The Promise and Peril of Oil Shale Development (February 5)

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SLIDES: The Logistics and Energy Needs of Oil Shale Extraction

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The Logistics and Energy Needs of Oil Shale Extraction

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There are number of issues to be addressed for oil shale development

- Water usage
- Contamination of aquifers
- Stress on communities
  - Population growth
  - Infrastructure needs
- Land and wildlife disturbance
- Air pollution, including CO_2

Different processes have different impacts

(From Burnham & McConaghy, 2006 Oil Shale Symp.)

- There are many different oil shale processes with different characteristics

Heating Method	Above Ground	Below Ground
Conduction through a wall (various fuels)	Pumpherston, Fischer assay, Oil-Tech	Shell ICP (primary method), E.G.L.
Externally generated hot gas	Union B, Paraho Indirect, Superior Indirect, Petrosix	Chevron
Internal combustion	Union A, Paraho Direct, Superior Direct, Kiviter	Oxy MIS, LLNL RISE, Geokinetics Horizontal, Rio Blanco*
Hot recycled solids (inert or burned shale)	Galoter, Lurgi, Chevron STB, LLNL HRS, Shell Spher, ATP, TOSCO II	
Reactive fluids	IGT Hytort (high-pressure H_2), Donor solvent processes	Shell ICP (some embodiments)
Volumetric heating		ITTRI and LLNL radio-frequency

- Different processes vary greatly in fuel source, CO_2 emissions, and energy gain

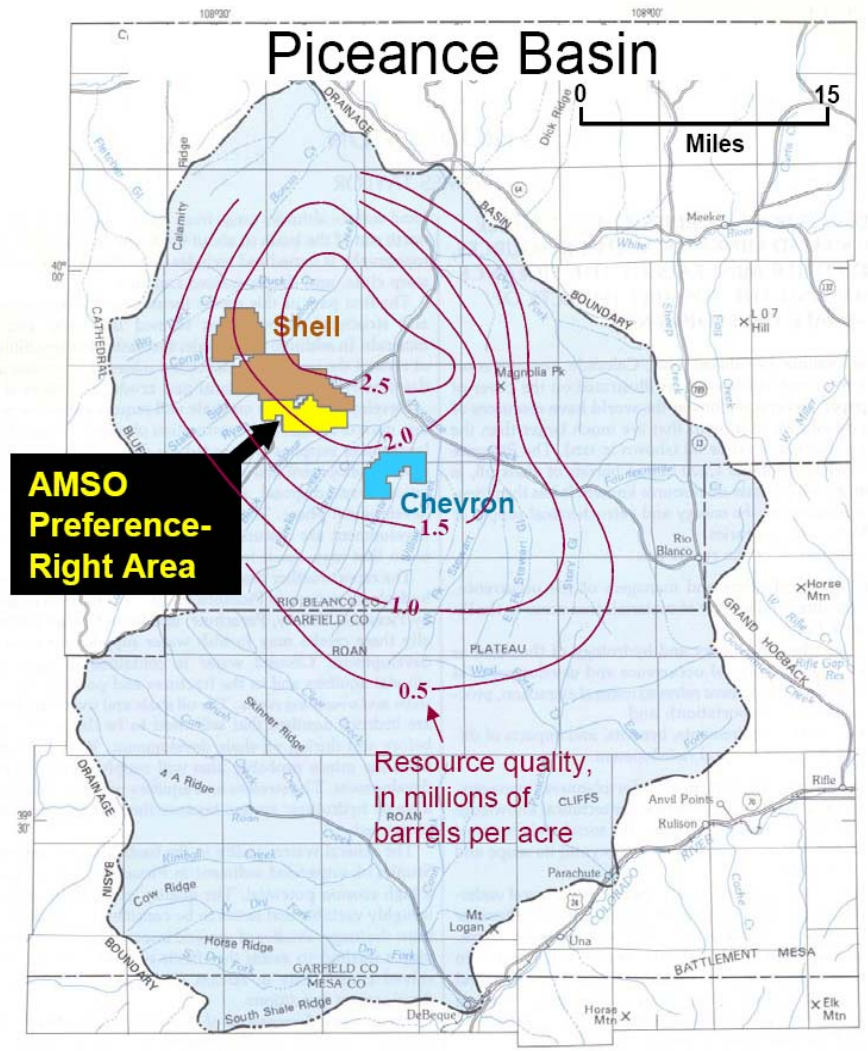
Comparison of CO_2 emissions and hypothetical mitigation costs for avg grade of 25 gal/ton

Process	Oil Yield, %FA	Pyrolysis CO_2, kg/bbl	Combustion CO_2, kg/bbl	Carbonate CO_2, kg/bbl	Total CO_2, kg/bbl	Mitigation cost, $/bbl	Energy gain
HRS	100	11	77	40	128	3.8	
Internal comb	90	12	85	150	247	7.4	
MIS	80	14	96	352	462	13.9	
Shell ICP[1]	80	14	146	0	160	4.8	~3
Shell ICP[2]	80	14	42	0	56	1.7	~8
Chevron	80	14	96	120	230	6.9	

[1]using coal to generate electricity [2]using downhole methane burners [3]assume mitigation cost of $30/ton

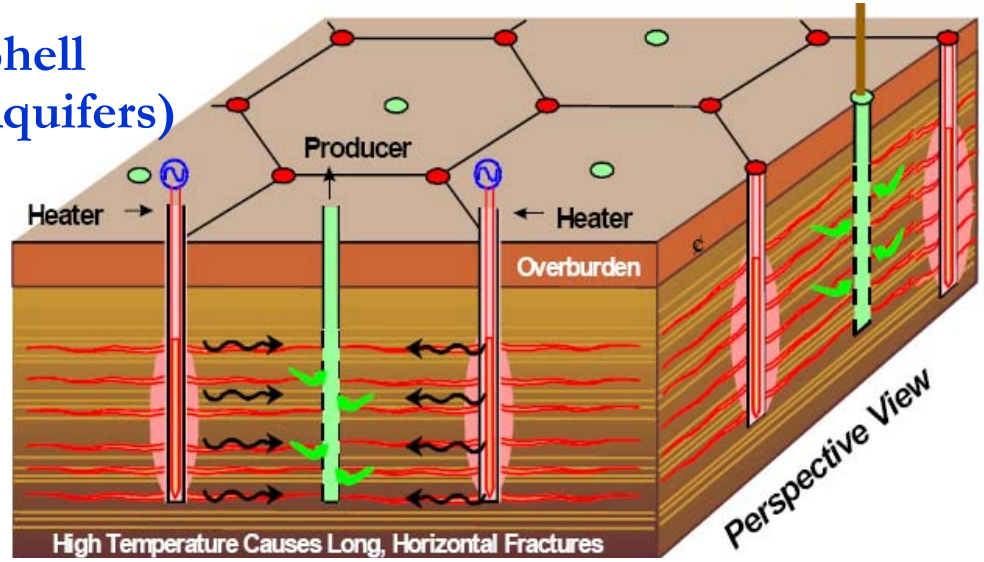
AMSO is one of three RD&D Leaseholders in Colorado's Piceance Basin

- The 160-acre BLM lease was established in January 2007 under EGL Resources and transferred shortly thereafter to EGL Oil Shale
- IDT acquired 90% of EGL Oil Shale in 2008 and renamed it AMSO
- In March 2009, Total acquired a 50% interest in AMSO

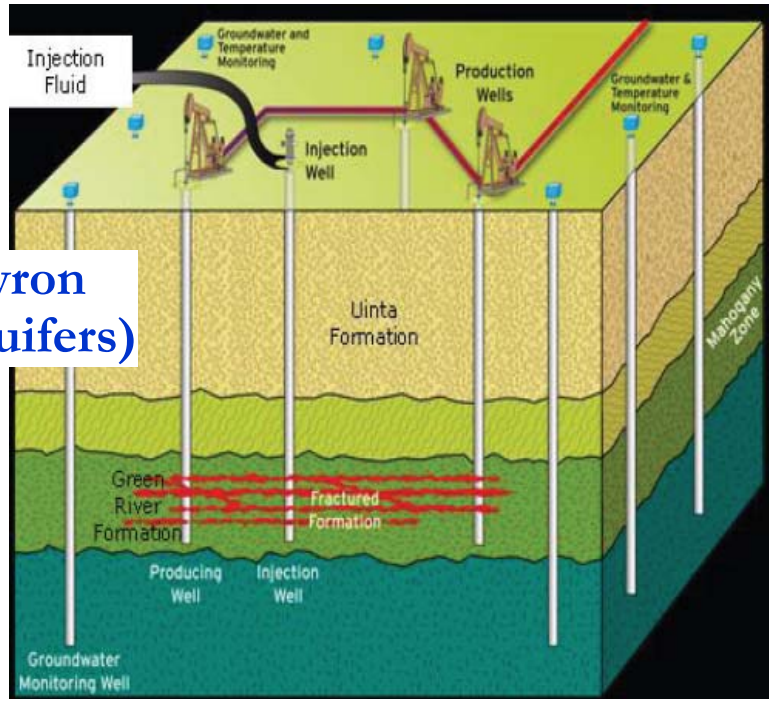


In-situ processing is being pursued in Colorado's Piceance Basin by others

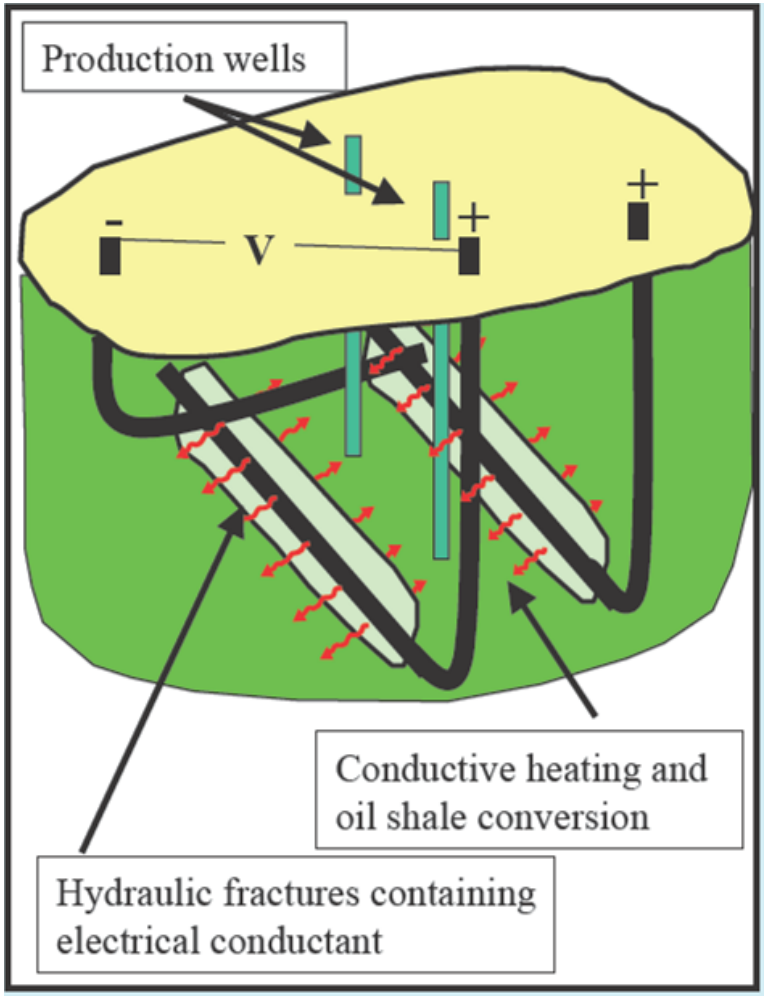
Shell (In Aquifers)



Chevron (In Aquifers)



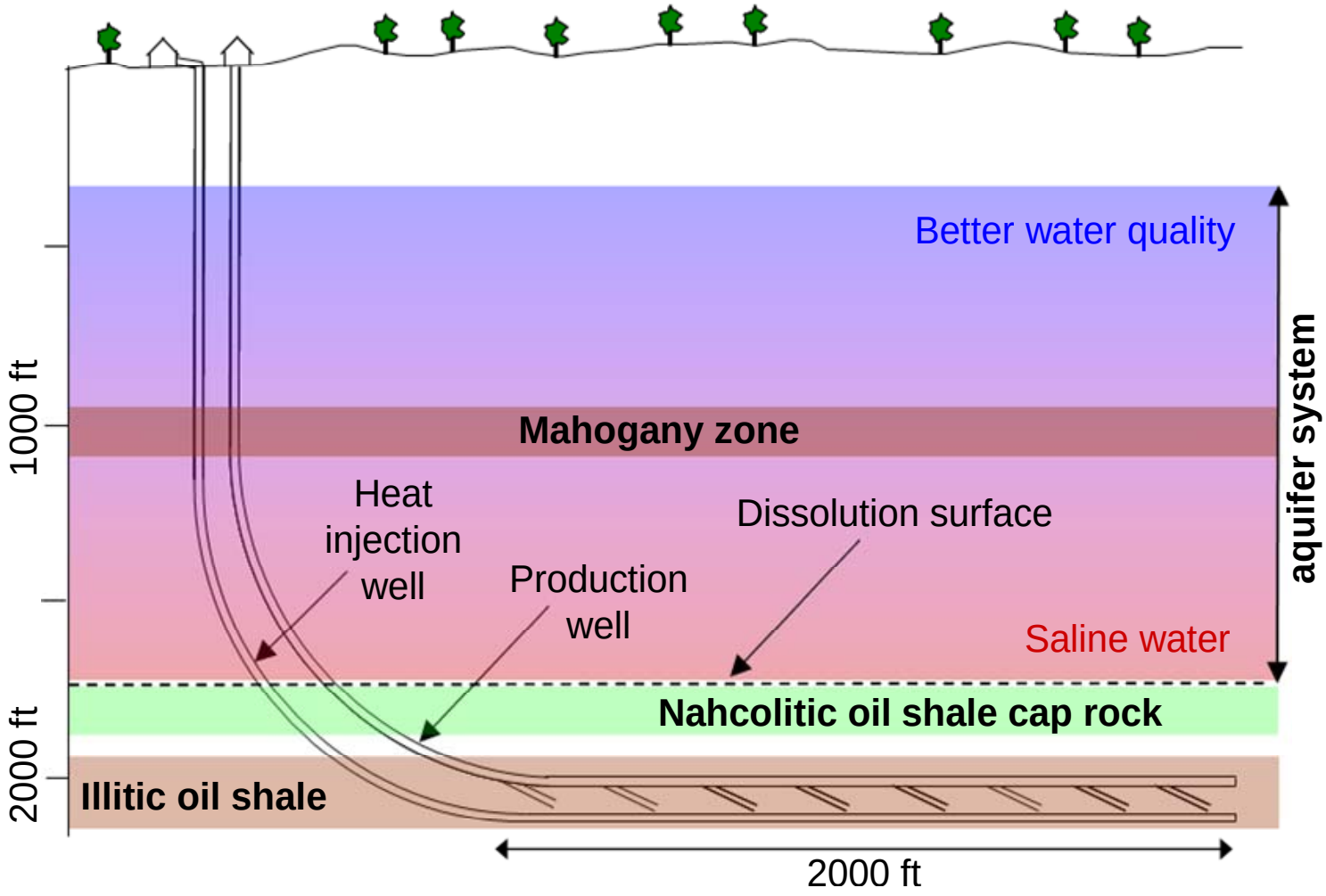
ExxonMobil (Below Aquifers in the Saline zone)



All pictures taken from public presentations by these companies

AMSO's process and production interval are different

- We propose to develop the illitic oil shale separated from aquifers by nahcolitic oil shale



Our goal is to maximize benefits to the Nation and the local communities

- **Our RD&D phase (~10 years) will involve about 20 people**
- **Our commercial process will use a small, stable labor force**
  - Approximately 300 people for drilling and production operations
  - Production target of about 100,000 bbl/day*
- **At 350 bbl/day per worker, each worker will produce enough oil for 5,000 people**
- **At a royalty rate of $10/barrel**, each worker would generate $1.2 million per year in royalties**
  - It is important that part of these royalties are used to improve infrastructure in the area

*** this exceeds Colorado's average annual oil production of 57,000 bbl/day over the past decade**
**** The BLM has established a maximum royalty rate of 12.5%, which at a price per barrel of $80, would translate into $10/barrel**

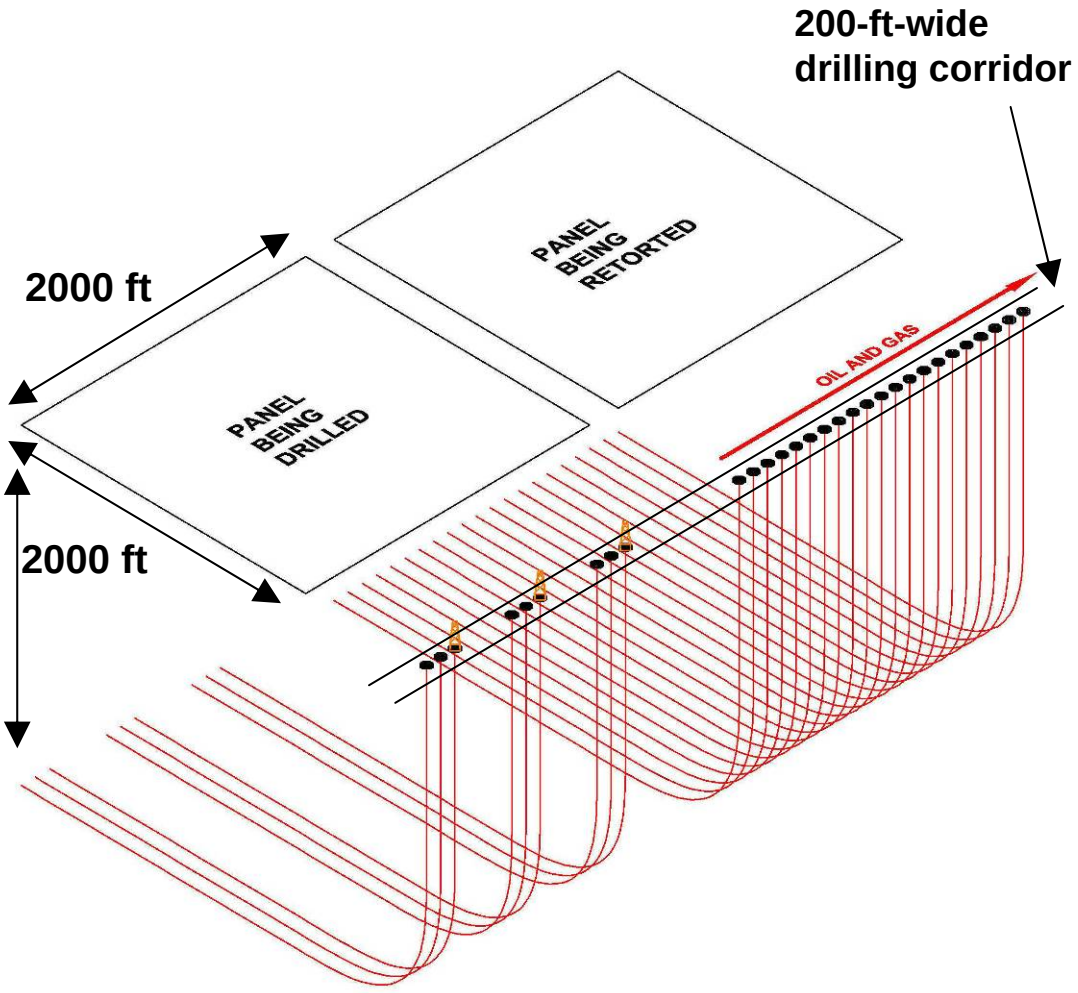
AMSO's oil shale process effectively uses water for high economic contribution

- True in-situ processes have no mining, crushing, or spent-shale disposal needing water for dust control
- AMSO's retort interval is isolated from drinking water, so no sub-surface reclamation of water required
- Anticipated water usage is less than one barrel of water per barrel of shale oil
- Projected to 100,000 bbl/day, AMSO would use ~0.1% of the state's water and generate ~1% of the state's GDP

White River in Rio Blanco County

AMSO plans fewer wells to minimize surface footprint

- Our retort panels will achieve high resource recovery in the illite shale
- By using long horizontal wells, drilling should impact <10% of the surface area



Land reclamation has already been demonstrated from the 1980s activity

Photo of reclaimed land from Rio Blanco Oil Shale Project in Piceance Basin