

RPSEA
Research Partnership to Secure Energy for America

PROPOSAL

Paleozoic Shale-Gas Resources of the Colorado Plateau and Eastern Great Basin, Utah: Multiple Frontier Exploration Opportunities

Submitted by
Utah Geological Survey – DUNS 176871572
Halliburton Energy Services
Bereskin and Associates
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In Response to:

Request for Proposal (RFP)
RFP 2007UN001

Unconventional Onshore Program

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LIST OF ACRONYMS.

AAPG American Association of Petroleum Geologists
 DNR – Department of Natural Resources
 DOGM – Division of Oil, Gas & Mining
 FT – Feet
 UCRC – Utah Core Research Center
 UGS – Utah Geological Survey
 IOG – Industry Outreach Geologist
 RPSEA – Research Partnership to Secure Energy for America
 TCFG – trillion cubic feet of gas
 TOC – Total Organic Carbon
 % – Percent

EXECUTIVE SUMMARY

Offeror: Utah Geological Survey, Salt Lake City, Utah
Project Director/Principal Investigator: Thomas C. Chidsey, Jr.

Major Participants (Partners):
Halliburton Energy Services
Bereskin and Associates
GeoX Consulting Inc.

Paleozoic Shale-Gas Resources of the Colorado Plateau and Eastern Great Basin, Utah: Multiple Frontier Exploration Opportunities

Shale gas reservoirs in Utah have tremendous untapped frontier potential. Paleozoic shales in the Colorado Plateau and eastern Basin and Range Provinces have long been known for their potential as source rocks for hydrocarbons that have migrated into other formations but have not been considered as in-situ gas reservoirs. These include the Mississippian Manning Canyon and Delle Phosphatic shales and the Pennsylvanian Paradox Formation of north-central, western, and southeastern Utah, respectively. Shale beds within these formations are widespread, thick, buried deep enough to generate dry gas, and contain sufficient organic material and fractures to hold significant recoverable gas reserves. Exploratory efforts are just beginning to target these frontier gas shales; many in environmentally sensitive areas.

The Manning Canyon Shale is mainly claystone with interbeds of limestone, sandstone, siltstone, and mudstone, and has a maximum thickness of 2000 ft. Total organic carbon (TOC) varies from 1% to more than 8%. In north-central Utah, the Manning Canyon was deeply buried by sediments in the Pennsylvanian-Permian-aged Oquirrh basin and is likely very thermally mature. The Delle Phosphatic Shale is a member of the Chainman Shale, Deseret Limestone and Little Flat Formation. The Delle Phosphatic Shale Member is composed of interbedded organic-rich phosphatic shale, siltstone and limestone deposited in a starved basin at the foot of the Paleozoic carbonate ramp. The member is typically 100 to 200 ft thick. Cyclic shale units in the Paradox Formation consist of thinly interbedded, black, organic-rich marine shale; dolomitic siltstone; dolomite; and anhydrite. Individual shale units generally range in thickness between 25 and 50 ft; the cumulative shale thickness is typically 100 to 200 ft. These units contain TOC as high as 15%, are naturally fractured (usually on the crest of anticlinal closures), and are often overpressured.

Although the organic content of some of these shales is partially known, the reservoir quality and the basic rock mechanic data so important to successful completions are virtually unknown. In addition, the distribution and thickness of these rocks are poorly mapped and the vertical succession and regional

correlation of the Manning Canyon and Delle Phosphatic has not been interpreted in a sequence stratigraphic framework. The burial history of the Manning Canyon and Delle Phosphatic appears complex and probably varies widely from deep burial in the Permian Oquirrh basin (>10,000 ft of overlying Pennsylvanian and Permian strata) to shallower burial along the Paleozoic shelf of central Utah. There are no published studies of the best completion practices for the Manning Canyon, Delle Phosphatic, and Paradox shales.

The proposed **tasks** include data compilation from existing wells and publications; detailed description and petrophysical, geochemical, and rock mechanical analysis of cores and cuttings from our collection; outcrop examination and sampling; regional mapping including structure, thickness, thermal maturity, and deposition facies maps of key shale gas reservoirs; and design, description, and recommendation of the best completion practices for these frontier Utah shale gas reservoirs based on various parameters defined by our study.

Thus, the overall **objectives and/or benefits** of this study are to (1) identify and map the major trends for target shale intervals and identify areas with the greatest gas potential, (2) characterize the geologic, geochemical, and petrophysical rock properties of those reservoirs, (3) reduce exploration costs and drilling risk especially in environmentally sensitive areas; and (4) recommend the best practices to complete and stimulate these frontier gas shales to reduce development costs and maximize gas recovery. All project maps, data reports, and results will be publicly available and presented to the petroleum industry (both small and large operators) through a proven technology transfer plan. The project will therefore, develop techniques and methods for exploration and production for emerging frontier basins where these operations typically encounter technical, economic, and environmental challenges.

A. TECHNICAL MERIT AND VALUE TO PROGRAM

Shale gas reservoirs in Utah have tremendous untapped frontier potential. Paleozoic shales in the Colorado Plateau and eastern Basin and Range Provinces have long been known for their potential as source rocks for hydrocarbons that have migrated into other formations but have not been considered as in-situ gas reservoirs. These include the Mississippian Manning Canyon (Figure 1) and Delle Phosphatic shales (Figure 2) and the Pennsylvanian Paradox Formation (Figure 3) of north-central, western, and southeastern Utah, respectively.

The Manning Canyon Shale is mainly claystone with interbeds of limestone, sandstone, siltstone, and mudstone, and has a maximum thickness of 2000 ft. Total organic carbon (TOC) varies from 1% to more than 8%. In north-central Utah, the Manning Canyon was deeply buried by sediments in the Pennsylvanian-Permian-aged Oquirrh basin and is likely very thermally mature. The Delle Phosphatic Shale is a member of the Chainman Shale, Deseret Limestone, and Little Flat Formation. The Delle Phosphatic Shale Member is composed of interbedded organic-rich phosphatic shale, siltstone and limestone deposited in a starved basin at the foot of the Paleozoic carbonate ramp. The member is typically 100 to 200 ft thick. Cyclic shale units in the Paradox Formation consist of thinly interbedded, black, organic-rich marine shale; dolomitic siltstone; dolomite; and anhydrite. Individual shale units generally range in thickness between 25 and 50 ft; the cumulative shale thickness is typically 100 to 200 ft. These units contain TOC as high as 15%, are naturally fractured (usually on the crest of anticlinal closures), and are often overpressured.

Shale beds within these formations are widespread, thick, buried deep enough to generate dry gas, and contain sufficient organic material and fractures to hold significant recoverable gas reserves. Exploratory efforts are just beginning to target these frontier gas shales; many in environmentally sensitive areas.

A.1 Proposed Technology/Methodology

A.1.1 Statement and Significance of the Problem

Although some information exists on the organic content of the Manning Canyon, Delle Phosphatic, and Paradox shales, the reservoir quality and the basic rock mechanic data so important to successful completions are virtually unknown. Numerous cores and cuttings are available at the Utah Geological Survey's Utah Core Research Center (Figure 4), but very few have been described in detail or have had reservoir analysis.

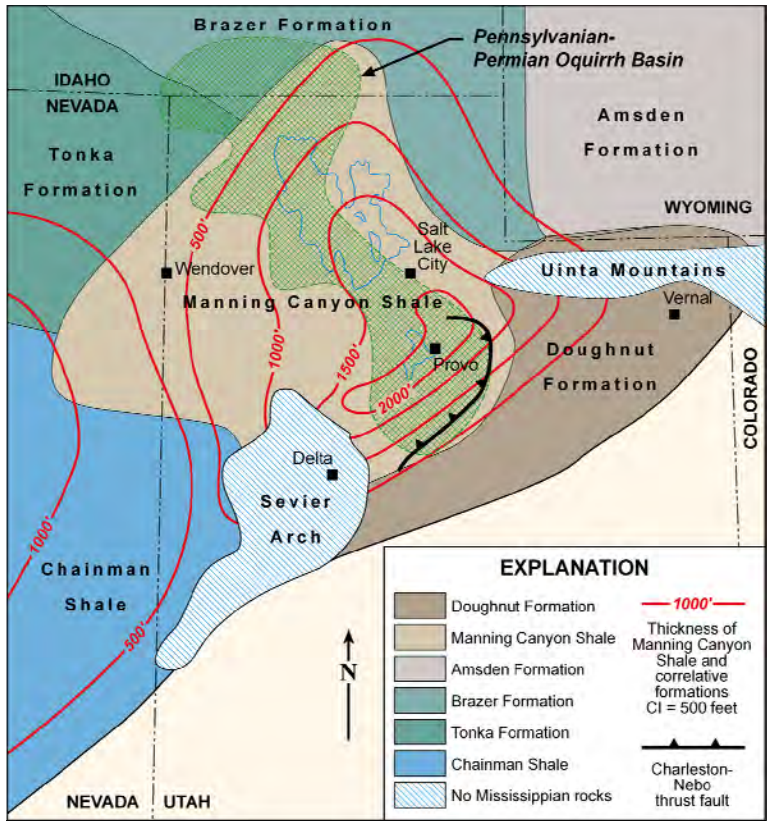


Figure 1. Location and thickness of the Manning Canyon Shale and correlative formations (modified from Moyle, 1958).

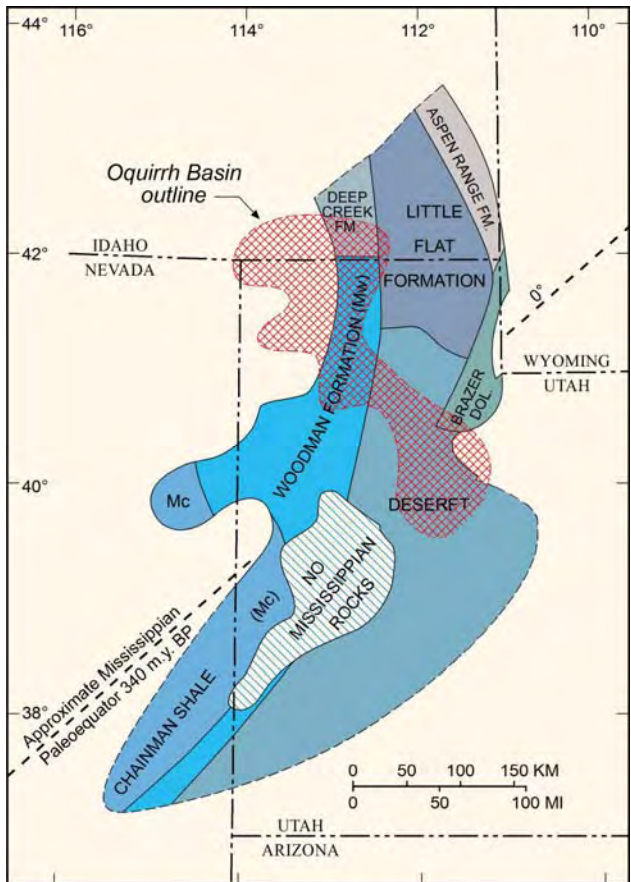


Figure 2. Location of the Mississippian Delle Phosphatic Member present in the Desert Limestone and other Mississippian formations (modified from Sandberg and Gutschick, 1984).

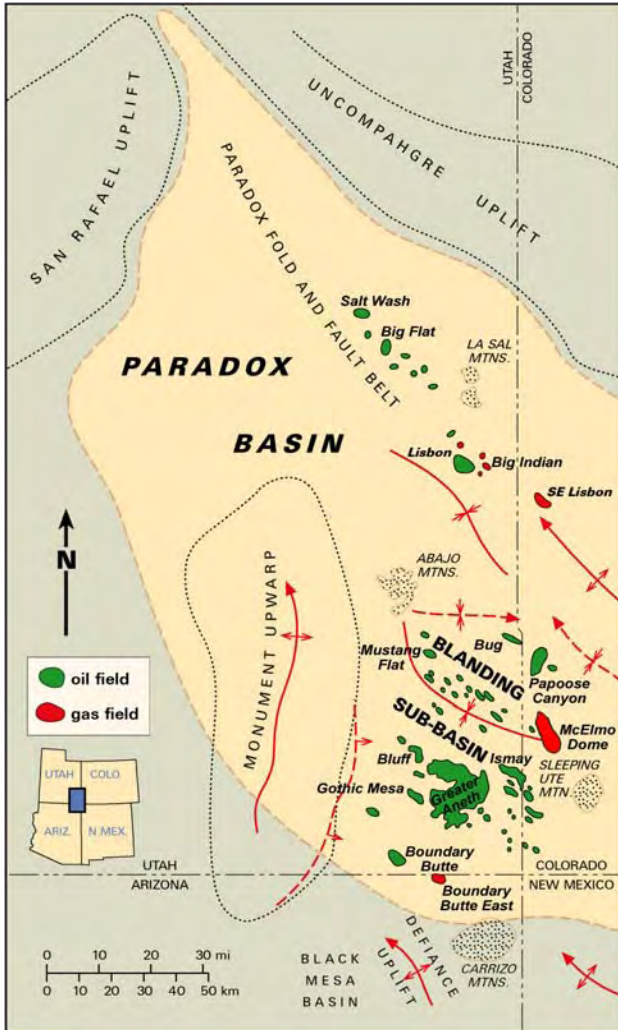


Figure 3. Location of the Paradox Formation (tan area) in the Paradox Basin of Utah and Colorado.

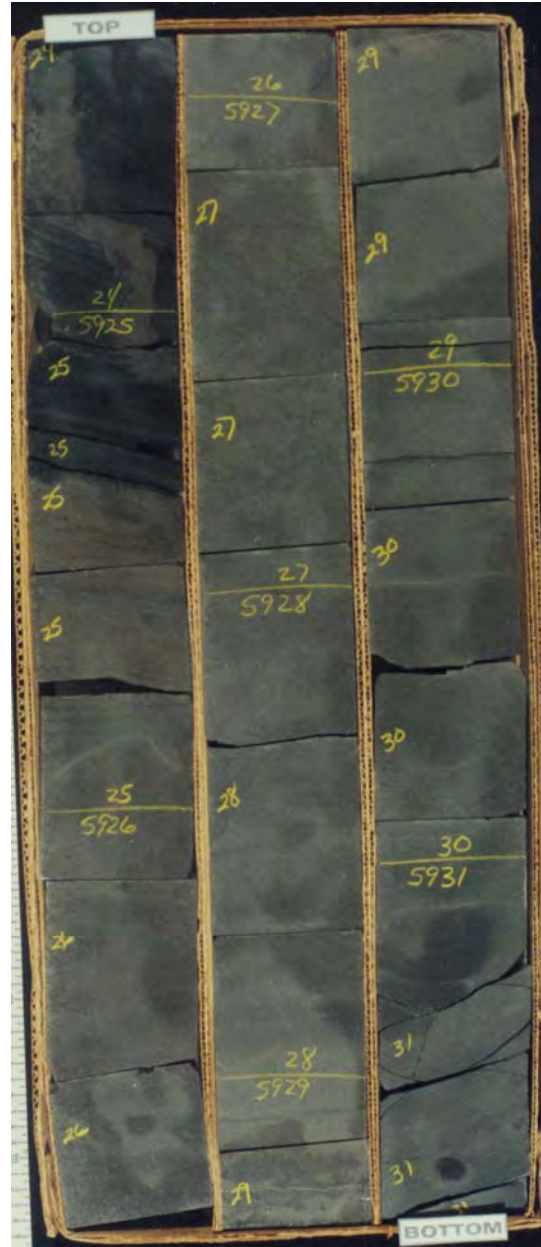


Figure 4. Core of the Gothic shale from the Paradox Formation, available at the Utah Geological Survey's Utah Core Research Center.

Existing published maps and information on the distribution and thickness of these rocks is poor and often incorrect. The vertical succession and regional correlation of the Manning Canyon and Delle Phosphatic units have not been interpreted in a sequence stratigraphic framework. The source potential of the Manning Canyon and Delle Phosphatic units is poorly understood and the burial history appears complex and probably varies widely from deep burial in the Permian Oquirrh basin (>10,000 ft of overlying Pennsylvanian and Permian strata) to shallower burial along the Paleozoic shelf of central Utah. In central Utah it is unknown if the formation is Doughnut or a tongue of the Manning Canyon.

The logical transition step from fundamental geologic evaluation to successful engineering implementation often focuses on wireline logging evaluation. This evaluation often relies on sophisticated "blackbox" numerical processing of curves from multiple signals with little or no regard for facies. How can detailed geologic and petrophysical work be used by operators, who cannot afford such expensive wireline evaluations? The answer for most operators is they can't afford such valuable data.

Our study will provide basin specific analyses of shale-gas reservoir properties, as has been done for shale-gas reservoir elsewhere in the U.S., to develop the best local completion practices that can be applied to the emerging Manning Canyon, Delle Phosphatic, and Paradox frontier gas shales.

A.1.2 Background and Existing Technologies/Methodologies

Very few existing technologies/methodologies have been developed for potential shale-gas reservoirs of the Colorado Plateau and eastern Basin and Range provinces. However, once the geologic regime has been identified and logging signatures have been processed, what happens next usually involves some sort of stimulation procedure involving fracture stimulation or acidization. In most cases, frac design will follow largely from triple combo type of information – use the gamma ray for lithology, use the density log to locate perforations, use of density-neutron crossover to identify gas. The operator might add some sequestering agents for iron control. However, these are very general methods not specifically designed for the potential shale-gas reservoirs to be evaluated in the study.

A.1.3 Relationship to the Program Goals/Objectives

This project will meet the RPSEA program goal to evaluate the rock properties, gas storage potential, and design stimulation techniques for gas shale reservoirs. The Manning Canyon, Delle Phosphatic, and Paradox shales are located in frontier areas where there has been no such studies and no prior commercial development. The proposed study will identify and characterize rock properties (formation evaluation)

for these three potential resource plays in two provinces with limited existing activity. From this formation evaluation study, appropriate local well completion and stimulating practices will be defined.

The overall objectives and/or benefits of this proposed study are to (1) identify and map the major trends for target shale intervals and identify areas that have the greatest gas potential, (2) characterize geologic, geochemical, and petrophysical rock properties of these reservoirs, (3) reduce exploration costs and drilling risk especially in environmentally sensitive areas; and (4) recommend the best practices to complete and stimulate these frontier gas shales to reduce development costs and maximize gas recovery. These objectives fulfill the RPSEA program objective by “providing information, knowledge, and methodologies to spur activity in currently underdeveloped and low activity resources.” They also fulfill Long-Term Objective 5 by “developing techniques and methods for exploration and production from frontier areas and formations where operations have been hindered by technical, economic, and environmental challenges.” The study will include both an initial assessment of the potential of these frontier shale gas resources as well as possible “novel” concepts for development.

This study will establish a template for more effective design of stimulations by integrating the geologic work and formation evaluation with basic rock mechanics data. This will allow access to gas that may be technically not feasible to drill based on current information. These objectives will also provide new approaches which will offer improvement in resource recovery, reduce cost of operations, and may lessen environmental impact as compared to current methods that would likely be applied. The proposed study will ensure the emerging, frontier potential Manning Canyon, Delle Phosphatic, and Paradox shales will be positioned to contribute to meeting program goals in later years.

A.2 Industry Participation and Support

A.2.1 Description of Industry Participation

Three organizations will partner with the Utah Geological Survey (UGS) on the proposed project: Halliburton Energy Services, Bereskin and Associates, and GeoX Consulting Inc. Halliburton will play the major role in determining the best completion practices for potential frontier shale-gas reservoirs as described in the Statement of Work. Bereskin and Associates and GeoX Consulting will advise and assist with description, petrophysical, geochemical, and rock mechanical analysis of cores and outcrop samples also described in the Statement of Work. Letters of support/commitment are included in the Appendix.

Five companies will serve on the Technical Advisory Board: Shell Exploration and Production, Bill Barrett Corp., Sinclair Oil Co., Encana Oil and Gas, (USA) Inc., and CrownQuest Operating Resources. Letters of support/commitment are also included in the Appendix.

A.2.2 Leverage of Project Funds

The project will be leveraged by cumulative contribution from the UGS and its three partners of 33% of the cost to complete the tasks estimated in the Cost Summary. This includes a share of UGS and partners personnel time, plus a share of the UGS's other direct expenses and overhead.

A.2.3 Source and Nature of Proposed Cost Share

The UGS will contribute a 20% cost share to the project covering salary and benefits, indirect costs/overhead, travel expenses, subcontracted laboratory analysis, and miscellaneous materials and offices supplies. Bereskin and Associates and GeoX Consulting Inc. will also contribute 20% cost share to the project in the form of a 20% contribution of their labor expenses. Halliburton's significant contribution will entirely be in-kind – 100% cost share of all project labor and other expenses. [Again refer to letters of commitment included in the Appendix] The cumulative budget for the project will be 33% cost share by the UGS and its partners; 67% from RPSEA.

A.3 Expected Project Impacts and Benefits

A.3.1 Impact on Reserves and Production

The proposed research will encourage new exploration for multiple emerging frontier shale-gas reservoirs that could ultimately result in trillions of cubic feet of gas (TCFG) added to our nation's resource potential. This research will help focus industry's attention on the extensive Paleozoic shale-gas resource potential in the Colorado Plateau and eastern Basin and Range Provinces, and will provide the necessary information to promote aggressive exploration and development programs.

Nationwide, shale-gas resources are calculated to be between 500 TCFG to 780 TCFG. The best known shale-gas play, the Barnett Shale in the Ft. Worth Basin, has 26 TCF of recoverable reserves (U.S. Geological Survey, 2004). The Barnett contains 50 to 200 billion cubic feet of gas per square mile. The Paleozoic shale-gas potential of the Colorado Plateau and eastern Basin and Range Provinces are currently an emerging frontier exploration play. As a result, the U.S. Geological Survey has not studied the resource potential in a formal resource assessment for either the Paradox Formation shales, Manning Canyon Shale, or any of the other potential Paleozoic shale-gas reservoirs.

A.3.2 Environmental Impact

The proposed research will have no significant environmental impacts. Much of the research will focus on core and cutting samples already in the Utah Core Research Center (UCRC). Analysis of rock samples will be conducted by commercial labs that meet all safety and environmental requirements for such work. Some samples and measurements will be collected from the outcrop. All field work will be from established roads or on foot. All samples collected will be typical “hand samples” or small plugs, to be studied in the lab. Outcrop measurements will consist of measuring the thickness of units, describing the geology, and in some cases measuring surface gamma ray, a non-invasive tool that measures the natural gamma ray emitted from the rock.

A.3.3 Applicability

This research project addresses the information needs of oil and gas exploration companies both large and small. The results of the research will be used to identify favorable target areas to acquire leases and begin active exploration of shale-gas reservoirs. The research can be used by other exploration companies and service companies as a basis for evaluating leases and development strategies. The work by Halliburton will identify best practices for the most efficient stimulation and completion practices for each of the Paleozoic shale-gas reservoirs in the various mapped play areas.

The appropriate path to application of the proposed technology/methodology will be making the results of the research available to industry and the public through the UGS’s technology transfer program which includes: Web postings, technical talks, booth exhibits at professional meetings, technical advisory board meetings, and published papers. The application of this research will be by oil and gas exploration companies, both large and small, through leasing, exploration, and ultimately production of shale gas. This research will provide geochemical, rock mechanics, maps and cross sections characterizing play areas, as well as best practices for stimulation and completion of each of the Paleozoic shale-gas reservoirs. This research will help focus industry’s attention to the extensive emerging frontier shale-gas resource in the Colorado Plateau and eastern Basin and Range Provinces, and will provide the necessary information to promote an aggressive exploration program.

A.3.4 Risks

The factors affecting the likelihood of the project achieving the proposed impacts are: (1) rock and other subsurface data proves inadequate to fully assess the resource on a basin-wide scale, and (2) the

study indicates that the Paleozoic shales are less favorable candidates for shale-gas reservoirs due to such factors as low organic carbon and/or poor thermal maturation, or low gas-in-place volumes, for example. Factors that could affect market acceptance are: (1) significant reduction in the price of natural gas making the reward-versus-cost ratio unacceptable, (2) limited exploration play areas reducing the total potential of the plays, (3) most promising play areas having significant topographic concerns and/or environmental restrictions, and (4) the techniques needed for efficient stimulations and completions proves to be cost prohibitive.

The specific ways in which the proposed work will benefit small producers exploring Paleozoic shale-gas reservoirs in an emerging frontier area is by providing an in-depth understanding of the geochemical, burial history, rock mechanics, and depositional environments of the shale beds. This type of data is often to expensive for small operators to obtain, especially on a basin-wide scale. Our research will provide the necessary data as well as map out play areas within the basins for each of the Paleozoic shale-gas reservoirs, thus providing small operators the data and tools to explore for the shale-gas reservoirs on an equal footing with larger companies that have a large technical resource base to draw on. The data from this research will also be used by Halliburton Energy Services to design best practices for proper stimulation and completion of each of the potential shale-gas reservoirs, a wealth of engineering generally not available to the small operator.

B. TECHNICAL APPROACH

B.1 Detailed Work Plan (Statement of Work)

I. Objectives

The overall **objectives** of this proposed three-year study of potential emerging frontier Paleozoic shale-gas reservoirs of the Colorado Plateau and eastern Basin and Range Provinces are to (1) identify and map the major trends for target intervals and identifying areas that have the greatest gas potential, (2) characterize geologic, geochemical, and petrophysical rock properties of these reservoirs, (3) reduce exploration costs and drilling risk especially in environmentally sensitive areas; (4) recommend the best practices to complete and stimulate these frontier gas shales to reduce development costs, (5) maximize gas recovery, and (6) make results available to the petroleum industry (both large and small operators) through a proven technology transfer plan. The project will therefore develop techniques and methods for

exploration and production from emerging frontier area basins where operations encounter technical, economic, and environmental challenges.

II. Scope of Work

The project objectives will be achieved in one continuous, three-year phase. The scope of work will begin with data compilation from existing wells and publications related to emerging frontier Paleozoic shale-gas reservoirs of the Colorado Plateau and eastern Basin and Range Provinces.

We will conduct a detailed description and petrophysical, geochemical, and rock mechanical analysis of cores from the collection at the UCRC. Core descriptions will involve a foot-by-foot examination and photography of slabbed sections. A subsequent electronic column or coregraph will be generated. Similarly, the presence of any natural fractures will be documented in the foot-by-foot inspection. Morphologic features to be documented include orientation (e.g. vertical, subvertical, or horizontal), fracture length, mineral infilling, aperture width, shape of fracture (e.g. curvilinear, planar), and presence or absence of oil stain. As most shale operators know, the presence of "open" fractures will greatly influence the hydrocarbon productivity for both vertical and horizontal wellbores, and even filled fractures are particularly important to hydraulic fracturing procedures. Additional well samples may become available from other core facilities and companies.

Concurrent with the megascopic inspection, samples will be collected for traditional petrography, X-ray diffraction, and scanning electron microscopy. Sampling bias will be based on original lithofacies classification obtained through the macroscopic examination. Additionally, the microscopic data will be incorporated into the electronic coregraph, such that accurate identification of lithofacies types ultimately occurs. Although a depositional history will be formulated for these shales based on the macroscopic examination, details and confirmation of such a history will also be provided, especially through the petrographic studies.

Finally, once the lithofacies and heterogeneity of shale units have been documented, careful correlation to diagnostic log signatures will be subsequently attempted (with any necessary depth-shifting of core depth to log depth). The core-to-log correlation will be attempted so that uncored portions of offset wellbores can be interpreted for future exploration/exploitation/development efforts. This petrophysical exercise can be rudimentary involving correlation of geologic parameters to single (or relatively few) log traces; in other cases, geologic parameters can be equated to a network or collection of multiple log characteristics. Such complex correlation can involve clustering and/or neural networks, but at this stage, it is not certain what technique(s) will ultimately be successful. Nonetheless, a major thrust of this investigation will involve core to log correlation, expressly for the purpose of interpreting

those wells solely possessing open-hole log data.

Although some geochemical data are already available to this proposed study, additional analyses of selected core and cuttings material will augment the gaps in the existing data package including total organic carbon and vitrinite reflectance. Additional analyses might document the full range geochemical variability common to many shale-gas plays elsewhere.

Another important and essential means of accomplishing core-to-log correlation involves rock mechanics testing including extensive use of tight rock analysis. This revolutionary recent (and proven) method is intended to provide the following parameters: (1) bulk density, (2) grain density, (3) bound and mobile water and hydrocarbon saturations, (4) total porosity, (5) gas-filled porosity, and (6) pressure decay permeability. This technique has been effectively utilized for many previous shale studies and appears very valuable in correlation to open-hole log data, to potential production rates, and to estimated ultimate reserve numbers. Triaxial and acoustic testing on core plugs under in-situ conditions for shale units will formalize the relationships developed to delineate facies-dependent correlations for Young's Modulus, Poisson's ratio, and resulting degree of hydraulic fracturing.

Halliburton will develop a best practice plans and recommendations for completion (drilling [horizontal vs. vertical], fracturing, acidization, perforation, etc.) based on geochemical and petrophysical information compiled by the UGS. This will be done by reviewing any past completions, and any petrophysical, production, and completion data which can be provided by the UGS database and analysis generated from the rock mechanic analysis (and other pertinent information provided from the core studies) or operators in the area. In addition, Halliburton will draw on its significant experience with shale-gas completions from established shale-gas reservoirs elsewhere in the U.S. (Barnett Shale, Woodford, etc.).

From outcrop examination, additional selected samples will be gathered for analysis and comparison to available cored intervals from wells. Key outcrops will be measured and described; this may include surface gamma-ray transects, to tie to subsurface information and fill in possible gaps regionally where wells are not present.

A regional well log correlation will be developed, and major horizons, facies, and possible sequence boundaries of potential gas shales will be identified and correlated throughout the southeastern and central Utah and entered into GIS database. Regional mapping will include structure, thickness, thermal maturity, and deposition facies maps of key shale-gas reservoirs. Regional cross sections and burial history plots for key shale gas reservoirs will also be constructed. Finally, significant play areas "sweet spots" for each of the major emerging shale gas reservoirs will be identified and mapped. All project results will submit for publication as a final report and as other topical papers.

III. Tasks to be Performed

Task 1.0: The Project Management Plan. "The Awardee will develop a Project Management Plan consisting of a work breakdown task structure and supporting narrative that concisely addresses the overall project as set forth in the agreement. The Awardee will provide a concise summary of the objectives and approach for each task and, where appropriate, for each subtask. The Awardee shall provide schedules and planned expenditures for each task including any necessary charts and tables, and all major milestones and decision points. The Awardee will identify key milestones that need to be met prior to the project proceeding to the next phase. This report is to be submitted within 30 days of the Award. The RPSEA Contracts/Procurement Manager shall have 20 calendar days from receipt of the Project Management Plan to review and provide comments to the Awardee. Within 15 calendar days after receipt of the RPSEA's comments, the Awardee will submit a final Project Management Plan to the RPSEA Contracts/Procurement Manager for review and approval."

The UGS will negotiate the final contract with RPSEA in consultation with other team members, including partners/subcontractors. The UGS will be responsible for ensuring that all required technical and financial reports are prepared and delivered to RPSEA as required in the final contract.

Task 2.0: Technology Status Assessment. "The Awardee will perform a Technology Status Assessment and submit a summary report describing the state-of-the-art of the proposed technology. The report will include both positive and negative aspects of each existing technology. The report will be no more than five typewritten pages in length. The report will not contain any proprietary or confidential data, and will be posted on the RPSEA website for public viewing. The report will be submitted within 30 days of the Award."

Task 3.0: Technology Transfer. "The Awardee has designated more than 2.5% of the amount of the proposed award for funding technology transfer activities. Throughout the project, the Awardee will work with RPSEA to develop and implement an effective Technology Transfer Program at both the project and program level." Base on our cost summary, we estimate that about 20% of the project budget will fund technology transfer activities.

The technology transfer will consist of, but not be limited, to the following subtasks.

3.1 Webpage: The UGS will maintain a Web site dedicated to the project.

The UGS will maintain a Web site dedicated to displaying project news, results, and reports.

3.2 Technical Advisory: A Technical Advisory Board of companies interested in exploring Utah's Paleozoic frontier shale-gas reservoirs will be established. The formation of the Technical Advisory Board ensures direct communication of the study methods and results with the Paleozoic shale-gas operators. Several companies have already committed to serving as Technical Advisors, more can be added as the project progresses.

3.3 Industry Outreach: The UGS Industry Outreach Geologist (IOG) will set up technical displays at two major industry conventions: regional and national American Association of Petroleum Geologists (AAPG).

3.4 Technical Presentations: Oral or poster presentations at AAPG, or other local, regional and national technical meetings.

3.5 Publications: The UGS will report all aspects of the project in a series of formal publications.

3.6 Core Workshops: One-day core workshops will be held at the Utah Geological Survey Core Research Center in Salt Lake City, Utah, and in Denver, Colorado, to examine core from selected regional wells and present geologic results and recommendations based on the project research.

3.7 Field Review: A field review will be led to significant outcrop exposures of the shale-gas reservoirs. The field review will be open to all interested parties.

Task 4.0: Data Compilation.

4.1 Compile a selected bibliography of published stratigraphic definition, petrologic, rock mechanics, geochemical, and geochronology analysis.

4.2 Create a well database of significant penetrations, tops, formation tests, completion information, production, and other reservoir data.

Task 5.0: Core and Cuttings Examination and Sample Analysis.

5.1 Detailed foot by foot megascopic description of slabbed core (including photography and tying to geophysical well logs); thin section and scanning electronic microscopy; X-ray diffraction; plug analysis for porosity and permeability, capillary pressure/mercury injection, and palyomorph/microfossil age dating.

5.2 Geochemical analysis including total organic carbon and vitrinite reflectance.

5.3 Rock mechanics analysis including micro probe, triaxial tests, scratch tests, and tight rock analysis.

Task 6.0: Outcrop Examination and Sample Analyses

6.1 Gather selected samples for analysis and comparison with available cored intervals from wells.

6.2 Measure and describe key outcrops; this may include surface gamma-ray transects.

6.3 Perform analyses of outcrop samples similar to those described in 5.1, 5.2, and 5.3 above, as appropriate.

Task 7.0: Determination of Best Completion Practices. Develop a best practices and recommendations for completion (drilling [horizontal vs. vertical], fracturing, acidization, perforation, etc.) based on information supplied by the UGS or operators in the area (past completions, production, completion, petrophysical data) and the wealth of shale-gas completion experience by Halliburton from established shale-gas reservoirs elsewhere in the U.S.

Task 8.0: Regional Correlation, Mapping, and Depositional History Determination

8.1 Prepare structure, thickness, thermal maturity, and depositional facies maps of key shale gas reservoirs to identify location and distribution of reservoirs.

8.2 Prepare regional cross sections of all major shale gas reservoirs to help visualize location and distribution of favorable reservoirs.

8.3 Construct burial history plots for key shale gas reservoirs to help understand timing of gas generation and potential expulsion or storage.

Task 9.0: Final Interpretations and Recommendations

9.1 Identify and map significant play areas “sweet spots” for each of the emerging Paleozoic shale-gas reservoirs.

9.2 Write and submit for publication a final report and other topical papers.

B.2 Labor Hours and Categories

List of estimated labor hours and labor categories including consultants required for each task in the statement of work by year.

	Description	Key Personnel	General Labor Category	2008 Year 1	2009 Year 2	2010 Year 3
Task 1	Project Management	T. Chidsey (Task Leader)	Geologist/Principal Investigator	200	200	200
		D. Tabet	Geologist/Manager	40	40	40
Task 2	Technology Status Assessment	T. Chidsey (Task Leader)	Geologist/Manager	40	Completed	Completed
Task 3	Technology Transfer	R. Bon (Task Leader)	Outreach Geologist	100	100	100
		T. Chidsey	Geologist/Manager	80	80	120
		C. Morgan	Geologist	80	80	80
		S. Carney	Geologist	80	80	80
		M. Laine	Geologist/Curator	80	80	80
		T. Dempster	Geotech	0	0	40
		B. Wolverton	Warehouse Worker	0	0	40
		Staff	Editorial	40	40	40
Staff	GIS	20	20	20		
Task 4	Data Compilation	S. Carney (Task Leader)	Geologist	120	Completed	Completed
		C. Morgan	Geologist	40		
		T. Chidsey	Geologist/Manager	40		
		Staff	Geotech	80		
Task 5	Core, Cuttings, & Outcrop Sample Analysis	T. Chidsey (Task Leader)	Geologist/Manager	120	120	Completed
		C. Morgan	Geologist	80	80	
		S. Carney	Geologist	80	80	
		T. Dempster	Geotech	80	80	
		M. Laine	Geologist/Curator	80	80	
		B. Wolverton	Warehouse Worker	40	40	
		L. Rogers	Office Tech	40	40	
		B. Bereskin	Geologic Consultant	93	93	
S. Schamel	Geologic Consultant	120	120			
Task 6	Outcrop Examination & Sampling	C. Morgan (Task Leader)	Geologist	160	160	Completed
		T. Chidsey	Geologist/Manager	80	80	
		S. Carney	Geologist	120	120	
Task 7	Determination of Best Completion Practices	Halliburton (R. Curtice, Task Leader)	Reservoir Engineer	40	280	280
		T. Chidsey	Geologist/manager	40	40	40
		C Morgan	Geologist	40	40	40
Task 8	Regional Mapping	C. Morgan (Task Leader)	Geologist	not started	160	120
		T. Chidsey	Geologist/manager		80	80
		S. Carney	Geologist		120	80
		Staff	Graphic Artist		40	40
		Staff	GIS Specialist		80	40
Task 9	Final Interpretation & Recommendations	T. Chidsey (Task Leader)	Geologist/Manager	not started	120	120
		C. Morgan	Geologist		100	100
		S. Carney	Geologist		100	100
		Staff	Reviewers		40	40
		Staff	Graphic Artist		40	40
		Staff	GIS Specialist		80	80

B.3 Project Schedule and Milestones

The project is scheduled to take three years (36 months) beginning on or after January 1, 2008 and ending approximately December 31, 2010. The milestone schedule for each task is shown in Figure 5 and Table in section B.2. Task 1: Project Administration and Task 3: Technology Transfer will be ongoing throughout the course of the project while Task 2: Technology Assessment, as required will be completed during the first 30 days of the project. Task 4: Data Compilation will take place during the first nine months of year 1. From this compilation targeted zones and areas will be identified. This will lead to the start of Task 5: Core and Cuttings Examination and Sample Analysis and Task 6: Outcrop Examination and Sample Analyses, although there will be some overlap with Task 4. In addition the analysis of outcrop samples collected in Task 6 will take place during the latter time periods obviously of Task 5. Task 7: Best Completion Practices will begin in earnest after particular shale gas zones have been identified by the work conducted during Task 4, 5, and 6. However, Halliburton (consultant and industry partner) may advise task leaders of additional data and petrophysical analysis necessary to best complete its task. Task 8: Regional Mapping will be fairly independent of all other tasks and will begin at the start of year 2. Task 9: Final Interpretation & Recommendations will be dependent on and the culmination of the results of all other tasks and will be a major focus of year 3.

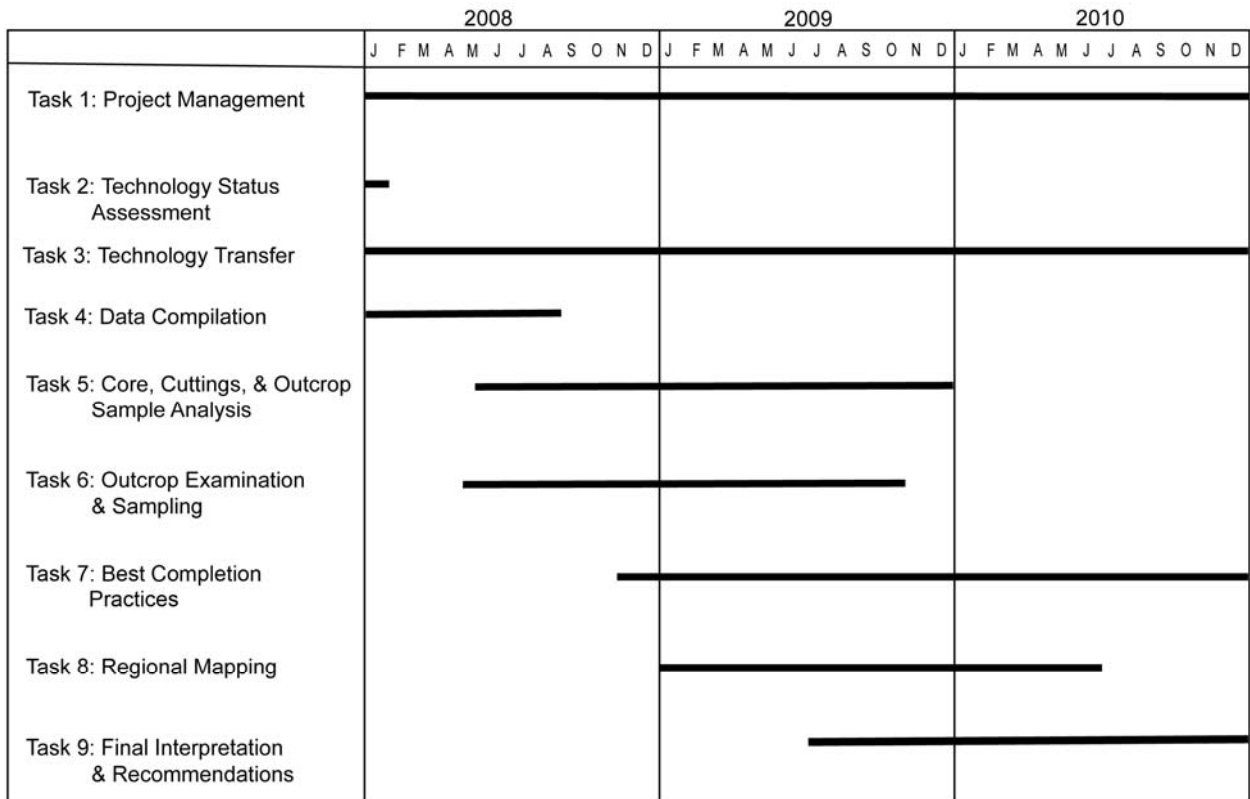


Figure 5 Gant chart showing project schedule and milestones.

Only catastrophic or unanticipated problems would affect successfully achieving the project schedule or milestones. All outcrops to be examined are on public lands. There are ample core/cutting materials available at the UCRC for the project and thus the UGS is not dependent on operator well sample donations. Production data, completion reports, and geophysical well logs from fields and exploratory wells are publicly available from the Utah Division of Oil, Gas and Mining. Should any delays or project issues occur, they will be reported to RPSEA and the Principal Investigator, who will be responsible for their resolution. If unexpected time constraints become a problem the UGS could hire additional staff.

B.4 Proposed Travel

Proposed travel can be divided into two categories: out of state and in state. Out of state travel is associated with technology transfer activities and a required RPSEA kickoff meeting (Tasks 1 and 3), and will originate in Salt Lake City, Utah. Specifically, the out of state travel will consist of trips to meet annually with the project Technical Advisory Board in Denver, Colorado, and attend annual and regional American Association of Petroleum Geologists (AAPG) conventions. The Technical Advisory Board will advise the project technical team on the direction of study, review technical progress, recommend changes and additions to the study, and, if possible, provide critical reservoir and engineering data. Most of these operators have their offices in Denver, Colorado. Therefore, the key personnel (Chidsey and Morgan [the Principal Investigator and project task leader]) will meet with board members in each year of the project (three [3] times) to present project overviews, review objectives and goals, timetables of activities, obtain critical data, review progress, receive industry feedback, and present project results.

The RPSEA kickoff meeting, as required, will take place in Sugarland, Texas, to arrange definitive schedules and coordinate other project actions.

Project results, plans, and objectives will be displayed at the UGS exhibit booth during AAPG annual national and regional conventions. The AAPG annual conventions for 2008, 2009, and 2010 will be in the following cities, respectively: San Antonio, Texas; Denver, Colorado; and Houston, Texas. The AAPG Rocky Mountain Section regional meetings for 2008 and 2010 will be the following cities respectively: Denver and Durango, Colorado, respectively (the 2009 regional meeting will held in conjunction with the national meeting in Denver). Key personnel will travel to the meeting venues and staff the exhibit booth at this event, answer questions about the project, and present project results at a technical session. A core workshop will also be presented in Denver at the conclusion of the project and will require attendance of four key project personnel for workshop set up and instruction.

The purpose of the in-state-travel will be to study and sample outcrop sites (Task 6), to meet annually with Halliburton in Vernal, Utah (Task 7), and to conduct a field review at the conclusion of the project (Task 3). We estimate outcrop visits will require at least a total of six weeks of work by two personnel during years one and two, and involve ground transportation from Salt Lake City to sites in central (and possibly western) and southeastern Utah. A field review to selected research sites will take place near the conclusion of the project in year three to examine key reservoir properties and relationship where well exposed.

All travel costs are based on State of Utah approved travel rates for out of state and in state per diem and lodging, as well as predicted airfares to Denver and Houston, and current state motor pool vehicles usage rates.

B.5 Recommended Technology Transfer Approach

The UGS already carries out an aggressive technology transfer and marketing campaign to promote prudent development of Utah's energy resources. UGS displays recent petroleum research at regional and national technical meetings with UGS scientists staffing the display. The UGS maintains a World-Wide-Web site for each of its major petroleum research projects. As a result, UGS receives hundreds of inquiries annually for further information.

The specific components of the technology transfer plan (Task 3) for the proposed project are as follows:

(Sub Task 3.1) The UGS will maintain a **Web page**, dedicated to the project (the UGS already has web pages for the other DOE projects it is conducting). The new web page will have a list containing e-mail addresses of personnel involved in the project. A description of the study and objectives will be posted as well as quarterly and annual reports, announcements of activities, and press releases. The project web page will provide instant access to information about the project and the latest results and eventually the release of final publications.

(Sub task 3.2) A voluntary **Technical Advisory Board** (see Appendix) of oil company operators exploring or developing Utah's emerging shale-gas reservoirs will be established at the beginning of the project. The Technical Advisory Board will meet each project year in Denver, Colorado, and will receive copies of all project reports throughout the year. The formation of the Technical Advisory Board ensures direct communication of the study methods and results with operators exploring for shale gas. The Technical Advisory Board will: (1) review technical project data which will include geologic interpretations and reservoir completion analysis; (2) conduct a

technical review of papers and reports prior to publication; (3) advise the project management team so the project moves in the most useful direction; and (4) may provide non-proprietary geologic, well, and engineering data which will be included in project data files and become part of the public record.

(Sub Task 3.3) The UGS Industry Outreach Geologist (IOG) will set up technical displays at the annual national AAPG conventions each year as part the UGS **Industry Outreach Program**. The IOG will also compile and maintain a contact list of people and companies interested in the project and provide them with technical progress reports, UGS news magazine *Survey Notes*, and press releases. The Industry Outreach Program will ensure that people and companies interested in the project are aware of ongoing developments, significant activities, and other information exchange opportunities. The UGS has successfully operated this outreach program for other grants for over 15 years.

(Sub Task 3.4) **Technical talks and poster displays** will be submitted to the Rocky Mountain Section and national AAPG meetings when appropriate. Additionally, presentations may be given at local and regional geologic and engineering societies. Annual presentations will be made to the Technical Advisory Board. Talks and technical presentations ensure that attendees interested in the project will have the latest information, results, and recommendations to apply to fields they operate or areas they explore.

(Sub Task 3.5) The UGS will submit for **publication** the findings of the research in regional and national journals as well as regional and local geologic guidebooks. The bulk of the research and data derived from the research, will be submitted to the UGS for publication on CD or DVD. The CD/DVD publication allows for extensive material to be presented at a low cost. Text, figures, plates, photomicrographs, maps, cross sections, and data tables will be in Adobe Acrobat (pdf) format. The CD/DVD publication can also contain data tables in xls or dbf format and shape files for all GIS data.

(Sub Task 3.6) **A core workshop** will be held in Denver, Colorado, or Salt Lake City, Utah. The workshop will present representative core along with all data derived from the core analysis along with presentation of regional interpretation of the shale gas potential.

(Sub Task 3.7) **A field review** will be conducted to show significant exposures of the shale-gas reservoirs. The field review will be publicly advertised and open to all interested parties.

C. TECHNICAL AND MANAGEMENT CAPABILITIES

C.1 Organizational Capabilities and Experience

Utah Geological Survey (UGS). The UGS, one of eight divisions of the Utah Department of Natural Resources (DNR), was established in 1931 to survey the geology and energy and mineral resources of the state. The UGS is empowered to undertake cooperative efforts with government and quasi-government agencies, academic institutions, private companies, and individuals in order to carry out its duties. Support staff include: geotechs, secretaries, cartographers, graphic artists, and sample and log librarians. The UGS geologic support staff, access to data, sample storage facilities, as well as computer and editorial capabilities will be applied to completion of the technical research and tech-transfer tasks.

The UGS is, or has been, the Principal Investigator and prime contractor for seven DOE petroleum-research projects (Class I, Class II, Class II Revisit, Fundamental Geoscience for Reservoir Characterization, Geoscience/Engineering Reservoir Characterization, PUMPII and Advanced & Key Oilfield Technologies for Independents programs). The UGS also funds companies, consultants and universities doing oil and gas research. The UGS program *Characterization of Utah's Hydrocarbon Reservoirs and Potential New Reserves* has funded 18 oil and gas research projects since it began in 2004.

The UGS worked cooperatively with the Colorado Geological Survey, the Geological Survey of Wyoming and the New Mexico Bureau of Mines and Mineral Resources to produce the *Atlas of Major Rocky Mountain Gas Reservoirs*, funded by the Gas Research Institute and the DOE.

Halliburton Energy Services is one of the world's largest providers of products and services to the energy industry. With nearly 50,000 employees in approximately 70 countries, the company serves the upstream oil and gas industry throughout the life cycle of the reservoir – from locating hydrocarbons and managing geological data, to drilling and formation evaluation, well construction and completion, and optimizing production through the life of the field. Halliburton has been serving the oil and gas industry since 1919. The company has been and continues to be one of the most innovative companies in the oil and gas industry. The range of major services which are provided to the industry include drilling fluids, direction drilling, logging, perforating, cementing, downhole tools, stimulation services, drill bits, and reservoir description and modeling.

C.2 Qualifications of Key Personnel

The following is a brief description of the experience of key personnel; complete resumes are available in **Appendix**.

Thomas C. Chidsey, Jr. has been the Petroleum Section Chief for the UGS for the past 18 years. He spent 10 years with Celsius Energy Company as an exploration geologist and three years with Exxon as a production geologist.

He is the Principal Investigator for U.S. Department of Energy (DOE) studies titled *Major Oil Plays in Utah and Vicinity* (DOE PUMPII Program) and *The Mississippian Leadville Limestone Exploration Play, Utah and Colorado: Exploration Techniques for Independents* (DOE Advanced & Key Oilfield Technologies for Independents Program). Chidsey was the Principal Investigator, as well as a member of the geologic technical team, for three past DOE-funded projects: (1) *Increased Oil Production and Reserves Utilizing Secondary/tertiary Recovery Techniques on Small Reservoirs in the Paradox Basin, Utah* (DOE Class II), (2) *Heterogeneous Shallow-Shelf Carbonate Buildups in the Blanding Sub-Basin of the Paradox Basin, Utah and Colorado: Targets for Increased Oil Production Using Horizontal Drilling Techniques* (DOE Class II Revisit Program), and (3) *Geological and Petrophysical Characterization of the Ferron Sandstone for 3-D Simulation of a Fluvial-deltaic Reservoir* (DOE Geoscience/Engineering Reservoir Characterization Program). He managed the UGS contribution to the *Atlas of Major Rocky Mountain Gas Reservoirs* (funded by the Gas Research Institute and DOE) and authored several play descriptions in the study. Chidsey has authored over 100 technical papers and abstracts on petroleum geology in Utah based on these and other projects.

Chidsey will serve as the project **Principal Investigator and Manager**, Task Leader of Tasks 1, 2, 5, and 9, as well as a member of the geologic technical team performing Tasks 2, 3, 4, 5, 6, 8, and 9. He will devote 30% of his time to the project.

Craig D. Morgan is a Senior Petroleum Geologist with the UGS. He worked 10 years with Celsius Energy Company and one year with UV Industries as an exploration geologist, and two years with Tooke Engineering as a well site mudlogger and geologist. He was project manager for a DOE Class I project entitled *Increased Oil Production and Reserves from Improved Completion Techniques in the Bluebell Field, Uinta Basin, Utah*, and the DOE Fundamental Geoscience for Reservoir Characterization project *Reservoir Characterization of the Lower Green River Formation, Southwest Uinta Basin, Utah*. He has been a major contributor to UGS/DOE Class II, Class III, and PUMP II projects. He is the project manager for the UGS program *Characterization of Utah's Hydrocarbon Reservoirs and Potential New Reserves* that has funded 18 oil and gas research projects since it began in 2004.

Morgan will serve as Task Leader of Tasks 6 and 8, as well as a member of the geologic technical team performing Tasks 3, 4, 5, 6, 8, and 9. He will devote 22% of his time to the project.

Stephanie Carney is a petroleum geologist with the Utah Geological Survey. She worked three years with UF3 LLC Geological Consultants as a staff geologist before joining the UGS in June of 2006. Major projects with the UGS include: (1) working with the Southwest Partnership for Carbon Sequestration on the field demonstration site at Aneth oil field, Utah, providing subsurface and surface geologic mapping and structural analysis of the demonstration site; and (2) a collaborative study titled *Surface to Subsurface Reservoir Characteristics and Facies Analysis of the Jurassic Navajo Sandstone, Central Utah* with Brigham Young University as part of UGS Mineral Lease Grant Program.

Carney will serve as Task Leader of Task 4, as well as a member of the geologic technical team performing Tasks 3, 4, 5, 6, 8, and 9. She will devote 19% of her time to the project.

Roger L. Bon is the Industry Outreach Geologist at the UGS where he has coordinated information exchange between the state and the energy and mineral industries since 1989. He spent 20 years in coal exploration across western North America previously. Roger has organized and presented exhibits at over 20 professional and national geologic conventions. He has been general chairman of oil and gas symposiums for the Uinta Basin (1992) and Paradox Basin (1996), and published oil field studies on the Uncompahgre uplift and thrust belt oil plays and industry infrastructure.

Bon will serve as the Task Leader of Task 3 (Technology Transfer). He will devote 5% of his time to the project.

Richard J. Curtice is a Principal Technical Professional for Halliburton Energy Services based out of Vernal, Utah. He has been employed by Halliburton since 1980 and has spent all but one year of his career in the oil and gas industry in the field. He has worked primarily in the designing, supervising, and implementation of stimulation, cementing and water conformance treatment. He was also involved in compiling best completion practices and making recommendations of implementing these better completion practices on a DOE Class I project for the Bluebell field study which was completed in 1995 by the UGS.

Curtice will serve as the Task Leader of Task 7 (Best Completion Practices). He will devote 10% of his time to the project.

Dr. S. Robert Bereskin has been involved with the Rocky Mountain region for over 25 years, having worked for two oil and gas operators involved with drilling and completion principally in Wyoming, Utah, and Colorado. Most importantly, during his tenure at TerraTek from 1986-1998, Bereskin researched the petrophysical properties of numerous reservoirs from the Rockies as a geologic analyst for extensive reservoir studies. Since 1994, most of his research has centered on unconventional coal and shale reservoirs, including many in Rocky Mountain examples. Dr. Bereskin has published numerous papers in

professional journals and served as an instructor for shale-gas short courses. He recently completed a study titled *Hydrocarbon Potential of Pennsylvanian "Black Shale" Reservoirs, Paradox Basin, Southeastern Utah*, funded under the UGS Characterization of Utah's Hydrocarbon Reservoirs and Potential New Reserves Program.

Bereskin will serve as a member of the geologic technical team performing Task 5. He will devote 3% of his time to the project.

Dr. Steven Schamel currently is the Principal in Salt Lake City-based GeoX Consulting, Inc. He has more than 30 years of experience in conducting a broad range of oil and gas research and resource evaluations in North America and internationally. Areas of professional competence include reservoir characterization, petroleum systems analysis, and enhanced recovery strategies. Since 2003, Dr. Schamel has carried out unconventional gas resource projects in Utah and adjacent portions of the Rocky Mountains for numerous clients, including work on tight-gas sandstone and shale-gas reservoirs. Recent GeoX Consulting projects have included gas resource evaluations of the Mississippian Manning Canyon-Doughnut Shale and the Pennsylvanian Paradox black "shale." He is the author of two Utah Geological Survey Open-file Reports: *Shale Gas Reservoirs of Utah: Survey of an Unexploited Potential Energy Resource* (2005) and *Shale Gas Resources of Utah: Assessment of Previously Undeveloped Gas Discoveries* (2006).

Schamel will serve as a member of the geologic technical team performing Task 5. He will devote 4% of his time to the project.

C.3 Quality and Suitability of Facilities, Equipment and Materials

Utah Geological Survey. UGS moved into new facilities on the DNR campus in 1996. These facilities provide more efficient space and allow for closer working relationships with other divisions such as the Utah Division of Oil, Gas and Mining (DOG M), a regulatory agency. There are over 19,000 square feet of office and laboratory space presently occupied. The UGS is well equipped for field work and has a hand-held gamma-ray spectrometer and global positioning satellite units. Well files, completion and production data, and geophysical well logs are readily available from the DOGM.

The UGS Editorial Section, which includes editorial, cartographic, drafting, and graphic design personnel, prepares full color and black-and-white maps, charts, and camera-ready text copy and digital products. This group also prepares digital text figures, slide copies, and poster material for meetings and for UGS publications.

The DNR Information Technology Section supports programming, database applications, and network operations for its LAN network, Macintosh, AutoCAD digitizing system, and analytical stereo

plotter. The UGS's main computer system consists of 50 IBM-compatible PC's tied to an asynchronous Novell network with many peripherals, including laser printers and color plotters. UGS is connected to DNR servers with access to ARCInfo/ArcView and other GIS systems. PC-based software includes programs for digitizing, databases, spread sheets, interactive graphics, contour mapping, cross-section construction, and statistical analysis, and reservoir modeling/characterization.

The UGS-operated UCRC is a modern warehouse of 12,000 square feet with core preparation and layout facilities. It is the only public repository of subsurface data in Utah, with samples from more than one-third of the state's wells. The UCRC houses Utah cores, cuttings, mineral samples, crude oils, and fossil collections. It has rock saws capable of cutting up to 8-inch diameter core, a drill press for taking core plugs, ultraviolet lights for identifying hydrocarbon bearing core intervals, and triocular microscopes for examination of drill cuttings. The UCRC is set up to produce high-resolution digital and film-based images of core and cuttings. The main core examination area is capable of displaying more than 1000 feet of core and accommodating 30 patrons.

Halliburton. The Vernal office of Halliburton operates in two major segments:

- Drilling and Evaluation
- Completion and Production

These segments offer a broad array of products and services to upstream oil and gas customers operating in Utah, ranging from integrated software and services to drilling tools, logging, and perforating technology and other down-hole and completion tools to pressure pumping services. Halliburton's integrated approach to reservoir testing and analysis provides operators with the information they need to properly characterize reservoirs and determine the net present value of assets.

Halliburton focuses on increasing net present value by taking a systems approach to well completion. Everything from completion fluids and perforating optimization to completion hardware and reservoir access is geared to maximum recovery. Operators are now able to develop difficult-to-access reservoirs including shale-gas formations that were previously uneconomical to produce. Halliburton in Vernal offers innovative, cost-effective fracturing technologies to help achieve this goal. It is a leader in the service industry in developing the best completion practices for the Barnett, Fayette, and other shale-gas reservoirs.

D. COST SUMMARY

D.1 Proposal Cost/Price Summary

	FY 2008			FY 2009			FY 2010			TOTAL LABOR COSTS	3-YEAR PROJECT TOTAL	UGS COST SHARE (20%)	RPSEA FUNDING 80%
	HOURLY WAGE W/FRINGE ON PROJECT	TOTAL LABOR COSTS	HOURLY WAGE W/FRINGE ON PROJECT	TOTAL LABOR COSTS	HOURLY WAGE W/FRINGE ON PROJECT	TOTAL LABOR COSTS	HOURLY WAGE W/FRINGE ON PROJECT	TOTAL LABOR COSTS	3-YEAR PROJECT TOTAL				
T. CHIDSEY, GEOLOGIST, MGR.	57.65	34,590.00	59.38	720	42,753.24	61.16	560	34,250.10	111,593.34	22,318.67	89,274.67		
S. MORGAN, GEOLOGIST	49.97	19,988.00	51.47	620	31,910.84	53.01	340	18,024.48	69,923.32	13,984.66	55,938.66		
R. CARNEY, GEOLOGIST	34.71	13,884.00	35.75	500	17,875.65	36.82	260	9,574.20	41,333.85	8,266.77	33,067.08		
R. BON, GEOLOGIST	43.83	4,383.00	45.14	100	4,514.49	46.50	100	4,649.92	13,547.41	2,709.48	10,837.93		
D. TABET, GEOLOGIST, MGR.	59.05	2,362.00	60.82	40	2,432.86	62.65	40	2,505.85	7,300.71	1,460.14	5,840.56		
M. LAINE, GEOLOGIST	35.56	5,689.60	36.63	160	5,860.29	37.73	80	3,018.05	14,567.94	2,913.59	11,654.35		
T. DEMPSTER, GEOTECH	26.29	2,103.20	27.08	80	2,166.30	27.89	40	1,115.64	5,385.14	1,077.03	4,308.11		
B. WOLVERTON, WAREHOUSE	12.72	508.80	13.10	40	524.06	13.49	40	539.79	1,572.65	314.53	1,258.12		
L. ROGERS, OFFICE TECH	10.6	424.00	10.92	40	436.72	11.25	0	-	860.72	172.14	688.58		
J. PARKER, EDITORIAL	31.52	1,260.80	32.47	40	1,298.62	33.44	40	1,337.58	3,897.01	779.40	3,117.61		
L. PATON, EDITORIAL	28.66	-	29.52	80	2,361.58	30.41	80	2,432.43	4,794.02	958.80	3,835.21		
S. WAKEFIELD, GIS/GEOLOGIST	32.96	659.20	33.95	180	6,110.78	34.97	140	4,895.42	11,665.40	2,333.08	9,332.32		
M. HYLAND, TECH REVIEWER	53.9	-	55.52	40	2,220.68	57.18	40	2,287.30	4,507.98	901.60	3,606.38		
V. DAVIS, DATA GEOTECH	19.53	1,562.40	20.12	0	-	20.72	0	-	1,562.40	312.48	1,249.92		
		87,415.00		2640	120,466.12		1760	84,630.75	292,511.87	58,502.37	234,009.50		
PROJECT TRAVEL EXPENSES		10,594.00			6,774.00			10,255.00	27,623.00	5,524.60	22,098.40		
MATERIALS, MISC.OFFICE SUPPLIES		4,100.00			3,600.00			6,400.00	14,100.00	2,820.00	11,280.00		
SPECIAL TESTING, LAB WORK		12,500.00			12,490.00			0	24,990.00	4,988.00	19,992.00		
		114,609.00			143,330.12			101,285.75	359,224.87	71,844.97	287,379.90		
INDIRECT COST / OVERHEAD (32.40%) :		37,133.32			46,438.96			32,816.58	116,388.86	23,277.77	93,111.09		
CONSULTANTS, SUB-CONTRACTS :													
GeoX CONSULTING		15,000.00			15,000.00			0	30,000.00	6,000.00	24,000.00		
BERESKIN & ASSOCIATES		15,000.00			15,000.00			0	30,000.00	6,000.00	24,000.00		
HALLIBURTON ENERGY SERVICES		7,000.00			49,000.00			49,000.00	105,000.00	105,000.00	0		
		188,742.32			268,768.08			183,102.33	640,613.73	212,122.75	428,490.99		
GRAND TOTALS :													

APPENDIX A - RESUMES

THOMAS C. CHIDSEY, JR
Utah Geological Survey
P.O. Box 146100
Salt Lake City, UT 84114-6100
Ph. : (801) 537-3364, Fax: (801) 537-3400
e-mail: tomchidsey@utah.gov

BACKGROUND SUMMARY

Petroleum Section Chief /Senior Scientist for Utah Geological Survey supervising petroleum program, conducting research in petroleum geology, and publishing project results. Over nine years experience as a senior petroleum exploration geologist working various Utah geologic provinces for Celsius Energy Company. Three years as a petroleum production geologist in south Texas for Exxon Company USA. Certified Petroleum Geologist (no. 4548) by the American Association of Petroleum Geologists (AAPG) and licensed Professional Geologist (no. 5239191-2250) by the State of Utah.

ACCOMPLISHMENTS

- Wrote grant proposals and served as Principal Investigator for *Increased Oil Production & Reserves Utilizing Secondary/Tertiary Recovery Techniques on Small Reservoirs in the Paradox Basin, Utah; Heterogeneous Shallow-Shelf Carbonate Buildups in the Paradox Basin, Utah and Colorado - Targets for Increased Oil Production and Reserves Using Horizontal Drilling Techniques; Geological & Petrophysical Characterization of the Ferron Sandstone for 3-D Simulation of a Fluvial-Deltaic Reservoir; The Mississippian Leadville Limestone Exploration Play, Utah and Colorado – Exploration Techniques and Studies for Independents; and Major Oil Plays in Utah and Vicinity* funded by the U.S. Department of Energy (Class II Oil, Geoscience/Engineering Reservoir Characterization, Advanced and Key Oilfield Technologies for Independents, PUMPII programs).
- Principal Investigator and project coordinator of (1) *Atlas of Major Rocky Mountain Gas Reservoirs (Utah portion)* funded by the Gas Research Institute; and (2) *Increased Petroleum Production from Directed Horizontal Drilling in Utah* funded by the Utah Office of Energy and Resource Planning.
- Generated over 40 wildcat prospects in Utah, Wyoming and Idaho, and 27 development wells and three outposts (stepouts) in south Texas.
- President - 1993 Rocky Mountain Section-AAPG; President - 1999-2000 Utah Geological Association (UGA), AAPG delegate (two terms) for UGA; editor for 1991 UGA Guidebook *Geology of East-Central Utah*; co-editor for 1992 UGA Guidebook *Hydrocarbon and Mineral Resources of the Uinta Basin, Utah and Colorado*; co-editor for 2000 UGA Guidebook *Geology of Utah's Parks and Monuments*; senior editor, 2004 AAPG *Studies in Geology Regional to Wellbore Analog for Fluvial-deltaic Reservoir Modeling – the Ferron Sandstone of Utah*; co-leader and co-author of field trips and road logs for AAPG, GSA, and UGA; General Chairman - 2003 AAPG national convention.
- Numerous publications on the petroleum geology, carbon dioxide resources and sequestration, economic mineral potential, hydrogeology, and general geology of Utah (see publication list); presented at regional and national geologic conventions, local geological societies, and universities.

WORK EXPERIENCE

Utah Geological Survey, Salt Lake City, UT

1989-Present

Petroleum/Energy Section Chief and Senior Scientist
Lead Petroleum Geologist

- Responsible for managing personnel evaluating petroleum potential in Utah (managed coal and salines programs 1991-1995) and the Utah Core Research Center. Write funding and research proposals, conduct document reviews, and implement projects.
- Conduct geologic research in petroleum exploration and production to encourage economic development in Utah. Projects include siliciclastic and carbonate reservoir characterization, facies studies, petrographic analysis, outcrop reservoir analog studies, source rock studies, play evaluations, carbon dioxide resource evaluation and sequestration, field case studies, and drilling activity summaries.
- Provide information and research results to industry, government and general public, through talks, workshops, displays, field trips, direct inquiries, and formal publications.

Celsius (Wexpro) Energy Company, Questar Corp., Salt Lake City, UT

1980-1989

Senior Exploration Geologist
Geologist
Associate Geologist

- Created 40 new oil and gas prospects and evaluated leases, farmouts and old prospects throughout the Utah-Wyoming-Idaho Thrust Belt, southwest Montana, Utah Hingeline-Basin and Range, Wasatch Plateau-San Rafael Swell, Moxa Arch-Green River Basin of Wyoming-Utah and the Uinta Basin; documented in the form of company reports.
- Gathered and exchanged well, production and geologic information for company prospects, studies, etc. through established industry contacts and scouts. Kept tract of regional drilling activity.

Exxon Company USA, Kingsville, TX

1977-1980

Production Geologist

- Responsible for the generation of 30 production and outpost prospects for nine different fields in south Texas including shallow oil and gas, hydrogen sulfide areas, tight sands, abnormally pressured deep marine Frio and Vicksburg Formations, diapiric structures, roll-over anticlines and faulted structures, Frio, Fleming and Catihoula fluvial stratigraphic plays. Work also included field studies, well summaries, reserve estimation, completion follow-up and logging and testing of over 50 wells at the well site. Spent three months as district drilling and evaluation geologic coordinator. Trained new geologist, reviewing their work.

EDUCATION

B.S., Geology, Brigham Young University

1974

Graduated Magna Cum Laude, Earned six academic scholarships;
GPA: 3.78 overall, 3.92 Geology.

M.S., Geology, Brigham Young University

1977

Major: Stratigraphy and Sedimentation; Minor: Paleontology; GPA: 3.87.

Thesis: *Stratigraphy, Attenuation Faulting, and Alteration in the Northern House Range, Utah* (see list of publications). Advisor was Lehi F. Hintze.

Hydrogeology, Brigham Young University
(non-degree seeking); GPA: 3.92.

1989-1990

HONORS AND AFFILIATIONS

Honors: AAPG Distinguished Service Award – 2005, Utah Geological Association Honorary Member (2003), Quey Hebrew Memorial Lecture, Brigham Young University - 2003, Utah Geological Survey Arthur L. Crawford Award - 2002, Salt Lake Convention & Visitors Bureau Ambassador Award – 2001, Geological Information Society Best Guidebook Award - 1993, AAPG Certificate of Merit - 1993, 2003, Phi Kappa Phi, Sigma Gamma Epsilon, Sigma Phi Epsilon, Max Pitcher Award, Graduate Student Council Representative, Eagle Scout.

Organizations: American Association of Petroleum Geologists, Geological Society of America, Society for Sedimentary Geology, Utah Geological Association, Rocky Mountain Association of Geologists, Four Corners Geological Society, Utah Friends of Paleontology, Brigham Young University Geoscience Alumni Association Board.

PUBLICATIONS Furnished upon request.

CRAIG D. MORGAN

Utah Geological Survey
Salt Lake City, Utah, 84114
(801) 537-3370
craigmorgan@utah.gov

PROFESSIONAL SUMMARY

Petroleum geologist for the Utah Geological Survey, Department of Natural Resources. Eleven years experience as senior level exploration geologist working the Rocky Mountain region for national energy corporations. Two years of well-site mudlogging in the Rocky Mountain Region.

EMPLOYMENT HISTORY

Utah Geological Survey, Salt Lake City, UT. 1990-Present
Senior Geologist

Conduct geologic research in reservoir characterization of petroleum and CO₂ reservoirs to encourage economic development in the state of Utah. Provide information to industry, government and general public, through publications, talks and direct inquiries.

Projects include:

Project Manager for the UGS program *Characterization of Utah's Hydrocarbon Reservoirs and Potential New Reserves* that has funded 18 oil and gas research projects since it began in 2004.

Project Manager for "Reservoir Characterization of the Lower Green River Formation, Southwest Uinta Basin, Utah", funded by the U.S. Department of Energy, NPTO, Fundamental Geoscience for Reservoir Characterization Program.

Project Manager for "Increased Oil Production and Reserves from Improved Completion Techniques in the Bluebell Field, Uinta Basin, Utah", funded by the U. S. Department of Energy, NPTO, Class I Oil Program.

"Advanced Fracture Modeling in the Uinta Basin (Utah) for Optimized Primary and Secondary Recovery"
subcontract with TerraTek Inc. With funding from The U.S. Department of Energy.

"Reservoir Characterization and Hydrocarbon Potential of the Cretaceous Dakota Sandstone, North Grand County"
funded by the Utah School and Institutional Trust Lands Administration.

Utah Division of Water Rights, Salt Lake City, UT. 1989-1990
Water Rights Specialist

Data base management of Water Use program and hydrogeologic basin studies.

Celsius (Wexpro) Energy Company, Salt Lake City, UT. 1979-1989
Subsidiary of Questar Corporation
Senior Geologist
Geologist
Associate Geologist

Responsible for the creation of new and evaluation of old prospects throughout the Rocky Mountain region.

UV Industries,(Oil Operations) Salt Lake City, UT. 1978-1979
Formerly U.S. Smelting, Refining and Mining
Geologist

Responsible for exploration and development of Paleozoic reservoirs in the Williston basin, Montana and North Dakota.

Tooke Engineering, Casper, WY.
Mudlogger

1976-1978

Responsible for the continuous monitoring of drilling mud gas and description of rock sample cuttings. Performed daily reporting to well site geologist or contracting company.

EDUCATION

B.S. Geology, University of Utah
B.S. Geography, University of Utah

June 1975
December 1975

PROFESSIONAL AFFILIATIONS

American Association of Petroleum Geologists
Utah Geological Association
Rocky Mountain Association of Geologists

PROFESSIONAL LICENSES

Professional Geologist
Professional Geoscientist

Utah No. 5213813
Texas Geology No. 2102

PUBLICATIONS

Furnished upon request

Stephanie Carney
Utah Geological Survey
P.O. Box 146100
Salt Lake City, UT 84114-6100
Ph.: (801) 537-3374, Fax: (801) 537-3400
e-mail: stephaniecarney@utah.gov

BACKGROUND SUMMARY

Geologist for the Utah Geological Survey, Department of Natural Resources. Main duties include conducting research in petroleum geology and publishing project results. Four years experience working with national energy companies and academic institutions on modeling and characterizing oil and gas reservoirs in the western United States.

WORK EXPERIENCE

Utah Geological Survey, Salt Lake City, UT 2006-Present

Geologist

- Conduct geologic research in reservoir characterization of petroleum and CO₂ reservoirs to encourage economic development in the state of Utah. Provide information to industry, government and general public, through publications, talks and direct inquiries.

Projects include:

- Work with the Southwest Partnership for Carbon Sequestration on the field demonstration site at Aneth oil field, Utah. Provided subsurface and surface geologic mapping and structural analysis of the demonstration site.
- "Surface to Subsurface Reservoir Characteristics and Facies Analysis of the Jurassic Navajo Sandstone, Central Utah" collaborative work with Dr. Tom Morris of Brigham Young University as part of UGS Mineral Lease Grant.

Utah Faults, Fluids, and Fractures (UF3), LLC, Logan, UT 2003-2006

Staff Geologist

- Produce three-dimensional models of seismic data using 2-D and 3-D geophysical modeling software in order to gain insights into the structural development of oil and gas plays. Assist in field mapping and collection of data for projects. Research and collect data to incorporate into field exercises for professionals in oil and gas industry. Write technical reports of project findings for clients.

EDUCATION

B.S., Geology, Mississippi State University 1997
GPA major: 3.52; GPA overall: 3.38

M.S., Geology, Utah State University 2002
Thesis Title: Evolution of a low-angle normal-fault system in the southern Bannock Range, southeast Idaho. Major Advisor: Susanne Janecke
GPA: 3.65

PROFESSIONAL AFFILIATIONS

Utah Geological Association
Rocky Mountain Association of Geologists
Association for Women Geoscientists

American Association of Petroleum Geologists
Geological Society of America

ROGER LEE BON
Utah Geological Survey
P.O. Box 146100
Salt Lake City, UT 84114-6100
rogerbon@utah.gov

PROFESSIONAL EXPERIENCE

UTAH GEOLOGICAL SURVEY, Salt Lake City, UT 10/89-present

Geologist, Energy and Minerals section

- * Overall responsibility for the Industry Outreach program for the UGS.
- * Liaison with mining and petroleum industry personnel.
- * Manage exhibits program for industry-wide professional meetings.
- * Assist in sponsoring professional meetings.
- * Prepare annual mineral activity summaries.
- * Present professional papers at national and regional meetings.
- * Conduct Industry Outreach activities for all DOE and UGS sponsored research programs

Highlights

- * General Chairman, Uinta Basin Oil and Gas Symposium (1992), Paradox Basin Oil and Gas symposium (1996).
- * Publicity/advertising chair for 1993 AAPG-RMS meeting.
- * Finance chair for the 2007 AAPG-RMS meeting.
- * Presented paper at 1991 AAPG regional meeting in Denver.
- * Presented paper at 1993 AAPG regional meeting in Salt Lake City.
- * Presented paper at 2003 SME national meeting in Salt lake City.
- * Organized and presented exhibits at over 30 professional national & regional conferences.
- * Research and prepare annual mineral activity summaries for publication in professional society magazines
- * Published oil and gas field studies on the Uncompahgre uplift.
- * Published industry brochure on oil plays in infrastructure of the Utah thrust belt area.

SELF EMPLOYED, Sandy, UT 9/85 - 10/89

Geological consultant in the precious metals and coal industries.

- * Assisted clientele in the geological evaluation of mineral deposits under exploration or development.

GETTY MINING COMPANY, Salt Lake City, UT 12/80 - 8/85

Senior Coal Geologist

- * Directing mine geology, project development, exploration and database management activities.
- * Administrative duties include presentation of project operating budgets, coordination and review of Federal Coal Management Program activities and long-range planning for departmental and corporate management.

WESCAR, INC., Lakewood, CO 1/77 - 10/80

Manager of Western Operations/ Exploration

- * Responsible for directing exploration and property acquisition activities in the western United States.

AMAX COAL COMPANY, Denver, CO 9/74 - 1/77
Billings, MT 12/73 - 8/74

Manager, Denver Area Office, Denver, CO

- * Manager and senior geologist responsible for the exploration and acquisition of coal properties in the western United States.
- * Organized and managed a staff of fourteen company employees and four full time consultants.
- * Developed program to evaluate Federal Coal Lease Tracts on a comparative basis and provided input into Federal Coal Management Program analysis and recommendations.

Billings, MT

- * Project geologist responsible for the development drilling of AMAX's Belle Ayr and Eagle Butte mines. Developed and directed extensive coal exploration drilling programs in the Powder River Basin.

GETTY OIL COMPANY, Denver, CO
Casper, WY

2/73 - 11/73
10/68 - 2/73

Exploration Geologist, Denver, CO

- * Researched and mapped coal-bearing areas in the Bloomfield Coal District, which led to a leasing program.

Casper, WY

- * Worked in ore control and mine development geology at the Petrotonics Mine (uranium) located in the Shirley Basin. Other duties included surveying, development drilling, and reserve analysis.

EDUCATION

UTAH STATE UNIVERSITY 1968

Major - Bachelor of Science in Geology

Richard James Curtice

Halliburton Energy Services – 1085 East Main – Vernal, Utah – 84078
435-789-2550 Office – 435-828-0172 Cell; Fax # 435-781-7576 or 435-789-2522
Richard.Curtice@Halliburton.com

Objective	Develop Best Practices for completions in the Paradox and Mississippian Manning Canyon Shales which are located in southeastern and central Utah, respectively.
Experience	<p>1980 – 1982 – Began employment with Halliburton Energy Services as and Engineer in Training in Gillette Wyoming, became a Field Engineer and worked primarily in Stimulation. Transferred as a Senior Field Engineer to Vernal, Utah in April of 1982.</p> <p>1982-1998 Worked in Vernal Utah in Cementing, Stimulation and Water Conformance. Helped design and pump the 1st foamed liner, and surface pipes pumped by Halliburton. Helped design and pump the 1st CO2 Foam Frac ever pumped in the world. Operated the 1st Computer Van released to the field by Halliburton. Worked on Water Conformance Treatments throughout the Western United States. Taught conformance classes in Venezuela, worked on conformance projects in Canada,</p> <p>1998 – 1998 Transferred to Duncan Oklahoma and worked as a Global advisor for Water Conformance from January – October. Worked in lab setting up lab test for specific conformance applications with Halliburton personnel throughout the world, gave technical advice on use and application of conformance products. Traveled to locations supervised the mixing and pumping of conformance products when needed. Also worked as an instructor for water conformance at the Halliburton Energy Institute.</p> <p>1998 – Present – Transferred back to Vernal Utah , continue to work as a Principal Technology Professional in Stimulation, Cementing, and Water Conformance. Supervised the largest RPM treatment, and the largest injectrol job pumped in the world. Helped supervise and mix the largest PermSeal Job ever pumped in the World in Indonesia, worked on conformance treatments in Papua New Guinea, Mexico, and Alaska. Continue to assist other locations throughout the Western United States with Conformance Treatments and implementations of new products. Help design, supervise and implement the use of cement to place remote seals in a coal mine to put out a coal mine fire, this was the 1st time this had every been successfully done anyplace in world.</p>
Education	<p>Graduated with a BS degree in Geological Engineering from the South Dakota School of Mines and Technology in May of 1980.</p> <p>Have continued with training within Halliburton specific to the oil and gas industry.</p>

Resume/Curriculum Vitae S. Robert Bereskin

2003 to present-Bereskin and Associates, 2129 E. 2100 S., Suite B, Salt Lake City, Utah
84109•

(801) 461-0477; bereskin@xmission.com

EDUCATION

- Ph.D.: University of California, Santa Barbara,
- M.A.: University of California, Santa Barbara,
- B.S.: University of Southern California

PROFESSIONAL ASSOCIATIONS

- American Association of Petroleum Geologists
- Society of Economic Paleontologists and Mineralogists
- Utah Geological Association
- Nevada Petroleum Society

PAST EXPERIENCES

TESSERACT CORPORATION, Salt Lake City, Utah: *Vice President of Geology* [1998 to 2003].
Oil and Gas Consulting Firm- Integration of Reservoir Engineering-Geology; Evaluation of
Exploration Concepts and Prospects

Prospect evaluation and due diligence of producing properties for several major clients.

Middle management of geologic and geophysical team pertaining to major exploration effort in
Central California

Numerous jobs involving reservoir assessment utilizing core description and interpretation,
petrography, and assorted formation evaluation techniques: complex carbonates, tight sandstones,
coals, and shales.

Grant work involving (1) the Lewis Shale of NW New Mexico, (2) enhanced production resulting
from rotation of stresses in numerous Rocky Mountain basins, and (3) Powder River Basin CBM
production

TERRATEK, INC. Salt Lake City, Utah [1985 to 1998].

Three positions as summarized below.

1985 to 1998—(1) **Staff Geologist**; (2) **Manager, Geologic Services**; and, (3) **Director,
Geosciences Division**. Responsibilities focused on obtaining and managing in-house projects
for oil and gas services division. Other responsibilities included marketing, the management of
20 employees, and completing special projects in complex carbonates, tight sandstones, and
coals (or shales).

UNIVERSITY OF UTAH, Salt Lake City, Utah: *Adjunct Professor* [1987 to Present].

Taught courses in advanced petroleum geology. Committee member for several Masters theses:
Nevada, Utah, and Wyoming geology. Teaching duties 1987, 2002-2007

UNIVERSITY OF OKLAHOMA, Norman, Oklahoma: *Thesis Supervisor* [1988].

Member of the graduate faculty, Chase Group of Hugoton Embayment.

LOMAX EXPLORATION COMPANY, Salt Lake City, Utah: **Division Exploration Manager** [1984 to 1985].

Territory included Uinta Basin, Tertiary Oil and Gas: Green River, and Wasatch Formations. Responsibilities were centered in the supervision of three geologists and one geologic technician. Maintained vigilance of 30 plus wells drilled in 1984: made decisions concerning logging, running of pipe, and completion. Made workover evaluations of pre-existing wells, which required extensive core work. Conducted surface and subsurface mapping in preparation for development drilling. Managed a variety of budgetary manners associated with well drilling.

NATURAL GAS CORPORATION OF CALIFORNIA, Denver, Colorado: **Development and Exploration Geologist** [1981 to 1984].

Four separate areas of responsibility, as summarized below:

Development Geologist (Uinta Basin). Responsible for the development of Green River Oil in northeastern Utah. Selected drilling locations; prepared surface and subsurface maps; conducted geochemical analyses and petrophysical work; and, supervised four geologists.

Exploration Geologist (Powder River Basin). Worked the Cretaceous primarily. This required subsurface mapping, development of prospects; company geologist for two Muddy-Dakota tests in eastern Wyoming.

Field Geologist (Utah Hingeline and Plateau). Responsibilities included supervision of field crews for two summers; stratigraphy, petrology and structural geology in preparation for prospect generation; and analysis for source and reservoir purposes.

Resident Petrophysicist. Aided other geologists and engineers in a variety of corporate areas of interest.

CALIFORNIA STATE UNIVERSITY, Fresno, California: **Professor of Geology** [1969 to 1981].

Taught courses with the following titles: Carbonate Petrology, Sedimentary Petrology, Sandstone Petrography, Historical Geology, Invertebrate Paleontology, Paleoecology, Summer Field Geology, Physical Geology, and Scientific Writing. Major Professor/Committee Member for several Masters students who are now working for various industries: oil/gas, engineering, environmental, and mining.

UNIVERSITY OF CALIFORNIA, Santa Barbara, California; **Associate in Geology** [1966 to 1969].

Taught upper-division courses in Invertebrate Paleontology and Sedimentary Petrology.

RESEARCH

Current interests generally involve Basin and Range stratigraphy, carbonate and sandstone formation evaluation (foreign and domestic), ancient reefs (foreign and domestic), Uinta Basin production geology, coalbed methane geology and operations, and producibility of Western Interior Cretaceous shales. Major grants include the following:

1. Principal Investigator for: Advanced Fracture Modeling in the Uinta Basin (Utah) for Optimized Primary and Secondary Recovery: GSG4S51729, United States Department of Energy. Funding \$770,000 [1995 to 1998].
2. Scientist and formulator of concept for: Investigation of Active and Ancient Geothermal Control on Oil-reservoir Evolution in the Basin and Range Province (Nevada): DE-FG02-

- 90ER14122, United States Department of Energy Services. Funding \$373,093 [1990 to 1996].
3. Scientist and formulator of concept for: Producibility of the Overpressured and Normally Pressured Lewis Shale of New Mexico. Gas Research Institute. Funding ~\$300,000 [1998-2000].
 4. Scientist for: Coal Gas Reservoir Sweet Spot Identification Based upon Stress Rotation. Gas Research Institute [1998-1999].
 5. Reservoir Characterization of the Lower Green River Formation, Southwest Unita Basin, Utah—Utah Geological Survey, C.D. Morgan, Principal Investigator, United States Department of Energy (1999-2002)

MAJOR CONSULTING

- LOUISIANA LAND AND EXPLORATION: Projects in central Montana.
- MOBIL OIL CORPORATION: Projects in southern and in east-central Nevada.
- SNYDER OIL CORPORATION: Projects in Cuyama Valley, California.
- NATURAL GAS CORPORATION OF CALIFORNIA: Field projects in UT, NV
- EPIC OIL AND GAS- CANADA: Member Board of Directors, Technical Advisory
- CRA- AUSTRALIA: Coalbed methane project (Bowen Basin).
- GHK CORPORATION: Fractured Cretaceous carbonates of Colombia
- BURLINGTON RESOURCES, INC.: Projects related to the Mancos and Lewis shales
- BPAMOCO: Onshore development in San Juan Basin, NM and CO

FOREIGN EXPERIENCE OF SOME DURATION

BAHAMAS	One month work on modern carbonate environments [1978].
SPAIN	Research project on Devonian stratigraphy and reef structures, northern Spain [1977(one year), 1995 (one month)].
SPAIN	Research project on Devonian reef structures [1974 (one year)].
SPAIN	Summer course sponsored by American Geological Institute/National Science Foundation [1971].
BERMUDA	Summer course on organism-sediment relationships sponsored by the National Science Foundation [1966].

OTHER

- Served as General Vice Chairman, AAPG Convention Salt Lake City, Utah [1998].

PUBLICATIONS Furnished upon request.

Steven Schamel, PhD

1265 Yale Avenue
Salt Lake City, Utah 84105
Tel: (801) 583-1146
Fax: (801) 583-1356
geox-slc@comcast.net

Over twenty-five years of experience carrying out high-quality exploration and production research in collaboration with and support from the petroleum industry, U.S. Department of Energy, and various national petroleum companies.

Global experience in characterizing the geological setting of hydrocarbon resources, including studies in the Northern Andes, North Africa, the Urals foreland basins (Pechora and Pricaspian), Western Europe, Southern Atlantic continental margins, and the Rocky Mountains and other parts of North America.
Field renovation and optimized enhanced oil recovery.
Unconventional gas and oil resource assessment.
Field-scale structural analysis.
Utah Professional Geologist 5366337-2250

PROFESSIONAL EXPERIENCE

2001-present	Principal, GeoX Consulting Inc.
2000-2004	Research Professor of Chemical & Fuels Engineering Associate Director Petroleum Research Center at the University of Utah
1994 - 2000	Research Professor of Civil and Environmental Engineering Senior Associate Director Energy & Geosciences Institute, University of Utah
1988 - 1995	Research Professor of Geology and Senior Associate Director Earth Sciences and Resources Institute, University of South Carolina
1982 - 1988	Research Professor of Geology and Associate Director Earth Sciences and Resources Institute, University of South Carolina
1980 - 1982	Research Associate Professor and Associate Director Earth Sciences and Resources Institute, University of South Carolina

EDUCATION
AB, Franklin and Marshall College (Geology)
PhD, Yale University (Geology & Geophysics)

REGISTRATION State of Utah Professional Geologist #5366337-2250

MEMBERSHIPS
American Association of Petroleum Geologists
Society of Petroleum Engineers
Geological Society of America
Rocky Mountain Association of Geologists

Utah Geological Association

**RESEARCH
SPECIALITIES**

Assessment of unconventional gas and oil resources
Reservoir characterization and enhanced oil recovery
Basin and petroleum systems analysis
Structure and regional tectonics
2D and 3D seismic interpretation
Geology for facilities planning and design

CITIZENSHIP

United States of America

PROFESSIONAL SERVICE

2006-2007 President, AAPG Rocky Mountain Section
2003-present Executive Committee, AAPG Rocky Mountain Section
2003 Chair, Steering Committee for SPE-ATW *Coalbed Gas Resources of Utah*,
Snowbird, UT, 24-25 October.
2001-2002 Society of Petroleum Engineers (Salt Lake Section), Chairman
2000-2001 Society of Petroleum Engineers (Salt Lake Section), Executive Board
member
2000-2005 American Association of Petroleum Geologists, Research Committee
member
1997-1998 Technical Program Chairman, 1998 Annual AAPG Convention (Salt
Lake City)
1990 Chair, GSA Committee on Geology and Public Policy
1989-1991 Member, GSA Committee on Geology and Public Policy
1989-1990 Chairman, Southeastern Section GSA Committee on Geology and Public
Policy
1985-1990 Member of Editorial Board, *Geology*
1988 Technical Program Chairman, Annual Meeting of the Southeastern Section,
Geological Society of America
1987-1988 Chairman, Special Committee on Examinations, South Carolina Board of
Registration for Geologists

EXTRAMURAL RESEARCH CONTRACTS RECEIVED SINCE 1995

Petroleum potential of the Sinu-San Jacinto belts, northern Colombia
\$200,000 January-June 1995, Ecopetrol

*Reactivation of an Idle Lease to Increase Heavy Oil Recovery through Application of Conventional
Steam Drive Technology in a Low-dip Slope and Basin Reservoir in the Midway-Sunset Field, San
Joaquin Basin, California* Class 3 Oil Technology Demonstration DE-FC22-95BC14937
\$2,169,411 June 1995-March 2001, U.S. Department of Energy National Petroleum
Technology Office

Geologic Framework of the Gulf of Mexico Basins: Development of an ArcView Database
\$122,710 September 1995-February 1996, Major oil & gas company

Oil and Gas Activity in China

\$24,717 October 1995-April 1996, Major oil & gas company

Tectonics and Sedimentation of the Great Salt Lake and Uinta Basins: Analogues for Nonmarine Petroleum Basins in China

\$29,590 September 1996, Major independent oil and gas company

Petroleum Basins of Brazil: Development of a Briefing Book

\$14,447 February-March 1997, Major oil & gas company

Petroleum Basins of North Africa: an Arc View GIS Synthesis

\$311,247 July 1997-September 1998, group of 9 EGI Associates

Petroleum Basins of northwest Africa: a Briefing Book

\$19,816 February-March 1998, Major oil & gas company.

Tectonics and Sedimentation of the Great Salt Lake and Uinta Basins, Utah: Analogues for Nonmarine Petroleum Basins in China

\$19,594 May 1998, Major independent oil & gas company

Hydrocarbon Provinces of Colombia: an Arc View GIS Synthesis

\$94,723 June 1998-March 1999, Major oil & gas company.

Global Identification of Underdeveloped and/or Undeveloped Oil Properties

\$48,762 July 1998-January 1999, Major independent oil & gas company

Offshore Sedimentary Basins of southwest Africa: Geology and Hydrocarbon Potential

\$209,707 July 1998-February 1999, Major oil & gas company

Systematics of Hydrocarbon Exploration and Development in Thrustbelts

\$264,970 January 1999-June 2000, Group of 5 EGI Associates.

Sedimentary Basins of the Southwest South Atlantic Continental Margin: Geology and Hydrocarbon Potential

\$209,292 February 1999-January 2000, major oil & gas company

Structural Characterization of the Elk Hills Field, southern San Joaquin Basin, California

\$54,293 September 1999-January 2000, major oil & gas company

Shale Gas Reservoirs of Utah: Survey of an Unexploited Potential Energy Resource

\$19,943, January-June 2005, Utah Geological Survey

Shale Gas Resources of Utah: Assessment of Previously Undeveloped Gas Discoveries

\$20,284, March-June 2006, Utah Geological Survey

INVITED PARTICIPATION IN RESEARCH CONFERENCES SINCE 1993

- *Understanding, Exploring and Developing Tight Gas Sands.* AAPG Hedberg Research Conference, Vail, Colorado, April 24-29, 2005.

- *Petroleum Technology Transfer Council (Pacific Region) forum on enhanced oil recovery methods for independent oil producers.* University of Southern California, Los Angeles, December 10, 1999.
- *Revitalization of Mature Petroleum Provinces.* Joint AMGP/AAPG Research Conference, Veracruz, Mexico, October 10- 13, 1999.
- *Oil and Gas Exploration and Production in Fold and Thrust Belts.* AAPG Hedberg Research Conference, Veracruz, Mexico, February 23-March 1, 1997.
- *BDM-DOE 4* International Reservoir Characterization Technical Conference.* Houston, TX, March 1-4, 1997.
- *DOE Bi-annual Contractors Conference.* Houston, TX, June 16-20, 1997.
- *Reservoir Scale Deformation.* AAPG Hedberg Research Conference, Bryce, UT, June 22-28, 1997.
- *Salt, Sediment and Hydrocarbons.* Gulf Coast SEPM Research conference, Houston, TX, December 3-5, 1995.
- *Geologic Aspects of Petroleum Systems.* AAPG/AMGP Hedberg Research Conference, Mexico City, Mexico, October 2-6, 1994
- *Salt Tectonics.* AAPG Hedberg Research Conference, Bath, England, September 13-17, 1993.

SHORT COURSES PRESENTED TO INDUSTRY SINCE 1995

- Modem Concepts of Structural Geology (normally a two-day course)
- Basin Analysis and Petroleum Systems (normally a two-day course)
- Wrench Fault Systems as Habitat for Hydrocarbons (one-day)
- Thrustbelt Systems as Habitat for Hydrocarbons (one-day)
- Evaluation and Construction of Balanced Structural Cross Sections (one-day)
- Salt Tectonics (one-day)
- Heavy Oils and Bitumens: Global Resource and Recovery Methods (one-day)

RECENT UPDATING OF PROFESSIONAL SKILLS

- Fundamentals of GeoGraphix Explorer. GeoGraphix, January 2000
- Fractured Reservoir Characterization and Modeling School. AAPG, November 2000
- Desktop Applications for the Petroleum Professional. PTTC, March 2001
- Injection Surveillance and Optimization. SPE, March 2001
- GeoPlus PETRA Basic Training. PTTC, May 2001
- Hydraulic Fracturing: Measurement, Characterization & Analysis. PTTC, January 2005
- New Structural Concepts and Applications in Rocky Mountain Hydrocarbon Plays. PTTC-RMAG, September 2007

PUBLICATIONS Furnished upon request.

APPENDIX B - LETTERS OF COMMITMENT AND SUPPORT



JON M. HUNTSMAN, JR.
Governor

GARY R. HERBERT
Lieutenant Governor

State of Utah

DEPARTMENT OF NATURAL RESOURCES

MICHAEL R. STYLER
Executive Director

Utah Geological Survey

RICHARD C. ALLIS
State Geologist/Division Director

November 26, 2007

To Whom It May Concern:

This letter commits the Utah Geological Survey (UGS) as the prime contractor for the proposed project entitled "Paleozoic Shale-Gas Resources of the Colorado Plateau and Eastern Basin and Range Provinces, U.S.A.: Multiple Frontier Exploration Opportunities" submitted in response to the Unconventional Onshore Program of the Research Partnership to Secure Energy (RPSEA) for America, Solicitation No. RFP2007UN001.

The UGS will be responsible for evaluating the shale gas potential of the Pennsylvanian Paradox Formation in southeastern Utah and the Mississippian Manning Canyon Shale in central Utah. The UGS will also be responsible for project administration and technology transfer tasks during the project. As the prime contractor and project administration leader, the UGS will ensure that all milestones, deliverables, and contract requirements are met. All billing and required financial and technical reports to the RPSEA will be the responsibility of the UGS. The UGS, in cooperation with organizations volunteering assistance, commits to carrying out to the best of their ability the tasks outlined in the proposal and publishing the results.

Sincerely,

Rick Allis
Director and State Geologist



Bereskin and Associates, Inc.

Geologic Consulting/Computer Programming

November 23, 2007

Mr. Thomas Chidsey, Petroleum Section Chief
Utah Geological Survey, Dept. Natural Resources
1594 West North Temple, Suite 3110
Salt Lake City, UT 84114-6100
Via e-mail

Subject: Letter of Commitment

Dear Tom:

Please accept this letter as acceptance for the terms related to the grant application concerning shale gas potential of both the Pennsylvanian Paradox shales (SE Utah) and the Mississippian Manning Canyon Shale (West-central Utah). As I understand the details of the project, our company would be involved as a project partner working with yourself and other members of the Utah Geological Survey. This arrangement is totally satisfactory to us as a corporation.

The financial terms are also acceptable as stated by your initial communique—\$30,000.00 total allotted in yearly installments of \$15,000.00. The hourly rate for this endeavor is \$160.00 per hour, but all monies are subjected to a 20% cost share as outlined to us. These financial parameters are all acceptable to our corporation.

In short, we are indeed committed to this potential project and look forward to an interesting association regarding these unconventional hydrocarbon reservoirs.

Sincerely,



S. Robert Bereskin
Geologist/President
Bereskin and Associates, Inc.

GeoX Consulting Inc

Innovative geoscience solutions

1265 Yale Avenue, Salt Lake City, UT 84105 USA

Tel: (801) 583-1146 Fax: (801) 583-1356

E-mail: geox-slc@comcast.net

November 25, 2007

Ms. Cheryl Gustin
Utah Geological Survey
P.O. Box 146100
Salt Lake City, UT 84114

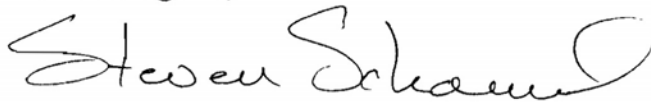
Dear Ms. Gustin,

This writing is to confirm that I agree to serve as a consultant to the Utah Geological Survey project entitled "*Paleozoic Shale-gas Resources of the Colorado Plateau and Eastern Basin and Range Provinces, U.S.A.: Multiple Frontier Exploration Opportunities*".

My company, GeoX Consulting Inc, will provide 20% matching funds for all expenses invoiced by the firm for consulting services provided to the project.

It will be a pleasure working with staff of the Utah Geological Survey on this important resource study.

With best regards,



Steven Schamel, PhD
Principal

HALLIBURTON

1085 E. MAIN STREET VERNAL, UT 84078
(435) 789-2550

Thomas C. Chidsey
Petroleum Section Chief
Utah Geological Survey
PO Box 146100
Salt Lake City, UT 84114-6100


To: Thomas C. Chidsey

As a provider of services and technology to the Oil and Gas Industry, Halliburton Energy Services researches and develops processes for the improvement of production from conventional and non-conventional sources of Oil and Gas. Halliburton is currently providing services in numerous commercial shale reservoirs, and Halliburton has on going technology development projects for shale reservoirs.

The Utah Geological Survey (UGS) is proposing a project to evaluate the shale gas potential of the Pennsylvanian Paradox Formation in Southeastern Utah and Mississippian Manning Canyon Shale in central and western Utah. The title of the Project will be "Paleozoic Shale-Gas Resources of the Colorado Plateau and Eastern Basin and Range Provinces, Utah: Multiple Frontier Exploration Opportunities".

Halliburton is committed to contributing \$105,000 (75 days at \$1400/day) of in-kind work to assist the Utah Geological Survey for this project. The specific area of Halliburton's technology expertise will be to assist in determining the best completion practices for the shale layers that the UGS evaluates geologically.

Sincerely,



Mark Farabee
Production Operation Manager
Halliburton Energy Services
Vernal, UT 84078



JON M. HUNTSMAN, JR.
Governor

GARY R. HERBERT
Lieutenant Governor

State of Utah

DEPARTMENT OF NATURAL RESOURCES

MICHAEL R. STYLER
Executive Director

Utah Geological Survey
RICHARD C. ALLIS
State Geologist/Division Director

LETTER OF AGREEMENT

I believe that the proposal by the Utah Geological Survey entitled "Paleozoic Shale-Gas Resources of the Colorado Plateau, Utah: Multiple Frontier Exploration Opportunities" will be beneficial to the U.S. petroleum industry. Therefore, if feasible when the proposed contract begins, I or a representative will serve as a member of the **Technical Advisory Board** as described in the proposal. The board term shall run concurrent with the project term beginning January 1, 2008 and ending December 31, 2010. I understand there is no financial obligation to the project other than the cost associated with attending the annual meetings.

As a member of the Technical Advisory Board, a company representative will:

- (1) review technical project data which will include geologic interpretations,
 - (2) conduct a technical review of papers and reports prior to publication,
 - (3) advise the project management team so the project moves in the most useful direction, and
 - (4) provide nonproprietary geologic and well data, if available, that will be included in project data files and become part of the public record.
- MAY (PER OUR PHONE CONVERSATION 11/28/07 MDR)*

Signed by: *David A. Bachant*

Date: *Nov 27, 2007*

Title: *Shale Gas Maturation Team Leader*
Shell E+P Co.

Shell Exploration and Production
700 Milam, PNT 14094
Houston, TX 77002

1594 West North Temple, Suite 3110, PO Box 146100, Salt Lake City, UT 84114-6100
telephone (801) 537-3300 • facsimile (801) 537-3400 • TTY (801) 538-7458 • geology.utah.gov





State of Utah
DEPARTMENT OF NATURAL RESOURCES

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Signed by: [Signature] Date: 11-26-07
Title: Exploration Manager

Sinclair Oil and Gas Company
550 East South Temple
Salt Lake City, UT 84130-0825

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NOV 30 2007

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Signed by: D. G. Hill

Date: 11/28/07

Title: Team Lead, DJ ? Paradox Basin

EnCana Oil and Gas "USA", Inc.
370 17th Street, Ste. 1700
Denver, CO 80202

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Signed by: _____

Date: 11/26/2007

Kurt Reinecke – SVP Exploration
Peter Moreland – Senior Exploration Geologist

Title: _____

Bill Barrett Corp.
1099 18th Street, Ste. 2300
Denver, CO 80202

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Signed by: _____

Date: _____

11-30-07

Title: _____

CEO
Crown Quast Operating, LLC

303 Veterans Airpark Ln., Ste. 1500
Midland, TX 79705

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