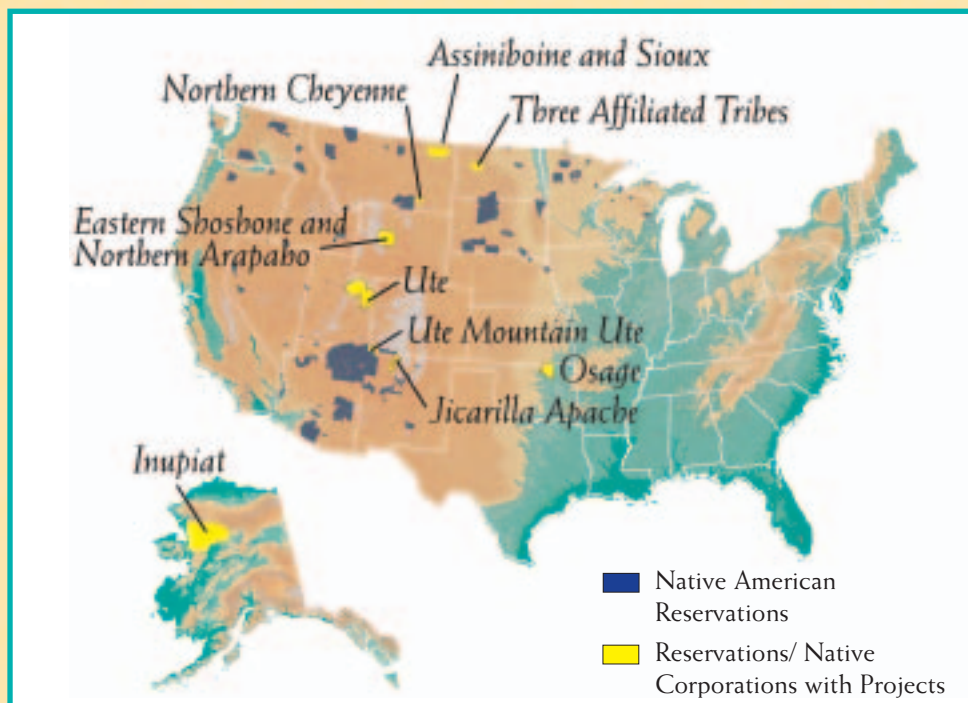


NATIVE AMERICAN INITIATIVE



The National Energy Technology Laboratory's Native American Initiative seeks to stimulate economic development and increase oil and natural gas production on American Indian lands while protecting the environment. The program supports the development and application of innovative petroleum technologies, and promotes government-to-government relationships and tribal partnerships with industry and academia—resulting in increased revenues and educational benefits for tribal members.

Some 13 million barrels of oil and 300 billion cubic feet of natural gas were produced on American Indian lands in 2002, generating \$183 million for tribes and allottees. However, potential revenue is far greater. If only a fraction of the estimated 890 million barrels of oil and 5.6 trillion cubic feet of gas on American Indian lands were produced, revenues could reach \$2.5 billion. For this to occur, the petroleum resources on tribal lands need to be located and produced.

The Native American Initiative funds research and demonstration projects that increase oil and gas exploration efforts and improve production on tribal lands. The program promotes partnerships between industry operators and tribes, and requires that tribes be partners in the projects. Since tribes retain their power over mineral resource exploration and development activities, they decide when, where, and how the work will be conducted, thus protecting their cultural values and economic interests.

Another advantage of the program is the creation of jobs for tribal members. Whenever possible, American Indians work directly on the projects. Additionally, some projects result in the development of facilities that employ tribal members for the long term.

Although the Native American Initiative has not been funded in fiscal year 2004, results from technologies developed in the projects will continue to benefit American Indian tribes and industry operators. More than \$260 million in economic activity on tribal lands and \$40 million in direct tribal royalty payments are expected to result from previous and current program projects over the next 20 years. These figures are conservative because most American Indian lands have not had enough exploration and development activity to accurately estimate their reserves. Additionally, the estimates do not include exploration and production activities kindled by successful projects conducted in this program.



JICARILLA APACHE TRIBE

PETROLEUM REFINERY PROCESS DESIGN, JICARILLA APACHE RESERVATION, NEW MEXICO



Seal of the Jicarilla Apache Nation.

PROJECT ID NUMBER:

DE-FC26-02NT15454

PROJECT START DATE:

9-30-2002

PROJECT END DATE:

10-29-2004

PROJECT INVESTIGATOR:

JESSE EVANS

JICARILLA APACHE

ENERGY CO.

P.O. Box 507

DULCE, NM 87528

PHONE: (505) 759-3224

EMAIL:

JEVANS232000@YAHOO.COM

DOE PROJECT MANAGER:

KATHY STIRLING

PHONE: (918) 699-2008

EMAIL:

KATHY.STIRLING@NETL.DOE.GOV

OBJECTIVES:

- Evaluate the feasibility of constructing an oil processing facility (refinery) on the Jicarilla Apache Reservation.
- When the project is complete, the participants will create a CD-ROM detailing their methodology as a guideline for other tribes and potential small refiners.

PARTNERS: Jicarilla Apache Nation, Jicarilla Apache Energy Company (JAECO), John D. Jones Engineering Inc.

PROJECT DESCRIPTION: There are approximately 65 petroleum companies operating about 2,500 wells on the Jicarilla Apache Reservation. Because of limited production and transportation options, the Nation is dependent on large regional refineries to process their crude oil. These refineries often set a low price for regionally produced crude oil because they have access to pipelines that can bring crude from distant sources. The Jicarilla Apache tribe is dependent on these facilities to supply their local fuel needs. The Tribe frequently does not get the best value for the crude oil they sell and they have to pay full value for the refined products they purchase.

The Jicarilla Apache Nation will collaborate with JAECO and John D. Jones Engineering Inc. to conduct a feasibility study to design and construct an oil processing facility on the Jicarilla Apache Reservation in northern New Mexico.

During the project, the participants will:

- Characterize the feedstocks for the refinery.
- Establish the major equipment to be installed.
- Determine the quantity and quality of products to be produced.
- Complete the capital and operating cost data for the project.
- Evaluate the feasibility of the project and quantify the value to the Jicarilla Apache Nation.
- Create a CD-ROM detailing the evaluation methodology as a guideline for other tribes and potential small refiners.

The detailed economic evaluation planned for this project will not be finished for several months. At this point the researchers know that the feedstock is light, sweet crude. The majority of the crude supply is over 40 degrees API and contains little sulfur and nitrogen. Researchers have developed a potential product slate and examined the market potential for the products. They have also looked at the processes, equipment, and infrastructure needs. The selected refinery site is within 30 miles of the majority of the crude that would be processed by the refinery. It is not near a population center, so the researchers are also looking at the potential for community development near the refinery.

UTE MOUNTAIN UTE TRIBE

MULTICOMPONENT SEISMIC ANALYSIS AND CALIBRATION IN THE PARADOX BASIN, COLORADO



Ruins of Ute ancestors, the Anasazi, that lived in the Four Corners area (Colorado, New Mexico, Utah, and Arizona) about 1300 A.D.

PROJECT ID NUMBER:
DE-FG26-02NT15451

PROJECT START DATE:
9-23-2002

PROJECT END DATE:
9-22-2004

PROJECT INVESTIGATOR:
PAUL LAPOINTE
GOLDER ASSOCIATES, INC.
18300 NE UNION HILL RD
REDMOND, WA 98052
PHONE: (425) 883-0777
EMAIL: PLAPOINTE@GOLDER.COM

DOE PROJECT MANAGER:
VIRGINIA WEYLAND
PHONE: (918) 699-2041
EMAIL:
VIRGINIA.WEYLAND@NETL.DOE.GOV

OBJECTIVES:

- Increase oil recovery from algal mound reservoirs on the Ute Mountain Ute, Southern Ute and Navajo tribal lands.
- Develop an understanding of 3D9C seismic data related to the variations in permeability and porosity of algal mounds, as well as lateral facies variations, for use in both reservoir development and exploration.
- Evaluate the effectiveness of seismic data for locating undiscovered algal mound fields on Tribal Lands.
- Evaluate the potential for applying CO₂ floods, steamfloods, or other secondary/tertiary recovery processes to increase oil production.
- Promote use of the technologies developed in the project through direct assistance to the Tribe.

PARTNER TEAM: Golder Associates, Inc., Ute Mountain Ute Tribe, Red Willow Production Co., Legacy Energy Corp., and Solid State Geophysical, Inc.

PROJECT DESCRIPTION: The Roadrunner/Towaoc seismic study has progressed through two critical phases: the design of the acquisition survey and associated processing approach, and the final contracting and permitting required to carry out the acquisition. Moreover, in order to enhance the resolution of the seismic data and improve its ability to detect subtle changes in algal mound permeability, porosity and facies architecture, the survey has been upgraded from a 3D3C (three-dimensional, three component) survey to a 3D9C (three-dimensional, nine-component) survey. In a nine-component survey, there are both shear and compressional wave sources and receivers. The surface acquisition will be coupled with a 3D VSP (vertical seismic profile) survey to aid in processing and interpretation. This type of acquisition and the planned processing will be the first of its kind for application to algal mounds, and represents the cutting edge of both seismic acquisition and processing technology. Permitting was successfully concluded in late Fall 2003, and crews are anticipated to undertake the acquisition as soon as weather permits in 2004.

A detailed reservoir study will be conducted to calibrate the seismic data to reservoir parameters such as permeability, porosity, and lithofacies. This will be done by developing a petrological and geological characterization of the mounds from well data; acquiring and processing the 3D9C data; and comparing the two using advanced pattern recognition tools such as neural networks.

The successful completion of this project will not only benefit the Ute Mountain Ute Tribe through increased oil revenues, but will also enhance the technical capabilities of the Red Willow Production Company, a wholly owned Southern Ute Tribe entity. Domestic oil producers in the Paradox Basin will also be able to apply this technology to increase recovery from fields where hundreds of millions of barrels of oil remain.

OSAGE TRIBE

ENHANCED OIL RECOVERY BY HORIZONTAL WATERFLOODING, OSAGE COUNTY, OKLAHOMA

Photo credit: Harvey Payne



Osage County, Oklahoma production well.

OBJECTIVES:

- Increase oil production by evaluating horizontal waterflooding technology in the Bartlesville Sandstone in Wolco Field, Osage County, OK.
- Conduct workshops, maintain a project website, and prepare publications to disseminate project findings.

PARTNERS: Grand Resources, Inc., Osage Tribe, Dauben International Energy Consultants.

PROJECT DESCRIPTION: The Bartlesville sandstone is a prolific oil producing horizon in northeast Oklahoma and the Osage Nation. An estimated 1.5 billion barrels of oil have been produced from the Bartlesville formation since the 1960's. In spite of the large cumulative production, as much as 80% of the original oil in place still remains in the ground.

Waterflooding using vertical injection wells are often not effective or economic due to shallow depth, existence of natural fractures and low formation permeability within the Bartlesville sand. Water cannot be injected at pressures below the reservoir parting pressure and at a high enough injection rate to increase production. Additional oil recovery is expected by using horizontal injection wells that allow larger volumes of water to be injected at pressures below the reservoir parting pressure.

The Wolco Field, in Osage County, OK was selected for the pilot field test site based on a lack of previous waterfloods, presence of a water supply well, and simulation studies performed to confirm the suitability of the field. The configuration of the three horizontal wells drilled in the Bartlesville Sandstone was two horizontal producing wells drilled adjacent and parallel to the horizontal injection well. A continuous improvement process was developed that included well planning, drilling, and a review process for each well drilled. Lessons learned from the well were applied to the following wells. This method resulted in each successive well being drilled more efficiently and therefore more cost effectively. The cost of the last of the 3 horizontal wells drilled was reduced by close to 20% from the first horizontal well.

Simulation results coupled with an economic evaluation indicate that the demonstration project could generate \$2.9 million cumulative revenue over a 6-year operation, compared to \$1.4 million cumulative revenue over 30 years of operation with a conventional 5-spot vertical waterflood. The \$673,000 cost of the horizontal wells could be recovered in approximately 1.5 years of production.

Technology transfer activities include the creation of a website that can be accessed at <http://www.grandoil.com/doe>, technical briefings to Osage Indian Nation personnel, participation in technical meetings and publishing articles in technical journals.

PROJECT ID NUMBER:

DE-FG26-02NT15452

PROJECT START DATE:

9-6-2002

PROJECT END DATE:

9-5-2004

PROJECT INVESTIGATOR:

SCOTT ROBINOWITZ
GRAND RESOURCES, INC.
2448 E. 81ST ST., STE. 4040
TULSA, OK 74137
PHONE: (918) 492-4366
EMAIL: SCOTT@GRANDOIL.COM

DOE PROJECT MANAGER:

VIRGINIA WEYLAND
PHONE: (918) 699-2041
EMAIL:
VIRGINIA.WEYLAND@NETL.DOE.GOV

THREE AFFILIATED TRIBES

REMOTE SENSING ANALYSIS TO IDENTIFY OIL EXPLORATION LEADS, FORT BERTHOLD INDIAN RESERVATION, NORTH DAKOTA



Tribal Shield of the Three Affiliated Tribes that consists of the Mandan, Hidatsa, and Arikara Tribes.

PROJECT ID NUMBER:

DE-FG26-02NT15453

PROJECT START DATE:

8-27-2002

PROJECT END DATE:

2-26-2004

PROJECT INVESTIGATOR:

SCOTT REEVES

ADVANCED RESOURCES INT'L.

9801 WESTHEIMER, STE. 805

HOUSTON, TX 77042

PHONE: (713) 780-0815

EMAIL:

SREEVES@ADV-RES-HOU.COM

DOE PROJECT MANAGER:

VIRGINIA WEYLAND

PHONE: (918) 699-2041

EMAIL:

VIRGINIA.WEYLAND@NETL.DOE.GOV

OBJECTIVES:

- Evaluate the oil exploration potential under Lake Sakakawea using remote imagery.
- Calibrate/validate the approach with existing seismic and offset production data.
- Understand the resolution requirements for a successful remote sensing analysis.
- Identify critical success factors via analysis of offset production.
- Identify specific target areas and develop reserve and economic forecasts.
- Disseminate the project results to industry, including potential development partners and Tribes.
- Transfer results of the project through presentations, publications, and a CD-ROM containing final reports and full-scale maps.

PROJECT TEAM: Advanced Resources International (ARI), the Three Affiliated Tribes, the Bureau of Indian Affairs, and Planetary Data.

PROJECT DESCRIPTION: Previous studies indicate a high potential for undiscovered oil and gas reserves on the Fort Berthold Reservation. Of particular interest are the Madison Limestone and Bakken Shale plays, which contain an estimated 320 million barrels of recoverable oil. Also of interest is the area beneath Lake Sakakawea. These 150,000 acres have never been explored and the absence of a credible, detailed technical assessment of the oil exploration potential remains a deterrent for oil companies to explore on the Reservation. Such a technical assessment is needed to better define the oil exploration opportunity and attract oil companies to proceed with exploration and development for the benefit of the Tribes. The area represents the largest contiguous acreage block under control of the Tribes, and since the land is tribally owned, their leasing and administration can be efficiently accomplished.

Statistical analysis for producing oil wells surrounding Lake Sakakawea and the Fort Berthold Reservation has been completed. In addition, analysis of high-resolution aeromagnetic data, 200 line-miles of 2D seismic data over the lake, satellite imagery, low resolution remote sensing data (gravity and aeromag), and a geologic structural analysis of the Reservation has been completed.

Analysis of the data collected has led to the identification of numerous exploration leads under Lake Sakakawea. The high-resolution aeromagnetic data was identified as the best imaging technique to identify the leads at the scales required. The leads identified are currently being evaluated. The final results of the project will be available for examination by interested parties at the 2004 NAPE meeting in Houston.

NORTHERN CHEYENNE TRIBE

ASSESSMENT OF COALBED METHANE RESOURCE AND PRODUCED WATER DISPOSAL OPTIONS,
NORTHERN CHEYENNE RESERVATION, MONTANA



View of a potential coalbed methane producing area in the Northern Cheyenne Reservation in Montana.

PROJECT ID NUMBER:

FEW 4340-72

PROJECT START DATE:

3-31-2002

PROJECT END DATE:

3-31-2004

PROJECT INVESTIGATOR:

SHAOCHANG WO

IDAHO NATIONAL
ENGINEERING AND
ENVIRONMENTAL
LABORATORY

P.O. Box 1625

IDAHO FALLS, ID 83415

PHONE: (208) 526-3552

EMAIL: WOS@INEL.GOV

DOE PROJECT MANAGER:

JESSE GARCIA

PHONE: (918) 699-2036

EMAIL:

JESSE.GARCIA@NETL.DOE.GOV

OBJECTIVES:

- Determine the best coalbed methane development scenarios and water handling options to maximize economic return to the Tribe while minimizing adverse environmental impacts.
- Transfer project results to the Tribe and other area operators through publications and workshops.

PROJECT TEAM: Idaho National Engineering and Environmental Laboratory, Northern Cheyenne Tribe, and Montana Bureau of Mining and Geology.

PROJECT DESCRIPTION: Natural gas production (methane) from coal represents a significant potential asset to the Northern Cheyenne Indian Tribe of Montana. The resource however, is largely unevaluated. The Tribe is interested in developing this resource if it can be done in an environmentally responsible manner.

A complete analysis of the coalbed methane (CBM) production potential for coal seams underlying the Northern Cheyenne Indian Reservation of Montana has been conducted. The work targeted a basic understanding of the CBM resource, and resolves environmental impact problems associated with CBM production. Water chemistry data was obtained in order to determine beneficial use of produced water. Multiple water handling options are being reviewed with an emphasis on reinjection of produced water.

A subsurface database has been completed that includes maps and cross sections of oil exploration wells in the Fort Union, Lance, Fox Hills and Bearpaw Shale. Coal thickness maps for the Cook, Wall, Pawnee, and Knobloch coal seams as well as sand thickness maps for six formations identified as potential formations for produced water reinjection. Permeability and porosity measurements of outcrop sand formations were used to evaluate the injectivity of the sand. Several of the coal seams have been modeled for sensitivity testing of permeability, net pay thickness, and Langmuir-isotherm parameters for gas production.

A member of the Northern Cheyenne Tribe was a summer intern sponsored by the DOE Mickey Leland Energy Fellowship. She worked on this project while stationed at the Idaho National Engineering and Environmental Laboratory.

INUPIAT

DEVELOPMENT OF MINIATURE MOBILE DRILLING TECHNOLOGY FOR THE ARCTIC ENVIRONMENT, ALASKA



Slimhole drill rig with small footprint adapted from the mineral industry and being used to explore for unconventional natural gas in Arctic terrain.

PROJECT ID NUMBER:
DE-FG26-01BC15151

PROJECT START DATE:
4-16-2001

PROJECT END DATE:
5-31-2003

PROJECT INVESTIGATOR:
PAUL GLAVINOVICH
NANA DEVELOPMENT CORP.
1001 E. BENSON BLVD.
ANCHORAGE, AK 99508
PHONE: (907) 265-4100
EMAIL:
GLAV@WORLDNET.ATT.NET

DOE PROJECT MANAGER:
RHONDA JACOBS
PHONE: (918) 699-2037
EMAIL:
RHONDA.JACOBS@NETL.DOE.GOV

OBJECTIVES:

- Design and develop an innovative low-cost, small footprint drilling rig
- Design reservoir testing and production procedures for characterizing and developing unconventional gas resources in the Alaskan Arctic environment.
- Transfer results of the project via presentations.

PROJECT TEAM: Northwest Alaska Native Association (NANA) Development Corp., TechCominco, and Advanced Resources International.

PROJECT DESCRIPTION: Traditionally, oil and gas field technology development in Alaska has focused on the high-cost, high-productivity oil and gas fields of the North Slope and Cook Inlet, with little or no attention given to Alaska's numerous shallow, unconventional gas reservoirs (carbonaceous shales, coalbeds, and tight gas sands). This is because the high costs associated with using the existing conventional oil and gas infrastructure, combined with the typical remoteness and environmental sensitivity of many of Alaska's unconventional gas plays, render the cost of exploring for and producing unconventional gas resources prohibitive.

In this project, drilling technology developed for the mineral industry was adapted for use in the exploration of unconventional gas in rural Alaska. These techniques have included the use of diamond drilling rigs that core small diameter (<3.0-inch) holes coupled with wireline geophysical logging tools and pressure transient testing units capable of testing in these slimholes. Project results indicated that the slimhole technology demonstrated in the project could reduce drilling and completion costs by as much as 80% of conventional oilfield technologies. Additionally, unconventional gas resources of >2 TCF were identified based on gas content analyses, geophysical logging and pressure transient testing conducted during the project.

Development of the mobile slimhole drilling and testing system designed for Arctic conditions will benefit both industrial complexes in rural Alaska and remote Native American communities. The slimhole system can be used to explore, evaluate and develop the numerous unconventional gas deposits in Alaska. Development of unconventional gas resources will alleviate the cost of diesel fuel and its associated high transportation costs. Currently diesel fuel is used for electrical power generation in remote Alaskan locations including mine facilities and residential communities. The environment will benefit by the reduced size of the surface drilling operation that is one third the footprint of conventional oilfield operations. In addition the increased mobility and air transportability of drilling and completion equipment will eliminate the necessity for building roads and disturbing the sensitive tundra and wildlife across great distances.

ASSINIBOINE & SIOUX TRIBES

ASSESSMENT OF GEOCHEMICAL HYDROCARBON DETECTION TECHNIQUES ON THE
FORT PECK RESERVATION, MONTANA



Hydrocarbon microseepage soil sampling in the Palomino Field, Fort Peck Reservation, Montana.

PROJECT ID NUMBER:
DE-FG26-00BC15192

PROJECT START DATE:
6-15-2000

PROJECT END DATE:
3-31-2003

PROJECT INVESTIGATOR:
LARRY MONSON
FORT PECK MINERAL
RESOURCES DEPT.
P.O. BOX 1027
POPLAR, MT 59255
PHONE: (406) 768-5155
EMAIL:
LMONSON@NEMONTEL.NET

DOE PROJECT MANAGER:
VIRGINIA WEYLAND
PHONE: (918) 699-2041
EMAIL:
VIRGINIA.WEYLAND@NETL.DOE.GOV

OBJECTIVES:

- Test selected surface geochemical hydrocarbon detection techniques over known oil fields that have structure-related surface linear features and other geophysical anomalies associated with hydrocarbon potential.
- Apply the most effective of these methods to explore known 3-D seismic and remote sensing anomalies on the Fort Peck Indian Reservation in Montana for potential recoverable oil reserves.
- Convey project results through presentations and publications.

PROJECT TEAM: Fort Peck Assiniboine & Sioux Tribes Mineral Resources Department, GCRL Energy Ltd., Kipp Carroll—consultant, and George Shurr—consultant.

PROJECT DESCRIPTION: Although adjacent to known oil production, the Fort Peck reservation is relatively unexplored. It contains favorable structural and stratigraphic trends. Previous work has demonstrated the existence of straight-lined or curvilinear surface features thought to be the result of structural movement over deep-seated fault blocks. This structural movement may have created structural traps for oil accumulation. Also, color anomalies on air photos have been detected that may mark surface chemical changes in soil caused by hydrocarbon seepage.

During the first phase of the project, evaluation of various methods of surface hydrocarbon exploration indicated that head gas, soil gas, microbial methods, iodine, and Eh, pH, conductivity, and micro-magnetic exploration techniques merited further testing. The techniques were tested in separate study areas ranging from small and simple to large and complex.

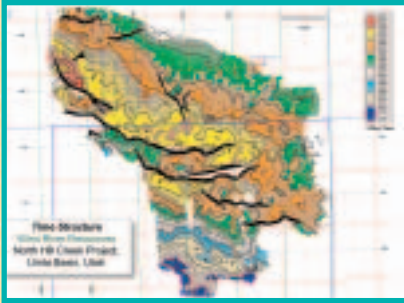
It was found that surface exploration techniques clearly document hydrocarbon seepage on the Fort Peck Reservation. Among the direct detection techniques, head gas and acid extract methods are the most useful in mapping production and potential prospects; thermal desorption, tested at only one field, correlated well to production. The soil gas method utility was inconclusive. Indirect techniques that were found useful include soil microbial, iodine, and Eh soil analyses. UV soil fluorescence, pH, and conductivity were all found relatively inclusive.

In the final year of this project a second survey that sampled several Landsat image features was conducted. Methods determined to be the most useful in Phases I and II were employed in this final Phase III of the study. Although an increase in light gas concentrations were associated with curved linear surface features, prospective micro-seepage chimneys were not conclusively verified.

Based on the findings of this work, the Assiniboine & Sioux Tribes of the Fort Peck Reservation intend to use surface hydrocarbon exploration techniques for future identification and confirmation of oil and gas prospects.

UTE TRIBE

3-D SEISMIC EXPLORATION, UINTAH AND OURAY RESERVATION, UTAH



Seismic survey of the North Hill Creek project, Utah. Black lines indicate faults.

OBJECTIVES:

- Apply 3-dimensional seismic surveying on the Uintah and Ouray Reservation in Utah.
- Assess the oil potential of the reservation to enable the Tribe to make informed decisions regarding reserves exploration.
- Engage in technology transfer activities designed to disseminate information about the utility of 3-D seismic technology as a tool for exploration on the Uintah & Ouray Indian Reservation.

PROJECT TEAM: Wind River Resources Corporation, Ute Indian Tribe, and Black Coral LLC.

PROJECT DESCRIPTION: A 3-D seismic survey in a 15-square mile area of Hill Creek Extension field was conducted in this project. The seismic data was combined with available geological data, drilling and test data, production data and other seismic data to identify future drilling targets. Prior to this survey there had been no significant 3-D work done on this oil- and gas-rich reservation. Project results showed that it is possible to see both gross and subtle structures (fault and folds) and such stratigraphic features as stream channels, in the seismic data.

The promising seismic data caused Wind River Resources and their partner to plan a drilling program to evaluate the gas potential of deeper formations. As of January, 2004 thirteen wells have been located, drilled and completed as gas producers. The fourteenth well is being drilled to below 10,000 ft. One well produced oil in addition to gas, and most of the wells produce natural gas liquids. This drilling program has had a 100% success rate. The best of deep wells is apparently the best gas well in Utah. It has been producing 6-7 million cubic feet of gas per day since early May 2003. The royalty revenue being generated for the tribe from this well is \$5,000 per day. Additional production and royalties are expected from the other 12 wells.

The value of the additional \$1.5 million cost of the seismic surveys is illustrated by 100% success rate of the drilling program. Drilling costs ranged from \$700,000 to \$4 million per well. Put in the perspective of drilling costs, the cost of the seismic survey was less than one deep dry hole.

The successful demonstration of the 3-D seismic survey conducted in this project has spawned four additional 3-D seismic surveys in the area: two are extensions of Wind River Resources Corp. to the east and to the south, and two are acquisitions by nearby operators.

PROJECT ID NUMBER:

DE-FG26-00BC15193

PROJECT START DATE:

9-15-2000

PROJECT END DATE:

12-31-2002

PROJECT INVESTIGATOR:

MARC ECKELS

WIND RIVER RESOURCES CORP.

RT. 3 BOX 3010

ROOSEVELT, UT 84066

PHONE: (425) 722-2546

EMAIL: MTE@UBTANET.COM

DOE PROJECT MANAGER:

VIRGINIA WEYLAND

PHONE: (918) 699-2041

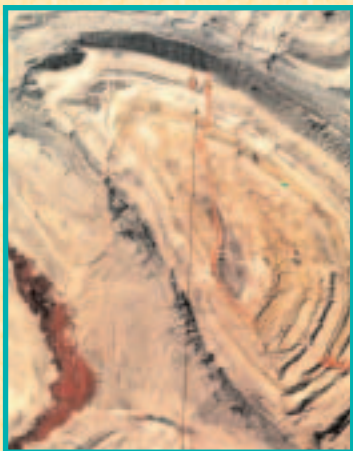
EMAIL:

VIRGINIA.WEYLAND@NETL.DOE.GOV

EASTERN SHOSHONE & NORTHERN ARAPAHO TRIBES

3-D RESERVOIR AND STOCHASTIC FRACTURE NETWORK MODELING FOR ENHANCED OIL RECOVERY

WIND RIVER RESERVATION, WYOMING



Air photo of Circle Ridge field and anticline.

OBJECTIVES:

- Develop models of fracture location, size, and orientation in oil reservoirs on the Wind River Reservation, Wyoming, through the integration of reservoir rock characterization, structural reconstruction and fracture characterization.
- Use the models developed to locate reservoir zones with potential for additional oil recovery and to recommend optimal recovery strategies.
- Disseminate project results to other tribes, companies, government agencies and other interested parties that might wish to apply similar methods to improve recovery in similar reservoirs.

PROJECT TEAM: Golder Associates, Inc., Marathon Oil Company, Roger Straub, and the Eastern Shoshone and Northern Arapaho Tribes of the Wind River Reservation.

PROJECT DESCRIPTION: Circle Ridge Field is operated for the Eastern Shoshone and Northern Arapaho Tribes by Marathon Oil Company. Because of the field's structural complexity, only 15% of the original oil in place has been recovered in over 50 years of operation. Current production is 97% water. The reservoir rock has good porosity, but fluid flow in the reservoir is controlled by fractures. Efficient production would move oil out of the matrix rock into adjacent fractures and then through the fracture network to wells. Golder Associates and its research team studied the matrix properties, geologic structure and fracture systems in the reservoir to seek ways to improve oil recovery.

The results of the study have led to a 15% to 20% increase in estimated matrix pore volume. A single, fully three-dimensional integrated reservoir model of the Circle Ridge Field has been constructed by combining a fault and fracture model with a reservoir matrix model. This model, along with bromide tracer test data has been incorporated in a three-dimensional Discrete Fracture Network (DFN) model of the field. The model has been validated by comparison to single well and multi-well flow tests and tracer tests. A commercial well has been drilled based on the model, however, Marathon is not releasing the production and reservoir data.

PROJECT ID NUMBER:

DE-FG26-00BC15190

PROJECT START DATE:

5-8-2000

PROJECT END DATE:

10-31-2002

PROJECT INVESTIGATOR:

PAUL LAPOINTE

GOLDER ASSOCIATES

18300 NE UNION HILL RD

REDMOND, WA 98052

PHONE: (425) 883-0777

EMAIL: PLAPOINTE@GOLDER.COM

PROJECT WEBSITE:

HTTP://WWW.

FRACTUREDRESERVOIRS.COM

DOE PROJECT MANAGER:

VIRGINIA WEYLAND

PHONE: (918) 699-2041

EMAIL:

VIRGINIA.WEYLAND@NETL.DOE.GOV

JICARILLA APACHE TRIBE

QUANTITATIVE ANALYSIS OF PRODUCTION RESERVE POTENTIAL, JICARILLA APACHE RESERVATION,
NEW MEXICO



Spring view of the relatively unexplored northern part of the Jicarilla Apache Reservation.

PROJECT ID NUMBER:

DE-FG26-00BC15194

PROJECT START DATE:

10-1-2000

PROJECT END DATE:

3-31-2002

PROJECT INVESTIGATOR:

SCOTT REEVES
ADVANCED RESOURCES INT'L.
9801 WESTHEIMER, STE. 805
HOUSTON, TX 77042
PHONE: (713) 780-0815
EMAIL:
SREEVES@ADV-RES-HOU.COM

DOE PROJECT MANAGER:

RHONDA JACOBS
PHONE: (918) 699-2037
EMAIL:
RHONDA.JACOBS@NETL.DOE.GOV

OBJECTIVES:

- Develop and demonstrate an integrated exploration framework that incorporates advanced fracture detection technology to promote the development of the Mancos Formation oil resources.
- Determine the exploration potential of the Mancos shale on the northern Jicarilla Apache Indian Reservation.
- Present project results to the Tribe and industry through meeting exhibits, technical presentations, and CDs containing final reports and maps.

PROJECT TEAM: Advanced Resources International and Jicarilla Apache Tribe.

PROJECT DESCRIPTION: The southern part of the Jicarilla Apache Indian Reservation located in north-central New Mexico along the eastern margin of the San Juan Basin, has a rich history of oil and gas production. The unexplored northern part of the Reservation lies on the same geologic and structural trend as the prolific Mancos fields in the south, indicating a high potential for additional Mancos discoveries in that area.

Advanced Resources International (ARI) and the Jicarilla Apache Tribe have conducted a study to develop an exploration rationale and identify hydrocarbon prospects in the Mancos Formation. ARI's proprietary triple-porosity/dual-permeability COMET2 reservoir simulator was used for a quantitative analysis of production and reserve potential.

Assembly of reservoir characterization information, regional geology, and theoretical understanding of fracture systems in faulted terrains resulted in the identification of four exploration leads on reservation lands. These areas are the most likely places to encounter multiple fracture directions (good permeability), strong extensional fracturing (better storage potential), and better reservoir energy and result in increased production.

Economic analysis of the successful development of the first lead indicates a potential profitability ratio of 2.6. This estimate is based on a total exploration cost of \$1.9 million, a total capital investment of \$22 million yielding an oil reserve of 16 million bbl of oil and a net present value (NPV) of \$57 million (at a 15% discount rate). Estimates of profitability for leads 2-4 are a profitability ratio of 4.8. This estimate is based on a total exploration cost of \$900,000, a total capital investment of \$7 million to yield an oil reserve of 9 million bbl and NPV of \$34 million. Successful development of all four leads could result in a NPV of \$159 million.

FOR MORE INFORMATION ABOUT THE PROGRAM, CONTACT:



National Energy Technology Laboratory
One West Third St., Suite 1400
Tulsa, Oklahoma 74103-3519



Rhonda Jacobs
Project Manager
Rhonda.Jacobs@netl.doe.gov
Phone: (918) 699-2037
Fax: (918) 699-2005

Virginia Weyland
Project Manager
Virginia.Weyland@netl.doe.gov
Phone: (918) 699-2041
Fax: (918) 295-6578

Kathy Stirling
Project Manager
Kathy.Stirling@netl.doe.gov
Phone: (918) 699-2008
Fax: (918) 295-6572

Bernadette Ward
Communications
Bernadette.Ward@netl.doe.gov
Phone: (918) 699-2033
Fax: (918) 295-6575

Jesse Garcia
Project Manager
Jesse.Garcia@netl.doe.gov
Phone: (918) 699-2036
Fax: (918) 295-6573

Office of Fossil Energy
1000 Independence Ave., SW
Washington DC 20585

Edith Allison
Exploration Program Manager
Edith.Allison@hq.doe.gov
Phone: (202) 586-1023
Fax: (202) 586-6221

Trudy Transtrum
Communications
Trudy.Transtrum@hq.doe.gov
Phone: (202) 586-7253
Fax: (202) 586-6221

Office of Congressional & Intergovernmental Affairs
1000 Independence Ave., SW
Washington DC 20585

Kristen Ellis
Intergovernmental Liaison Officer
Kristen.Ellis@hq.doe.gov
Phone: (202) 586-5450
Fax: (202) 586-7314

Steven Grey
Director for DOE Indian Affairs
Steven.Grey@hq.doe.gov
Phone: (202) 586-5377
Fax: (202) 586-7314

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