Unconventional Resources Technology Advisory Committee (URTAC)

January 18, 2012

Seventeenth Meeting

Meeting Minutes

A Federal Advisory Committee to the U.S. Secretary of Energy

Unconventional Resources Technology Advisory Committee

I hereby certify that this transcript constitutes an accurate record of the Unconventional Resources Technology Advisory Committee meeting held on January 18, 2012.

James Dwyer, Chair
Unconventional Resources Technology
Advisory Committee

18 Jan 12
Date

Unconventional Resources Technology Advisory Committee (URTAC) Meeting
January 18, 2012, Hilton Houston North, Houston, Texas

The meeting was opened at 8:00 a.m. by Elena Melchert, the Acting Designated Federal Officer (DFO) in place of Christopher Smith, the Deputy Assistant Secretary of the Office of Oil and Natural Gas. (Attachment 1) After welcoming remarks, Ms. Melchert appointed James P. Dwyer and Jessica Cavens to serve as the new Chair and Vice-Chair, respectively, of the URTAC for the remainder of the two year term of 2010-2012. (Attachment 2)

Ms. Melchert, DOE Program Manager for Oil and Gas Production Research, briefed the Committee on future assignments and deadlines then provided an overview of Title IX, Subtitle J of the Energy Policy Act of 2005 commonly referred to as "Section 999" by the Committee.

James Dwyer, URTAC Chair, identified this meeting as the first of three meetings focused on the DOE Draft *2012 Annual Plan*. He outlined the tasks for the day: 1) review the DOE Draft *2012 Annual Plan* and the RPSEA *2012 Draft Annual Plan,* 2) establish *ad hoc* subcommittees to review specific aspects of the documents, and 3) develop a strategy for providing DOE with written comments and recommendations. He reminded the Committee of the planned dates for the remaining two meetings at which the recommendations were to be finalized on February 28-29, 2012 and approved by vote on March 8, 2012 via conference call.

He then called for introductions, and introduced, in turn, each presenter according to the agenda (Attachment 3). The Chair welcomed all visitors and staff and reported that 18 of 21 URTAC members were present and a quorum was in effect (Attachment 4).

Presentation by Roy Long, Technology Manager, National Energy Technology Laboratory (Attachment 5)

Mr. Long summarized the "Section 999" implementation process. He discussed how DOE is meeting statutory requirements and streamlining the subcontracting process. He summarized the RPSEA 2011 solicitations, the Complementary Program elements, and the Traditional Program. Within the Traditional Program he discussed the 2010 funded ongoing projects and the 2012 appropriations. He finished by discussing the Integrated Technology Transfer Program with a focus on the Knowledge Management Database (KMD) and the statistics they have been measuring to monitor its use. This was followed by Committee discussion.

Presentation by Rick Hammack, National Energy Technology Laboratory (Attachment 6)

Mr. Hammack presented to the Committee the nine tasks the Unconventional Resources portion of the EPAct Complementary Program is facing at the Marcellus Shale Test Site in Washington County, Pennsylvania. The specific tasks are:

1. Characterize Baseline Environmental Signals
2. Fugitive Air Emissions

3. Produced Waters
4. Fluid-Gas-Rock Interactions in Shale
5. Prediction of Fracture Propagation
6. Coupling Microseismic Measurements and Geomechanical Models
7. Naturally Occurring Isotope Tracers
8. High-TDS Water and Gas in Shallow Reservoirs
9. Integrated Assessment Model for Predicting Risks to Groundwater

The presentation was followed by Committee discussion.

Presentation by Kent Perry, Vice President Onshore, Research Partnership to Secure Energy for America (RPSEA) (Attachment 7)

Mr. Perry's presentation described the RPSEA organization, its membership, structure/organization, how its advisory committees work, and the RPSEA process flow for development of the RPSEA draft annual plan. He summarized the Small Producer and Program element by providing the mission, goals, and objectives of the Program. He ended by giving a status update of the current project portfolio. This was followed by a discussion and question/answer session.

After lunch, Mr. Perry continued his presentation by discussing the goals and objectives of the Unconventional Resources Program element. He ended by describing the current program solicitations. This was followed by a discussion and question/answer session.

Overview of the 2012 Draft Annual Plan Process
The DFO then explained to the Committee how they are required to develop a document of Findings and Recommendations as written comments on the DOE *2012 Annual Plan* (*http://www.fossil.energy.gov/programs/oilgas/ultra_and_unconventional/2011-2012_Committees/Draft_2012_Annual_Plan_1-10-12.pdf).* Ms. Melchert described the process in which changes were made to the prior year plan to arrive at the current version. Discussion regarding the process for fulfilling the requirement then followed.

Establishment of *ad hoc* Review Subcommittees
After a short break, the Chair led the Committee in establishing *ad hoc* review subcommittees and membership. After some discussion, the five review subcommittees were:

Policy and Regulation
Brown, **Hall**, Kleinberg, Bromfield, Cavens, Oglesby, **Mason**
Value and Public Outreach
Hall, Lewis, Martin, **Nilson**, Daugherty, Arthur
Environmental
Mall, Mason, Mohaghegh, Hardage, **Kleinberg**, Martin, Arthur
R&D
Camp, Harju, Lewis, Martin, Mohaghegh, Nilson, **Oglesby**, **Whitney**, Mall, Sparks

Editing
Dwyer, Cavens, Mason, Hall

***Chairs in bold**

Following the establishment of the subcommittees, Elena Melchert discussed some administrative topics related to the next meetings

No members of the public made requests for public comments.

The meeting was adjourned at 4:15 p.m.

Attachments

	Presenter	Topic
1	For the Record	Acting Designated Federal Officer Letter
2	For the Record	Chair and Vice-Chair Appointment Letter
3	For the Record	Meeting Agenda
4	For the Record	Committee Members and Meeting Participant Attendance
5	Mr. Roy Long	DOE Oil and Gas Research Program Overview
6	Mr. Rick Hammack	Marcellus Shale Project
7	Mr. Kent Perry	Unconventional and Small Producer Project Portfolio Overviews

Attachment 1

Department of Energy
Washington, DC 20585

MEMORANDUM TO THE UNCONVENTIONAL RESOURCES TECHNOLOGY ADVISORY COMMITTEE

FROM: CHRISTOPHER A. SMITH
DESIGNATED FEDERAL OFFICER
UNCONVENTIONAL RESOURCES TECHNOLOGY ADVISORY COMMITTEE

SUBJECT: Acting Designated Federal Officer

I hereby designate Elena Melchert, Petroleum Engineer/Program Manager for Oil and Gas Production Research, to serve as the Acting Designated Federal Officer for the meeting of the Unconventional Resources Technology Advisory Committee on January 18, 2012, in Houston, TX.

Attachment 2

Department of Energy
Washington, DC 20585

MEMORANDUM TO THE UNCONVENTIONAL RESOURCES TECHNOLOGY ADVISORY COMMITTEE

FROM: CHRISTOPHER A. SMITH
DEPUTY ASSISTANT SECRETARY
OFFICE OF OIL AND NATURAL GAS

SUBJECT: Appointment of Committee Chair and Vice-Chair
Unconventional Resources Technology Advisory Committee

Whereas, article 12 of the committee charter states that the Secretary shall designate a chair and vice-chair, and article 1.23 of the Department of Energy Delegation Order No. 00-002.00G and article 1.5 of the Department of Energy Redelegation Order No. 00-002.04C transfer this authority of the Secretary to the Assistant Secretary for Fossil Energy, the Assistant Secretary has designated Mr. James P. Dwyer and Ms. Jessica J. Cavens to serve as the Chair and Vice-Chair, respectively, of the Unconventional Resources Technology Advisory Committee for the remainder of the two year term of 2010-2012.

Attachment 3

17th Meeting

Unconventional Resources Technology Advisory Committee

January 18, 2012

Hilton Houston North, 12400 Greenspoint Drive, Houston, Texas 77060

Meeting Room: DaVinci

AGENDA

7:30 am Registration		
8:00	Call to Order, Welcome, Introductions Opening Remarks Appointment of the Chair Committee Assignment and Deadline Overview of "Section 999"	Elena Melchert, DOE Acting Designated Federal Officer (ADFO)
8:30	Committee Discussion	Chair
9:00	**DOE Oil and Gas Research Program** -- Marcellus Shale Project	Roy Long, Technology Manager, NETL Rick Hammack, NETL
	Committee Discussion	Chair
9:45	-- Cost-Shared Research ---Results and Accomplishments to date Small Producers Research	Bob Siegfried, President, RPSEA Kent Perry, Vice President Onshore, RPSEA
	Committee Discussion	Chair
10:15	*BREAK*	
10:30	---Results and Accomplishments to date Unconventional Resources Research	K. Perry
	Committee Discussion	Chair
Noon	*WORKING LUNCH*	
1:15	**Overview of the *Draft 2012 Annual Plan***	E. Melchert, Senior Program Manager, DOE
	Committee Discussion	Chair
2:15	*BREAK*	
2:30	Establish of ad hoc Review Subcommittees Appoint Subcommittee Chairs	Chair
4:45	Administrative Topics	CM
5:00 pm	Adjourn	Chair

APPROVED: _____ 17 Jan 2012

Christopher A. Smith, Designated Federal Officer — Date

Attachment 4

Unconventional Resources Technology Advisory Committee Meeting
January 18, 2012

U.S. Department of Energy – Office of Oil and Natural Gas

Christopher Smith Deputy Assistant Secretary	Designated Federal Officer
Elena Melchert	Committee Manager

National Energy Technology Laboratory

Roy Long	Strategic Center for Natural Gas & Oil
Eric Smistad	Strategic Center for Natural Gas & Oil
Jamie Brown	Office of Research & Development
Rick Hammack	Office of Research & Development
Kelly Rose	Office of Research & Development

Contractors

Bob Siegfried, RPSEA	President
Kent Perry, RPSEA	Vice President, Onshore
James Pappas, RPSEA	Vice President, Ultra-Deepwater
Rob Matey, IBM	Meeting General Support
Jennifer Presley, LTI	Registration Support

Unconventional Resources Technology Advisory Committee Meeting
Sign-In Sheet - January 18, 2012

Last Name	First Name	Organization	Initial
Arthur	Dan J.	ALL Consulting, LLC	**UNABLE TO ATTEND**
Bromfield	Kenneth	Dow Hydrocarbons and Resources, LLC	
Brown*	Nancy J.	Lawrence Berkeley National Laboratory	
Camp	Wayne K.	Anadarko Petroleum Corporation	
Cavens	Jessica J.	EnCana Oil & Gas (USA)	
Daugherty	Bill	Blackridge Resources	
Dwyer	James P.	Baker Hughes	
Hall	J. Chris	Drilling & Production Co.	
Hardage*	Bob	University of Texas at Austin	
Harju*	John A.	University of North Dakota	
Kleinberg	Robert L.	Schlumberger-Doll Research	
Lewis	Fletcher S.	Rainmaker Oil & Gas	
Mall	Amy	Natural Resources Defense Council	
Martin*	John P.	JPMartin Energy Strategy LLC	
Mason	Gregory	The Energy Cooperative	
Mohaghegh*	Shahab D.	West Virginia University	
Nilson	Gary J.	Pioneer Natural Resources USA, Inc.	
Oglesby	Kenneth D.	Acorn Resources, Inc.	
Rodgers	Brady D.	Focus Resources E&P	**UNABLE TO ATTEND**
Sparks	Don L.	Discovery Operating, Inc.	**UNABLE TO ATTEND**
Whitney	Sam W.	Shell E&P Company	

* Special Government Employee

Attachment 5

NATIONAL ENERGY TECHNOLOGY LABORATORY

NETL Sec. 999 Implementation Overview

Roy Long, Technology Manager, NETL

17th URTAC & UDAC Meetings, Houston, Texas

U.S. DEPARTMENT OF ENERGY

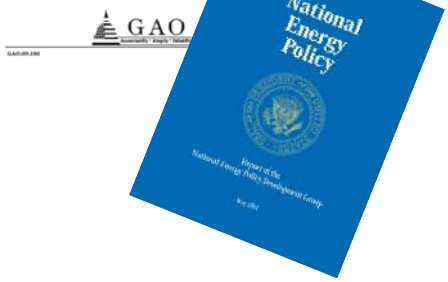
January 18, 2012

Outline: FY11 Implementation Overview

- **Meeting Statutory Requirements**
- **Streamlined Subcontracting Process**
- **RPSEA 2011 Solicitations**
- **Complementary Program Elements**
- **Traditional Program**
  - **FY10 Funded Ongoing Projects**
  - **FY12 Appropriations**
- **Integrated Technology Transfer Program**
  [Focus on Knowledge Management Database (KMD)]
  - KMD Statistics Measurement

Meeting Statutory Requirements

- Technical Committee Review Meeting
- Compliance Audits
- RPSEA Contract Management



Streamlined Subcontracting Process

Research Partnership to Secure Energy for America

Subcontract Notification and Certification Form under Prime Contract DE-AC26-07NT42677

In accordance with the Energy Policy Act of 2005 (EPAct 2005), RPSEA shall oversee the implementation of subcontracts under Section 999 of EPAct 2005, consistent with Subtitle J, Section 999, the Annual Plan, including disbursing funds and monitoring activities carried out under such subcontracts for compliance with the terms and conditions of the prime contract.

Subcontractor Name:			
Subcontractor's Address:			
Consortium Partners:			
Title of the Project:			
Access ID:			
Subcontract No:			
Subcontract Technical Representative:			
RPSEA Technical Representative:			
Technical Readiness and Compliance with EPAct 2005, Section 999:			
Subcontract Amount:	RPSEA Share		
Harvard Petroleum, Well Enhancement	Industry Cost Share		
	Total Project Cost		
RPSEA has reviewed and analyzed all proposed cost share. To the best of my knowledge, the cost share as reviewed and analyzed is allowable, allocable, verifiable, appropriately valued and from non-Federal sources.			
Industry Cost Share:			
Source (Name of the Organization):	Amount:	Nature: (Cash or In-kind)* Source:	
NM Institute of Mining and Technology		In-Kind	
Harvard Petroleum			
Well Enhancement Services			
RPSEA has included in the subcontract all prime contract award flow down requirements including Intellectual Property Provisions as appropriate.			
All negotiation issues were reviewed, discussed and mitigated.			

09123-03- New Mexico Institute of Mining and Technology
Notification and Consent Form

Research Partnership to Secure Energy for America

Department of Energy (DOE) Environmental Questionnaire (NETL Form 451.1-1/3) has been submitted to the NETL Contracting Officer's Representative for the proposed Subcontractor (as well as for any lower tier Subcontractor(s)).

In accordance with EPAct 2005, Section 999(c), 2.5% of the total amount of the subcontract has been designated for technology transfer and outreach activities.

*An in-kind contribution is a non-cash input which can be given a cash value. Examples include but are not limited to personnel, fringe benefits, travel, etc.

Attached is the approved Scope of Work for the above referenced project. Attached is a full listing of anticipated Subcontractor acquired property.

I, Robert W. Siegfried II, President of RPSEA, hereby certify that the information outlined above is current, accurate and factual. I request DOE's approval to enter into a binding subcontract with the New Mexico Institute of Mining and Technology.

Sincerely,

Robert W. Siegfried II
Date:

09123-03- New Mexico Institute of Mining and Technology
Notification and Consent Form

RPSEA 2011 Solicitations

2011 Small Producer Solicitation

- Opened: December 13, 2011
- Closes: February 27, 2012

2011 Unconventional Resources Solicitation

- Opened: December 20, 2011
- Closes: March 6, 2012

2011 UDW Solicitation

- Planned opening in March/April timeframe

EPAct Complementary Program FY12 Research Portfolio

FY12 Complementary Program Unconventional Resources Overview

1. Characterize baseline environmental signals - Field
2. Fugitive air emissions - Field + Modeling
3. Produced water - Field + Laboratory
4. Fluid-gas-rock interactions in shale - Field + Laboratory
5. Prediction of fracture propagation - Existing Data + Laboratory + Modeling
6. Coupling microseismic measurements and geomechanical models - Existing Data + Field + Modeling
7. Naturally-occurring isotope tracers - Field + Laboratory
8. High-TDS water and gas in shallow reservoirs - Existing Data + Modeling
9. Integrated assessment model for predicting potential risks to groundwater - Field + Existing Data + Laboratory + Modeling

FY12 Complementary Program Ultra-Deepwater Overview

10. Metallic components & cement barriers - Existing Data + Laboratory + Modeling
11. Multiphase Fluids in HPHT systems - Existing Data + Laboratory + Modeling
12. Flow assurance & quantification - Field + Existing Data + Laboratory + Modeling
13. Systems Models for Risk Prediction & Response (subsurface, wellbore & water column) - Existing Data + Modeling

Traditional Program Overview
(Supported by FY10 Funding)

- **67 Projects (excludes Hydrates and Section 999 projects)**
- **$121 MM Total Value ($85 MM Gov't. Share, $36 MM Cost-Share)**
- **Current projects from prior year funding:**
  - Fracture Flowback & Produced Water Treatment and Mgmt.
  - Environmental Impact Mitigation
  - Water Resources Management
  - Enhanced Oil Recovery
  - Unconventional Oil Production
  - Increasing Domestic Oil and Gas Production
  - Reservoir Characterization
  - Drilling/Completion/HPHT Downhole Tools
  - Seismic Technology
  - Oil and Gas Infrastructure-Related
  - Technology Transfer

Traditional Program Overview
(FY12 Appropriations)

$20 million in FY12

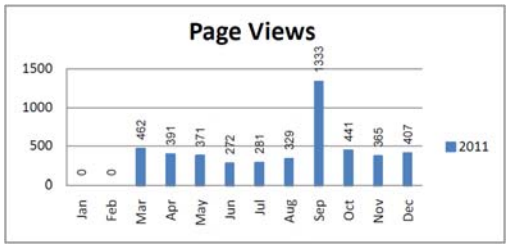
- **$10 million hydrates**
- **$5 million (balance of NG)**
  - ➢$2 million for GWPC/RBDMS
- **$5 million (Unconventional FE technologies: CO^2 EOR)**

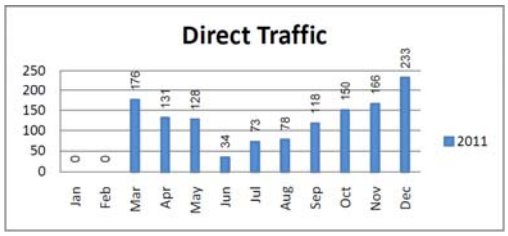
Integrated Technology Transfer Program
[Focus on Knowledge Management Database (KMD)]

Knowledge Management Database (KMD):

FE's First "One Stop Shopping" for all Current and Historical DOE Oil & Gas R&D

More than 30,000 records and reports of R&D in upstream oil and gas





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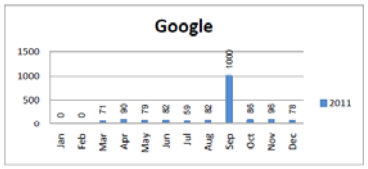
NATIONAL ENERGY TECHNOLOGY LABORATORY

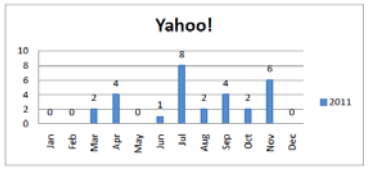
www.netl.doe.gov/kmd

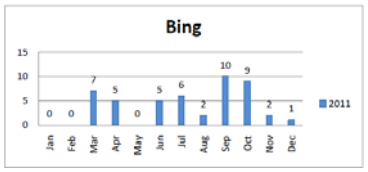
Integrated Technology Transfer Program
[Focus on Knowledge Management Database (KMD)]

Knowledge Management Database (KMD):

Monitoring Referrals from Major Search Engines







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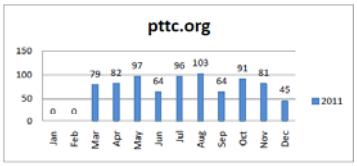
NATIONAL ENERGY TECHNOLOGY LABORATORY

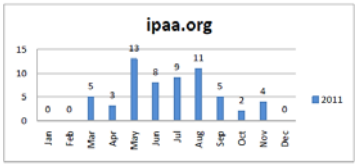
www.netl.doe.gov/kmd

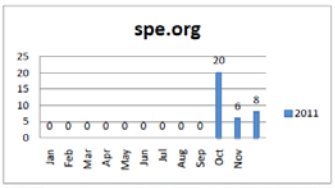
Integrated Technology Transfer Program
[Focus on Knowledge Management Database (KMD)]

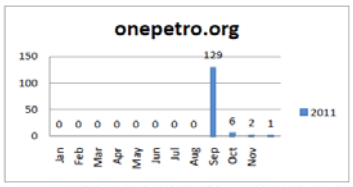
Knowledge Management Database (KMD):

Monitoring Referrals from Industry Stakeholders







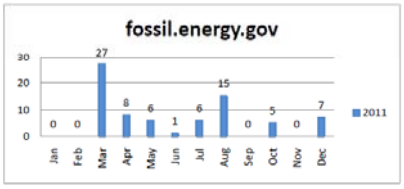


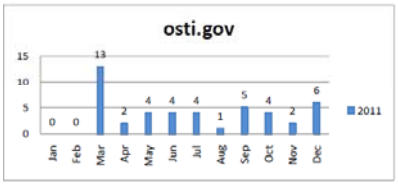
www.netl.doe.gov/kmd

Integrated Technology Transfer Program
[Focus on Knowledge Management Database (KMD)]

Knowledge Management Database (KMD):

Monitoring Referrals from Our Federal Stakeholders





www.netl.doe.gov/kmd

Questions

Attachment 6

NATIONAL ENERGY TECHNOLOGY LABORATORY

EPAct Complementary Program- Unconventional Resources

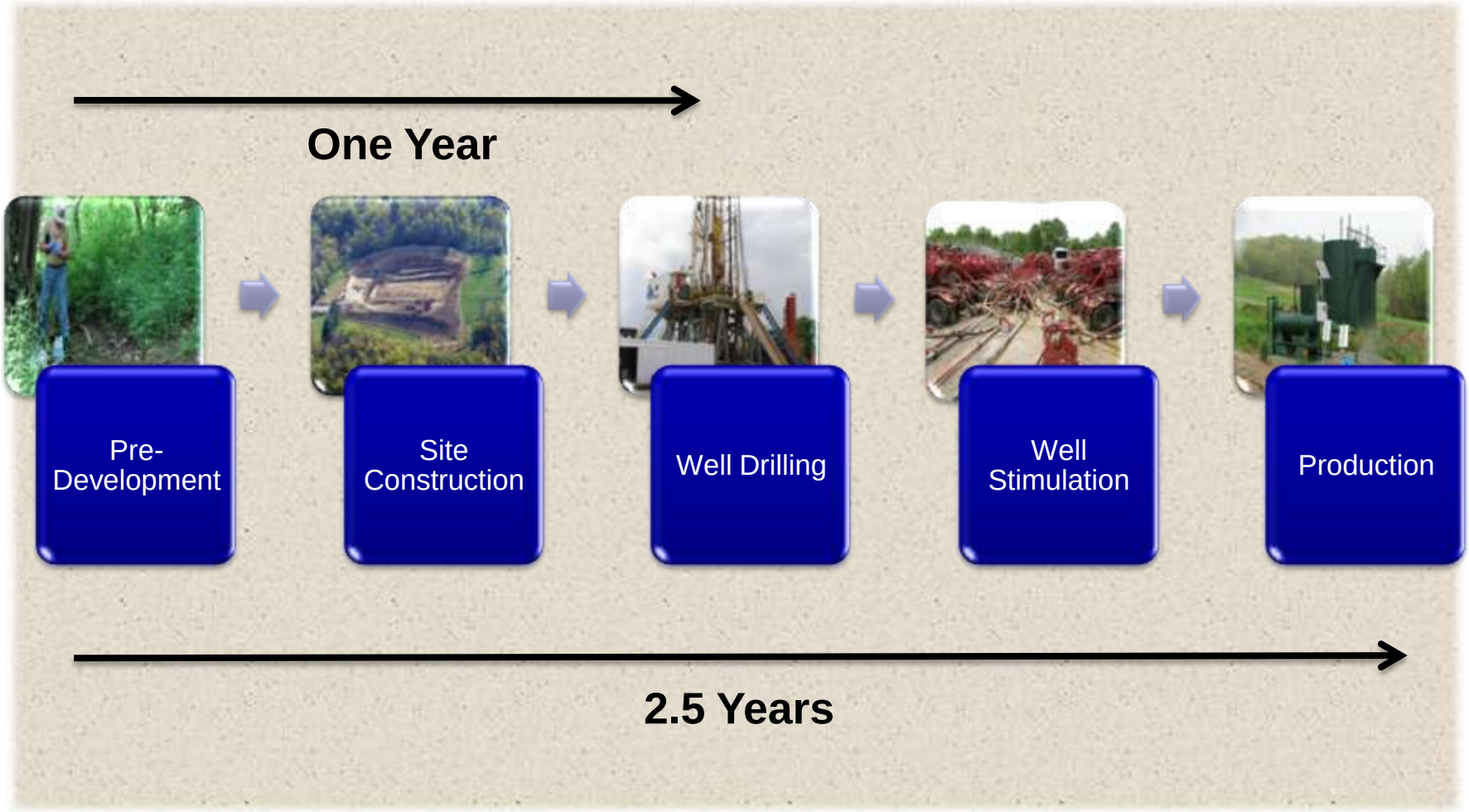
Office of Research and Development

January 18, 2012

NETL-RUA Regional University Alliance

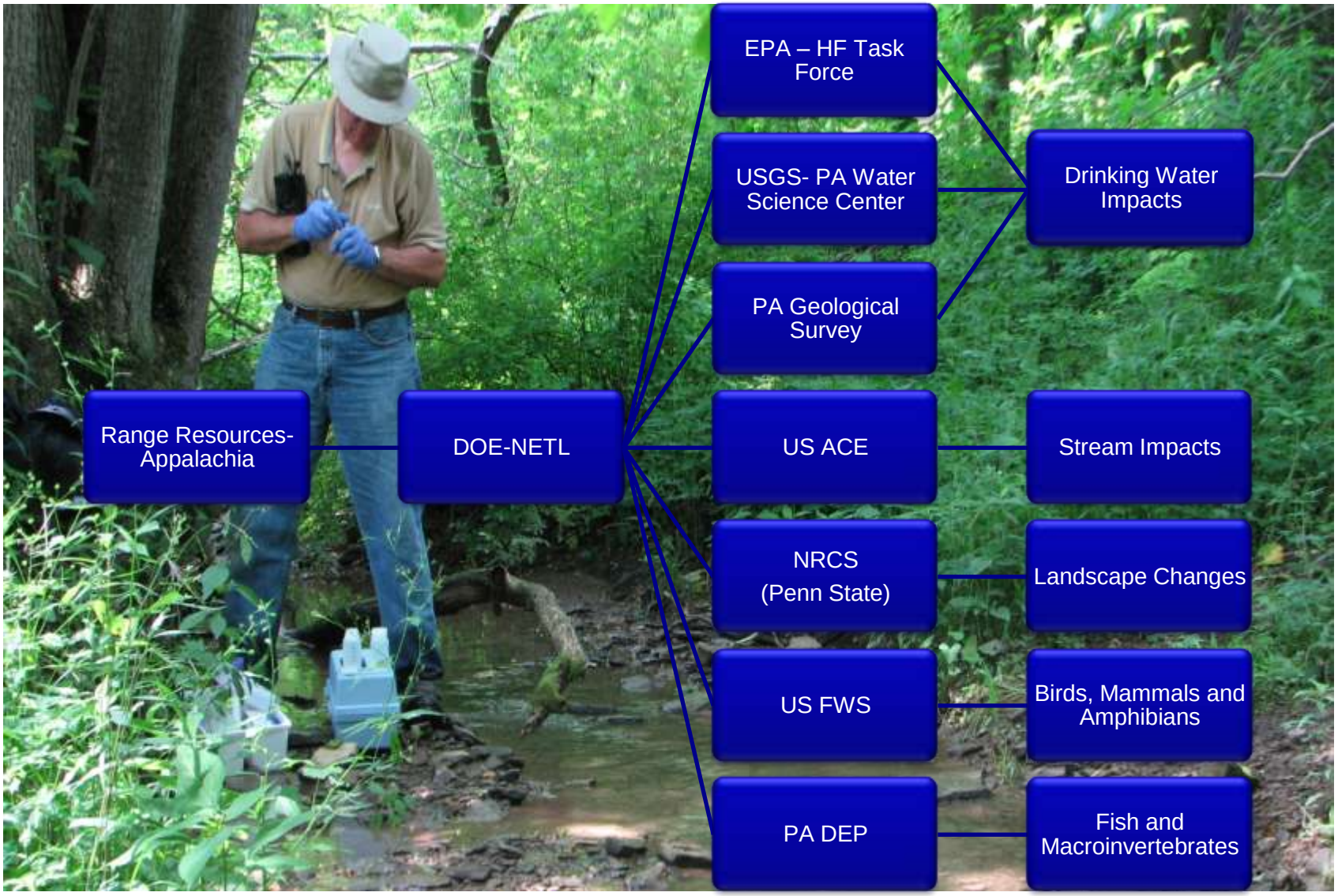
U.S. DEPARTMENT OF ENERGY

1. Characterize Baseline Environmental Signals



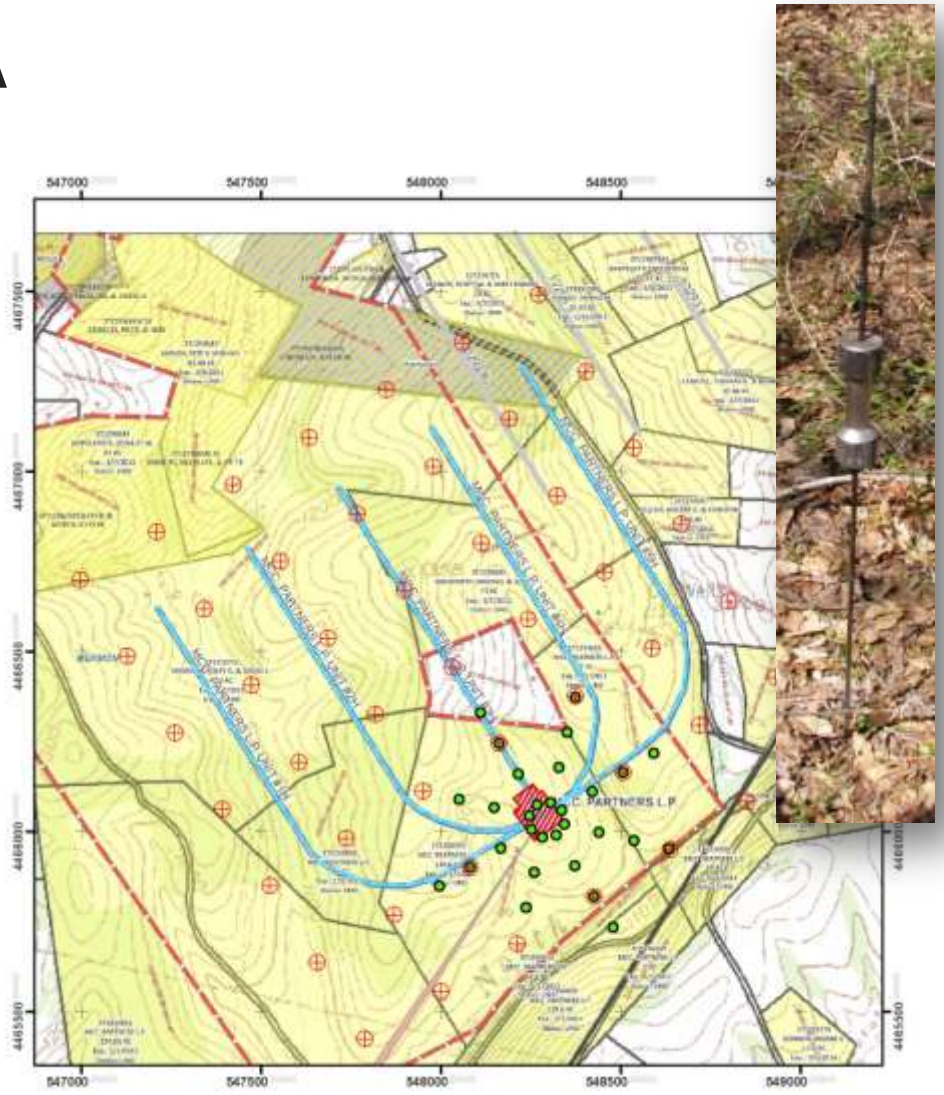
Marcellus Test Site

Range Resources Site-Monitoring Team



Fugitive Methane

- Groundwater- USGS/EPA
- Soil Gas- NETL
- Atmosphere- NETL



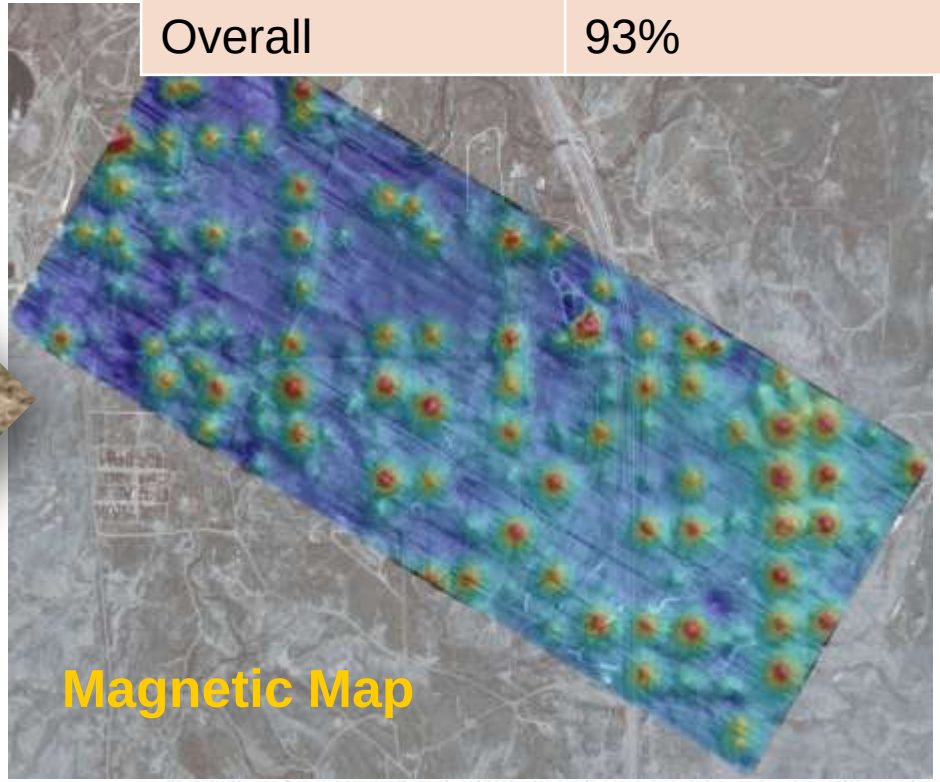
Migration of Production Fluids

- Groundwater- USGS/EPA
- Streams- NETL/USACE/PADEP
- Electromagnetic Surveys - NETL

Abandoned Wells

- **Well Database- PAGS**
- **Helicopter Magnetic Surveys- NETL**

Completion Date	Wells Found
1912-1926	100%
1965-1990	82%
Overall	93%



2. Fugitive Air Emissions

- **Ambient Air Quality- NETL**

Mobile Air Monitoring Laboratory

- **VOC's** (52 components on the EPA PAMS list)
- **CH_4 and CO_2** w/isotope speciation
- **Ozone**
- **SO_2**
- **NO_x** (NO, NO_2 and $NO+NO_2$)
- **$PM_{2.5}$ and PM_{10}**
- **Ammonia**
- **Organic and Elemental Carbon in Aerosols**
- **Nephelometer** (measures scattering of light from particles, gives visual range)
- **Meteorological station** (temperature, relative humidity, wind speed, wind direction, rainfall, solar radiation)
- **Radon**

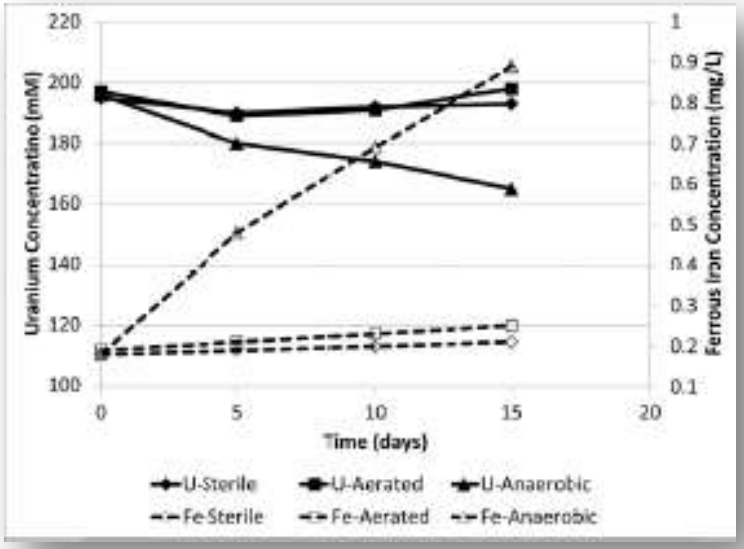
3. Produced Waters

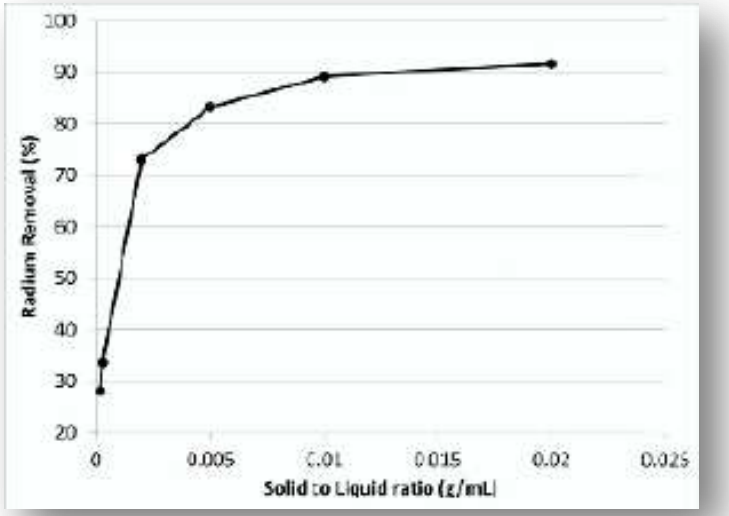
1. Inorganic Components
2. Organic Components
3. Isotopic Characterization
4. NORM
5. Microbial Ecology

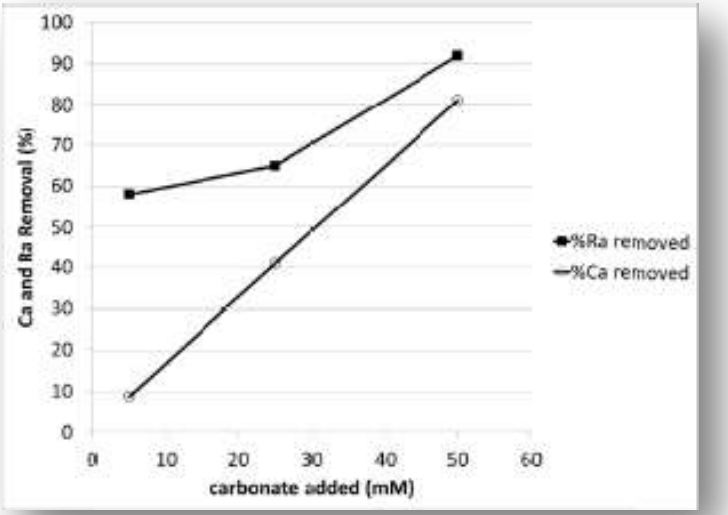
LC-Q-TOF

3. Produced Waters

- **NORM (Pitt, CMU)**

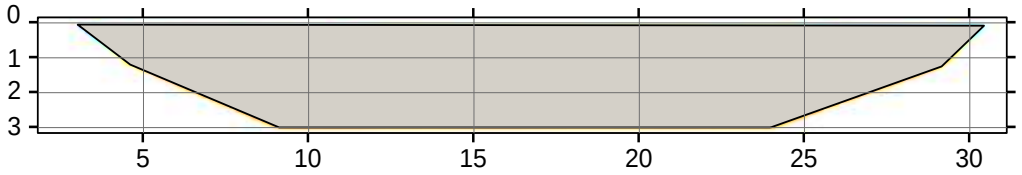






3. Produced Waters

- **Pit Chemistry**



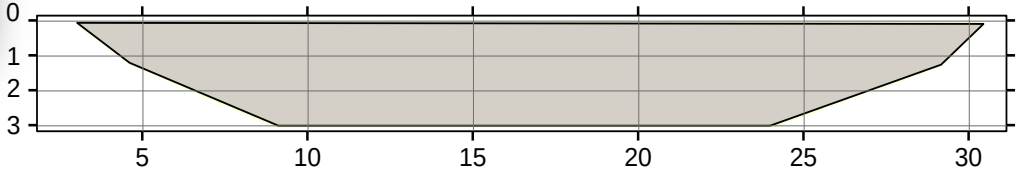
Explanation

Conductivity at center transect (Sept 9, 2011)

Value

High : 65000

Low : 20000



Explanation

Conductivity at center transect (Sept 23, 2011)

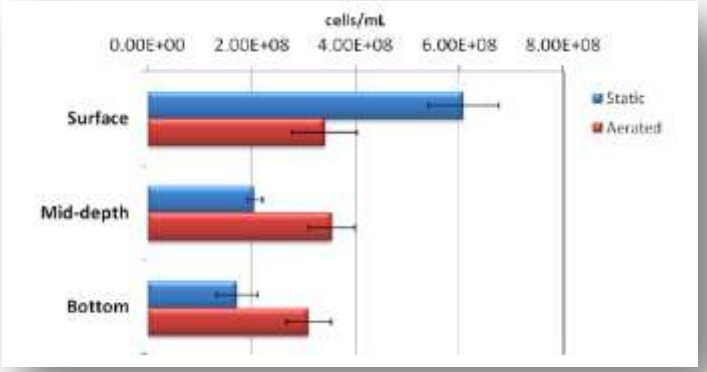
Value

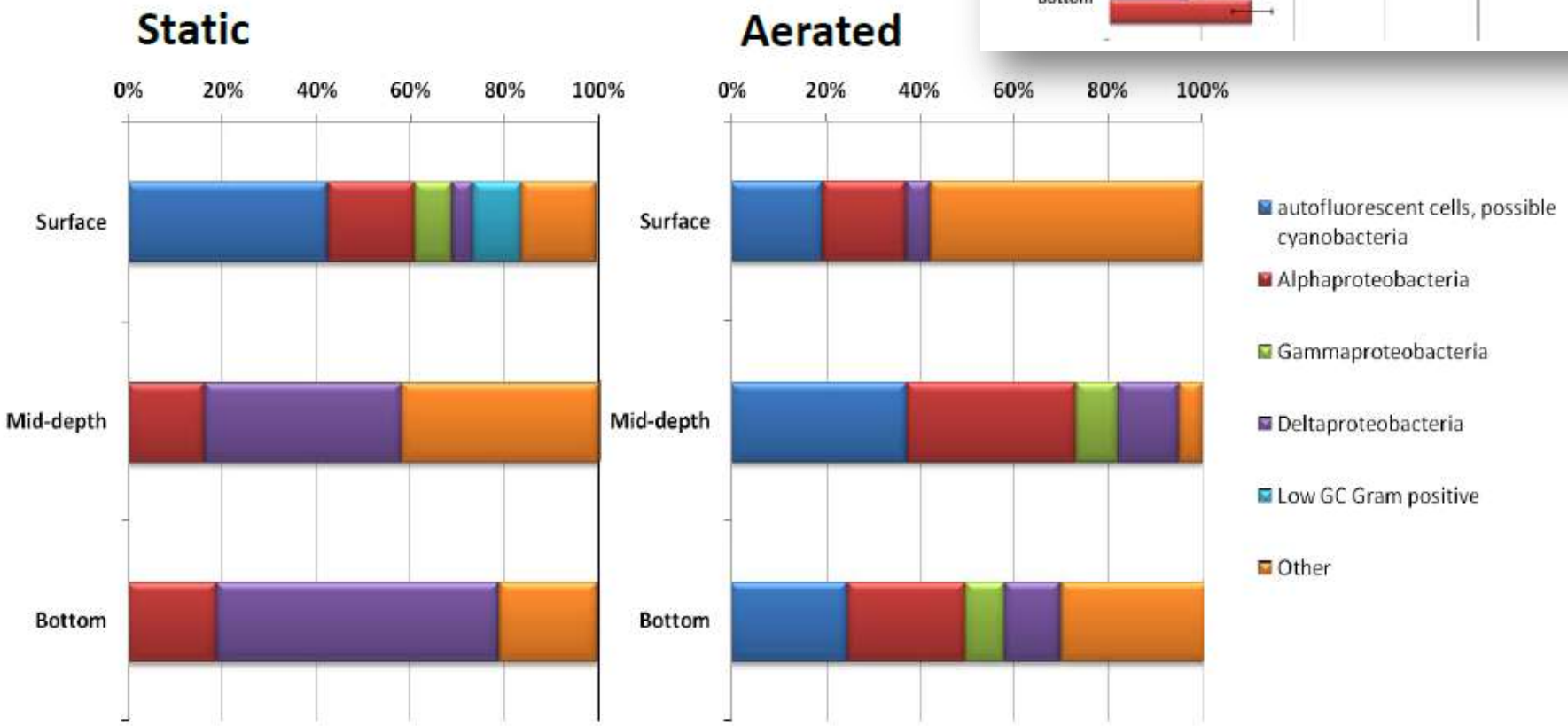
High : 65000

Low : 20000

3. Produced Waters

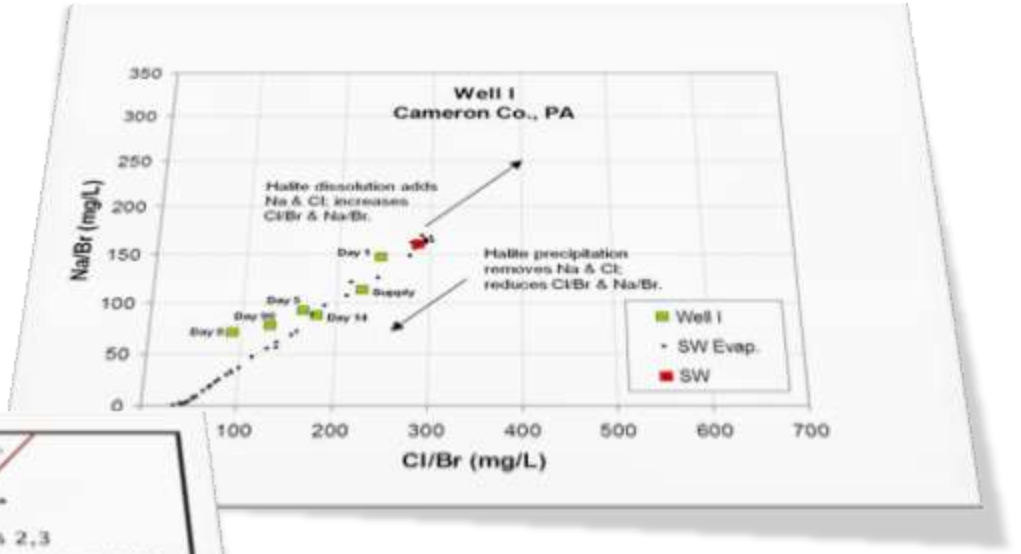
- **Microbial Ecology**

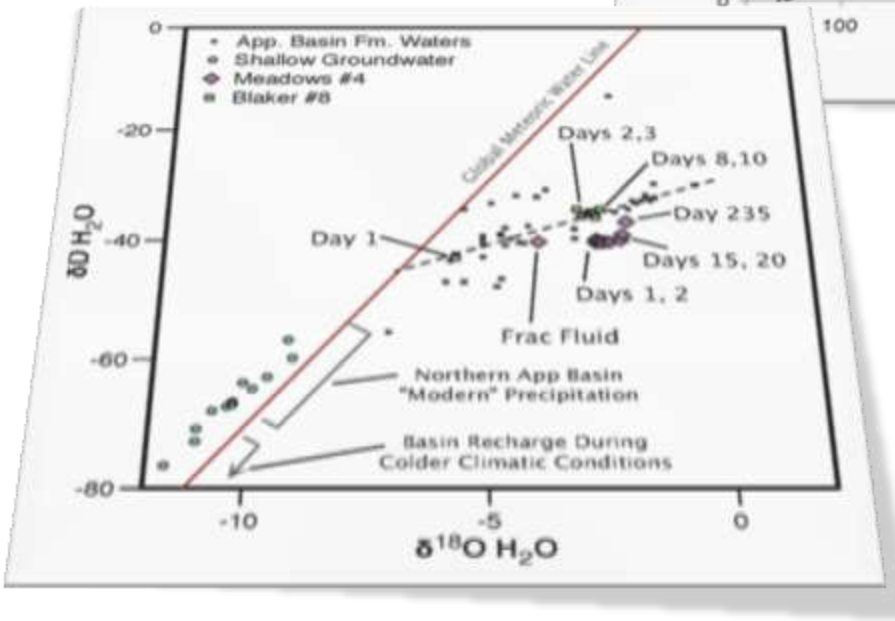




4. Fluid-Gas-Rock Interactions in Shale

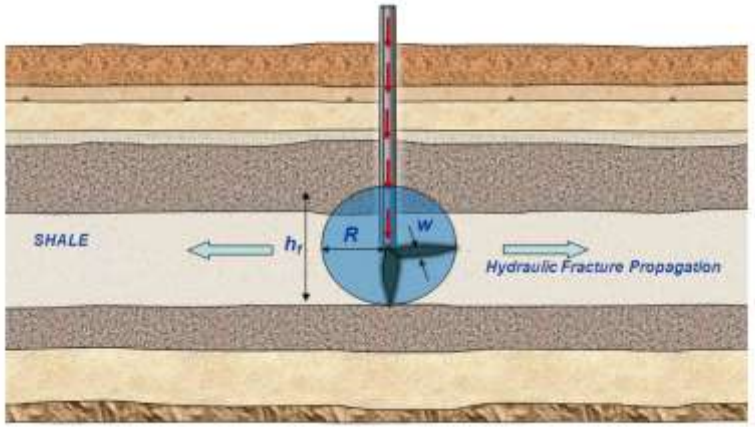
1. Sources of TDS
2. Fate of frac water
3. Water imbibition
4. NORM

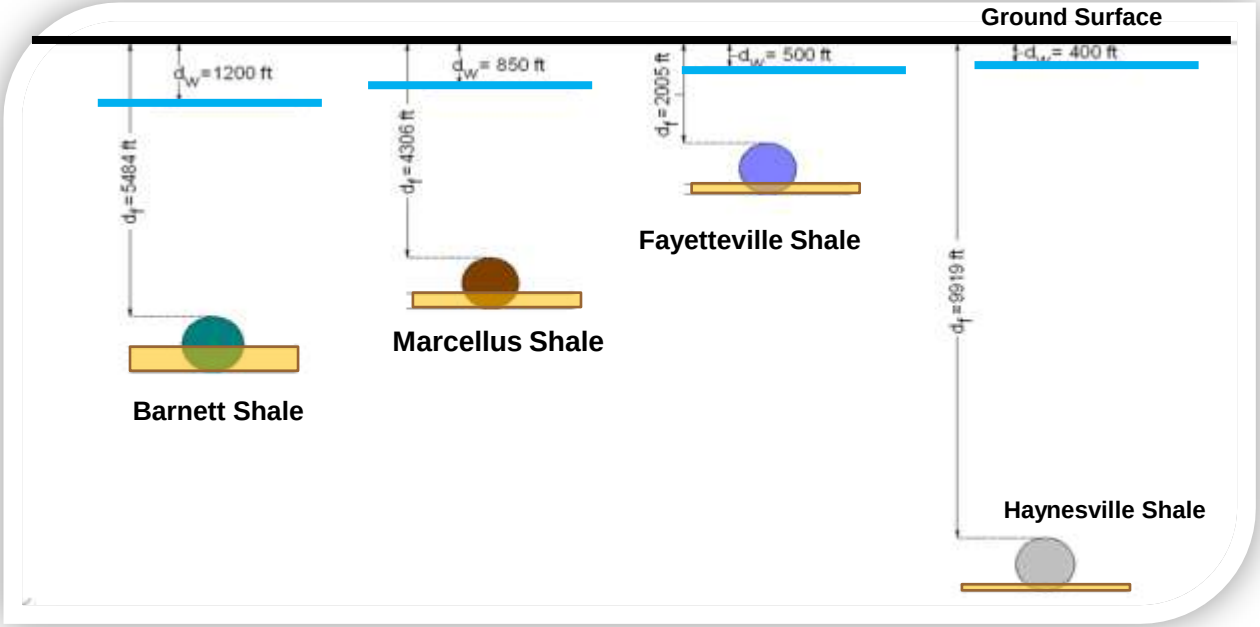




5. Prediction of Fracture Propagation

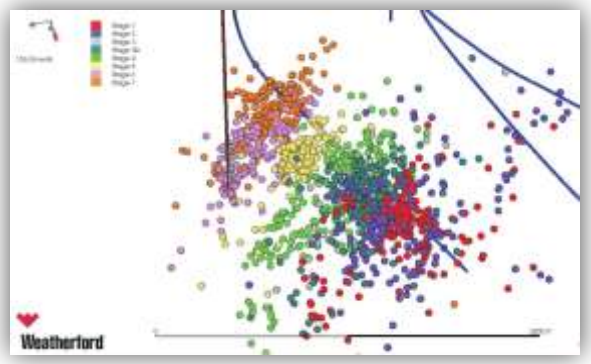
1. **Laboratory measurements of rock properties**
2. **Geomechanical modeling**





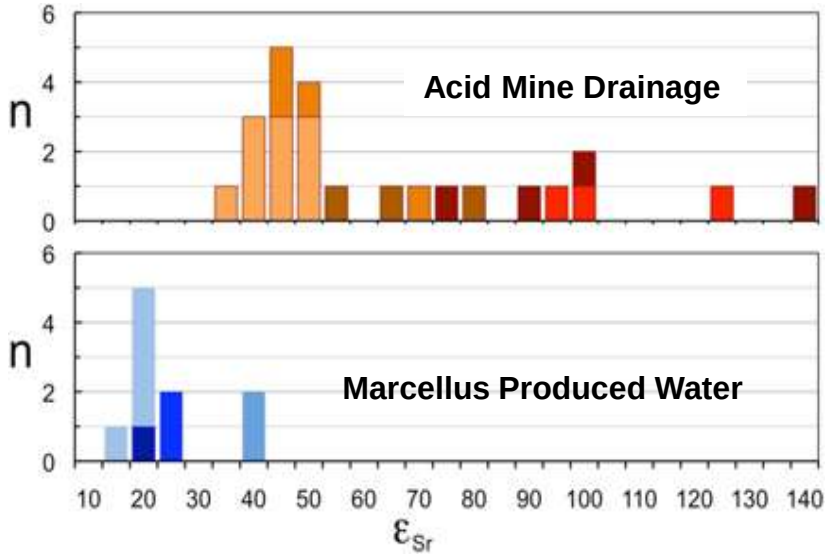
6. Coupling Microseismic Measurements and Geomechanical Models

1. **Geomechanical Modeling**
2. **Microseismic Monitoring**
    1. ECA Site
    2. RPSEA GTI (Range Resources)
3. **Tiltmeters**
4. **Pressure Perturbation**
5. **Gas-Phase Tracers**



7. Naturally Occurring Isotope Tracers

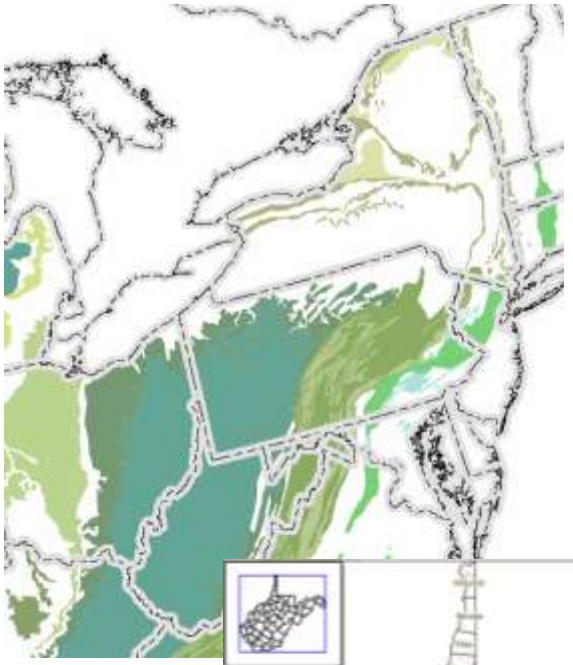
1. **Indication of Fluid Source or Reactive Pathway**
2. **Develop Rapid Analysis Method**
3. **Identify Isotopic Signature for Marcellus Waters**



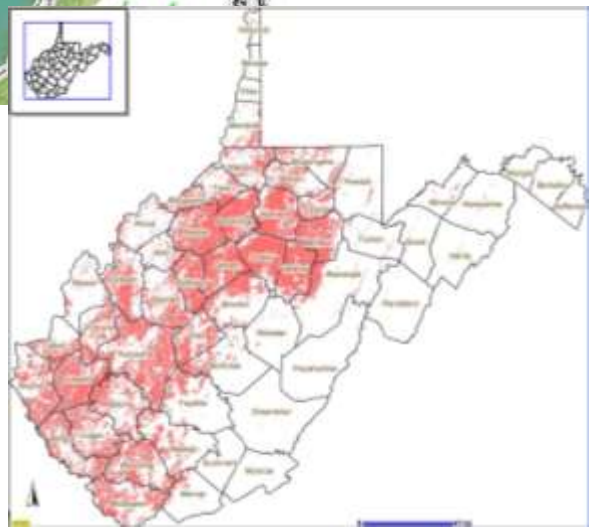
Multicollector ICP-MS

8. High-TDS Water and Gas in Shallow Reservoirs

1. **Compile Data from Public Sources**
2. **Include Aggregated Data from Industry (protective of landowner privacy)**
3. **Develop Data Tools to Evaluate Methane and High-TDS Fluid Distribution**
4. **Share Information with Public**



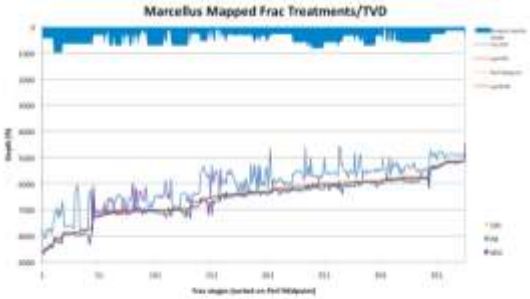
Regional Shallow Aquifers, USGS Groundwater Atlas Data

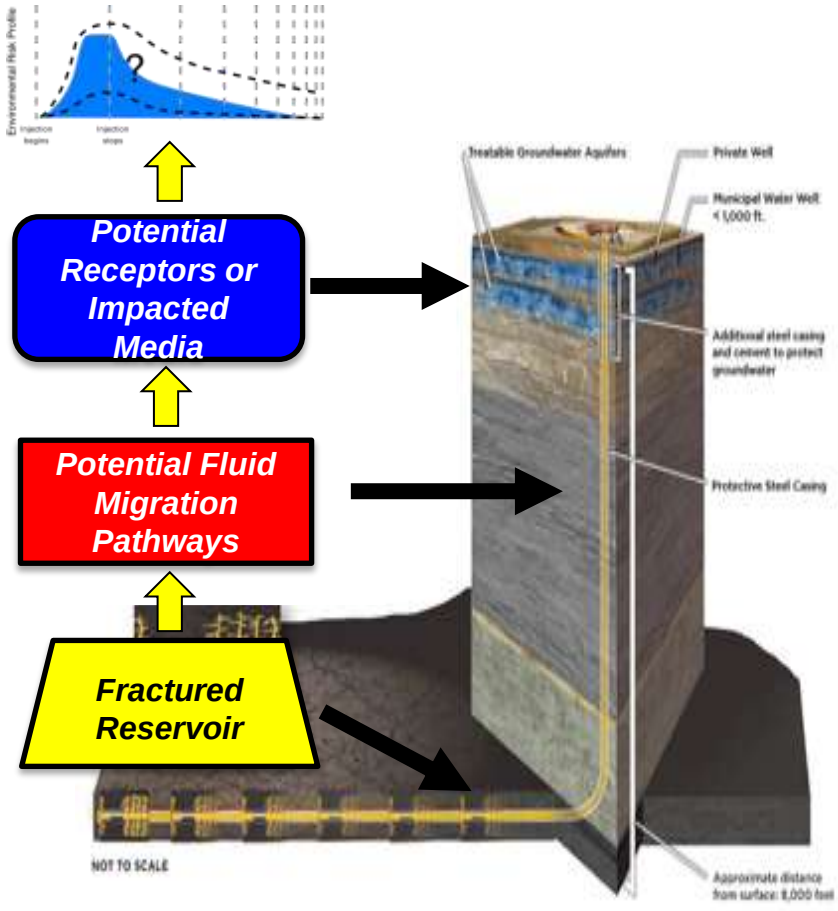


Existing Gas Well Distribution Source: West Virginia Geological and Economic Survey

9. Integrated Assessment Model for Predicting Risks to Groundwater

1. **Develop Integrated Assessment Model that Predicts Risk to Groundwater and Surface Waters**
    1. Establish Representative Scenario
    2. Build Subsystem Model Elements, Subsystem Linkages, and Exercise IAM for Select Scenario
    3. Generate First Generation Risk Profiles w/ Sensitivity Analysis and Uncertainty Quantification





Pinnacle

Attachment 7

RPSEA

Research Partnership to Secure Energy for America

Unconventional Onshore & Small Producer FACA Meeting

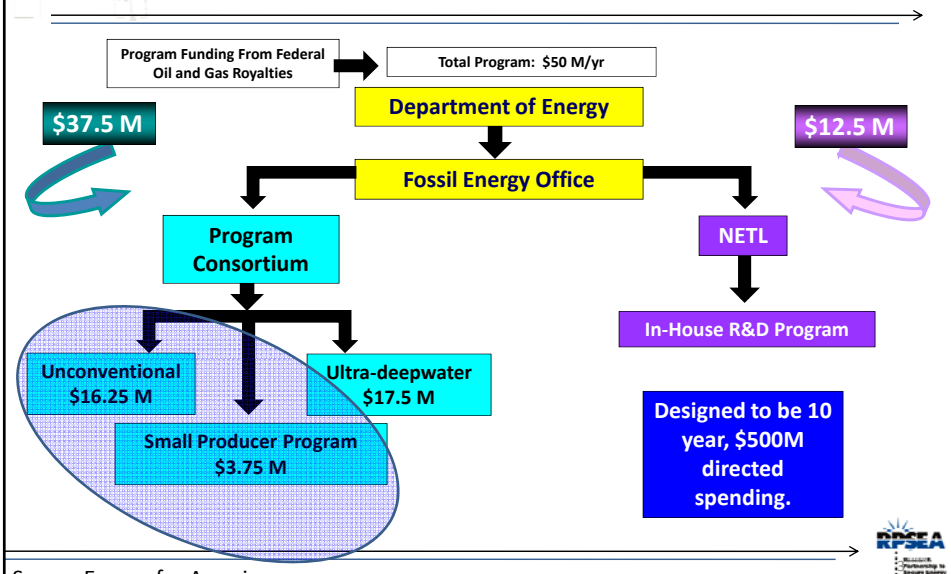
Kent F. Perry

January 18, 2012
Houston, TX

Topics

- RPSEA Organization
- Small Producer Program Element
- Unconventional Resources Program Element

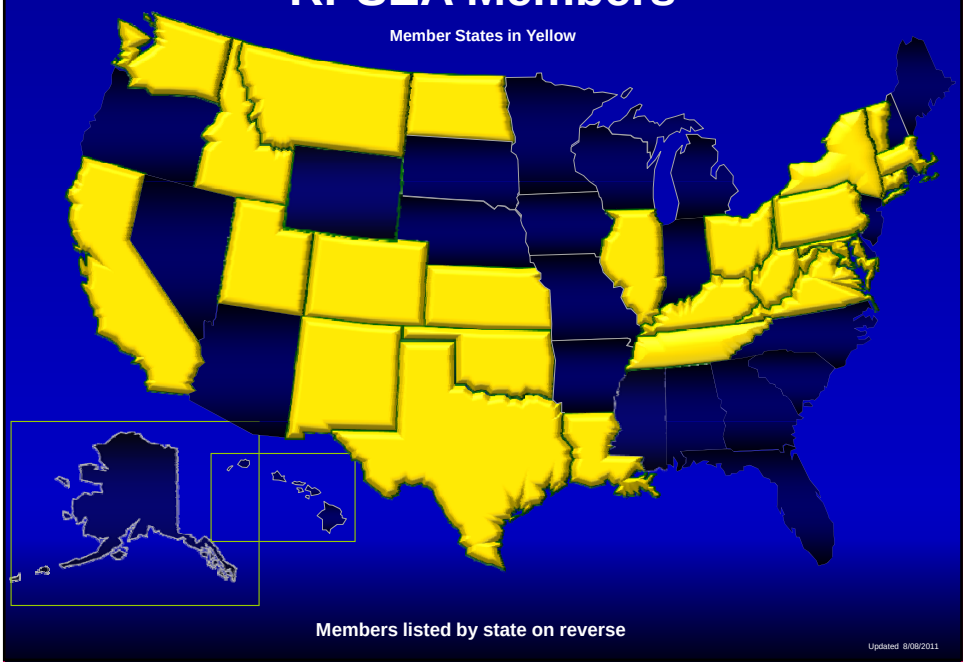
Current Program Structure/Funding



Secure Energy for America

RPSEA Members

Member States in Yellow



Members listed by state on reverse

Updated 8/08/2011

California
Chevron Corporation
Conservation Committee of California Oil & Gas Producers
Drilling & Production Company
Jacobs Engineering Group Inc.
Lawrence Berkeley National Laboratory
Lawrence Livermore National Laboratory
Jet Propulsion Laboratory
Natural Carbon, LLC
Paulsson, Inc.
SR2020 Inc.
Stanford University
University of Southern California

Colorado
3D at Depth, LLC
Altira Group LLC
Bill Barrett Corporation
Colorado Oil & Gas Association
Colorado School of Mines
DCP Midstream, LLC
EnCana Corporation
Energy Corporation of America
Foro Energy
Gunnison Energy Corporation
Julander Energy Company
Leede Operating Company
NiCo Resources
Noble Energy, Inc.
Robert L. Bayless, Producer LLC
Spatial Energy
University of Colorado at Boulder
Western Energy Alliance

Connecticut
APS Technology, Inc.

Idaho
Idaho National Laboratory

Illinois
Gas Technology Institute

Kansas
The University of Kansas

Kentucky
Greensburg Oil, LLC
NGAS Resources, Inc.

Louisiana
HydroFlame Technologies, LLC
Louisiana State University

Maryland
Lockheed Martin Corporation

Massachusetts
Entropy Risk Management, Inc.
Massachusetts Institute of Technology
Woods Hole Oceanographic Institution

Montana
KC Harvey Environmental, LLC
Nance Resources

New Mexico
Correlations Company
Harvard Petroleum Corporation
Independent Petroleum Association of New Mexico
Los Alamos National Laboratory
New Mexico Institute of Mining and Technology
Sandia National Laboratories
Strata Production Company

New York
Hess Corporation

North Dakota
Laserlith Corporation

Ohio
NGO Development Corporation
The Ohio State University
Wright State University

Oklahoma
Chesapeake Energy Corporation
Devon Energy Corporation
Interstate Oil and Gas Compact Commission
Oklahoma Independent Petroleum Association
Oklahoma State University
MAP Royalty, Inc.
Panther Energy Company, LLC.
Petroleum Technology Transfer Council
The Fleischaker Companies
The University of Oklahoma
The University of Tulsa

Pennsylvania
The Pennsylvania State University

Tennessee
Oak Ridge National Laboratory

Texas
Advantek International Corp.
AGR Subsea, Inc.
Alcoa Oil and Gas
AMOG Consulting, Inc.
Anadarko Petroleum Corporation
Apache Corporation
At Balance Americas L.L.C.
Athens Group
Baker Hughes Incorporated
BG Group plc
Blade Energy Partners, Ltd.
BJ Services Company
BP America, Inc.
BMT Scientific Marine Services Inc.
Cameron/Curtiss-Wright EMD
CARBO Ceramics, Inc.
CDL Inc
ConocoPhillips Company
Consultate LLC
Consumer Energy Alliance
CSI Technologies,Inc.
Cubility
DeepFlex Inc.
Deepwater XLP Technology, LLP
Det Norske Veritas (USA)
DOF Subsea USA
Energy Valley, Inc.
Energy Ventures
ExxonMobil Corporation
GE Oil & Gas
General Marine Contractors, LLC
Granherne, Inc.
Greater Fort Bend Economic Development Council
GSI Environmental, Inc.
Halliburton
Hamilton Group
HIMA Americas, Inc
Hoerbiger Corporation of America Inc.
Houston Advanced Research Center
Houston Offshore Engineering, LLC
Houston Technology Center
Knowledge Reservoir, LLC
Konsberg Oil & Gas Technologies Inc.
Kvaerner
Letton-Hall Group
Marathon Oil Corporation
M&H Energy Services
Merrick Systems, Inc.
Nalco Company
NanoRidge Materials, Inc.
Nautilus International, LLC
Nautronix, Inc.
Neptec USA
Nexen Petroleum USA Inc.
Oceaneering International, Inc.
Octave Reservoir
OTM Consulting Ltd.
Oxane Materials, Inc.
Peritus International Inc.
Petris Technology, Inc.
Petrobras America, Inc.
Pioneer Natural Resources Company
QO Inc.
Quest Offshore Resources
Radoil, Inc.
Rice University
Rock Solid Images
Roxar
RTI Energy Systems
Schlumberger Limited
Shell International Exploration & Production
Siemens Energy, Inc.
Southern Methodist University
Southwest Research Institute
Statoil
Stress Engineering Services, Inc.
Subsea Riser Products
Technip
Technology International
Tejas Research & Engineering, LP
Tenaris
Texas A&M University
Texas Energy Center
Texas Independent Producers and Royalty Owners Association
Texas Tech University
The Research Valley Partnership, Inc.
The University of Texas at Austin
Titanium Engineers, Inc.
TOTAL E&P USA, Inc.
Tubel Energy LLC
University of Houston
Water Standard
Weatherford International Ltd.
WFS Energy & Environment
2H Offshore Inc.

Utah
The University of Utah

Vermont
New England Research, Inc.

Virginia
Advanced Resources International, Inc.
Independent Petroleum Association of America

Washington
BlueView Technologies, Inc.

Washington D.C.
Consortium for Ocean Leadership
Hogan Lovells US LLP

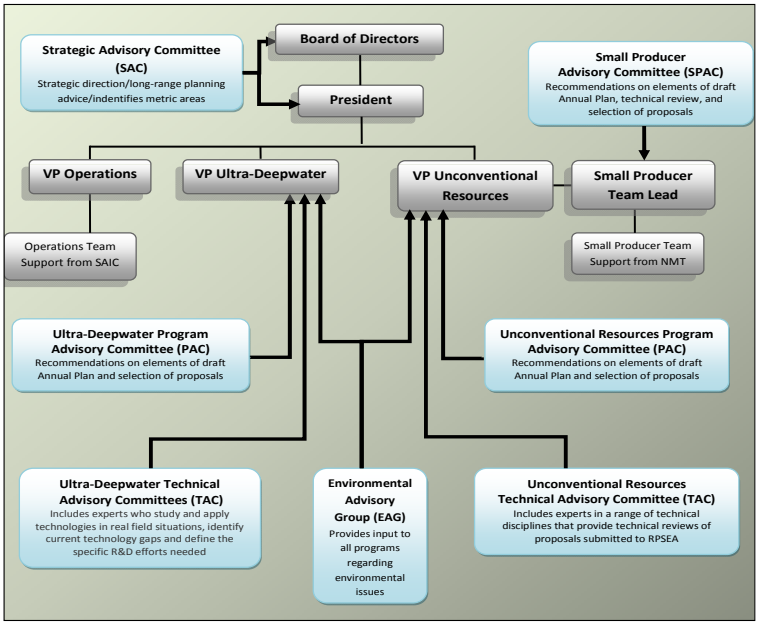
West Virginia
West Virginia University

Alberta, Canada
C-FER Technologies

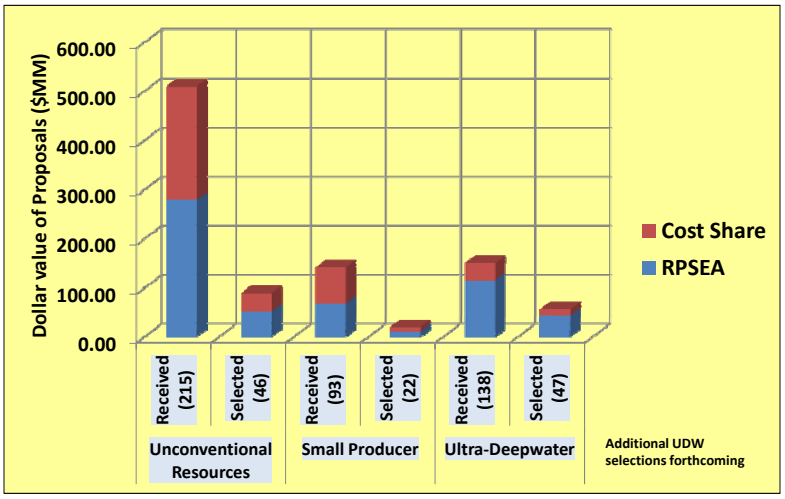
Newfoundland, Canada
Propel Inc.

Pending Member Company Name

RPSEA Organization



2007-2010 Proposals



Secure Energy for America

Portfolio Overview by Type of Research Organization

RPSEA Program Selections 2007-2010				
	Small Producer	Unconventional Resources	Ultra-Deepwater*	Total
Universities	15	30	10	55
For Profits	5	5	30	40
Non-Profits	1	5	6	12
National Labs	1	3	1	5
State Agencies	0	3	0	3
Total Selected	22	46	47	115

* Additional selections to be made

Secure Energy for America

Topics

- RPSEA Organization
- **Small Producer Program Element**
- Unconventional Resources Program Element

Annual Plan (s) – Small Producer Program

- **Mission & Goals**
  - **Increase supply from mature resources**
    - **Reduce cost**
    - **Increase efficiency**
    - **Improve safety**
    - **Minimize environmental impact**
- **Objectives**
  - **Near Term**
    - **Improve water management & optimize water use.**
    - **Improve oil & gas recovery in mature fields, extending economic life, while protecting the environment.**
    - **Reduce field operating costs.**
  - **Longer Term**
    - **Apply developed technologies to new basins/areas.**
    - **Ongoing development of new technologies.**

Small Producer Program

- **Technology Challenges**
  - Water management
  - Improve recovery/extend economic life of reservoirs
  - Reduce field operating costs and decrease environmental impact
  - Well monitoring and reservoir modeling to allow efficient field operations
  - Improved methods for well completions and recompletions
  - Well and field data management
  - Capture and reuse of waste products to reduce costs or increase recovery
  - Leverage existing wellbores and surface footprint to maximize recovery
  - Novel Concepts to increase production from mature fields
  - Field tests of emerging technology

Small Producer Program – 2007-2010 Projects

- **22 projects addressing concerns of small producers operating mature assets**
  - **Produced water treatment (2)**
  - **Reservoir Characterization (4)**
  - **Enhanced oil and gas recovery (8)**
  - **Environmental impact & increased efficiency (4)**
  - **Stimulation, improved recovery and sweep efficiency (4)**
- **Projects each involve a consortium of researchers and small producers**
- **Small Producer Advisory Committee (SPAC) actively involved**

12

Small Producer Program - 2011 RFP

- **2011 goal of the Small Producer Program :**
  - **Extend the Economic Life of Mature Fields Through Environmentally Responsible Efficiency Improvements.**
- **Scope includes:**
  - **Water Mgmt.**
  - **Reservoir Mgmt.**
  - **Remediation**
  - **Environmental Mgmt.**
  - **Utilizing Existing Wellbores and Surface Footprint**

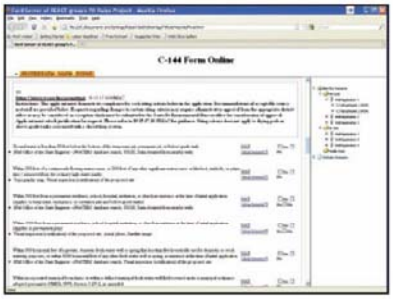
Secure Energy for America

13

Reducing Impacts of New PIT Rules on Small Producers

Environmental, Safety and Regulatory--completed

Project Goal: to provide a web portal allowing users to easily obtain a variety of data required in filling out various O&G permits in New Mexico



The electronic NMOCD C-144 form on the portal. The application may be submitted electronically, and questions may be answered and supporting maps generated and attached to document the site application.

New Mexico Institute of Mining & Technology

19

Field Site Testing of Low Impact Oil Field Access Roads: Reducing the Footprint in Desert Ecosystems

Environmental, Safety and Regulatory

Project Goal:
Testing innovative, minimal impact road designs for reducing the environmental footprint of field development in sensitive desert ecosystems

Scott's Environmental Artificial Gravel Road

Newmark Mat Road

University of Wyoming and Heartland Biocomposites Inc, Laydown Road

Texas Transportation Institute,
Texas A&M University
Scott Environmental Services
Newpark Mats & Integrated Services
Inland Environmetal
McFaddin Ranches

Texas A&M University

15

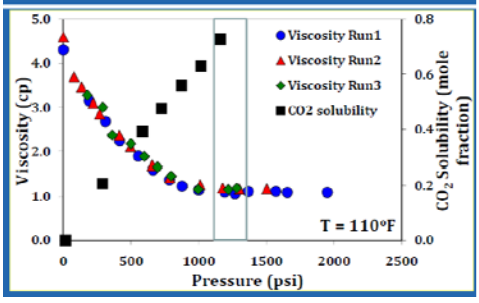
Near Miscible CO_2 Application to Improved Oil Recovery for Small Producers

Increased Recovery—completed project

Project Goal: investigate possibility of using CO2 for EOR in mature fields that are near or below miscibility pressures.

- **Oil recovery efficiency was increased by 1.3 to 4.8% as a result of the injection of CO2.**
- **Improved recovery efficiency is likely resulting from the improvement of relative mobility ratio of the CO2 and oil and the efficacy of CO2 extraction.**
- **Effective storage capacity of CO2 varied from 39 to 63%.**

Effect of CO_2 Dissolution into Crude Oil



Carmen Schmitt, Inc.

University of Kansas

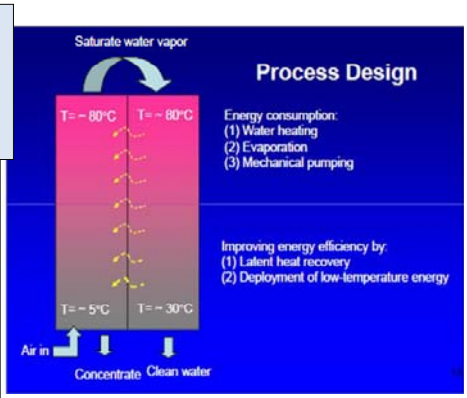
16

Cost-Effective Treatment of Produced Water Using Co-Produced Energy Sources for Small Producers

Environmental, Safety and Regulatory

Project goal: Development and demonstration of a low-temperature distillation using co-produced energy sources for produced water purification at wellhead.

- Prototype design capacity 20 bbl/day
- TDS reduced from 1.98×10^4 to 76.75 mg/L
- Total organic carbon was reduced from 470.2 to 17.83 mg/L.
- Purified produced water is suitable for alternative uses, such as agriculture, irrigation and industrial processing.



Harvard Petroleum Company

New Mexico Institute of Mining & Technology

17

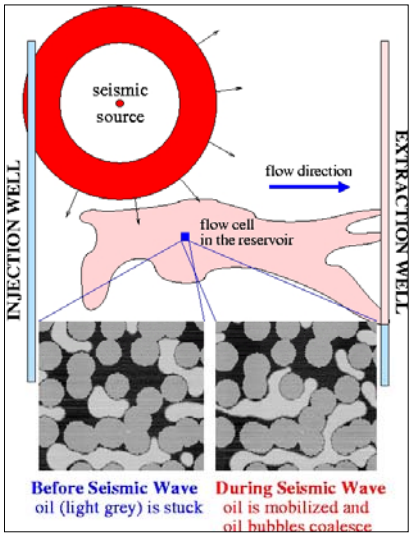
Seismic Stimulation to Enhance Oil Recovery

Increased Recovery

Project goals:
Test the effectiveness of seismic stimulation in EOR, and use reservoir simulation to help determine the optimum placement of a seismic source within a reservoir.

A seismic wave is to "***shake the stuck oil loose***" and get it flowing again toward a production well.

U.S. Oil & Gas Corporation,
Berkeley GeoImaging Resources



Lawrence Berkeley National Laboratory

18

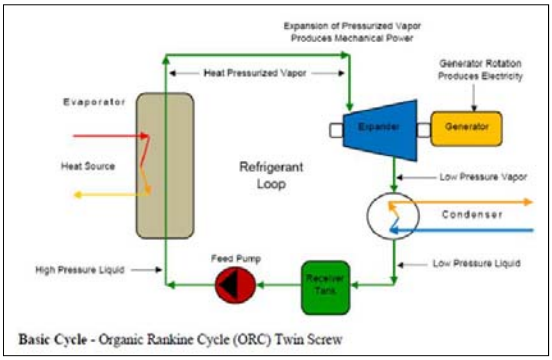
Electrical Power Generation from Produced Water: Field Demonstration of Ways to Reduce Operating Costs of Small Producers

Operations

Project Goal: using heat in produced water to create electricity.

Identify and demonstrate technology that will reduce the field operating cost of electricity

Minimize the environmental impact by creating green electricity using produced water and no additional fossil fuel.



Basic Cycle - Organic Rankine Cycle (ORC) Twin Screw

Denbury Resources, Inc.,
ElectraTherm Inc.,
Dry Coolers, Inc

Gulf Coast Green Energy

19

Topics

- RPSEA Organization
- Small Producer Program Element
- **Unconventional Resources Program Element**

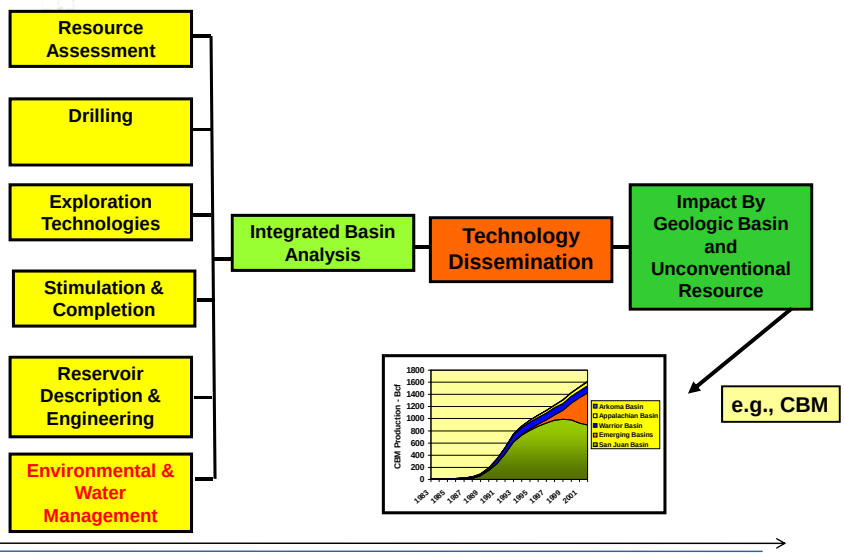
RPSEA Unconventional Onshore Program 2007-2011

- **Mission & Goal**
  - ***Economically viable*** **technologies to allow** ***environmentally acceptable*** **development of unconventional gas resources**
    - **Gas Shales**
    - **Tight Sands**
    - **Coalbed Methane**
- **Objectives**
  - **Near Term**
    - **Increase production & recovery from established unconventional gas resources, accelerate development of existing & emerging plays**
    - **Decrease environmental impact of unconventional gas development**
    - **Integrate project results & deliverables and engage in technology transfer to ensure application of program results**
  - **Longer Term**
    - **Technologies for high-priority emerging & frontier resources**

Unconventional Gas

- **Challenges**
  - **Cost**
  - **Environmental impact of development**
  - **These challenges are closely related**
  - **Concern over safety and unplanned environmental impact**
- **Technical Issues**
  - **Low porosity and permeability**
  - **Heterogeneous reservoirs**
  - **Many wells required**
  - **Aggressive well treatment**
  - **Variability in well productivity**

RPSEA Unconventional Gas Program Components & Approach – Built Over 2007-2010



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	CBM 10%	Gas Shales 45%	Tight Sands 45%
Integrated Basin Analysis		New Albany (GTI) $3.4	Piceance (CSM) $2.9
Drilling			
Stimulation and Completion	Microwave CBM (Penn) $.08	Cutters (Carter) $.09 Frac (UT Austin) $.69 Refrac (UT Austin) $.95	Gel Damage (TEES) $1.05 Frac Damage (Tulsa) $.22
Water Management	Integrated Treatment Framework (CSM) $1.56		
Environmental			
Reservoir Description & Management		Hi Res. Imag. (LBNL) $1.1	Tight Gas Exp. System (LBNL) $1.7
Reservoir Engineering		Decision Model (TEES) $.31	Wamsutter (Tulsa) $.44 Forecasting (Utah) $1.1 Condensate (Stanford) $.52
Resource Assessment		Alabama Shales (AL GS) $.5 Manning Shales (UT GS) $.43	Rockies Gas Comp. (CSM) $.67
Exploration Technologies	Coal & Bugs (CSM) $.86		
2008 Program Priorities	H	High Priority	2007 Projects
	M	Medium Priority	
	L	Low Priority	

	CBM 10%	Gas Shales 45%	Tight Sands 45%
Integrated Basin Analysis		New Albany (GTI) $3.4	Piceance (CSM) $2.9
Drilling			
Stimulation and Completion	Microwave CBM (Penn) $.08	Cutters (Carter) $.09 Frac (UT Austin) $.69 Refrac (UT Austin) $.95 Frac Cond (TEES) $1.6	Gel Damage (TEES) $1.05 Frac Damage (Tulsa) $.22
Water Management	Integrated Treatment Framework (CSM) $1.56	Barnett & Appalachian (GTI) $2.5	Frac Water Reuse (GE) $1.1
Environmental	*	Environmentally Friendly Drilling (HARC)* $2.2	*
Reservoir Description & Management		Hi Res. Imag. (LBNL) $1.1 Gas Isotope (Caltech) $1.2 Marcellus Nat. Frac./Stress (BEG) $1.0	Tight Gas Exp. System (LBNL) $1.7 Strat. Controls on Perm. (CSM) $0.1
Reservoir Engineering		Decision Model (TEES) $.31 Coupled Analysis (LBNL) $2.9	Wamsutter (Tulsa) $.44 Forecasting (Utah) $1.1 Condensate (Stanford) $.52
Resource Assessment		Alabama Shales (AL GS) $.5 Manning Shales (UT GS) $.43	Rockies Gas Comp. (CSM) $.67
Exploration Technologies	Coal & Bugs (CSM) $.86	Multi-Azimuth Seismic (BEG) $1.1	

2008 Program Priorities	H	High Priority	2007 Projects
	M	Medium Priority	2008 Projects
	L	Low Priority	

	Gas Shales	Tight Sands
Integrated Basin Analysis	New Albany (GTI) $3.4 *Marcellus (GTI) $3.2* *Mancos (UTGS) $1.1*	Piceance (CSM) $2.9
Stimulation and Completion	Cutters (Carter) $.09 Frac (UT Austin) $.69 Refrac (UT Austin) $.95 Frac Cond (TEES) $1.6 *Stimulation Domains (Higgs-Palmer) $0.39* *Fault Reactiviation (WVU) $0.85*	Gel Damage (TEES) $1.05 Frac Damage (Tulsa) $.22 *Foam Flow (Tulsa) $0.57* *Fracture Complexity (TerraTek) $0.83*
Reservoir Description & Management	Hi Res. Imag. (LBNL) $1.1 Gas Isotope (Caltech) $1.2 Marcellus Nat. Frac./Stress (BEG) $1.0 *Frac-Matrix Interaction (UT-Arl) $0.46* *Marcellus Geomechanics (PSU) $3.1*	Tight Gas Exp. System (LBNL) $1.7 Strat. Controls on Perm. (CSM) $0.1 *Fluid Flow in Tight Fms. (MUST) $1.2*
Reservoir Engineering	Decision Model (TEES) $.31 Coupled Analysis (LBNL) $2.9 *Shale Simulation (OU) $1.05*	Wamsutter (Tulsa) $.44 Forecasting (Utah) $1.1 Condensate (Stanford) $.52
Exploration Technologies	Multi-Azimuth Seismic (BEG) $1.1	
Drilling	*Drilling Fluids for Shale (UT Austin) $0.6*	
Water Management	Barnett & Appalachian (GTI) $2.5 Integrated Treatment Framework (CSM) $1.56	Frac Water Reuse (GE) $1.1
Environmental	Environmentally Friendly Drilling (HARC)* $2.2	*
Resource Assessment	Alabama Shales (AL GS) $.5 Manning Shales (UT GS) $.43	Rockies Gas Comp. (CSM) $.67

	Anchor Project	2007 Projects
	2009 RFP Focus	2008 Projects
	Novel Concepts	*2009 Projects*

	Gas Shales	Tight Sands
Integrated Basin Analysis	New Albany (GTI) $3.4 Marcellus (GTI) $3.2 Mancos (UTGS) $1.1 *Technology Integration (HARC) $6.0*	Piceance (CSM) $2.9 *Piceance Permeability Prediction (CSM) $0.5*
Stimulation and Completion	Cutters (Carter) $.09 Frac (UT Austin) $.69 Refrac (UT Austin) $.95 Frac Cond (TEES) $1.6 Stimulation Domains (Higgs-Palmer) $0.39 Fault Reactiviation (WVU) $0.85 *Cryogenic Frac Fluids(CSM) $1.9* *Geomechanical Frac Containment Analysis (TAMU) $0.65* *Frac Diagnostics (TAMU) $0.76*	Gel Damage (TEES) $1.05 Frac Damage (Tulsa) $.22 Foam Flow (Tulsa) $0.57
Reservoir Description & Management	Hi Res. Imag. (LBNL) $1.1 Gas Isotope (Caltech) $1.2 Marcellus Nat. Frac./Stress (BEG) $1.0 Frac-Matrix Interaction (UT-Arl) $0.46 Marcellus Geomechanics (PSU) $3.1	Tight Gas Exp. System (LBNL) $1.7 Strat. Controls on Perm. (CSM) $0.1 Fluid Flow in Tight Fms. (MUST) $1.2
Reservoir Engineering	Decision Model (TEES) $.31 Coupled Analysis (LBNL) $2.9 Shale Simulation (OU) $1.05	Wamsutter (Tulsa) $.44 Forecasting (Utah) $1.1 Condensate (Stanford) $.52
Exploration Technologies	Multi-Azimuth Seismic (BEG) $1.1	
Drilling	Drilling Fluids for Shale (UT Austin) $0.6	
Water Management	Barnett & Appalachian (GTI) $2.5 Integrated Treatment Framework (CSM) $1.56 *NORM Mitigation (GE) $1.6*	Frac Water Reuse (GE) $1.1 *Engineered Osmosis Treatment (CSM) $1.3*
Environmental	Environmentally Friendly Drilling (HARC)* $2.2 *Zonal Isolation (CSI) $3.0*	*
Resource Assessment	Alabama Shales (AL GS) $.5 Manning Shales (UT GS) $.43	Rockies Gas Comp. (CSM) $.67

2007 Projects
2008 Projects
2009 Projects
2010 Projects

2011 Draft Annual Plan – Onshore Program Solicitation

- **Environment and safety risk assessment, reduction and mitigation**
  - Explicit focus, increased emphasis in all aspects of program
- **Innovative approaches for project integration**
  - Plan and manage field trials
  - Integrate the results of existing projects
  - Plan tech transfer
- **Develop an integrated resource-focused program**
  - Topic areas (amended as per 2010 URTAC recommendations)
    - Resource Assessment
    - Geosciences
    - Basin Analysis and Resource Exploitation
    - Drilling
    - Stimulation and Completion
    - Water Management
    - Reservoir Description and Management
    - Reservoir Engineering
    - Environmental

- **Novel concepts for unconventional gas development**

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2012 Unconventional Resources Program Objectives

- **Minimize Surface Disruption**
  - Direct well site impacts
  - Air emissions, noise, traffic, visual, water resources impact
- **Ensure Zonal Isolation**
  - Eliminate communication with aquifers
- **Maximize Hydraulic Fracturing Efficiency**
  - Minimize need for fluids
  - Minimize need for re-fracture treatments
- **Predict and Mitigate Induced Seismicity**
  - Hydraulic fracturing
  - Injection well disposal
- **Manage Fluids**
  - Minimize impact on water resources
  - "Green" drilling and frac fluids
  - Improved treatment and re-use
  - Minimize fluid waste streams
- **Integrate and Apply Technologies**

2012 Objectives	Gas Shales	Tight Sands
Minimize Surface Disruption	Hi Res. Imag. (LBNL) $1.1 Gas Isotope (Caltech) $1.2 Marcellus Nat. Frac./Stress (BEG) $1.0 Multi-Azimuth Seismic (BEG) $1.1 Coupled Analysis (LBNL) $2.9 Shale Simulation (OU) $1.05 Frac-Matrix Interaction (UT-Arl) $0.46 Marcellus Geomechanics (PSU) $3.1	Wamsutter (Tulsa) $.44 Condensate (Stanford) $.52 Tight Gas Exp. System (LBNL) $1.7 Rockies Gas Comp. (CSM) $.67 Strat. Controls on Perm. (CSM) $0.1 Fluid Flow in Tight Fms. (MUST) $1.2
Ensure Zonal Isolation	*Zonal Isolation (CSI) $3.0*	
Maximize Hydraulic Fracturing Efficiency	Cutters (Carter) $.09 Frac (UT Austin) $.69 Refrac (UT Austin) $.95 Frac Cond (TEES) $1.6 Stimulation Domains (Higgs-Palmer) $0.39 Drilling Fluids for Shale (UT Austin) $0.6 *Geomechanical Frac Containment Analysis (TAMU) $0.65* *Frac Diagnostics (TAMU) $0.76*	Gel Damage (TEES) $1.05 Frac Damage (Tulsa) $.22
Predict and Mitigate Induced Seismicity	Fault Reactiviation (WVU) $0.85	
Manage Fluids	Integrated Treatment Framework (CSM) $1.56 Frac Water Reuse (GE) $1.1 Barnett & Appalachian (GTI) $2.5 *NORM Mitigation (GE) $1.6* *Cryogenic Frac Fluids(CSM) $1.9*	*Engineered Osmosis Treatment (CSM) $1.3*
Integrated Resource Studies (Address Multiple Objectives)	New Albany (GTI) $3.4 Environmentally Friendly Drilling (HARC) $2.2 Marcellus (GTI) $3.2 *Technology Integration (HARC) $6.0*	Piceance (CSM) $2.9 *Piceance Permeability Prediction (CSM) $0.5*

2007 Projects
2008 Projects
2009 Projects
2010 Projects

Program Impact

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Unconventional Gas Program Results

Gas Resources
Hydraulic Fracturing
Environmental
Gas Recovery
Basic

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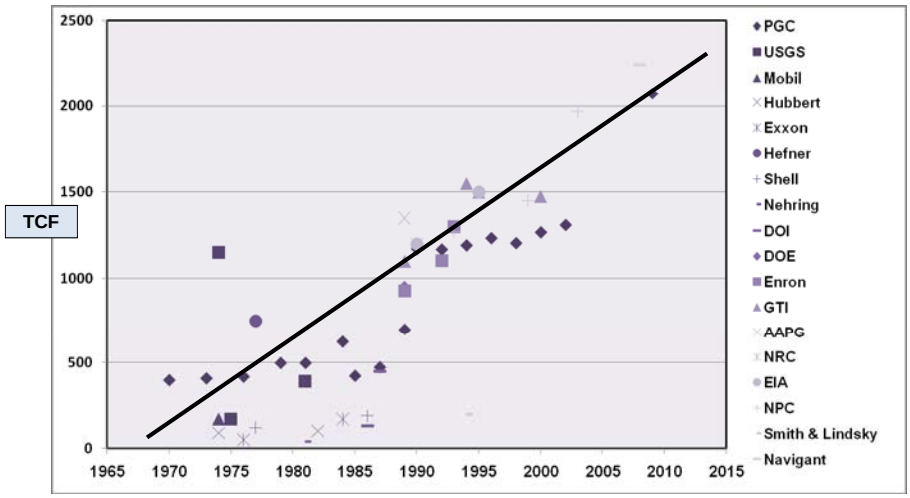
U. S. Technically Recoverable Gas Resource Base - Tcf



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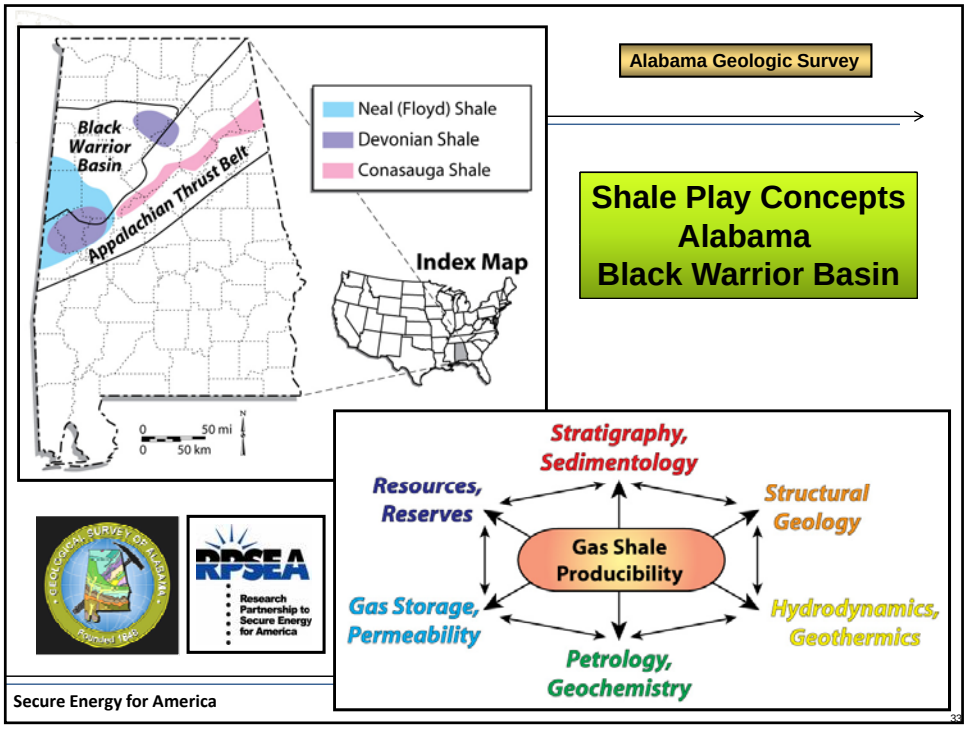
Alabama Geologic Survey
Black Warrior Basin
Appalachian Thrust Belt
Neal (Floyd) Shale
Devonian Shale
Conasauga Shale
Index Map
0 50 mi
0 50 km
Shale Play Concepts
Alabama
Black Warrior Basin
Stratigraphy, Sedimentology
Resources, Reserves
Structural Geology
Gas Shale Producibility
Gas Storage, Permeability
Hydrodynamics, Geothermics
Petrology, Geochemistry
RPSEA
Research Partnership to Secure Energy for America
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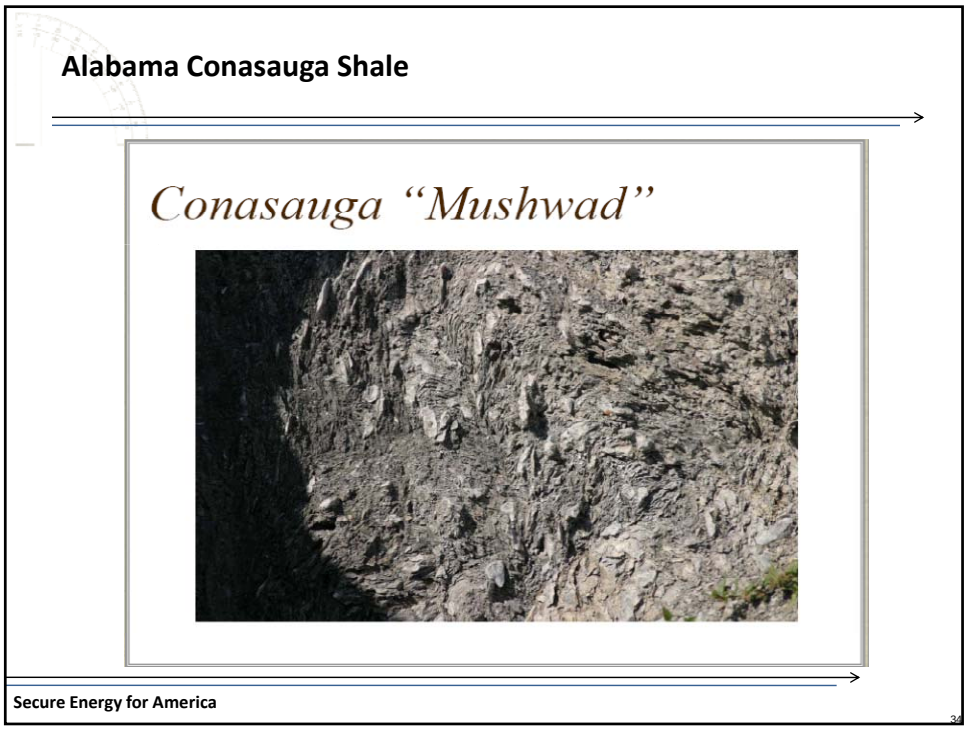
Alabama Conasauga Shale
Conasauga "Mushwad"
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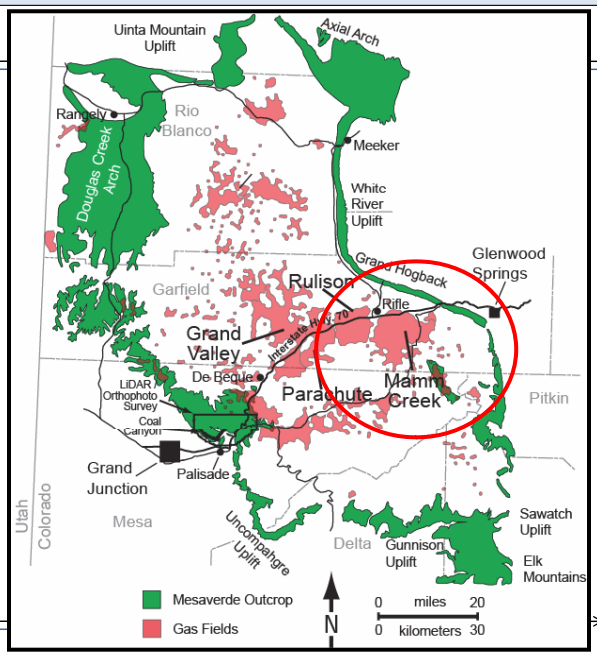
Mamm Creek – Piceance Basin



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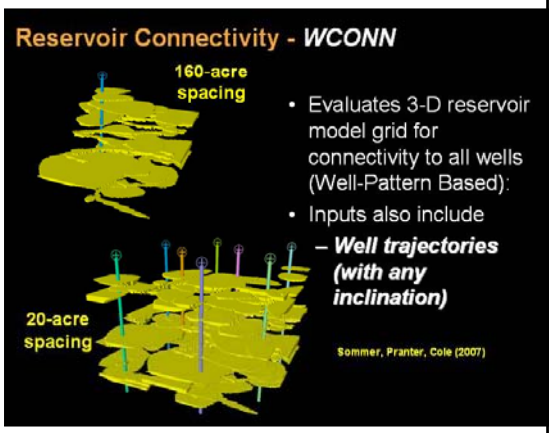
Mamm Creek Field – Piceance Basin - Reservoir Connectivity and Stimulated Gas Flow in Tight Sands

The Rocks

- ***Basin-wide Stratigraphy***
- ***Static reservoir models***
- ***Regional structure***
- ***Natural fractures***
- ***Azimuthal AVO and attenuation***

The Fluids

- **Reservoir flow simulation tied to rock properties**
- **Electrical methods to monitor subsurface flow**
- **Fracturing of rocks & Micro-earthquake location**



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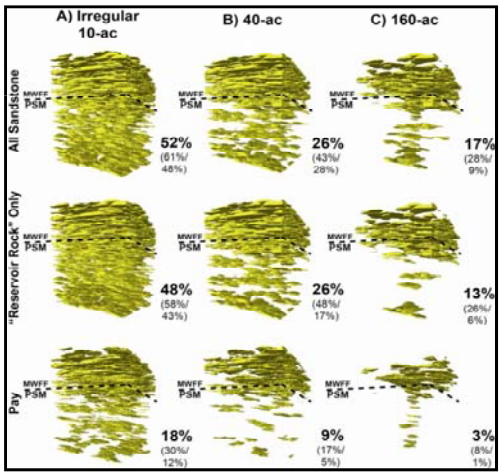
Colorado School of Mines

Mamm Creek Field, Piceance Basin, Colorado
Fluvial Architecture and Static Connectivity of the Williams Fork Formation



Reservoir Connectivity - Tight Gas Sands – Various Well Spacing

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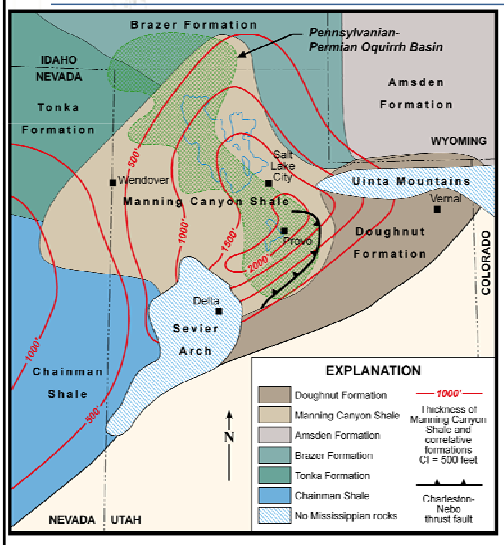
Paleozoic Shales – Utah
Manning Canyon Shale



- Characterize Geological Properties
- ID Greatest Gas Potential
- Best Completion Practices

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Utah Geologic Survey

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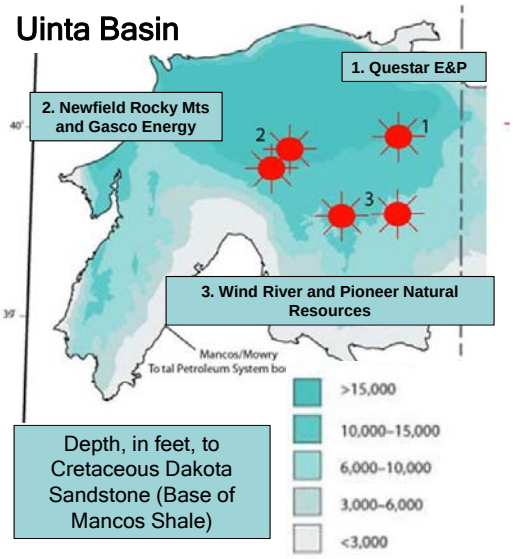
Cretaceous Mancos Shale Uinta Basin, Utah: Resource Potential and Best Practices for Emerging Shale Gas Play



Depth, in feet, to Cretaceous Dakota Sandstone (Base of Mancos Shale)

- Characterize the geology
- Define the geologic parameters that determine various geomechanical properties
- Based on this geologic model, establish preferred drilling, completion, and production techniques from targeted intervals.

Utah Geologic Survey

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Unconventional Gas Program Results

Gas Resources
Hydraulic Fracturing
Environmental
Gas Recovery
Basic

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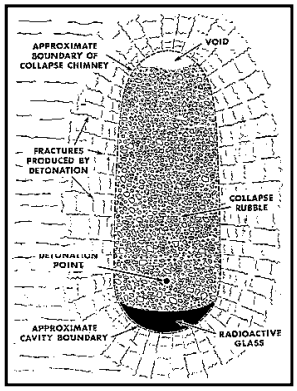
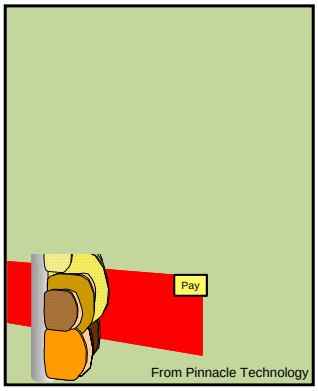
Hydraulic Fracturing

1960's



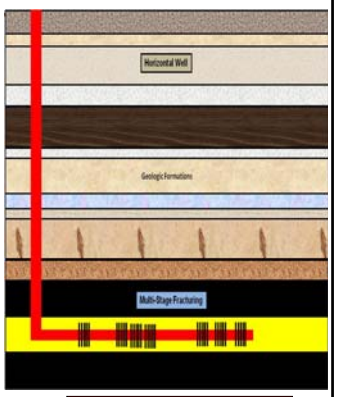
Nuclear Stimulation

1980's



Massive Hydraulic Fractures

2000's

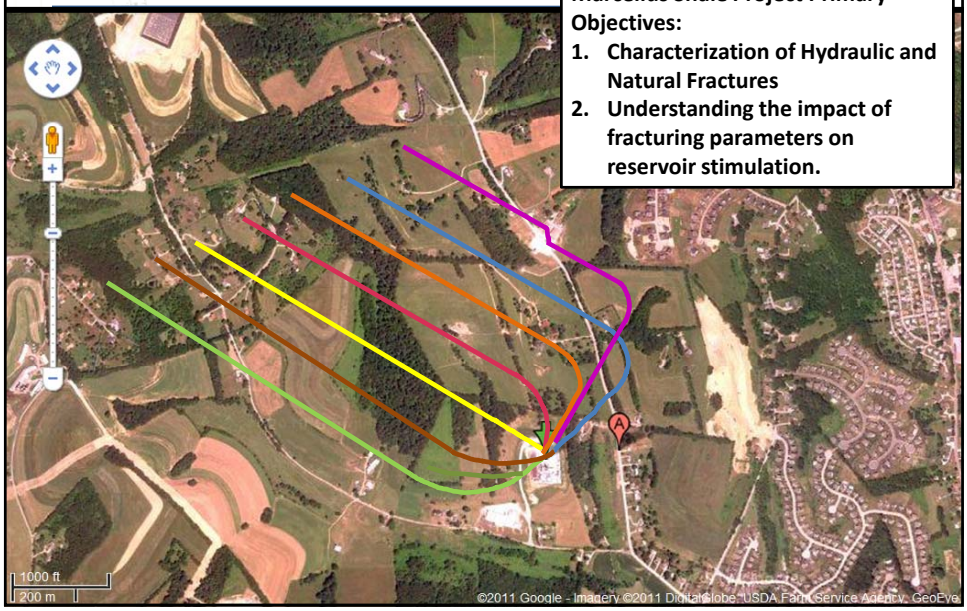


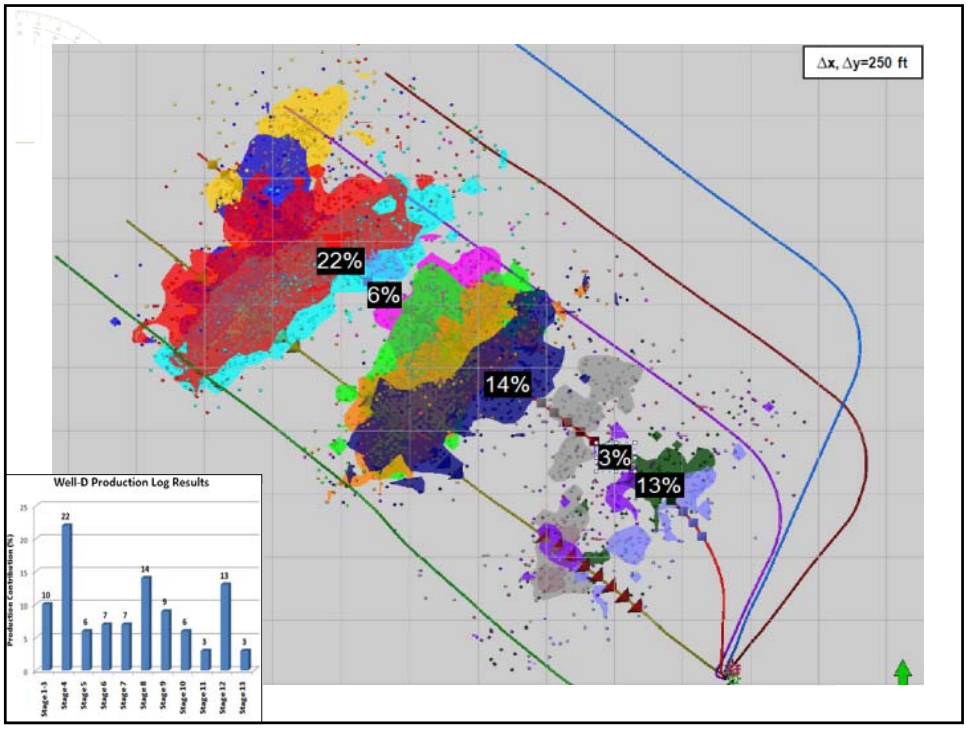
Precise Size & Precise Placement

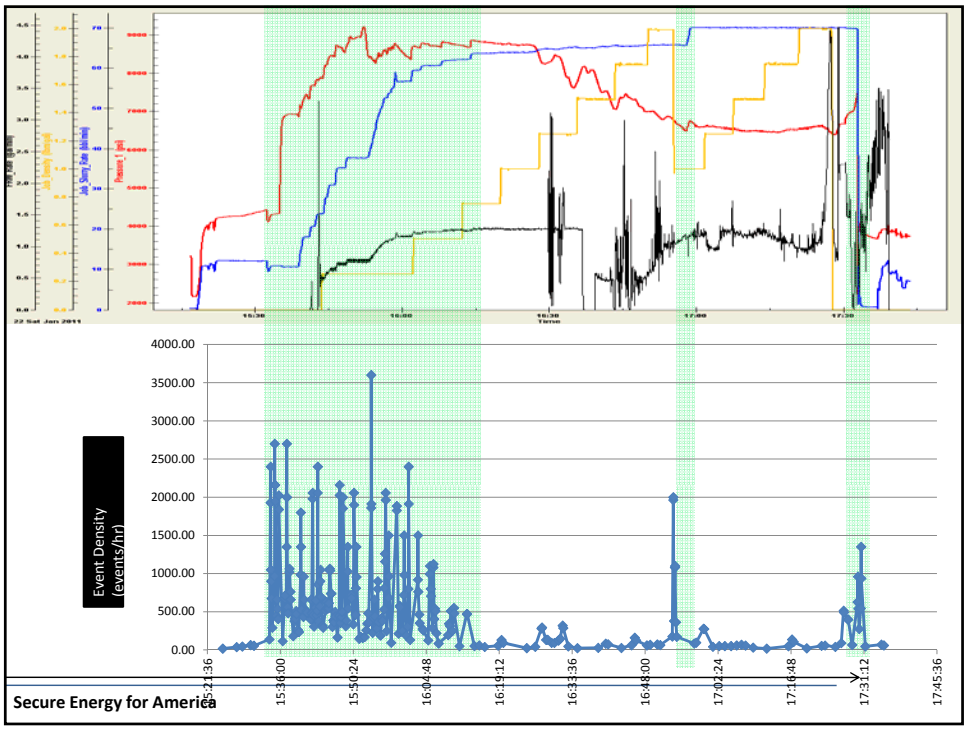
Marcellus Hydraulic Fracturing – Range Resources

Marcellus Shale Project Primary Objectives:

1. **Characterization of Hydraulic and Natural Fractures**
2. **Understanding the impact of fracturing parameters on reservoir stimulation.**




Δx, Δy=250 ft
22%
6%
14%
3%
13%
Well-D Production Log Results
Production Contribution (%)
10
22
6
7
7
14
9
6
3
13
3
Stage 1-3
Stage 4
Stage 5
Stage 6
Stage 7
Stage 8
Stage 9
Stage 10
Stage 11
Stage 12
Stage 13


Event Density (events/hr)
4000.00
3500.00
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
15:21:36
15:36:00
15:50:24
16:04:48
16:19:12
16:33:36
16:48:00
17:02:24
17:16:48
17:31:12
17:45:36
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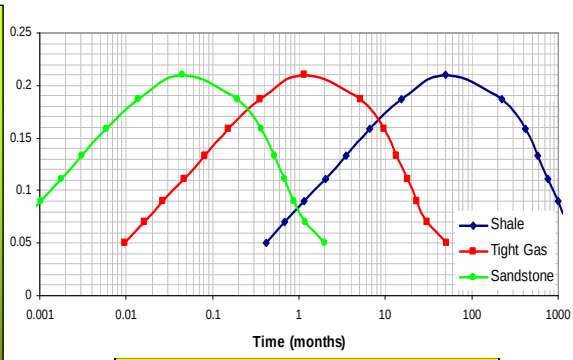
Identification of Refracturing Opportunities

- Methodology for candidate selection based on poro-elastic models and analysis of field data.
- Recommendations for the time window most suitable for re-fracturing
- Re-fracture treatment design for horizontal and deviated wellbores



Optimum time for re-fracturing

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University of Texas

Key Seat Slots Cut in Dogleg Hole

2000 ft² Planar Slots for Enhanced Productivity

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Carter Technologies

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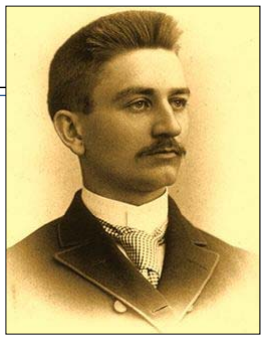
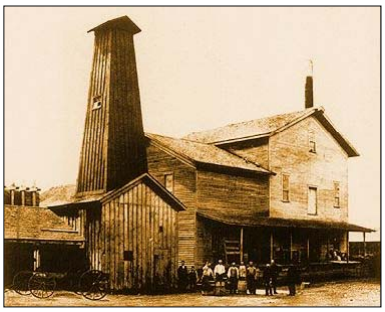
Unconventional Gas Program Results

Gas Resources
Hydraulic Fracturing
Environmental
Gas Recovery
Basic

Beneficial Use

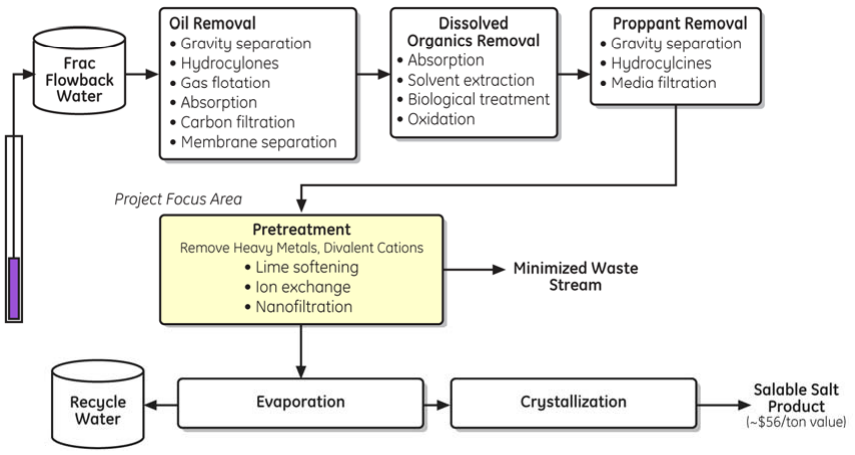


Deep under the flatlands of Midland, Michigan, lie *salt-rich rocks*, rich in magnesium, chlorine, calcium, sodium and bromine. Inside these rocks, Herbert Dow found the raw materials of creative chemistry (1897).



Road Salt –	**$56 per ton**
Road Brine –	**$.63 per gallon**
Bromine -	**$1,128 per ton**
Fresh Water	**$?**

Pretreatment and Water Management for Frac Water Reuse and Salt Production



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GE Global Research

Summary of Pretreatment Processes Analyzed

Pretreatment Process	$/bbl produced water (Design Case)	Issue
Ion Exchange	> 6	High chemicals cost
Nanofiltration	7.7	High cost, low recovery
Sulfate precipitation	17	NORM in sludge; must dispose as LLRW
Lime-soda precipitation	63	
Modified lime-soda precipitation	3.5	Lab development needed
MnO_2 adsorption	1.7-2.4	Benefits: cost, Ra, Ba disposal by UIC[a]

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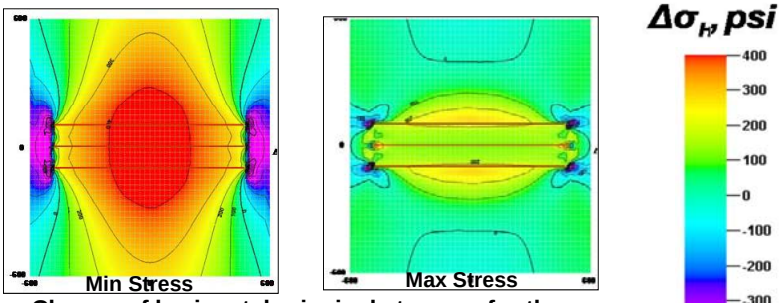
Prediction of Fault Reactivation in Hydraulic Fracturing of Horizontal Wells in Shale Gas Reservoirs



Change of horizontal principal stresses for three parallel fractures (spacing of 100 ft)

Both maximum and minimum horizontal principle stresses have been significantly changed after one stage

The induced stress field change in the fracturing process has significant effects on the geometries of created multiple fractures

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West Virginia University Research Corporation

Barnett Shale Water Conservation and Management Committee (BSWCMC)

About the Committee

- An industry consortium
- Made up of approximately 20 Barnett Shale Energy Companies
- Initiated in March 2006
- Completed its Charter, Spring 2006
- Status:
  - Collecting information on industry water use
  - Review of Reuse/Recycle Technologies
  - Planning Future Projects for 2007

Founding Members

Chesapeake Energy
Conoco Phillips
Denbury Resources
Derrick Resources
Devon Energy
DTE Gas Resources
EnCana Oil and Gas
Harding Company
Pitts Oil Company
Quicksilver Resources
Range Resources
Sauder Land Co.
Shell Oil Company
Sundance Resources
Williams Production
XTO Energy

Characteristics of the Future Program

- Best Management Practices (BMP's)
- Technology Development
  - ✓ Performance
  - ✓ Reliability and Cost
- Reducing Freshwater Demands Through:
  - ✓ Reuse
  - ✓ Recycle
  - ✓ Alternate Water Sources
- Deployment of Treatment Systems
- Information Sharing / Dissemination to Stakeholders

Mission

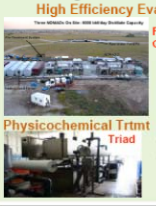
Develop best management practices (BMP's) for the Barnett Shale development in the Fort Worth Basin to ensure that water is managed in an efficient and responsible manner.

To Achieve the Mission, BSWCMC Will ....

- Define best methods and technologies currently used for water management during drilling, completion and production operations
- Promote a Balanced Approach
  - Efficient and responsible management of water
  - Conservation
  - Environmental Protection / Safety
  - Outreach and Education
- Utilize New Technology (Where Needed)

Technologies Considered for Water Reuse

High Efficiency Evaporation Equipment



Fountain Quail

Intevras

Membrane Separations

Texas A&M
GE

Physicochemical Trtmt Triad

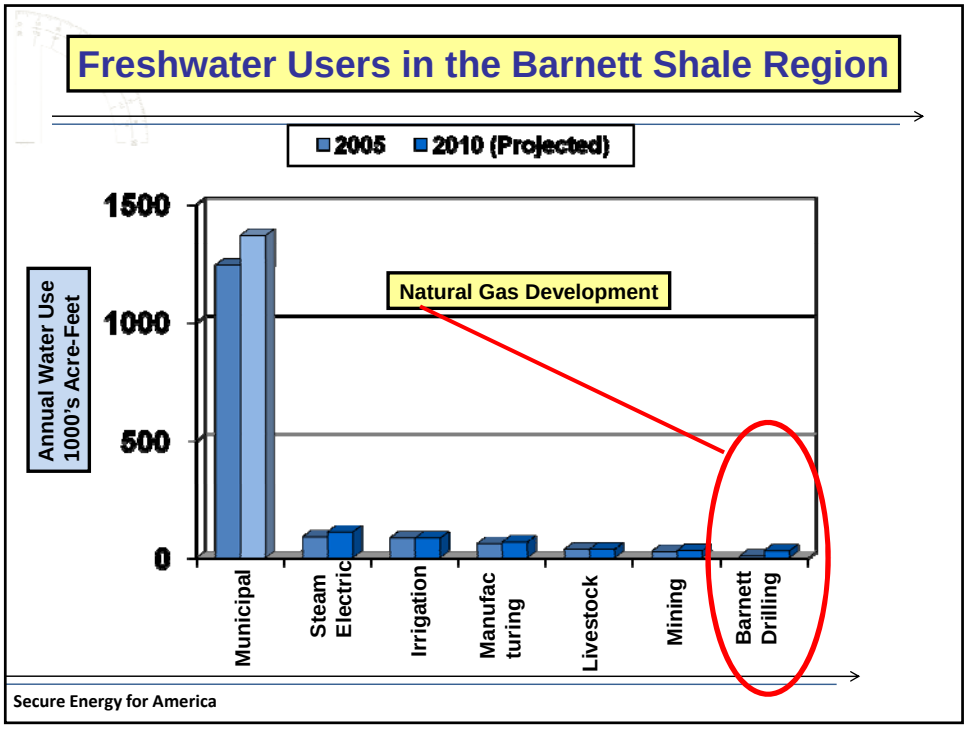
For More Information, Contact:
Tom Hayes, Gas Technology Institute
Phone: 847.768.0722
Mobile: 847.736.1009
E-mail: tom.hayes@gastechnology.org

Goals

1. Determine current and future water demands for the Barnett Region
2. Estimate current and future "waste" water generation for Barnett O&G development
3. Define water quality specifications for drilling and fracturing jobs
4. Identify technologies to provide solutions for water management
5. Determine the feasibility of technical solutions to improve water conservation
6. Conduct a proactive "Best Management Practices" information transfer effort for industry
7. Promote information dissemination to Stakeholders in the Barnett Area
8. Engage in effective responses to inquiries and concerns about water management

Accomplishments

- Conducted a preliminary water use survey among major energy developers
- Obtained information from experts on five treatment technologies for water reuse and recycle
- Launched a preliminary survey on the availability of freshwater in the Barnett
- Prioritized goals and initiated planning of the program


Freshwater Users in the Barnett Shale Region
2005
2010 (Projected)
Annual Water Use
1000's Acre-Feet
1500
1000
500
0
Natural Gas Development
Municipal
Steam Electric
Irrigation
Manufac turing
Livestock
Mining
Barnett Drilling
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11 8 '06

The Environmentally Friendly Drilling Systems Program

EFD

integrating advanced technologies into systems that significantly reduce the impact of drilling and production in environmentally sensitive areas.

www.efdsystems.com

Houston Advanced Research Center

University/NL Alliance

- ***Texas A&M*** *– Systems Engineering Design Methodology: Low Impact Well Design Optimization*
- ***University of Colorado*** *– Best Practices Database*
- ***University of Arkansas*** *– Dissemination and Decisions Support*
- ***University of Wyoming*** *– Western Mountain States Studies*
- ***Utah State University/Sam Houston State University*** *– Public Perception*
- ***West Virginia University*** *– Eastern Mountain States Studies*
- ***Los Alamos National Laboratory/Argonne National Laboratory*** *– Technology Partnership*

Engineering Designs for Low Impact Drilling and Fracturing

- *Application for Semi Arid Ecosystem*
- *Disappearing Roads*
- *Prototype Small Footprint Drilling Rig*
- *NOx Air Emissions Studies*
- *Reduced Fracturing Footprints*
- *Measuring Effectiveness of EFD*

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HARC

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An Integrated Framework for Treatment and Management of Produced Water

Research Objectives

- **Compile data on quality and quantity of produced water associated with unconventional gas production**
- **Explore most appropriate and cost-efficient water treatment technologies**
- **Assess requirements to minimize environmental impacts and reduce institutional barriers**
- **Compile findings into a decision analysis framework for management of produced water**

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Colorado School of Mines

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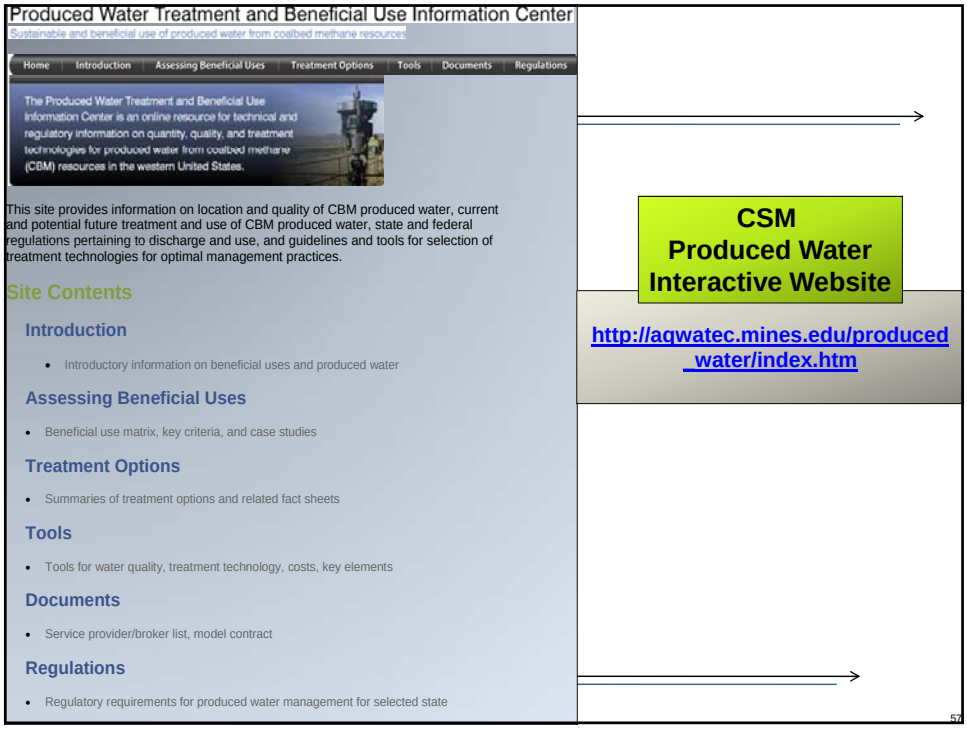
Produced Water Treatment and Beneficial Use Information Center
Sustainable and beneficial use of produced water from coalbed methane resources
Home
Introduction
Assessing Beneficial Uses
Treatment Options
Tools
Documents
Regulations
The Produced Water Treatment and Beneficial Use Information Center is an online resource for technical and regulatory information on quantity, quality, and treatment technologies for produced water from coalbed methane (CBM) resources in the western United States.
This site provides information on location and quality of CBM produced water, current and potential future treatment and use of CBM produced water, state and federal regulations pertaining to discharge and use, and guidelines and tools for selection of treatment technologies for optimal management practices.
Site Contents
Introduction
Introductory information on beneficial uses and produced water
Assessing Beneficial Uses
Beneficial use matrix, key criteria, and case studies
Treatment Options
Summaries of treatment options and related fact sheets
Tools
Tools for water quality, treatment technology, costs, key elements
Documents
Service provider/broker list, model contract
Regulations
Regulatory requirements for produced water management for selected state
CSM
Produced Water
Interactive Website
http://aqwatec.mines.edu/produced_water/index.htm
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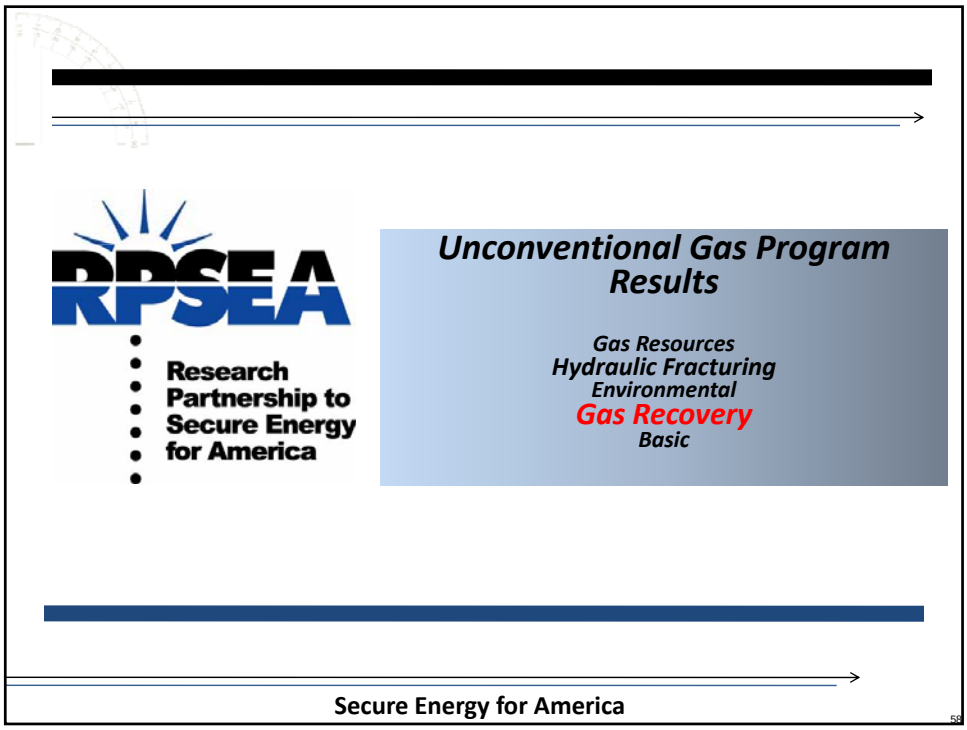
RPSEA
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for America
Unconventional Gas Program Results
Gas Resources
Hydraulic Fracturing
Environmental
Gas Recovery
Basic
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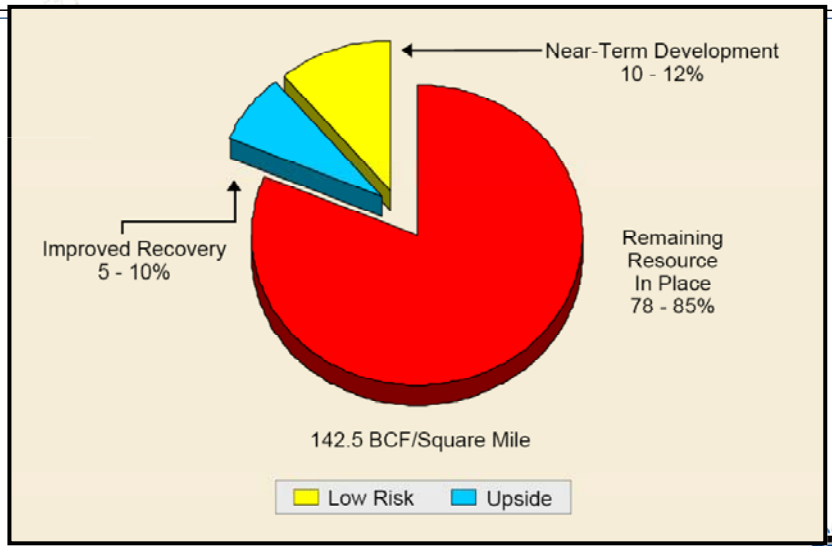
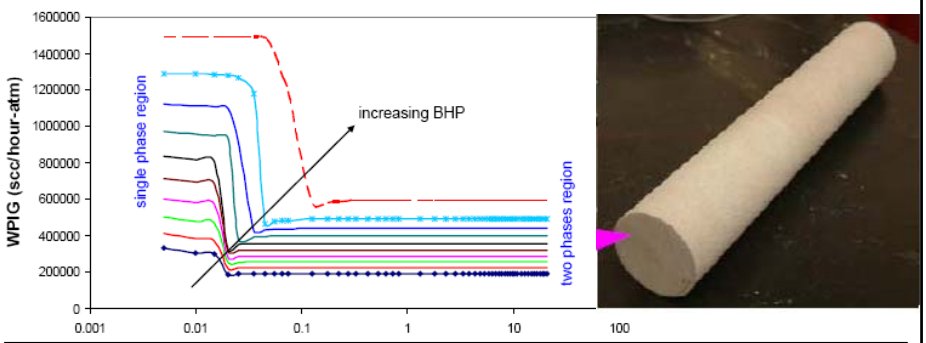
Barnett Reserves and Resource



Gas Condensate and Tight Gas Sand Productivity

Mitigating Productivity Loss Due to Sand face Precipitation



Gas Well Productivity Decreases Significantly Due to Condensate Precipitation

1. **Shutting well in to remove condensate not a good strategy as condensate will not revaporize.**
2. **Condensate banking still occurs in the presence of immobile water.**
3. **Condensate banking can be reduced by minimizing the pressure drop either by producing the well slowly.**

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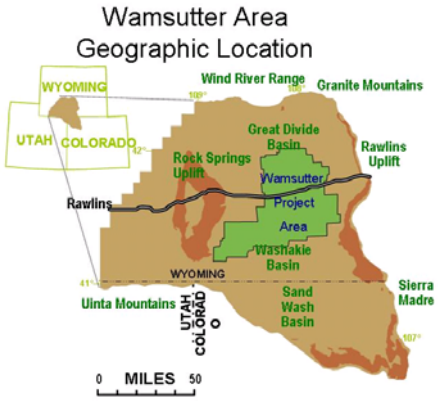
Stanford University

Optimizing Infill Drilling at Wamsutter

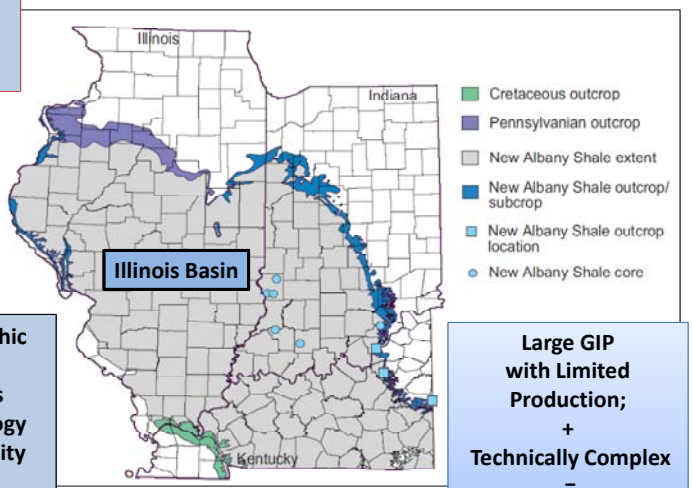
- Over 2,000 square miles
- k < 0.1 md
- 80 acre spacing

- Generate static reservoir descriptions of sands using geostatistical procedures
- History match 80 &160 acre spaced wells
- Project the future performance of 40 acre spaced wells & Identify Best Locations



New Albany Shale Outcrops and Core Locations

86 to 160 Tcf New Albany Shale Gas in Place



- Large Geographic Area
- Multiple States
- Complex Geology
- Low Permeability

Large GIP with Limited Production;
+
Technically Complex
=
R&D Target

GTI New Albany Shale Research Project

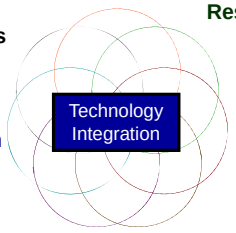
Resource Characterization - Well Stimulation - Well Cost

Geologic Studies
Bureau of Economic Geology

Geochemical Analysis
Amherst & U Mass

Reservoir Engineering
Texas A&M

New Albany Consortium



Formation Evaluation
ResTech

Fracture Modeling and Diagnositc
Pinnacle Technology and Texas A&M

Field Data, Environmental and Project Management

Best Practice Analysis
West Virginia University

Producer Participants

> NGAS
> Aurora Oil & Gas
> Noble Energy
> CNX Gas
> Trendwell
> Breitburn Energy
> Diversified Operating

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Gas Technology Institute

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RPSEA
Research Partnership to Secure Energy for America

Unconventional Gas Program Results

Gas Resources
Hydraulic Fracturing
Environmental
Gas Recovery
Basic

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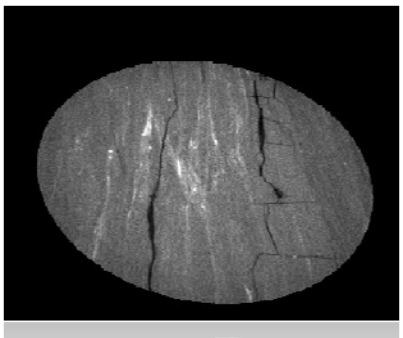
Enhancing Appalachian Coalbed Methane Extraction by Microwave-Induced Fractures

- Microwave energy have been shown to induce fractures.
- Can we *in situ* generate new macro and micro fractures with a microwave burst?
- What is the influence of these changes on methane permeability?
- Lab experiments will scan coal core, establish fracture/permeability baseline.
- A burst of microwave energy will be tested for permeability enhancement



Microwave Induced Fractures in Bituminous Coal

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Penn State University

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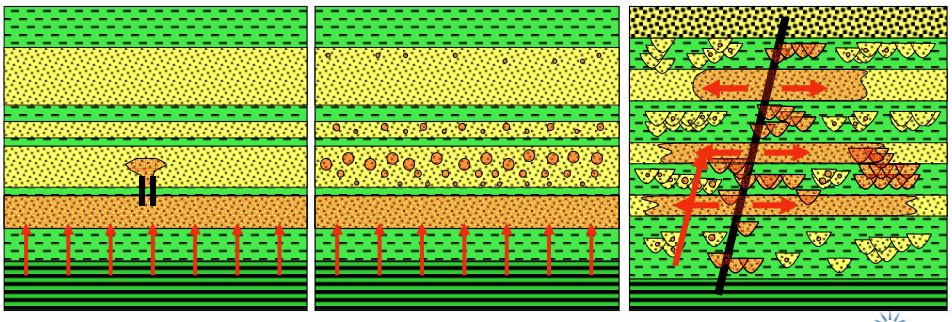
How Does Gas Migrate into and Fill Unconventional Reservoirs?

Different Mechanisms Should Leave Different Signatures in the Gas Composition; Assisting with Exploration Strategy

Gas pressure Produces Fractures

Gas Diffuses Through Seals

Gas Migrates Along Faults



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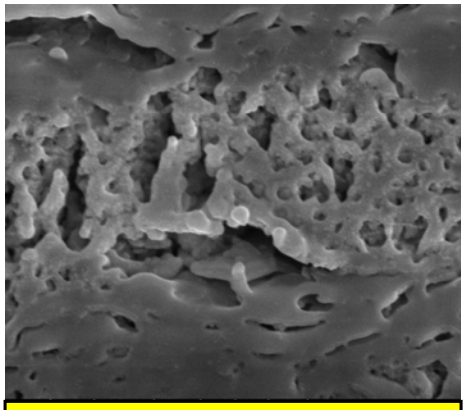
Petrophysical Studies of Unconventional Gas Reservoirs using High-Resolution Rock Imaging

Main Objectives

- ID Mechanisms Limiting Gas Recovery
- Means of Extending Well Productive Life

Technical Approach

- High-resolution images of low k rocks
- Analysis of flow properties from 3D pore space geometry
- Recovery strategies preventing condensate precipitation



500 nm
Pore space geometry of a hydrocarbon-bearing shale. Nanometer-scale

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Lawrence Berkeley National Lab

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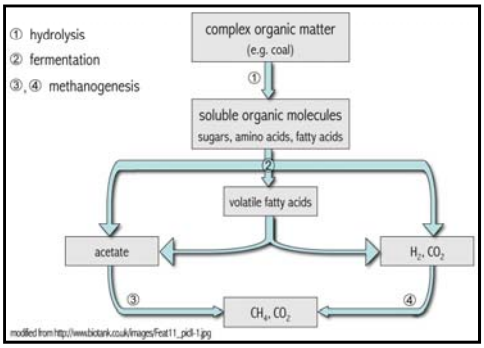
Comprehensive Investigation of Factors Enhancing Microbially Generated Coal Bed Methane

- Much coal bed methane is microbial in origin
- Enhancement of microbial methane production from coal has promise (up to 300 SCF/ton generated in lab).
- Fundamental factors influencing methane generation from coal will be investigated:
  - Coal composition
  - Growth conditions
  - Microbial dynamics
  - Chemical pathways
  - Coal pretreatment



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Thank You

kperry@rpsea.org