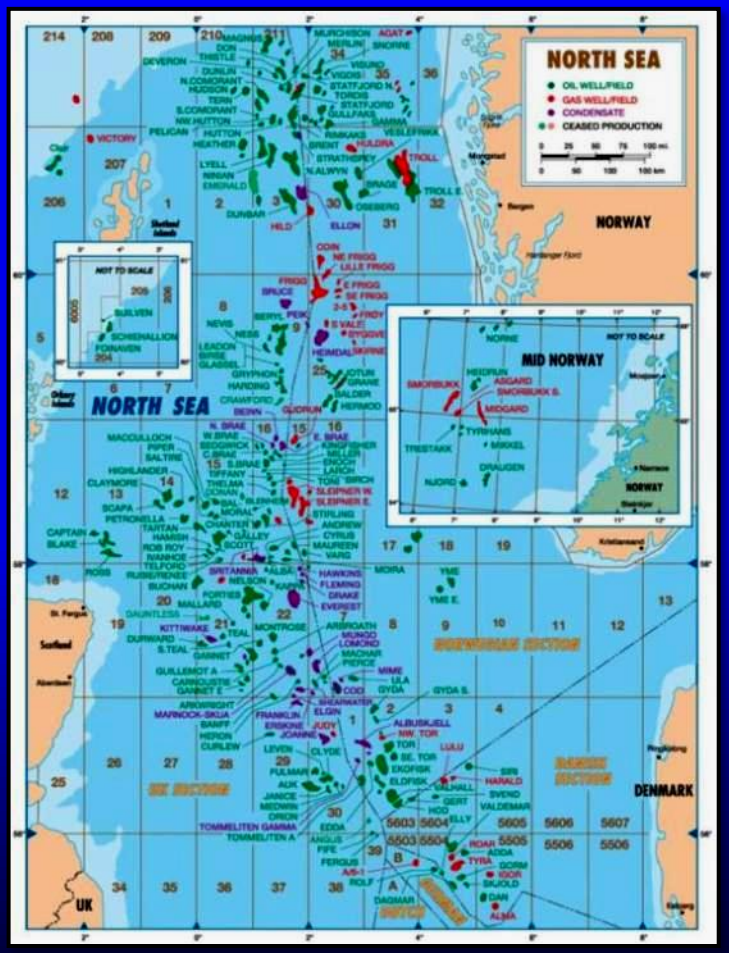
Table 10.1 • *The world's 20 biggest oilfields by production*

Field	Country	Location	Year of discovery	Peak annual production		2007 production
				Year	kb/d	kb/d
Ghawar	Saudi Arabia	Onshore	1948	1980	5 588	5 100
Cantarell	Mexico	Offshore	1977	2003	2 054	1 675
Safaniyah	Saudi Arabia	On/off	1951	1998	2 128	1 408
Rumaila N & S	Iraq	Onshore	1953	1979	1 493	1 250
Greater Burgan	Kuwait	Onshore	1938	1972	2 415	1 170
Samotlor	Russia	Onshore	1960	1980	3 435	903
Ahwaz	Iran	Onshore	1958	1977	1 082	770
Zakum	Abu Dhabi (UAE)	Offshore	1964	1998	795	674
Azeri-Chirag-Guneshli	Azerbaijan	Offshore	1985	2007	658	658
Priobskoye	Russia	Onshore	1982	2007	652	652
Top 10 total						**14 260**
Bu Hasa	Abu Dhabi (UAE)	Onshore	1962	1973	794	550
Marun	Iran	Onshore	1964	1976	1 345	510
Raudhatain	Kuwait	Onshore	1955	2007	501	501
Gachsaran	Iran	Onshore	1928	1974	921	500
Qatif	Saudi Arabia	On/Off	1945	2006	500	500
Shaybah	Saudi Arabia	Onshore	1968	2003	520	500
Saertu (Daqing)	China	Onshore	1960	1993	633	470
Samotlor (Main)	Russia	Onshore	1961	1980	3 027	464
Fedorovo-Surguts	Russia	Onshore	1962	1983	1 022	458
Zuluf	Saudi Arabia	Offshore	1965	1981	677	450
Top 20 total						**19 163**

Sources: IHS, Deloitte & Touche and USGS databases; other industry sources; IEA estimates and analysis.

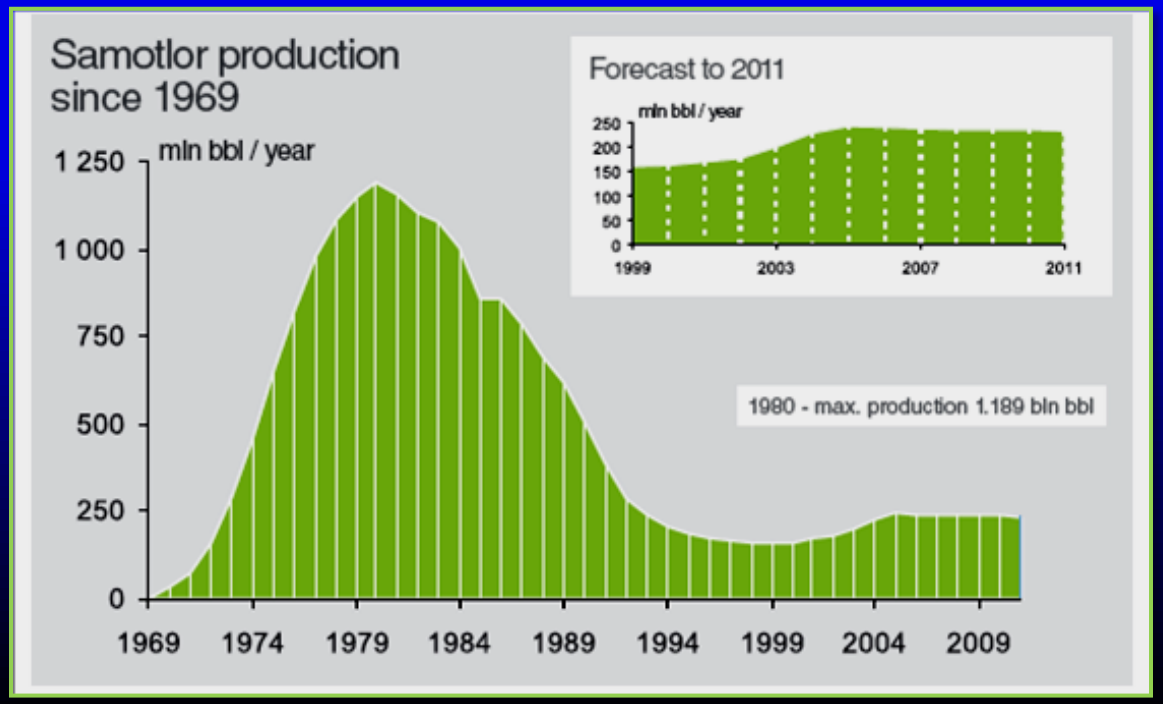
North Sea: Same Story

- North Sea last major new oil frontier (1969).
- Its oil production grew for 3 decades, peaking at 6.4 MMB/D (1999).
- By 2008, North Sea oil output off 50%.
- Only a handful of fields still produce over 10,000 – 20,000 B/D.



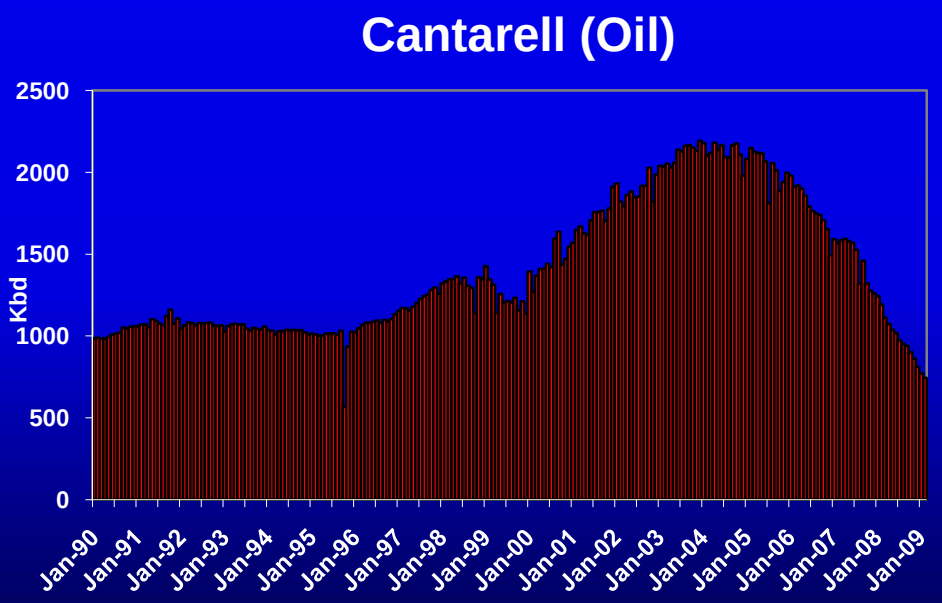
Russia's Samotlor Is Another Peak Oil Case Study

- Samotlor was Russia's super-giant oil field -- production started 40 years ago.
- Production grew to 3.425 MMB/D in 1980 (30% of USSR oil).
- "Mature" field now stabilized at ≈250,000 B/D.
- TNK/BP will spend $1 billion/year to trying to keep this supply stable.



PEMEX's Cantarell Is Another Classic Case Study

- World's 3rd largest flowing oil field discovered in 1974/75.
- First production began in 1977.
- 40 oil wells produced 1MMB/D for next 20 years.
- Then, reservoir pressures waned.
- Furious drilling ensued.
- Nitrogen injection created artificial gas caps.
- Production soared, peaking at 2.2 MMB/D in 2005.
- Production began a long collapse.
- Current year-over-year declines in 35 – 38% range.

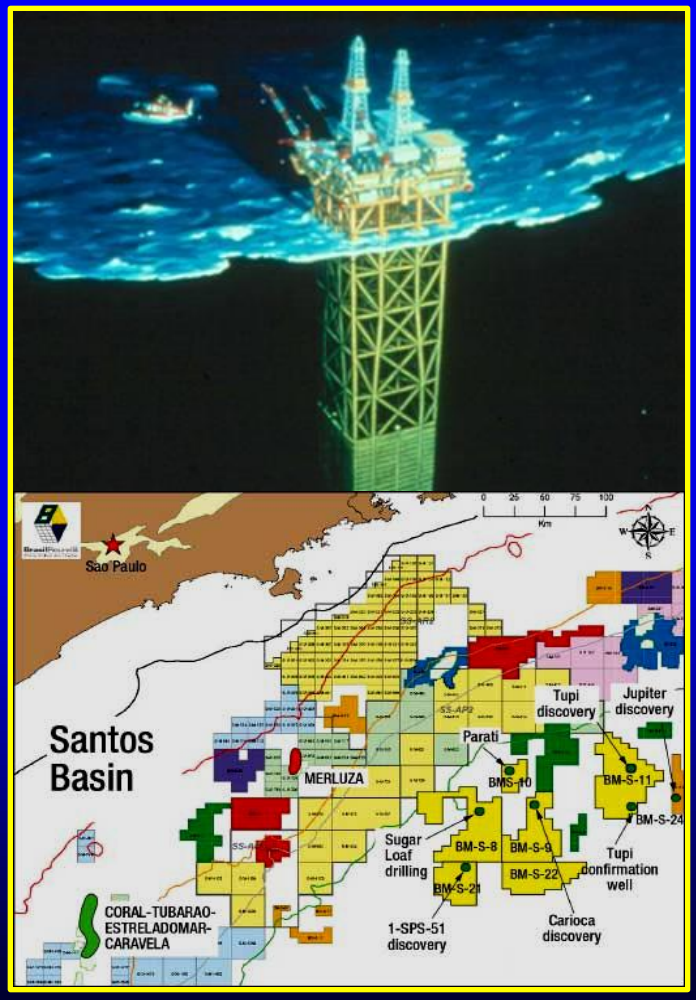


World's Crude Oil Future Growth: Deepwater And Unconventional Oil

- Until a new oil frontier is found onshore or in shallow waters, world will rely on almost all new production to come from deepwater finds or unconventional oil
- Both are extremely expensive and take an enormous amount of time to bring to production.

Brazil's Santos Basin: Classic New Frontier Challenge

- "Discoveries" at Tupi and nearby structure might have found a new North Sea or something greater.
- But, so far, only few exploratory wells have tested in 2 – 3 structures:
  - None have been cored
  - None have been flow-tested
- These wells are "beyond any normal challenge":
  - They occur in ultra-deep water
  - They involve ultra-deep vertical drilling through salt
  - Below salt is intense heat/extreme pressure



Santos Will Take 2 – 4 Decades To Develop

- Senior Petrobras E&P executives estimate time needed to really know what the Santos Basin contains and best way to get its production:
  - 2 – 4 decades?
  - Hundreds of ultra-deepwater rigs?
  - Floating platforms for extended well-testing
- Cost to establish this will be staggering.
- Until some extended flow tests are done, no idea how commercial this new play might be.

Optimists Argue That Unconventional Oil Will Save The World

- Unconventional oil comes in various "shapes":
  - Very heavy oil
  - Oil and tar sands
  - Orinoco
  - Shale oil (i.e. Bakken Shale)
  - Oil shale (i.e. Utah/Colorado kerogen producible oil shale)
- The technology, energy and water intensity to create any flows from these shale plays varies by type of shale.
- The quality of each basin varies from good to poor.

"Unconventional Natural Gas Supply Could Exceed 1,000 TCF"

- Recent pronouncements create myth that America's energy problems are over.
- "Significant portion of the resources is in U.S. Rockies and Canadian Western Sedimentary Basin":
  - Advanced coal bed methane
  - Production from tight sands
  - Shale gas plays
  - Enhanced gas recovery techniques
- How much of this can actually flow and for how long is not being addressed.

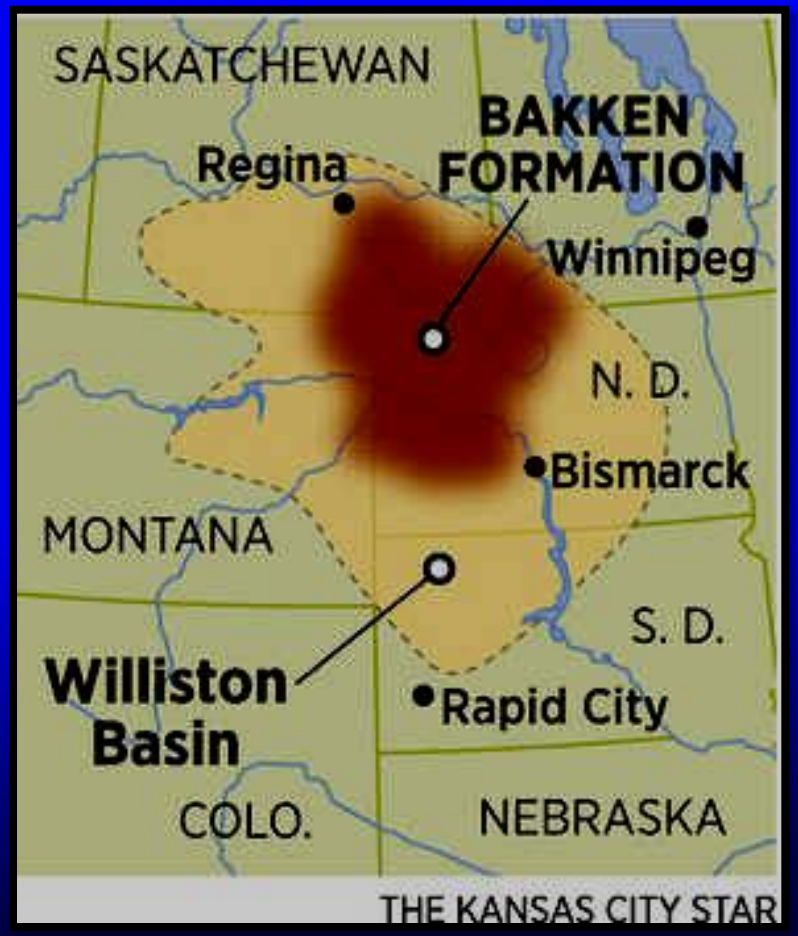
It Is Impossible To Substitute Unconventional Oil For High Flows Of Sweet Oil

- Energy intensity to produce unconventional oil is too great.
- The flow rates per well bore are too low.
- The quality of oil produced is often very low.

Athabasca Oil Sands expansion cost $20+ billion to add 100,000 B/D.

Will Shale Resources Be The Solution To Peak Oil?

- Assuming conventional crude declines, can abundant oil shale be our salvation?
- According to USGS (April 2008) Bakken Shale oil discovery is “largest domestic oil discovery since Alaska’s Prudhoe Bay and has potential to eliminate America’s dependence on foreign oil.”
- The EIA estimates Bakken Shale to produce 503 billion barrels.
- This implies that Williston Basin (Bakken Shale) has almost 2 times Saudi Arabia’s oil.

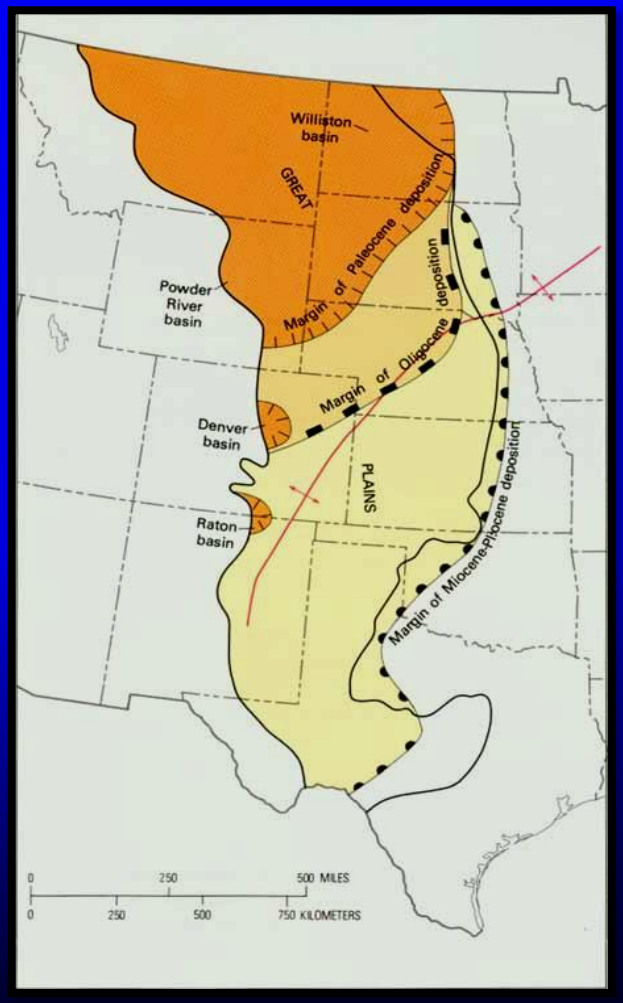


Truth About Bakken Formation (i.e. Williston Basin)

- A rock unit covering about 200,000 square miles.
- Unlike oil shale, which contains kerogen, Bakken is high quality oil.
- On April 8, 2008 USGS estimated that Bakken technically recoverable oil is 3.0 – 4.0 billion barrels, with a mean of 3.65 billion.
- Somehow, optimists blew this up to 300 billion barrels.

Other Realities Of Bakken Shale

- The Bakken Shale is a thin bed of oil in extremely tight rocks quite deep in the earth.
- Great Bakken wells produce between 300 – 500 B/D.
- 40 – 50% of well's oil is produced in first year.
- To create one million barrels per day of Bakken oil would mean 2,900 wells would need to be drilled each year.
- This would use up a large percentage of U.S. oil rigs.



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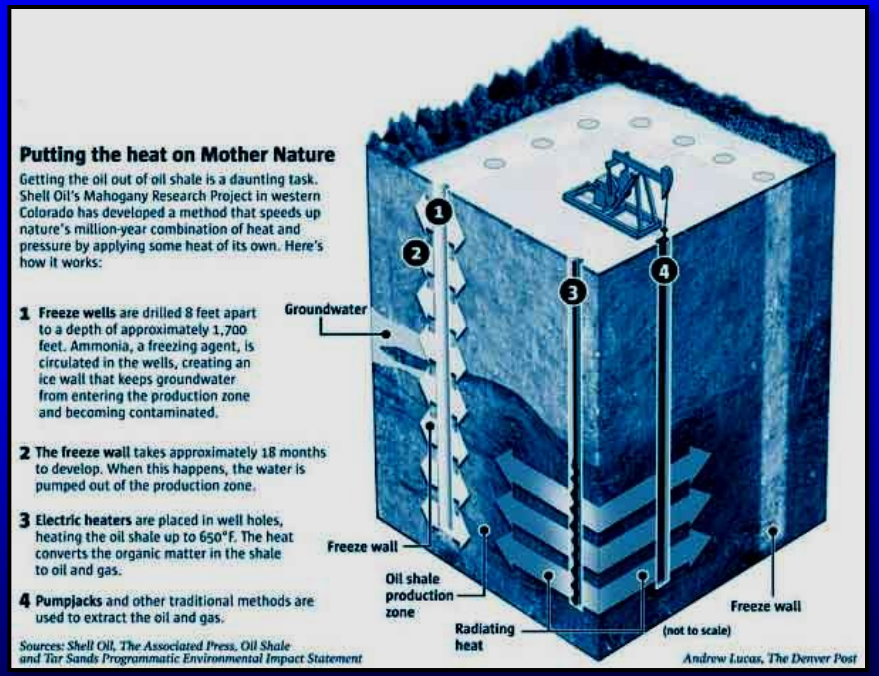
Utah/Colorado's Oil Shale Contains Trillions Of Barrels Of Oil

- If anyone can unlock oil shale by baking out the kerogen, this could be inexhaustible, but…
- So far, there are no proven techniques that create any sizeable flows.
- The heat required consumes enormous amounts of energy.
- So, oil shale will likely be left for our great grandchildren.



“Tool Shortages” Also Crimp Supply Growth

- As E&P expenditures soared, need for more rigs and other services used up industry’s total capacity.
- The average age of capacity also got very rusty.
- When replacement economics hit the oil patch, it was termed “oil field inflation.”
- But it was merely Economics 101: Replacement costs were extremely high.

Our Biggest Energy Challenge: The Volumes We Now Consume

- Americans are world's largest energy hogs.
- Our daily use:
  - We burn a train-car load of coal every second (or 86,400 trains cars per day)
  - In same second, we use 10,000 gallons of oil (or 864 million gallons per day)
  - We consume 60 billion cubic feet of natural gas. Stacked in a tower, this would reach the moon and back 25 times.

Source: John Hoffmeister speaking at Harvard's JFK Center

Keeping Crude (And Natural Gas) Production Stable Requires Vast Spending

- The reason industry spent ≈$400 billion in 2008 is because it costs a lot to offset declining production.
- Current low oil prices make this spending impossible to fund.
- Oil companies' new drive to reduce drilling costs will not work.
- Price to drill and complete wells needs to rise, not drop.

The Industry's Work Force And Asset Base Is Too Old

- The "maturity" problem goes beyond old giant oil fields.
- The entire infrastructure to deliver oil and gas from the well bore to the consumer is too old and needs rebuilding.
- The era of pretending that robust maintenance can sustain rusty assets is over.
- Core of industry's employee base is "just as rusty."

Cost To Rebuild Infrastructure Is Huge

- To replace 6 million miles of oil and gas pipeline and gathering systems would exceed $15 trillion.
- Replacing 20% of world's refinery capacity would cost $2 trillion.
- And costs would soar as equipment scarcity sets in.

World Faced Big Supply Problem When Oil Prices Were "High"

- $100 - $150/Bbl oil did not grow supply.
- It did not induce replacement programs to build new rigs or any other assets.
- It did not create a recruitment driver.
- But, low prices virtually guarantee this will not happen.

Natural Gas Supply Possibly Shakier Than Oil

- Natural gas decline rates far higher than oil.
- Most of world's largest giant gas fields are in steep decline or mostly depleted.
- Most of unproduced giant gas fields have not been properly discovered.
- High percentage of new gas is in unconventional/sour or both.

How Should The World React To Pending Crisis?

Go To Immediate "War Footing"

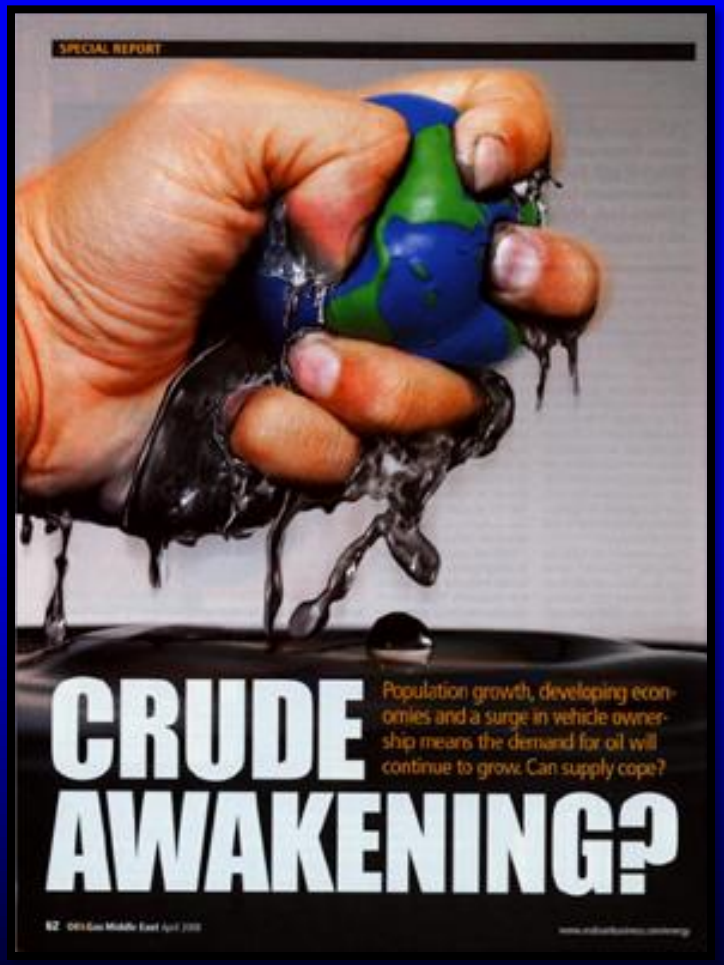
- Step One: Enact genuine "data reform" on all key producing oil and gas fields.
- Step Two: Begin blue prints for rebuilding our energy infrastructure.
- Step Three: Get oil and gas prices high and create a floor.
- Step Four: Adopt global Plan B to reduce our oil and gas use ASAP.

What Will The World Likely Do?

- Ignore need for data reform:
  - Why when USGS/EIA, etc. gives us perfect data?
  - Who would agree to share actual production status of their mature field?
  - Consumers love low prices
- Instead, we will embrace climate change rules to use less fossil fuels over long period of time.
- Create a Green Revolution that might work:
  - Geo-engineers
  - Biofuels
  - Hybrid cars

The Consequences Of Inaction

- Unless prices rise soon: E&P industry will downsize:
  - Asset rebuilding will not start
  - Demand might soften, but as fast as supply drops
- What will happen when supply cannot meet demand?:
  - Consumers will use too much
  - Shortages begin
  - Consumers then hoard stocks
  - Shortage lead to “run on the energy bank”



Does It Have To Work Out This Way?

- No, but wake-up needs to happen fast.
- Given current economic woes, low prices, mania about climate change, etc. odds to wake-up are low.
- So, buckle your seat belts!

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Investment Bankers *to the* Energy Industry

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