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DEVONIAN SHALE PROGRAM

Quarterly Progress Report, July–September 1979

MASTER

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Work Performed Under Contract No. EY-76-C-05-5194

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U. S. DEPARTMENT OF ENERGY

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QUARTERLY PROGRESS REPORT

U. S. Department of Energy

Contract no. DE-AC21-76MC05194
(formerly EY-76-C-05-5194)

July - September 1979

submitted by

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75

INDEX

	<u>Page</u>
Executive Summary	1
Figure 1 - Contract area	3
Figure 2 - Structure of the Parkersburg Syncline Area, West Virginia	4
Papers Given, July thru September 1979	7
Meetings Attended, July thru September 1979	7
Field Trips	7
Un-sponsored Research	7
Deliverables and Milestones Delivered July thru September 1979	8
Contract Objectives	9
Technical Progress	11
Structure Contour Maps (R. C. Shumaker)	12
Cross Sections	13
Isopach Maps	14
Structure Contour Maps (J. Negus-de Wys)	14
Oil and Gas Maps	15
Seismic	16
Structure Studies	17
Fracture Density and Orientation	19
Fracture Studies	20
Structure/Production Correlation	21
Lineament/Structure Correlation	21

1.0 EXECUTIVE SUMMARY

QUARTERLY REPORT

JULY - SEPTEMBER 1979

U. S. Department of Energy
Contract no. DE-AC21-76MC05194
(formerly EY-76-C-05-5194)

1.0 EXECUTIVE SUMMARY

- 1.0.1 Major accomplishments this past quarter include the writing and submission of 8 reports summarizing our progress over the last year to be published in the Preprints volume of the third annual EGSP program. In addition, we have prepared four oral papers and five poster session papers to be presented at that meeting. Several exploration rationales concerning Devonian shale gas exploration are included in those manuscripts.

Progress in each task covering our work within the contract area (Figure 1) over the last quarter is summarized below.

1.0.2 Regional Structure Studies

We have completed a detailed structure map of the Jackson, Mason, and Putnam Counties area that shows a subdued flexure at the Berea level (Figure 2) which connects the Midway-Extra and Cottageville shale gas fields. Inasmuch as these two fields can be related by structure (Shumaker, et al., ref. 1) it is presumed that this untested trend has exploration potential. It is recommended here that additional structure and seismic work be accomplished on this trend by the exploration group of DOE-EGSP.

Sub-sea elevations on all available wells penetrating the Berea sandstone are spotted along the eastern flank of the Warfield anticline along the fracture domain boundary as outlined by Kulander (1978, manuscript in press). Structural contours on top of the Berea sandstone should be completed for the east flank of this structure during the next quarter.

1.0.3 Production Studies

A brief report was written by R. C. Shumaker (ref. 1) summarizing and comparing the structural controls on production at the Midway-Extra (ref. 2) and the Cottageville fields (ref. 3). Exploration rationales

Figure 1. Contract area.

1.0 EXECUTIVE SUMMARY - continued

R. C. Shumaker

1.0.3 Production Studies - continued

were presented that develop as an outgrowth of this comparison. These rationales are the first supported by hard production data in this area. Future exploratory trends can be selected based on the map discussed in 1.0.2 above. Shumaker (ref. 4) predicted that clues to the permeability type could be inferred by the production pattern from the shale. Clearly the linear, off structure, production within the two fields discussed support a fault related fracture permeability, and that the shale does not support a blanket porosity related either to the shale matrix or systematic joint patterns. Furthermore, Rauch's work (ref. 5) also suggests that lineaments picked from remote sensing (ERTS) in the Cottageville and Midway-Extra fields study areas do not correspond to high producing (faulted) zones.

Work on the Eastern Kentucky Shale Gas Field continues to progress as production, lithologic, geochemical, and regional structural studies are completed. Next quarter will include the integration and analysis of these studies.

1.0.4 Geophysics

We returned to test site 11 in order to reshoot the seismic line completed last year. Analysis of the latter suggests that the fracture anomaly shown on that data may relate to equipment malfunction. Additional recording problems surfaced during the reshoot of test site 11, but they should be resolved by early next quarter.

We obtained our first computer generated plot of the seismic line shot at Cottageville (Figure 1). The plot showed very high frequency reception that is encouraging in respect to defining precise bed boundaries. However, the data also showed a malfunctioning start mechanism. This malfunction made datuming individual shot spreads impossible. A new start mechanism has been designed and tested satisfactorily. Unfortunately, the Cottageville data is uninterpretable, and therefore the line must be reshot.

1.0.5 Fracture studies

We have completed the study of 13 oriented cores of Devonian shale wells. A final report covering the results of these analyses is underway, and a rough draft manuscript should be complete by the end of next quarter.

1.0 EXECUTIVE SUMMARY - continued

R. C. Shumaker1.0.6 Structural Studies

Field work to collect joint data concerning fracture intensities across the westward extension of the Parsons and Petersburg CSDs has been completed. Both lineaments are reflected by increased joint intensity within the Plateau sediments. A rough manuscript covering the results of this analysis is in preparation and should be complete by the end of next quarter.

1.0.7 Hydrologic Studies

A manuscript covering hydrologic analysis of the Midway-Extra field has been completed and is submitted with this report. This report is the final manuscript of this program as the financial support has terminated as of this quarter. Results of the analysis of the Midway-Extra field show a positive correlation among shale gas production, short low-altitude photo linears, photo linear density, and mineral content of the ground water. A negative correlation was found between ERTS satellite imagery lineaments and shale gas production.

References

1. Shumaker, R. C., J. Negus-de Wys, J. M. Dixon, M. A. Evans, K. G. Kirk, K. D. Lee, B. R. Long, H. W. Rauch, J. E. Ruotsala, T. H. Wilson, W. W. Schaefer, R. T. Williams, 1979, "Parameters of Geologic Structure Which Affect Devonian Gas Shale Production in West Virginia and Eastern Kentucky - A Progress Report 1978-1979: Preprints 3rd Annual Joint EGSP-ES/AAPG Symposium, Lakeview Country Club, Morgantown, W. Va., October.
2. Schaefer, William W., 1979, "Geology and Producing Characteristics of Certain Brown Shales in the Midway-Extra Field, Putnam County, W. Va.": Masters thesis, Department of Geology and Geography, West Virginia University, Morgantown, W. Va., 67 p.
3. de Wys, J. Negus, and Shumaker, R. C., 1978, "Pilot Study of Gas Production Analysis Methods Applied to Cottageville Field": Devonian Shale Program, Department of Geology and Geography, West Virginia University under Contract EY-76-C-05-5194, Department of Energy, Morgantown Energy Research Center, Morgantown, W. Va.
4. Shumaker, R. C., 1978, "Porous Fracture Facies in the Devonian Shales of Eastern Kentucky and West Virginia": Preprints 2nd Annual Eastern Gas Shales Symposium, U.S.D.O.E., METC/SP 78/6, vol. 1, pp. 360-365.
5. Beebe, R. R., and H. W. Rauch, 1979, "Lineaments and Water Wells as Exploration Tools in the Midway-Extra Gas Field": Preprints 3rd Annual Joint EGSP-ES/AAPG Symposium, Lakeview Country Club, Morgantown, W. Va., October.

JULY THRU SEPTEMBER 1979

PAPERS GIVEN

Shumaker, Robert C., "Form-line Structure and Basement Structure Maps of the Appalachian Basin - a Comparison," Caledonides in U.S.A. Symposium, Caledonide Orogen Project, Virginia Polytechnic Institute and State University, Blacksburg, Va., Sept. 5-9, 1979.

MEETINGS ATTENDED

Robert C. Shumaker - as above.

J. Negus-de Wys - Caledonides in U.S.A. Symposium, Caledonide Orogen Project, Virginia Polytechnic Institute and State University, Blacksburg, Va., Sept. 5-9, 1979.

FIELD TRIPS

J. Negus-de Wys - Participated in the Southern Appalachian Field Trip associated with the Caledonide Orogen Project (as above) held September 9-16, 1979.

J. Negus-de Wys - One week field trip to eastern Kentucky outcrops following the studies of Swager for his Masters thesis at University of Kentucky. Outcrops in Pine Mountain area included and sampled. Accompanied by Dr. Jessie Donahue of Gulf Research Lab, and Dr. Jack Donahue of University of Pittsburgh.

UNSPONSORED RESEARCH

"Predicting Natural Gas Well Production from the Cottageville Gas Field, West Virginia, Using Interactive Computing," by Patrick F. Mbendera, Geology Graduate Student, West Virginia University, Morgantown, W. Va.: placed on Open File at Morgantown Energy Technology Center.

JULY THRU SEPTEMBER 1979

DELIVERABLES AND MILESTONES DELIVERED

Deliverable	3.3.18	"A Study of Hydrogeologic Trends in Exploration for Devonian Shale Gas in the Midway-Extra Gas Field of Putnam County, West Virginia" - Robert R. Beebe (delivered October 1979)
"	3.3.22	
Milestone	3.4.11	
Milestone	3.4.31	"Field Techniques for Measuring Joint Intensity" - Jeanelle M. Dixon (delivered October 1979)
Milestone	3.4.29	"Bedding Orientation Contours of Middle Devonian Shales Exposed in the Middle Mountain Syncline, Valley and Ridge Province, West Virginia" - Thomas H. Wilson (delivered July 1979)

2.0 CONTRACT OBJECTIVES

2.0 CONTRACT OBJECTIVES

Collect, compile and analyze geological data and prepare geological structure maps for eastern Kentucky and western West Virginia.

Determine if structural types and styles and surface lineations for productive areas of the Black Shales differ from those in non-productive areas.

Identify and define along with other contractors those geologic parameters that control gas production from the shales.

Determine the feasibility of using shallow penetration resistivity and seismic surveys to detect near surface faults and fractures and demonstrate their relationship to lineations observed on airborne imagery.

Determine if a relationship exists between ground water movement and shale gas productivity.

In conjunction with other contractors develop a method for selecting areas for drilling shale wells that have a potential for gas production.

3.0 TECHNICAL PROGRESS

3.1 Work Package 2100-2-1 STRUCTURE CONTOUR MAPS

Robert C. Shumaker

3.1.1 Current status of work and scheduled deliverables

We have completed calculating and spotting Berea sandstone well tops for a structure map of the Midway-Extra to Cottageville area. The contouring is nearly complete and based on this work we have isolated a basement flexure that extends from Cottageville to Midway-Extra. No deliverables required this quarter.

3.1.2 Problem areas and suggested improvements

No problems.

3.1.3 Work plan for next quarter

Construct a detailed structure map on the Berea sandstone for the eastern flank of the Warfield Anticline.

* * * * *

3.1 Work Package 2100-1-1 CROSS SECTIONSJ. Negus-de Wys

3.1.1 Current status of work and scheduled deliverables

Current status of work: 80% completed.

- Lithology studies completed on well cuttings from 14 wells in the Eastern Kentucky Gas Field.
- Paper on Lithology studies prepared, submitted, and accepted for October meetings at Lakeview.
- Preliminary geochemistry studies on elemental and mineralic analyses of ~700 well cuttings initiated.
- Paper on geochemistry studies prepared, submitted, and accepted for October meetings at Lakeview.
- Paper on structural setting and possible plate tectonics effects on the Eastern Kentucky Gas Field, prepared, submitted, and accepted for Lakeview meetings.
- Abstracts for two papers on the eastern Kentucky studies submitted to the International Geological Congress.
- Meetings per monthly reports including: Blacksburg, Virginia - Caledonide Symposium and field trip in southern Appalachians.

3.1.2 Problem areas and suggested improvements

None.

3.1.3 Work plan for next quarter

Prepare final report.

* * * * *

3.2 Work Package 2100-1-2 ISOPACH MAPSJ. Negus-de Wys

3.2.1 Current status of work and scheduled deliverables

Current status: emphasis on lithology studies and geochemistry
substituted for redoing Provo isopachs.

3.2.2 Problem areas and suggested improvements

None.

3.2.3 Work plan for next quarter

Prepare final report.

* * * * *

3.3 Work Package 2100-2-1 STRUCTURE CONTOUR MAPSJ. Negus-de Wys

3.3.1 Current status of work and scheduled deliverables

Final report in preparation based on existing structure maps.

3.3.2 Problem areas and suggested improvements

None.

3.3.3 Work plan for next quarter

Prepare final report

* * * * *

3.4 Work Package 3200-4-1 OIL AND GAS MAPSJ. Negus-de Wys

3.4.1 Current status of work and scheduled deliverables

Preparing final report.

3.4.2 Problem areas and suggested improvements

None.

3.4.3 Work plan for next quarter

Prepare final report (see 3.1.1), and compare gas occurrence and open flow with geological parameters.

* * * * *

3.1 Work Package 2100-1-1 SEISMIC

James E. Ruotsala

3.1.1 Current status of work and scheduled deliverables

Equipment problems have prevented the completion of data acquisition at the Pricetown II site (Wetzel County) and the start of work in the Cottageville Gas Field. When an electronics technician was hired in August, the problem of establishing time zero at the time of the shot was solved. The reader is referred to the 1978-1979 Annual Report of the Devonian Shale Project (October 1979) for a more complete discussion of this subject.

The data collected at Pricetown last spring was transcribed to nine-track tape and plotted. In spite of its problems (aliasing and uncertain zero-time), it demonstrates a potential for high resolution. The reader is referred to the Devonian Shale Project Annual Report (October 1979) for a more complete discussion.

3.1.2 Problem areas and suggested improvements

The reader is referred to the Annual Report.

3.1.3 Work plan for next quarter

The next few months will be spent in modifications, repairs, and field tests to get the Bison seismograph working up to its full potential. Judgment on what can be done with the current equipment to map subsurface fracture zones will be made after field testing at the Pricetown II site. Work at Cottageville will begin after field testing is successfully completed.

* * * * *

3.1 Work Package 2100-2-2 STRUCTURE STUDIESThomas H. Wilson

3.1.1 Current status of work and scheduled deliverables

- A. Mapping of the Middle Mountain syncline has been completed. In addition, the adjacent Elkhorn Mountain and Long Ridge anticlines were mapped to the southeast and the map area was extended an additional five miles to the south of its previous extent.
- B. Analysis of fracture data has been taken as far as it can go. Some additional data will have to be collected when time permits.
- C. The geology manuscript is about 60% complete. Considerable work remains in the drafting of illustrations and writing.

Additional analysis was initiated on the gravity and magnetic data available for the region along the Parsons structural lineament.

3.1.2 Problem areas and suggested improvements

None.

3.1.3 Work plan for next quarter

- A. Residual Bouguer anomalies will be calculated for the Nittany anticlinorium cross sections of Roy Sites and Bill Perry.
- B. Cross sections through the Appalachian basin from the structural front will be constructed, if possible, by the end of this quarter.
- C. Planned calculation of second vertical derivatives for the magnetic data will be continued and hopefully completed. This is primarily a programming problem.

* * * * *

3.1 Work Package 2100-2-2 STRUCTURE STUDIESJeanette M. Dixon

3.1.1 Current status of work and scheduled deliverables

All field work on joint intensities has been completed.

Analyses of all studies are in the final stages and the final descriptions are being written.

Two papers were submitted for the Preprints in the October EGSP meeting: Wilson, Dixon, Shumaker, Wheeler; and Dixon and Wilson.

3.1.2 Problem areas and suggested improvements

None.

3.1.3 Work plan for next quarter

Complete the final report.

* * * * *

3.1 Work Package: 2200-1-2 FRACTURE DENSITY AND ORIENTATIONMark A. Evans

3.1.1 Current status of work and scheduled deliverables

Core fracture analysis is complete; writing of final report entitled "Fractures in Oriented Devonian Shale Cores from the Appalachian Plateau" is in progress. Drafting of illustrations for that report is proceeding.

3.1.2 Problem areas and suggested improvements

None.

3.1.3 Work plan for next quarter

Complete final report and illustrations.

* * * * *

3.1 Work Package 2200-1-2 FRACTURE STUDIESKevin D. Lee

3.1.1 Current status of work and scheduled deliverables

- A. Work was completed in Prestonsburg, Ky., at Kentucky-West Virginia Gas Company, collecting depths of stratigraphic horizons in the Big Sandy gas field. Approximately 4,500 wells were collected over a ten county area.
- B. The mathematics on the data has been completed, and work has started on a structure contour map on the top of the drillers' Corniferous.

3.1.2 Problem areas and suggested improvements

None.

3.1.3 Work plan for next quarter

- A. Complete the Corniferous map and construct structure contour maps on the top and bottom of the Devonian brown shale.
- B. Construct sufficient cross sections as needed.

* * * * *

3.3 Work Package 3200-5-1 STRUCTURE/PRODUCTION CORRELATIONHenry W. Rauch

Subtask - Correlate all data and attempt to establish a relationship between geologic features, lineaments, fractures, ground water, and oil and gas production.

3.3.1 Current status of work and scheduled deliverables

All work has been completed for the Midway-Extra study and a final project paper and M.S. thesis have been prepared; this paper and thesis appear in the annual report for fiscal year 1979.

3.3.2 Problem areas and suggested improvements

No problems.

3.3.3 Work plan for next quarter

METC/DOE has terminated funding for this project; so no more work will be done under U.S. government sponsorship. Instead, I have arranged private funding for continuing the research in other study areas.

* * * * *

3.4 Work Package 3200-5-3 LINEAMENT/STRUCTURE CORRELATIONH. W. Rauch

3.4.1 Current status of work and scheduled deliverables

Correlate fractures and lineaments derived from photo analysis with results of ground water tests to determine if any relationship exists between ground water production and the occurrence of lineaments.

3.4.1 Current status of work and scheduled deliverables

See 3.3.1 of task 3200-5-1 above.

3.4.2 Problem areas and suggested improvements

None.

3.4.3 Work plan for next quarter

See task 3200-5-1 above.

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