PROCEEDINGS

UNCONVENTIONAL GAS RECOVERY PROJECT REVIEW

a. EASTERN GAS SHALES PROJECT

b. METHANE RECOVERY FROM COALBEDS PROJECT

c. WESTERN GAS SANDS PROJECT

March 11-12, 1980

Incorporating Martin Adams' Notes

VOLUME I--March 11

a. Eastern Gas Shales Project

DEPARTMENT OF ENERGY
Morgantown Energy Technology Center
Morgantown, WV

Vol. I of II

March 11-12, 1980

UNCONVENTIONAL GAS RECOVERY
PROJECT REVIEW

Tuesday, March 11

8:30 a.m.	WELCOME	Augie Pitrolo
8:45	OPENING REMARKS	Martin Adams
9:00	UGR - STRATEGY	Paul Wieber
9:15	UGR - OVERVIEW	Arlen Hunt
9:30	PROJECT OVERVIEWS	
	. Eastern Gas Shales	Chuck Komar
	. Methane Recovery from Coalbeds	John Duda
	. Western Gas Sands	Harry Johnson/Alex Crawley
11:00	DISCUSSION	
11:15	Eastern Gas Shales Project	(Chuck Komar)
	RESOURCE CHARACTERIZATION	
	. Core and Log Acquisition	Charlie Byrer
	Gruy Federal	
	Cliffs Minerals	
11:35	. Structural/Stratigraphic	Yonnie Williams
	State Surveys (PA, OH, NY, WV, IN, IL, KY)	
	Tetra Tech - Prospect Sites	
12:00	. Exploration R&D	Claude Dean
	ERIM	
	WVU (Geochem)	
	WVU (Structural Discontinuity)	
	Tennessee G. S.	
12:20	. Outgassing/Geochem Characterization	Ron Zielinski, Mound Lab
12:40	DISCUSSION	
1:00	LUNCH	
2:00	. Resource Assessment	
	Appalachian Basin	Wally de Witt, USGS
2:20	Illinois & Michigan Basins	Bill Gwilliam
2:40	. Geologic Data Base Integration	Stephanie Bialobok
3:00	EXTRACTION TECHNOLOGY R&D	
	. Fracture Mechanics	Chuck Komar
	Ohio State	
	SRI (Model Development)	
	University of Maryland	
	SAI	
	DuPont	
	SRI (Proppant Research)	
	Terra Tek (Fluid/Shale)	
	Terra Tek (Stress Tool)	
3:30	Proposed Mineback Project	Jim White
3:40	Technical Support-NTS	Dave Northrop, Sandia

Tuesday, March 11 (Cont.)

4:00	. Production Enhancement Tetra Tech (Dual Completion) Waggoner (Recompletion) Mitchell	Karl Frohne
	. Reservoir Performance Gruy (Well Test Analysis) Gruy & SAI (Offset Well)	Karl Frohne
4:30	TECHNOLOGY TESTING & VERIFICATION	
	. Exploration/Reservoir Mitchell Energy Donohue (OH) Donohue (NY)	Al Yost
	. Exploitation/Production Verification Tests Columbia Gas Weed/Henry Houghton College	Al Yost
5:00	DISCUSSION	
7:00 - 9:00	UGR FY 81 REVIEW AND REPORTING	

Wednesday, March 12

8:30 a.m.	Methane Recovery from Coalbeds Project	(Duda)
	RESOURCE CHARACTERIZATION . Resource Engineering . Resource Assessment . Resource Evaluation TRW	Harold Shoemaker
	TECHNOLOGY TEST Waynesburg Occidental	
	PROJECT INTEGRATION	
	RESEARCH & DEVELOPMENT (Overview)	Harold Shoemaker
	. Fracture Mechanics Physics International WVU	
	. Drilling Sandia Maurer	
	. Production Enhancement University of Pittsburgh	

Wednesday, March 12 (Cont.)

9:10	TECHNOLOGY TESTING & VERIFICATION	
	. Mined Coalbeds	
	Westinghouse (Power Generation)	Jerry Rennick
9:20	U.S. Steel	Steve Lambert
9:30	Clinchfield	Mike Trevits
9:40	Emerald Mine	Pat Diamond
9:50	. Unmined Coalbeds	
	Mt. Fuel	Harold Shoemaker
10:00	Intercomp/Coseka	Harold Shoemaker
10:10	Westinghouse (Space Heating)	Jerry Rennick
10:20	DISCUSSION	
10:30	GAS HYDRATES	Bill Overbey
11:00	DISCUSSION	
11:15	Western Gas Sands Project	(Alex Crawley)
	RESOURCE CHARACTERIZATION	Charles Spencer
12:00	LUNCH	
1:00	PRODUCTION TECHNOLOGY DEVELOPMENT	Charles Atkinson
	. Cost-Shared Field Test	
1:20	RESEARCH, INSTRUMENTATION & MODELING	
	. Fracture Performance Research	Herb Carroll
	. Mine-Back Experiments	Dave Northrop
	. Fracture Modeling	Merle Hanson
	. Fracture Instrumentation	Carl Schuster
	. Reservoir Diagnostic Research	Herb Carroll
	. Reservoir Diagnostic Instrumentation	Carl Schuster
3:30	PRODUCTION TECHNOLOGY DEVELOPMENT	
	. Field Laboratory	Dave Northrop
4:00	DISCUSSION	
7:00 - 9:00	UGR FY 81 BUDGET REVIEW	

ATTENDEES LIST

UNCONVENTIONAL GAS RECOVERY REVIEW

March 11-12, 1980

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UNCONVENTIONAL GAS RECOVERY

PROGRAM REVIEW

MARCH 11, 12 AND 13, 1980

MORGANTOWN, WV

U G R TECHNICAL OBJECTIVES

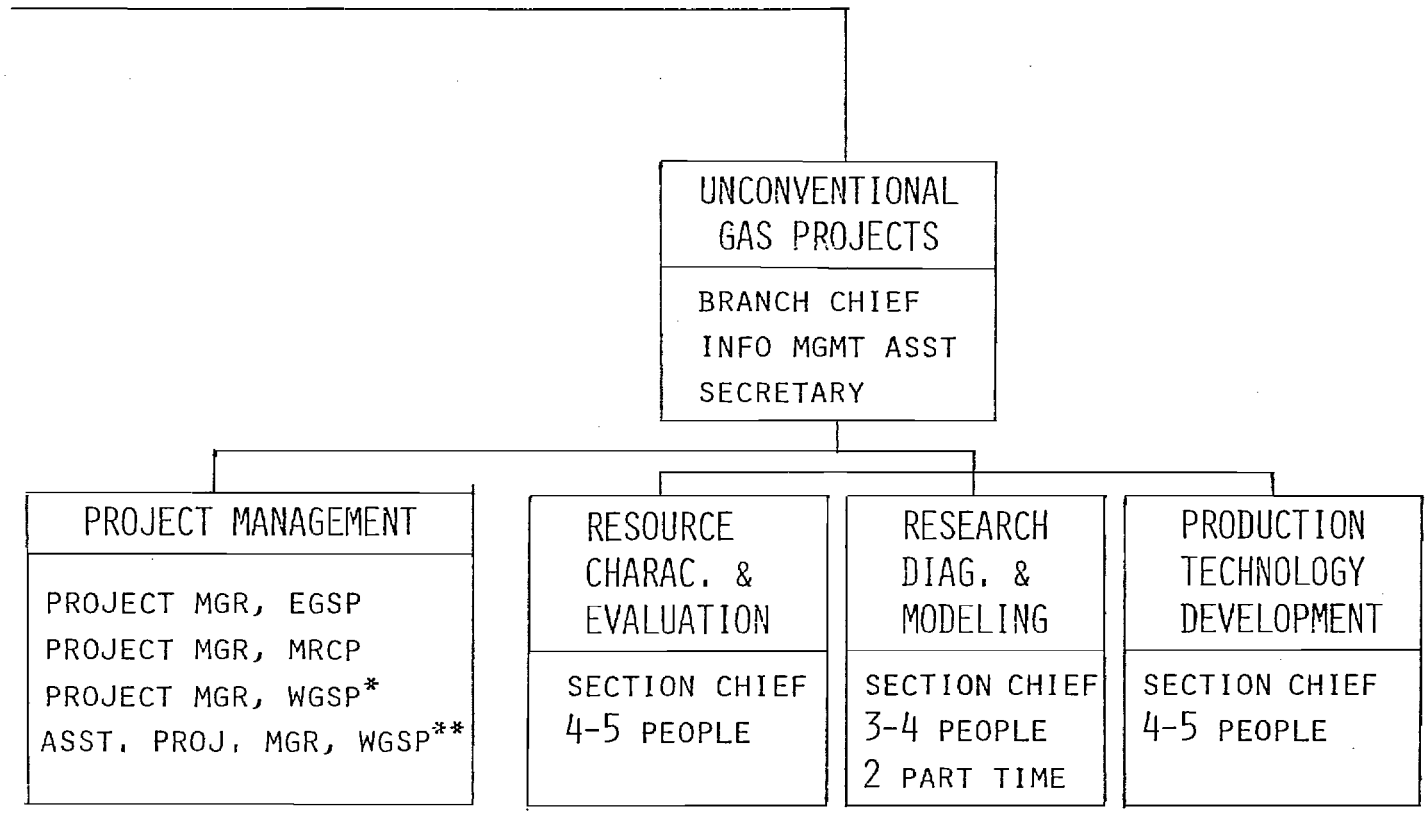
- RESOURCE/RESERVE DEFINITION
- DEVELOP UNDERSTANDING OF RESERVOIR
- ESTABLISH EXPLORATION RATIONALES
- DEVELOP STIMULATION DESIGN CRITERIA
- PROVIDE BASIS FOR ECONOMICS
- TECHNOLOGY TRANSFER

UNCONVENTIONAL SOURCES OF GAS

- WESTERN GAS SANDS
- EASTERN GAS SHALES
- METHANE FROM COALBEDS
- GEOPRESSURE AQUIFERS

UGR ACTIVITIES

- EVALUATION
- RESOURCE CHARACTERIZATION
- RESEARCH, INSTRUMENTATION AND MODELING
- PRODUCTION TECHNOLOGY DEVELOPMENT



* REPORTS ADMINISTRATIVELY TO BETC

** REPORTS ADMINISTRATIVELY TO METC

U G R BUDGET

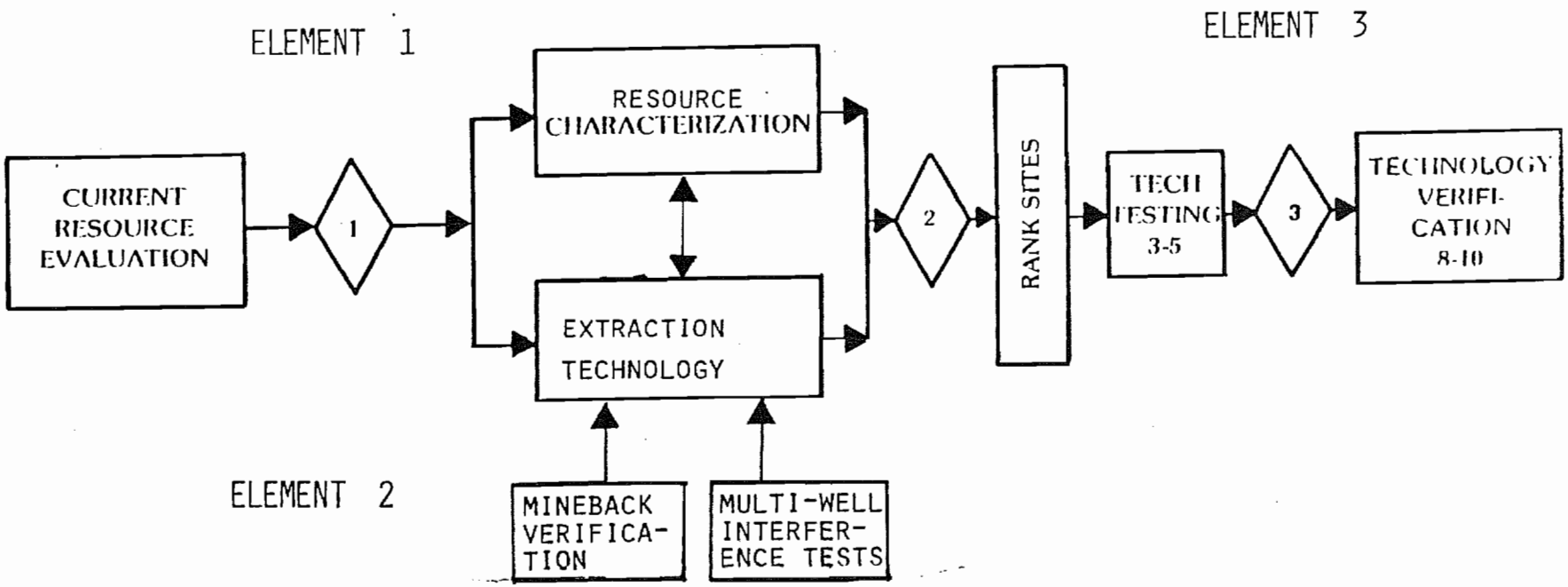
FY 80

	(MILLIONS $)	
• EGSP.	9.0	BASE
	4.0	SUPPLEMENTAL
	13.0	
• MRCP.	5.0	BASE
	0.0	SUPPLEMENTAL
	5.0	
• WGSP.	8.8	BASE
	4.0	SUPPLEMENTAL
	12.8	
• NATIONAL LABS		
SANDIA	2.3	
LLL.	.9	
	3.2	
TOTAL	34MM	

CRITICAL FY 81 PROGRAM AREAS

- OFFSET WELL TEST
- EASTERN MINEBACK
- MODEL VERIFICATION
- FIELD LABORATORY
- DIAGNOSTIC INSTRUMENTATION
- STIMULATION EVALUATION

RESOURCE → RESERVE



1 BASED ON GEOLOGY

2 BASED ON FAVORABLE GEOLOGY AND TECHNOLOGY

3 BASED ON EFFECTIVE AND AFFORDABLE STIMULATION

TECHNICAL ISSUES FOR RESOLUTION

- ESTABLISHMENT OF EXPLORATION RATIONALES TO LOCATE PREFERRED GEOLOGIC PROSPECTS

- UNDERSTANDING OF FRACTURE MECHANICS OF SHALE
  DECISION PENDING - NEED FOR MINEBACK FACILITY IN SHALE

- UNDERSTANDING OF RESERVOIR PRODUCTION PERFORMANCE
  DECISION PENDING - NEED FOR MULTI WELL INTERFERENCE TEST PROJECT IN GEOLOGIC PROVINCES

- CALIBRATION OF PREDICTIVE MODELS FOR PROJECTING RESERVOIR PRODUCTION & FOR PROJECTING THE EFFECTIVENESS OF STIMULATION TECHNIQUES

- IDENTIFICATION OF SITE SPECIFIC EXPLORATION AND EXPLOITATION TECHNIQUES FOR COST EFFECTIVE GAS PRODUCTION

- DETERMINATION OF ECONOMICALLY RECOVERABLE RESOURCES

EXPECTED PROJECT ACCOMPLISHMENTS

IN

FY 81

- COMPLETE DATA ACQUISITION FOR RESOURCE CHARACTERIZATION
- IDENTIFY FAVORABLE AREAS FOR PRODUCTION IN SOUTHERN APPALACHIAN, ILLINOIS, AND MICHIGAN BASINS
- COMPLETE FABRICATION OF IN SITU STRESS TOOL
- VERIFY EXISTENCE OF RESERVOIR ANISOTROPY IN AREA OF ESTABLISHED PRODUCTION
- COMPLETE MINING ACCESS TO EXPERIMENTAL TEST LEVEL IN THE DEVONIAN SHALE
- VERIFY SEISMIC VELOCITY LOW CONCEPT FOR EXPLORATION
- VERIFY PRODUCTION POTENTIAL IN NORTHEASTERN OHIO AND SOUTHERN TIER COUNTIES OF NEW YORK
- VERIFY DEPOSITIONAL RECONSTRUCTION CONCEPT OF RESERVOIR DELINEATION

CRITICAL ISSUES

- DEVIATED WELL CORE IN PROVINCE OF ESTABLISHED GAS PRODUCTION REQUIRES ADDITIONAL FUNDS OF 700 K TO VERIFY RESULTS OF MULTIWELL INTERFERENCE TEST

- MINEBACK FACILITY IN SHALE REQUIRES INVESTMENT OF 6 MILLION OVER 3 YEARS

- VERIFICATION OF STIMULATION EFFECTS OF PROPELLANT GASES BY SANDIA, SRI, UNIVERSITY OF MARYLAND, AND SAI MAY WARRANT FIELD TESTS OF NEW PROCESS

EXPECTED ACCOMPLISHMENTS
(CONTINUED)

PROJECT INTEGRATION

- ESTABLISH COMPUTER DATA MANAGEMENT SYSTEM
- EXPAND TECHNOLOGY TRANSFER ACTIVITIES
- COMPLETE PROBABILITY DISTRIBUTION OF ECONOMICALLY RECOVERABLE RESOURCE IN APPALACHIAN BASIN
- COMPLETE ENVIRONMENTAL DEVELOPMENT PLAN

EXPECTED ACCOMPLISHMENTS
CONTINUED

TECHNOLOGY TESTING AND VERIFICATION

- COMPLETE 11 WELL TEST OF EXPLORATION CONCEPT (OHIO)
- COMPLETE 13 WELL PRODUCTION TEST (OHIO)
- COMPLETE 3 WELL TEST OF SEISMIC EXPLORATION (OHIO)
- COMPLETE 8± WELL EXPLORATION/PRODUCTION TEST (NEW YORK)

EXPECTED ACCOMPLISHMENTS (CONTINUED)

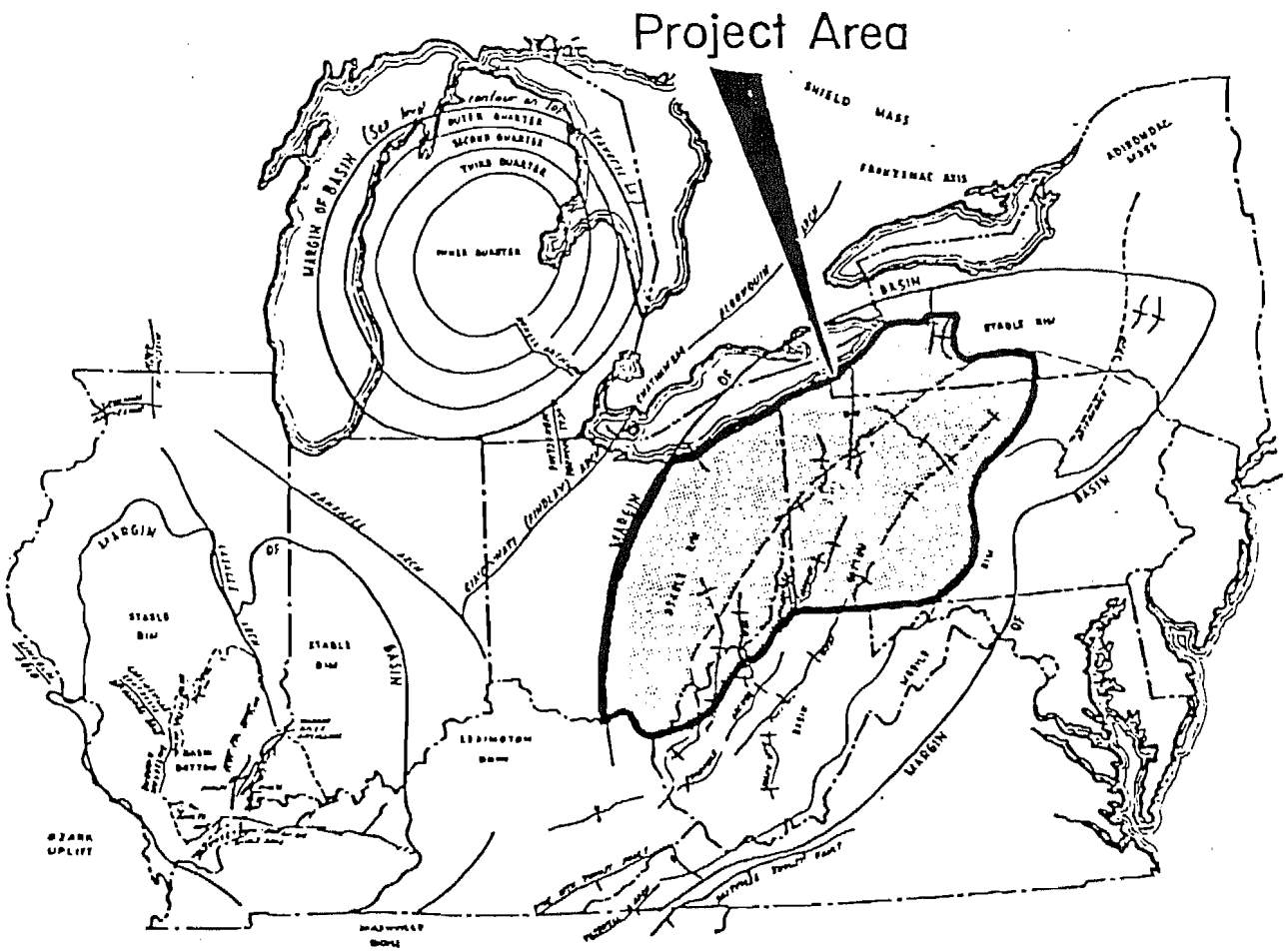
EXTRACTION TECHNOLOGY R & D

- ASSESS TAILOR PULSE CONCEPT FOR STIMULATION (CREATION OF 30-FOOT FRACTURES VIA PROPELLANT GASES)
- DEVELOP WIRELINE STRESS TOOL FOR WELLBORE MEASUREMENTS
- DETERMINE FLUID/SHALE STABILITY FOR ALL REGIONS
- ASSESS NEW EXPLOSIVE PROCESS BY DUPONT IN 8 WELL FIELD TEST
- VERIFY PREDICTIVE MODEL FOR GAS PRODUCTION
- COMPLETE SITE SELECTIONS FOR DUAL COMPLETION TESTS
- DESIGN & CONDUCT 3 WELL INTERFERENCE TEST IN AREA OF ESTABLISHED PRODUCTION
- DECIDE MINEBACK FEASIBILITY

EXPECTED ACCOMPLISHMENTS IN FY 80

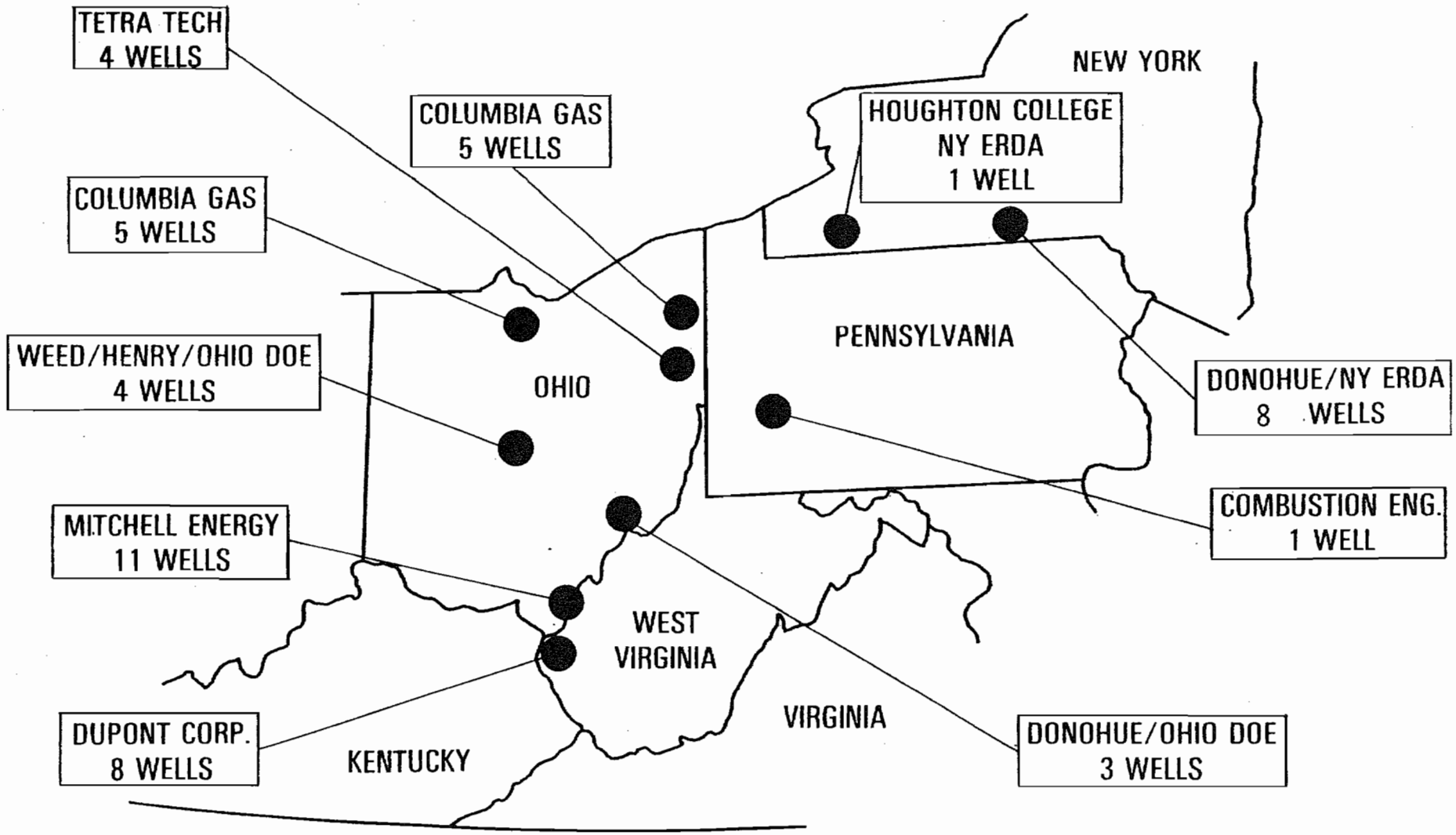
RESOURCE CHARACTERIZATION

- CORE & LOG 5 ADDITIONAL WELLS
- COMPLETE ALL GEOLOGIC MAPPING FOR APPALACHIAN AND ILLINOIS BASINS
- COMPLETE RESOURCE ASSESSMENT FOR APPALACHIAN AND ILLINOIS BASINS
- DEVELOP EXPLORATION RATIONALE FOR ILLINOIS BASIN AND APPALACHIAN BASIN
- EVALUATE & CORRELATE GEOCHEMICAL & GEOPHYSICAL DATA FOR APPALACHIAN BASIN
- DETERMINE GEOLOGICAL FAVORABLE AREAS FOR TEST WELLS



TECTONIC MAP OF APPALACHIAN, MICHIGAN AND ILLINOIS BASINS SHOWING PROJECT AREA

EASTERN GAS SHALE TEST SITES
FY '79-80



SUMMARY OF STIMULATION TESTS

COMPLETED:

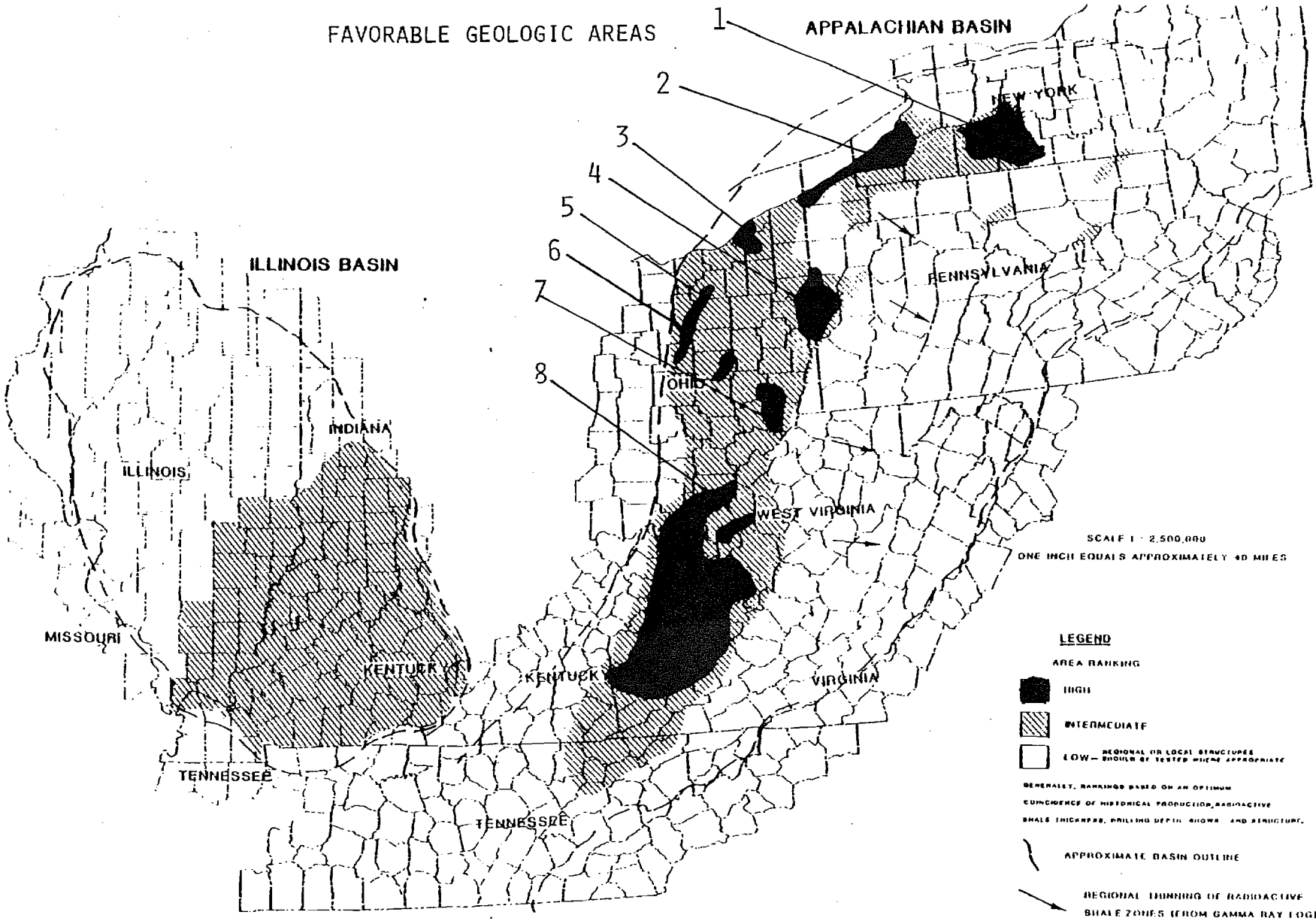
GAS PROVINCES
No/Average Flow

NO / TYPE	1	2	3	4	5	6
4 MHF	4 (255)	0	0	0	0	0
6 CRYOGENIC	3 (301)	1 (36)	0	2 (21)	0	0
8 FOAM	4 (207)	2 (150)	0	0	2 (283)	0
5 CHEM. EXPLOSIVES	5 (314)	0	0	0	0	0
23	16	3	0	2	2	0

SCHEDULED:

GAS PROVINCES

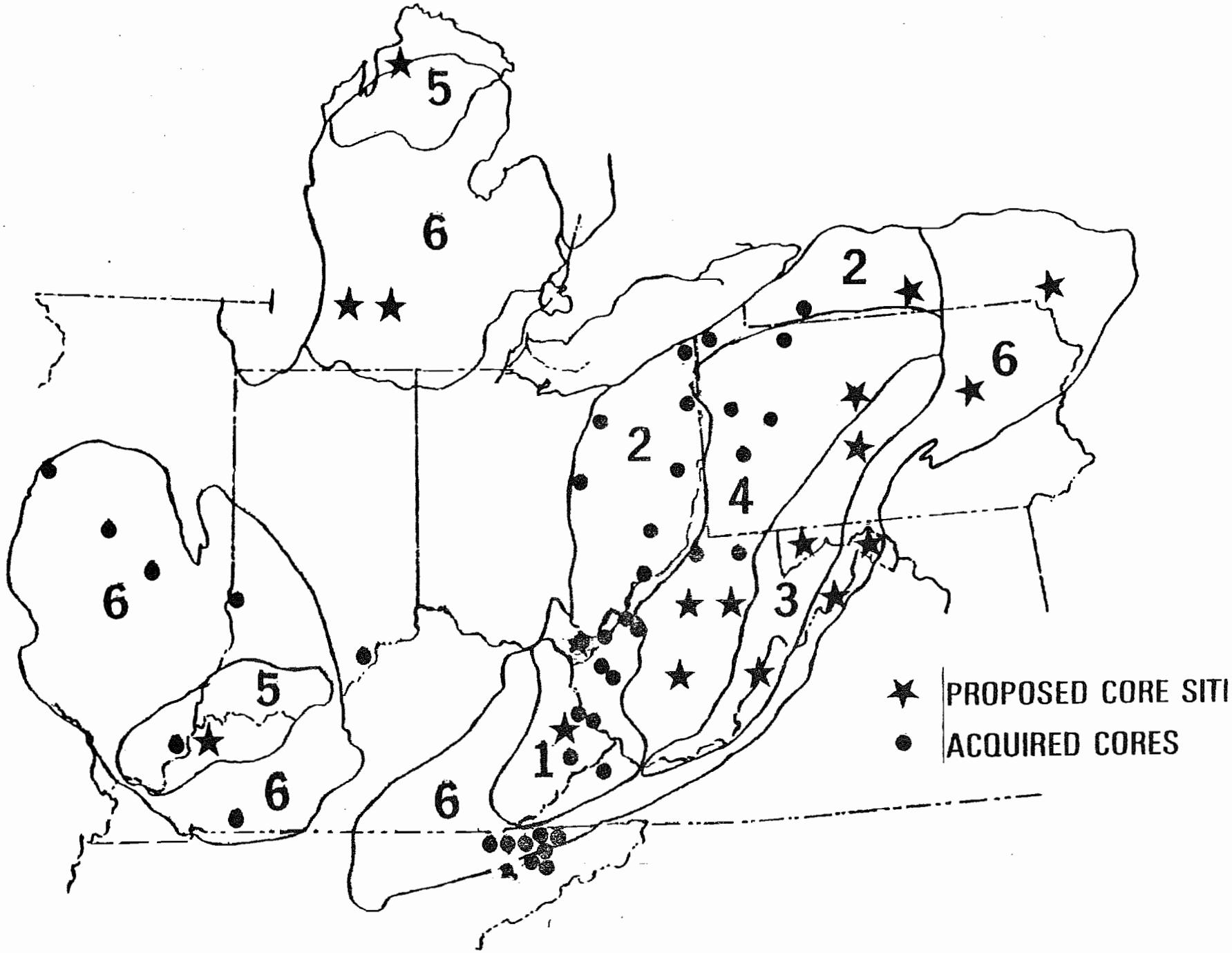
NO / TYPE	1	2	3	4	5	6
1 CRYOGENIC	0	1	0	0	0	0
33 FOAM	0	33	0	0	0	0
1 CHEM. EXPLOSIVES	0	1	0	0	0	0
8 SOLID EXPLOSIVES	8	0	0	0	0	0
43	8	35	0	0	0	0

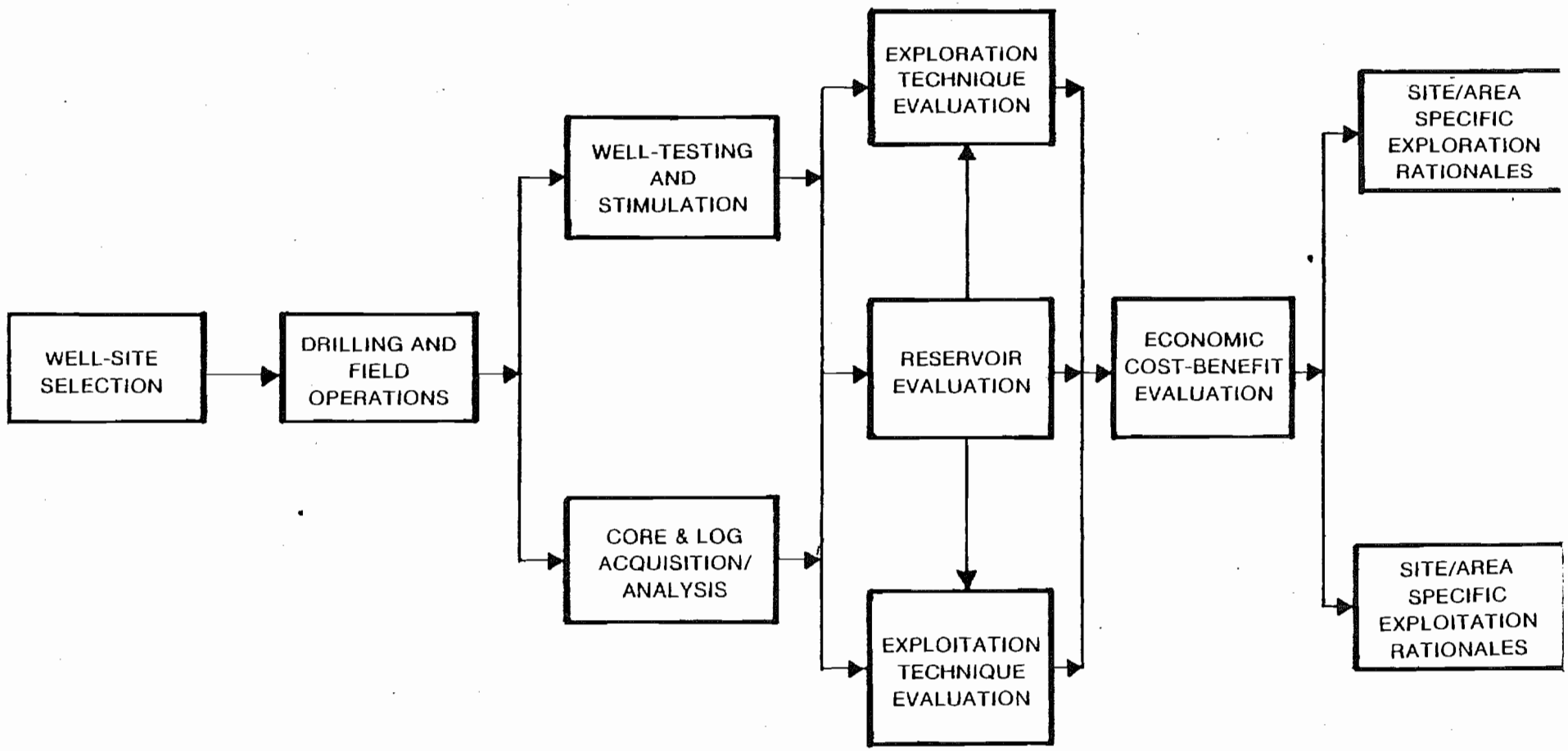


COMPOSITE MAP OF APPALACHIAN AND ILLINOIS BASINS SHOWING PROSPECTIVE AREAS FOR DEVONIAN SHALE GAS WELLS.* (DRAFT)

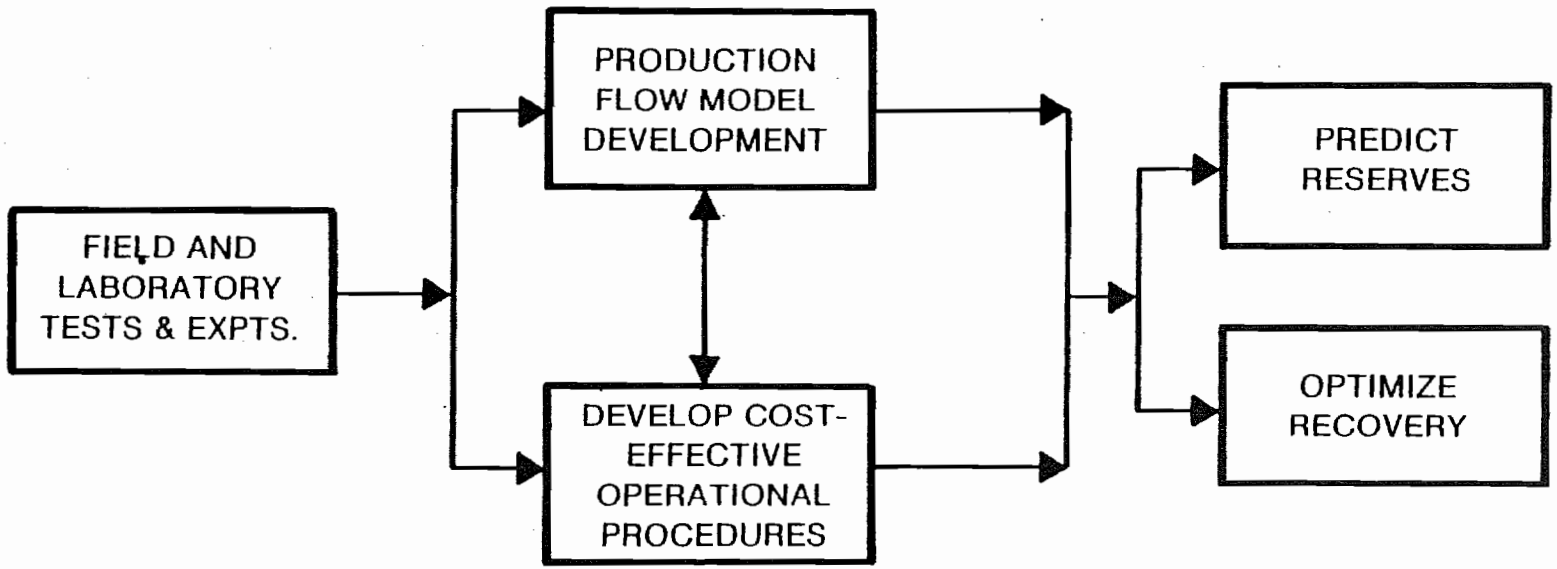
* FOR DETAILS ON THE STATES OF WV, PA, AND NY AND THE IL BASIN, REFER TO INDIVIDUAL ALTERNATE STUDIES

EASTERN GAS SHALE CORE SITES



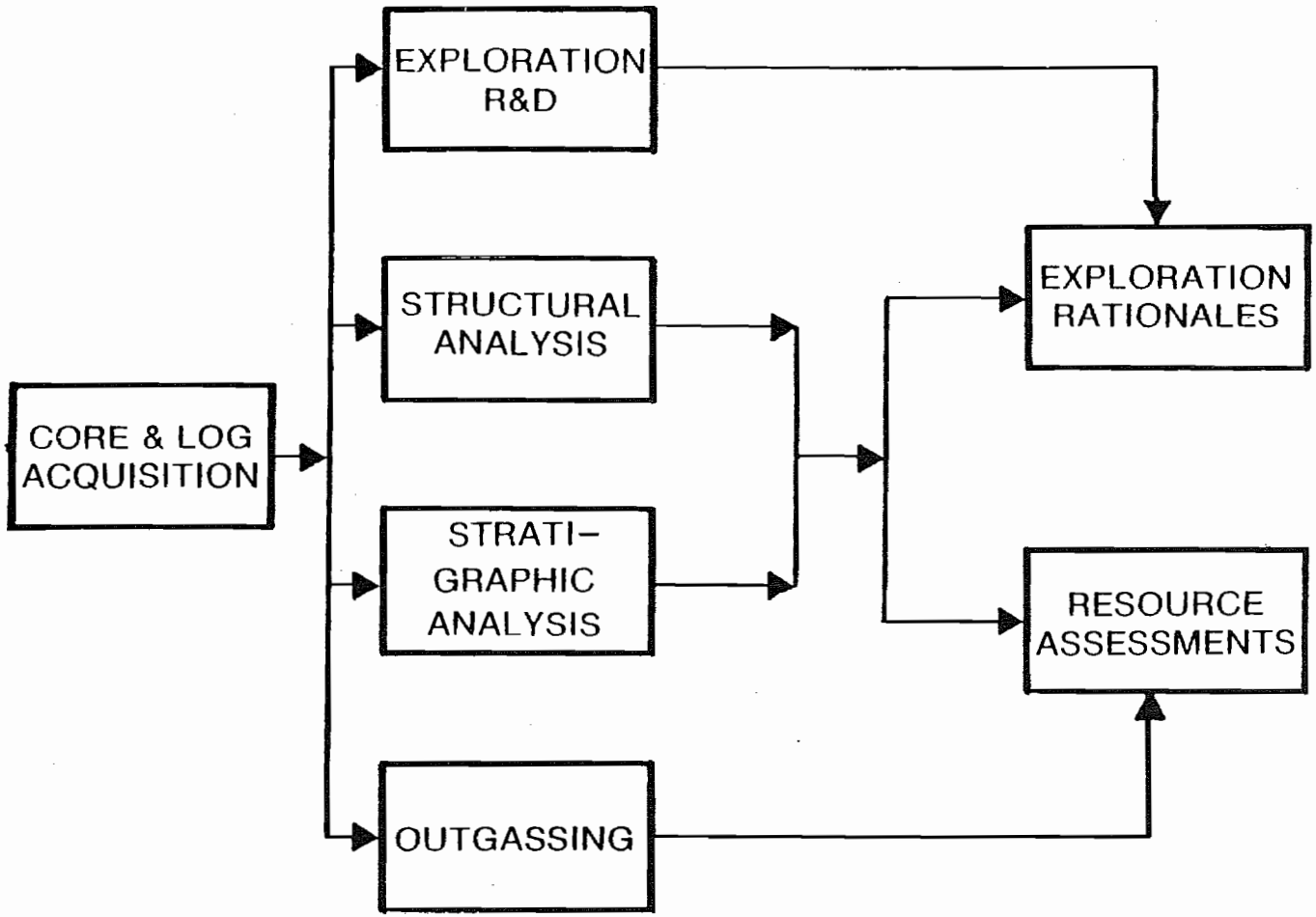


CRITICAL ACTIVITY FLOW - ELEMENT 3
(Technology Testing & Verification)



CRITICAL ACTIVITY FLOW - ELEMENT 2

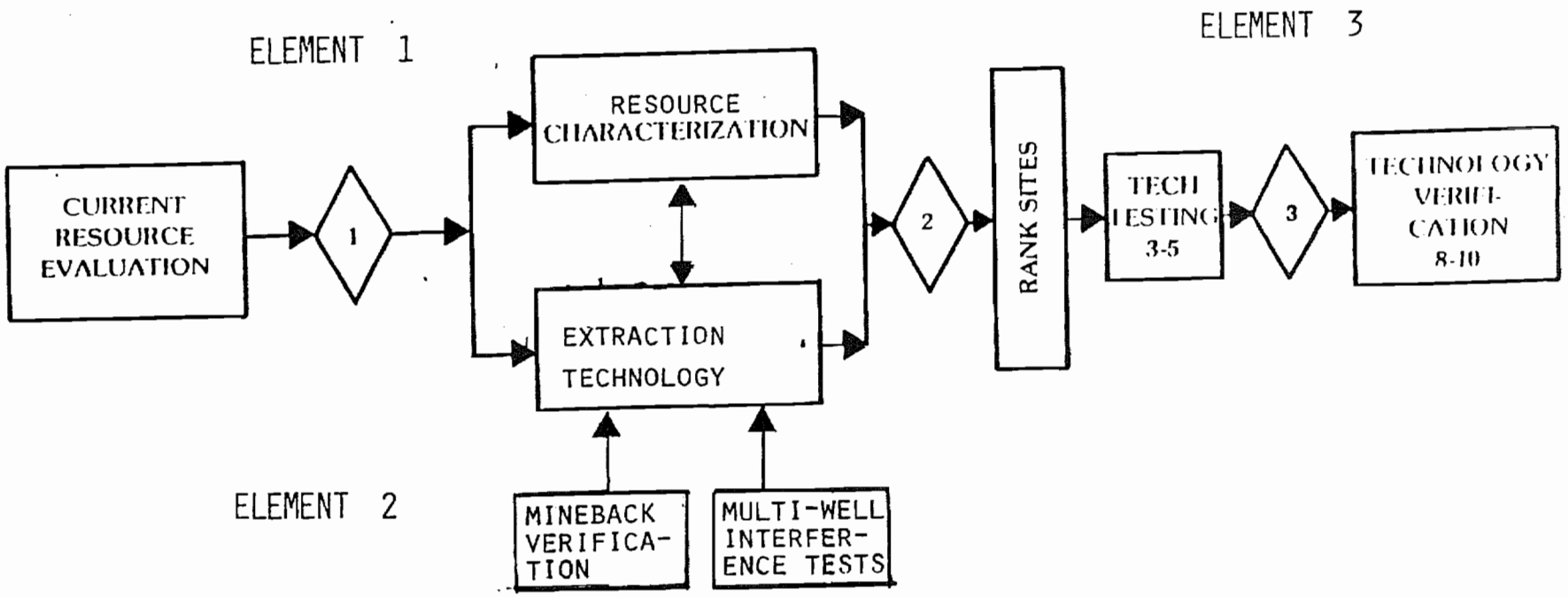
(EXTRACTION TECHNOLOGY R&D)



CRITICAL ACTIVITY FLOW - ELEMENT 1

(RESOURCE CHARACTERIZATION & INVENTORY)

RESOURCE → RESERVE



1 BASED ON GEOLOGY

2 BASED ON FAVORABLE GEOLOGY AND TECHNOLOGY

3 BASED ON EFFECTIVE AND AFFORDABLE STIMULATION

ACCOMPLISHMENTS TO DATE

- GEOLOGIC MAPPING IS ESSENTIALLY COMPLETE
- 46 WELLS HAVE BEEN CORED (20,000 FEET) FROM 9 STATES
- ORGANIC CARBON AND THERMAL MATURITY HAVE BEEN QUANTIFIED AS THE MAJOR FACTORS CONTROLLING GAS CONTENT
- NEW EXPLORATION RATIONALES (3) ARE UNDER CONTRACT FOR TESTING
- MODEL FOR SHALE GAS PRODUCTION HAS BEEN DEVELOPED
- RATIONALE FOR STIMULATION DESIGN IN GEOLOGIC PROVINCES HAS BEEN DEVELOPED
- PILOT STIMULATION TESTS (23) HAVE BEEN COMPLETED IN PROVINCES 1, 2, 4 AND 5
- TECHNOLOGY TEST WELLS 43 ARE UNDER CONTRACT IN PROVINCES 1 AND 2

PROJECT INTEGRATION

CONTRACTOR	FUNDING LEVEL PRIOR YR	FUNDING LEVEL FY80
DOE / METC		1,800,000
MOUND LAB		450,000

TECHNOLOGY TESTING

CONTRACTOR	FUNDING LEVEL PRIOR YR	FY80
COLUMBIA GAS	1,500,000	-
DONOHUE, ANSTEY & MORRILL	795,000	-
DONOHUE, ANSTEY & MORRILL	370,000	387,000
HOUGHTON COLLEGE	75,000	13,000
J. T. WAGGONER	90,000	-
MITCHELL ENERGY	110,000	-
MITCHELL ENERGY	3,100,000	-
WEED & HENRY ASSOCIATES	430,000	-

EXTRACTION TECHNOLOGY R & D

CONTRACTOR	FUNDING LEVEL	
	PRIOR YR	FY80
E.I. DUPONT	250,000	-
GRUY FEDERAL, INC.	700,000	-
GRUY FEDERAL, INC.	_	800,000
OHIO STATE UNIVERSITY	60,000	-
PITTSBURGH PLATE GLASS	-	200,000
SRI INTERNATIONAL	175,000	130,000
SRI INTERNATIONAL	163,000	134,000
TERRA TEK	50,000	150,000
TERRA TEK	430,000	-
TETRA TEK	540,000	-
UNIVERSITY OF MARYLAND	94,000	116,000
UNIVERSITY OF TULSA	-	85,000
WEST VIRGINIA UNIVERSITY	79,000	-
SCIENCE APPLICATIONS, INC.	-	1,470,000

RESOURCE CHARACTERIZATION

CONTRACTOR	FUNDING LEVEL	
	PRIOR YR	FY80
APPALACHIAN BASIN:		
CLIFFS MINERALS	600,000	460,000
COMMONWEALTH OF PENNSYLVANIA	70,000	-
ENVIRONMENTAL RES. INST. OF MICHIGAN	102,000	-
GRUY FEDERAL, INC.	1,200,000	1,500,000
JUNIATA COLLEGE	111,000	-
MOUND LAB	1,200,000	1,230,000
NEW YORK GEOLOGICAL SURVEY	63,000	-
OHIO GEOLOGICAL SURVEY	580,000	-
TETRA TECH	_	450,000
UNIVERSITY OF CINCINNATI	126,000	-
UNIVERSITY OF KENTUCKY RES. FOUND.	224,000	-
USGS	920,000	815,000
WEST VIRGINIA UNIVERSITY	380,000	240,000
WEST VIRGINIA GEOLOGICAL SURVEY	525,000	-
ILLINOIS BASIN:		
ILLINOIS STATE GEOLOGICAL SURVEY	359,000	35,000
UNIVERSITY OF ILLINOIS	43,000	-
UNIVERSITY OF INDIANA	148,000	-
UNIVERSITY OF KENTUCKY RES. FOUND.	-	100,000
SCIENCE APPLICATIONS, INC.	-	820,000

FY 80 BUDGET

PROJECT ELEMENT	ACTIVITY	FUNDS
RESOURCE CHARACTERIZATION	o DATA ACQUISITION & EVALUATION	5,000,000
	o RESOURCE ASSESSMENT	650,000
EXTRACTION TECHNOLOGY R & D	o FRACTURE MECHANICS	1,150,000
	o PRODUCTION ENHANCEMENT	350,000
	o RESERVOIR PERFORMANCE *	1,500,000
TECHNOLOGY TESTING	o EXPLORATION RATIONALE	0
	o EXPLOITATION RATIONALE	400,000
PROJECT INTEGRATION	o MANAGEMENT AND SUPPORT	1,800,000
	o DATA INTEGRATION	450,000
TOTAL		11,300,000

*SUPPLEMENT FUNDS OFFSET TEST PROJECT

UGR	o SANDIA	2,420,000
TECHNICAL SUPPORT	o LLL	900,000
	o LASL	100,000

BUDGET SUMMARY

FY80

DOE/METC IN-HOUSE	$1,500,000
TECHNICAL SUPPORT CONTRACTOR	2,200,000
NATIONAL LABS (MOUND, LASL)	1,080,000
USGS	815,000
UNIVERSITIES (5)	555,000
INDUSTRY CONTRACTS (18)	5,350,000
T O T A L	11,500,000

PRIOR YEAR FUNDS

MANAGEMENT 8 FIELD PROJECTS INVOLVING 45 WELLS	5,900,000

FUNDING PROFILE

(MILLIONS)

← PAST →			CURRENT	← FUTURE →					
FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86
6	12	16	11.5	12.4	← PROJECT PLAN PROJECTION →				
					20.1	18.3	15.1	6.4	6.4
					← 66.3 MILLION →				
					← BASIC LEVEL PROJECTION →				
					9.9	9.4	8.0	8.0	7.0
					← 42.3 MILLION →				

PROJECT IMPACT:

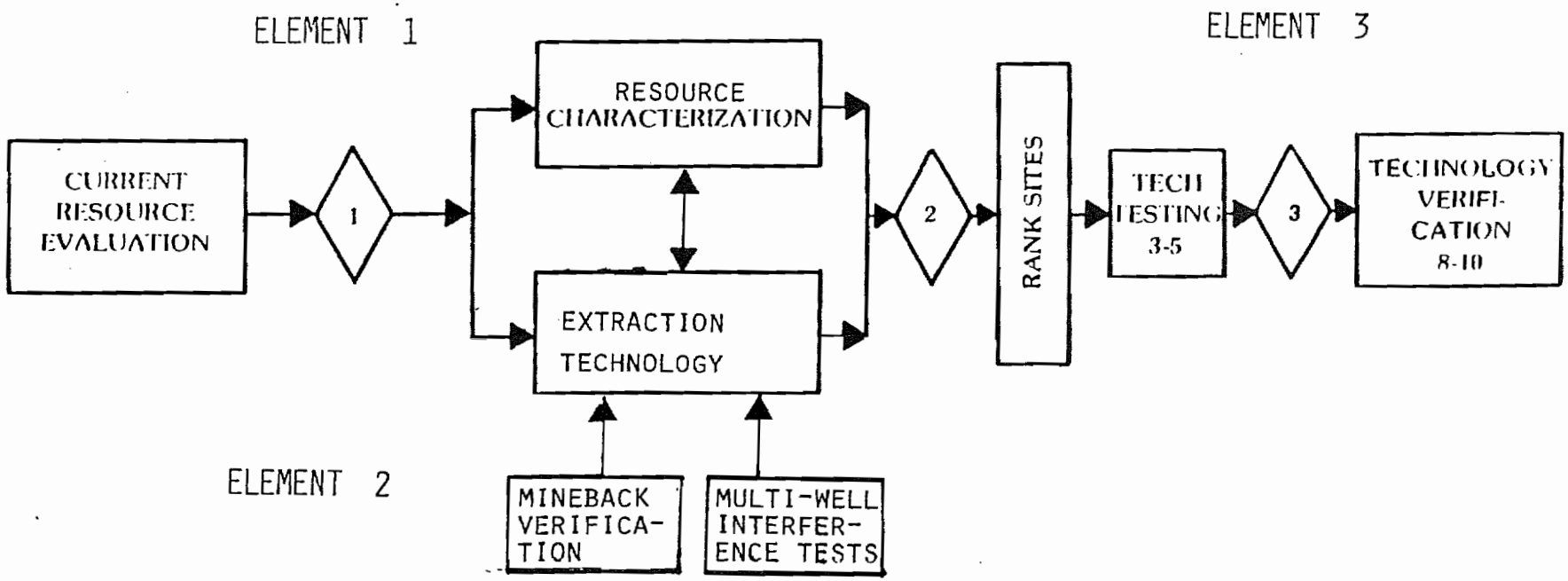
- DELETION DEEP TEST WELLS IN PA, NY, WV, MD, VA
- DELETION RESERVOIR VERIFICATION TESTS IN IL AND MI BASINS
- DELETION DUAL COMPLETION TESTS IN IL AND MI BASINS
- DELETION OF ADDITIONAL OFFSET WELL PROJECTS

EASTERN GAS SHALE PROJECT

TECHNICAL OBJECTIVES

- DEVELOP ACCURATE ESTIMATES OF GAS IN PLACE AND ECONOMICALLY RECOVERABLE RESOURCES
- DEVELOP EXPLORATION RATIONALES AND TECHNIQUES FOR IDENTIFICATION OF DRILLING TARGETS
- DEVELOP EFFECTIVE AND AFFORDABLE EXTRACTION METHODS

RESOURCE → RESERVE



1 BASED ON GEOLOGY

2 BASED ON FAVORABLE GEOLOGY AND TECHNOLOGY

3 BASED ON EFFECTIVE AND AFFORDABLE STIMULATION

Charlie Byers

EASTERN GAS SHALES PROJECT

CORING AND LOGGING

(1974 - 1980)

Cleveland Cliffs ovr doing the units and bolts on processing cores; Gruy is a mgt function

1974 • FIRST DEVONIAN SHALE CORE

1975 • METC ESTABLISHED FIELD / LAB PROCEDURES
• DEFINED LOGGING PROGRAM

---

* 1976 • EASTERN GAS SHALES PROJECT
• ESTABLISHED TARGET AREAS FOR CORES
• TEN CORE WELLS AND 4700 FEET

1977 • FIELD LAB DUTIES CONTRACTED TO W.V.G.S.
• FIRST WELLS IN ILLINOIS BASIN

* 1978 • CLEVELAND CLIFFS IRON CO. AWARDED CONTRACT
• FIRST EXPLORATORY WELL (METC)

* 1979 • GRUY FEDERAL AWARDED CONTRACT
• FIRST PRESSURIZED CORES

1980 • FIRST EXPLORATION WELL IN TENNESSEE
• FIRST CORE WELL IN MICHIGAN BASIN
• 46 WELLS COMPLETED TO DATE

- CONTRACT: DATA COLLECTION FROM DRILLING, CORING, LOGGING AND STIMULATION ACTIVITIES FOR EGSP

  GRUY FEDERAL, INC.
  DE-AC05-78MC08382

- CONTRACT DATE: APRIL 1, 1979

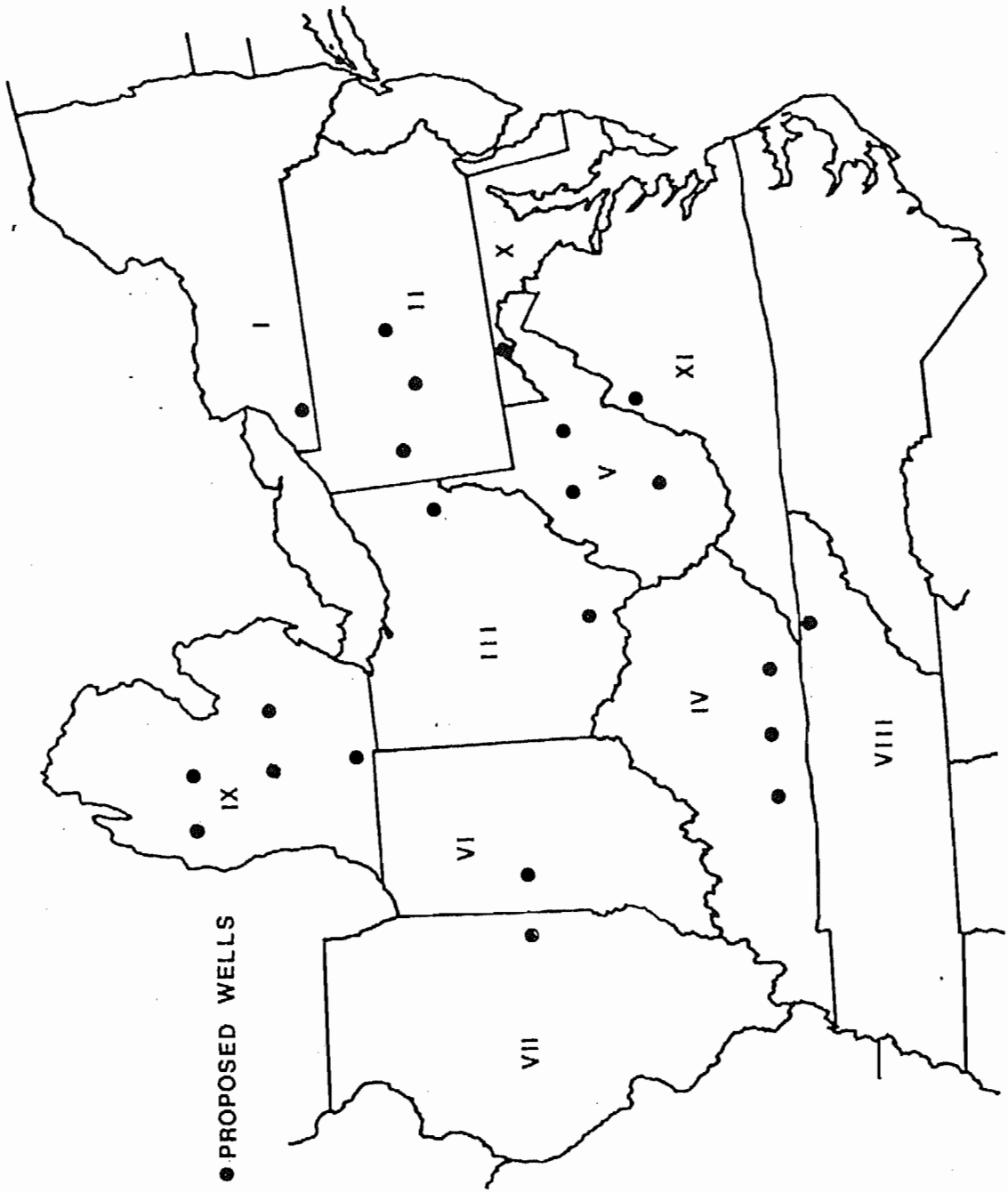
- ANTICIPATED COMPLETION DATE: APRIL 1981

- TOTAL COST: $1,410,500 - MANAGEMENT
  +$2,000,000 - SUBCONTRACTING ESTIMATE (procuring core)

- DOE COST: $3,410,500 - TOTAL ESTIMATED

- OBJECTIVE: TO PLAN, ORGANIZE, AND MANAGE A PROGRAM FOR COLLECTION, CONSOLIDATION, AND DELIVERY OF CORE MATERIAL, LOGGING DATA, AND LIMITED STIMULATION DATA FROM 22 DEVONIAN SHALE WELLS IN THE THREE BASINS

- LOCATION MAP:



EGSP Proposed Well Locations

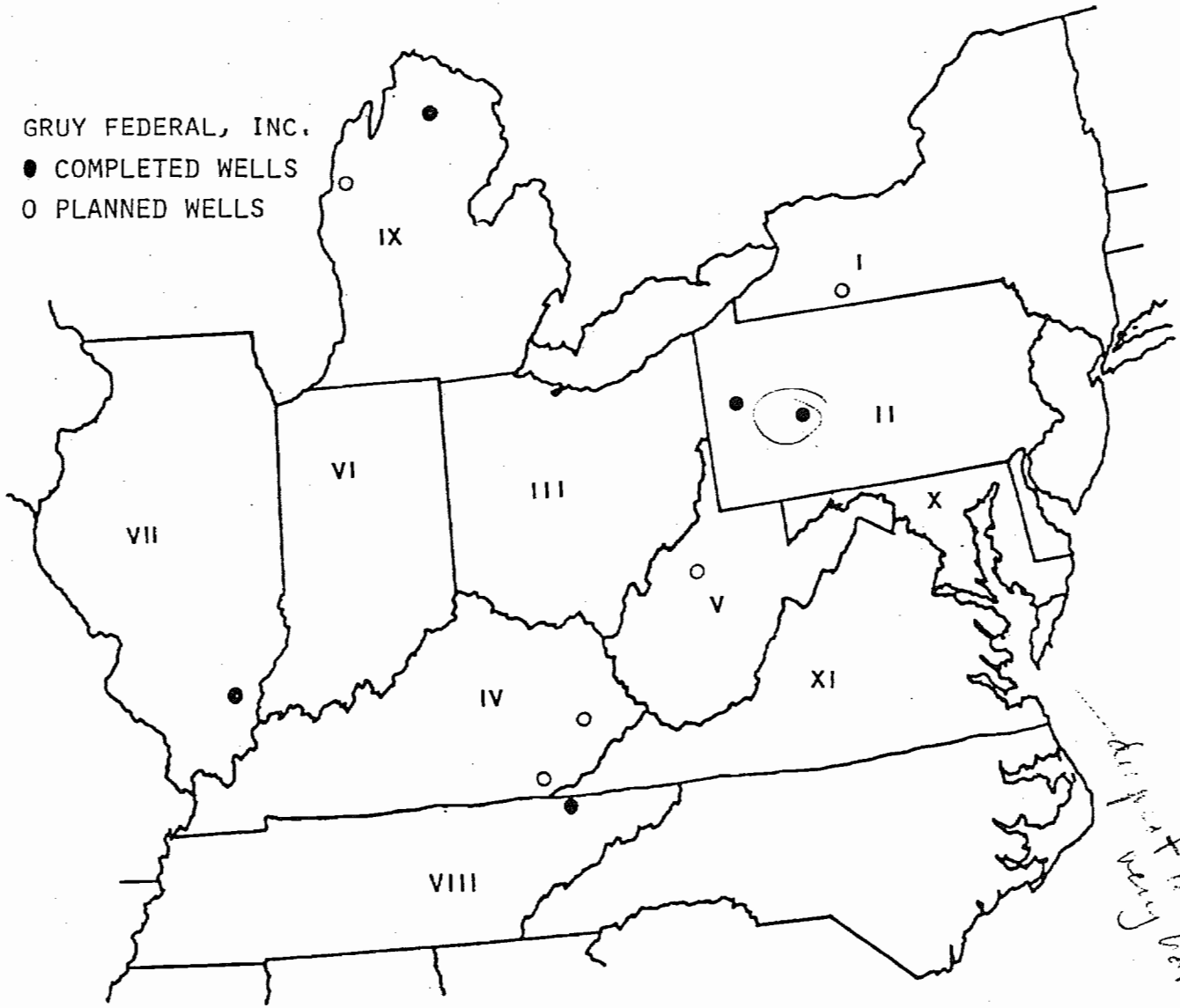
Location of Proposed EGSP Core Wells

STATE NUMBER	STATE	NUMBER OF WELLS	COUNTIES
I	New York	1	Chautauqua
II	Pennsylvania	3	Indiana-Clearfield Clinton-Centre Lawrence-Butler
III	Ohio	2	Richland-Ashland Pike-Scioto
IV	Kentucky	3	Laurel-Clay Barren-Warren Wayne-Adair
V	West Virginia	3	Gilmer-Calhoun Barbour-Randolph-Upshur Raleigh-Fayette
VI	Indiana	1	Putnam-Morgan
VII	Illinois	1	Douglas-Champlain
VIII	Tennessee	1	Hawkins-Green
IX	Michigan	5	Branch-Hillsdale Clinton-Eaton Clare-Isabella Mason-Lane Oakland-Genessee
X	Maryland	1	Allegany
XI	Virginia	1	Highland-Beth

GRUY FEDERAL, INC.

● COMPLETED WELLS

O PLANNED WELLS

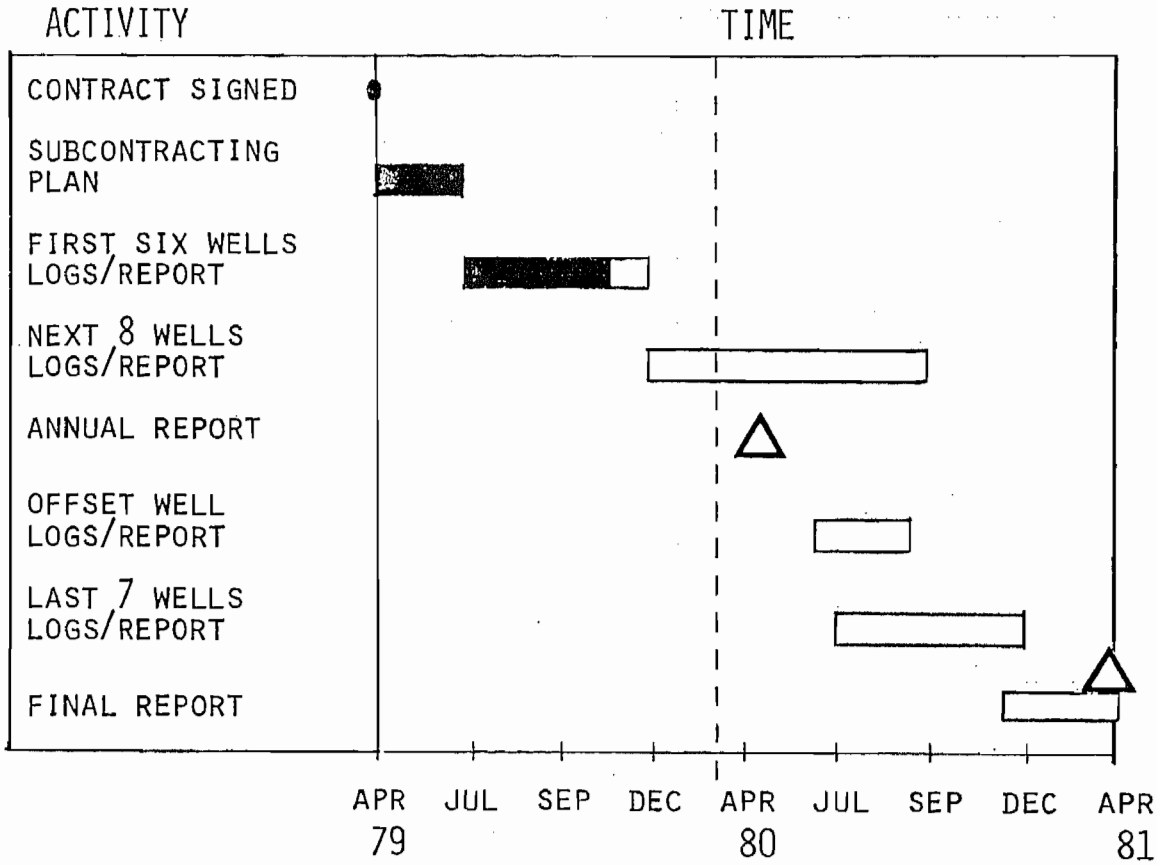


All flat with lots of very wet.

8500'

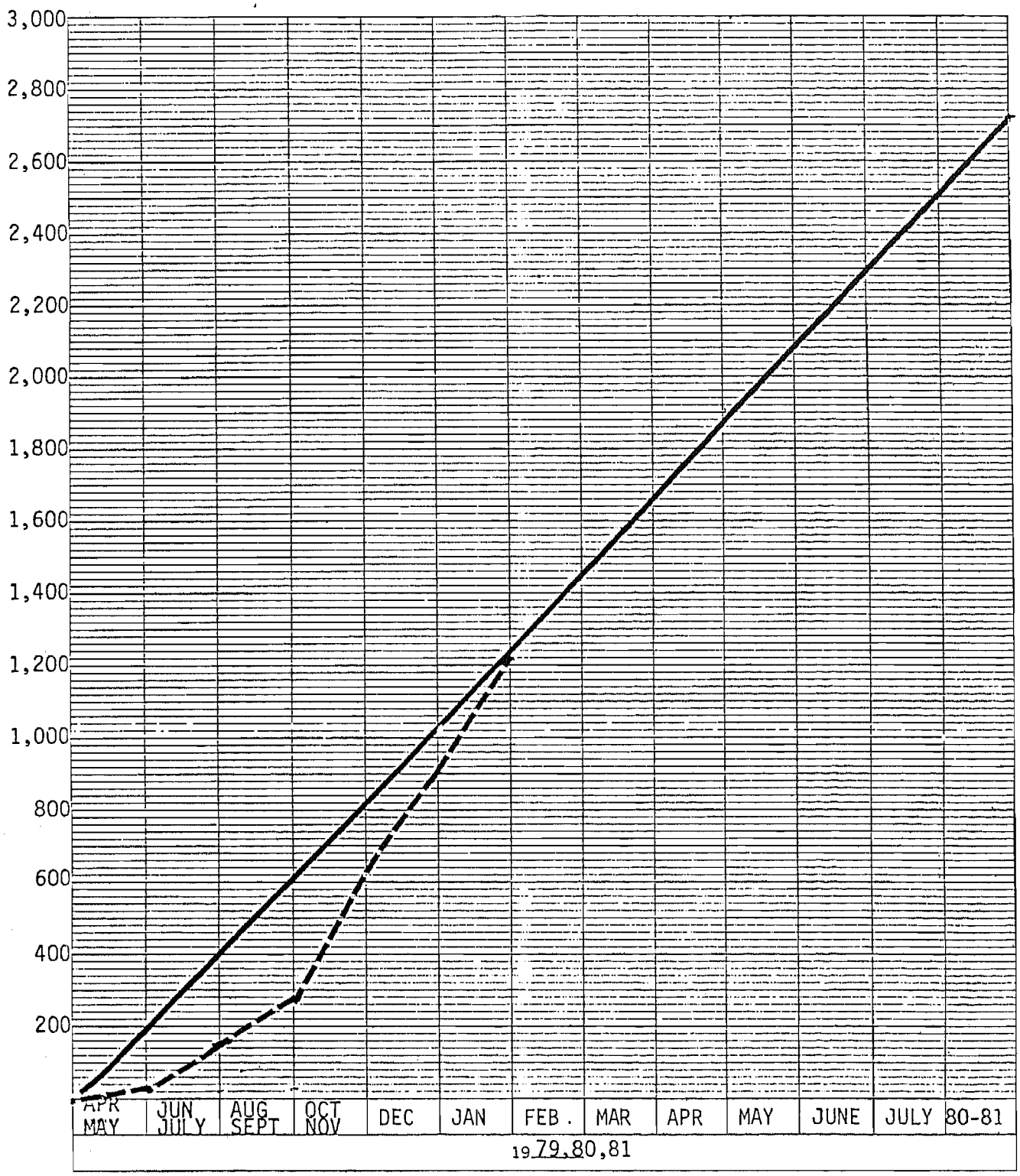
- SUMMARY OF PROGRESS:
  - FIVE WELLS HAVE BEEN COMPLETED
  - FIVE WELLS ARE PLANNED FOR THIS SPRING
  - REMAINING PROPOSED WELL LOCATIONS STILL FEASIBLE
  - DEEPEST EGSP WELL DRILLED IN PENNSYLVANIA
  - SUCCESSFULLY CORED AND LOGGED TENNESSEE WELL
  - * FIRST PROSPECTIVE WELL WITH MAJOR OIL COMPANY (Shell). because of their extensive operations in Michigan.
- CRITICAL ITEMS:
  - CONTRACT IS HALF COMPLETED (APRIL 1980) - obtained 5 con...
  - SUBCONTRACTING COSTS ARE INCREASING RAPIDLY
  - DOE WILL BE SELECTIVE FOR REMAINING WELL LOCATIONS

- MAJOR ACTIVITIES:



Contract No. DE-AC05-79MC08382

GRUY FEDERAL, INC.



Planned ——— Actual - - -

- CONTRACT: COLLECTION, DESCRIPTION, AND LOGGING OF EGSP DEVONIAN SHALE CORES

  CLIFFS MINERALS, INC.
  DE-AC21-78MC08199

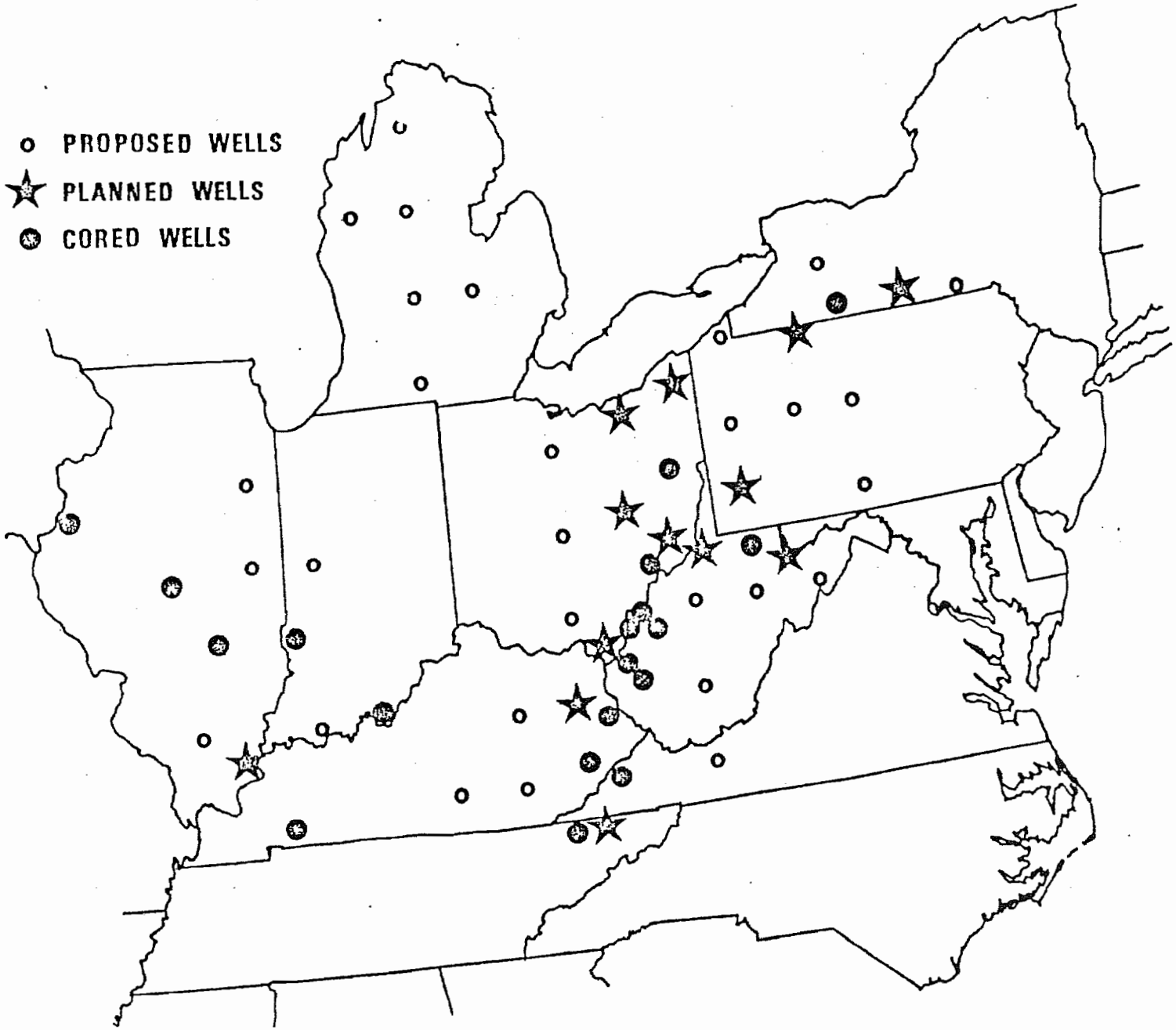
- CONTRACT DATE: AUGUST 16, 1978

- ANTICIPATED COMPLETION DATE: MAY 31, 1982

- COST:

- ORIGINAL CONTRACT:	$1,778,448
- MODIFICATIONS:	
-ADDITIONAL PERSONNEL/TASKS	216,360
-DATA INTEGRATION: (IN-SITU STRESS AND FRACTURES)	200,000
-FINAL ESTIMATED COST TO DOE:	2,194,808

- OBJECTIVE:
  - TO COLLECT, DESCRIBE LITHOLOGY, AND LOG ORIENTED DEVONIAN SHALE CORE
  - TO ANALYZE THE 3 BASINS FOR IN-SITU STRESS AND TO IDENTIFY MAJOR FRACTURE SYSTEMS
  - MAINTAIN EGSP WELL-LOG FILE

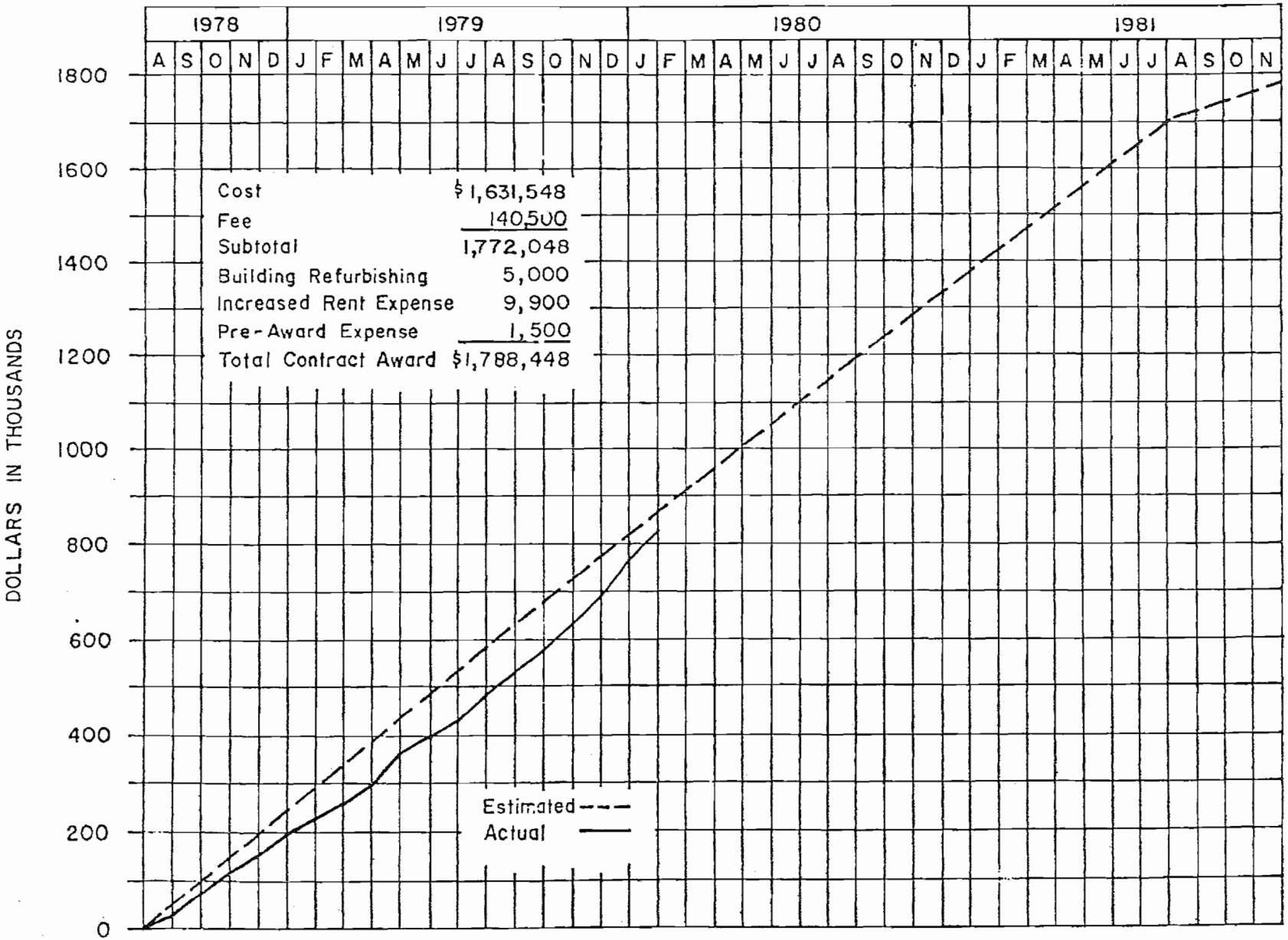


MAP OF EGSP CORE LOCATIONS

1978

CLIFFS MINERALS

CLIFFS MINERALS, INC.
United States Department of Energy
CONTRACT NO. DE-AC21-78MC08199
Estimated and Actual Expenditures



- SUMMARY OF PROGRESS:

FIELD ACTIVITY:

- EXTRACTED OVER 13,000 FEET OF CORE
- SUPERVISED 21 EGSP WELLS SINCE 1978
- UTILIZATION OF PLASTIC SLEEVE HAS IMPROVED EFFICIENCY
- FIELD SAMPLING AND CANNING FOR OUT-GASSING AND GEOCHEMICAL
- UTILIZATION OF GAMMA-RAY SCINTILLOMETER
- NINETEEN PHASE I REPORTS HAVE BEEN COMPLETED.

EGSP LABORATORY - GRANVILLE, WV:

- RENOVATION COMPLETED IN MARCH 1979
- MODELED AFTER AMOCO CORE LABORATORY IN TULSA, OKLAHOMA
- LEASE AGREEMENT FOR METC STORAGE

LABORATORY ANALYSES:

- TEN CORES HAVE BEEN DESCRIBED IN THE LABORATORY
- PHASE II REPORTS ARE BEING COMPLETED
- MICHIGAN TECH IS SUBMITTING FIRST RESULTS

EGSP WELL-LOG FILE (MODIFICATION):

- AMPLE SPACE IS NOW NEEDED FOR WELL LOGS (47 WELLS)
- CLERICAL HELP IS NEEDED TO MAINTAIN FILE

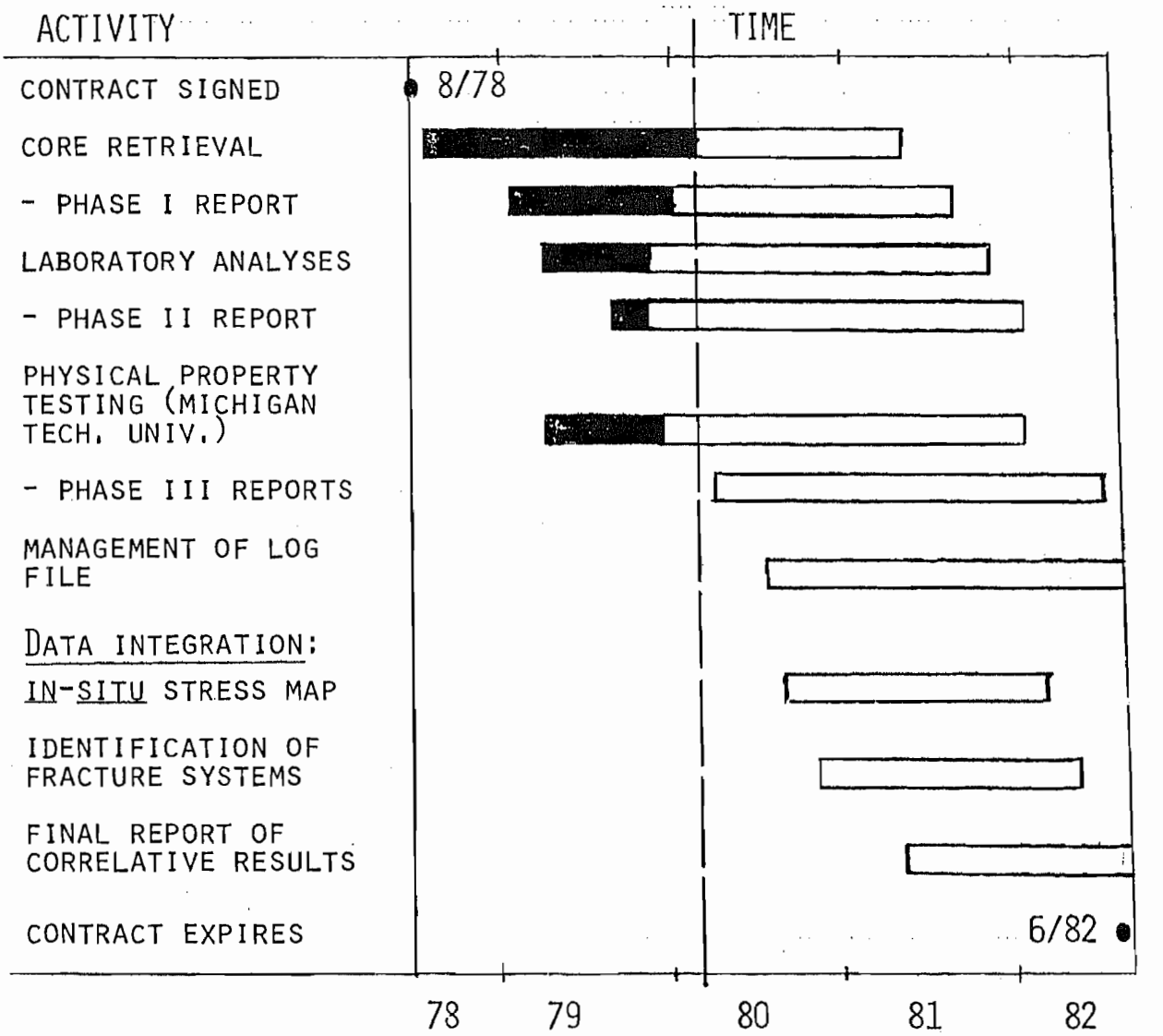
DATA INTEGRATION (MODIFICATION):

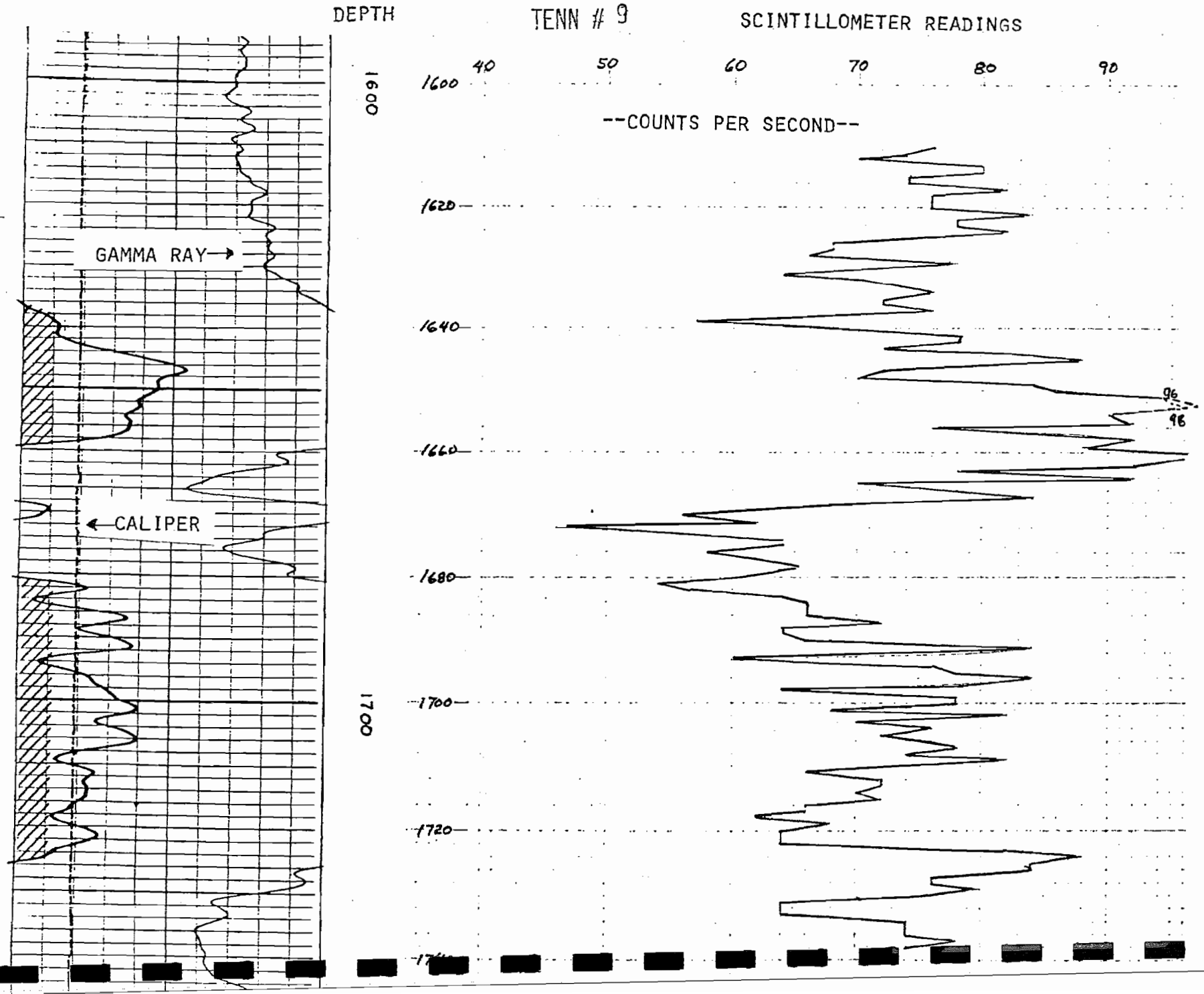
- IN-SITU STRESS OF CORES IN 3 BASINS
- SIGNIFICANT FRACTURE SYSTEMS
- FINAL REPORT OF CORRELATIVE RESULTS

- CRITICAL ITEMS:

- EXTENSIVE FIELD WORK HAS CAUSED BACKLOG OF CORE IN LABORATORY
- MULTIPLE WELLS OCCURRING SIMULTANEOUSLY CAUSE FIELD PERSONNEL AND EQUIPMENT SHORTAGE
- DATA INTEGRATION START-DATE DEPENDS UPON AVAILABILITY OF EXPERTISE (JUNE 1)
- MICHIGAN TECH RESULTS WILL BE UTILIZED IN PHASE III REPORTS AND BASIN ANALYSIS EFFORT

- MAJOR ACTIVITIES:




DEPTH
TENN # 9
SCINTILLOMETER READINGS
40
50
60
70
80
90
--COUNTS PER SECOND--
1600
1620
1640
1660
1680
1700
1720
1600
1700
GAMMA RAY
CALIPER
96
98

Yonnie Williams

This includes work that focuses down on pretty specific prospects. Tetra Tech is going to drill into these high priority areas with DOE funding first. They will be looking at completions, providing production of the conventional reservoir to justify completion in the shale. Tetra Tech operates a middle man, gathering the lease...

- APPALACHIAN BASIN

A. GEOLOGICAL INVESTIGATION

1. PENNSYLVANIA GEOLOGIC SURVEY
2. NEW YORK STATE GEOLOGIC SURVEY

OBJECTIVE

PERFORM STRATIGRAPHIC AND STRUCTURAL INVESTIGATIONS IN ORDER TO CONSTRUCT MAPS AND CROSS SECTIONS WHICH DEFINE THE EXTENT AND PRODUCTIVE CAPACITY OF THE POTENTIALLY GAS-PRODUCTIVE DEVONIAN BLACK SHALES.

-- DELIVERABLE ITEMS MAY INCLUDE:

CROSS SECTIONS	OIL & GAS SHOWS / PRODUCTION MAPS
STRUCTURE MAPS	LINEAMENT MAPS
ISOPACH MAPS	LITHOFACIES MAPS
GAS POTENTIAL MAPS	
DRILLING DEPTH	

B. GEOLOGICAL AND GEOCHEMICAL INVESTIGATIONS

1. WEST VIRGINIA GEOLOGICAL & ECONOMIC SURVEY
2. OHIO GEOLOGIC SURVEY
3. KENTUCKY RESEARCH FOUNDATION
4. UNIVERSITY OF CINCINNATI

OBJECTIVE

CONDUCT GEOLOGICAL AND GEOCHEMICAL STUDIES OF THE DEVONIAN BLACK SHALES TO DETERMINE THEIR POTENTIAL AS A FUEL RESOURCE.

-- DELIVERABLE ITEMS MAY INCLUDE:

CROSS SECTIONS	OIL & GAS SHOWS / PRODUCTION MAPS
STRUCTURE MAPS	LINEAMENT MAPS
ISOPACH MAPS	LITHOFACIES MAPS
GAS POTENTIAL MAPS	DRILLING DEPTH
SHALE CHARACTERIZATION GEOCHEMICAL STUDIES	

- ILLINOIS BASIN

1. INDIANA GEOLOGICAL SURVEY
2. KENTUCKY RESEARCH FOUNDATION (8215)
3. ILLINOIS GEOLOGIC SURVEY

OBJECTIVE

CONDUCT GEOLOGICAL AND GEOCHEMICAL INVESTIGATIONS OF THE NEW ALBANY SHALE TO CHARACTERIZE IT AND TO DETERMINE ITS POTENTIAL AS A HYDROCARBON SOURCE.

-- DELIVERABLE ITEMS MAY INCLUDE:

CROSS SECTIONS	ISOPACH MAPS
STRUCTURE MAPS	LITHOFACIES MAPS
LINEAMENT MAPS	OIL & GAS SHOWS / PRODUCTION MAPS
GEOCHEMICAL STUDIES	

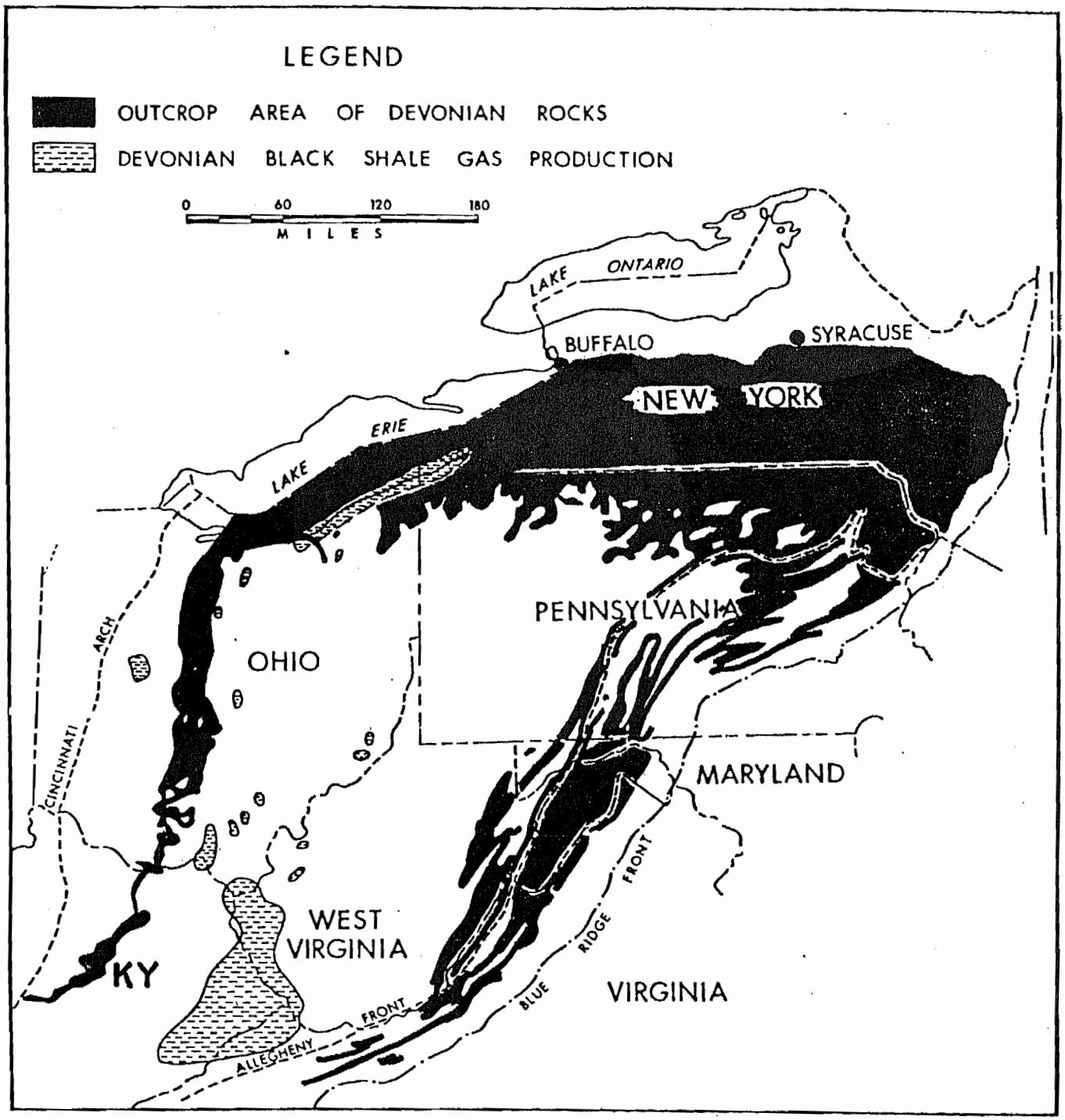
- CONTRACT: COMMONWEALTH OF PENNSYLVANIA, BUREAU OF TOPOGRAPHIC & GEOLOGIC SURVEY
  DE-AS21-76MC05198
- CONTRACT DATE: JULY 1, 1976
- ANTICIPATED COMPLETION DATE: FEBRUARY 1, 1980 (excellent work)
- DOE COST: $260,491
- OBJECTIVE: TO ASSEMBLE, PROCESS AND MAP GEOLOGIC DATA TO INVENTORY THE BLACK SHALES OF THE APPALACHIAN BASIN IN PENNSYLVANIA AS A FUEL RESOURCE.
- SUMMARY OF PROGRESS:

	1980 JAN	FEB	MAR
ISOPACH MAPS		▲	
STRUCTURE MAPS		▲	
LITHOFACIES		▲	
CROSS SECTIONS	▲		
DRILLING DEPTH	▲		
SHOWS/PRODUCTION	▲		

FINAL COPY RECEIVED ▲

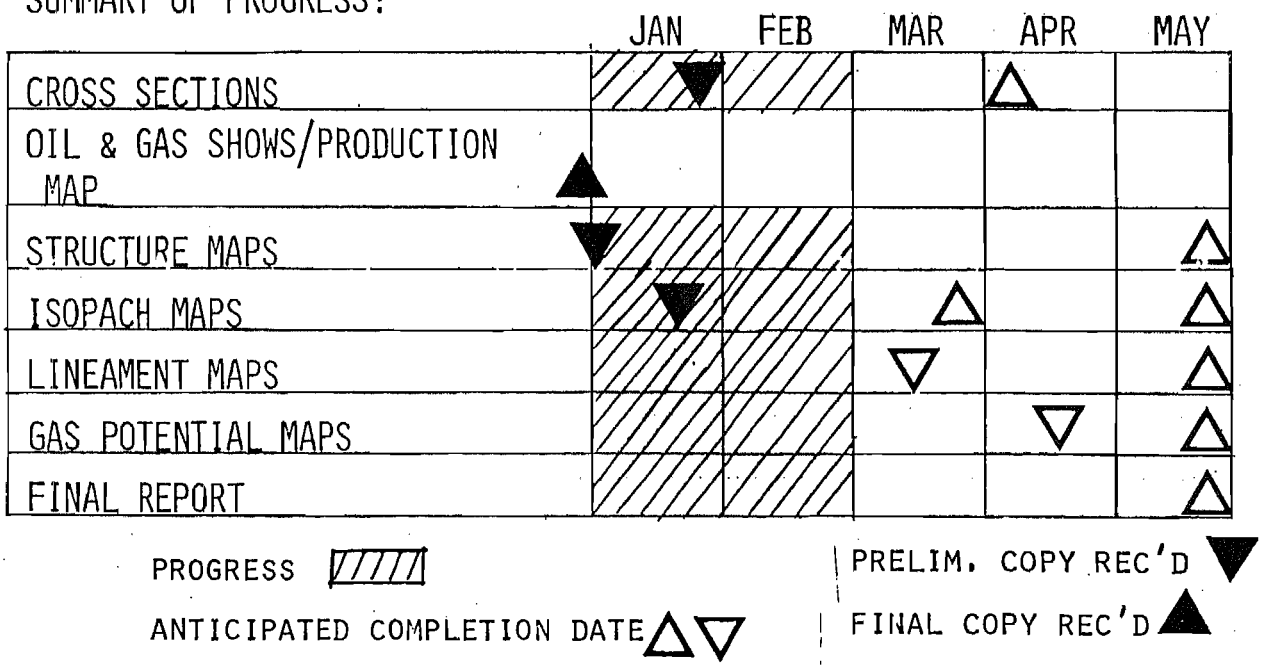
- THE MOST LIKELY TARGETS FOR EXPLORATION OF THE DEVONIAN SHALES IN PENNSYLVANIA ARE THE RHINESTREET AND THE DUNKIRK SHALE FACIES.

- FUNDING:
  - TOTAL ESTIMATED COST TO DOE: $260,491
  - TOTAL COST TO DATE: $253,609



Regional outcrop pattern of Middle and Upper Devonian clastics and locations of Devonian shale gas fields.

- CONTRACT: NEW YORK STATE GEOLOGICAL SURVEY
  DE-AS21-76MC05206
- CONTRACT DATE: JUNE 1, 1976
- ANTICIPATED COMPLETION DATE: MAY 1, 1980
- TOTAL & DOE COST: $188,875
- OBJECTIVE: TO PERFORM MAJOR STRATIGRAPHIC & STRUCTURAL GEOLOGICAL INVESTIGATIONS IN ORDER TO CONSTRUCT MAPS & CROSS SECTIONS WHICH DEFINE THE EXTENT AND PRODUCTIVE CAPACITY OF THE POTENTIALLY GAS-PRODUCTIVE DEVONIAN SHALES OF NEW YORK
- SUMMARY OF PROGRESS:



- FUNDING:
  - TOTAL ESTIMATED COST TO DOE: $188,875
  - COST TO DATE $173,497

- CONTRACT: WEST VIRGINIA GEOLOGICAL AND ECONOMIC SURVEY
  DE-AC21-76MC05199

- CONTRACT DATE: JULY 1, 1976

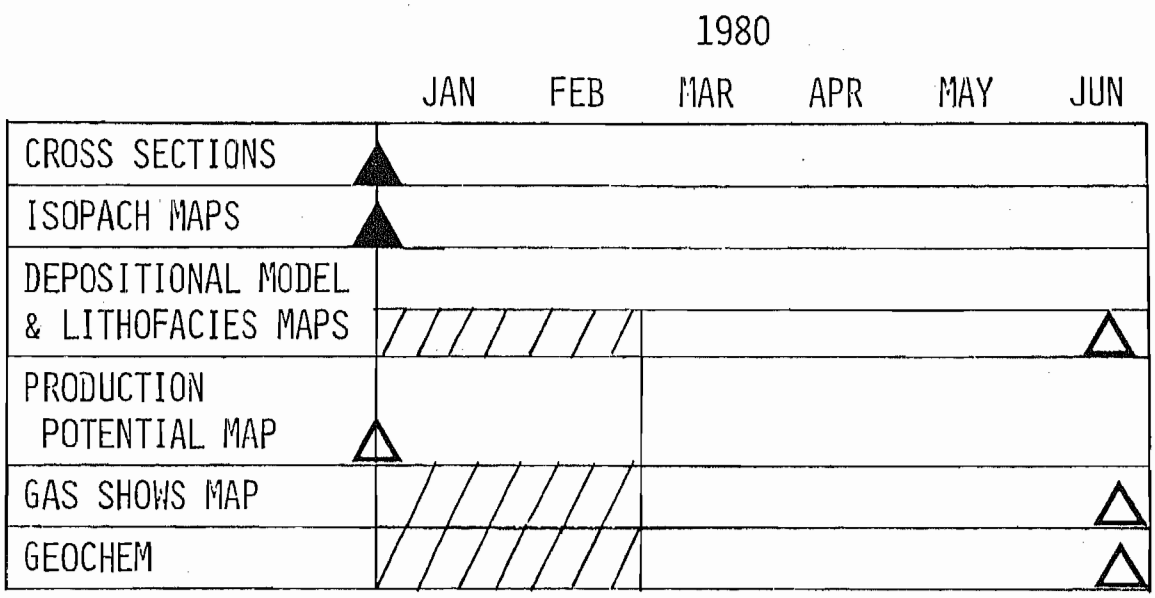
- ANTICIPATED COMPLETION DATE: JULY 31, 1980

- TOTAL COST: ($1,809,800 — big cost due to geochemical work being done by WVGS.

- DOE COST: $1,686,400

- OBJECTIVE: TO CONDUCT A DETAILED AND COMPREHENSIVE STRATIGRAPHIC AND GEOCHEMICAL STUDY OF THE DEVONIAN SHALES IN WEST VIRGINIA TO RESULT IN A COMPREHENSIVE APPRAISAL OF THE TOTAL ENERGY RESOURCE POTENTIAL OF THESE SHALES.

- SUMMARY OF PROGRESS:



PROGRESS

MAP RECEIVED

ANTICIPATED COMPLETION DATE

- FUNDING:

  - TOTAL ESTIMATED COST TO DOE: $1,686,439

  - COST TO DATE:

- CONTRACT: STATE OF OHIO, DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGIC SURVEY

  DE-AS21-76MC05200

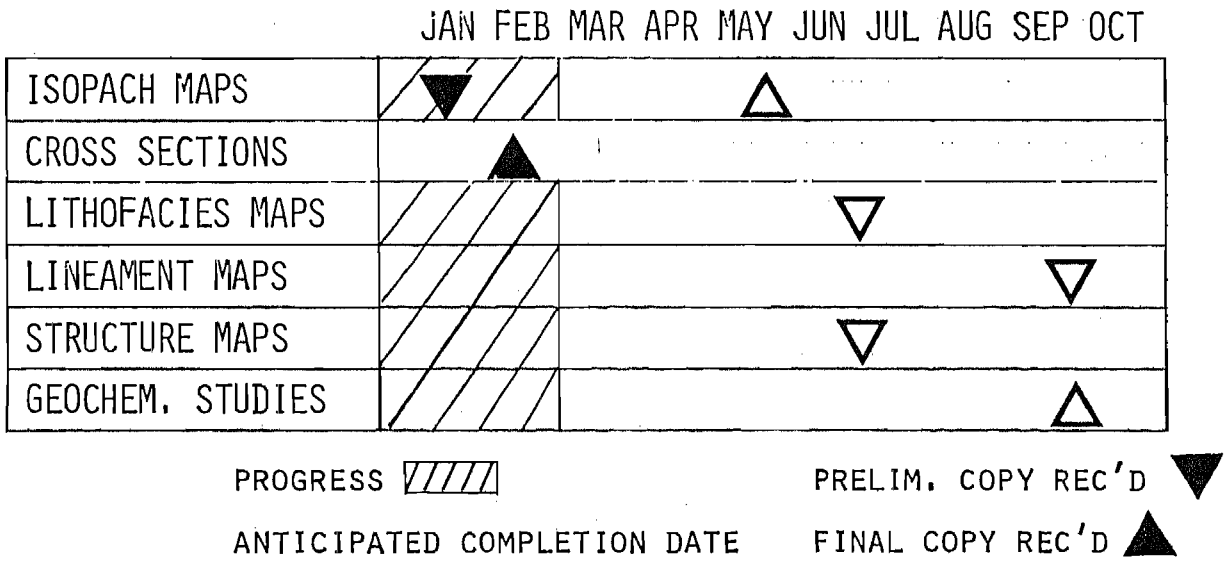
- CONTRACT DATE: JULY 1, 1976

- ANTICIPATED COMPLETION DATE: SEPTEMBER 30, 1980

- DOE COST: $1,074,473

- OBJECTIVE: TO GENERATE DATA FROM WHICH GEOLOGICAL AND GEOCHEMICAL INTERPRETATION CAN BE MADE RELATIVE TO THE RESOURCE POTENTIAL, STRUCTURE AND STRATIGRAPHY OF THE DEVONIAN SHALES IN EASTERN OHIO.

- SUMMARY OF PROGRESS:



- FUNDING:

  - TOTAL ESTIMATED COST TO DOE: $1,074,473
  - COST TO DATE: $867,033

- CONTRACT: UNIVERSITY OF KENTUCKY RESEARCH FOUNDATION
  DE-AC21-76MC05202

- CONTRACT DATE: JULY 1, 1976

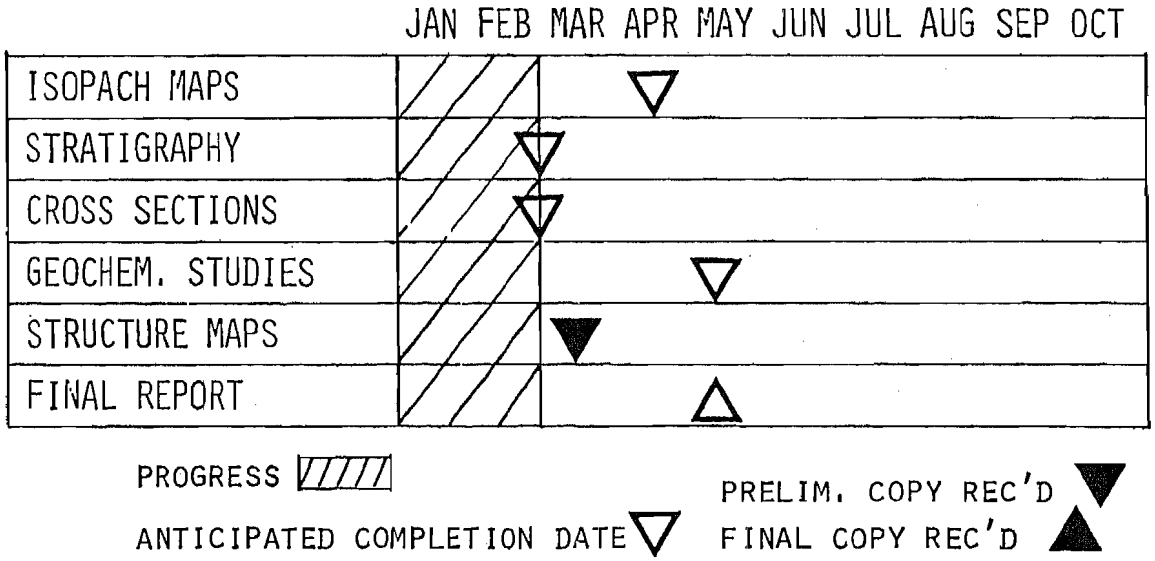
- ANTICIPATED COMPLETION DATE: MAY 31, 1980

- TOTAL COST: $509,398

- TOTAL DOE COST: $509,398

- OBJECTIVE: TO CONDUCT A GEOLOGICAL AND GEOCHEMICAL STUDY OF THE DEVONIAN BLACK SHALE IN EASTERN KENTUCKY TO DETERMINE ITS POTENTIAL AS A FUEL RESOURCE

- SUMMARY OF PROGRESS:



- FUNDING:
  - TOTAL ESTIMATED COST TO DOE: $509,398
  - COST TO DATE: $405,579

- CONTRACT: UNIVERSITY OF CINCINNATI
  DE-AS21-76MC05201
- CONTRACT DATE: JULY 1, 1976
- ANTICIPATED COMPLETION DATE: DECEMBER 31, 1979
- TOTAL COST: $465,533
- DOE COST: $465,533
- OBJECTIVE: TO PROVIDE SPECIAL STUDIES OF THE DEVONIAN SHALE IN THE APPALACHIAN BASIN
- SUMMARY OF PROGRESS:

  A. PALEOCURRENT STUDY INDICATES THAT A HOMOGENEOUS SEDIMENT SOURCE, LOCATED TO THE EAST, PROVIDED MOST OF THE DEVONIAN SHALE SEDIMENT.

  B. THE PINE MOUNTAIN OVERTHRUST STUDY IS ESSENTIALLY COMPLETE. IT WILL INCLUDE A TEXT, A COMBINED ISOPACH AND STRUCTURE MAP AND A CROSS SECTION. THE TOTAL VOLUME OF THE SHALE SEQUENCE WITHIN THE OVERTHRUST SHEET IS 254 CUBIC MILES.

  C. THE BRALLIER FORMATION STUDY IS IN PRESS AT METC UNDER THE TITLE "SEDIMENTOLOGY, PETROLOGY AND GAS POTENTIAL OF THE BRALLIER FORMATION--UPPER DEVONIAN TURBIDITE FACIES OF THE CENTRAL AND SOUTHERN APPALACHIANS".

D. GEOLOGY OF THE OHIO SHALE ALONG LAKE ERIE STUDY CONCENTRATES ON GAS POTENTIAL, STRATIGRAPHY, AND SEDIMENTOLOGY OF THE DEVONIAN SEQUENCE IN THIS AREA.

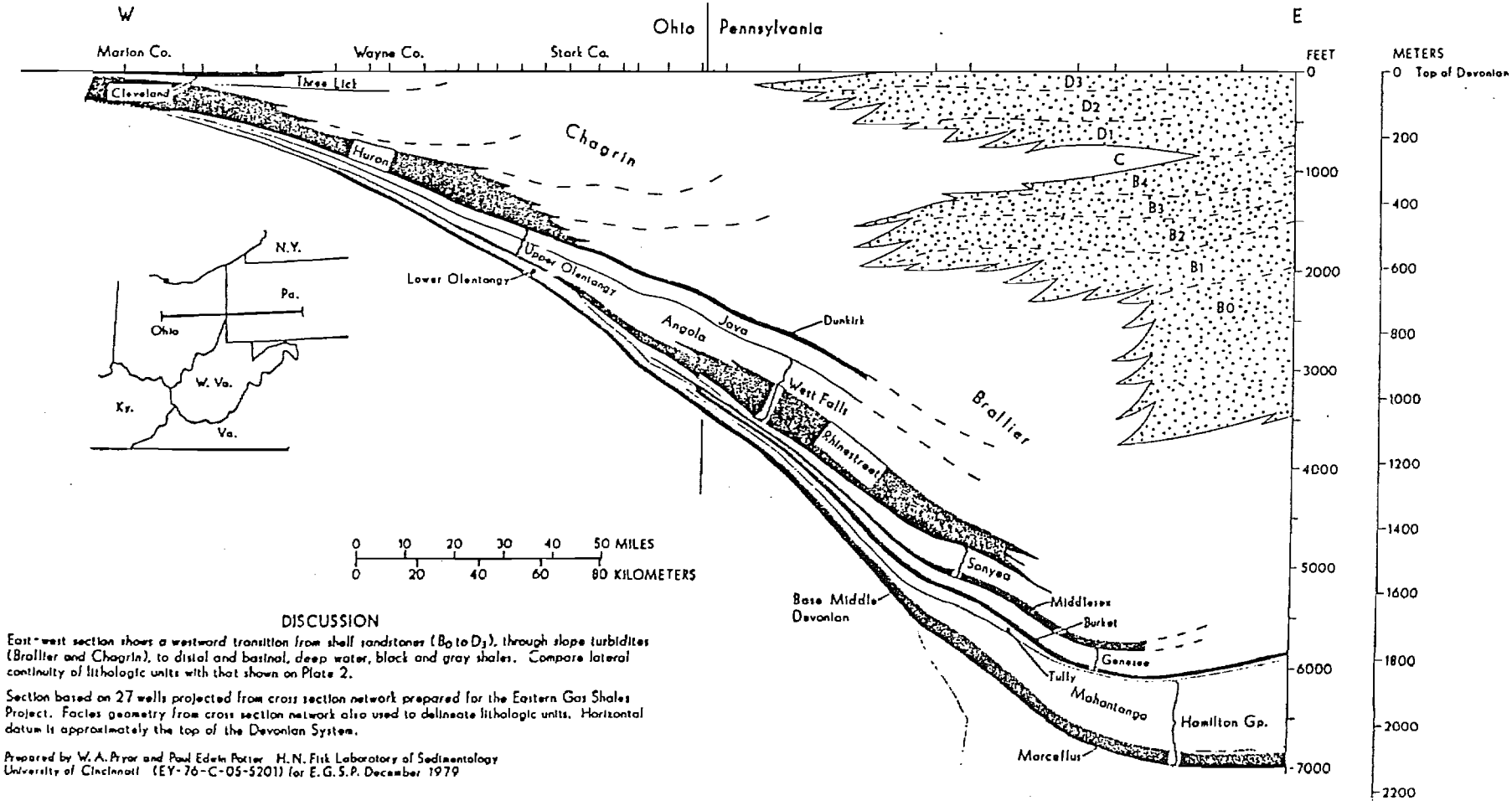
E. THE BASIN ANALYSIS IS A SUMMARY OF INFORMATION AVAILABLE, AS OF SEPTEMBER 30, 1979, PERTAINING TO THE DISTRIBUTION AND ORIGIN OF THE UPPER DEVONIAN SEDIMENTS OF THE APPALACHIAN BASIN.

- FUNDING: TOTAL ESTIMATED COST TO DOE: $465,533

  COST TO DATE: $444,789

STRATIGRAPHIC CROSS-SECTION OF UPPER AND MIDDLE DEVONIAN ROCKS FROM CENTRAL OHIO TO CENTRAL PENNSYLVANIA

PLATE 1



DISCUSSION

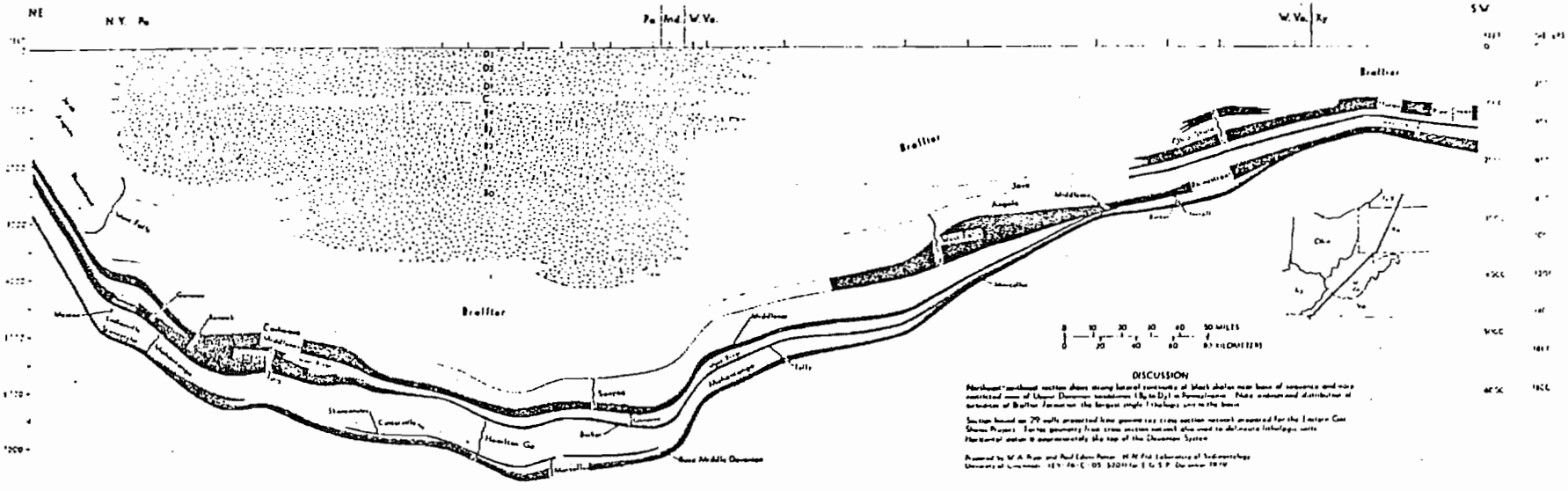
East-west section shows a westward transition from shelf sandstones (B_0 to D_3), through slope turbidites (Brallier and Chagrin), to distal and basinal, deep water, black and gray shales. Compare lateral continuity of lithologic units with that shown on Plate 2.

Section based on 27 wells projected from cross section network prepared for the Eastern Gas Shales Project. Facies geometry from cross section network also used to delineate lithologic units. Horizontal datum is approximately the top of the Devonian System.

Prepared by W. A. Pryor and Paul Edwin Potter H. N. Fisk Laboratory of Sedimentology
University of Cincinnati (EY-76-C-05-5201) for E.G.S.P. December 1979

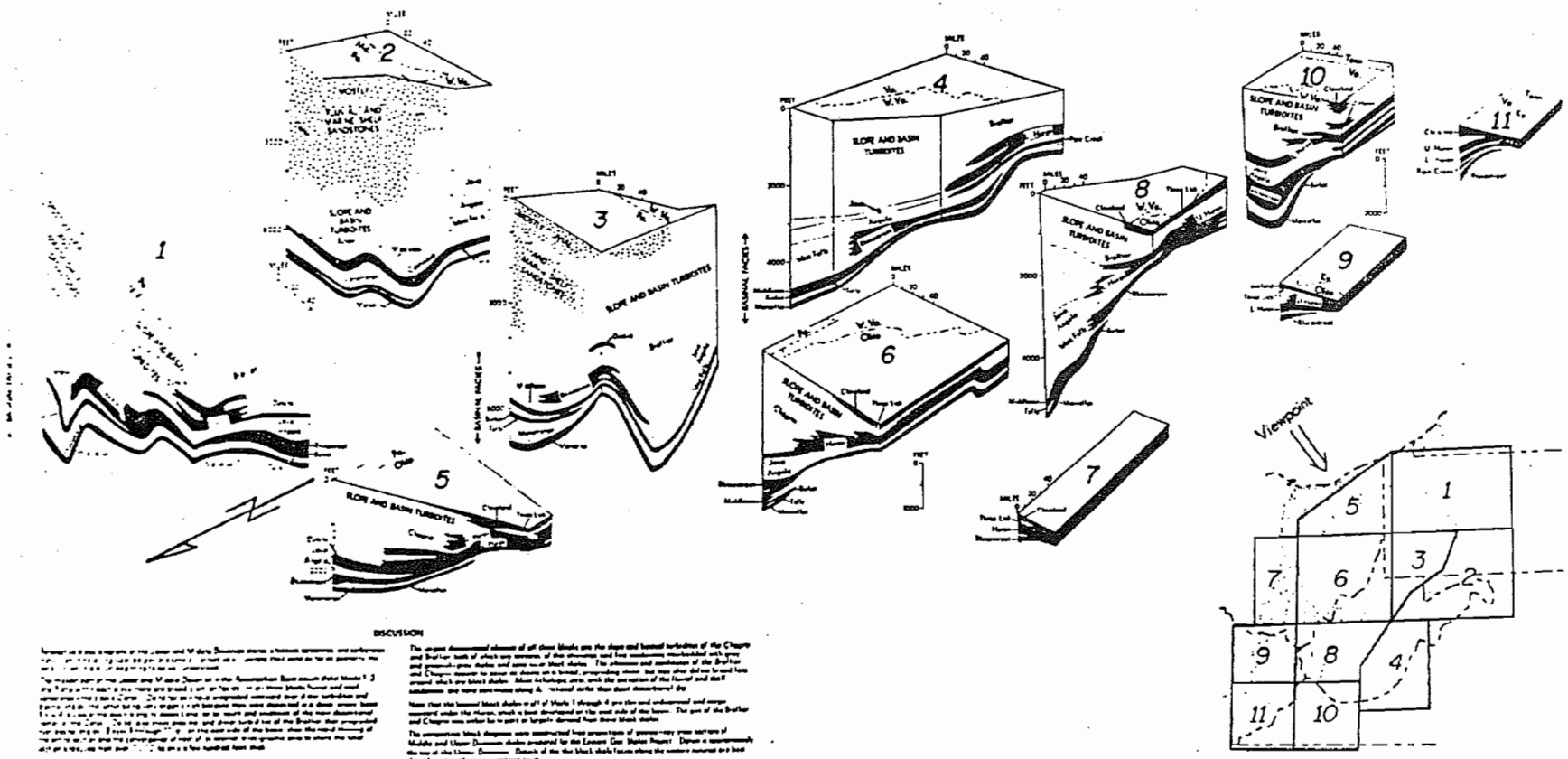
STRATIGRAPHIC CROSS-SECTION OF UPPER AND MIDDLE DEVONIAN ROCKS FROM WESTERN NEW YORK TO WESTERN VIRGINIA

PLATE 2

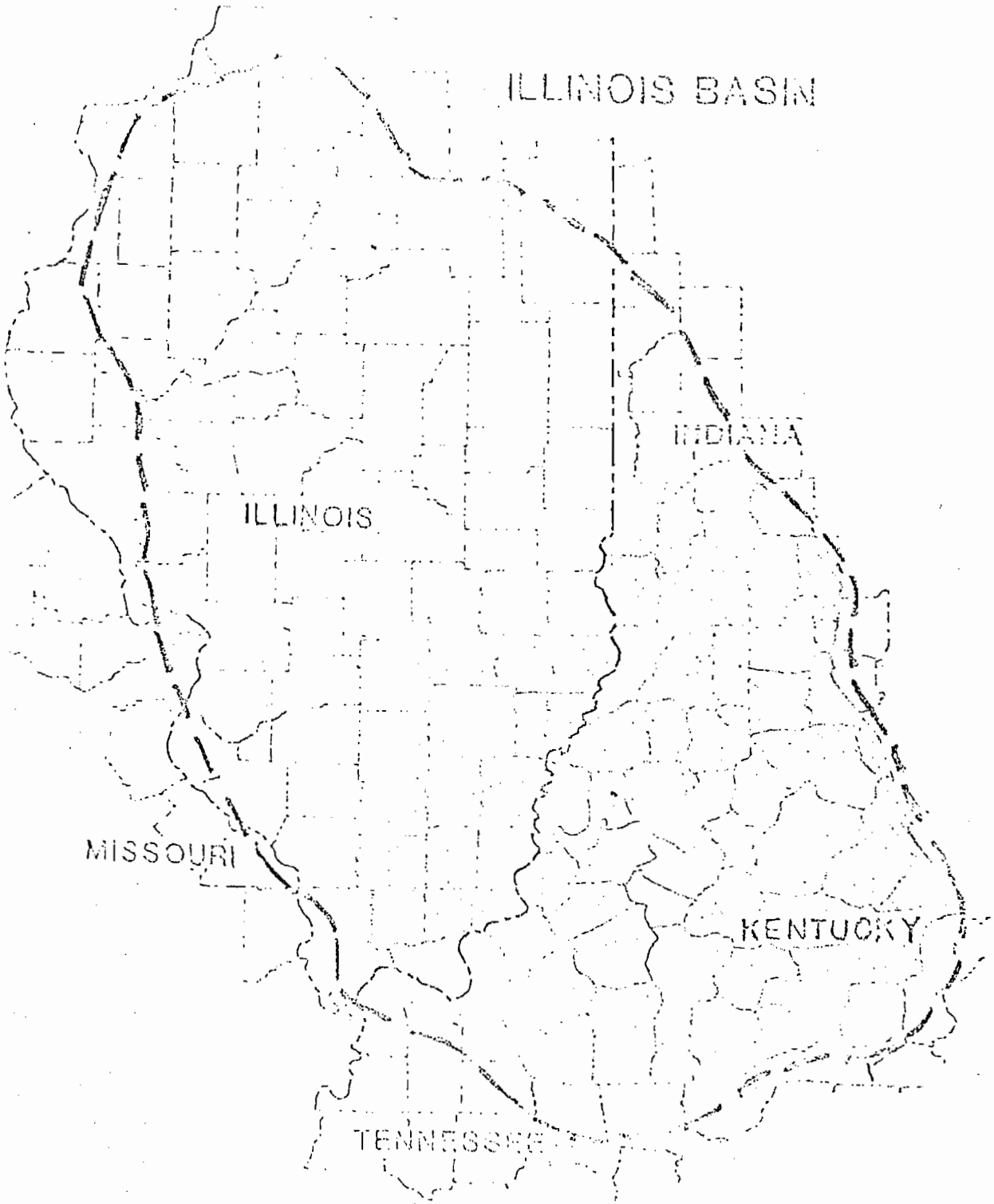


FACIES GEOMETRY OF UPPER AND MIDDLE DEVONIAN OF APPALACHIAN BASIN

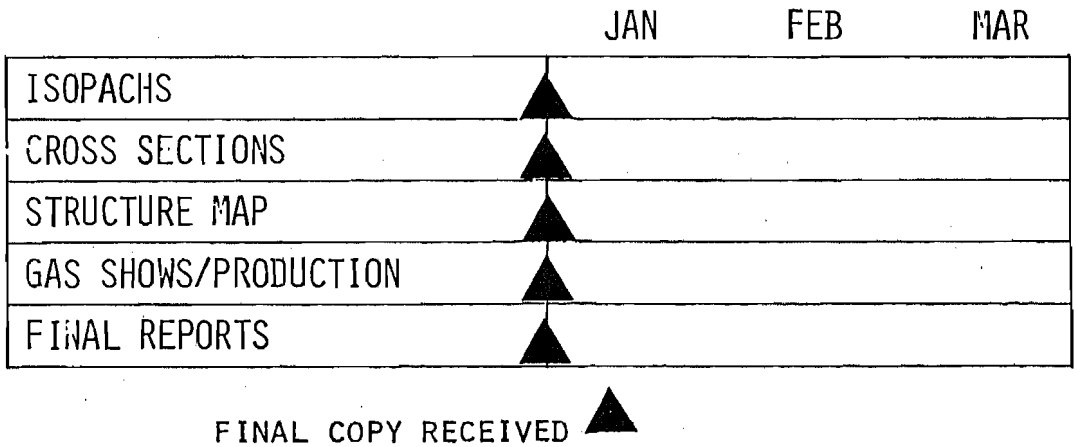
PLATE 3



DISCUSSION

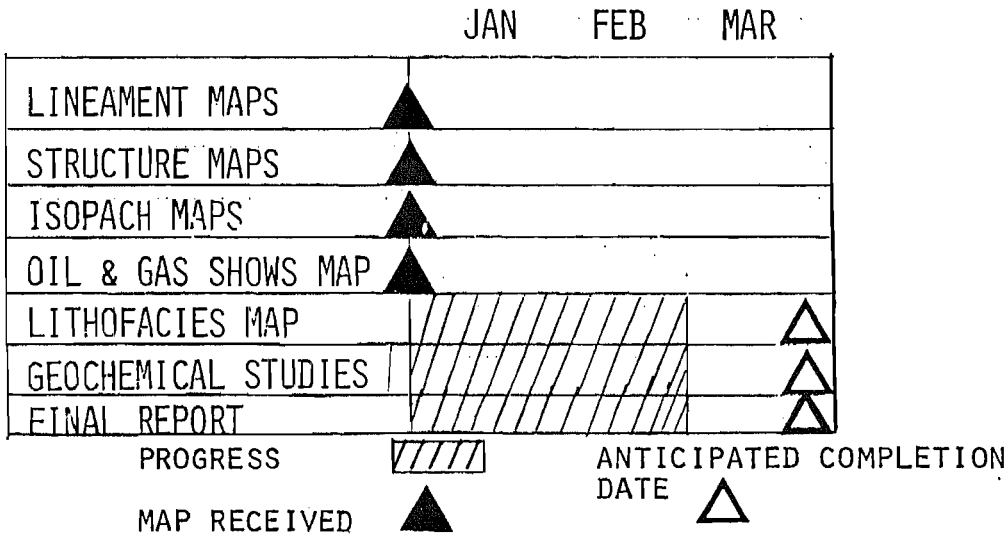

ILLINOIS BASIN
INDIANA
ILLINOIS
MISSOURI
KENTUCKY
TENNESSEE

- CONTRACT: UNIVERSITY OF KENTUCKY RESEARCH FOUNDATION
  DE-AS21-78MC08215
- CONTRACT DATE: DECEMBER 1, 1977
- ANTICIPATED COMPLETION DATE: NOVEMBER 30, 1979
- TOTAL COST: $109,000
- DOE COST: $109,000
- OBJECTIVE: TO COLLECT, INTERPRET AND REPORT GEOLOGICAL INFORMATION ABOUT THE NEW ALBANY SHALE OF WESTERN KENTUCKY
- SUMMARY OF PROGRESS:



- FUNDING:
  - TOTAL ESTIMATED COST TO DOE: $109,000
  - COST TO DATE: $ 98,700

- CONTRACT: INDIANA GEOLOGICAL SURVEY
  DE-AC21-76MC05204
- CONTRACT DATE: SEPTEMBER 21, 1976
- ANTICIPATED COMPLETION DATE: MARCH 31, 1980
- TOTAL COST: $574,992
- DOE COST: $574,992
- OBJECTIVE: TO DETERMINE THE MAGNITUDE OF POTENTIAL GAS RESERVES AND TO CHARACTERIZE THE NEW ALBANY SHALE IN INDIANA
- SUMMARY OF PROGRESS:



- FUNDING: TOTAL ESTIMATED COST TO DOE: $574,992
  COST TO DATE: $570,704

- CONTRACT: ILLINOIS STATE GEOLOGICAL SURVEY
  DE-AC21-76MC05203

- CONTRACT DATE: JULY 1, 1976

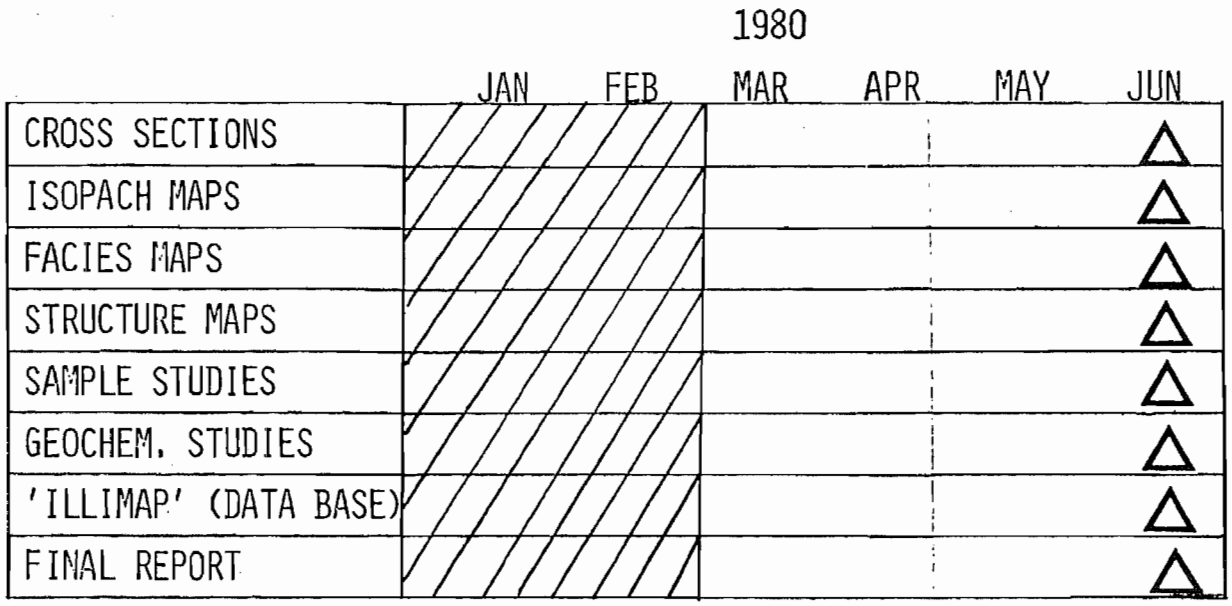
- ANTICIPATED COMPLETION DATE: JUNE 30, 1980

- TOTAL COST: $1,287,500

- DOE COST: $1,287,500

- OBJECTIVE:
  - TO CONDUCT A GEOLOGICAL STUDY OF THE NEW ALBANY GROUP IN ILLINOIS TO DETERMINE ITS POTENTIAL AS A HYDROCARBON SOURCE.
  - TO COORDINATE THE INDEPENDENT GEOLOGICAL AND GEOCHEMICAL STUDIES BEING DONE BY THE KENTUCKY RESEARCH FOUNDATION (8215), THE INDIANA GEOLOGIC SURVEY, AND THE ILLINOIS GEOLOGIC SURVEY TO RESULT IN A DATA BASE (ILLIMAP) FOR THE DEVONIAN BLACK SHALE IN THE ILLINOIS BASIN, AN INTEGRATION OF ANALYSES AND A SUMMARY OF RESULTS.

- SUMMARY OF PROGRESS:



PROGRESS

MAP RECEIVED

ANTICIPATED COMPLETION DATE

- FUNDING:

  - TOTAL ESTIMATED DOE COST: $1,287,500
  - COST TO DATE: $1,151,145

- SUMMARY:

APPALACHIAN BASIN CONTRACTOR	TOTAL COST TO DOE	COMPLETION DATE
PENNSYLVANIA GEOLOGIC SURVEY	$260,500	FEB 1980
NEW YORK STATE GEOLOGIC SURVEY	188,875	MAY 1980
KENTUCKY RESEARCH FOUNDATION (5202)	509,398	MAY 1980
OHIO GEOLOGIC SURVEY	1,074,473	SEP 1980
WEST VIRGINIA GEOLOGIC & ECONOMIC SURVEY	1,686,400	JUL 1980
UNIVERSITY OF CINCINNATI	465,533	DEC 1979
	4,185,179	

ILLINOIS BASIN CONTRACTOR:

INDIANA GEOLOGIC SURVEY	574,992	MAR 1980
KENTUCKY RESEARCH FOUNDATION (8215)	109,000	NOV 1979
ILLINOIS STATE GEOLOGICAL SURVEY	1,287,500	JUN 1980
	1,971,492	

TOTAL FOR GEOLOGIC EVALUATION PHASE $6,156,671

- CONTRACT: TETRA TECH
  DE-AC21-79MC10389

- PROGRAM DESIGNED TO ACQUIRE, EVALUATE, AND INTEGRATE DEVONIAN SHALE DATA IN ORDER TO IDENTIFY FAVORABLE DEVONIAN SHALE PROSPECTS TO BE TESTED BY MEANS OF WELLS THAT ARE SUBJECT TO DUAL COMPLETION IN THE DEVONIAN SHALE AND ANOTHER RESERVOIR. THIS IS AN EXAMPLE OF INTEGRATION AND INTERPRETATION OF THE GEOLOGIC DATA AVAILABLE IN THE EGSP DONE BY INDUSTRY.

- REGIONAL STUDIES HAVE ADVANCED SUFFICIENTLY TO PERMIT SELECTION OF SIX SPECIFIC AREAS IN WHICH MORE DETAILED STUDIES WILL BE MADE.

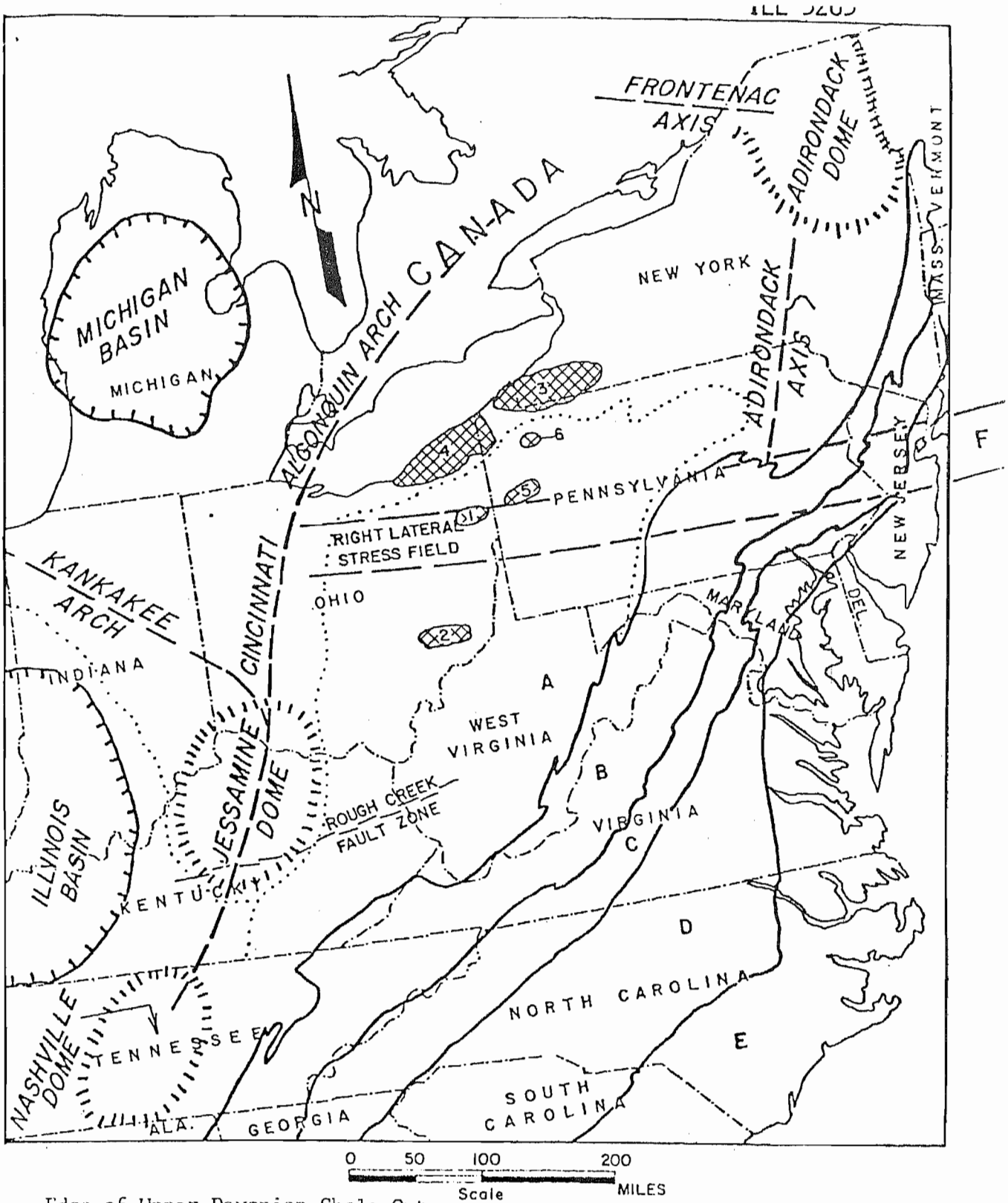
  100' or more thk

  (IN ORDER OF PRIORITY WITH RESPECT TO QUALITY*):

  1. CENTRAL COLUMBIANA COUNTY TREND (OHIO)
  2. CENTRAL WASHINGTON COUNTY TREND (OHIO)
  3. CHAUTAUQUA TREND (NEW YORK AND PENNSYLVANIA)
  4. ASHTABULA COUNTY TREND (OHIO AND PENNSYLVANIA)
  5. BUTLER COUNTY TREND (PENNSYLVANIA)
  6. CENTRAL VENANGO COUNTY TREND (PENNSYLVANIA)

  These are specific prospects. Next step is to put down wells.

  * BASED ON ORGANIC SHALES IN SUFFICIENT THICKNESSES, POTENTIAL INTERSECTING FRACTURE PATTERNS, AND COST/DEPTH FACTORS.



....Edge of Upper Devonian Shale Outcrop

(1) Devonian Shale Prospective Area in Order of Priority

A. Appalachian Plateaus Province
B. Valley & Ridge Province
C. Blue Ridge Province
D. Piedmont Province
E. Coastal Plain Province
F. Oceanographer Transform Fracture Zone

PRINCIPAL TECTONIC ELEMENTS OF THE APPALACHIAN BASIN AND LOCATION OF AREAS WITH A POTENTIAL FOR DEVONIAN SHALE GAS PRODUCTION.

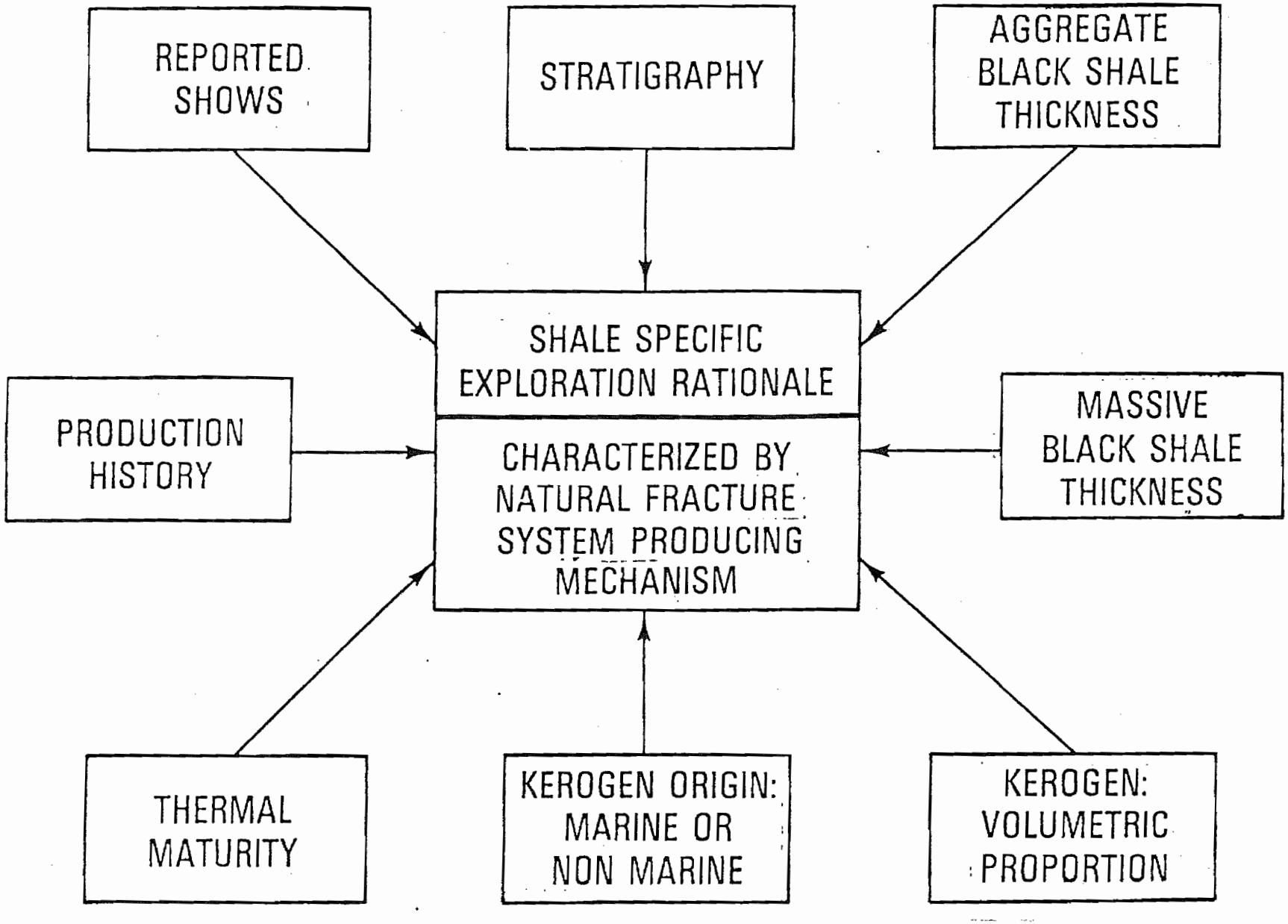
Claude Dorn

EXPLORATION STRATEGY FOR AN UNCONVENTIONAL NATURAL GAS RESOURCE:

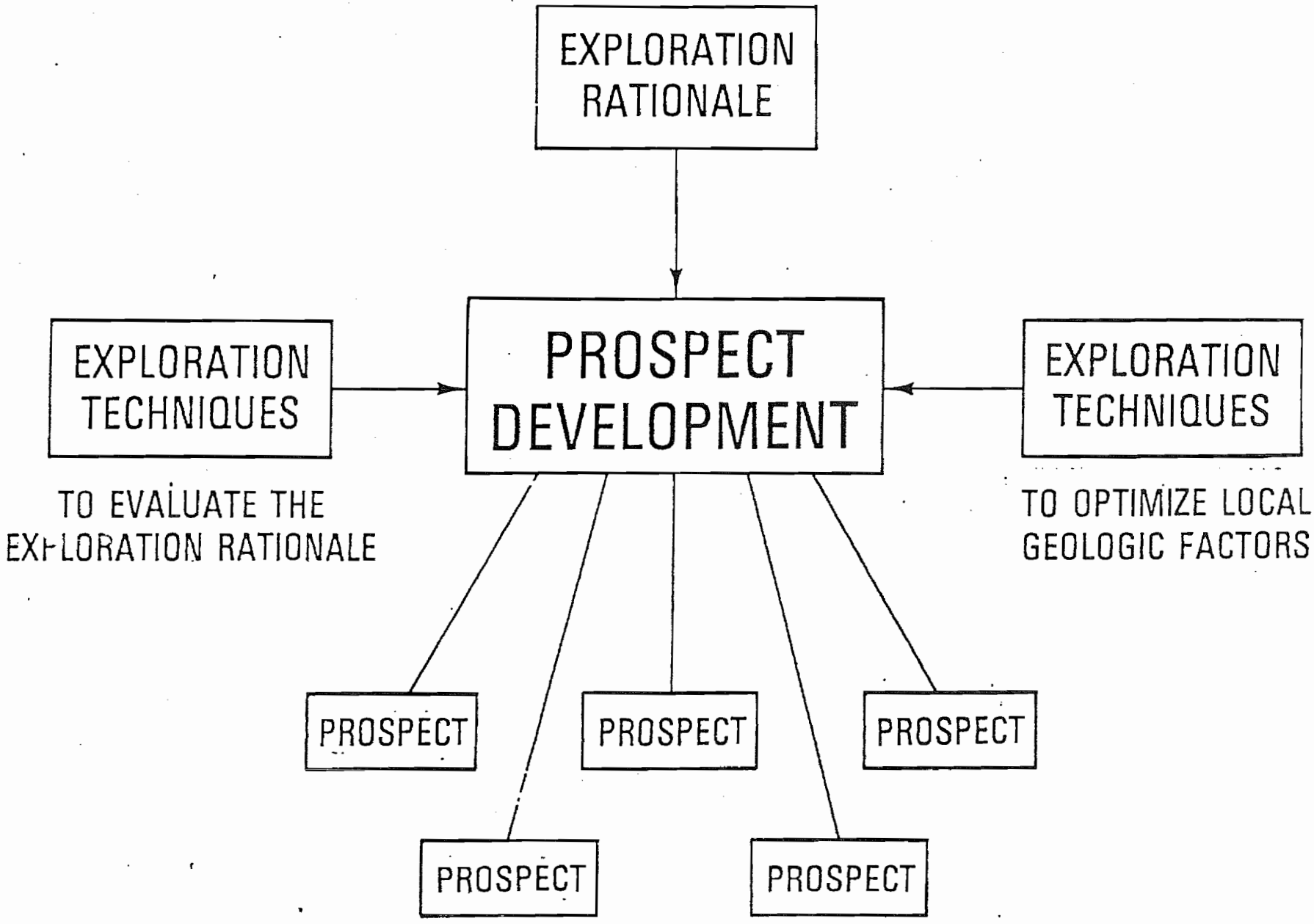
DEVONIAN SHALE

DEFINITIONS AND COMPARISON

EXPLORATION RATIONALE	VS.	EXPLORATION TECHNIQUE
ABSTRACTION		CONCRETE
AREA SPECIFIC		SURVEY CAPABILITY
GENERALLY NOT SITE SPECIFIC		CAN IDENTIFY SPECIFIC SITES
ANALOG IN NATURE		ANALOG IN NATURE


REPORTED SHOWS
STRATIGRAPHY
AGGREGATE BLACK SHALE THICKNESS
SHALE SPECIFIC EXPLORATION RATIONALE
PRODUCTION HISTORY
CHARACTERIZED BY NATURAL FRACTURE SYSTEM PRODUCING MECHANISM
MASSIVE BLACK SHALE THICKNESS
THERMAL MATURITY
KEROGEN ORIGIN: MARINE OR NON MARINE
KEROGEN: VOLUMETRIC PROPORTION

GENERAL EXPLORATION STRATEGY



EGSP EXPLORATION EFFORT

PROSPECT DEVELOPMENT

BASED ON

- SELECTED SHALE SPECIFIC EXPLORATION RATIONALES

REGIONAL SCREENING

BASED PRIMARILY ON

- PRODUCTION HISTORY AND REPORTED SHOWS
- AGGREGATE THICKNESS OF BLACK SHALE AND STRATIGRAPHY
- DRILLING DEPTH AND DUAL COMPLETION POSSIBILITIES

EXPLORATION INVENTORY

FOR THE

DEVONIAN SHALE

EXPLORATION RATIONALES

1. BASEMENT TECTONICS RELATED
2. DETACHMENT TECTONICS RELATED
3. STRATIGRAPHIC
4. GLACIAL LOADING & UNLOADING
5. UPLIFT AND EROSIONAL UNLOADING
6. ASTROBLEMS & CRYPTO-EXPLOSION STRUCTURES
7. DIAGENETIC

EXPLORATION TECHNIQUES

1. NON-PENETRATIVE (SURFACE OR NEAR-SURFACE)
2. PENETRATIVE (SUB-SURFACE)
   - SUBSURFACE DATA: MAPPING & ANALYSIS
   - ANALYSIS OF WELL CUTTINGS
   - REFLECTION SEISMIC
   - RESISTIVITY AND RELATED TECHNIQUES
3. INTERPRETIVE
   - FINITE ELEMENT STRESS ANALYSIS

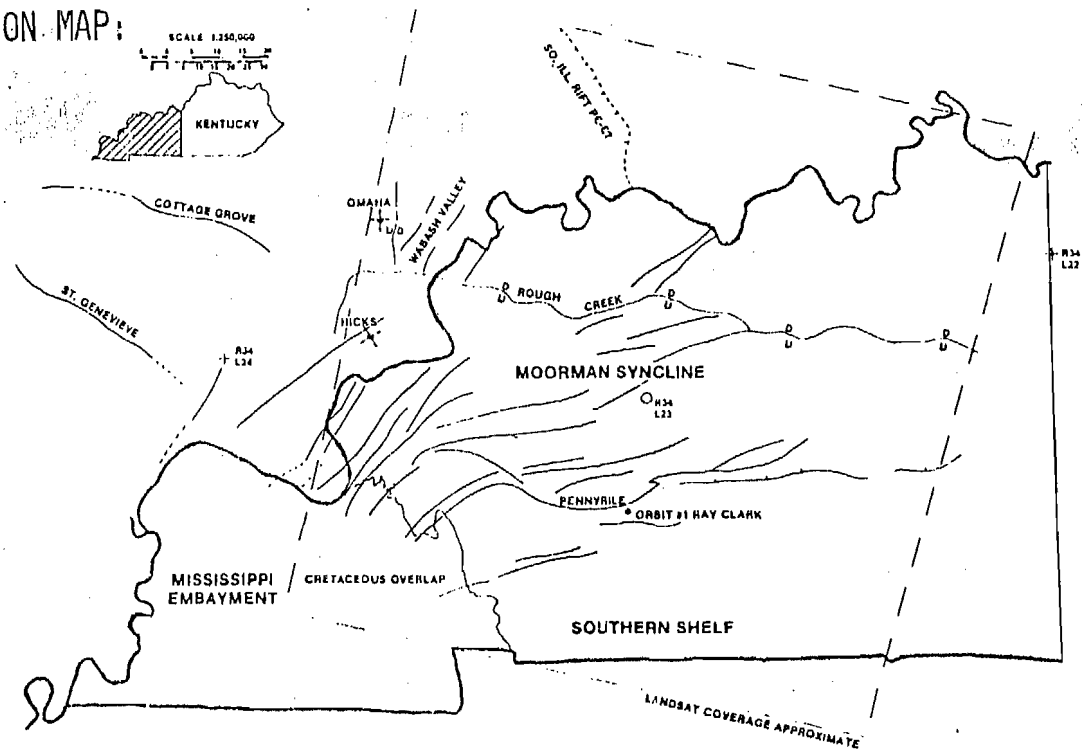
EXPLORATION TECHNIQUES

1. NON-PENETRATIVE (SURFACE OR NEAR-SURFACE)
   - REMOTE SENSING
   - FIELD FRACTURE INVESTIGATIONS
   - GEOLOGIC MAPPING
   - ANALYSIS OF MAGNETIC AND GRAVITY SURVEYS
   - WATER WELL PRODUCTION SURVEYS
   - GEOCHEMICAL MAPPING
2. PENETRATIVE (SUB-SURFACE)
3. INTERPRETIVE

- CONTRACT: ENVIRONMENTAL RESOURCES INSTITUTE OF MICHIGAN (ERIM) DE-AC21-79MC11687
- CONTRACT DATE: AUGUST 1, 1979
- ANTICIPATED COMPLETION DATE: JULY 31, 1980
- TOTAL COST: $98,136
- DOE COST: AS ABOVE
- OBJECTIVE: TO DEVELOP REMOTE SENSING AS AN EXPLORATION TECHNIQUE FOR NATURAL GAS FROM THE DEVONIAN SHALES OF THE APPALACHIAN, ILLINOIS, AND MICHIGAN BASINS. EMPHASIS IS PLACED ON REMOTE SENSING IMAGE ENHANCEMENT USING SOPHISTICATED DIGITAL PROCESSING TECHNIQUES IN ORDER TO BETTER REVEAL FEATURES BELIEVED TO BE RELATED TO SHALE PRODUCTION POTENTIAL.

They selected this area because it was near ideal.

- LOCATION MAP:



LANDSAT FRAME PATH 23/ROW 34 AREA, WESTERN KENTUCKY
WITH INCLUDED REGIONAL GEOLOGIC FEATURES
(GENERALIZED FROM SCHWALB & POTTER, 1978)

They want to try to validate the technique in a virgin area.

ERIM
DE-AC21-79MC11687

- SUMMARY OF PROGRESS

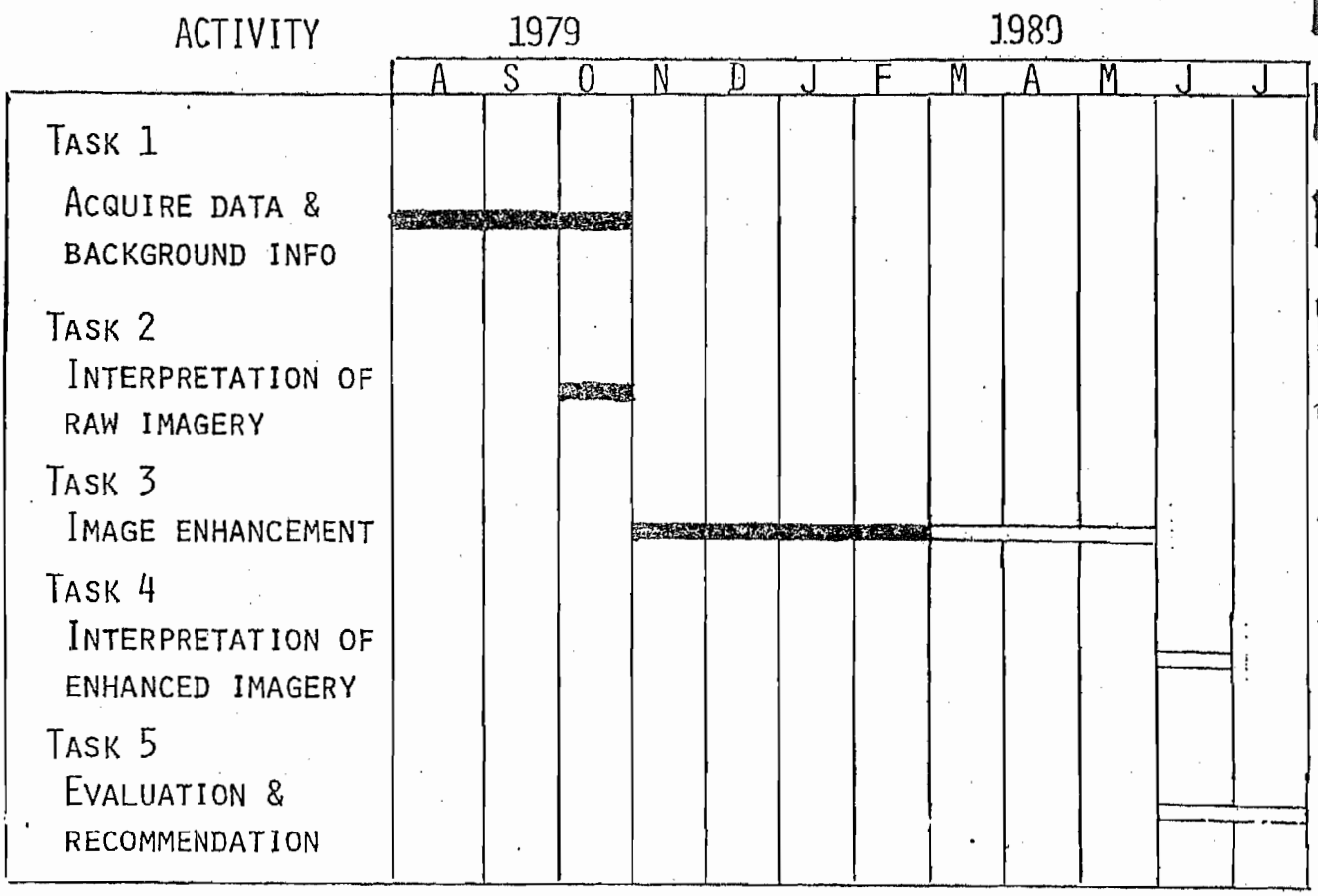
  - RAW REMOTE SENSING IMAGERY AND DATA ACQUIRED
  - CONSULTANT REPORT ON THE GEOLOGY OF WESTERN KENTUCKY SUBMITTED, COMPLETE WITH TRANSPARENT OVERLAY MAPS AT IMAGERY SCALE
  - RAW IMAGERY INTERPRETED
  - SUB-AREAS FOR INTENSIVE DIGITAL IMAGE ENHANCEMENT SELECTED
  - IMAGE ENHANCEMENT R&D IN PROGRESS

- CRITICAL ITEMS

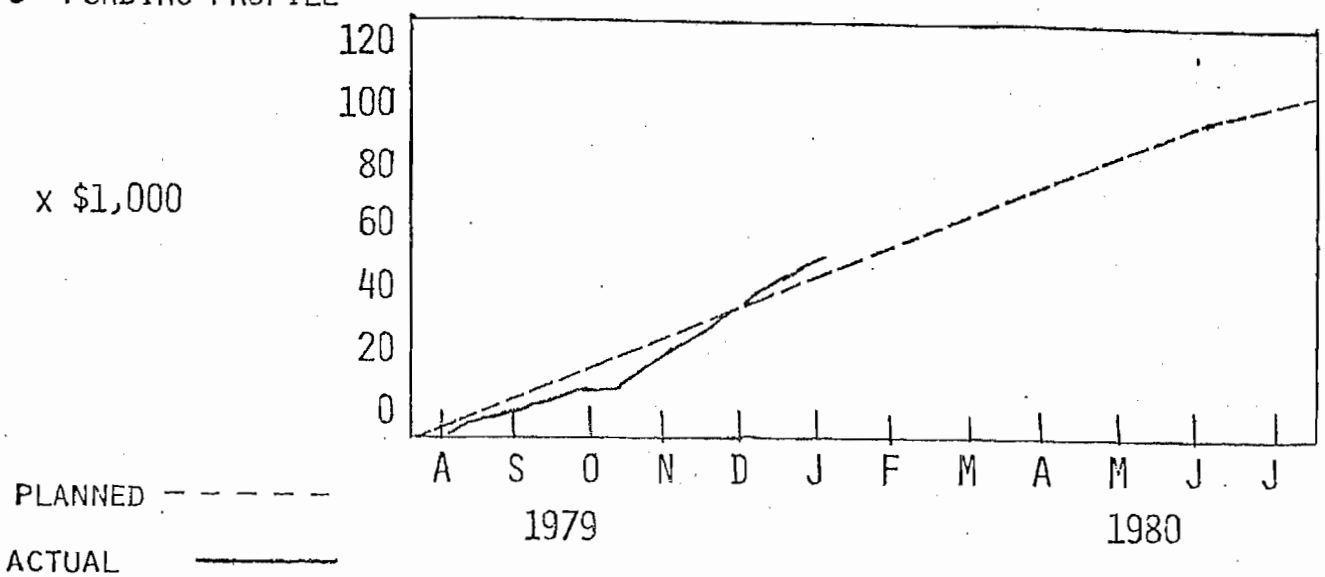
  - SOP FOR IMAGE INTERPRETERS

They are going to write a well on the basis of this work.

- TIME TASK CHART - MAJOR ACTIVITIES



- FUNDING PROFILE



- CONTRACT: WEST VIRGINIA UNIVERSITY
  DE-AC21-76-MC05194 (MOD) DE WYS
- CONTRACT DATE: APRIL 1, 1980
- ANTICIPATED COMPLETION DATE: MARCH 31, 1982
- TOTAL COST: $159,869 - FIRST YEAR
  $172,727 - SECOND YEAR (TENTATIVE)
- DOE COST: AS ABOVE
- OBJECTIVE: TO DEVELOP A PROMISING EXPLORATION TECHNIQUE FOR GAS FROM THE DEVONIAN SHALES THAT DEPENDS ON INTENSIVE LITHOLOGIC AND GEOCHEMICAL ANALYSIS OF WELL CUTTINGS. THE TECHNIQUE PRESUMES THAT CERTAIN GEOCHEMICAL PARAMETERS AND LITHOLOGIC INDICATORS RELATE TO DEPOSITIONAL ENVIRONMENT AND FRACTURE INTENSITY IN THE SHALES, AND HENCE TO PRODUCTIVITY POTENTIAL

- LOCATION MAP:

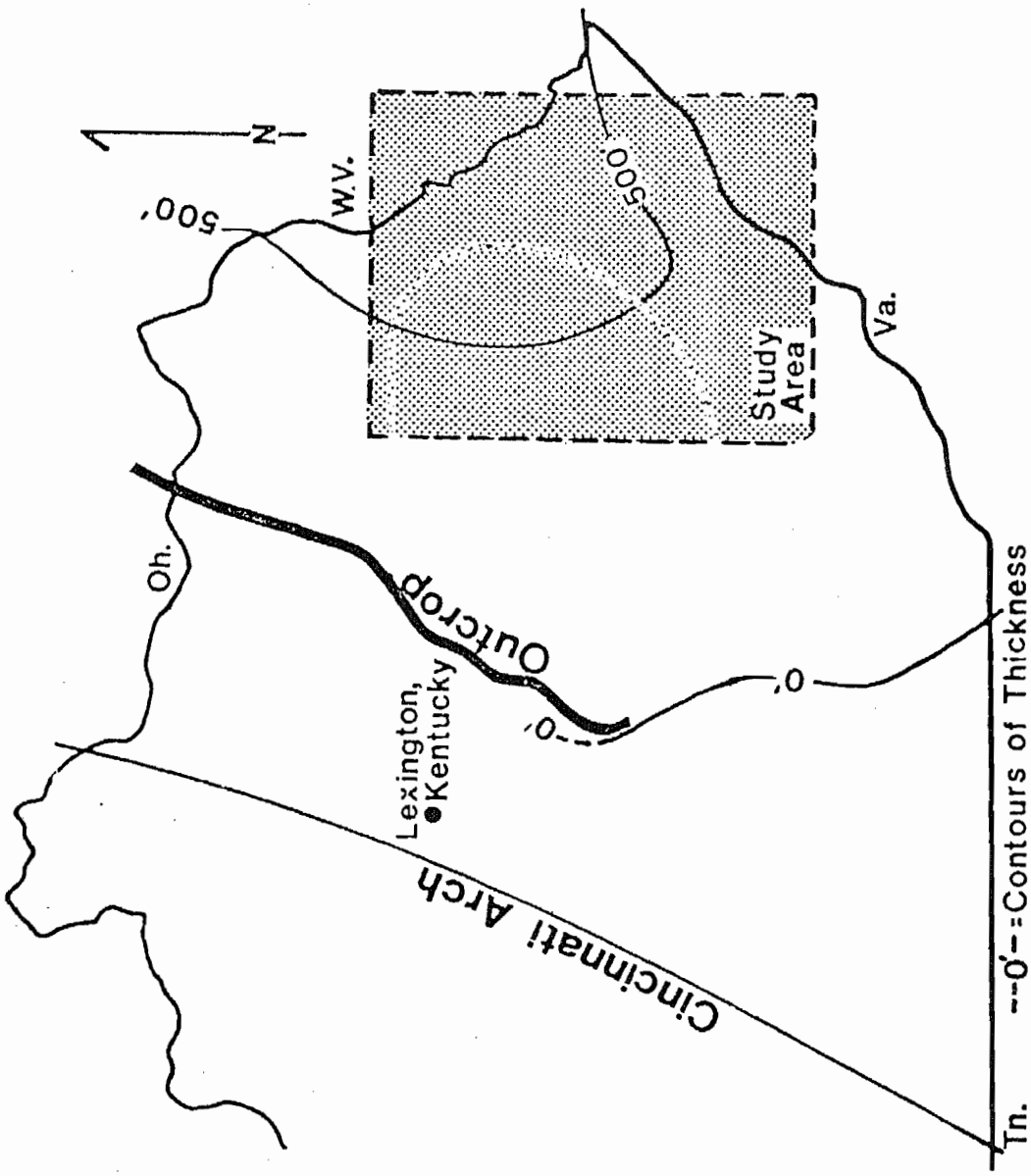
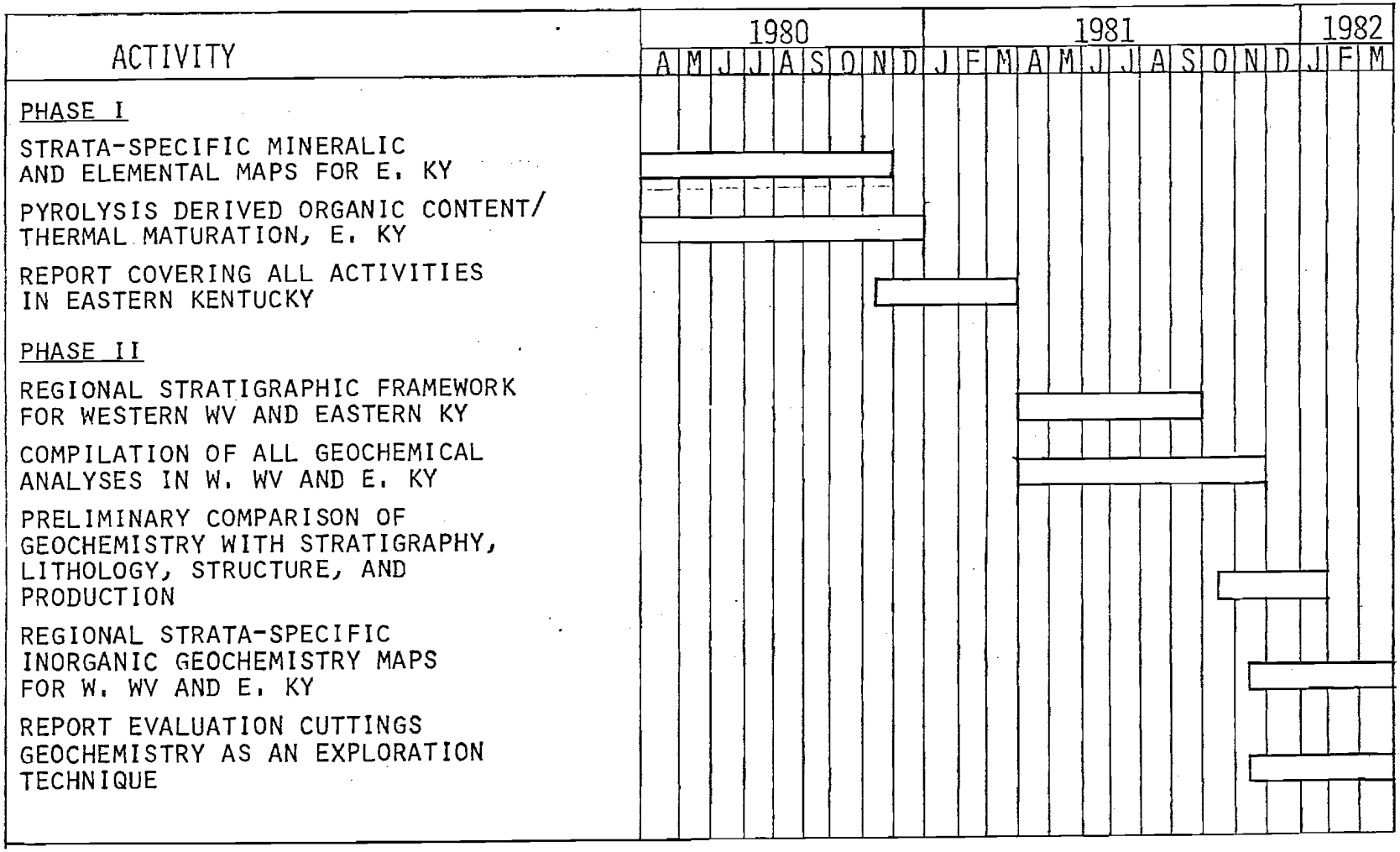


Figure 1. Location of study area
Isopach lines (after Weaver and McGuire, 1973)

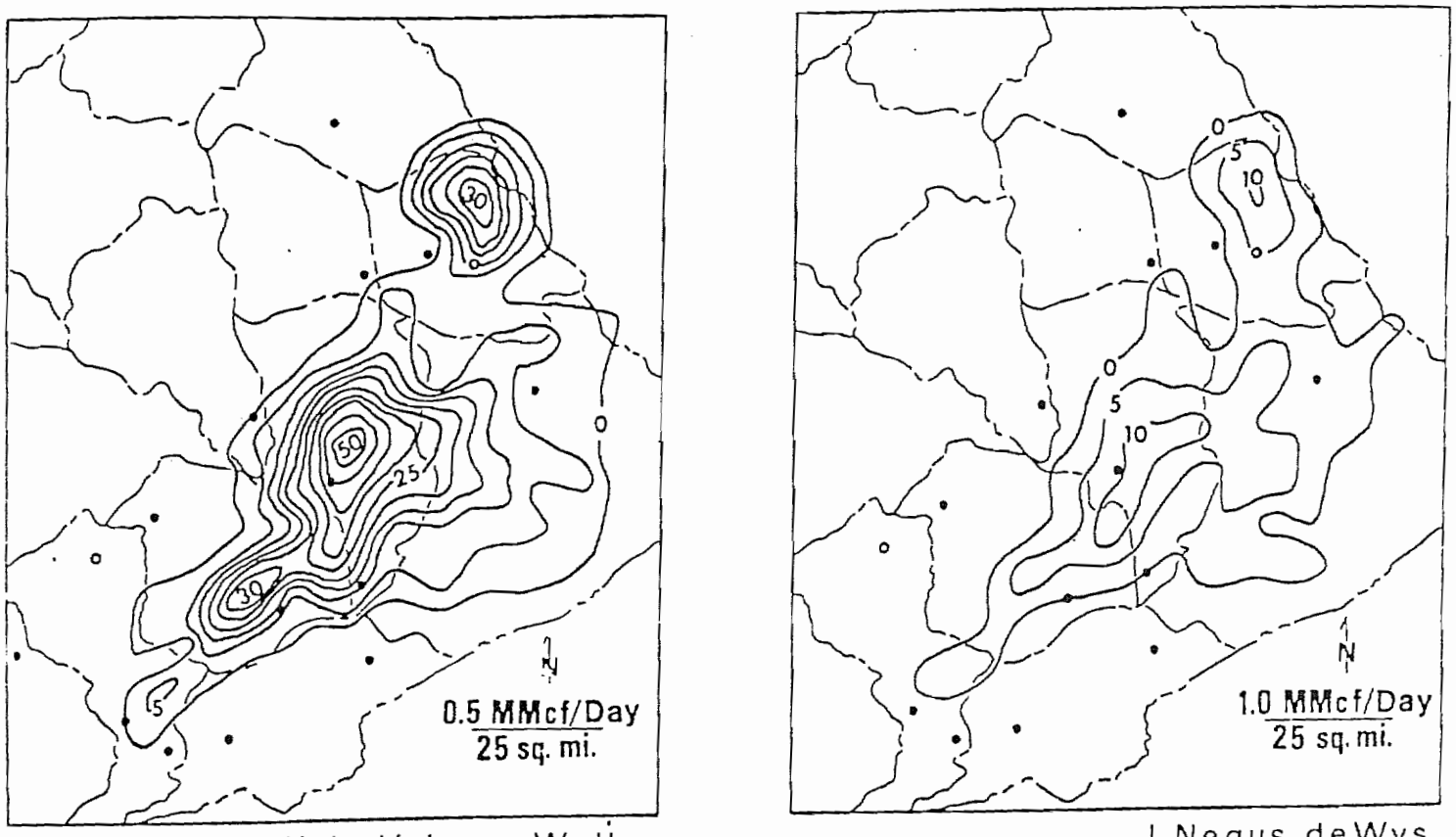
- SUMMARY OF PROGRESS:
  - CONTRACT MODIFICATION IN PROCESS, BUT NOT YET AWARDED. PRELIMINARY WORK WITH PROMISING RESULTS, HOWEVER, HAS PREVIOUSLY BEEN ACCOMPLISHED IN CONJUNCTION WITH OTHER WORK UNDER CONTRACT NO. 5194:
  - SAMPLE SUITES OF CABLE TOOL WELL CUTTINGS WERE OBTAINED FROM TEN COUNTIES COVERED BY THE DEVONIAN SHALE BIG SANDY GAS FIELD IN EASTERN KENTUCKY
  - LITHOTYPES WERE IDENTIFIED AND FRACTURE INDICATORS NOTED FROM OBSERVATION UNDER A BINOCULAR MICROSCOPE. X-RAY DIFFRACTION AND X-RAY FLUORESCENCE WERE USED TO ANALYZE THE CUTTINGS FOR 14 MINERALS AND 16 ELEMENTS
  - FRACTURE INDICATOR ANOMALIES DIRECTLY CORRESPOND IN A GENERAL WAY WITH PRODUCTION ANOMALIES
  - SEVERAL ELEMENTAL AND ELEMENTAL RATIO ANOMALIES DISPLAY STRIKING CONCORDANCE WITH PRODUCTION ANOMALIES. PRELIMINARY STRATA-SPECIFIC CORRELATIONS SUGGEST THAT THIS IS MOST TRUE OF THE LOWER HURON SHALE, THE HIGHEST-PRODUCING AND MOST INTENSELY FRACTURED, INTERVAL IN THE BIG SANDY FIELD.

- CRITICAL ITEMS: - AWARD CONTRACT MODIFICATION

TIME TASK CHART



WVU 5194



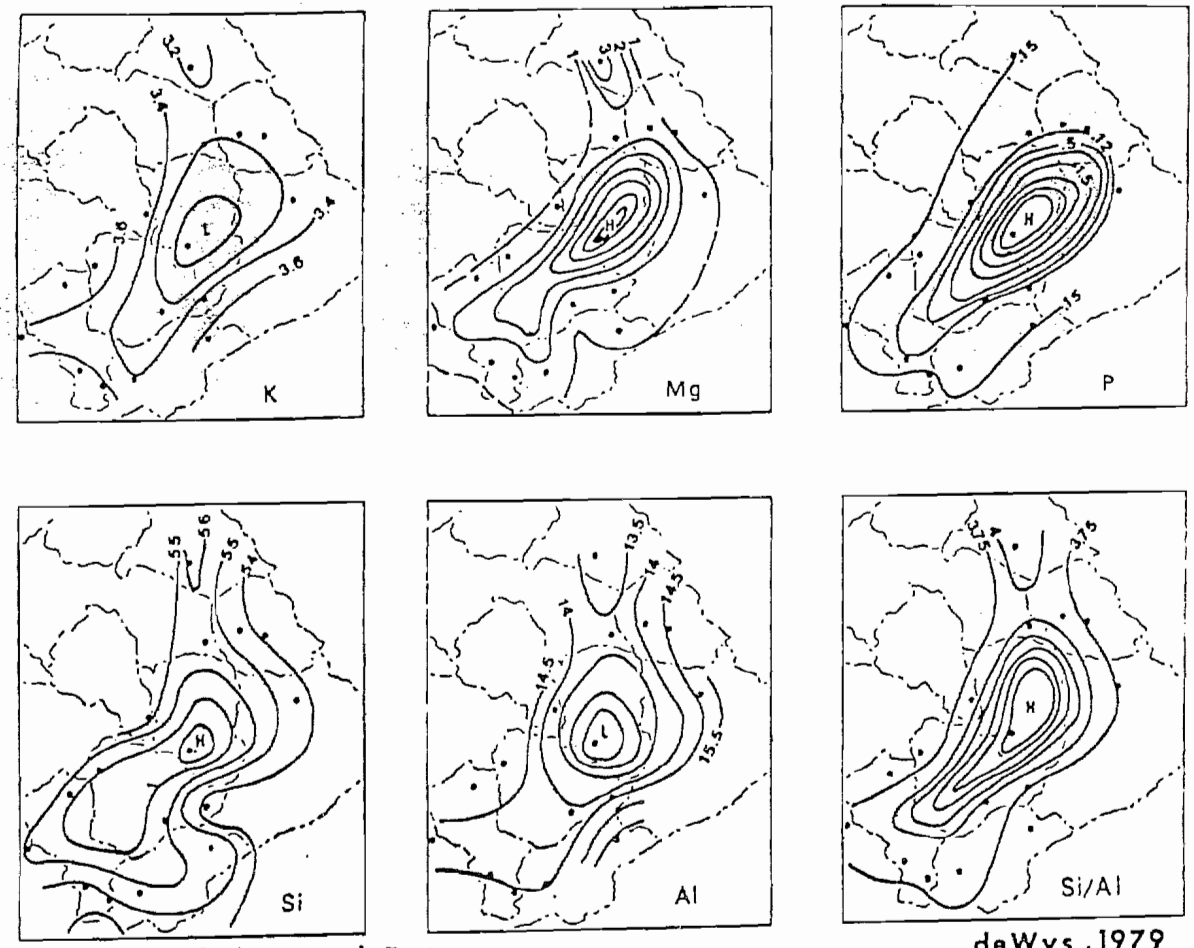
Contours of High Volume Wells
Based on ~4750 Wells
(after Griffith, 1976)

J. Negus deWys
March, 1979

Figure 80.

Contours of density of high producing wells (after Griffith, 1976). Contours represent number of wells ≥ .5 MMcf/day/25 square miles (left) and ≥ 1 MMcf/day/25 square miles (right). These figures may be interpreted as the area of gas accumulation with recovery details smoothed out. Note pattern irregularities suggesting linear peripheral extensions. Compare with Figures 77a and 77b.

WVU 5194 MOD



Contours of Elemental Data

deWys, 1979

Figure 102. Hand-contoured maps of elemental data representing averages of values for the entire shale sequence. These are some of the maps which showed similarity to the contours of density of high producing wells.

- CONTRACT: WEST VIRGINIA UNIVERSITY (WHEELER)
  EY-77-C-21-8087, TASK ORDER 25

- CONTRACT DATE: MAY 16, 1978

- ANTICIPATED COMPLETION DATE: DECEMBER 15, 1978

- TOTAL COST: $27,950

- DOE COST: AS ABOVE

- OBJECTIVE:
  - TO DEVELOP A MEANS OF PREDICTING FRACTURE INTENSITY IN ROCKS RELATIVE TO MAJOR GEOLOGIC STRUCTURES
  - TO DETERMINE WHETHER OR NOT ROCKS WITHIN CROSS-STRIKE STRUCTURAL DISCONTINUITIES (CSD'S) ARE MORE HIGHLY FRACTURED THAN ELSEWHERE IN THE DETACHED APPALACHIAN FORELAND
  - TO GENERATE AN EXPLORATION RATIONALE FOR THE DEVONIAN SHALES UNDERLYING THE EASTERN APPALACHIAN PLATEAU AND IDENTIFY PROMISING AREAS FOR EGSP EXPLORATORY DRILLING

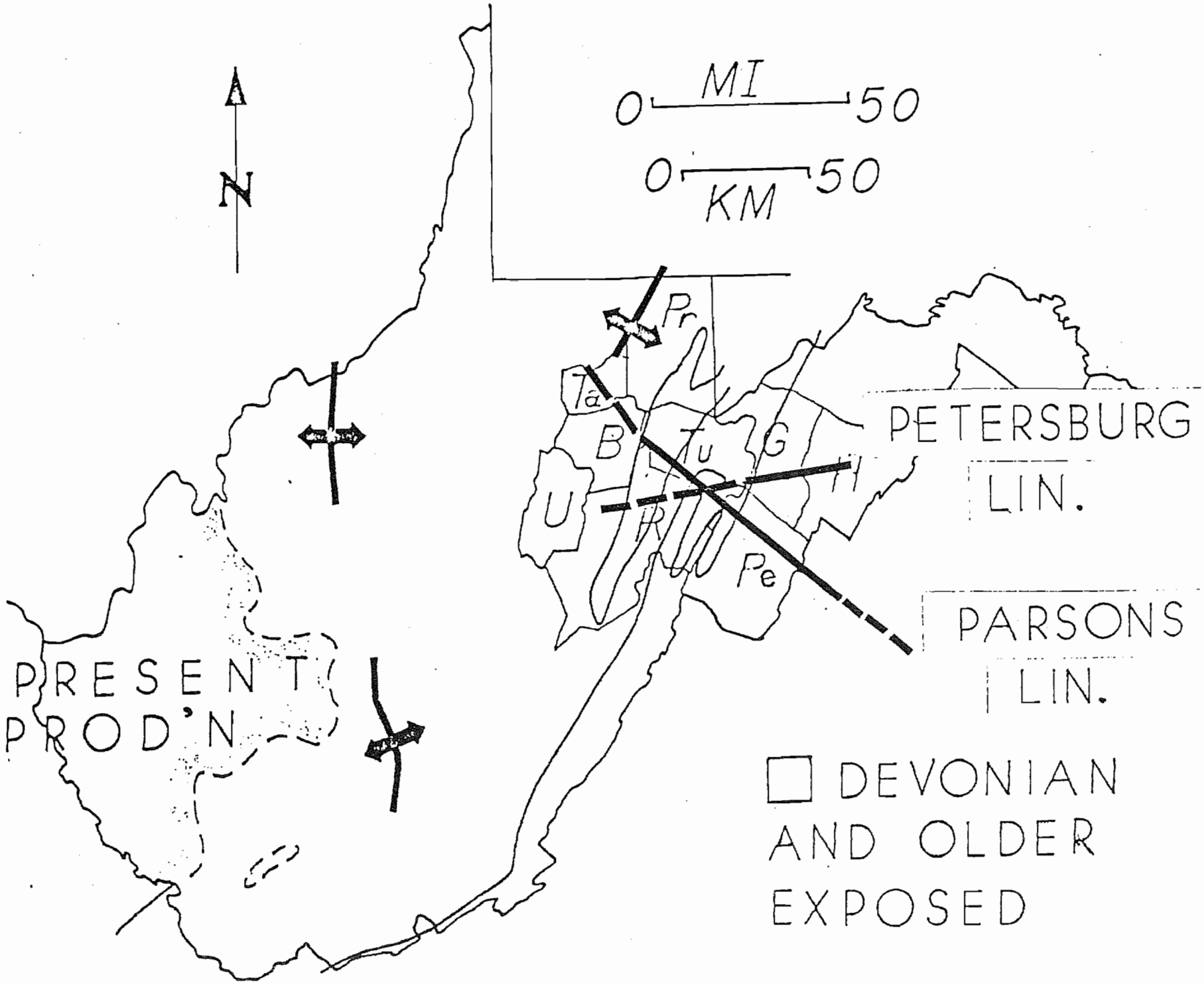
- MAJOR ACCOMPLISHMENTS:

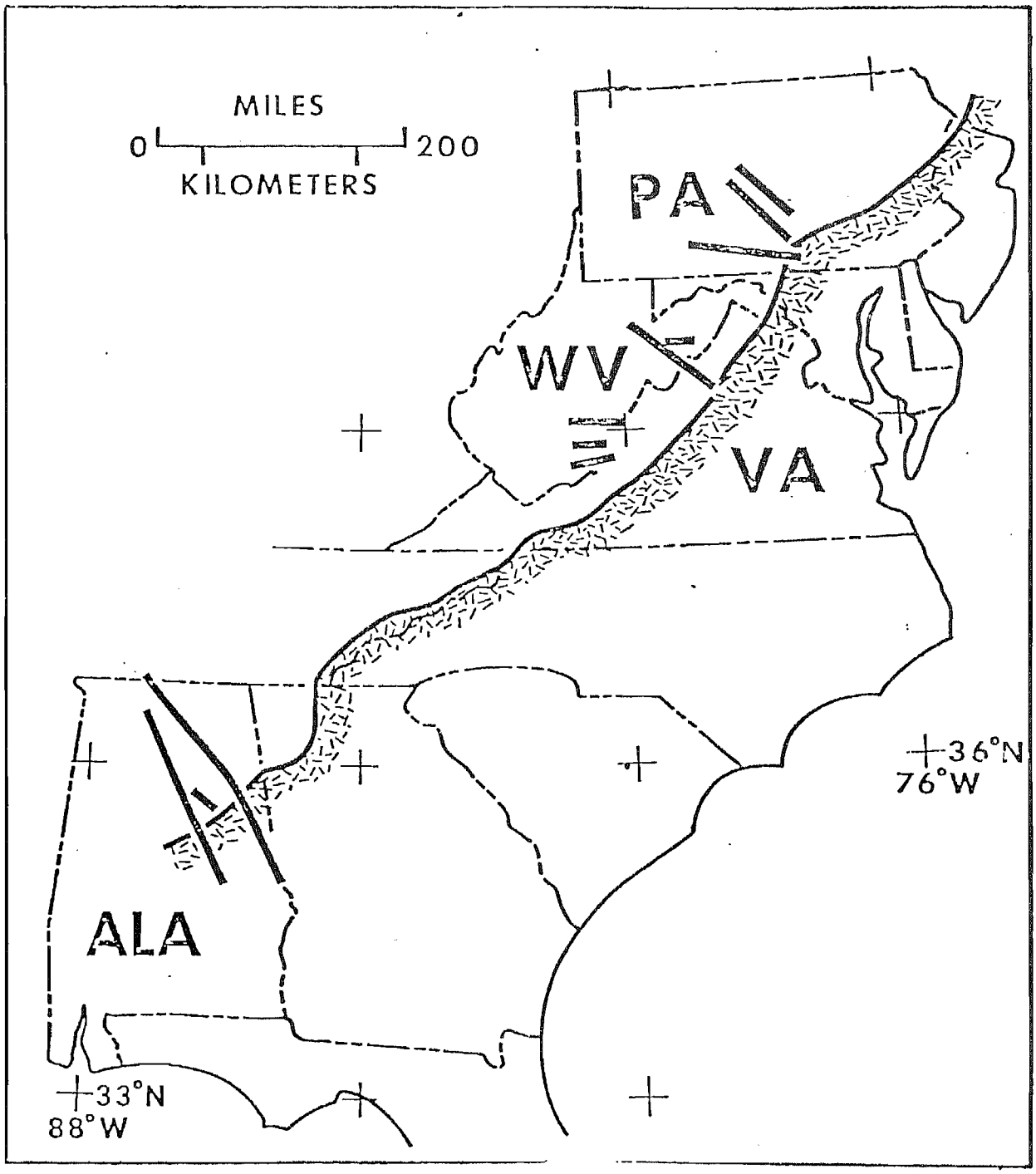
  - A STATISTICALLY VERIFIED ESTIMATOR OF SUBSURFACE FRACTURE INTENSITY USING A FRACTURE PARAMETER EASILY MEASURED IN THE FIELD HAS BEEN DERIVED. FRACTURE INTENSITY RELATIVE TO MAJOR SUBSURFACE STRUCTURES CAN BE PREDICTED BY ANALOGY WITH SIMILAR STRUCTURES WHERE EXPOSED.

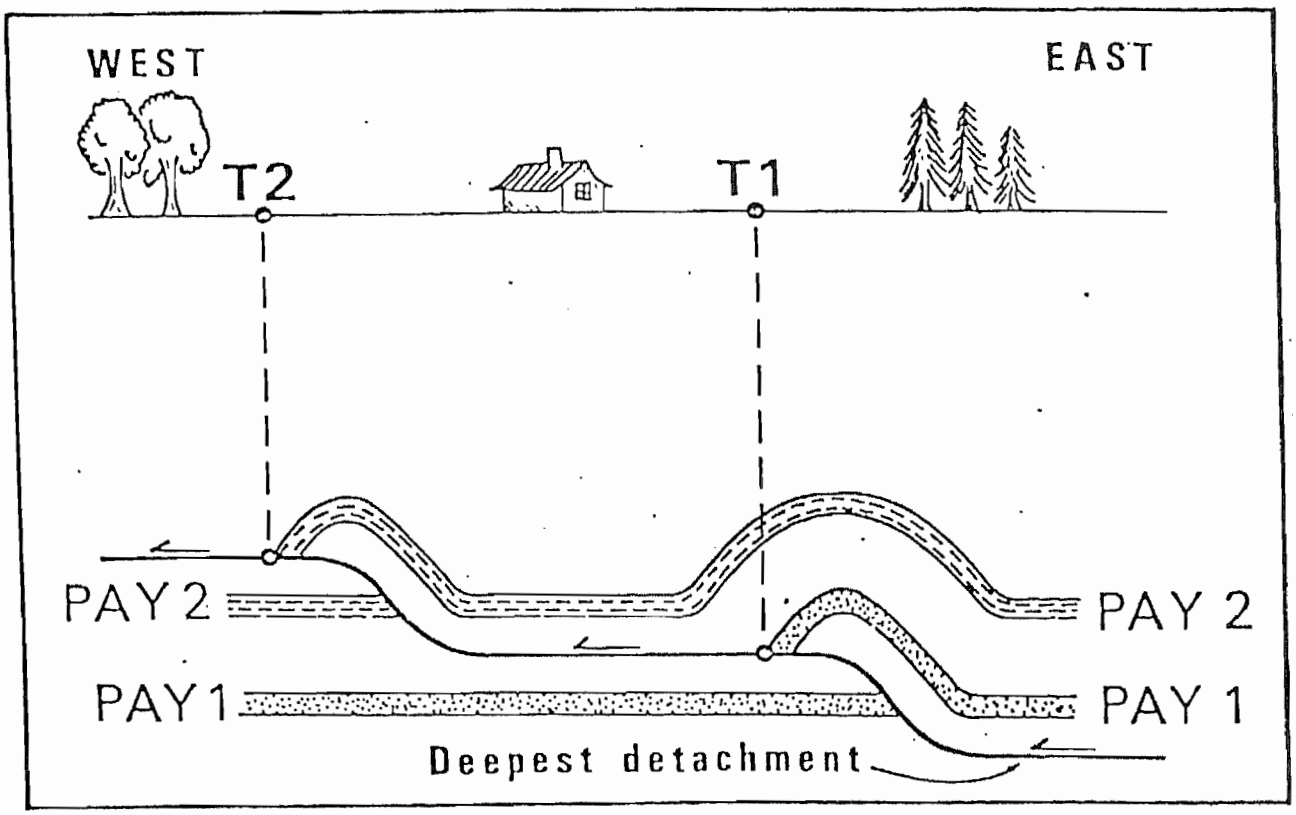
  - FRACTURE INTENSITY WITHIN CROSS-STRIKE STRUCTURAL DISCONTINUITIES (CSD's), WHERE EXPOSED, WAS DETERMINED TO BE UP TO TWICE AS GREAT AS WITHOUT. CSD's ARE SUBSTANTIAL EXPLORATION TARGETS:

WIDTH: 2 MI LENGTH: 50 MI DEPTH: 2-1/2 MI	VOLUME: 250 CU MI (CSD's CONSTITUTE PERHAPS 15% OF THE DETACHED APPALACHIAN FORELAND)

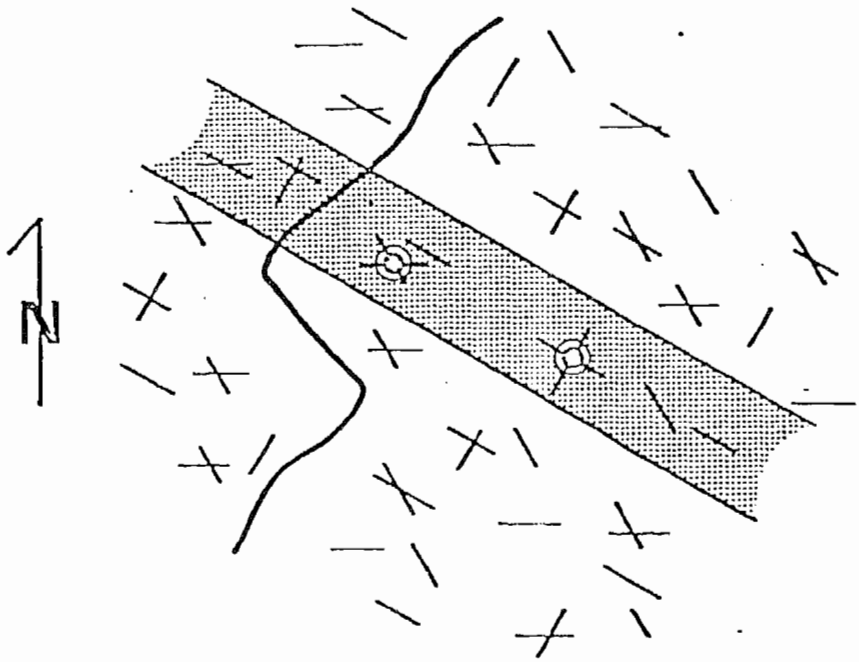
  - STRATEGY FOR EXPLOITING THE DEVONIAN SHALE GAS PRODUCING POTENTIAL OF CSD's SET FORTH AND EXPLAINED.


N
0 MI 50
0 KM 50
Pr
Ta
B
Tu
G
U
R
Pe
PETERSBURG LIN.
PARSONS LIN.
PRESENT PROD'N
DEVONIAN AND OLDER EXPOSED


MILES
0
200
KILOMETERS
PA
WV
VA
ALA
36°N
76°W
33°N
88°W


WEST
EAST
T2
T1
PAY 2
PAY 2
PAY 1
PAY 1
Deepest detachment

Exploration Strategy (Schematic)

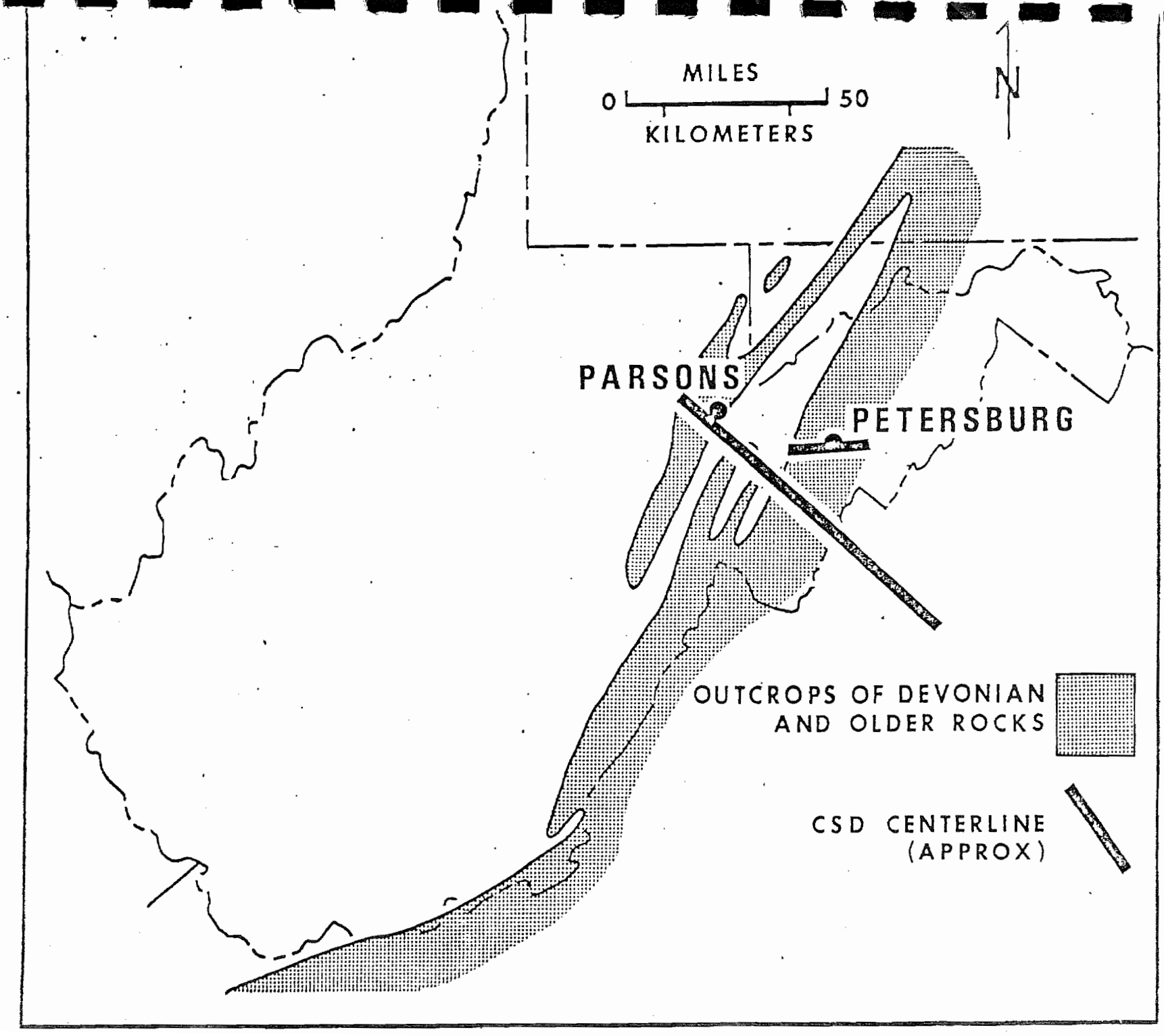


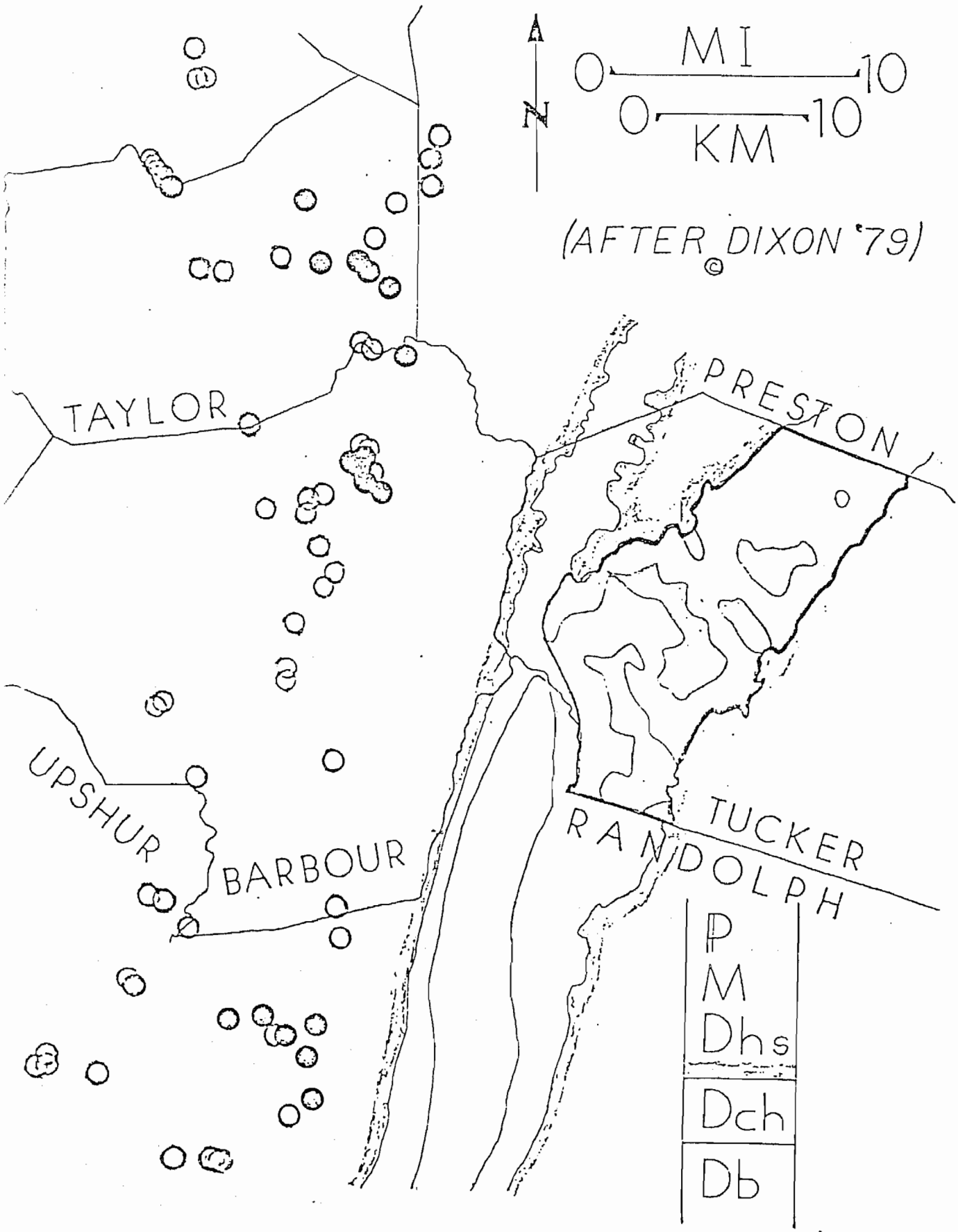
Trace of T2 across ground surface

Short photolineament

Recommended well site

CSD


MILES
0
50
KILOMETERS
N
PARSONS
PETERSBURG
OUTCROPS OF DEVONIAN
AND OLDER ROCKS
CSD CENTERLINE
(APPROX)


N
0 MI 10
0 KM 10
(AFTER DIXON '79)
TAYLOR
PRESTON
UPSHUR
BARBOUR
TUCKER
RANDOLPH
P
M
Dhs
Dch
Db

- CONTRACT: TENNESSEE DIVISION OF GEOLOGY
  DE-AC21-76MC05196

- CONTRACT DATE: JULY 1, 1976

- ANTICIPATED COMPLETION DATE: DECEMBER 31, 1979

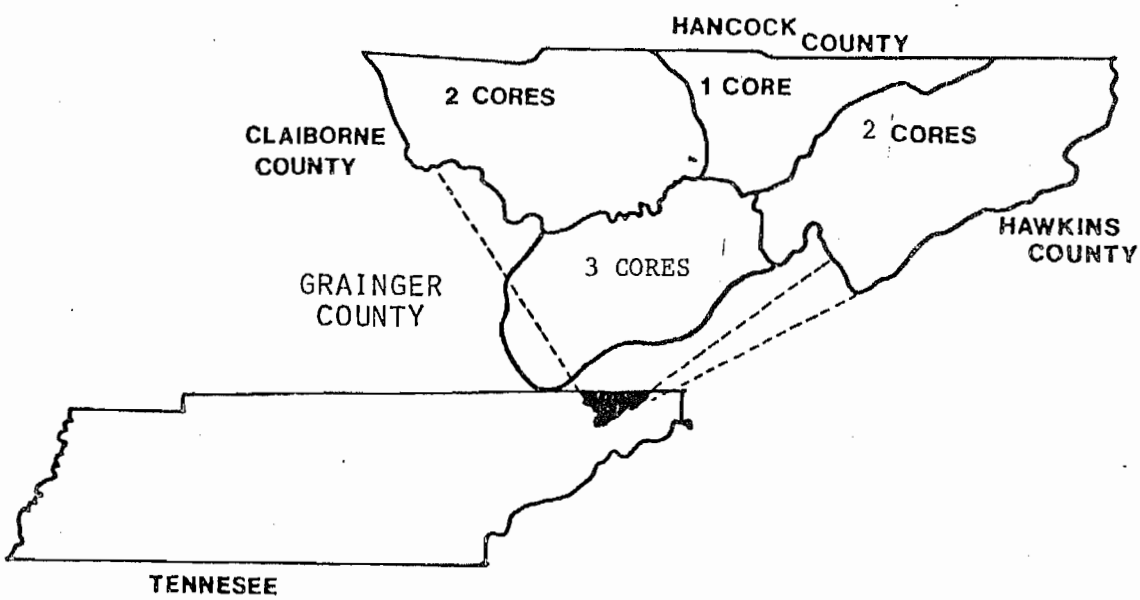
- TOTAL COST: $296,100 - (BUDGETED)

- DOE COST: $290,700 - (BUDGETED)

  $272,600 - (ACTUAL)

- OBJECTIVE: TO DEFINE THE BLACK SHALE GAS RESOURCE WITHIN THE DEVONIAN-MISSISSIPPIAN CHATTANOOGA SHALE OF THE EASTERN TENNESSEE VALLEY AND RIDGE PROVINCE, BOTH THE VOLUMETRIC PROPORTION OF BLACK SHALE RELATIVE TO THE ENTIRE FORMATION AND THE SUBSURFACE EXTENT OF POTENTIALLY HIGHLY FRACTURED SHALE BENEATH THE MAJOR OVERTHRUSTS

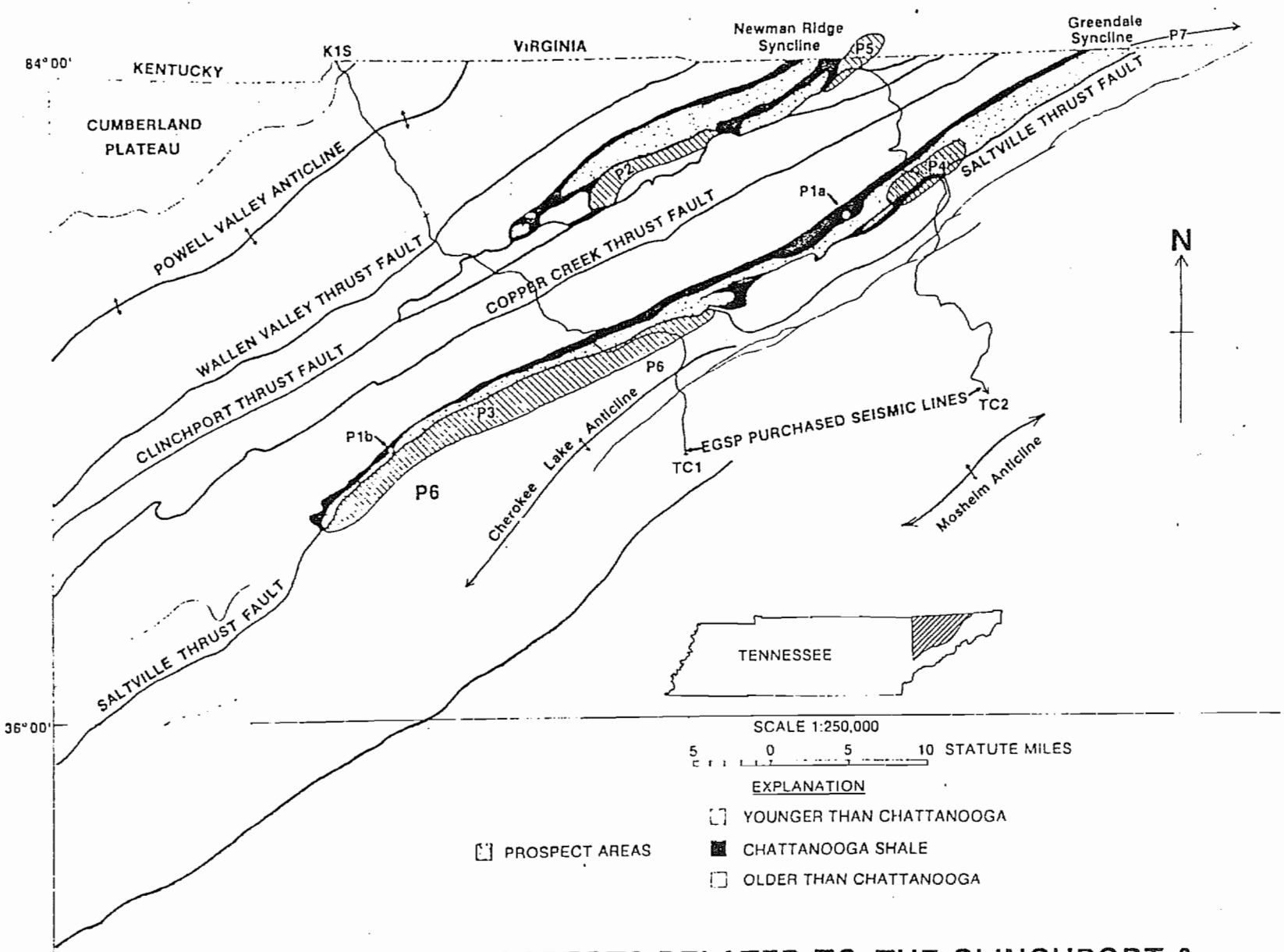
- LOCATION MAP:



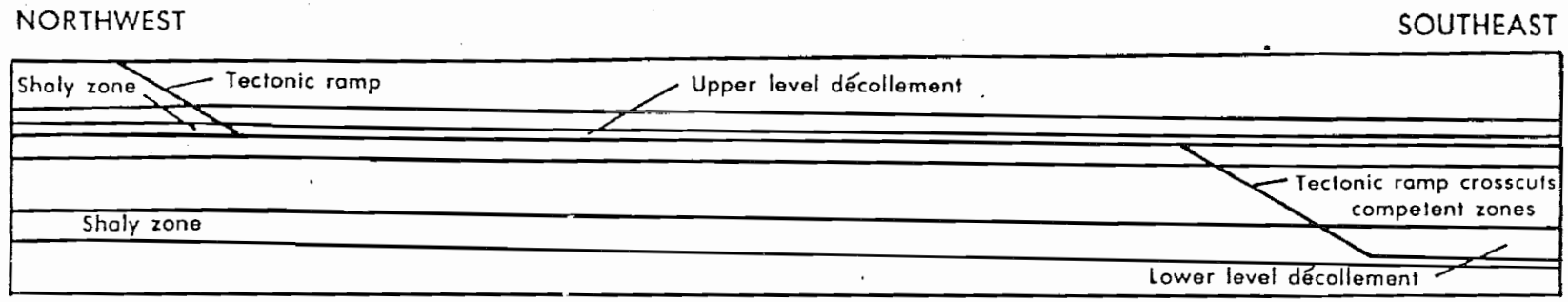
- MAJOR ACCOMPLISHMENTS:
  - EIGHT NX CORE HOLES HAVE BEEN DRILLED ALONG THE TWO MAJOR CHATTANOOGA SHALE OUTCROP BELTS IN EASTERN TENNESSEE IN ORDER TO DEFINE THE INTERNAL STRATIGRAPHY OF THE CHATTANOOGA SHALE.
  - WIRELINE LOGGING OF NX CORE HOLES AND LITHOLOGIC DESCRIPTION OF CORES, COMPLETE. MAJOR ORGANIC RICH AND ORGANIC LEAN UNITS WITHIN THE CHATTANOOGA SHALE HAVE BEEN IDENTIFIED AND STRATIGRAPHICALLY CORRELATED.
  - TWO CROSS-STRIKE VEIBROSEIS SEISMIC SURVEYS HAVE BEEN CONDUCTED BY GEOPHYSICAL SUBCONTRACTOR (GSI) IN ORDER TO DETERMINE THE SUBSURFACE EXTENT OF THE CHATTANOOGA SHALE BENEATH THE HUNTER VALLEY, CLINCHPORT, AND SALTVILLE THRUST FAULTS. PARTIALLY SUCCESSFUL.
  - SEISMIC DATA, PROCESSED AND INTERPRETED BY GEOPHYSICAL SUBCONTRACTOR (GSI). A MORE SOPHISTICATED REINTERPRETATION OF THE SEISMIC SECTIONS HAS BEEN RENDERED BY THE CONTRACTOR (TDG) IN ORDER TO BETTER REFLECT THEIR UNDERSTANDING OF THE GEOLOGY OF THE REGION.

- FINAL REPORT AUTHORED BY THE PRINCIPAL INVESTIGATOR SUMMARIZING ALL RESULTS AND CONCLUSIONS IS ESSENTIALLY COMPLETE AND EXPECTED IMMINENTLY

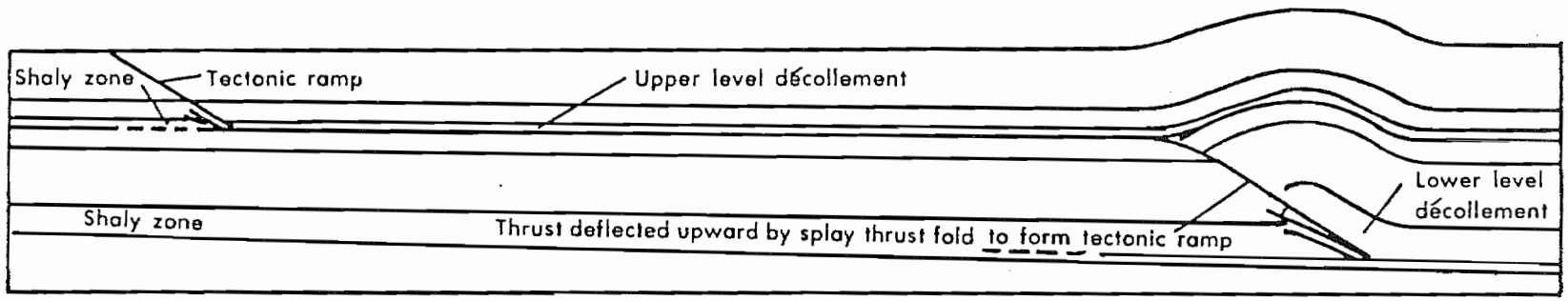
- OUTCOME:
  - DOE-EGSP IDENTIFIED SEVEN DEVONIAN SHALE EXPLORATORY DRILLING PROSPECTS IN EASTERN TENNESSEE BASED ON AN EXPLORATION RATIONALE AND EXPLORATION TECHNIQUES DEVELOPED THROUGH THIS CONTRACT
  - DOE-EGSP DRILLED A WILDCAT WELL IN GRAINGER COUNTY, TN, TO TEST ONE OF THESE PROSPECTS WITH AS YET INCONCLUSIVE, THOUGH POSITIVE-LEANING, RESULTS.



EGSP EXPLORATION PROSPECTS RELATED TO THE CLINCHPORT & SALTVILLE THRUST FAULTS, EASTERN TENNESSEE & SOUTHWESTERN VIRGINIA



A

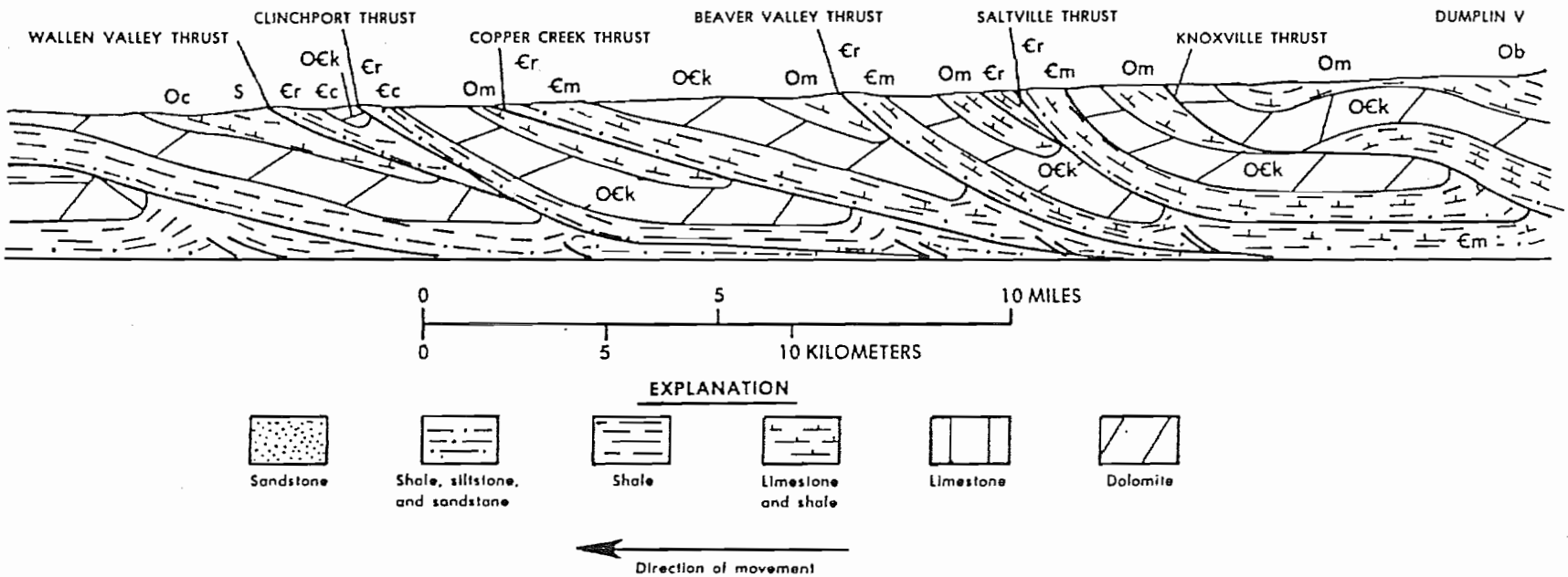


(after Harris & Milici, 1977, fig. 4)

B

Two Stages in the development of a ramping Décollement System

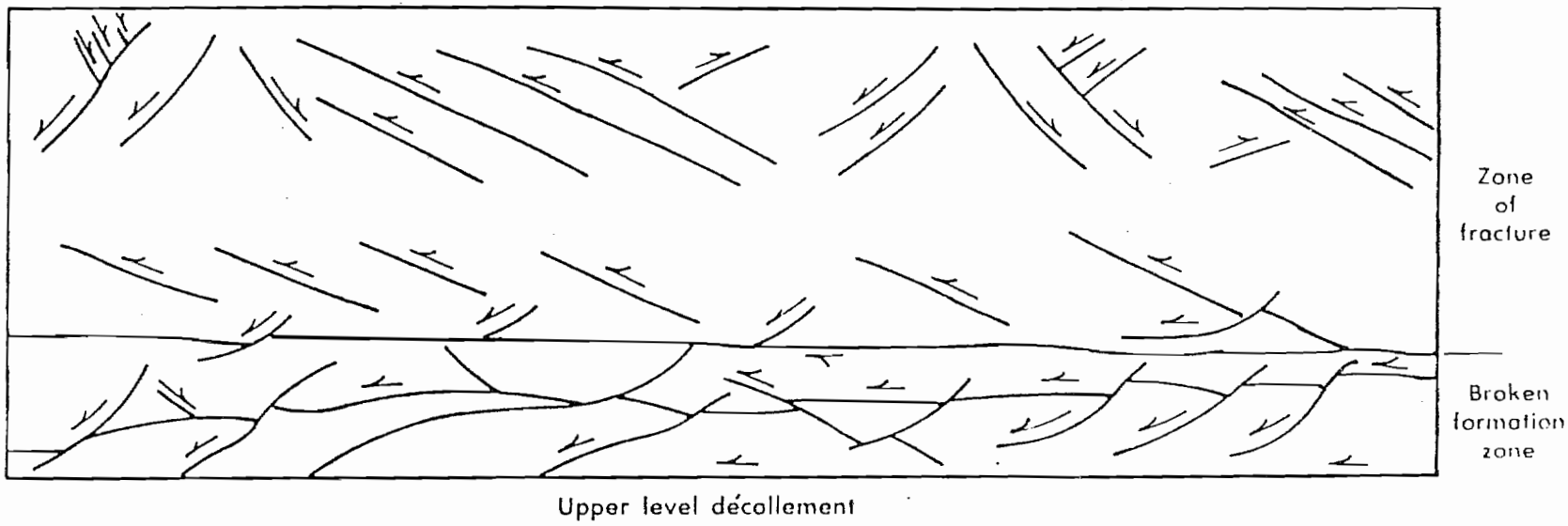
Figure 2



(after Harris & Milici, 1977, pl. 6)

IMBRICATE STRUCTURE of the VALLEY AND RIDGE PROVINCE

Figure 3

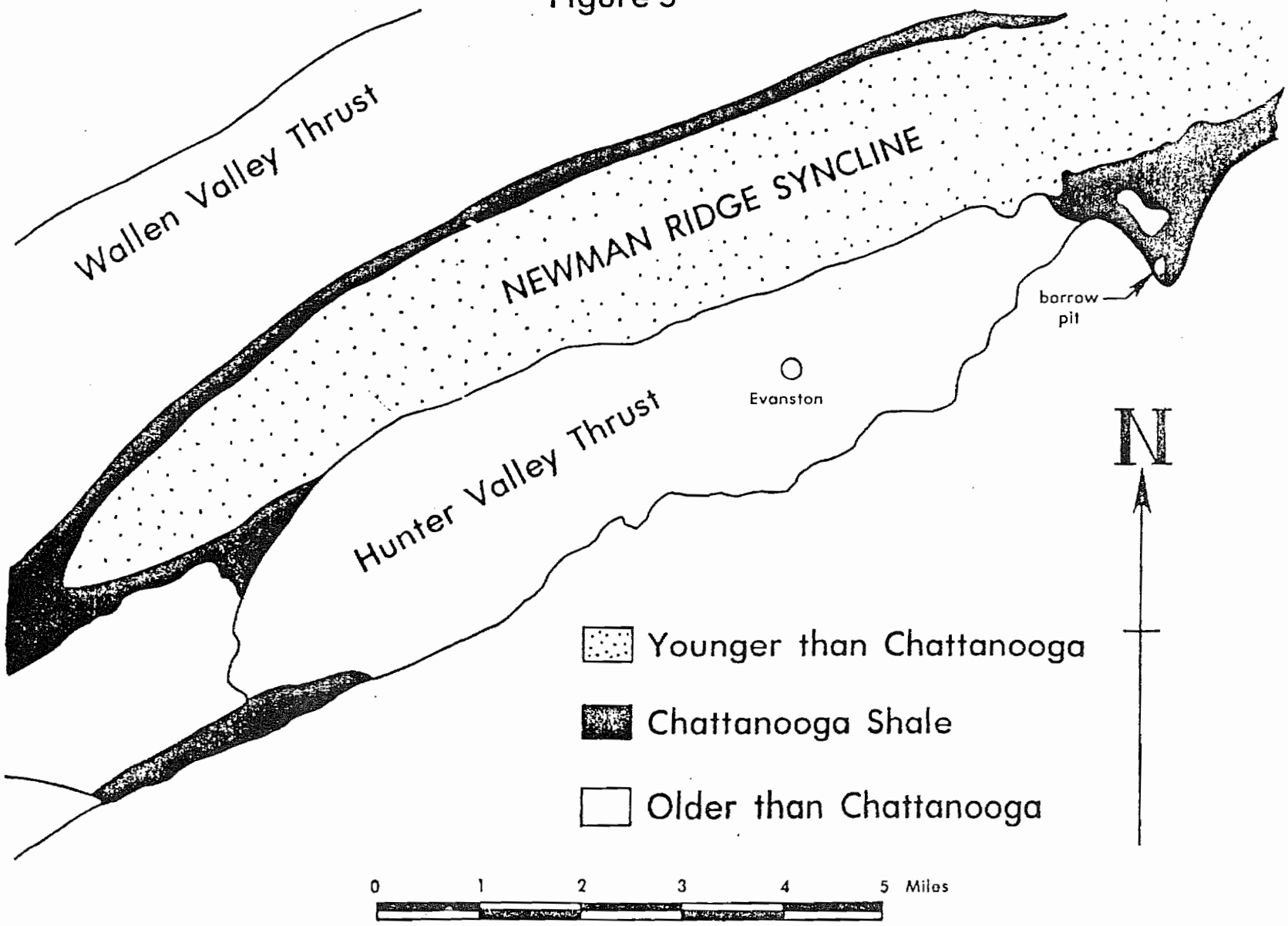


(after Harris & Milici, 1977, pl. 5)

FRACTURING IN ROCKS OVERLYING AN UPPER LEVEL DÉCOLLEMENT

Figure 4

Figure 5



GEOLOGIC MAP OF THE EVANSTON AREA, TENNESSEE

RESOURCE CHARACTERIZATION AND BASIN ASSESSMENT

R. E. ZIELINSKI

MOUND FACILITY

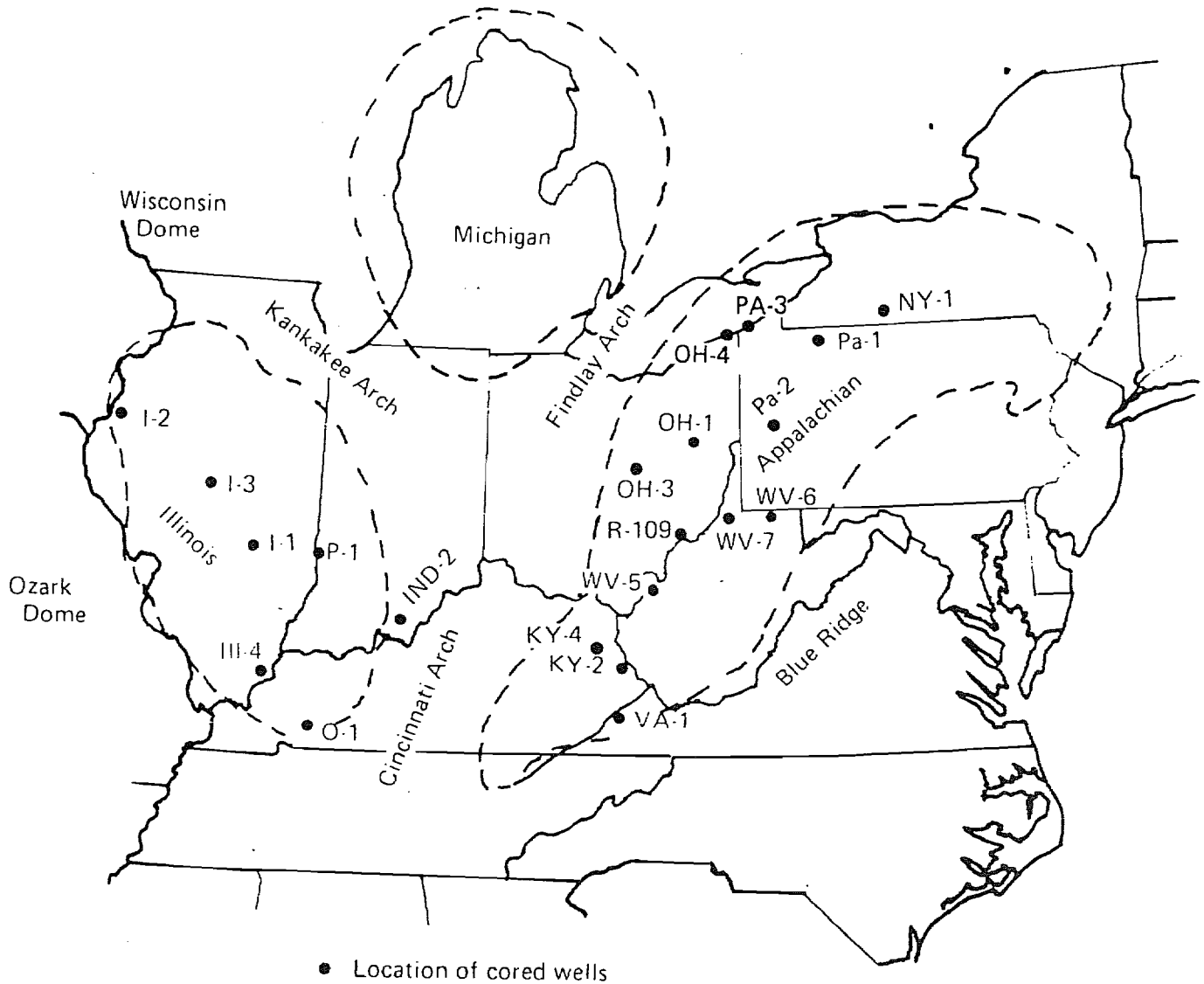
THE OBJECTIVES ARE:

- PHYSICOCHEMICAL CHARACTERIZATION
- IDENTIFICATION OF KEY SOURCE ROCK PARAMETERS
- SELECTION OF HIGH POTENTIAL BASIN REGIONS
- DETERMINATION OF TOTAL AND RECOVERABLE RESERVES

TO DATE, PHYSICOCHEMICAL CHARACTERIZATION RESULTS INCLUDE:

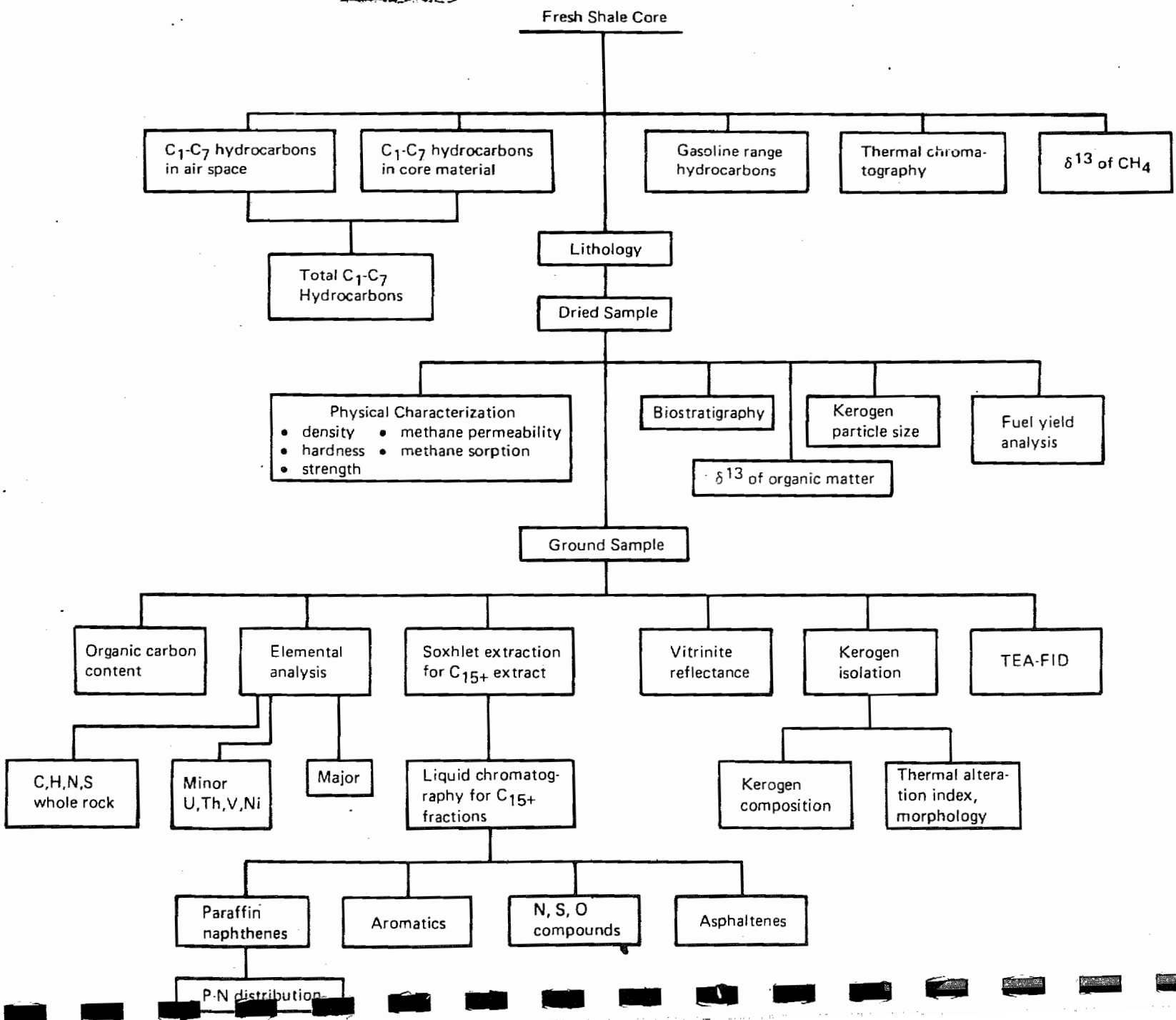
- 22 CORED WELLS
- ∿ 1200 SAMPLES
- ∿ 40 ANALYSES PER SAMPLE

DEVONIAN SHALE SAMPLES HAVE BEEN RECOVERED
FROM ILLINOIS AND APPALACHIAN BASIN WELLS



Distribution of cored wells in the Illinois and Appalachian Basins.

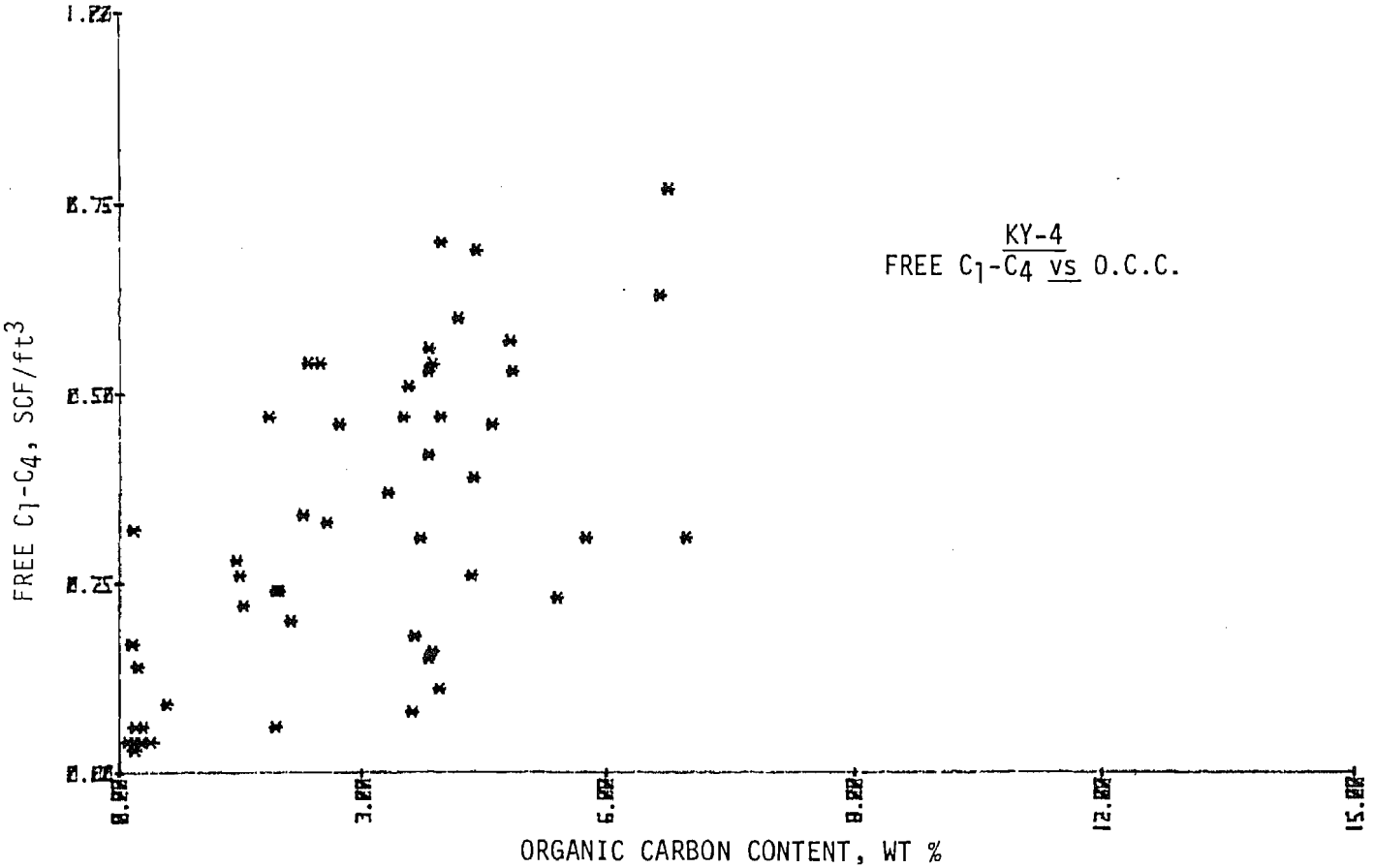
THESE SAMPLES ARE SUBJECTED TO A DETAILED PHYSICOCHEMICAL ANALYSIS



KEY SOURCE ROCK PARAMETERS ARE

- ORGANIC CARBON CONTENT
- THERMAL MATURATION
- DEPOSITIONAL FACIES

GAS CONTENT IS RELATED TO ORGANIC CARBON CONTENT



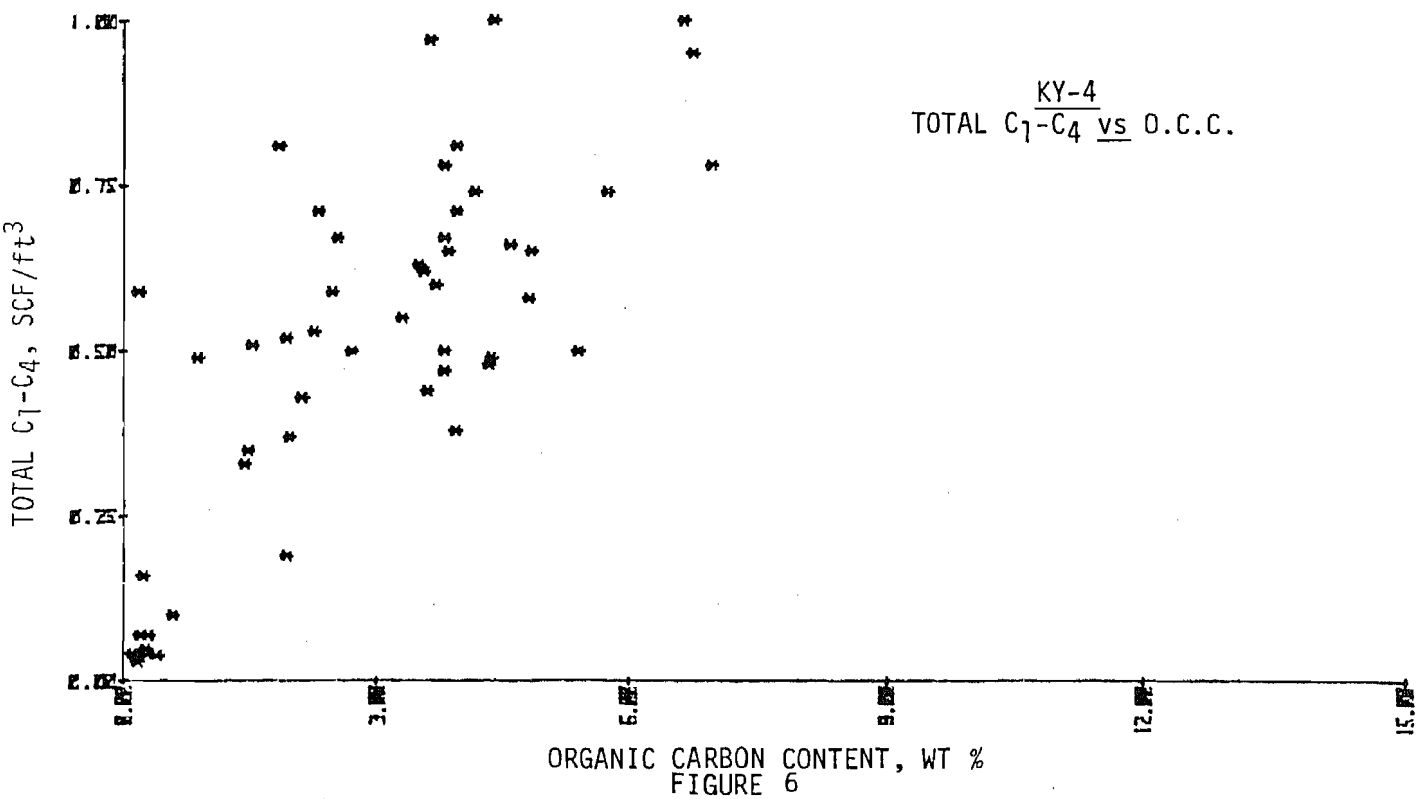
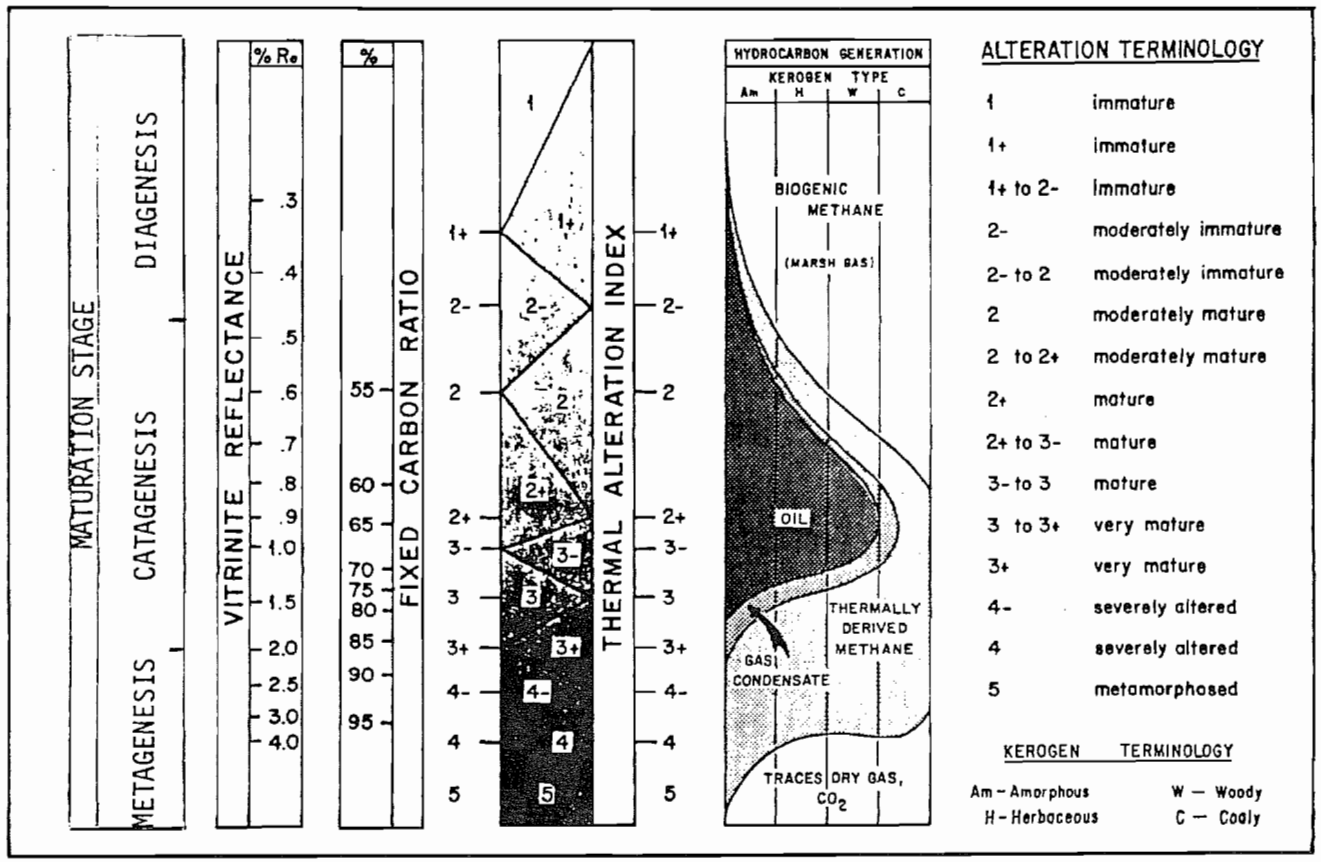


FIGURE 6

The free and total gas content versus organic carbon content for KY-4 samples.

GEOTHERMAL DIAGENETIC CRITERIA



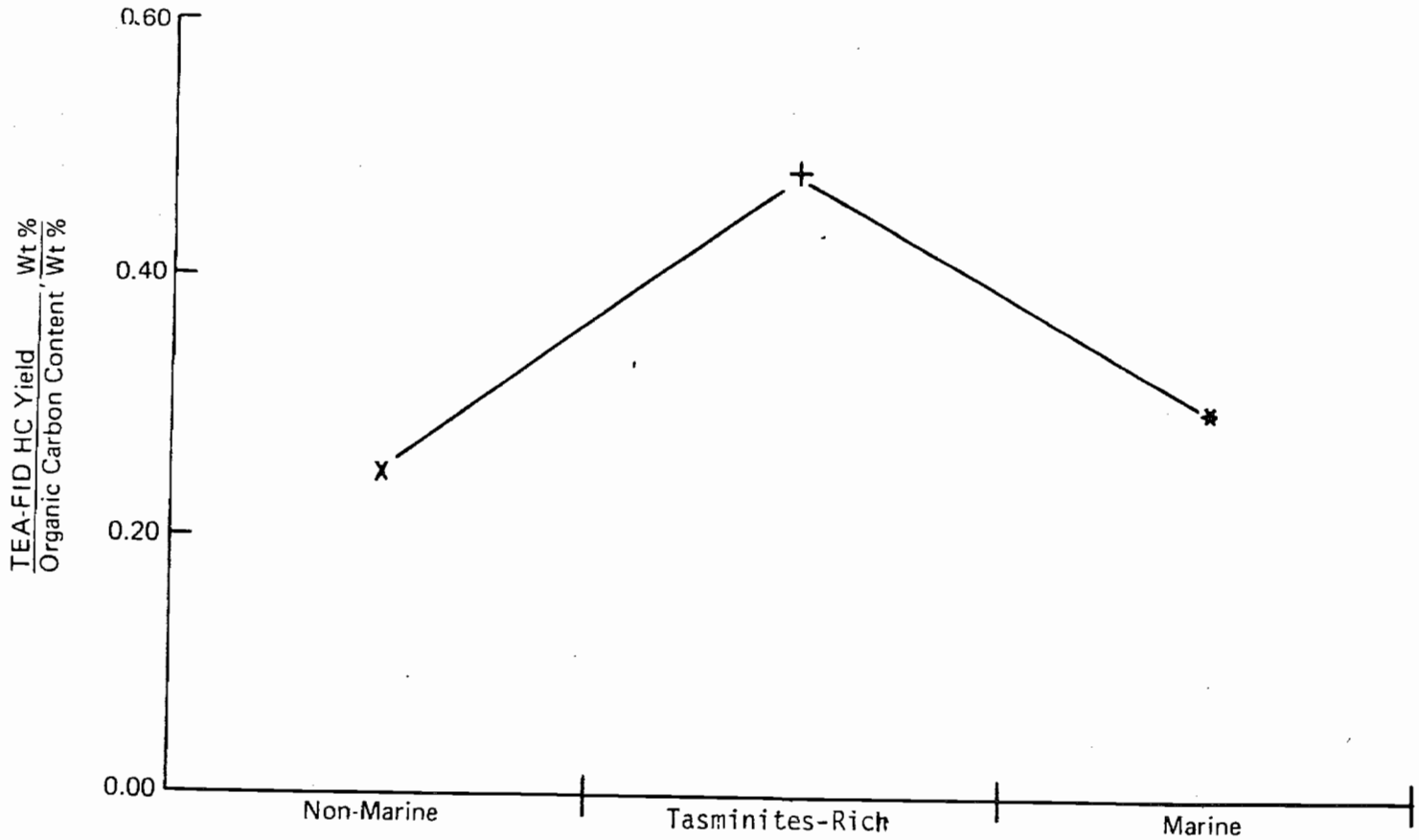
ALTERATION TERMINOLOGY

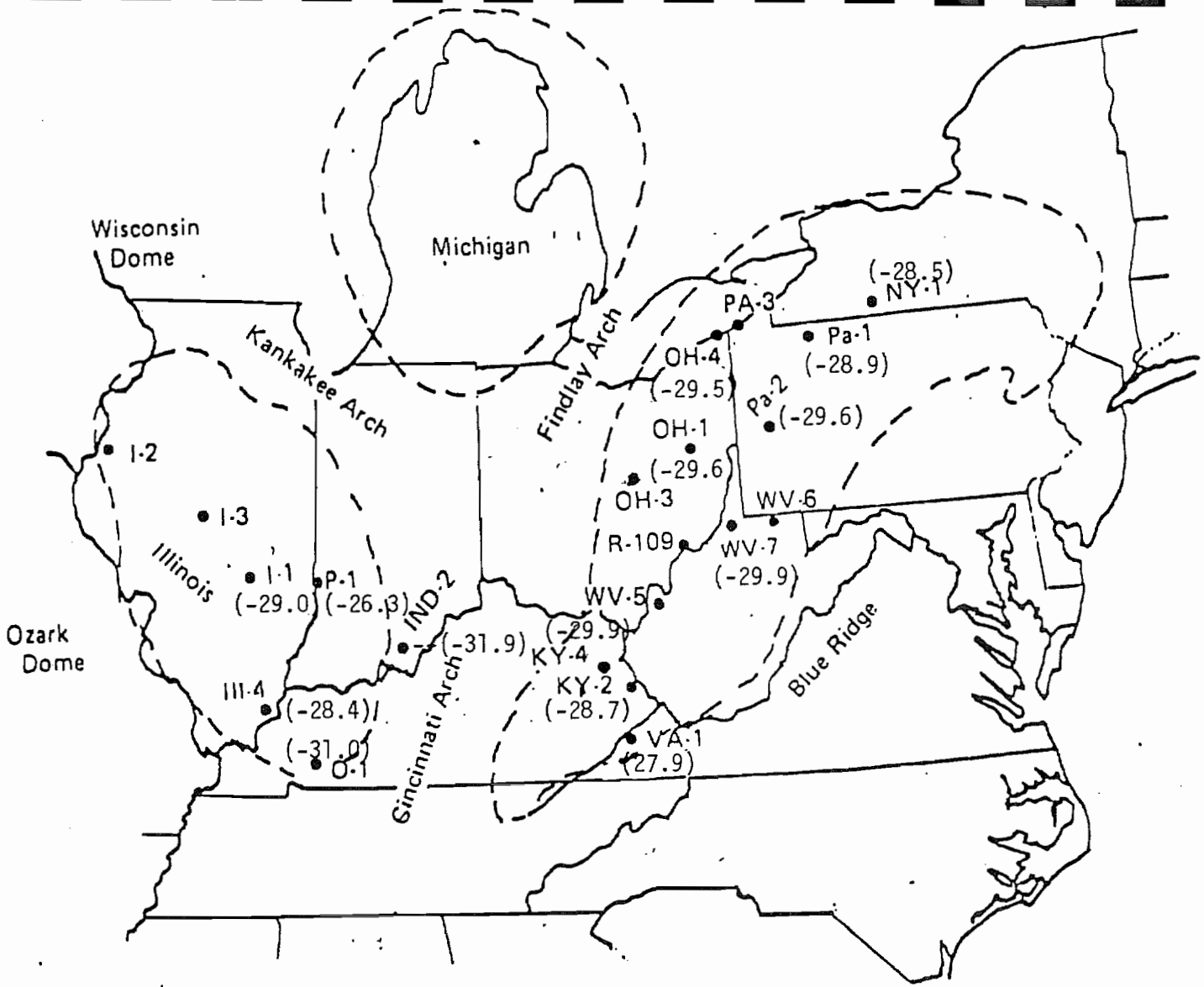
1	immature
1+	immature
1+ to 2-	immature
2-	moderately immature
2- to 2	moderately immature
2	moderately mature
2 to 2+	moderately mature
2+	mature
2+ to 3-	mature
3- to 3	mature
3 to 3+	very mature
3+	very mature
4-	severely altered
4	severely altered
5	metamorphosed

KEROGEN TERMINOLOGY

Am – Amorphous
H – Herbaceous
W – Woody
C – Coaly

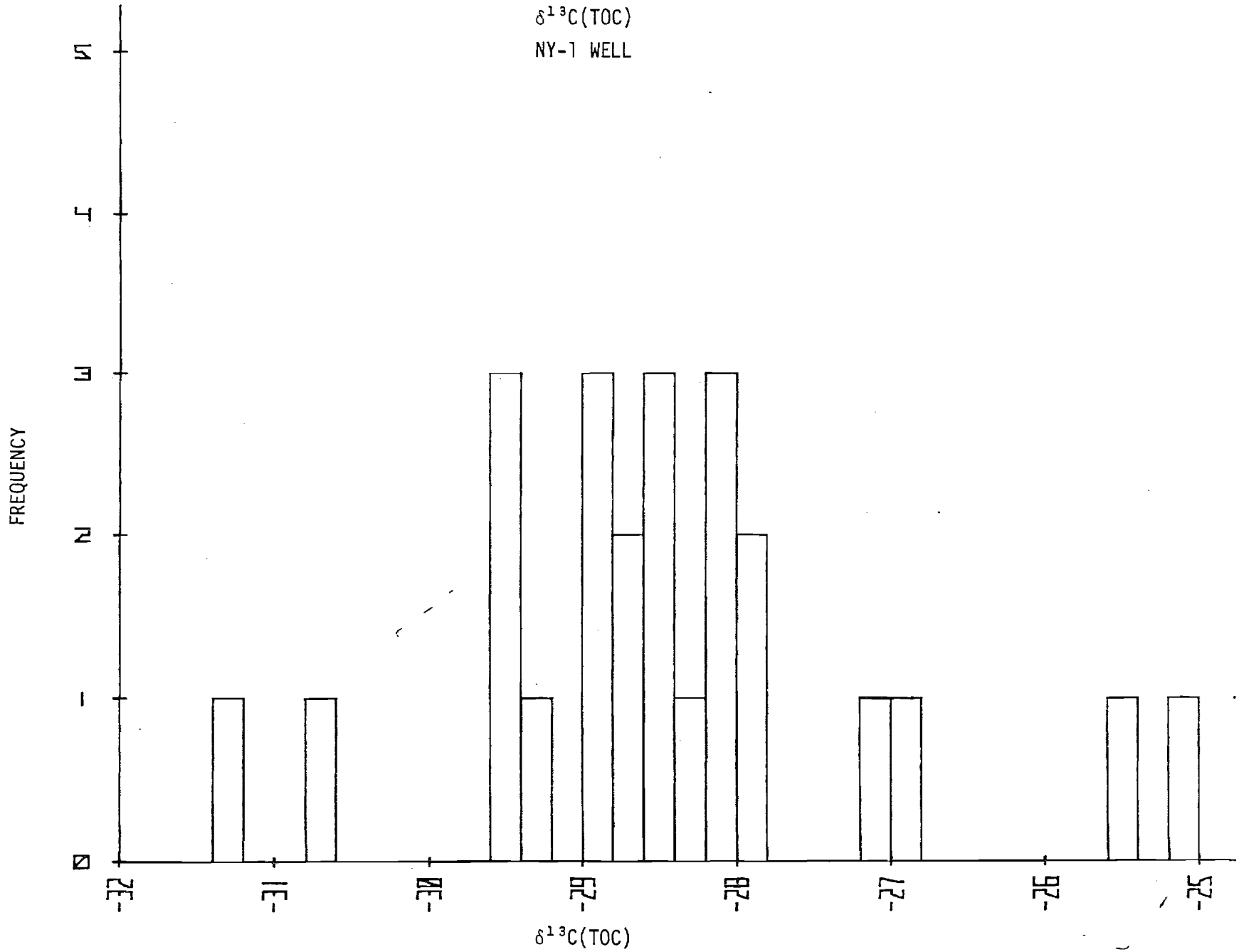
GAS POTENTIAL HIGHEST FOR SAMPLES DEPOSITED
IN A TASMANITES-RICH ENVIRONMENT

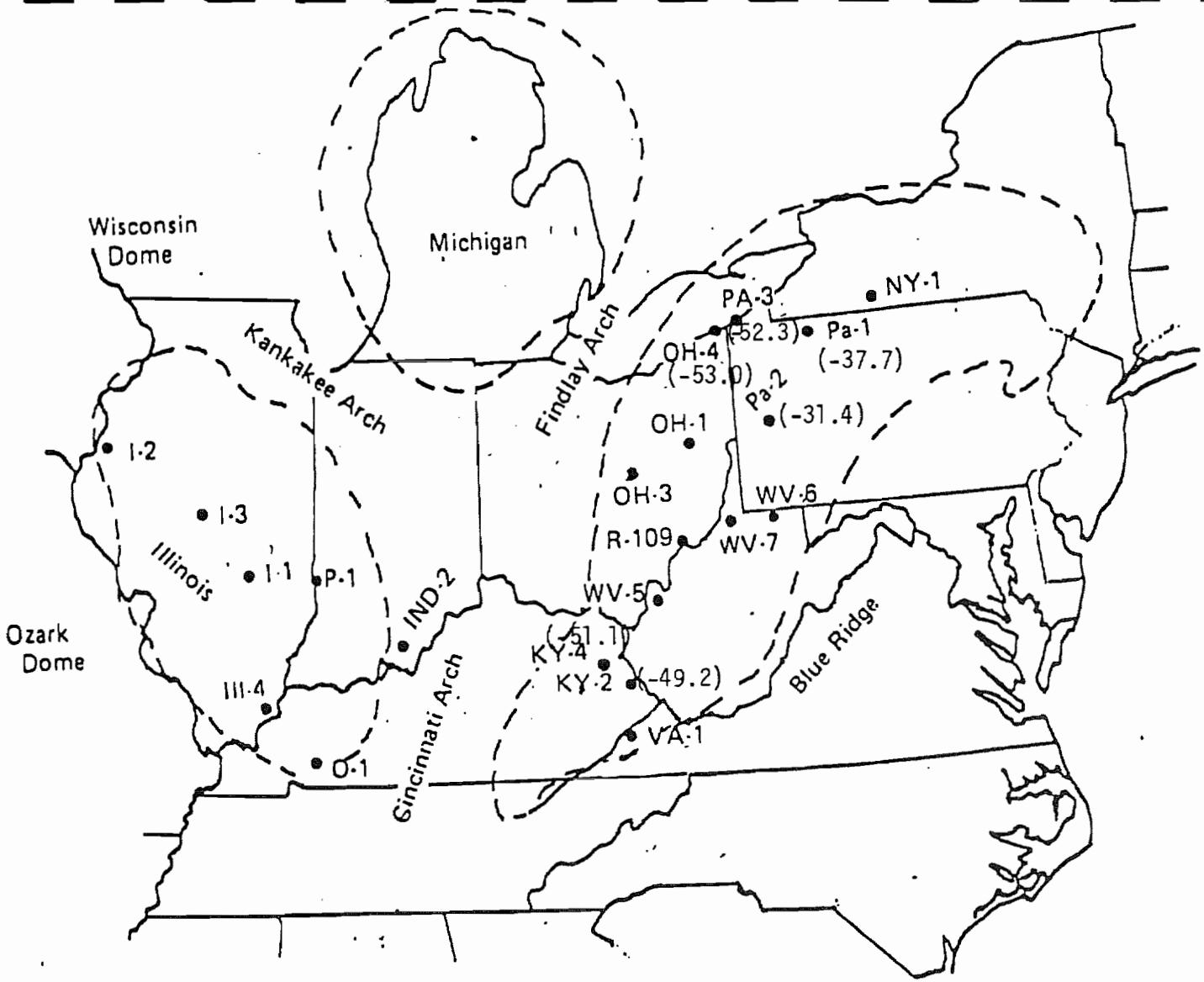




• Location of cored wells

Average $\delta^{13}C$ For TOC Does Not Indicate Any Basinal Trend

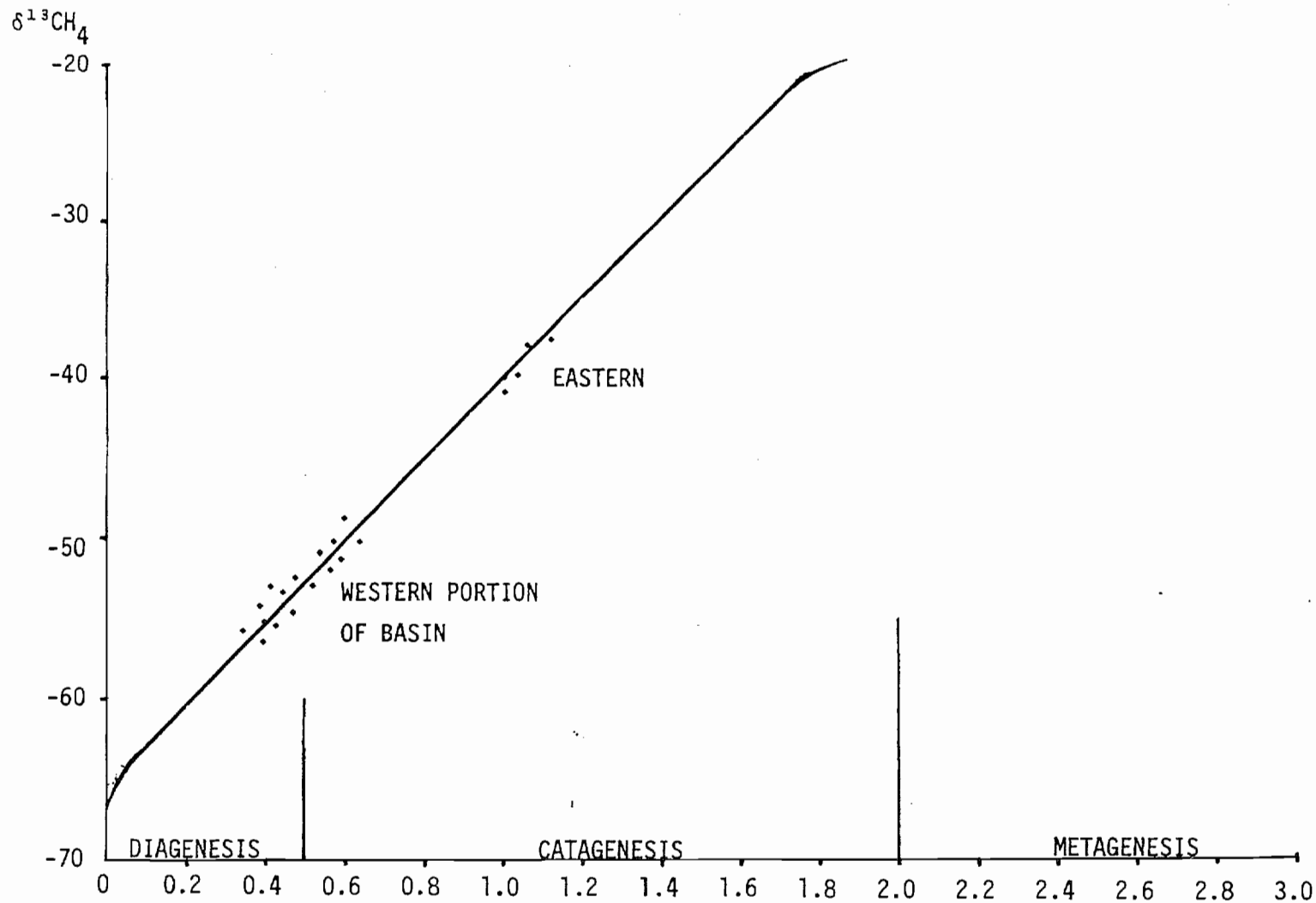

δ13C(TOC)
NY-1 WELL
FREQUENCY
0
1
2
3
4
5
-32
-31
-30
-29
-28
-27
-26
-25
δ13C(TOC)

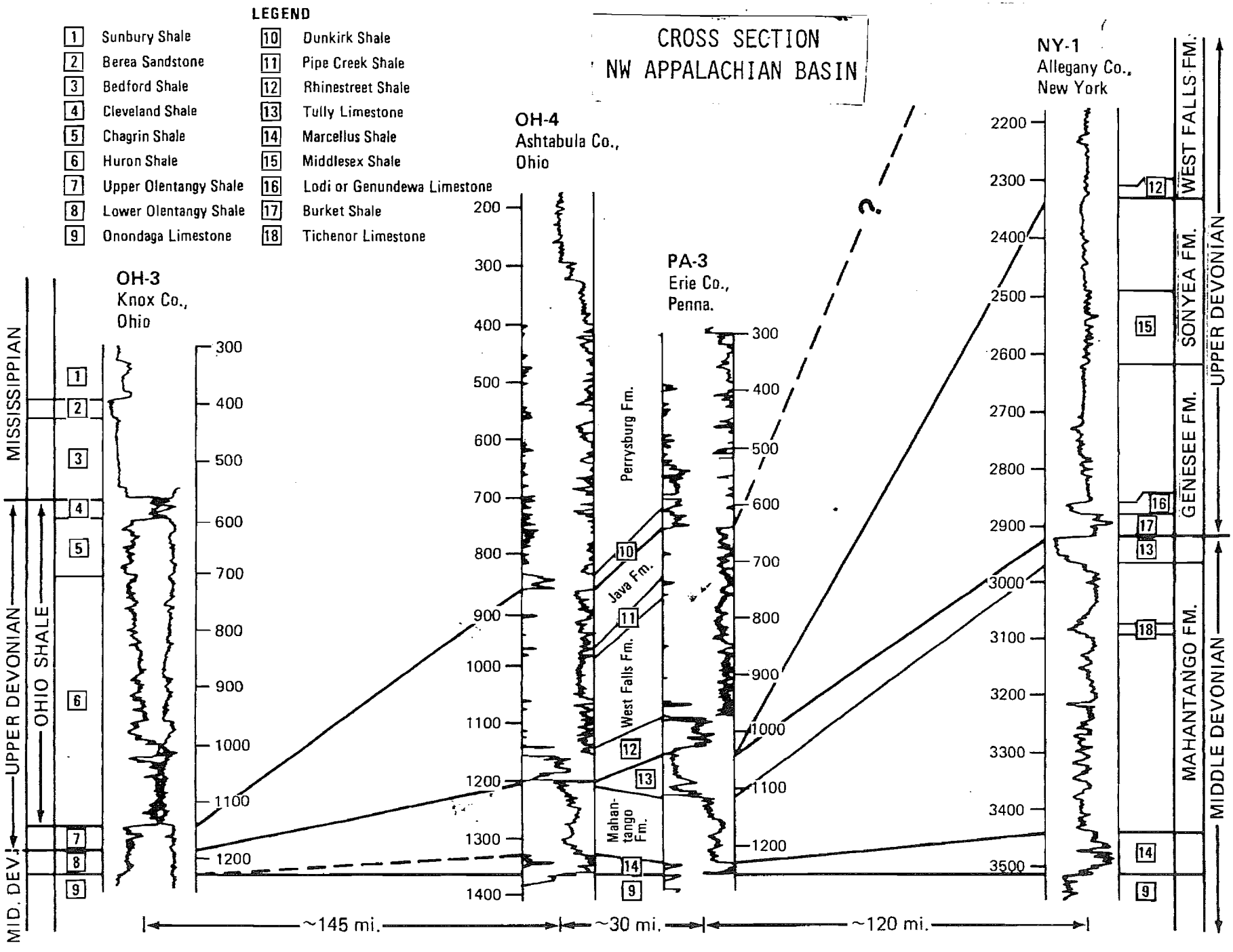


• Location of cored wells

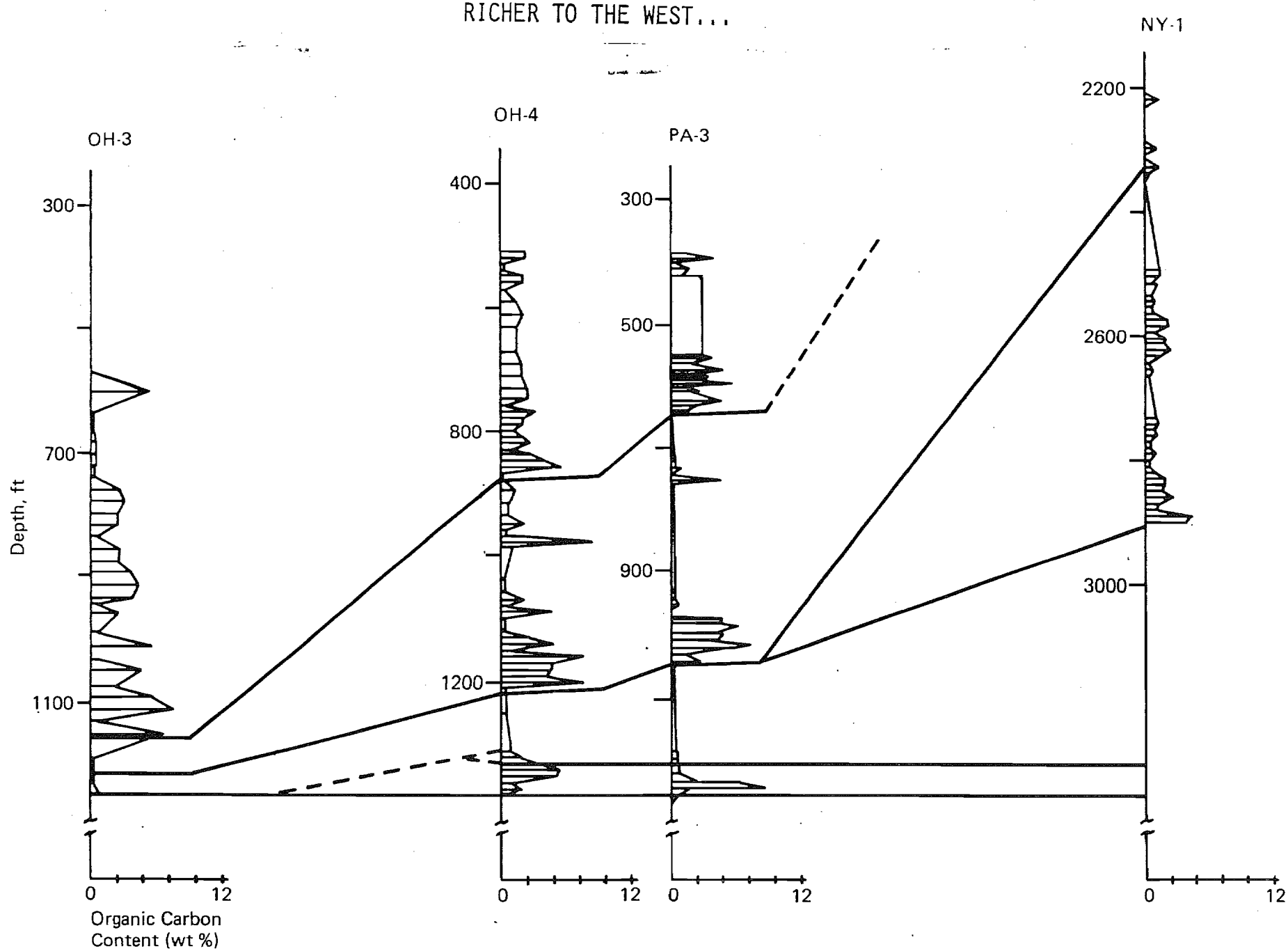
Average $\delta^{13}C$ For CH_4 Does

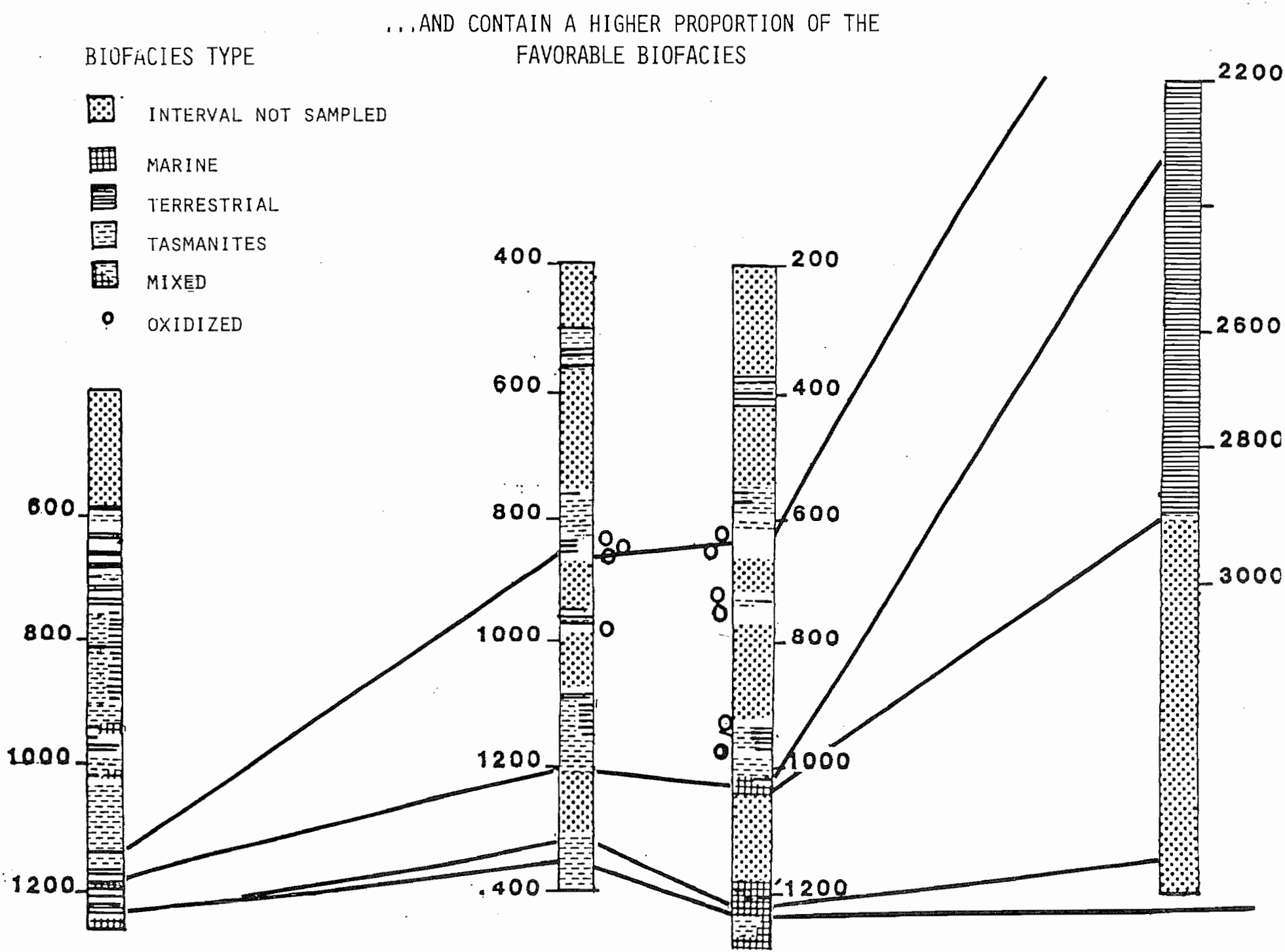
Reflect Kerogen Maturity


δ13CH4
-20
-30
-40
-50
-60
-70
EASTERN
WESTERN PORTION
OF BASIN
DIAGENESIS
CATAGENESIS
METAGENESIS
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0

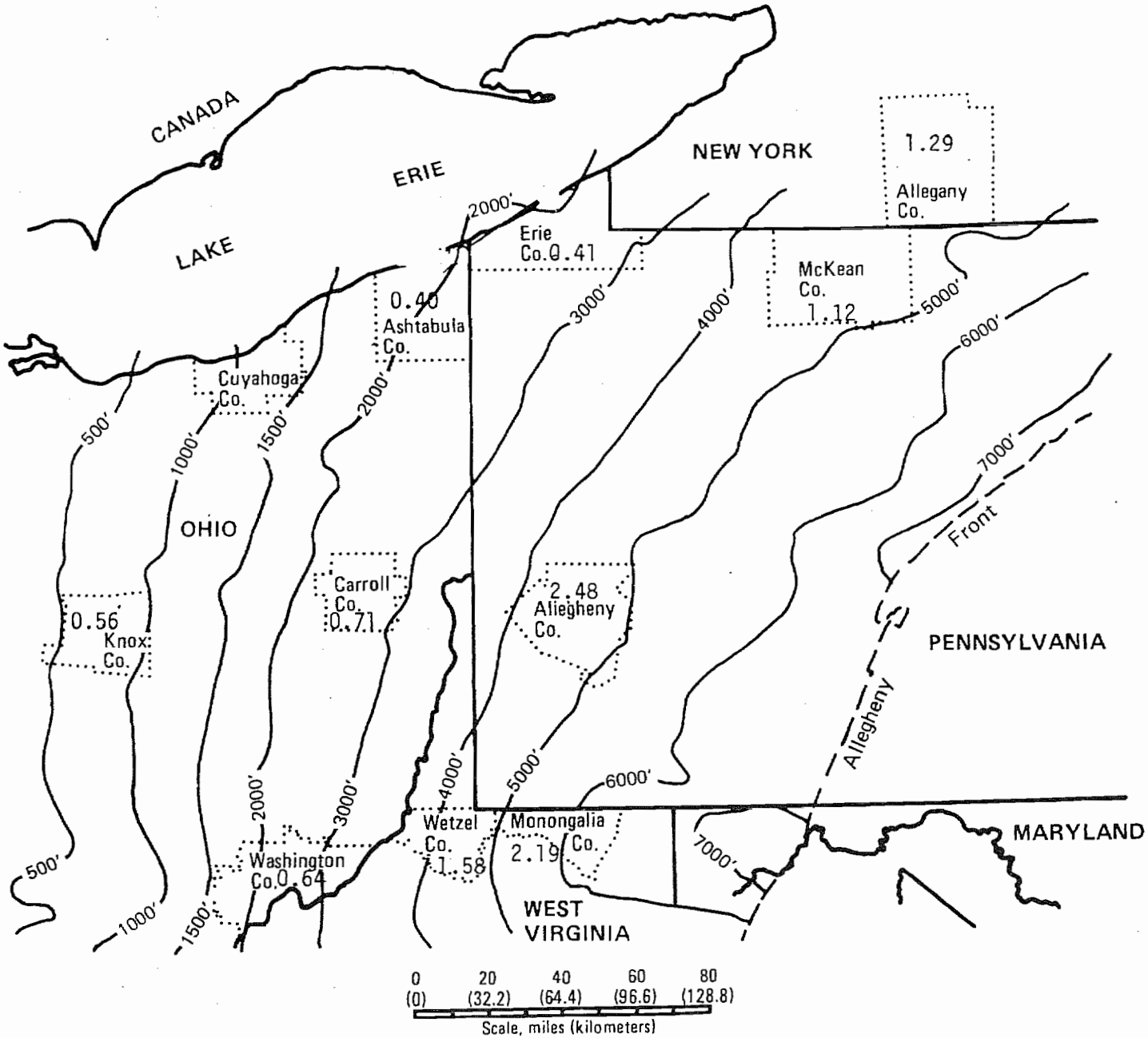

CROSS SECTION
NW APPALACHIAN BASIN
LEGEND
1 Sunbury Shale
2 Berea Sandstone
3 Bedford Shale
4 Cleveland Shale
5 Chagrin Shale
6 Huron Shale
7 Upper Olentangy Shale
8 Lower Olentangy Shale
9 Onondaga Limestone
10 Dunkirk Shale
11 Pipe Creek Shale
12 Rhinestreet Shale
13 Tully Limestone
14 Marcellus Shale
15 Middlesex Shale
16 Lodi or Genundewa Limestone
17 Burket Shale
18 Tichenor Limestone
OH-3
Knox Co.,
Ohio
OH-4
Ashtabula Co.,
Ohio
PA-3
Erie Co.,
Penna.
NY-1
Allegany Co.,
New York
MISSISSIPPIAN
UPPER DEVONIAN
OHIO SHALE
MID. DEV.
Perrysburg Fm.
Java Fm.
West Falls Fm.
Mahantango Fm.
WEST FALLS FM.
SONYEA FM.
GENESEE FM.
MAHANTANGO FM.
UPPER DEVONIAN
MIDDLE DEVONIAN
~145 mi.
~30 mi.
~120 mi.

THE SHALES OF THIS BASIN BECOME ORGANICALLY RICHER TO THE WEST...

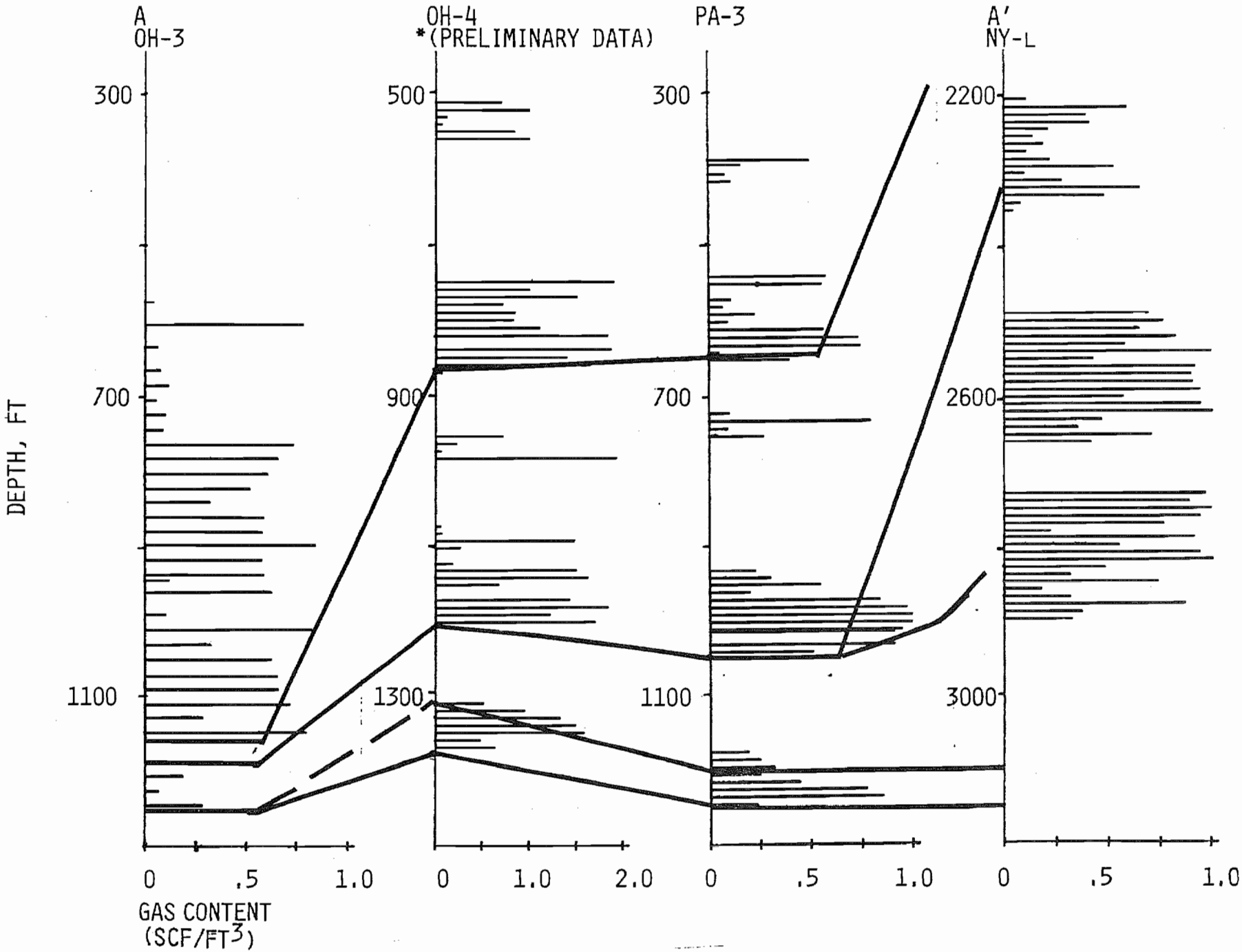



...AND CONTAIN A HIGHER PROPORTION OF THE FAVORABLE BIOFACIES
BIOFACIES TYPE
INTERVAL NOT SAMPLED
MARINE
TERRESTRIAL
TASMANITES
MIXED
OXIDIZED
600
800
1000
1200
400
600
800
1000
1200
400
200
400
600
800
1000
1200
2200
2600
2800
3000

THE THERMAL MATURITY OF THE APPALACHIAN BASIN SHALES INCREASES TO THE EAST



THE TOTAL GAS POTENTIAL OF WESTERN SHALES
IS SIMILAR TO THEIR DEEPER EASTERN EQUIVALENTS

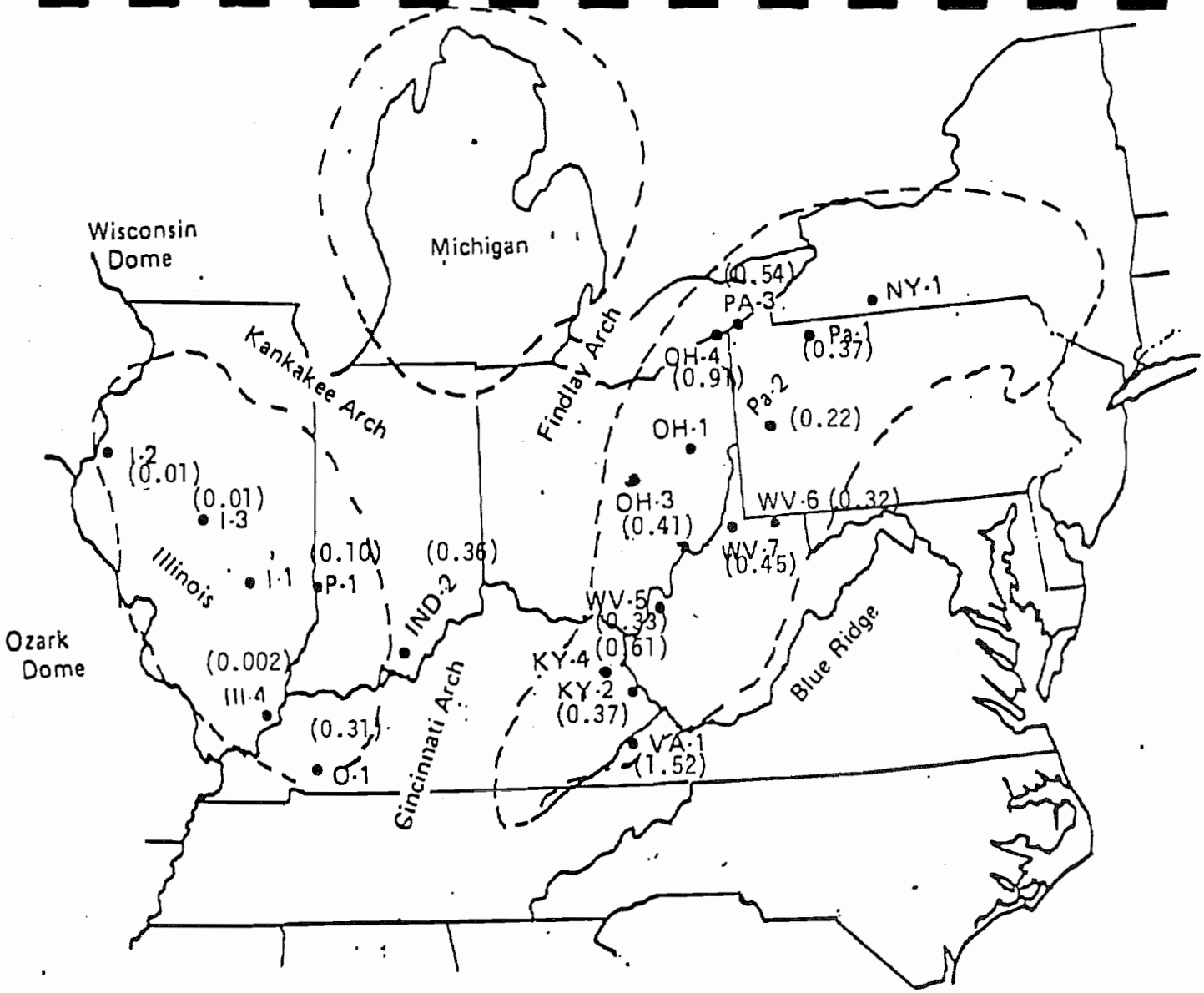


WISE COUNTY, VIRGINIA (1)

Stratigraphic Zone	Depth	Gas Volume (ft^3/ft^3) Free	Matrix
Chagrin Member	4868'-4870'	----	----
Cleveland Member	4870'-4938	1.62	0.10
Chagrin Member	4938'-5036'	0.14	0.01
Upper Huron	5036'-5086'	----	----
Chagrin-Chemung	5086'-5330'	1.36	0.04
Lower Huron	5330'-5480'	2.41	0.11
Upper Olentangy	5480'-5506'	----	----
Pipe Creek Member	5506'-5520'	----	----
Upper Olentangy	5520'-5630'	----	----
Rhinestreet Member	5630'-5678'	----	----
		1.52	

JOHNSON COUNTY, KENTUCKY

Stratigraphic Zone	Depth	Gas Volume (ft^3/ft^3) Free	Matrix
Chagrin (Base (?)	- 992'	0.05	0.004
Cleveland (?)	992'-1085'	0.56	0.12
Three Lick (?)	1085'-1125'	0.34	0.09
Ohio Shale	1125'-1315'	0.49	0.20
Lower Huron (?)	1315'-1415'	0.42	0.40
Olentangy	1415'-1480	0.28	0.04
	1480'-	0.14	0.06
		0.61	



• Location of cored wells

Average C_1-C_7 Gas Contents for the Cored Wells

TECHNOLOGY VERIFICATION

- TEST EXPLORATION RATIONALE FOR SITING WELLS IN AND NEAR ERIE CO., PENNSYLVANIA

- UTILIZE PRESSURE CORE BARREL TO VERIFY RESOURCE ASSESSMENT VALUES

EXPLORATION RATIONALE

- PAST PRODUCTION HISTORY OF AREA
- THICKNESS OF THE BLACK SHALES
- LITHOLOGIC NATURE OF THE BLACK SHALE INTERVALS
- STRUCTURAL TRENDS
- DRILLING DEPTH
- LINEAMENT/FRACTURE TRACE ANALYSIS

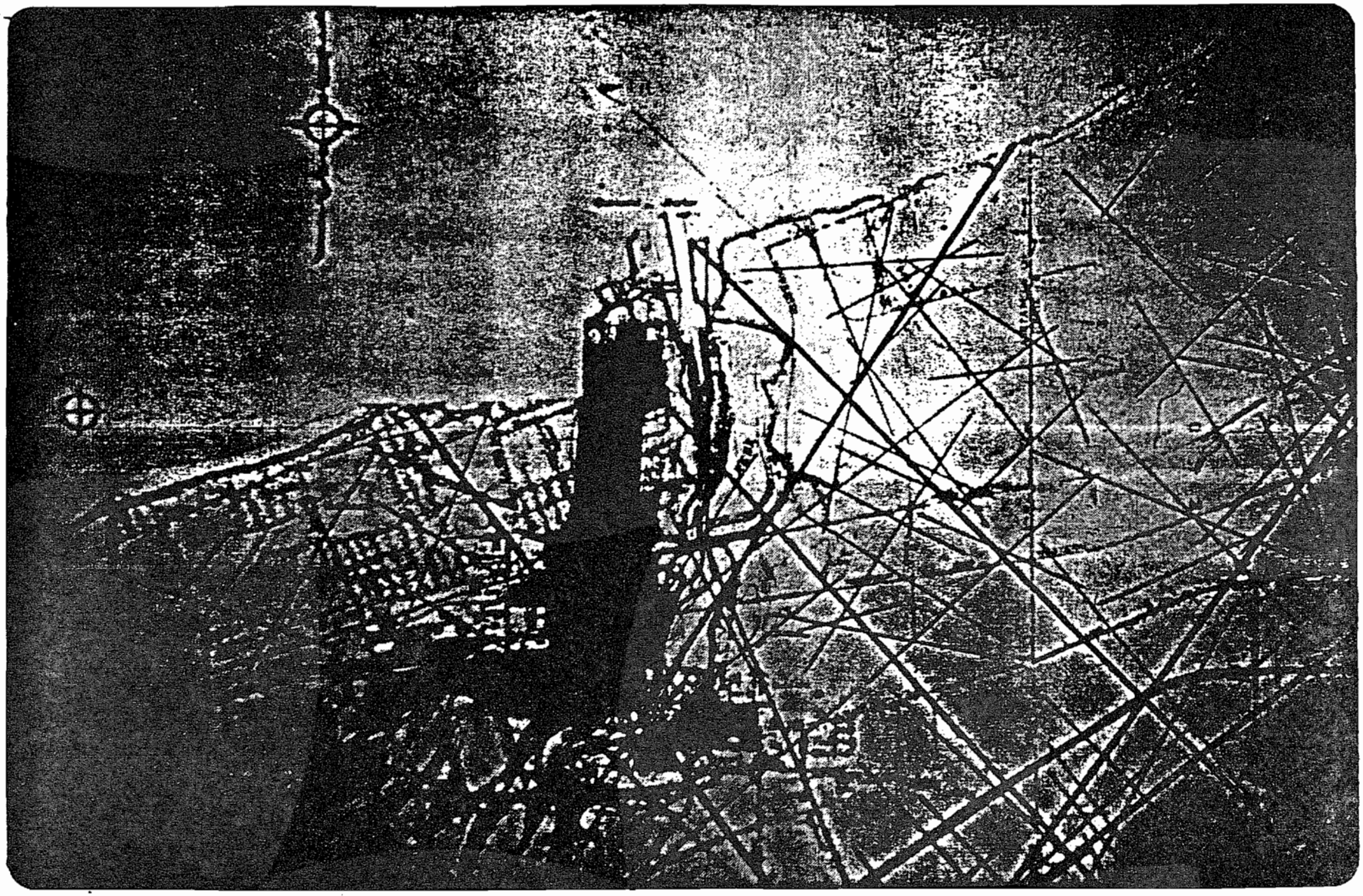
FRACTURE TRACE ANALYSIS WAS KEY STEP IN SITING.

FOR THE TWO WELLS ....

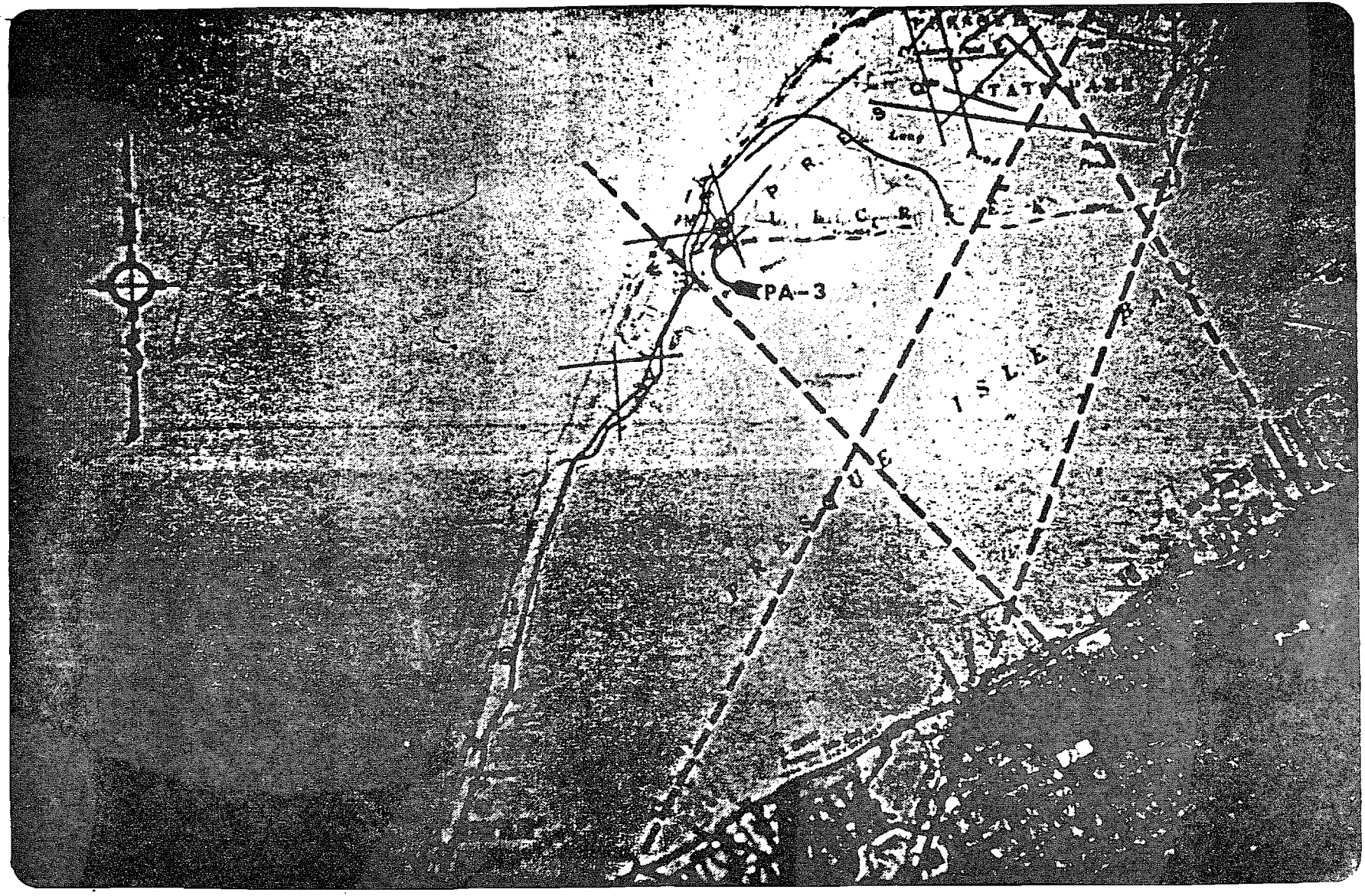
THE FIRST WELL, OH-4 IN ASHTABULA CO.,

OHIO WAS <u>NOT</u> SITED IN ACCORDANCE WITH

THE FRACTURE TRACE ANALYSIS ....



.... WHILE THE SECOND WELL, PA-3 IN ERIE CO.,
PENNSYLVANIA, WAS SITED ACCORDING TO THE
FRACTURE TRACE ANALYSIS ....


PA-3

RESULTS OF THE WELLS:

WELL	INITIAL OPEN FLOW PRODUCTION
OH-4	5-10 MCF/DAY
PA-3	160 MCF/DAY

ASHTABULA COUNTY, OHIO

Stratigraphic Units		Depth	Total Gas (ft^3/ft^3)
Perrysburg Formation	Dunkirk Facies	837'- 862'	0.72 1.76
Java FM	Pipe Creek Facies	862'- 968' 968'- 984'	0.30 2.15
West Falls FM	Rhinestreet Facies	984'-1140' 1140'-1204'	1.08 1.49
Tully LS	Tully LS	1204'-1208'	0.69
Hamilton Grove	Mahantango FM Marcellus Facies	1208'-1330' 1330'-1365'	1.32 0.44
			0.91

ERIE COUNTY, PENNSYLVANIA

Stratigraphic Units		Depth	Total Gas (ft^3/ft^3)
Perrysburg FM	Dunkirk Facies	375'- 606' 606'- 639'	0.23 0.69
Java FM	Pipe Creek Facies	639'- 732' 732'- 758'	0.39 0.40
West Falls FM	Rhinestreet Facies	758'- 973' 973'-1040'	0.84 1.20
Tully LS	Tully LS	1040'-1115'	0.51
Hamilton Grove	Mahantango FM Marcellus Facies	1115'-1230' 1230'-1250'	0.34 0.59
	Onondaga LS	1250'-	0.54

PA-3

ERIE COUNTY, PENNSYLVANIA

PRESSURE BUILD-UP DATA

14 HOUR SHUT-IN (10-12-79 THROUGH 10-13-79): 144 PSI

TABLE 4

PA-3
ERIE COUNTY, PENNSYLVANIA

PRESSURE BUILD-UP DATA

SHUT-IN PRESSURE AS GAUGED 10-13-79 THROUGH 11-14-79

TIME (HRS.)	PRESSURE (PSI)	TIME (HRS.)	PRESSURE (PSI)
0:10	29.0	215:15	167.0
0:20	52.0	222:00	167.0
0:30	69.0	239:00	167.0
0:40	82.0	245:05	167.0
0:51	94.0	263:05	166.0
1:00	102.0	267:05	166.5
1:10	108.0	269:05	166.5
1:20	113.0	287:05	166.5
1:30	117.0		
2:50	131.0	769:47	170.0
3:05	134.0		
3:25	135.5		
3:40	136.0		
4:25	139.5		
4:38	140.0		
5:00	140.5		
5:35	141.5		
6:00	143.0		
6:30	143.5		
7:00	144.5		
7:30	145.5		
8:05	146.0		
8:55	147.0		
10:00	149.0		
24:00	156.0		
29:00	158.0		
47:12	160.0		
51:05	161.0		
71:05	162.0		
77:05	162.0		
95:05	162.0		
101:15	163.0		
119:05	163.0		
143:25	164.0		
167:55	165.0		
175:49	166.0		
191:27	166.0		
199:06	167.0		

PRESSURE CORE BARREL DATA SHOW

THAT RESOURCE ASSESSMENT VALUES

ARE CONSERVATIVE, ESPECIALLY FOR

FREE GAS ....

PA-3

ERIE COUNTY, PENNSYLVANIA

PRESSURE BUILD-UP DATA

14 HOUR SHUT-IN (10-12-79 THROUGH 10-13-79): 144 PSI

FREE GAS CONTENT WOULD BE BIASED LOW FOR

CONVENTIONAL METHOD

	METHOD	GAS CONTENT (CM^3/GM)	PERCENT (%)
	PCB	0.5349	100
OH-4	CONTROLLED	0.2398	45
	CONVENTIONAL	0.1610	30
	PCB	0.0551	100
PA-3	CONTROLLED	0.0316	57
	CONVENTIONAL	0.0	0

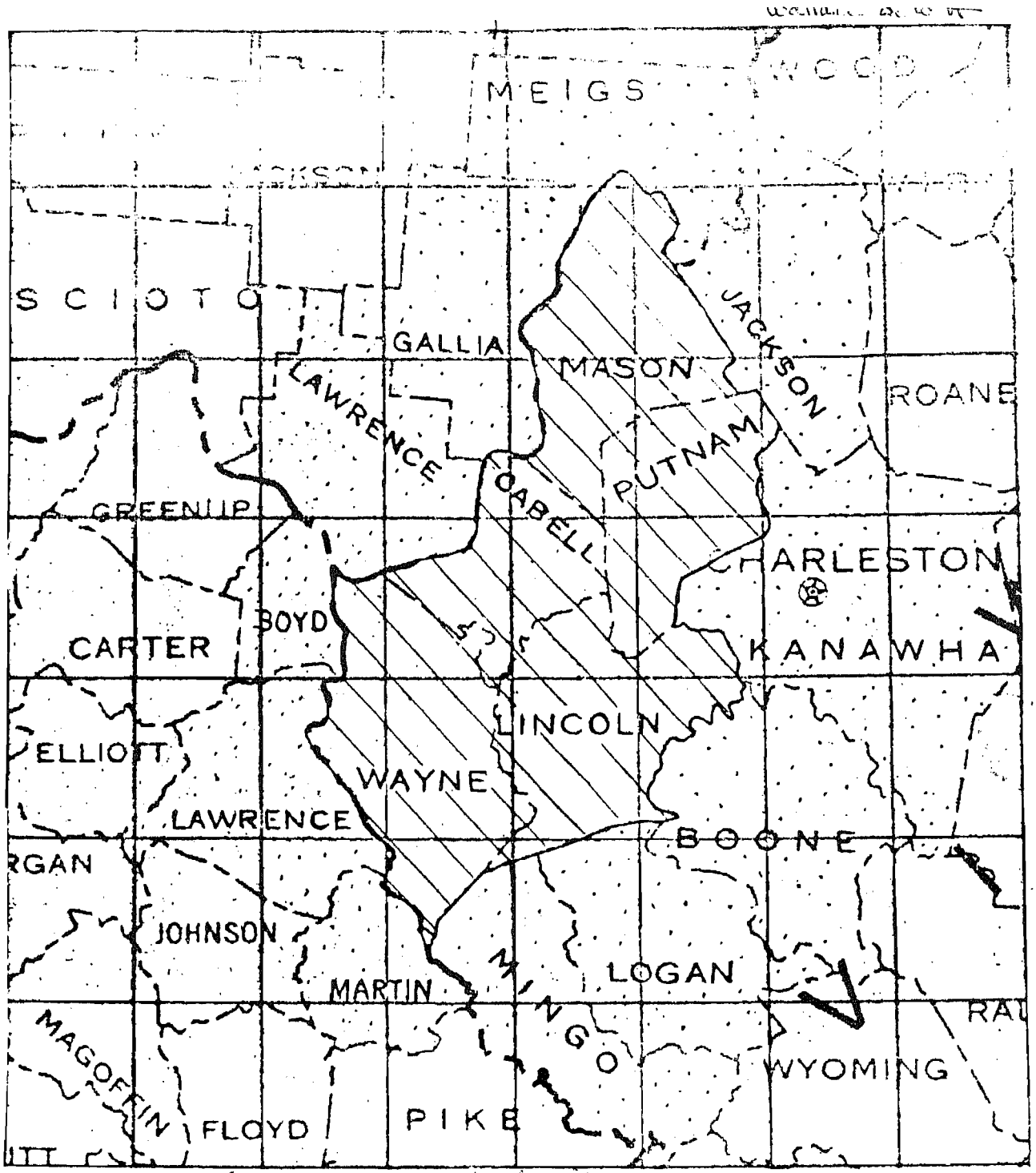
ALSO, CONTROLLED OFF-GASSING YIELDS A BETTER VALUE FOR FREE GAS CONTENT VS. THE CONVENTION METHOD.

WELL AVERAGES:

	METHOD	GAS CONTENT (CM^3/GM)	PERCENT
OH-4	CONTROLLED	0.2322	100
	CONVENTIONAL	0.1592	69
PA-3	CONTROLLED	0.1441	100
	CONVENTIONAL	0.0679	47

SUMMARY

- FRACTURE TRACE ANALYSIS KEY ELEMENT IN SITING WELLS
- RESOURCE ASSESSMENT VALUES FROM CONVENTIONAL METHOD CONSERVATIVE, VS. PRESSURE CORE BARREL $\approx$ 1/3 OF FREE GAS VALUES
- CONTROLLED OFF-GASSING A MORE VIABLE ALTERNATIVE FOR DETERMINING GAS CONTENT



U.S. Geological Survey - Devonian Shale Study Program's
Proposed Pilot Area for Devonian Black Shale Resource Appraisal
Cabell, Lincoln, Mason, Putnam, and Wayne Counties, West Virginia.

Border control data will be needed from stippled area adjacent to the study area. Ohio - Gallia, Lawrence, Meigs; Kentucky - Boyd, Lawrence, Martin, West Virginia - Boone, Kanawha, Jackson, Logan, Mingo

Bill Gwilliam

RESOURCE ASSESSMENT

ILLINOIS AND MICHIGAN BASINS

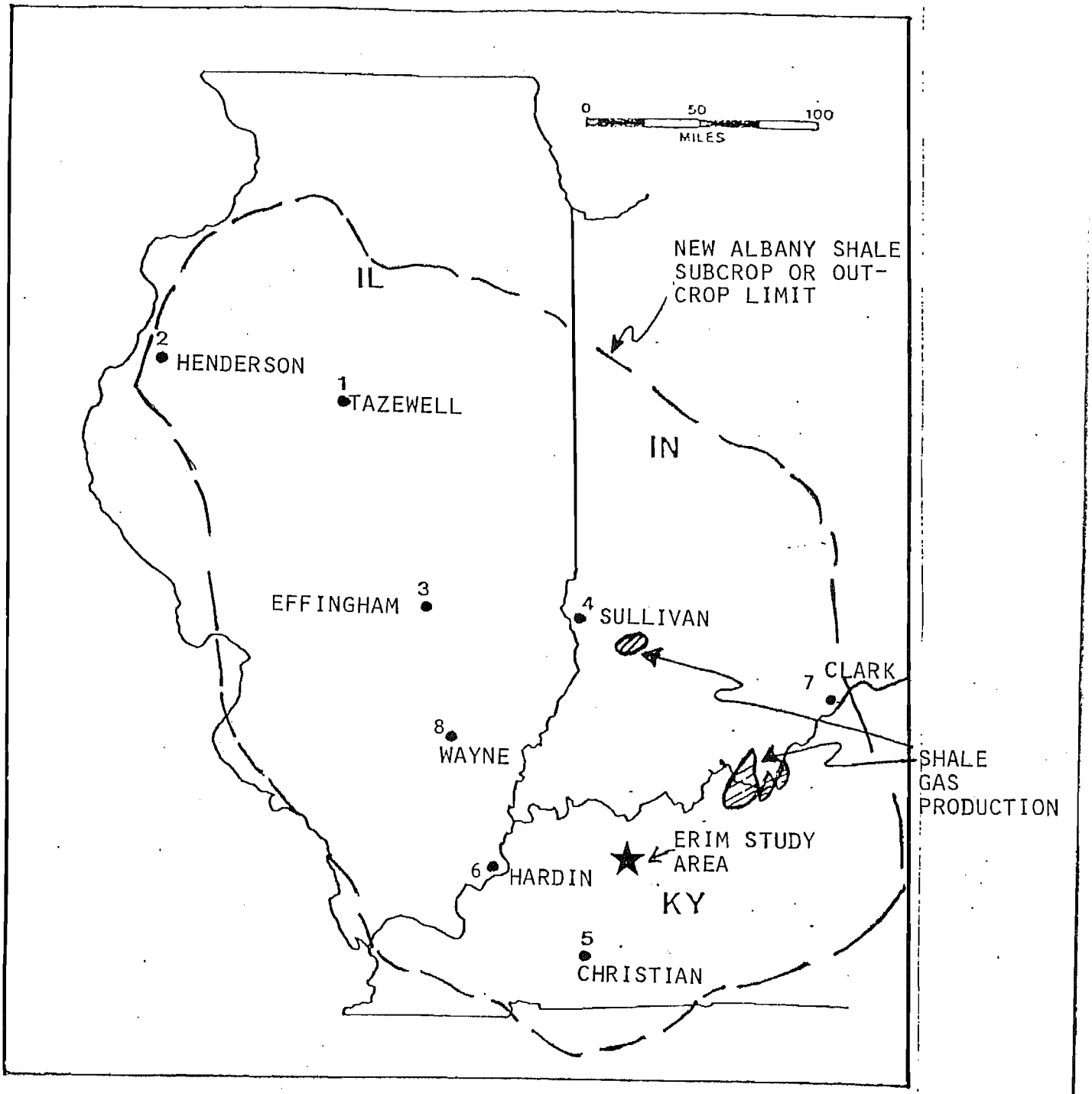
A C T I V I T I E S

- RESOURCE CHARACTERIZATION
- SCREENING FOR TARGET AREA (S)
- DRILLING AND TESTING WELL (S) IN HIGH - RANKED TARGET AREA
- UPDATE ESTIMATE OF GAS IN PLACE
- UPDATE ESTIMATE OF PRODUCIBLE GAS

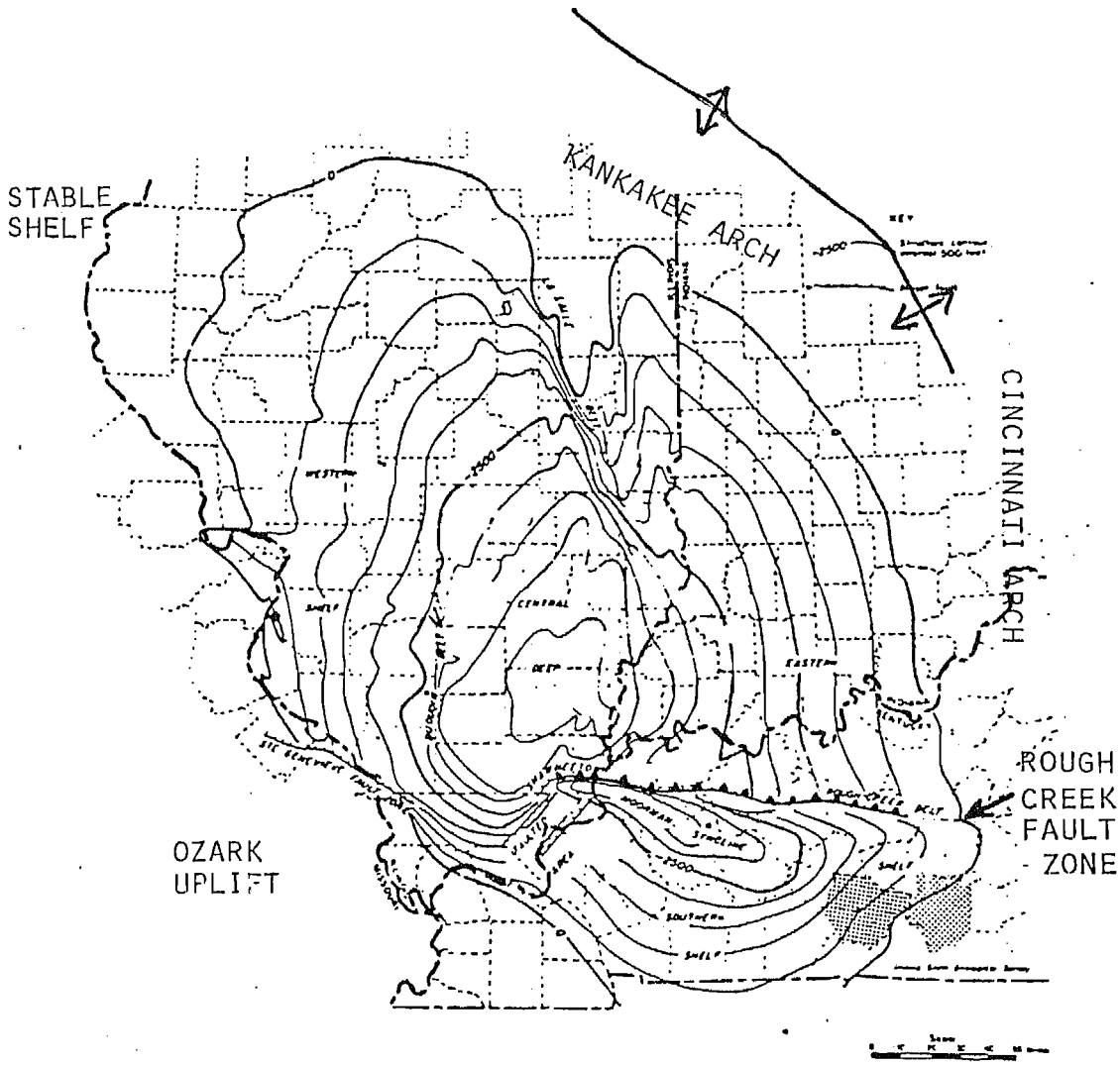
RESOURCE CHARACTERIZATION SUMMARY

ILLINOIS BASIN

- BASIN CENTRAL DEEP AREA COINCIDES WITH THICKER AREAS OF NEW ALBANY SHALE
- STRUCTURAL COMPLEXITY OF THE BASIN INCREASES DRAMATICALLY FROM NORTHWEST TO SOUTHEAST
- IN GENERAL THE SHALE OF THE ILLINOIS BASIN IS LESS MATURE THAN THE SHALE OF THE APPALACHIAN BASIN
- THERMAL MATURITY INCREASES WITH DEPTH
- THE LIMITS OF THERMAL MATURITY NECESSARY FOR GAS GENERATION AND RETENTION ARE UNCLEAR AT PRESENT, BUT SOME DATA SUGGEST A RELATIONSHIP BETWEEN INCREASED Ro AND INCREASED GAS DESORPTION VOLUMES.
- GAS PRODUCTION FROM THE NEW ALBANY SHALE IS KNOWN TO HAVE OCCURRED, AND SCATTERED GAS SHOWS ARE REPORTED THROUGHOUT THE SOUTHEASTERN PORTION OF THE BASIN



Location of EGSP Wells in the Illinois Basin



STRUCTURE OF THE ILLINOIS BASIN

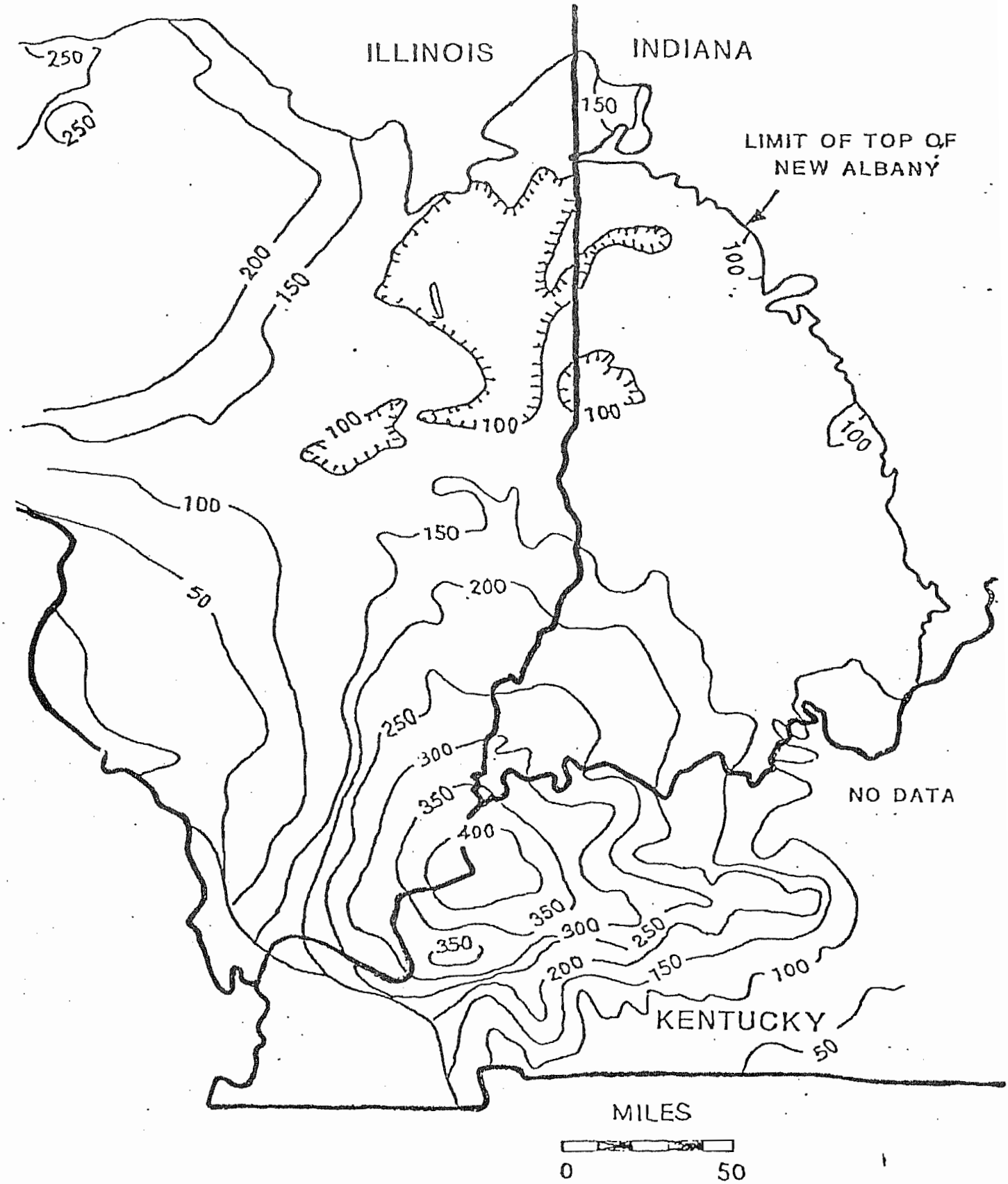


Figure 5. Preliminary thickness map of the New Albany Shale Group in the Illinois Basin(modified from ref. 8).

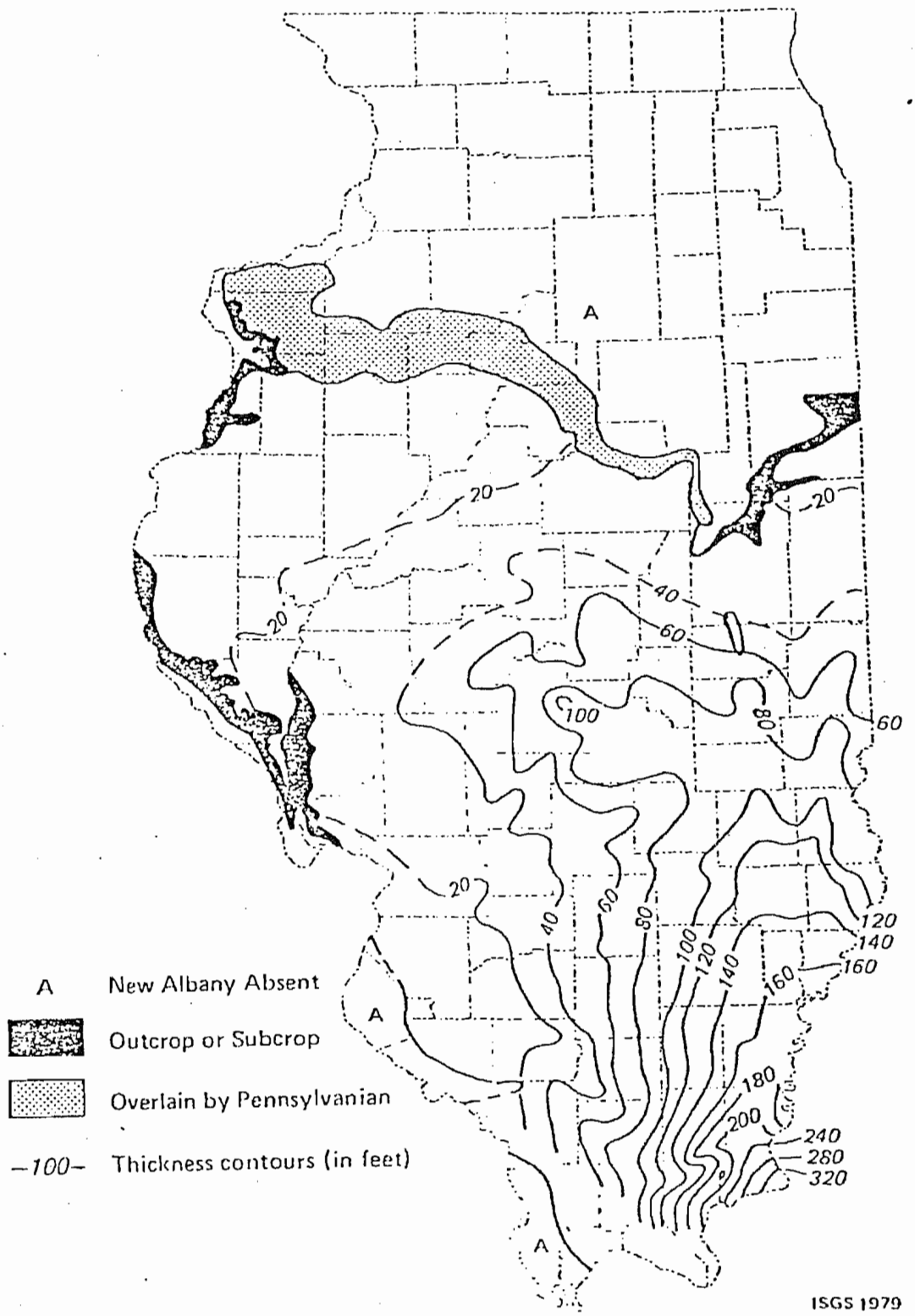


Figure 6 Cumulative thickness of radioactive shale within the New Albany Shale Group in Illinois. Radioactive shale is here defined as that having a gamma ray log value >60 API units above a normal shale base line.

ILLINOIS BASIN

COMPARISON CHART
OF
NEW ALBANY SHALE ZONES DESORPTION DATA
WITH
THERMAL MATURITY (AS SHOWN BY VITRINITE REFLECTANCE, Ro)

	AV. CU FT GAS/CU FT SHALE			
	NEW ALBANY SHALE ZONES			
LOCATION OF WELL	HANNIBAL-SAVERTON SHALES	GRASSY CREEK SHALES	SWEETLAND CREEK SHALES	MEAN AVERAGE Ro
TAZEWELL COUNTY, IL	0.006	0.020	0.003	0.43
HENDERSON COUNTY, IL	NA	.007	.001	.49
EFFINGHAM COUNTY, IL	NA	.474	.538	.46
SULLIVAN COUNTY, IN	NA	1.552	1.180	.53
CHRISTIAN COUNTY, KY	NA	.512	.373	.45

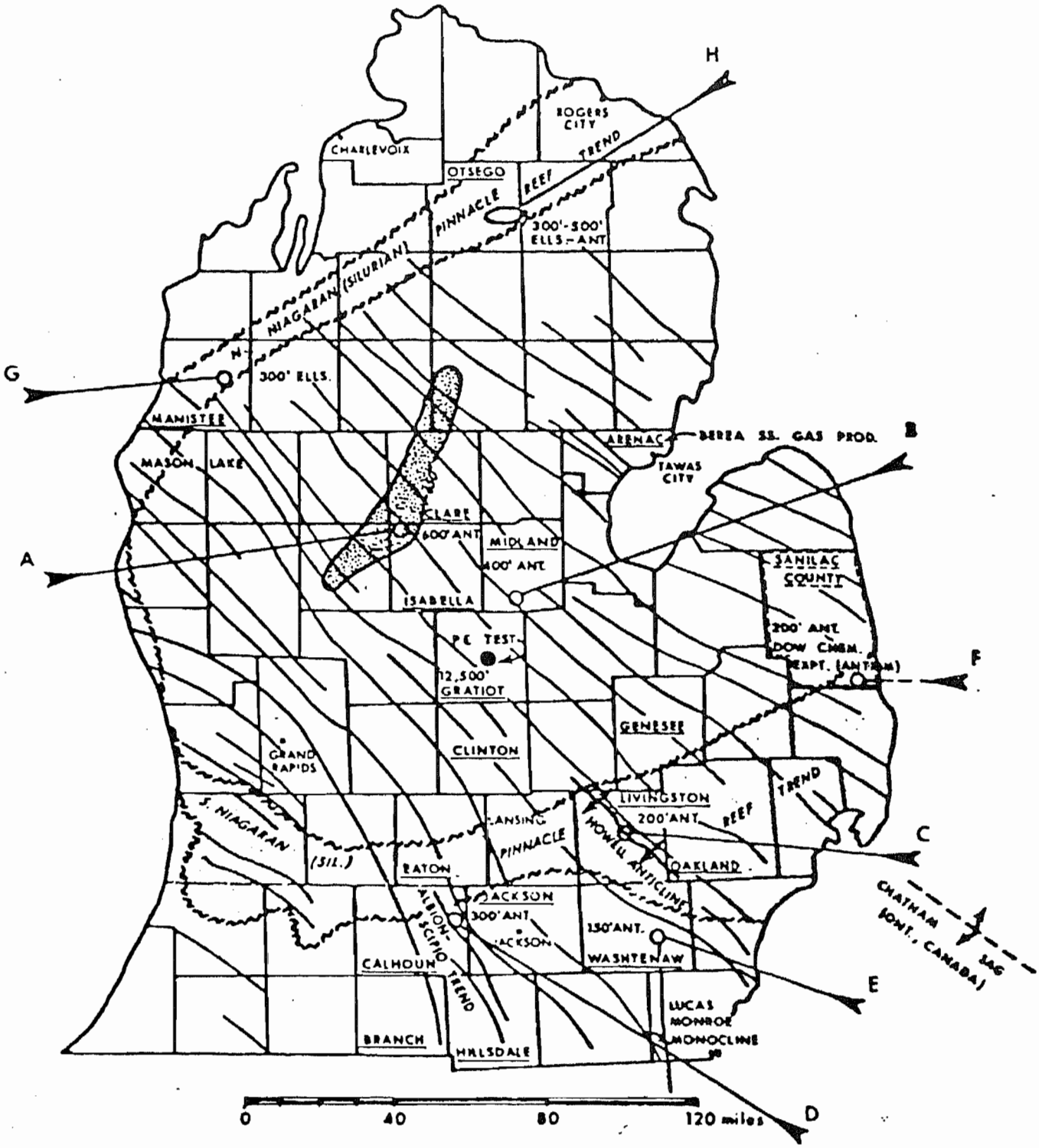
- CONCLUDING REMARKS CONCERNING RESOURCE ASSESSMENT

ILLINOIS BASIN

- IMMEDIATE OBJECTIVE IS TO FINALIZE AND REVIEW THE ERIM REMOTE SENSING STUDY IN THE SOUTHEAST ILLINOIS BASIN TARGET AREA, AND TO LOCATE WELL (S) SUITABLE FOR CORING AND TESTING.
- UPDATE ESTIMATES OF GAS IN PLACE AND PRODUCIBLE GAS WITHIN THE BASIN.

MICHIGAN BASIN

- IMMEDIATE OBJECTIVE IS TO COMPLETE THE CORING PROGRAM WITH AT LEAST THREE MORE CORE WELLS AND TO FINALIZE THE CHARACTERIZATION EFFORT IN THE BASIN.
- SCREEN FOR TARGET AREA (S).
- UPDATE ESTIMATES OF GAS IN PLACE AND PRODUCIBLE GAS WITHIN THE BASIN.



MAP OF MICHIGAN SHOWING TRENDS OF ANTICLINAL STRUCTURES (MISS.–DEV.)

(from Whitten and Beckman, 1969)

RESOURCE CHARACTERIZATION SUMMARY

OF THE

MICHIGAN BASIN

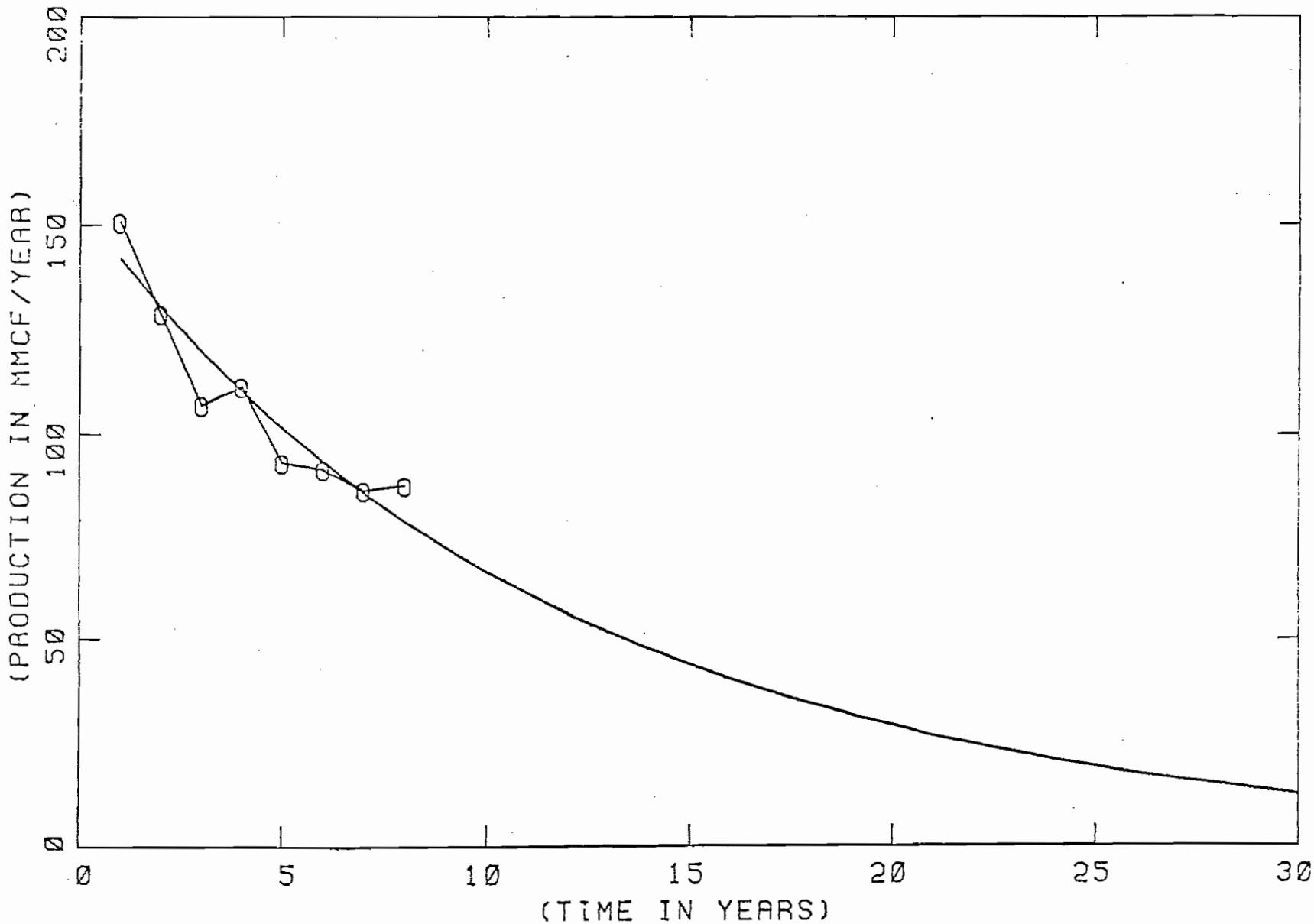
- PRELIMINARY RESULTS FROM DOW CHEMICAL COMPANY'S ANTRIM SHALE IN SITU PROCESSING, SHALE CHARACTERIZATION STUDY INDICATES THE EXISTENCE OF SHALE PROPERTIES SIMILAR TO THOSE FOUND IN THE APPALACHIAN AND ILLINOIS BASINS

- VERY LIMITED CORE DATA

- CROSS SECTION STUDIES INDICATE THAT THE WESTERN PORTION OF THE BASIN MAY NOT BE PROSPECTIVE DUE TO PRONOUNCED THINNING OF THE ANTRIM SHALE

- THE ANTRIM SHALE HAS PRODUCED IN EXCESS OF 1.5 BCF OF NATURAL GAS FROM 6 FIELDS IN THE BASIN

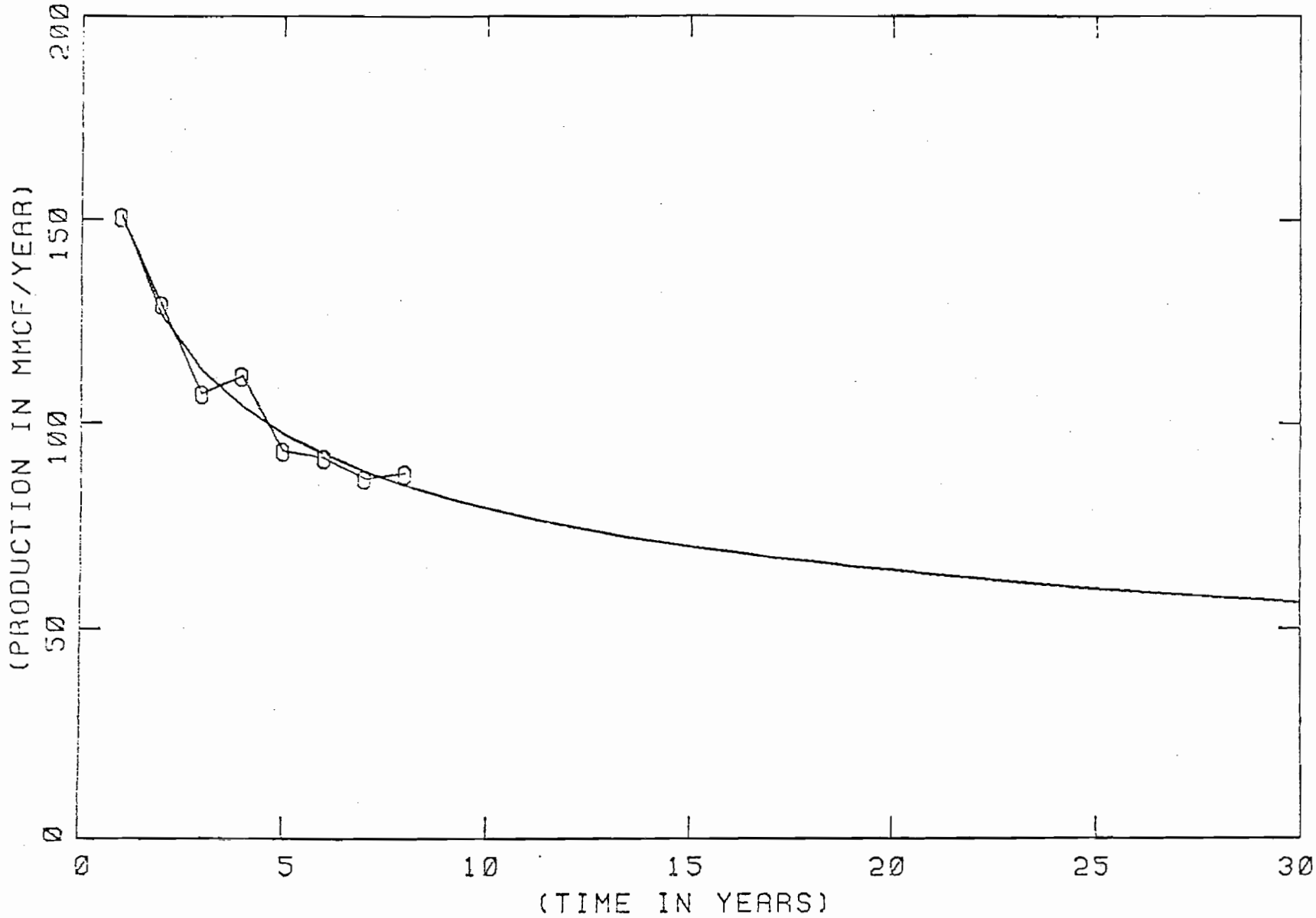
ANTRIM SHALE FORMATION
OTSEGO COUNTY, MICHIGAN



COMPOSITE PRODUCTION - 13 WELLS
TIME TO ECONOMIC LIMIT = 19.0 YEARS
TOTAL RESERVES = 541.54 MMCF
EXPONENTIAL CURVE FIT

(After A. B. Cobb II)

ANTRIM SHALE FORMATION
OTSEGO COUNTY, MICHIGAN



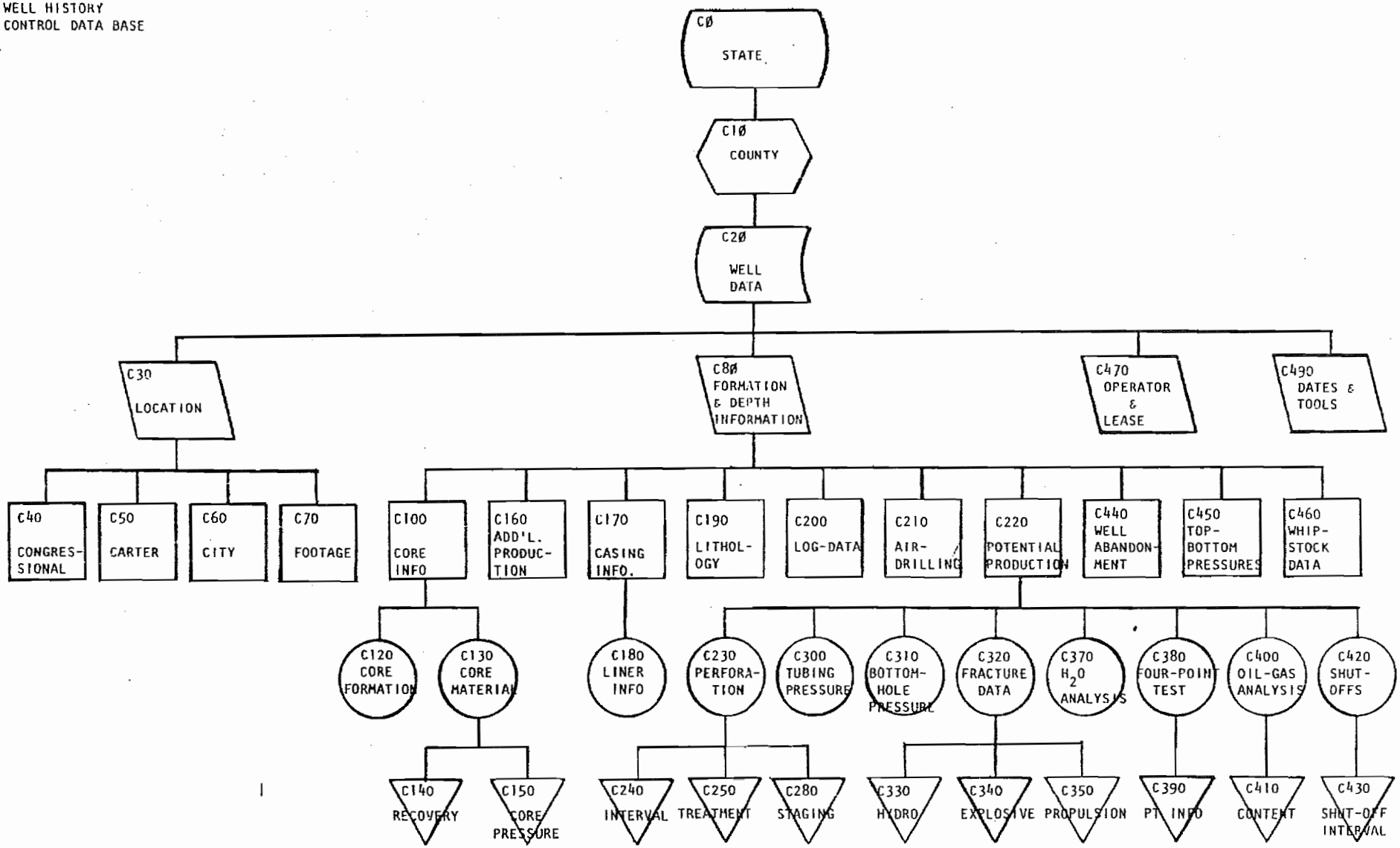
COMPOSITE PRODUCTION - 13 WELLS
TIME TO ECONOMIC LIMIT -206.1 YEARS
TOTAL RESERVES -8296.61 MMCF

DATA MANAGEMENT SUPPORT

TECHNICAL OBJECTIVES

- COLLECT DATA ON SHALE CORE CHARACTERIZATION
- ESTABLISH DATA BASE FOR INFORMATION NEEDS OF MANAGEMENT, SCIENTIFIC AND TECHNICAL PERSONNEL
- ESTABLISH CAPABILITY TO MEET THE NEEDS OF INDUSTRIAL USERS

WELL HISTORY
CONTROL DATA BASE



DATA MANAGEMENT SUPPORT

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- COLLECT DATA ON SHALE CORE CHARACTERIZATION
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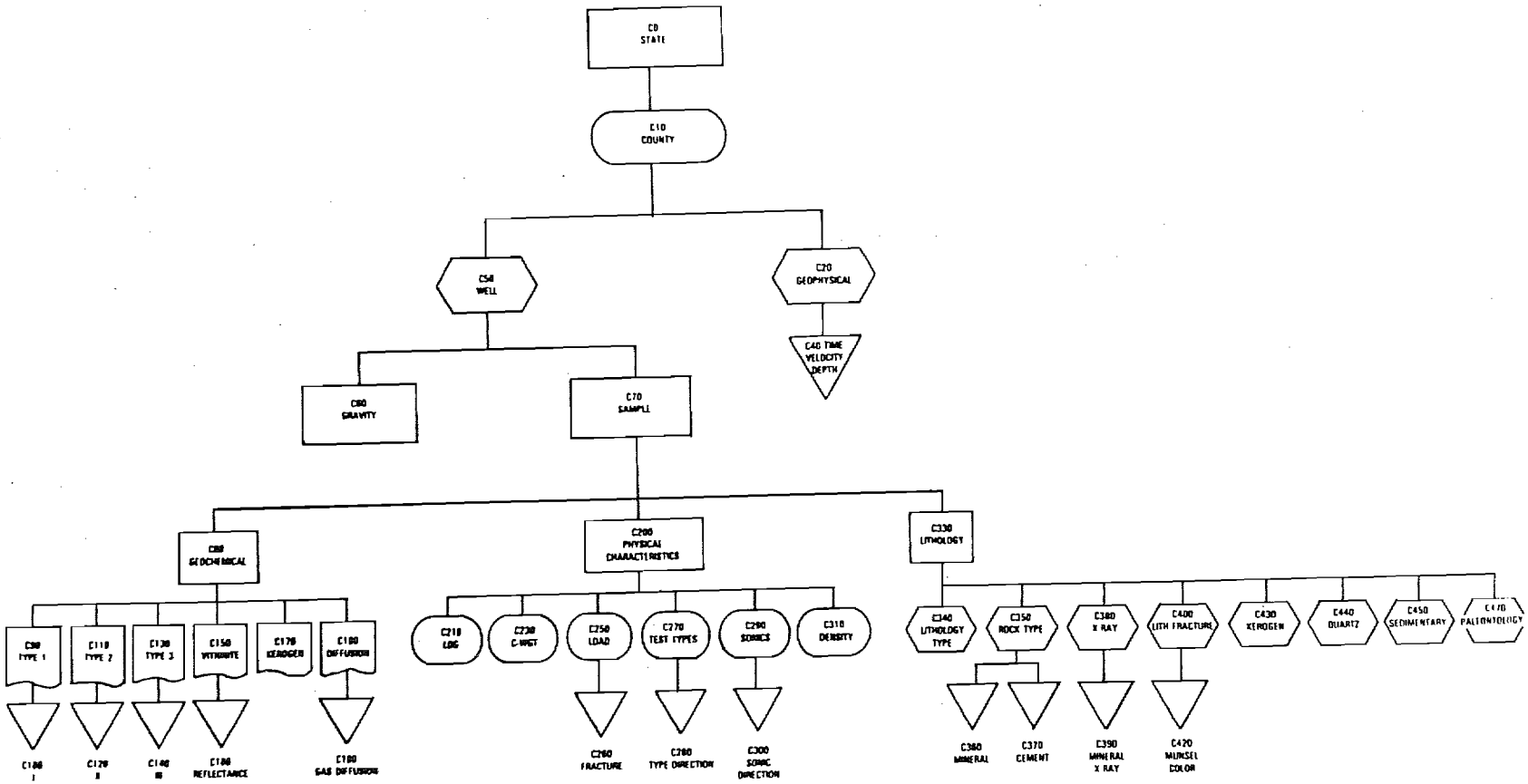
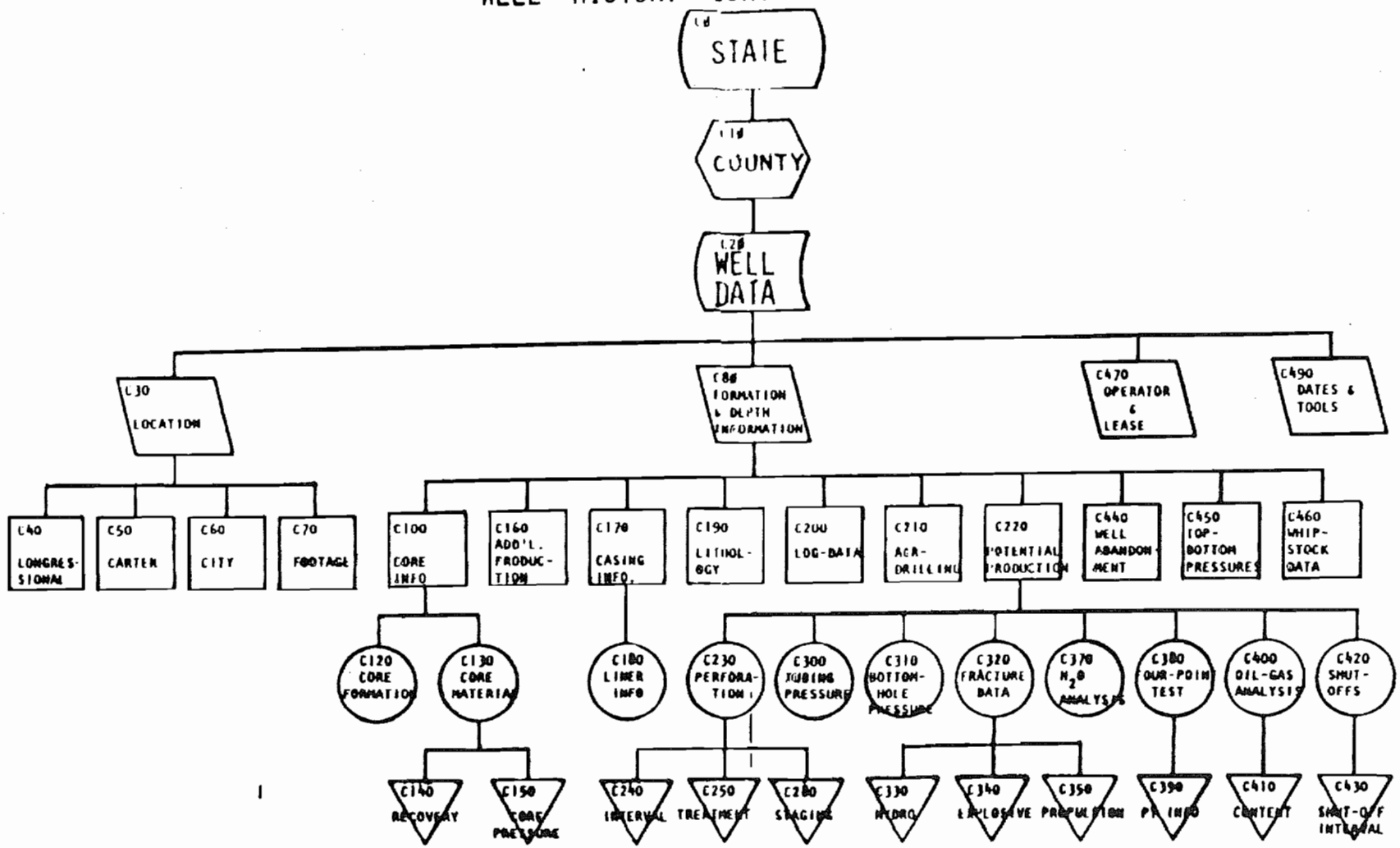
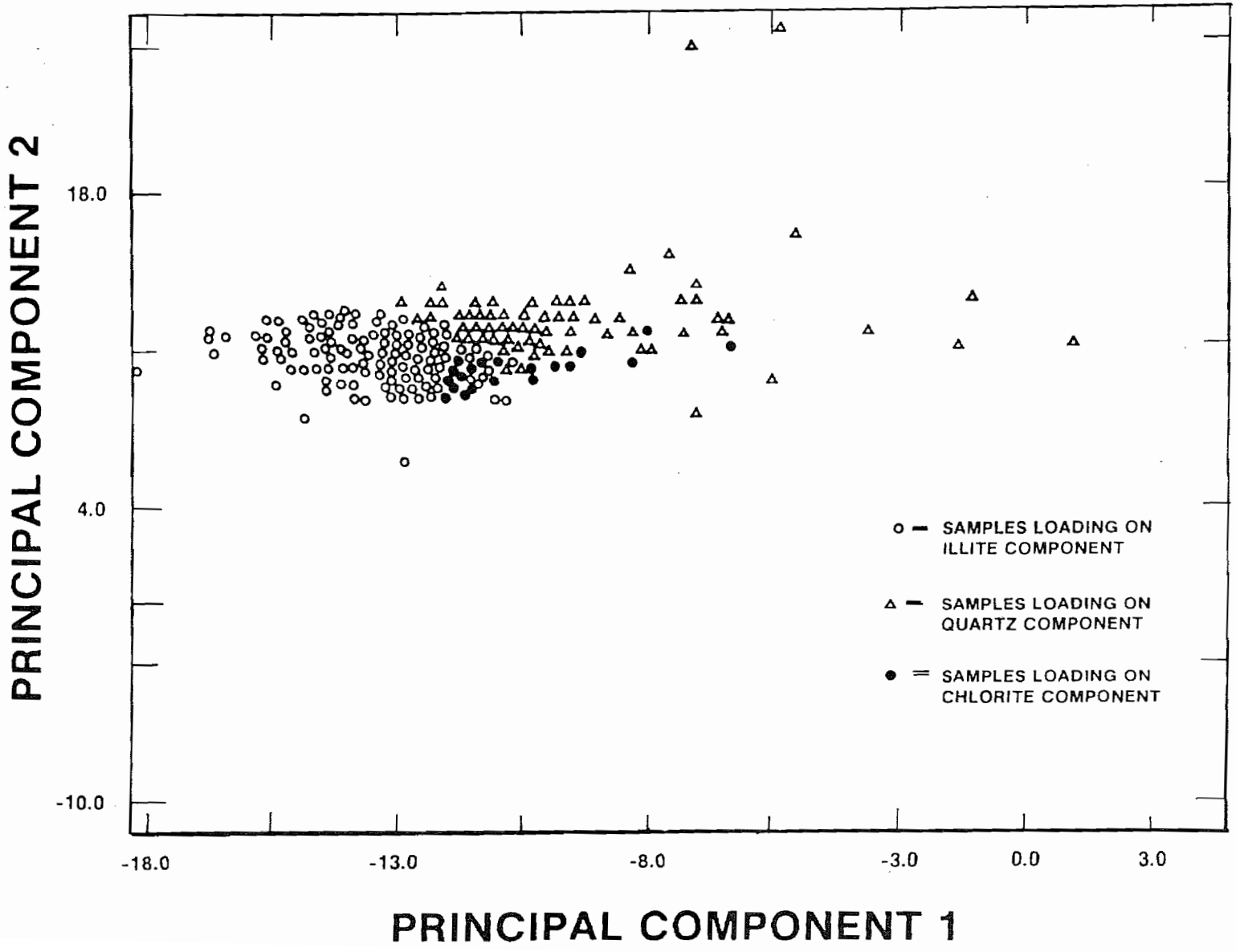
EGSP SUBFILE DATA BASE

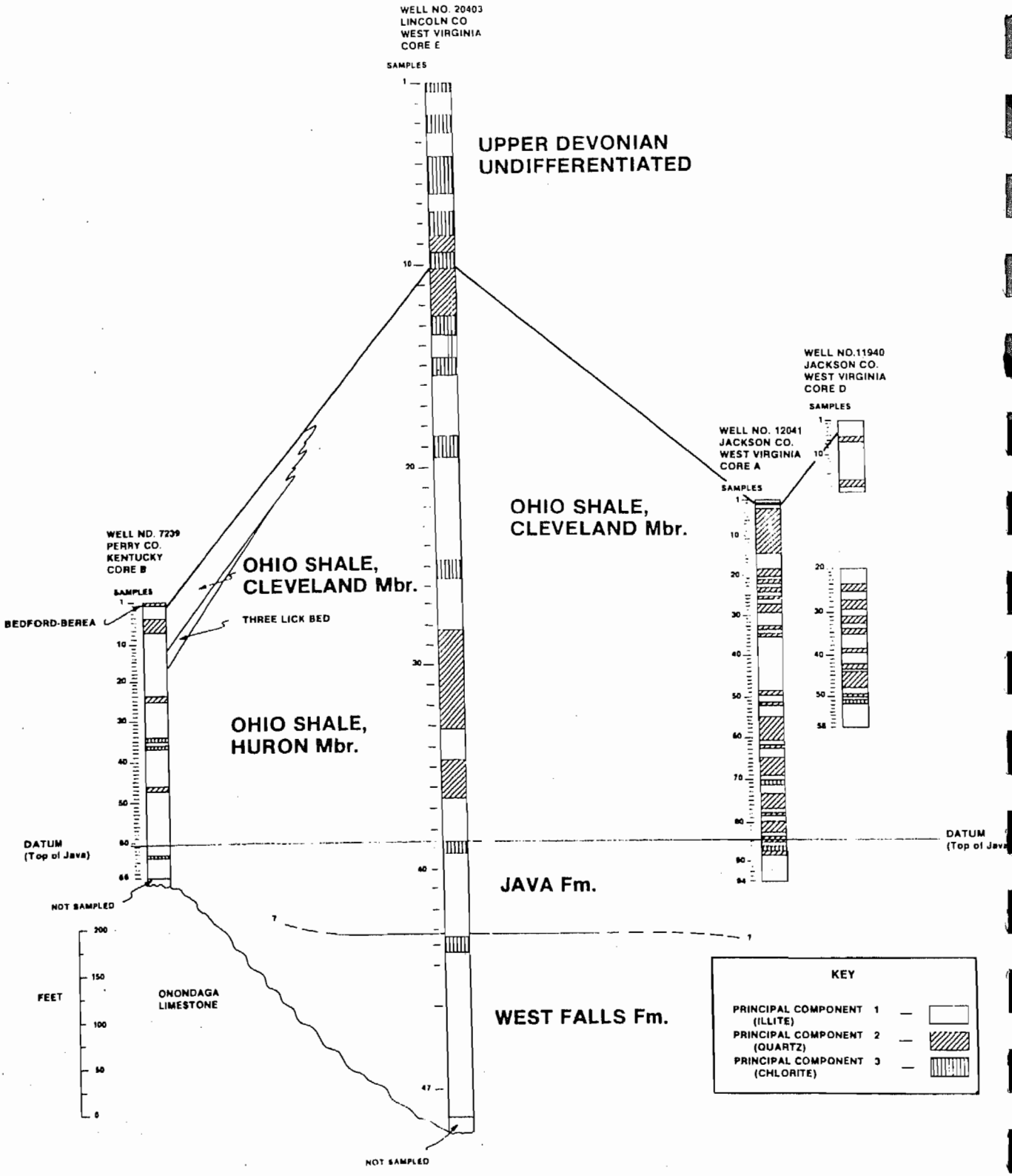


WELL HISTORY CONTROL DATA BASE

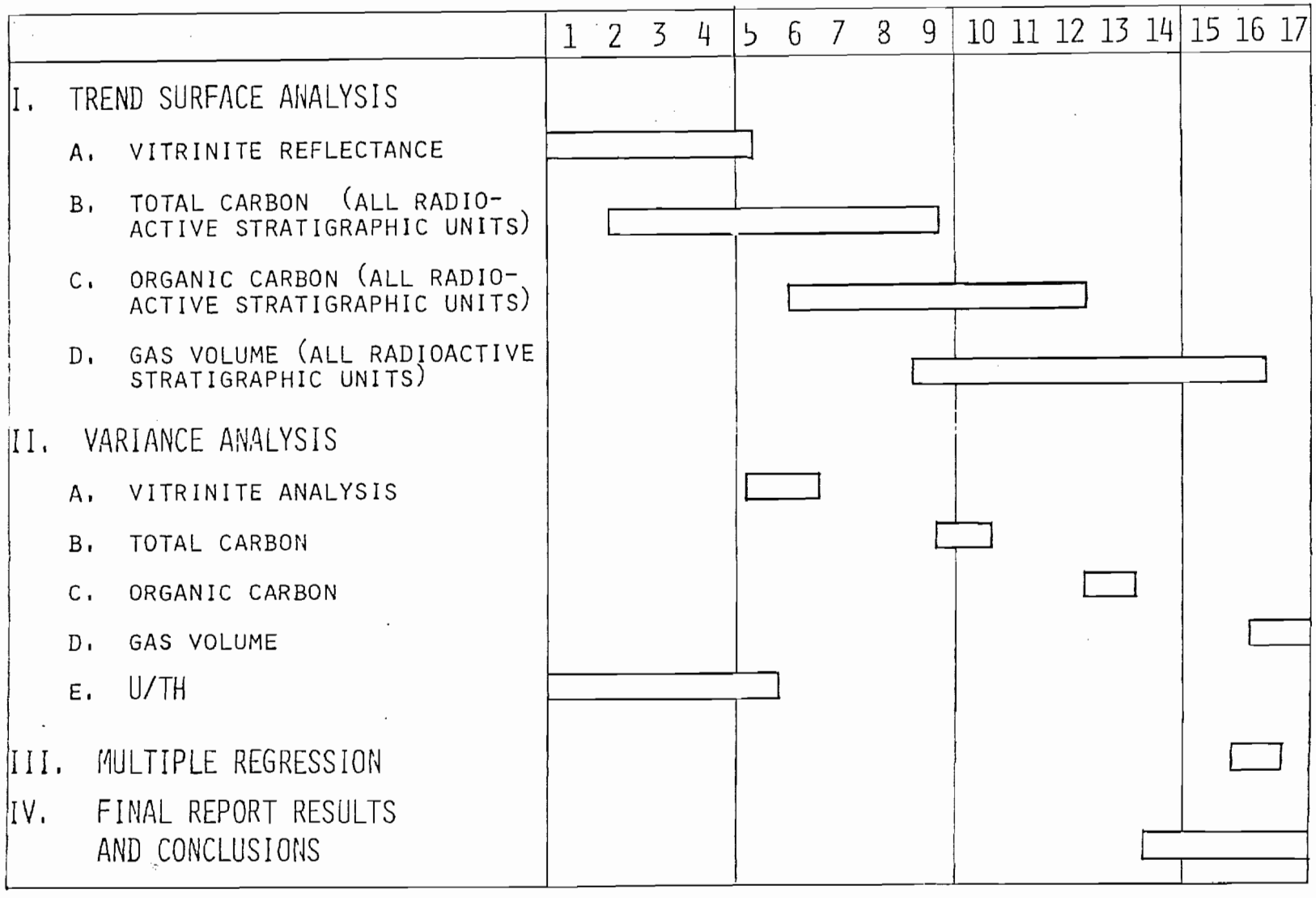


MICHIGAN
N
PENNSYLVANIA
C
OHIO
WEST
VIRGINIA
A
D
E
VIRGINIA
B
KENTUCKY


PRINCIPAL COMPONENT 2
18.0
4.0
-10.0
-18.0
-13.0
-8.0
-3.0
0.0
3.0
PRINCIPAL COMPONENT 1
o — SAMPLES LOADING ON ILLITE COMPONENT
△ — SAMPLES LOADING ON QUARTZ COMPONENT
● = SAMPLES LOADING ON CHLORITE COMPONENT


WELL NO. 20403
LINCOLN CO
WEST VIRGINIA
CORE E
SAMPLES
UPPER DEVONIAN
UNDIFFERENTIATED
WELL NO.11940
JACKSON CO.
WEST VIRGINIA
CORE D
SAMPLES
WELL NO. 12041
JACKSON CO.
WEST VIRGINIA
CORE A
SAMPLES
OHIO SHALE,
CLEVELAND Mbr.
WELL NO. 7239
PERRY CO.
KENTUCKY
CORE B
SAMPLES
OHIO SHALE,
CLEVELAND Mbr.
BEDFORD-BEREA
THREE LICK BED
OHIO SHALE,
HURON Mbr.
DATUM
(Top of Java)
DATUM
(Top of Java)
JAVA Fm.
NOT SAMPLED
FEET
ONONDAGA
LIMESTONE
WEST FALLS Fm.
NOT SAMPLED
KEY
PRINCIPAL COMPONENT 1
(ILLITE)
PRINCIPAL COMPONENT 2
(QUARTZ)
PRINCIPAL COMPONENT 3
(CHLORITE)

EGSP DATA BASE STUDY



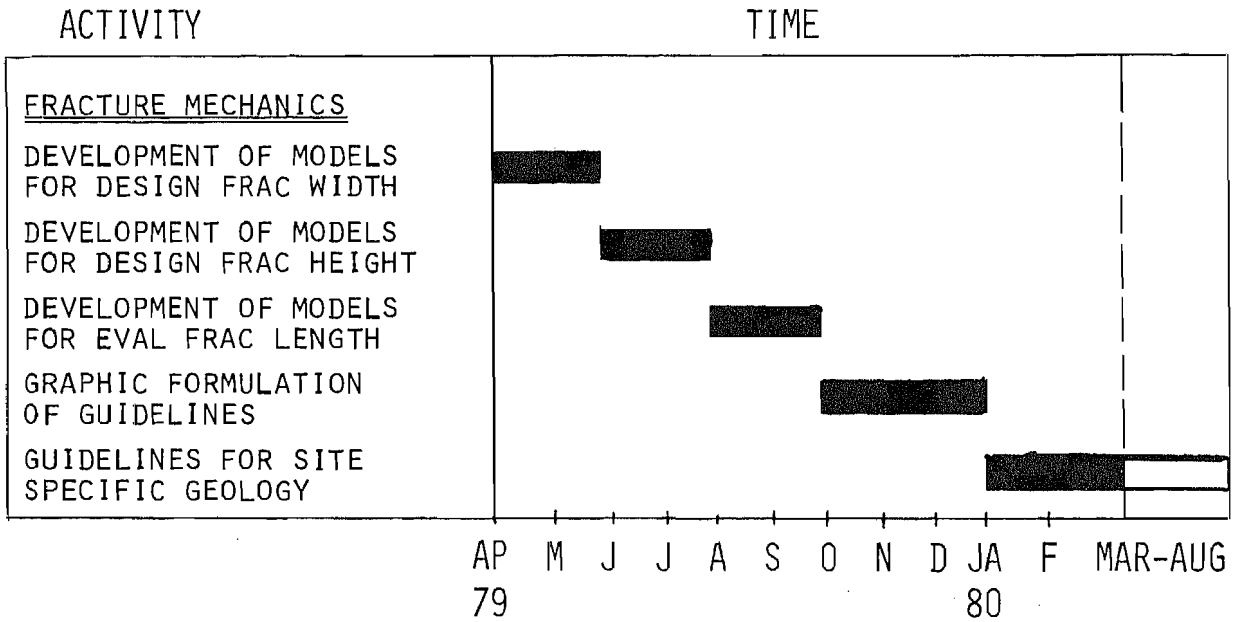
- CONTRACT: OHIO STATE UNIVERSITY
  DE-AC21-79MC10514
- CONTRACT DATE: APRIL 1979
- ANTICIPATED COMPLETION DATE: AUGUST 1980
- TOTAL COST: $62,000
- DOE COST $58,000
- OBJECTIVE:
  - TO DEVELOP ENGINEERING GUIDELINES FOR PREDICTING VERTICAL FRACTURE GEOMETRY.
  - TO PROVIDE GUIDELINES FOR STIMULATION TESTS IN METC PROGRAMS.
- SUMMARY OF PROGRESS:
  - ANALYTICAL CALCULATIONS OF FRACTURE GEOMETRY WERE MODIFIED TO INCLUDE FACTORS OF
    (A) IN SITU STRESS
    (B) LAYERING
    (C) FRACTURE FLUIDS
    (D) SAND CONCENTRATIONS
  - GRAPHICAL REPRESENTATION OF FRAC DESIGN GUIDELINES HAVE BEEN FORMULATED.
- CRITICAL ITEMS:
  - TIME EXTENSION (NO-COST) IS REQUIRED FOR PRINCIPAL INVESTIGATOR (DR. ADVANI) TO COMPLETE MONOGRAPH ON FRAC DESIGN.

KEY SOURCE ROCK PARAMETERS ARE

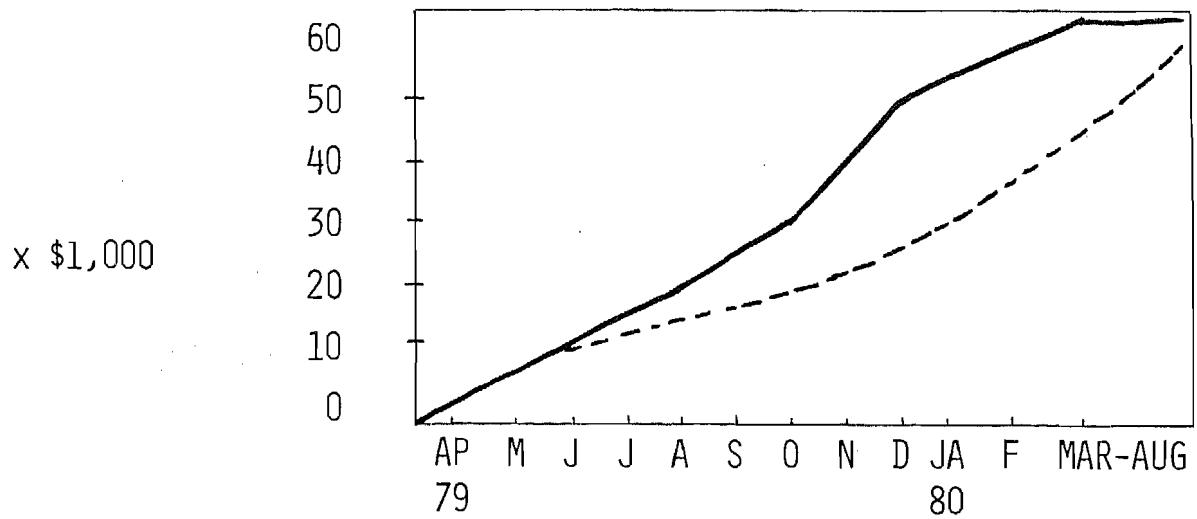
- ORGANIC CARBON CONTENT
- THERMAL MATURATION
- DEPOSITIONAL FACIES

OHIO STATE UNIVERSITY
DE-AC21-79MC10514

- MAJOR ACTIVITIES:



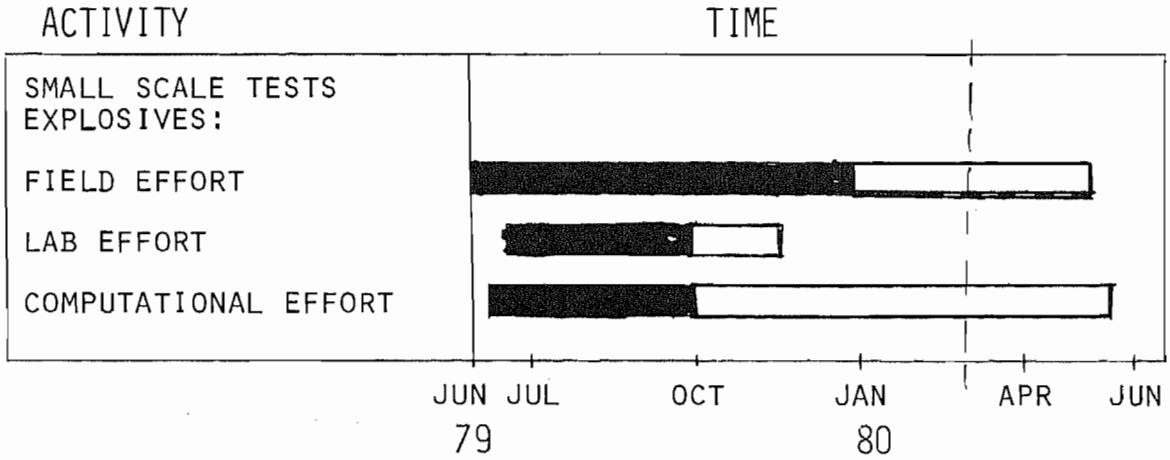
- FUNDING PROFILE:



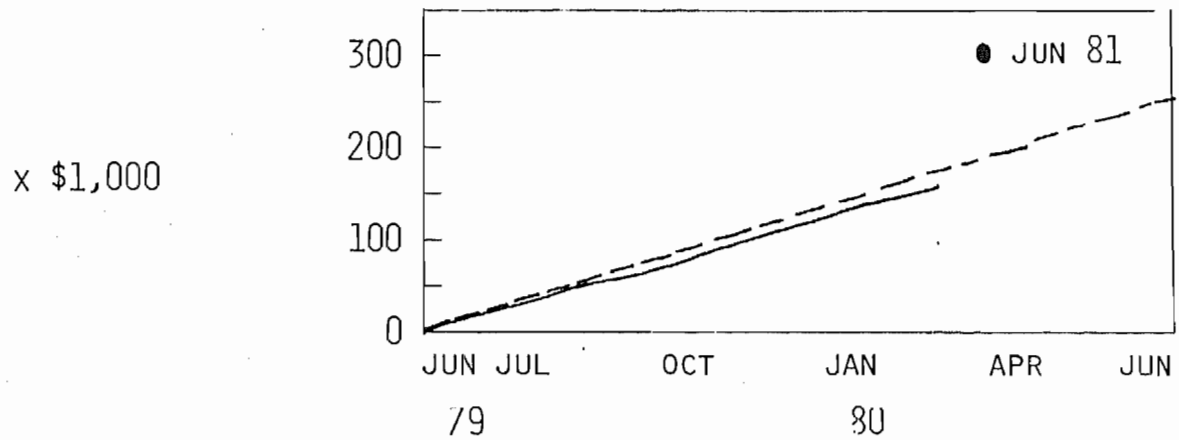
PLANNED - - - - -

ACTUAL ————————

- MAJOR ACTIVITIES:



- FUNDING PROFILE:

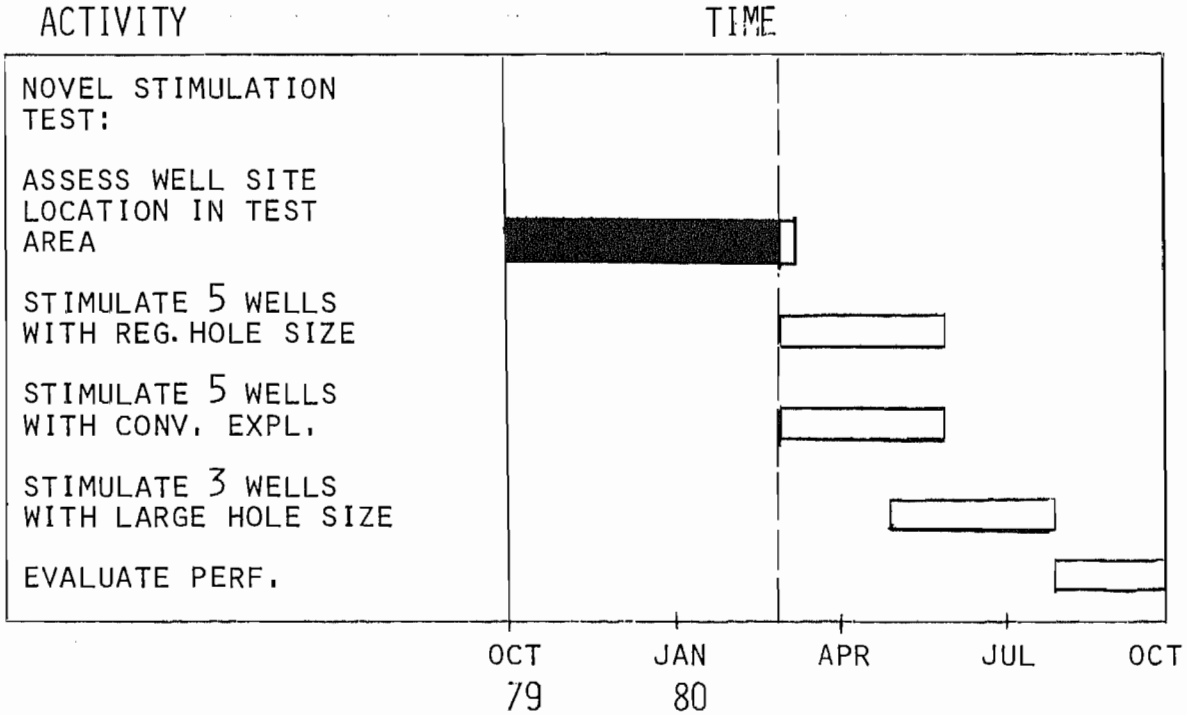


PLANNED - - - - -

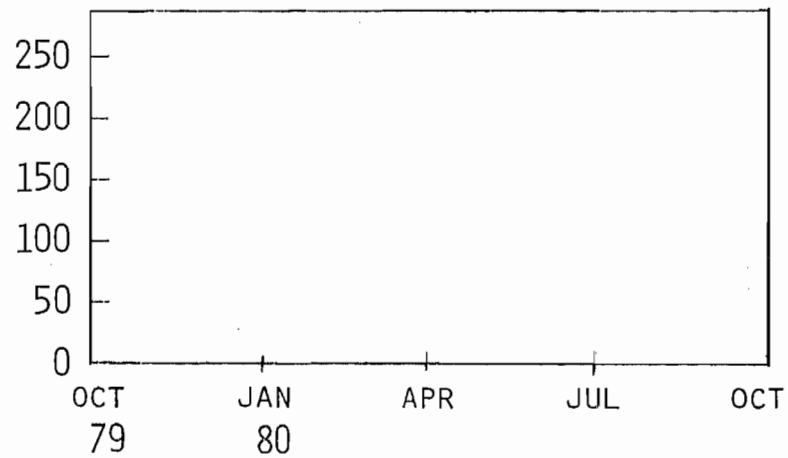
ACTUAL ————

- CONTRACT: SRI INTERNATIONAL
  DE-AC21-79MC11577
- CONTRACT DATE: JUNE 1979
- ANTICIPATED COMPLETION DATE: JUNE 1981
- TOTAL COST: $305,000
- DOE COST: $305,000
- OBJECTIVE: TO CONDUCT SMALL SCALE FIELD EXPERIMENTS TO EVALUATE THE EFFECTS PRODUCED BY TAILORED PULSE LOADING ON THE SHALE FORMATION.
- SUMMARY OF PROGRESS:
  - FIELD DESIGN EFFORTS AT NTS HAVE BEEN COMPLETED.
  - LAB EFFORTS INVOLVING SPRINGING EXPERIMENTS IN SUPPORT OF MODEL DEVELOPMENT WERE COMPLETED.
  - COMPUTATIONAL AND EVALUATION EFFORTS ARE IN PROGRESS USING THE RECENTLY ACQUIRED DATA.
- CRITICAL ITEMS:
  - POST-STIMULATION EVALUATION OF NTS TESTS OF TAILORED PULSE LOADING MAY WARRANT DESIGN APPLICATION IN <u>SHALE MINE</u> BEFORE CONTRACT CAN BE COMPLETED. ACCORDINGLY, ADDITIONAL TIME AND FUNDS MAY BE REQUIRED.

- MAJOR ACTIVITIES:



- FUNDING PROFILE:

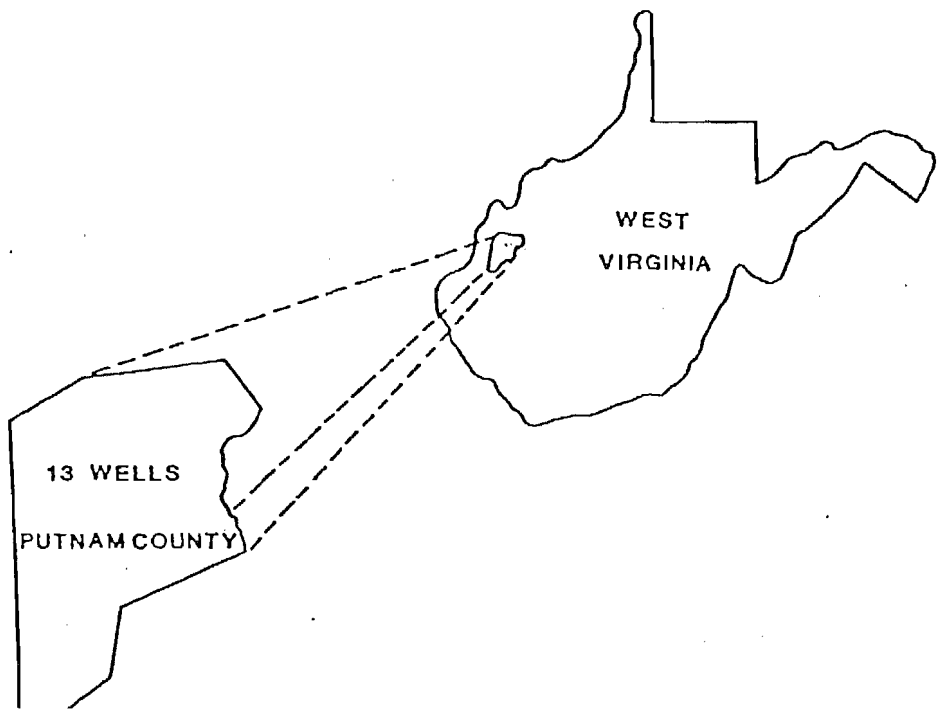


PLANNED - - - - -

ACTUAL ————

- CONTRACT: E. I. DuPONT
  DE-AC21-79MC11843
- CONTRACT DATE: SEPTEMBER 1979
- ANTICIPATED COMPLETION DATE: SEPTEMBER 1980
- TOTAL COST: $385,000
- DOE COST: $250,000
- OBJECTIVE: TO ACHIEVE A DIRECT COMPARISON OF A NOVEL GAS WELL STIMULATION TECHNIQUE WITH CONVENTIONAL EXPLOSIVE STIMULATION IN AN ESTABLISHED SHALE GAS RESERVOIR

LOCATION MAP:



E. I. DUPONT
DE-AC21-79MC11843

- SUMMARY OF PROGRESS:

  - ANALYSIS OF PHOTO TRACES AND THEIR INFLUENCE ON EXISTING PRODUCING WELLS IS NEAR COMPLETION

- CRITICAL ITEMS:

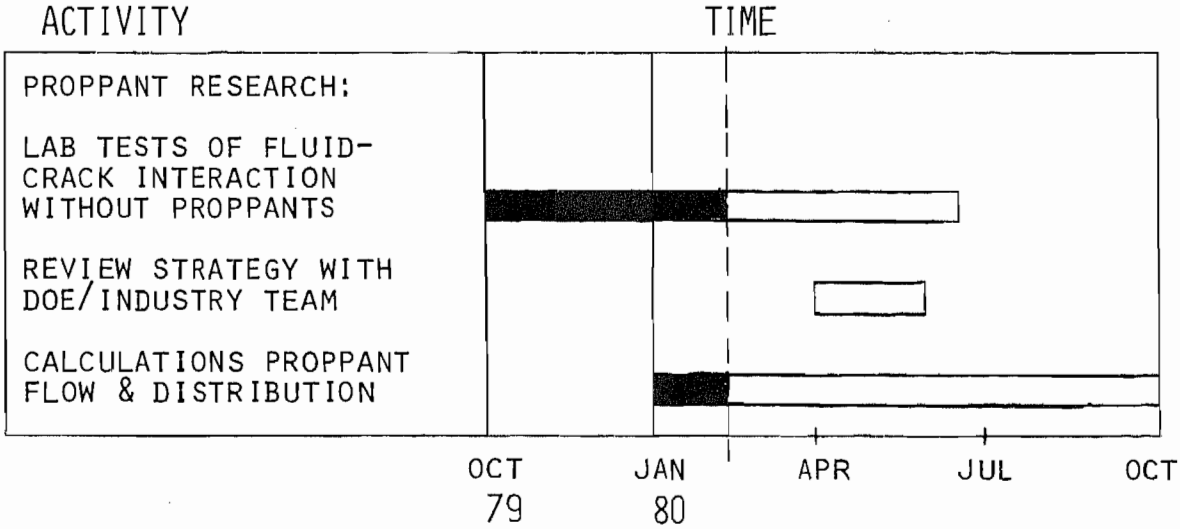
  - ADVERSE RULING BY PUC PROHIBITS CONTRACTOR'S ABILITY TO ACCESS NEW SHALE WELLS FOR THE TESTS AS PLANNED. OPTIONS NOW IN PURSUIT ARE:

    (A) CANCELLATION OF PROJECT

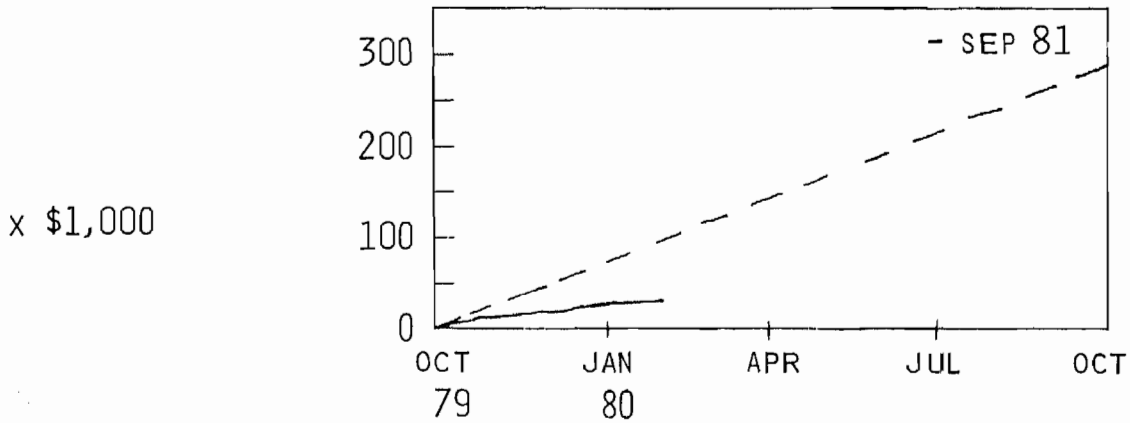
    (B) REDUCED EFFORT TO FOUR WELLS.

- CONTRACT: SRI INTERNATIONAL
  DE-AC21-79MC11597
- CONTRACT DATE: SEPTEMBER 1979
- ANTICIPATED COMPLETION DATE: SEPTEMBER 1981
- TOTAL COST: $300,000
- DOE COST: $300,000
- OBJECTIVE: TO DEVELOP PREDICTIVE CAPABILITY FOR PRODUCTIVITY OF WELLS FOLLOWING STIMULATION BY APPLICATION OF THE FLOW CYCLE TREATMENT PROCESS AND PROPPANT DISTRIBUTION THEORY.
- SUMMARY OF PROGRESS:
  - MODEL EXPERIMENTS TO ACHIEVE A VISUAL RECORD OF THE HYDROFRACTURE PROCESS WERE COMPLETED AS PLANNED.
- CRITICAL ITEMS:
  - NONE

- MAJOR ACTIVITIES:



- FUNDING PROFILE:

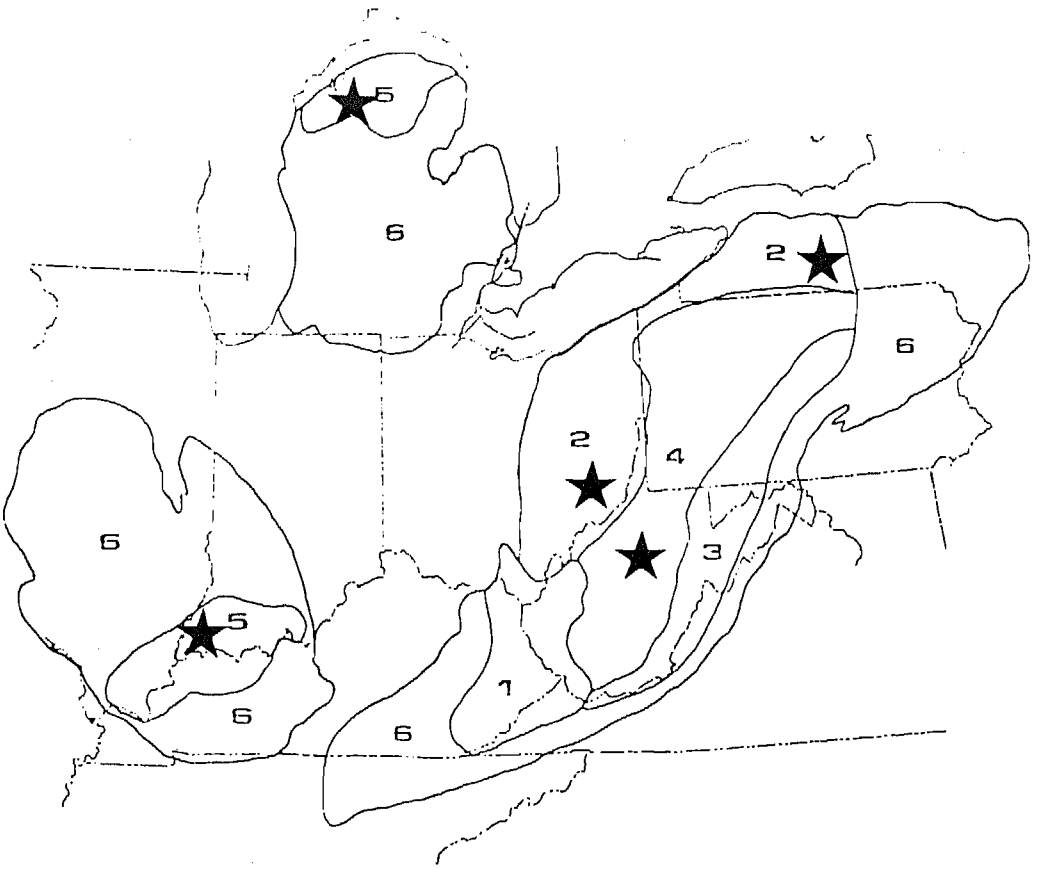


PLANNED - - - - -

ACTUAL ————

- CONTRACT: TERRA TEK
- CONTRACT DATE: MARCH 1980
- ANTICIPATED COMPLETION DATE: FEBRUARY 1981
- TOTAL COST: $150,000
- DOE COST: $150,000
- OBJECTIVE: TO DEVELOP ENGINEERING EVALUATION OF FLUID COMPATIBILITY WITH SHALE FROM DIFFERENT GEOLOGIC REGIONS. MEASUREMENTS INCLUDE MATRIX PERMEABILITY, CRACK CLOSURE VERSUS STRESS AND FRACTURE CONDUCTIVITY.

- LOCATION MAP:



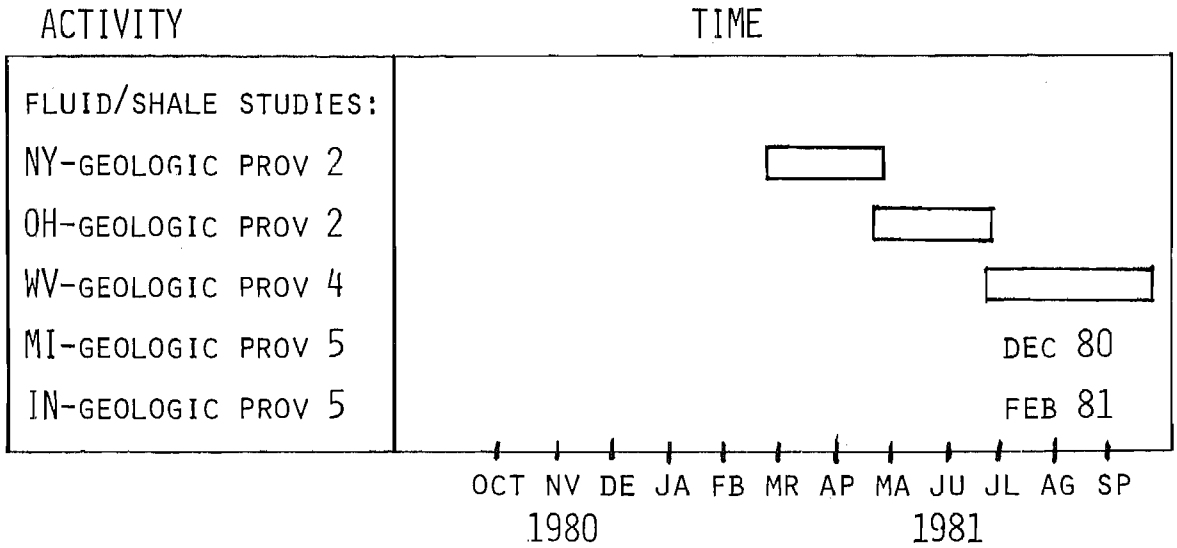
- SUMMARY OF PROGRESS:

  - DEVELOPMENT OF TEST DESIGN COMPLETED - OHIO
  - TESTING PROJECT JUST INITIATED

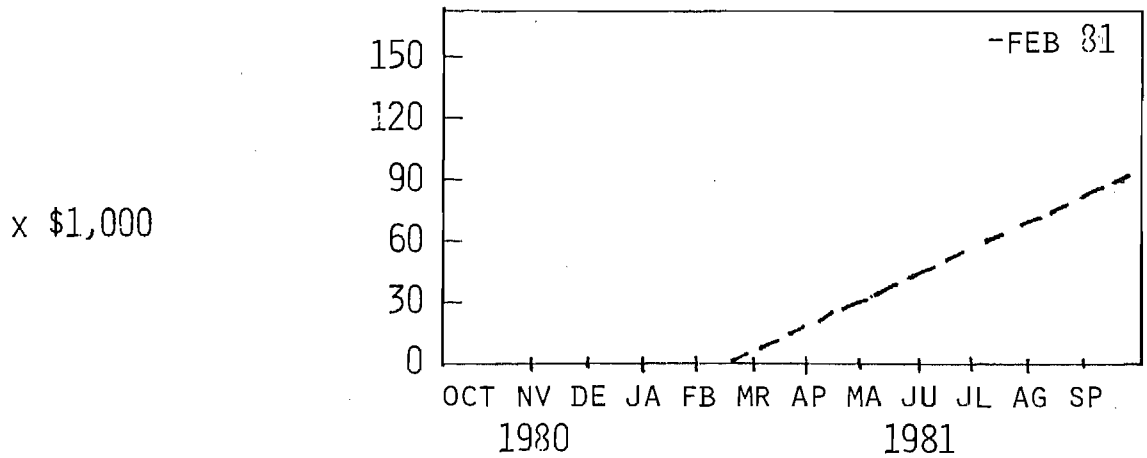
- CRITICAL ITEMS:

  - NONE ANTICIPATED

- MAJOR ACTIVITIES:



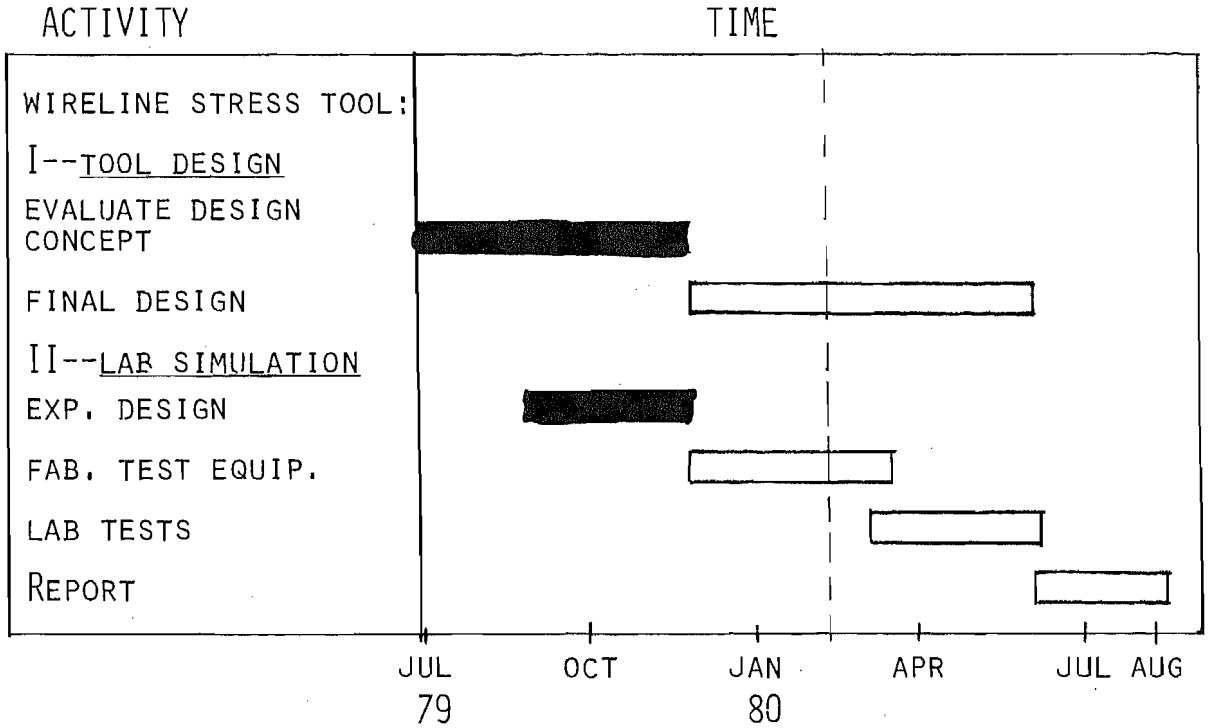
- FUNDING PROFILE:



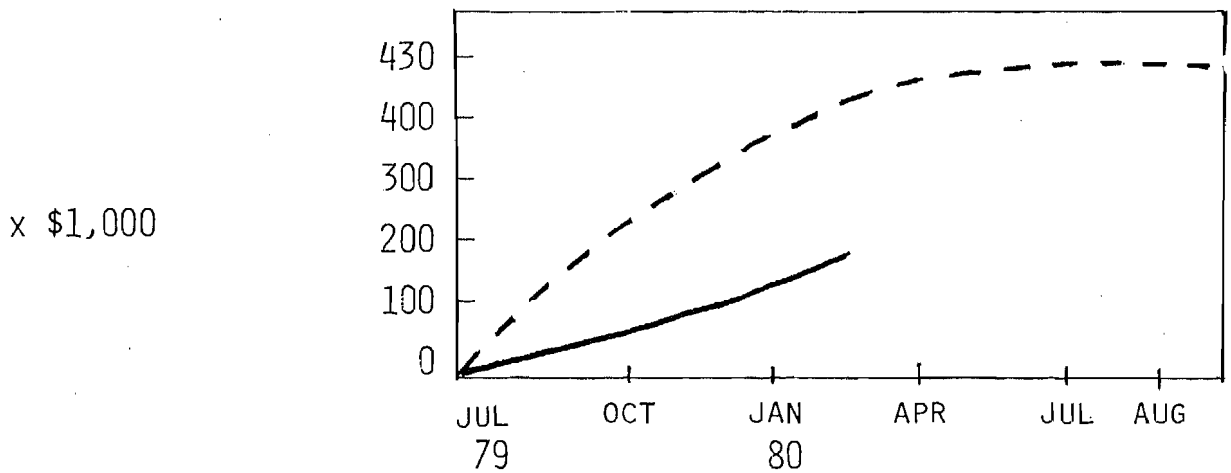
PLANNED - - - - -

ACTUAL ————

- MAJOR ACTIVITIES:



- FUNDING PROFILE:



PLANNED - - - -

ACTUAL ————

- CONTRACT: TERRA TEK
  DE-AC21-79MC11047
- CONTRACT DATE: JULY 1979
- ANTICIPATED COMPLETION DATE: AUGUST 1980
- TOTAL COST: $430,000
- DOE COST: $430,000
- OBJECTIVE: TO DESIGN A WIRELINE TOOL THAT WILL DETERMINE THE MINIMUM IN SITU STRESS MAGNITUDE AND ORIENTATION.
- SUMMARY OF PROGRESS:
  - PRELIMINARY DESIGN OF WIRELINE TOOL CONCEPT COMPLETED FOR PEER REVIEW.
- CRITICAL ITEMS:
  - DECISION POINT: PENDING UPON SUCCESSFUL ENDORSEMENT OF DESIGN BY DOE/INDUSTRY EVALUATION TEAM.

GOALS:

1. ESTABLISH THE EXISTING IN-SITU FRACTURE SPACING THROUGH ACTUAL INSPECTION.

2. OBSERVE AND MEASURE IN-SITU GAS DIFFUSION RATES AND STORAGE CHARACTERISTICS OF THE SHALE.

3. STUDY THE CHANGE IN GAS LIBERATION DUE TO STIMULATION THROUGH

   A) SHOT WELLS AND

   B) HYDRAULIC FRACTURES

4. STUDY VARIATIONS IN PHYSICAL CHARACTERISTICS OF THE SHALE AFTER STIMULATION AND FRACTURING.

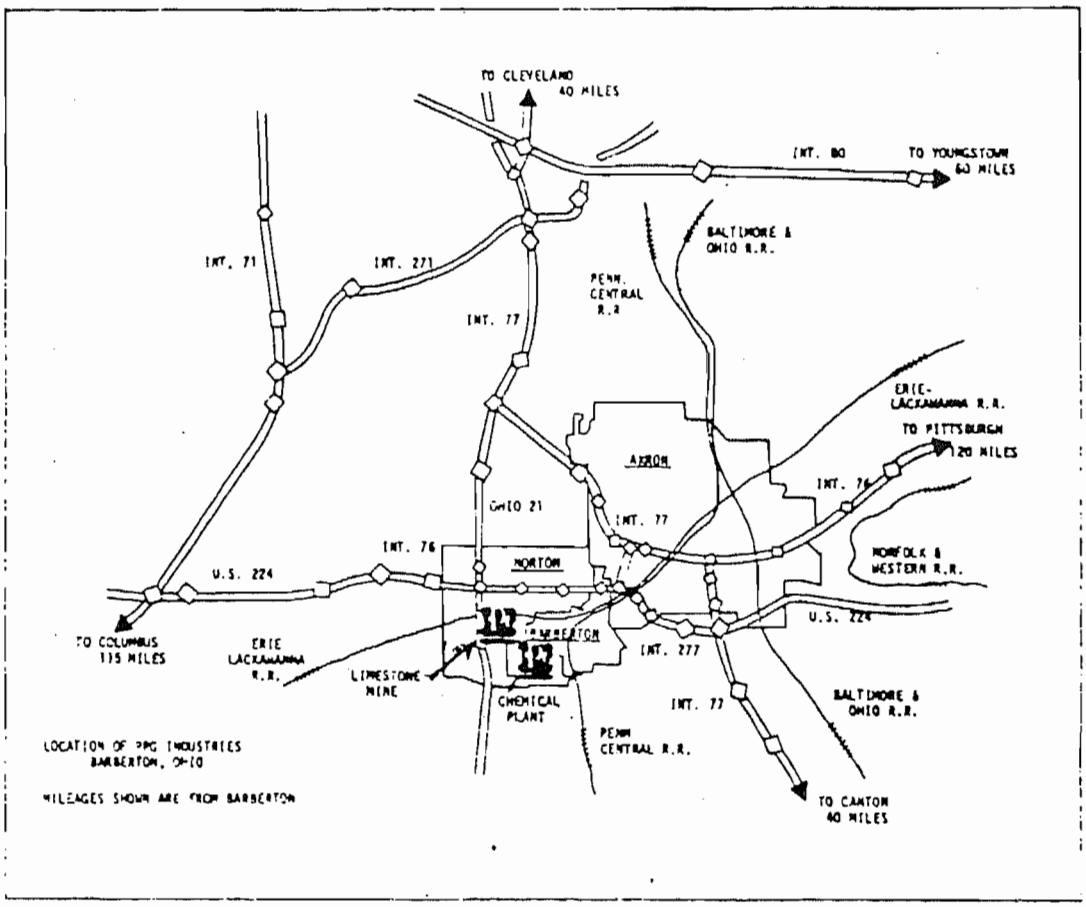
LOCATION

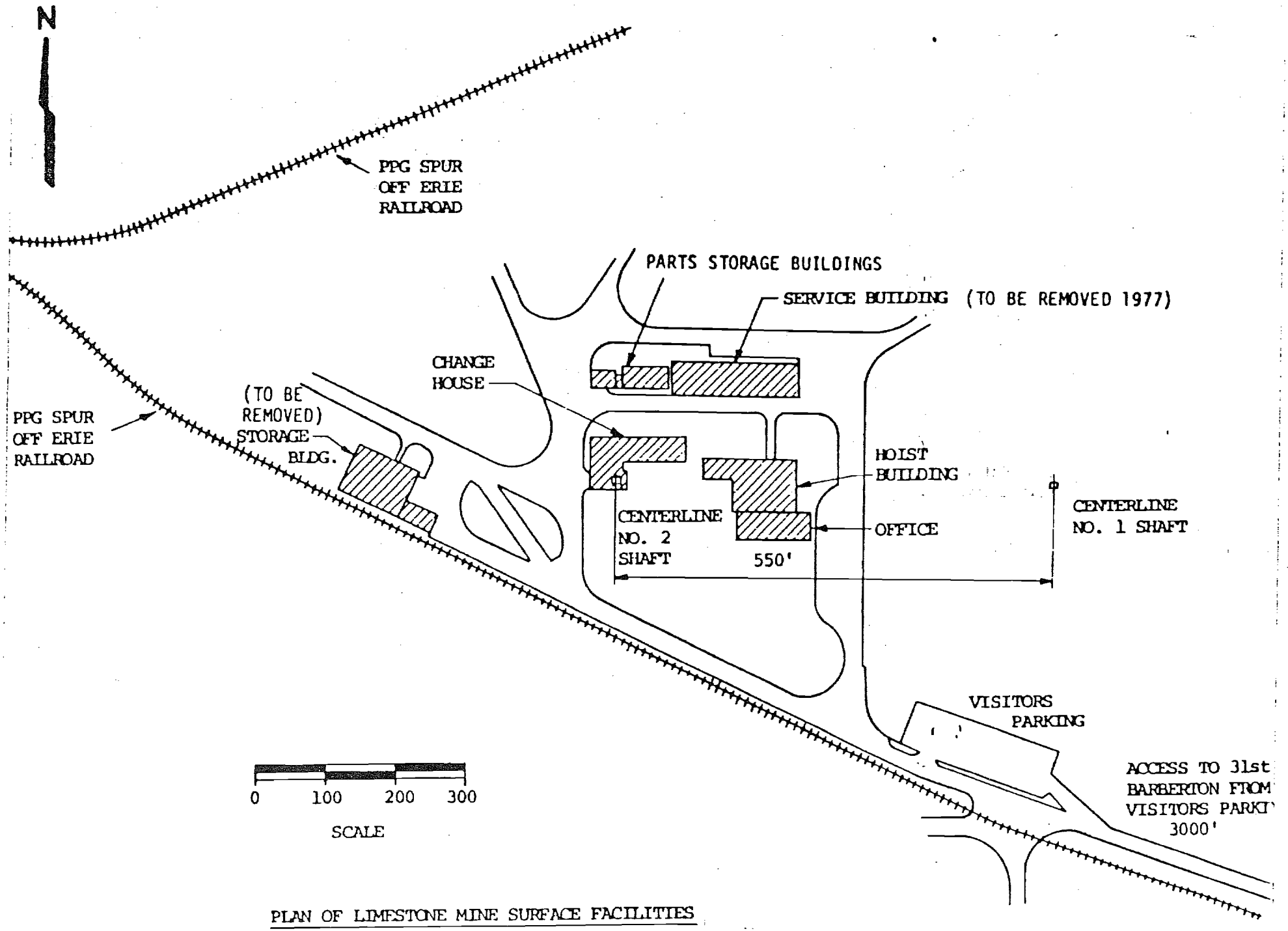
The mine is located within the Municipal boundaries of Norton in Summit County, Ohio.

No. 1 shaft is shown on USGS Wadsworth Quadrangle Map at coordinates East - 2,234,900 (X) and North - 492,000 (Y) on the Ohio 10,000 Foot Grid System, North Zone. (See Page 4)

Location with respect to highways and rail system is shown below.

A plan of mine surface facilities and access road is shown on Page 5.





PLAN OF LIMESTONE MINE SURFACE FACILITIES

GEOLOGIC CROSS SECTION

CORRELATED TO SHAFT NO. 1 IN BARBERTON MINE

GEOLOGIC TIME	SECTION	DEPTH FROM SURFACE	ROCK TYPE	REMARKS
		580	Cleveland Shale	
		640	Chagrin Shale	
		1100	Huron Shale	
		1948		Experimental Mine
DEVONIAN		2089	Hamilton Shale	
		2197	Delaware Limestone	
		2202 2248	Columbus Limestone	Existing Mine
		2417	Lucas Dolomite	
		2453	Sylvania Sandstone	
SILURIAN		2457		

FIGURE A-2

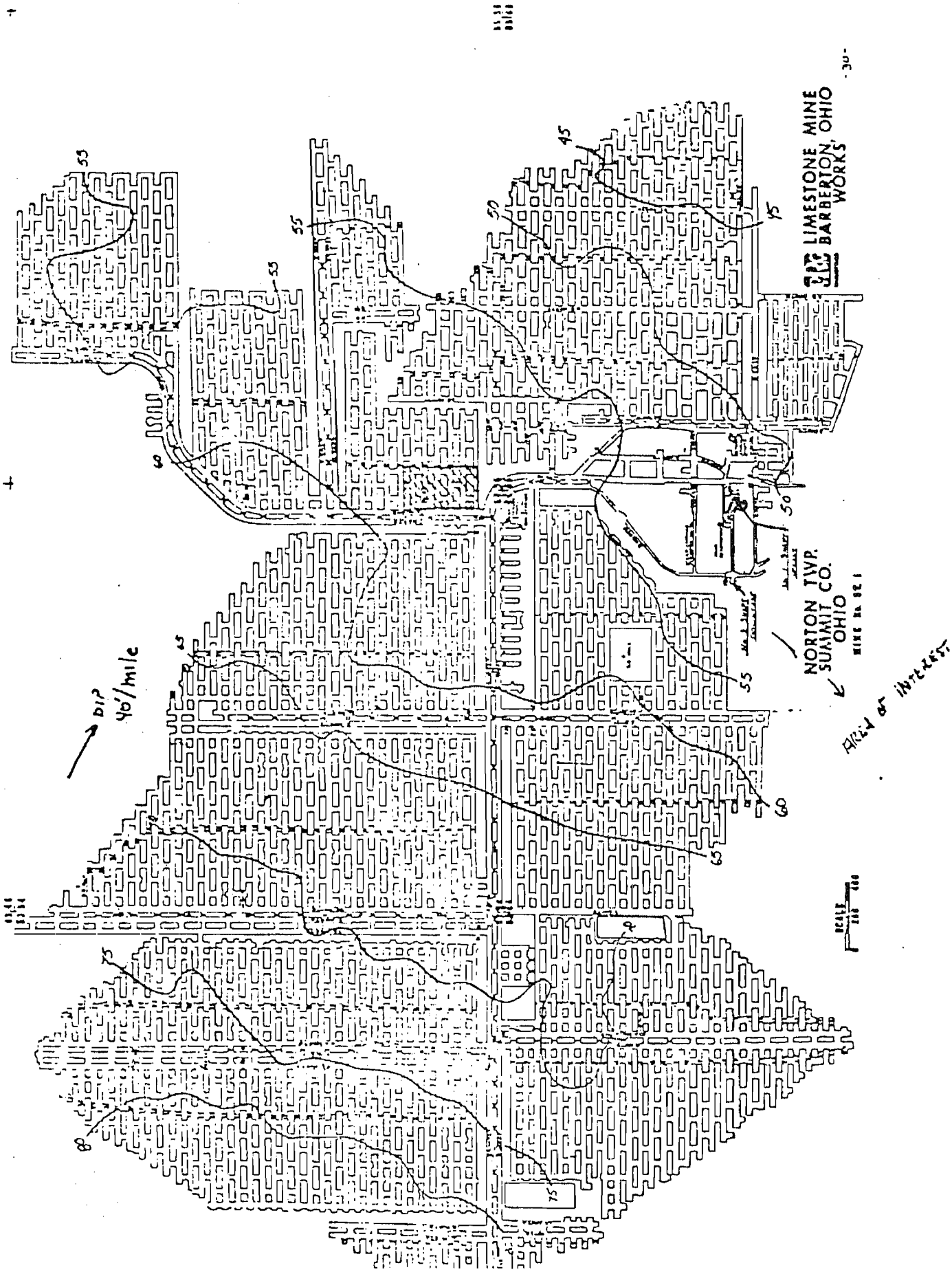

LIMESTONE MINE
BARBERTON, OHIO
WORKS
NORTON TWP.
SUMMIT CO.
OHIO
AREA OF INTEREST
DIP
40'/mile

FIGURE 1

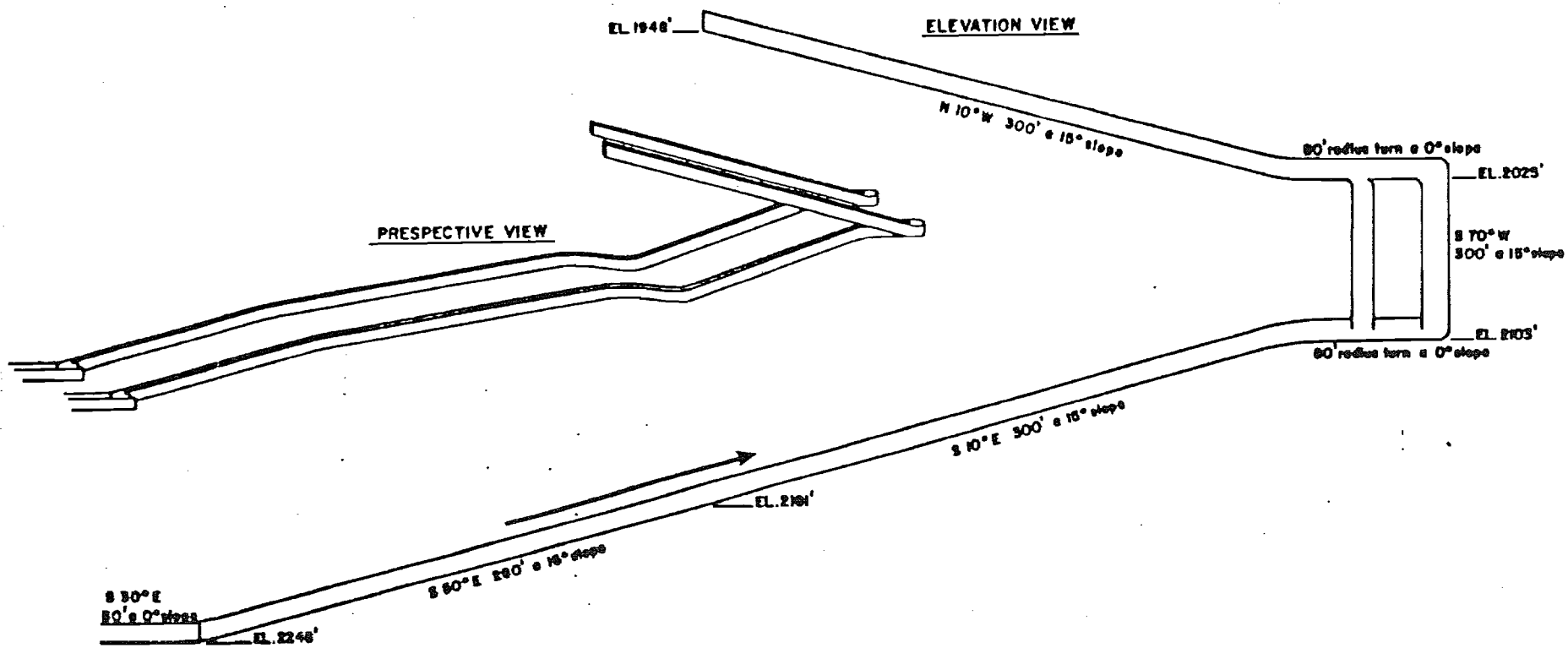
DEVONIAN SHALE DEVELOPMENT, MINE BACK

Barberton, Ohio

PLAN VIEW

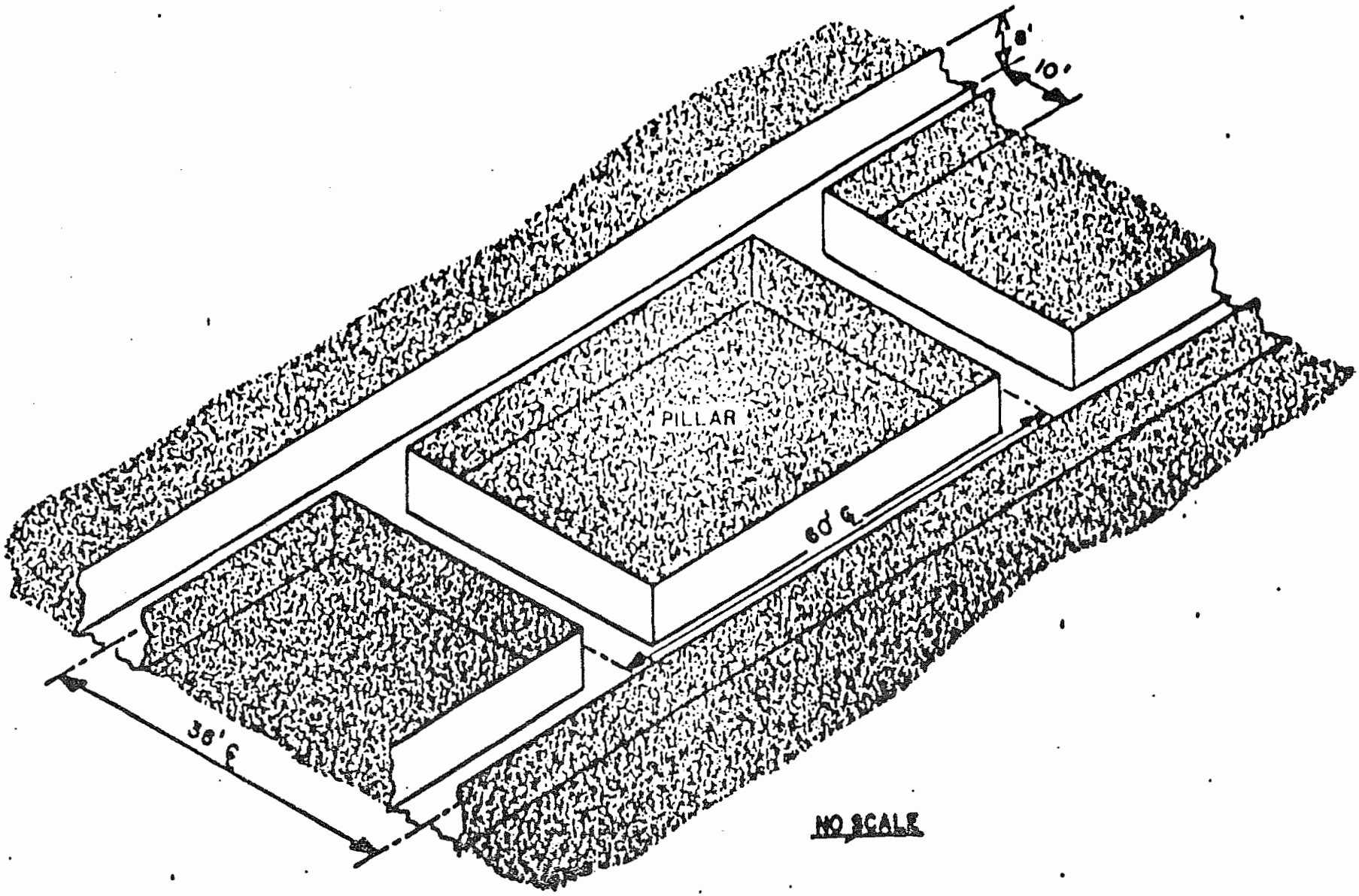
SCALE: 1"=50'

DEVONIAN SHALE DEVELOPMENT, MINE BACK

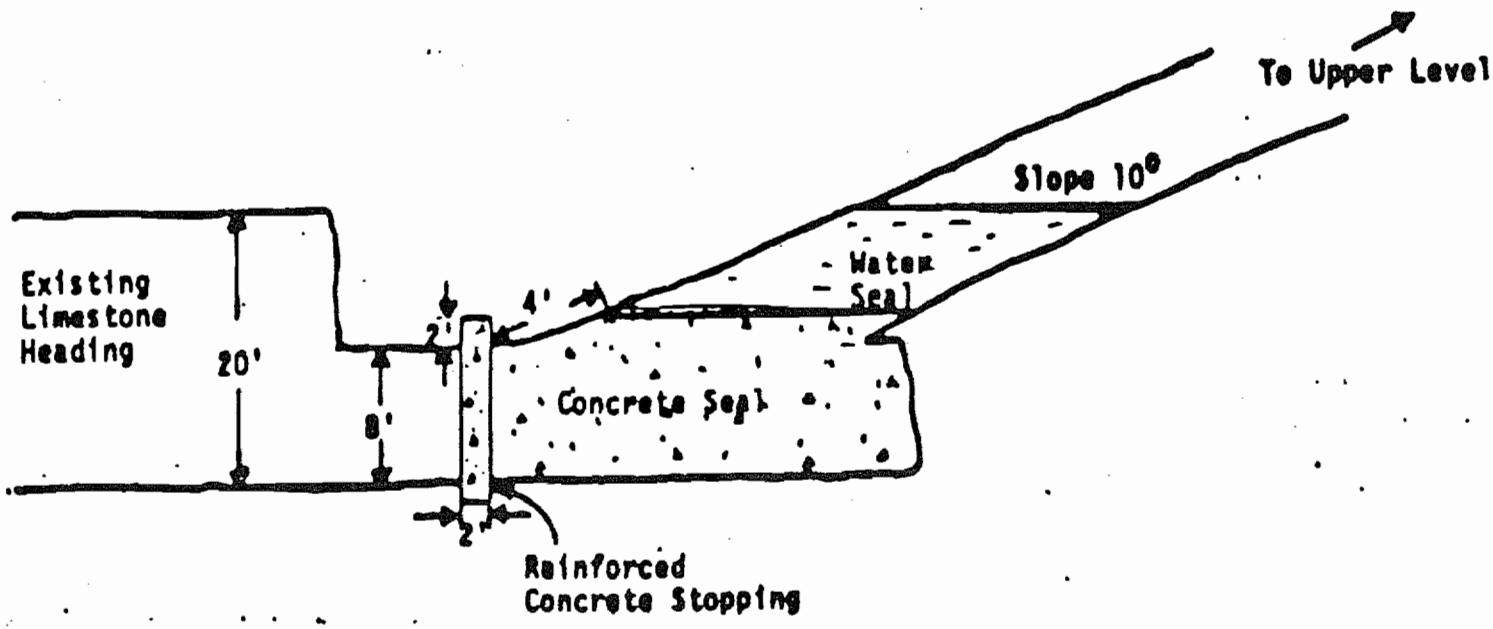


DEVONIAN SHALE DEVELOPMENT, MINE BACK

ISOMETERIC VIEW



NO SCALE



CROSS SECTION OF THE SEAL (Not To Scale)

E.G.S.P. MINEBACK TESTS AND OBJECTIVES

IN-SITU STRESS

- Over core during Mining
- Mini frac in test holes

IN-SITU FRACTURE SYSTEM

- Mapping during mining
- Detailed mapping during mineback
- Test hole injection tests
- Test hole TV/camera log

DESORPTION STUDIES

- Methane release during mining
- Outgassing of samples
- In-situ outgassing?

HYDRAULIC FRACTURE PROPAGATION

- Mineback for length, height, and orientation
- Mineback for interaction with natural fractures
- Mineback for proppant erosion
- Borehole tests for production modification

PROPPANT PLACEMENT

- Mineback for sand transport
- Mineback for natural fracture offsets

EXPLOSIVE STIMULATION EFFECTS

- Mineback for fracture length and morphology
- Borehole tests for production modification
- Mineback and in-situ stress for wellbore damage

TAILORED PULSE LOADING EFFECTS

- Mineback for maximum fracture length
- Mineback and in-situ stress for wellbore damage
- Borehole tests for production modification

OBJECTIVES:

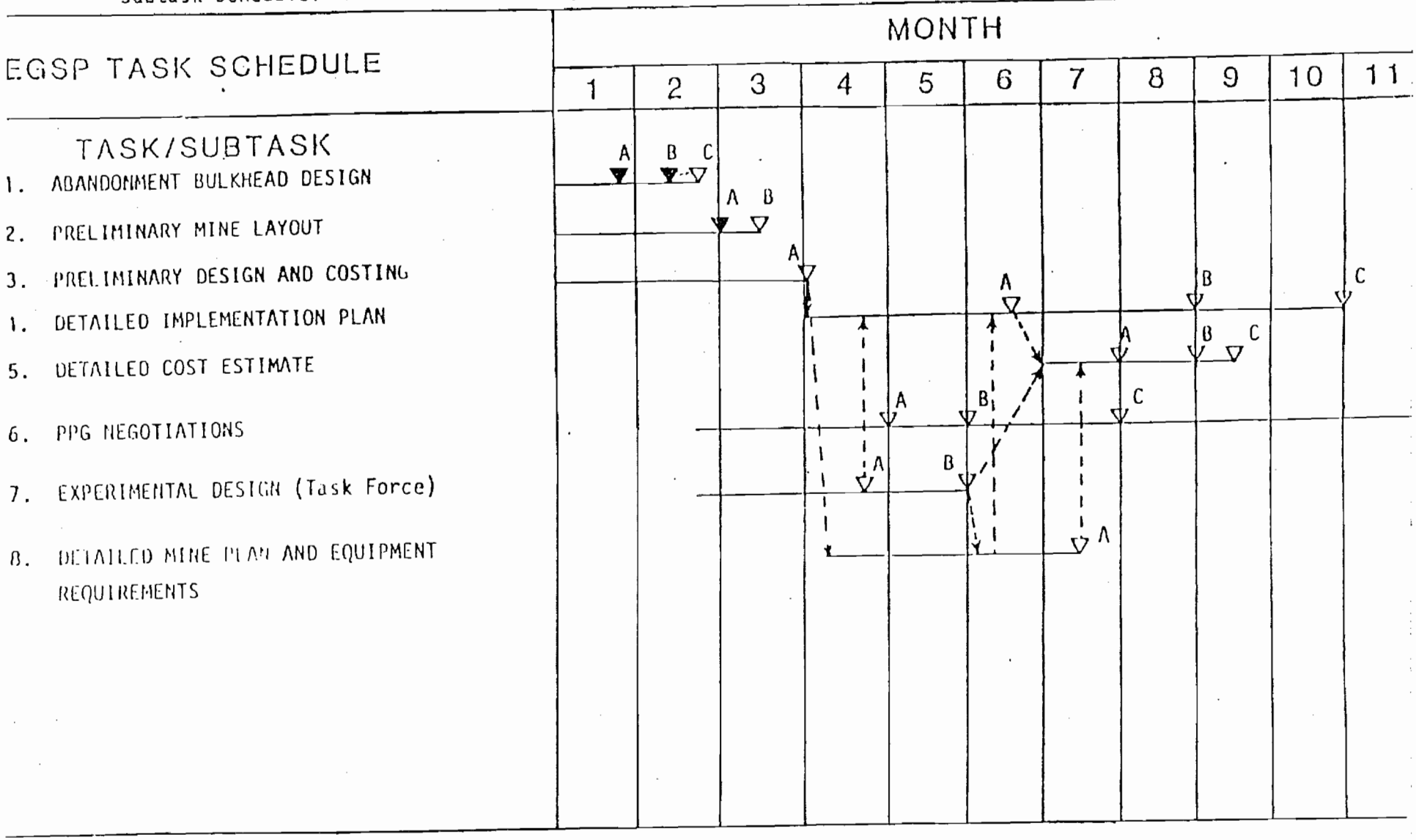
1. TO NEGOTIATE AND LEASE AN AREA WHERE AN UNDERGROUND EXPERIMENTAL MINE MAY BE DEVELOPED IN THE DEVONIAN SHALE AT A CONSIDERABLE DEPTH FOR THE STIMULATION TESTS.

2. TO DESIGN THE ACCESS SYSTEM AND THE EXPERIMENTAL MINE.

3. TO DEVELOP A PLAN OF EXPERIMENTS.

4. A DETAILED COST ESTIMATE FOR THE COMPLETE OPERATION.

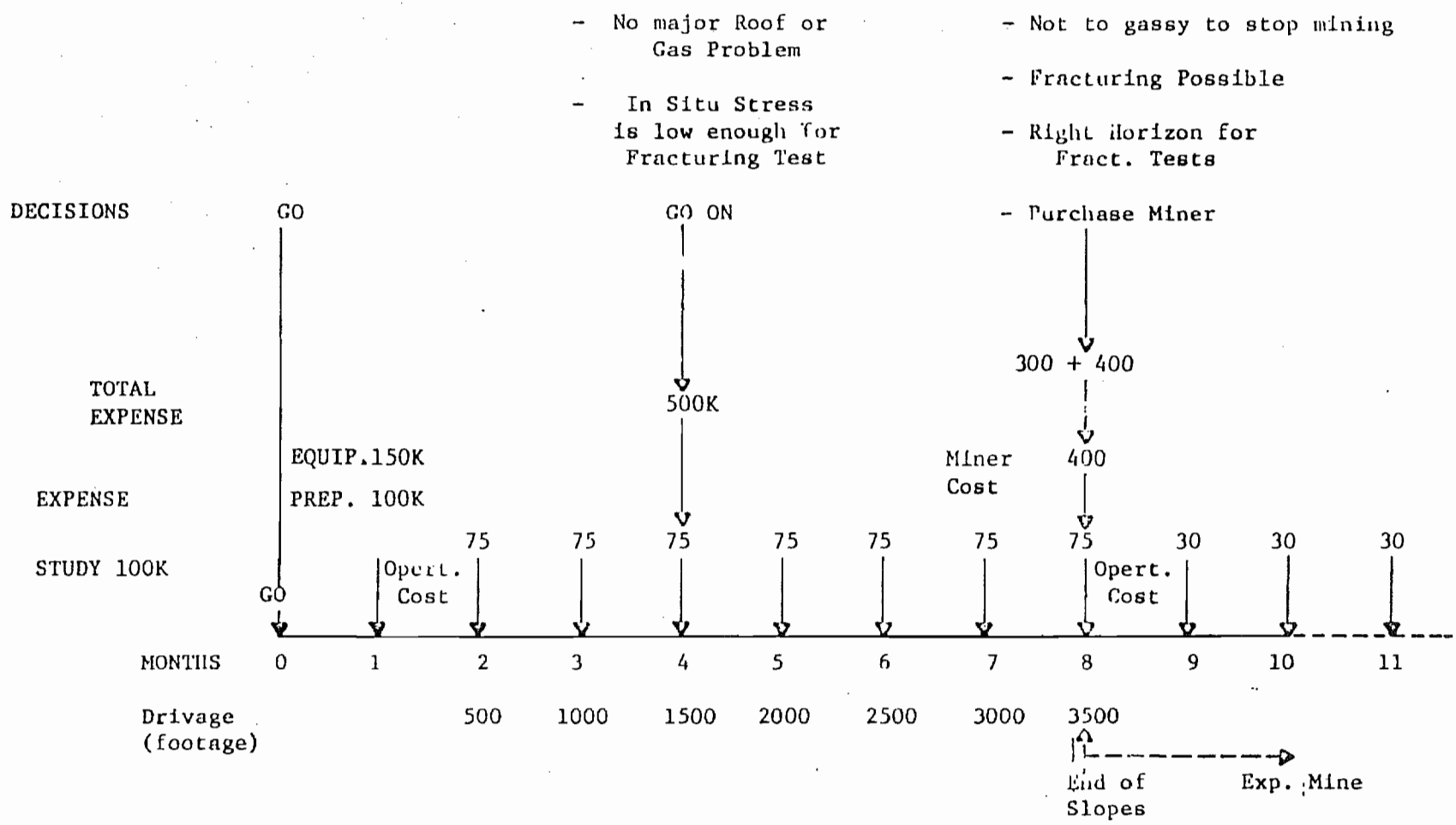
Subtask Schedule: Mineback Feasibility Study (Modification)



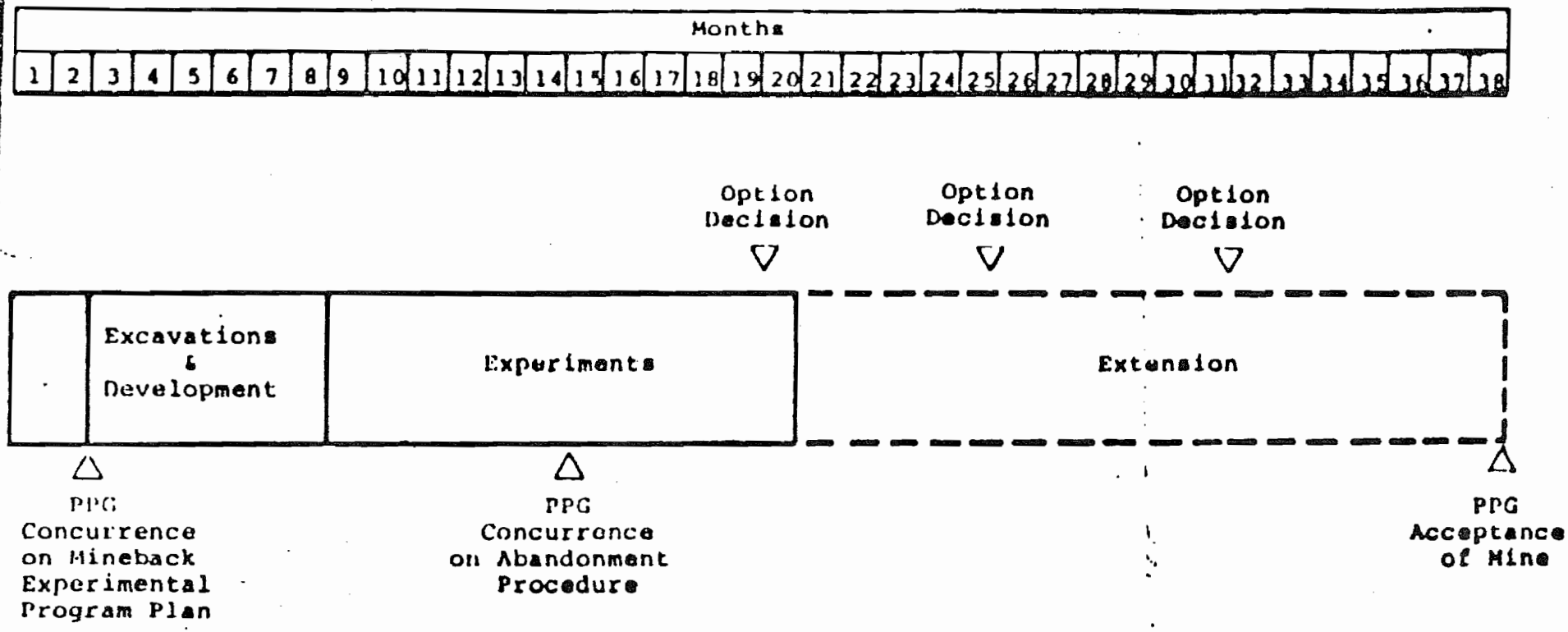
MILESTONE LEGEND

1A Complete Design
B Design Acceptance
C Mine Safety and Health Administration (MSHA) Approval
2A Mine Layout
B Acceptance by PPG and MSHA
3A Preliminary Report
4A MRI
[redacted]

5A Mining Costs
B Experiment Costs
C Final Report
6A Typical Lease
B METC Approval
C Ops. off. Legal Approval
D PPG/DOE Signed Lease
7A [redacted] of Experiments
B Detailed Design Complete


- No major Roof or Gas Problem
- In Situ Stress is low enough for Fracturing Test
- Not to gassy to stop mining
- Fracturing Possible
- Right Horizon for Fract. Tests
DECISIONS
GO
GO ON
- Purchase Miner
TOTAL EXPENSE
300 + 400
500K
EXPENSE
EQUIP.150K
PREP. 100K
Miner Cost
400
STUDY 100K
GO
Opert. Cost
75
75
75
75
75
75
75
Opert. Cost
30
30
30
MONTHS
0
1
2
3
4
5
6
7
8
9
10
11
Drivage (footage)
500
1000
1500
2000
2500
3000
3500
End of Slopes
Exp. Mine

Program Plan



ESTIMATED MINEBACK PROJECT COSTS

MINE PREPARATION	100K
MINE EQUIPMENT	150K
MINER	400K
LEASE (38 MONTHS)	25K/MONTH
TUNNEL DRIVING (8 MONTHS)	75K/MONTH
OPERATIONAL COSTS (30 MONTHS)	30K/MONTH
SURFACE BOREHOLE	400K
R & D COSTS (30 MONTHS)	75K/MONTH
TOTAL ESTIMATED COSTS (38 MONTHS)	6,000K

Dave Northrop

MULTIPLE FRACTURING

This is based on MHF and Explosive Fracturing.

OBJECTIVES

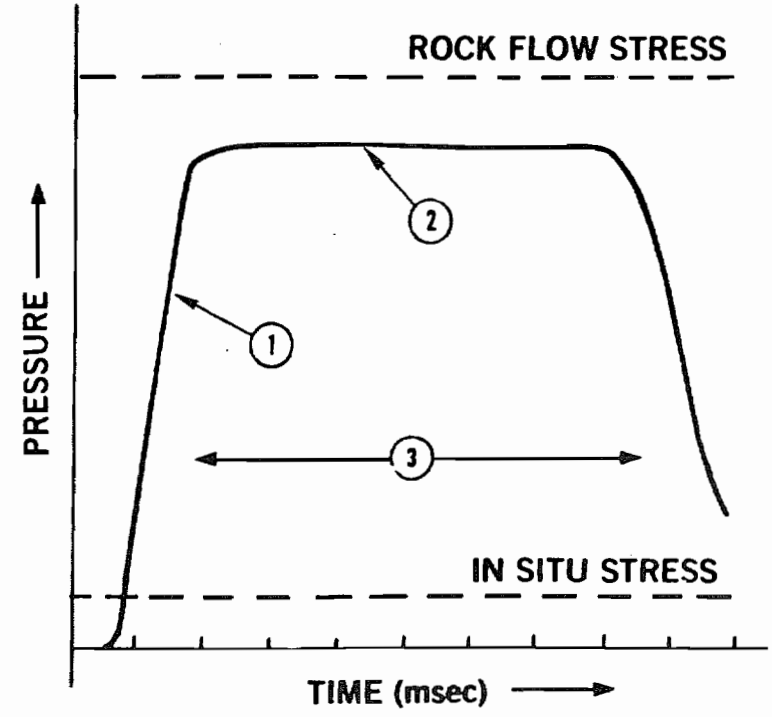
- TO CREATE MULTIPLE FRACTURES RADIATING FROM A WELLBORE
- TO AVOID THE LIMITATIONS OF:

HYDRAULIC FRACTURING	-	SINGLE FRACTURE PLANE
	-	ORIENTATION DICTATED BY IN SITU STRESSES
EXPLOSIVE FRACTURING	-	WELLBORE DAMAGE
	-	RESIDUAL STRESS EFFECTS

MULTIPLE FRACTURING

IDEALIZED LOADING CURVE

1. PRESSURE LOADING RATE RAPID ENOUGH TO CREATE MULTIPLE FRACTURES
2. PEAK PRESSURES CONSIDERABLY ABOVE IN SITU STRESS BUT BELOW FLOW STRESS OF THE ROCK
3. DURATION SUFFICIENT TO ALLOW FLUID PENETRATION AND EXTENSION OF FRACTURES



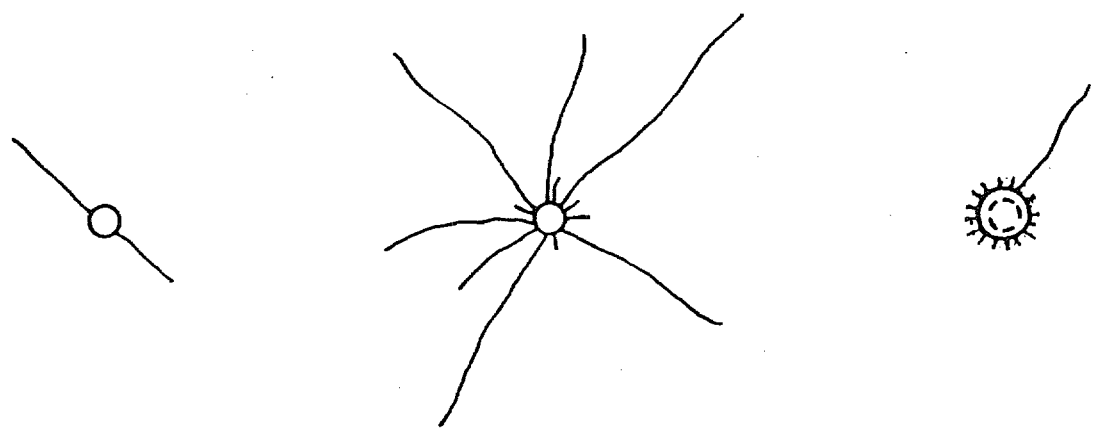
RESULTS FROM HIGH ENERGY GAS FRAC EXPERIMENTS

	"SLOW'	"INTERMEDIATE"	"FAST"
LOADING RATE (psi/μsec)	0.09	20	>1500
PEAK PRESSURE (psi)	6250	13,800	>20,000
PULSE DURATION (msec)	900	9	~1

MINEBACK OBSERVATION

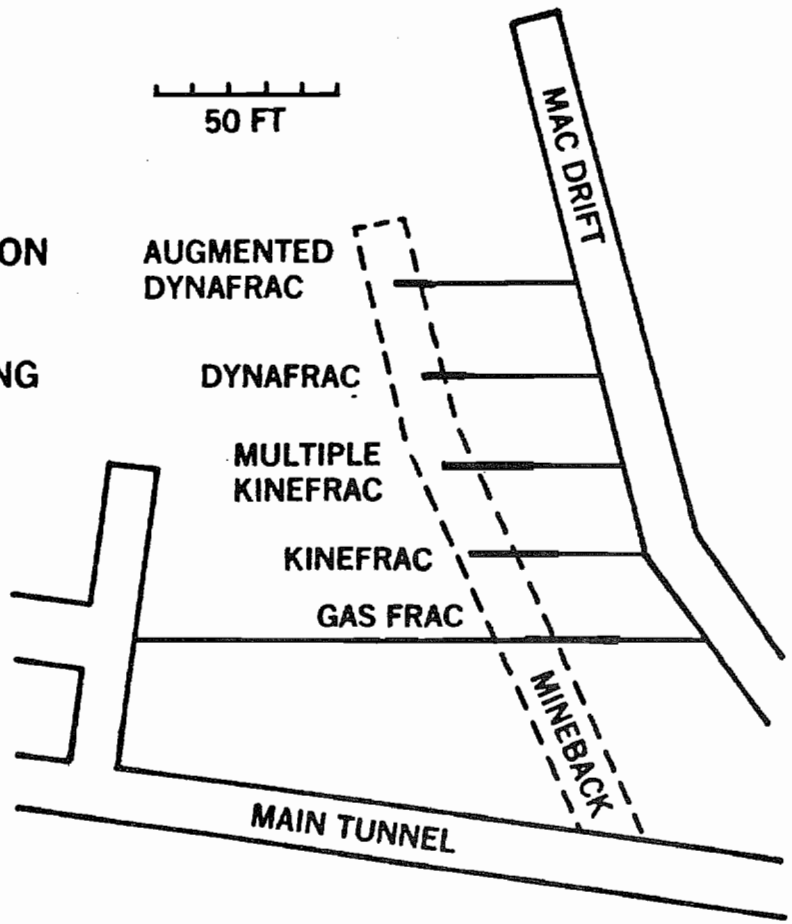
(SCHEMATIC)

0 4 FT



EGSP MULTI-FRAC TEST SERIES

- IN SITU TESTS OF FOUR CONCEPTS
- INSTRUMENTATION, FRACTURE EVALUATION AND MINEBACK
- MODELING FOR CONCEPT UNDERSTANDING AND FUTURE DESIGN



PRELIMINARY EGSP MULTI-FRAC TEST RESULTS
3/7/80

	"FORMATION ACCEPTANCE" PRETEST	POSTTEST	IMPROVEMENT
GAS FRAC	0.012	10	830
KINEFRAC	0.0015	0.004	2.7
KINEFRAC (MULTIPLE)	0.007	0.022	3.1
DYNAFRAC	0.20		
AUGMENTED DYNAFRAC*	0.83	2.1	2.5

* ONLY PROPELLANT FIRED

THE NEXT STEP: TECHNOLOGY DEVELOPMENT THROUGH FIELD AND SUPPORTING STUDIES

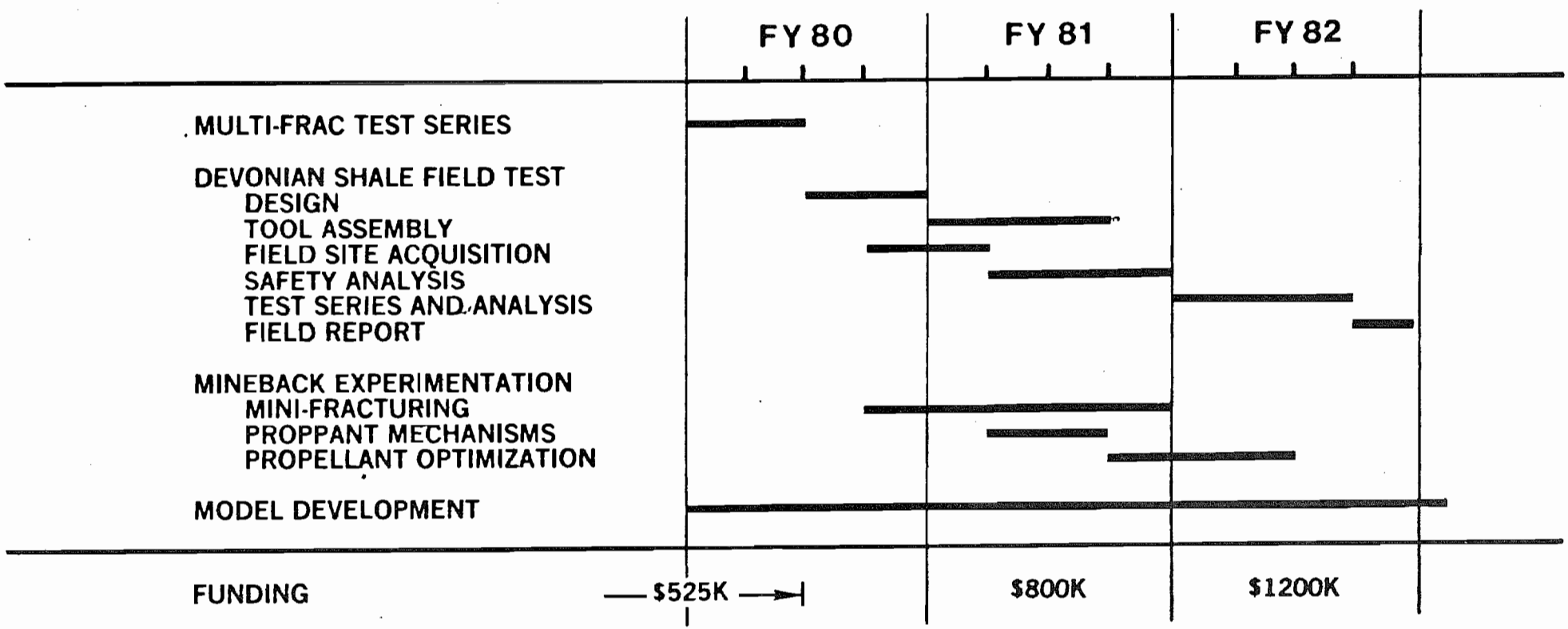
- DEVONIAN FIELD EXPERIMENT TO EXAMINE OPERATIONAL FEASIBILITY AND OBTAIN PRELIMINARY FIELD DATA
- IN SITU EXPERIMENTATION TO INVESTIGATE PARAMETER SENSITIVITY, PROPPING, OPTIMIZATION AND SCALING
- ANALYTICAL AND EMPIRICAL MODELING FOR PREDICTABILITY AND DESIGN

MULTIPLE FRACTURING

MULTIPLE FRACTURING TECHNOLOGY COULD SIGNIFICANTLY ENHANCE PRODUCTION FROM FRACTURED RESERVOIRS.

- FEASIBILITY DEMONSTRATED BY IN SITU EXPERIMENTS
- ENGINEERING DATA OBTAINED FROM EGSP MULTI-FRAC TESTS
- PLAN DEFINED FOR EVALUATION IN DEVONIAN SHALES

MULTIPLE FRACTURING



EGSP FIELD TESTING

PRODUCTION ENHANCEMENT

ACTIVITY:	PARTICIPANTS:
• Dual completion	• Tetra Tek
• Recompletion	• J.T. Waggoner
	• Mitchell Energy

RESERVOIR PERFORMANCE

ACTIVITY:	PARTICIPANTS:
• Well Testing & Analysis	• Gruy Federal
• Offset Well Test	• SAI/Gruy Federal

- CONTRACT: ASSESSMENT OF SHALE PRODUCTION IN DUAL COMPLETED WELLS

  TETRA TECH, INC. DE-AC21-78MC10389

- CONTRACT DATE: FEBRUARY 5, 1979

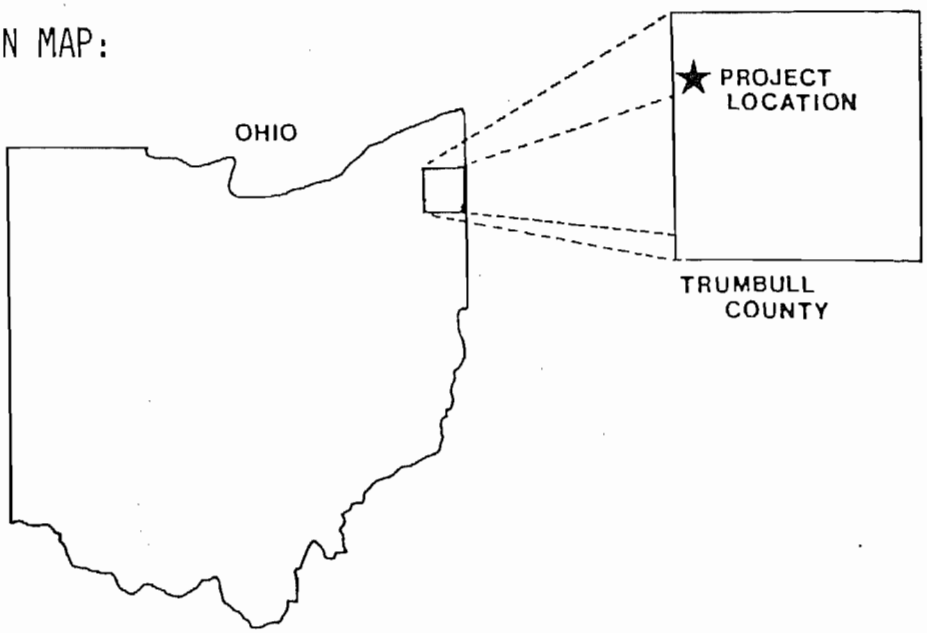
- ANTICIPATED COMPLETION DATE: SEPTEMBER 30, 1980

- TOTAL COST: $279,784

- DOE COST: $279,784

- OBJECTIVE: TO TEST THE FEASIBILITY OF PRODUCING FROM TWO HORIZONS SIMULTANEOUSLY (DEVONIAN SHALE AND CLINTON SAND) AS AN EFFECTIVE MEANS OF EXPLOITING THE UNCONVENTIONAL DEVONIAN SHALE GAS RESOURCE.

- LOCATION MAP:



- SUMMARY OF PROGRESS

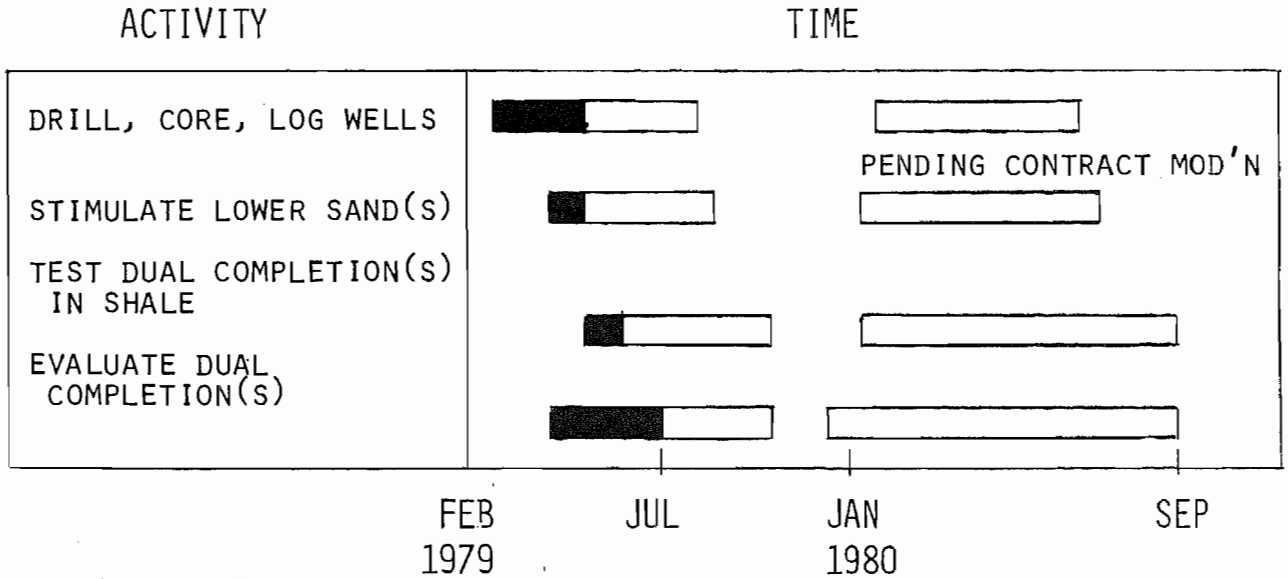
  DRILLED TWO WELLS AND STIMULATED TWO SHALE ZONES IN ONE WELL. STRESS GRADIENT WAS 0.9, NO COMMERCIAL PRODUCTION. FIVE-WELL DUAL COMPLETION TEST TERMINATED.

- CRITICAL ITEMS

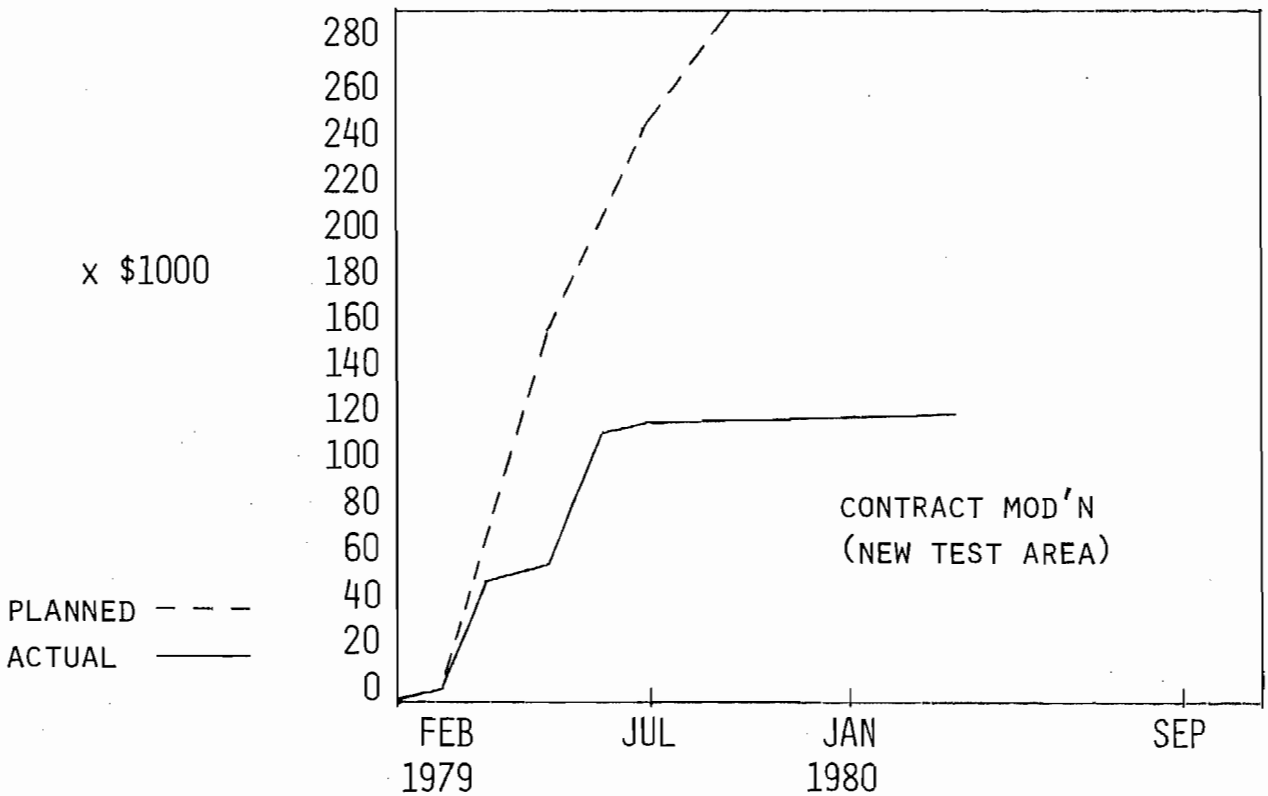
  RESTART FIELD TESTS IN NEW PROSPECT AREA AS DEFINED BY CONTRACT MODIFICATION.

TETRA TECH, INC.
DE-AC21-78MC10389

- MAJOR ACTIVITIES



- FUNDING PROFILE



- CONTRACT: ASSESSMENT OF DEVONIAN SHALE POTENTIAL IN PRESTON COUNTY, WEST VIRGINIA

  J. T. WAGGONER DE-AC21-79MC010515

- CONTRACT DATE: JANUARY 1, 1979

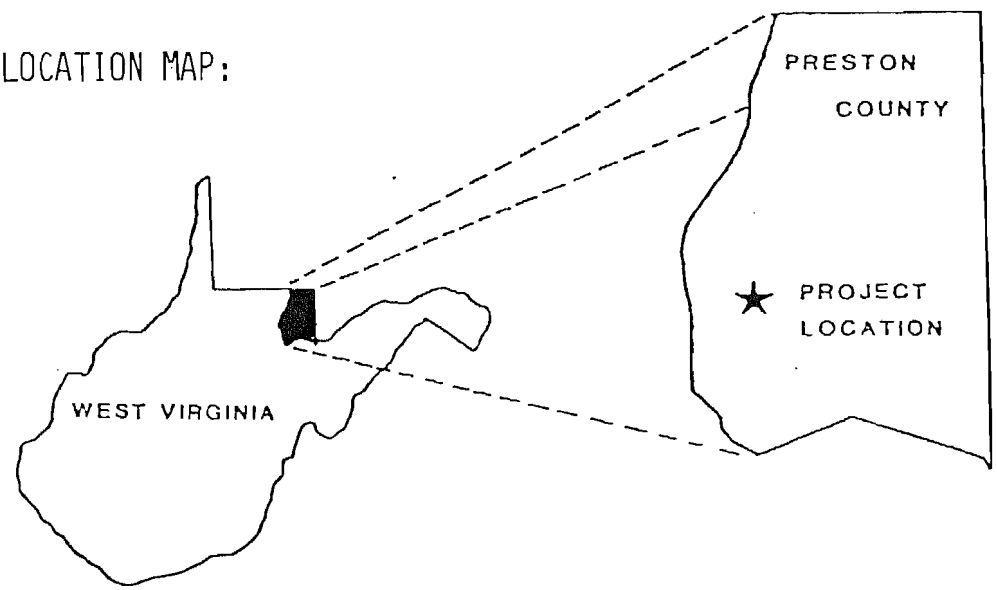
- ANTICIPATED COMPLETION DATE: MAY 1980

- TOTAL COST: $105,500

- DOE COST: $105,500

- OBJECTIVE: TO ASSESS THE PRODUCTION POTENTIAL OF THE DEVONIAN SHALE IN PRESTON COUNTY, WV, THROUGH RECOMPLETION TECHNIQUES IN EXISTING WELLS.

- LOCATION MAP:



- SUMMARY OF PROGRESS

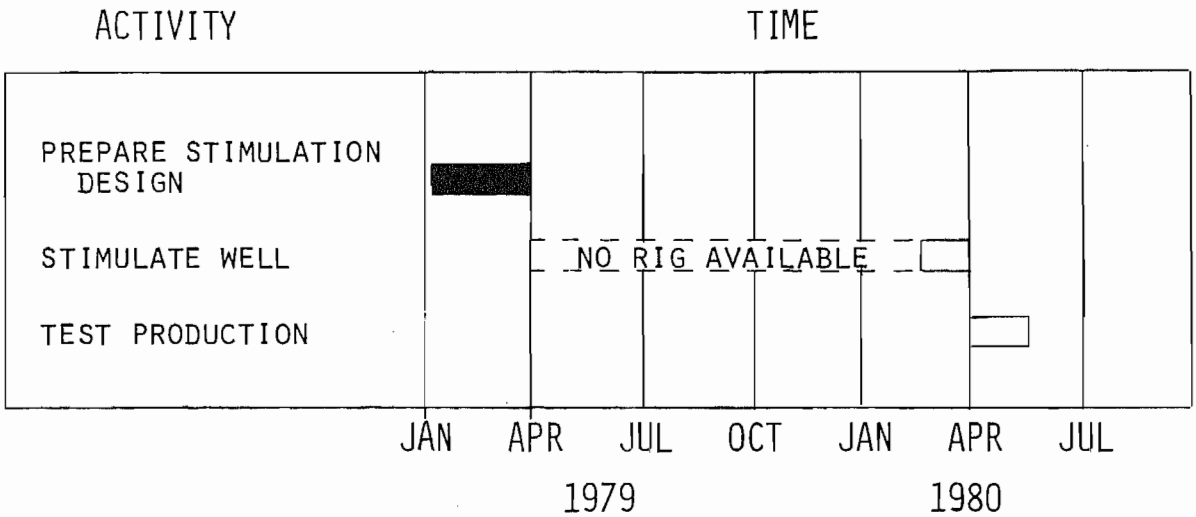
  WELL LOGS ANALYZED AND STIMULATION PROCEDURE COMPLETED. COMPLETION DELAYED BY WEATHER AND COMPLETION RIG UNAVAILABILITY.

- CRITICAL ITEMS:

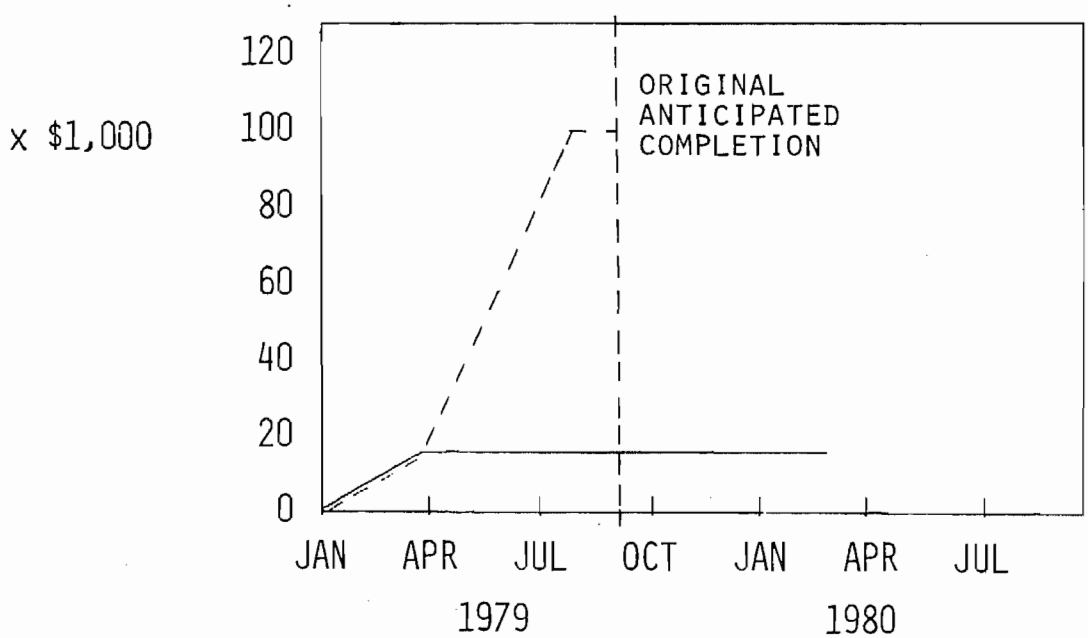
  COMPLETE STIMULATION AND WELL TESTING.

J. T. WAGGONER
DE-AC21-79MC010515

- MAJOR ACTIVITIES



- FUNDING PROFILE



PLANNED - - - - -
ACTUAL ————

- CONTRACT: ASSESSMENT OF DEVONIAN SHALE POTENTIAL IN CARROLL COUNTY, OHIO

  MITCHELL ENERGY CORP. DE-AC21-78MC12537

- CONTRACT DATE: SEPTEMBER 8, 1979

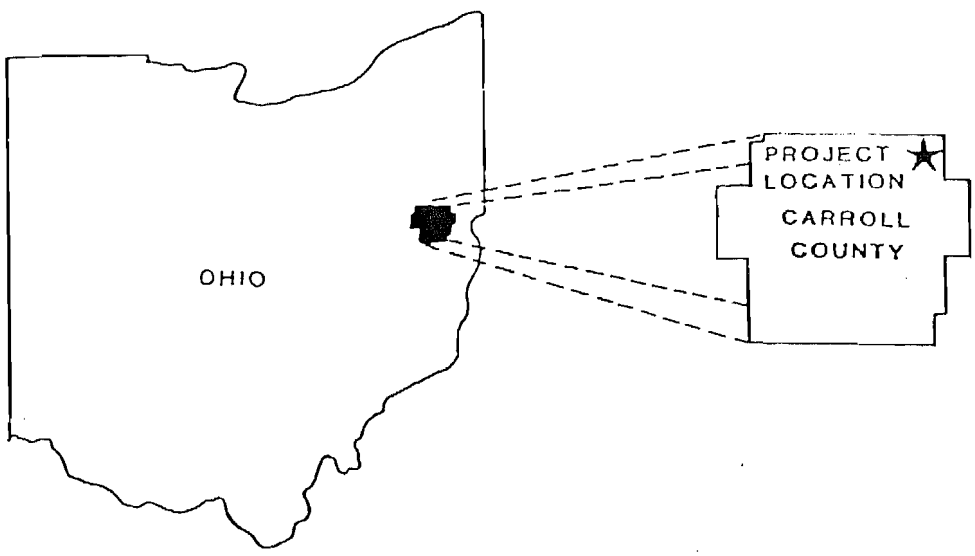
- ANTICIPATED COMPLETION DATE: MAY 9, 1980

- TOTAL COST: $96,262

- DOE COST: $96,262 (+$29,000 OPTION)

- OBJECTIVE: TO ASSESS THE PRODUCTION POTENTIAL OF THE DEVONIAN SHALE IN CARROLL COUNTY, OHIO, THROUGH RECOMPLETION TECHNIQUES IN EXISTING WELLS.

- LOCATION MAP:



- SUMMARY OF PROGRESS

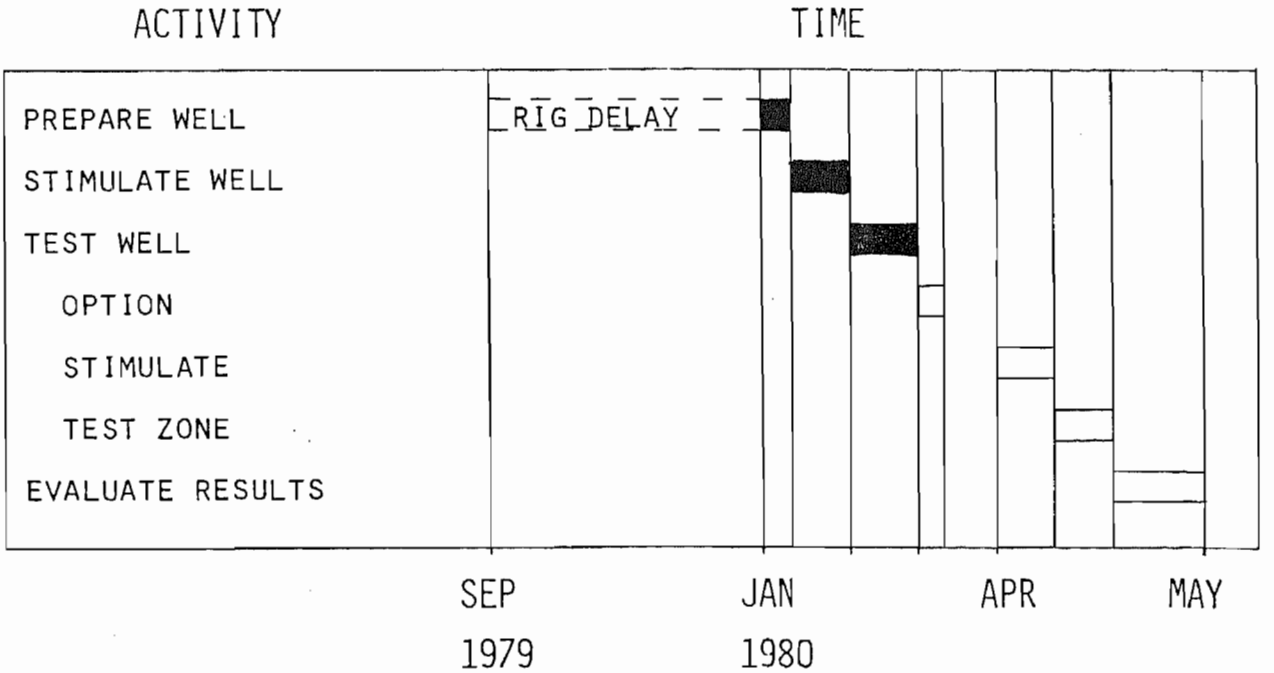
  HAVE STIMULATED PRIMARY TEST INTERVAL WITH 50,000-GALLON FOAM FRAC. WELL IS BEING EVALUATED FOR GAS PRODUCTIVITY.

- CRITICAL ITEMS

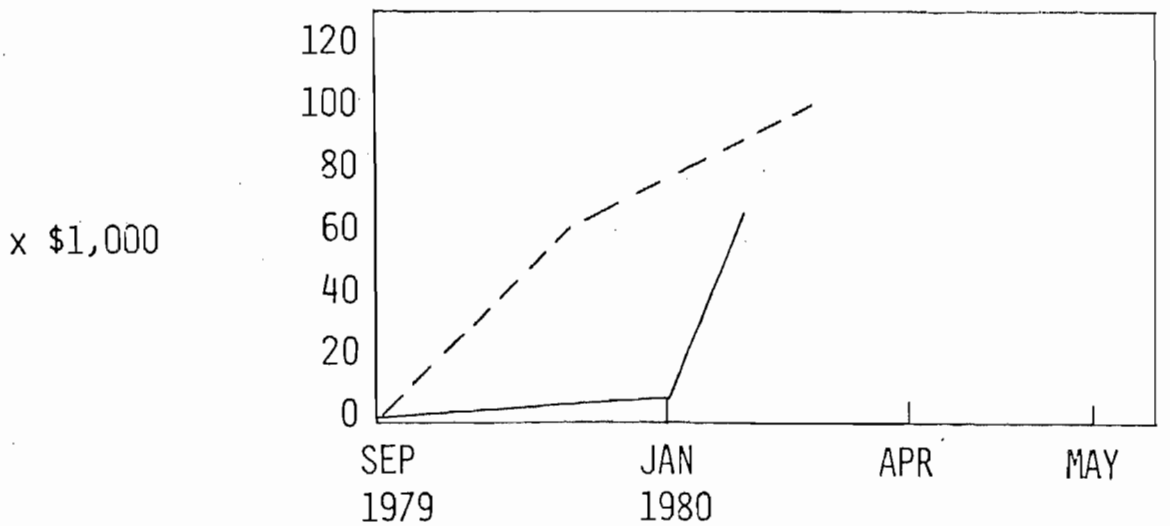
  EVALUATE PRIMARY ZONE AND MAKE DECISION ON THE $29,000 OPTION ON TESTING A SHALLOWER SHALE INTERVAL.

MITCHELL ENERGY CORP.
DE-AC21-78MC12537

- MAJOR ACTIVITIES



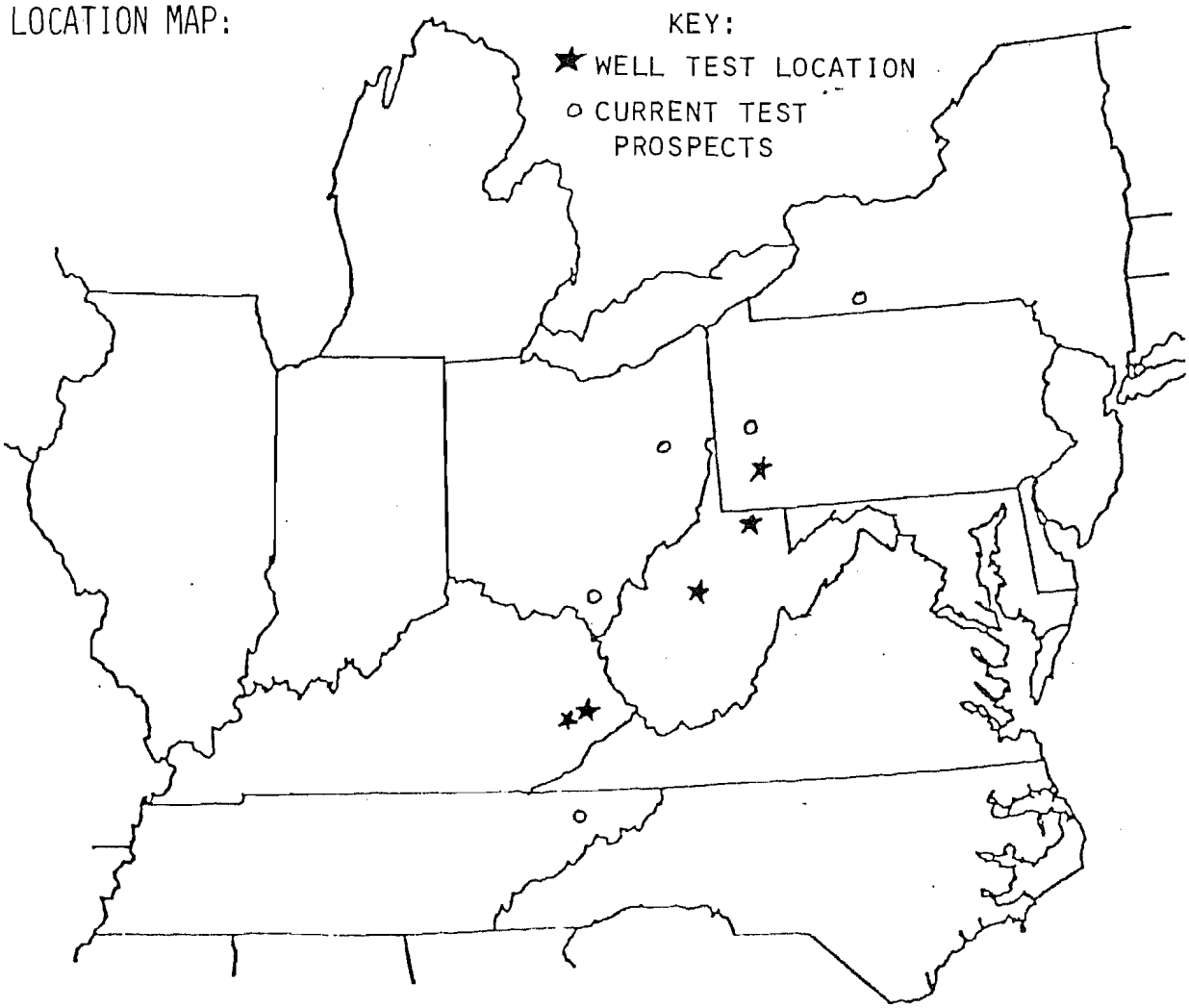
- FUNDING PROFILE



PLANNED - - - - -
ACTUAL ————

- CONTRACT: GAS WELL TESTING AND ANALYSIS SERVICE IN THE DEVONIAN SHALE

  GRUY FEDERAL, INC. EW-78-C21-8096
- CONTRACT DATE: APRIL 17, 1978
- ANTICIPATED COMPLETION DATE: OCTOBER 1, 1980 (NO-COST TIME EXTENSION ANTICIPATED)
- TOTAL COST: $789,378
- DOE COST: $789,378
- OBJECTIVE: TO DEVELOP AND CONDUCT A PROGRAM OF UNIFORM GAS WELL TESTING PROCEDURES, AND TO ANALYZE THE TEST RESULTS IN SUPPORT OF THE EASTERN GAS SHALES PROJECT.
- LOCATION MAP:



- SUMMARY OF PROGRESS

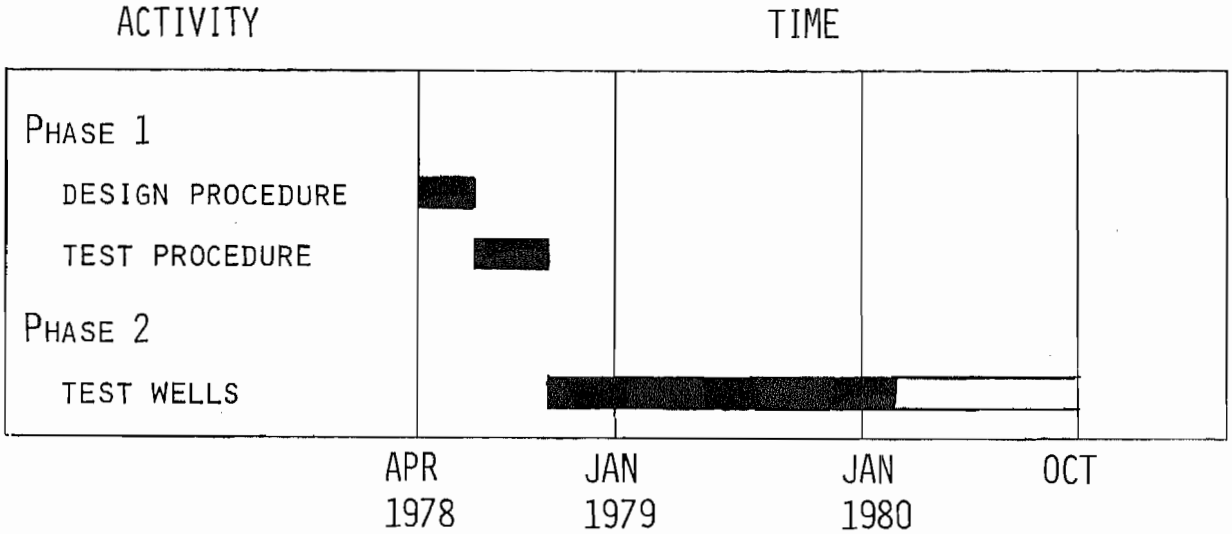
  PHASE 1 COMPLETED, DEFINING UNIFORM TEST PROCEDURE (3 WELLS, PHASE 1 REPORT).
  UNIFORM PROCEDURE EXECUTED ON 2 EGSP WELLS.

- CRITICAL ITEMS

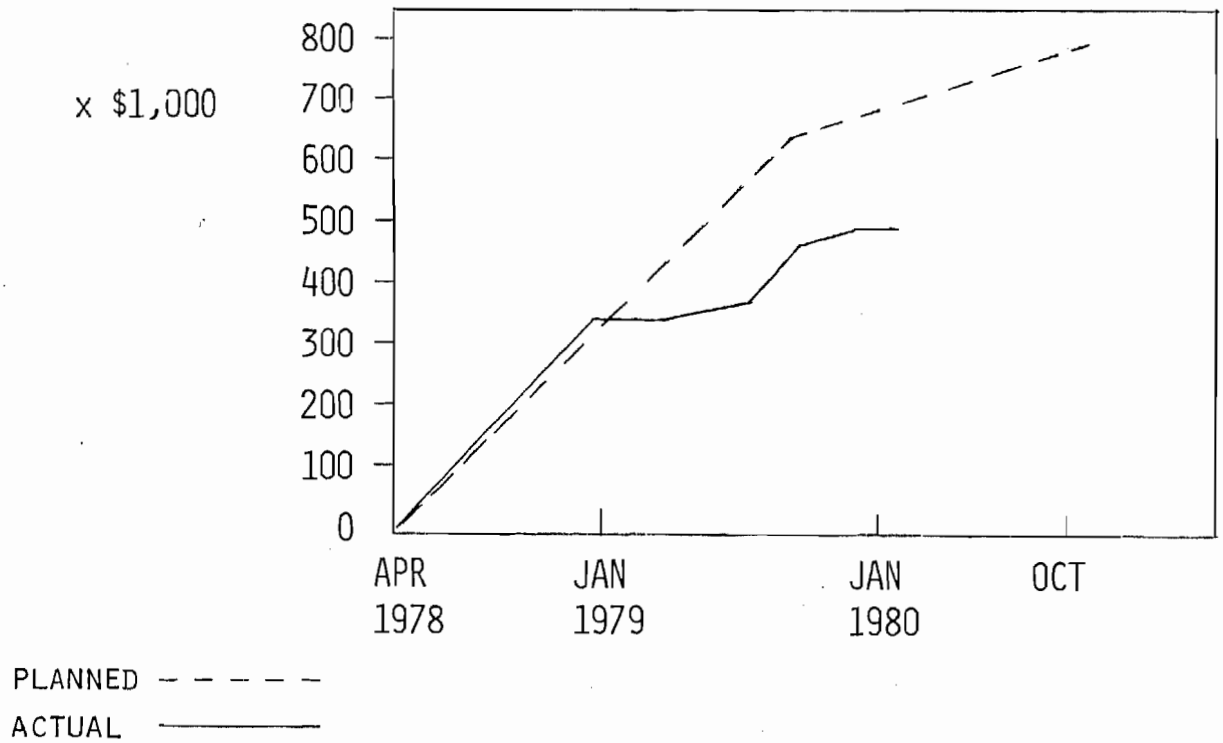
  RESTART FIELD OPERATIONS AFTER SUBCONTRACTOR CHANGE AND TEST EQUIPMENT REPAIR/REPLACEMENT. SCHEDULED MID-MARCH 1980.

GRUY FEDERAL, INC.
EW-78-C21-8096

- MAJOR ACTIVIITES



- FUNDING PROFILE



- CONTRACT: OFFSET WELL TEST PROGRAM

  SCIENCE APPLICATIONS, INC., AND GRUY FEDERAL, INC.

- CONTRACT DATE: APRIL 1980

- ANTICIPATED COMPLETION DATE: JULY 1981

- TOTAL COST: $1,500,000

- DOE COST: $1,500,000

- OBJECTIVE: DEVELOP BETTER UNDERSTANDING OF DEVONIAN SHALE GAS PRODUCTION CHARACTERISTICS.
  - IDENTIFY SPATIAL DISTRIBUTION OF PERMEABILITY, PRESSURE, AND POROSITY.
  - ORIENTATION OF IN SITU NATIVE FRACTURES.
  - FLOW OF GAS IN NATIVE FRACTURES.
  - GAS RELEASE MECHANISM OF IN SITU SHALE MATRIX.

- LOCATION: MINGO COUNTY, WV; MEIGS COUNTY, OH, OR OTHER (TBD)

SCIENCE APPLICATIONS, INC.,
GRUY FEDERAL, INC.

- SUMMARY OF PROGRESS

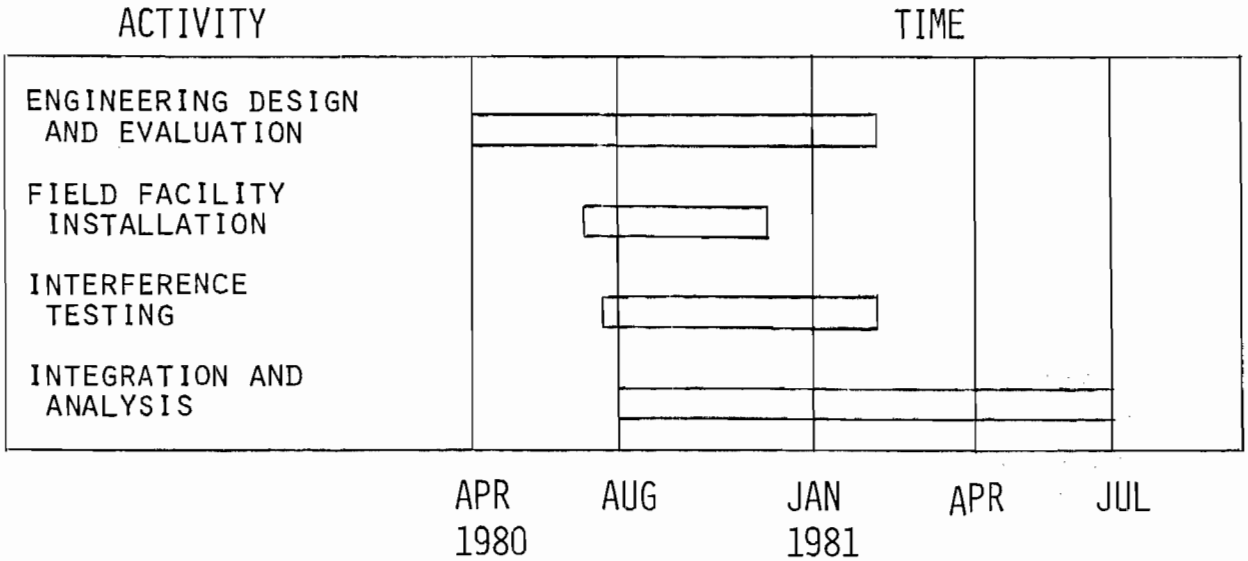
  INITIAL SITE SELECTION AND MODELING SUPPORT CURRENTLY BEING PERFORMED UNDER TASKS. PROCUREMENT ACTIONS IN PROGRESS FOR CONTRACTS.

- CRITICAL ITEMS

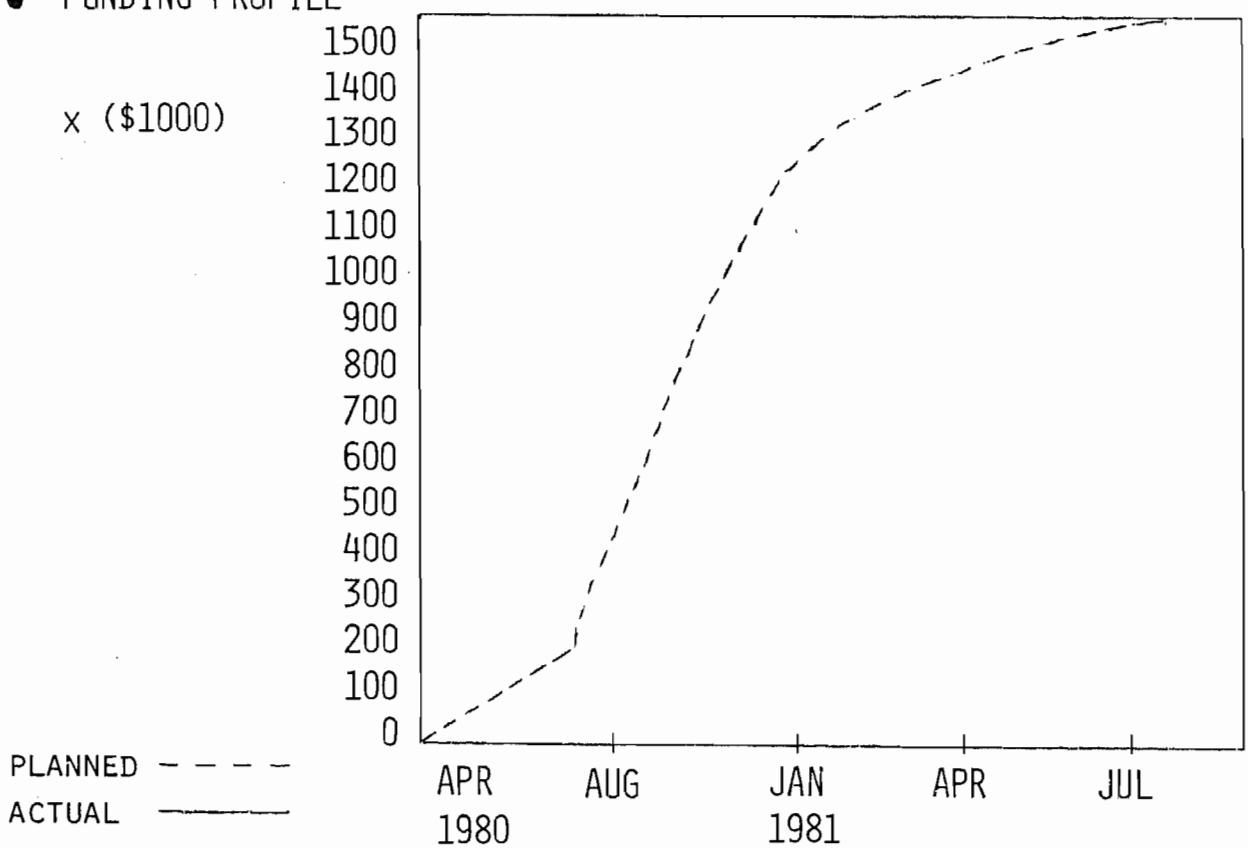
  ENLIST INDUSTRY COOPERATOR FOR FIELD TEST SITE.
  LOCATE DRILLING CONTRACTOR WHEN REQUIRED.
  LOCATE SERVICE RIG WHEN REQUIRED.

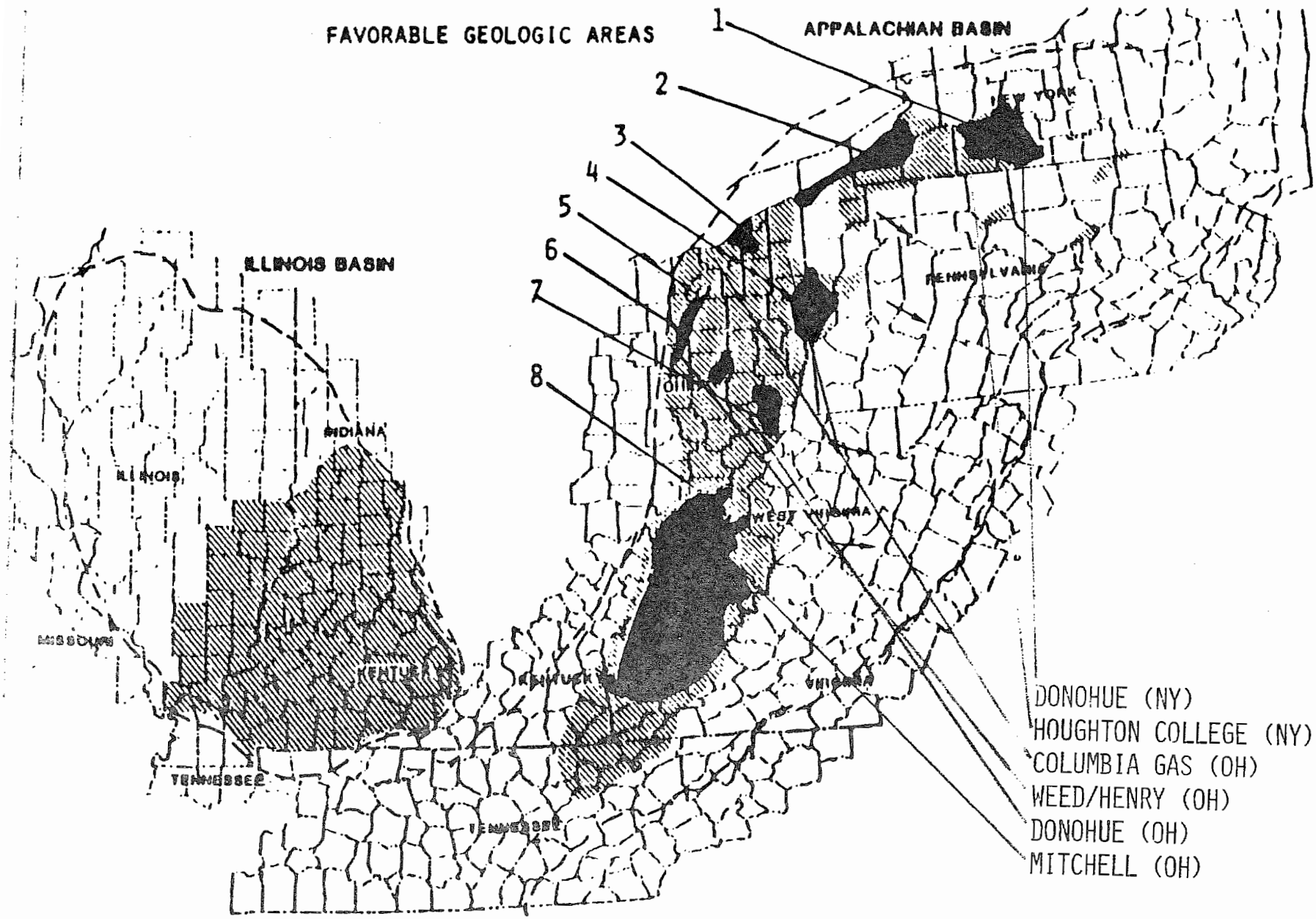
SCIENCE APPLICATIONS, INC.
GRUY FEDERAL, INC.

- MAJOR ACTIVITIES



- FUNDING PROFILE





COMPOSITE MAP OF APPALACHIAN AND ILLINOIS BASINS SHOWING PROSPECTIVE AREAS FOR DEVONIAN SHALE GAS WELLS (DRAFT)

- CONTRACT: SUPPORT DEVELOPMENT OF AN UNCONVENTIONAL EXPLORATION TECHNIQUE TO SELECTIVELY LOCATE NATURAL FRACTURE SYSTEMS IN THE DEVONIAN-OHIO SHALE

  MITCHELL ENERGY CORPORATION
  DE-AC21-78MC08387

- CONTRACT DATE: SEPTEMBER 27, 1978

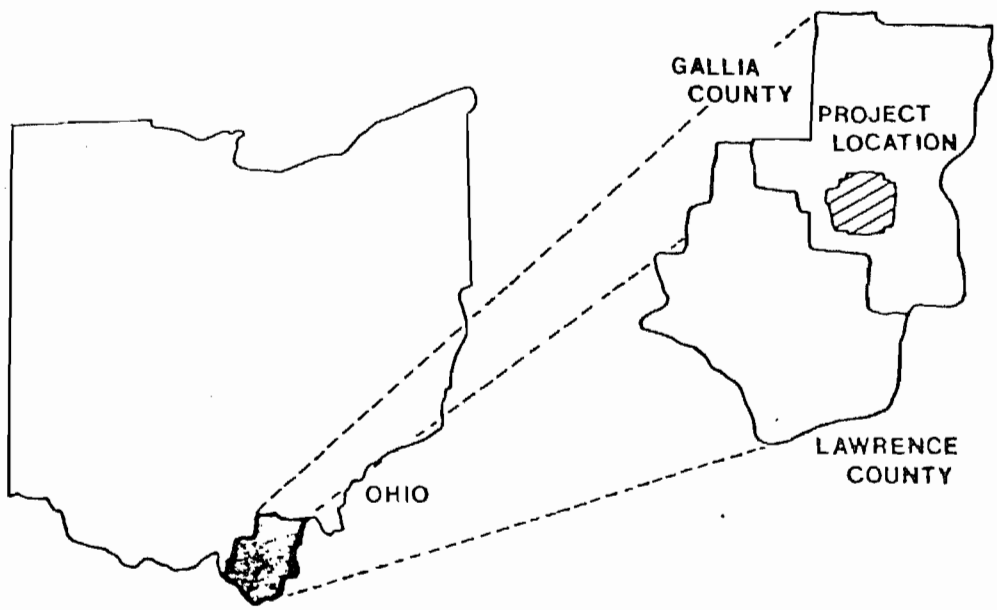
- ANTICIPATED COMPLETED DATE: MARCH 1981

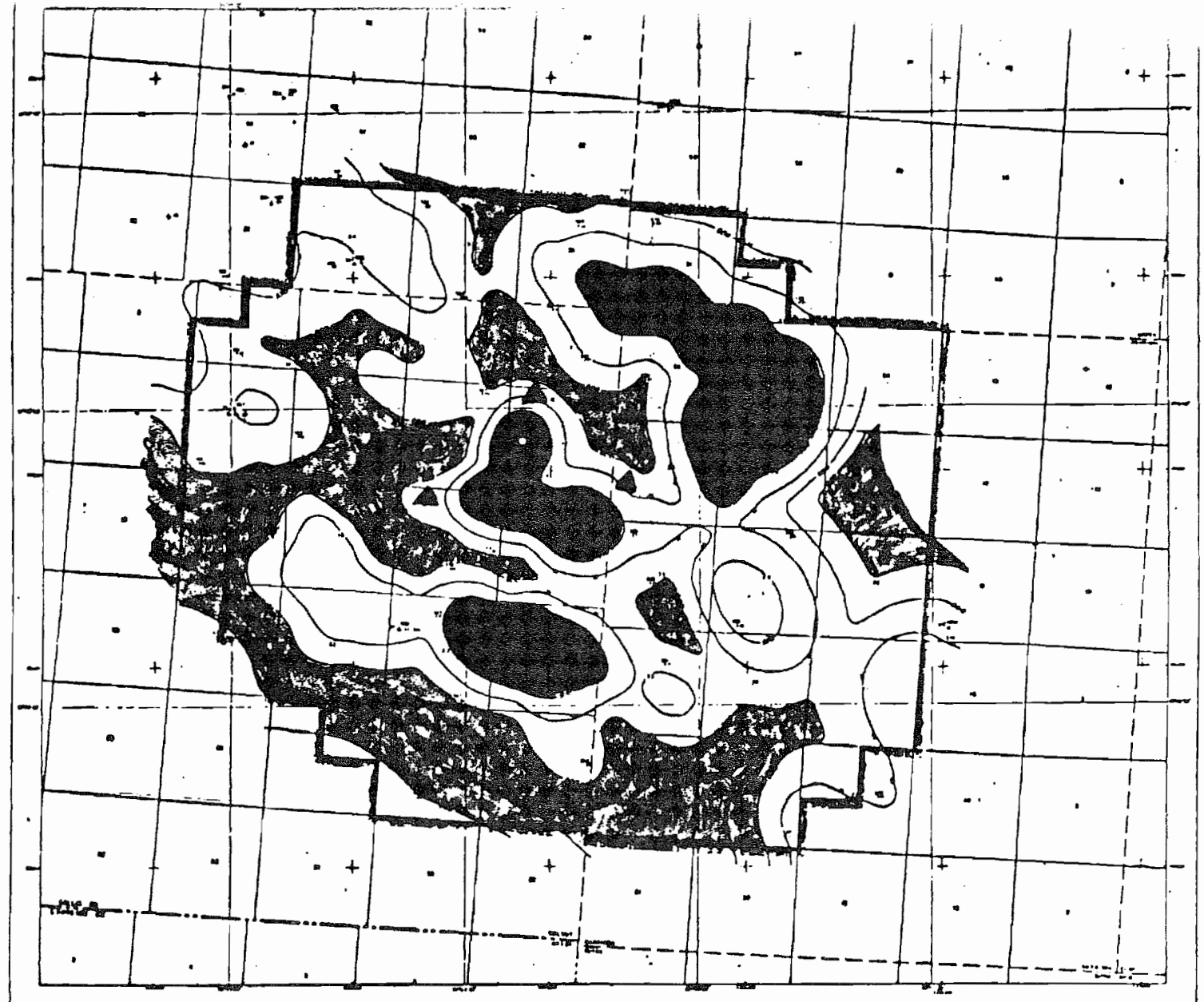
- TOTAL COST: $5,456,000

- DOE COST: $3,110,000

- OBJECTIVE: TO ESTABLISH: AN UNCONVENTIONAL TECHNIQUE TO SELECTIVELY LOCATE NATURALLY FRACTURED SHALE RESERVOIRS; THE PRESENCE AND ORIENTATION OF NATURALLY FRACTURED RESERVOIRS; AND THE RELATIONSHIP OF HYDROCARBON DISTRIBUTION TO DEPOSITIONAL ENVIRONMENT.

- LOCATION MAP:





DEPARTMENT OF ENERGY
CONTRACT NO. DE-AC21-78MC08387

MITCHELL ENERGY CORPORATION

APPROXIMATE DEPOSITIONAL STRUCTURE
GALLIA COUNTY, OHIO

CONTOUR INTERVAL 50

DATE JUNE 25, 1979 | HENNINGTON

PLAT 3

- SUMMARY OF PROGRESS:

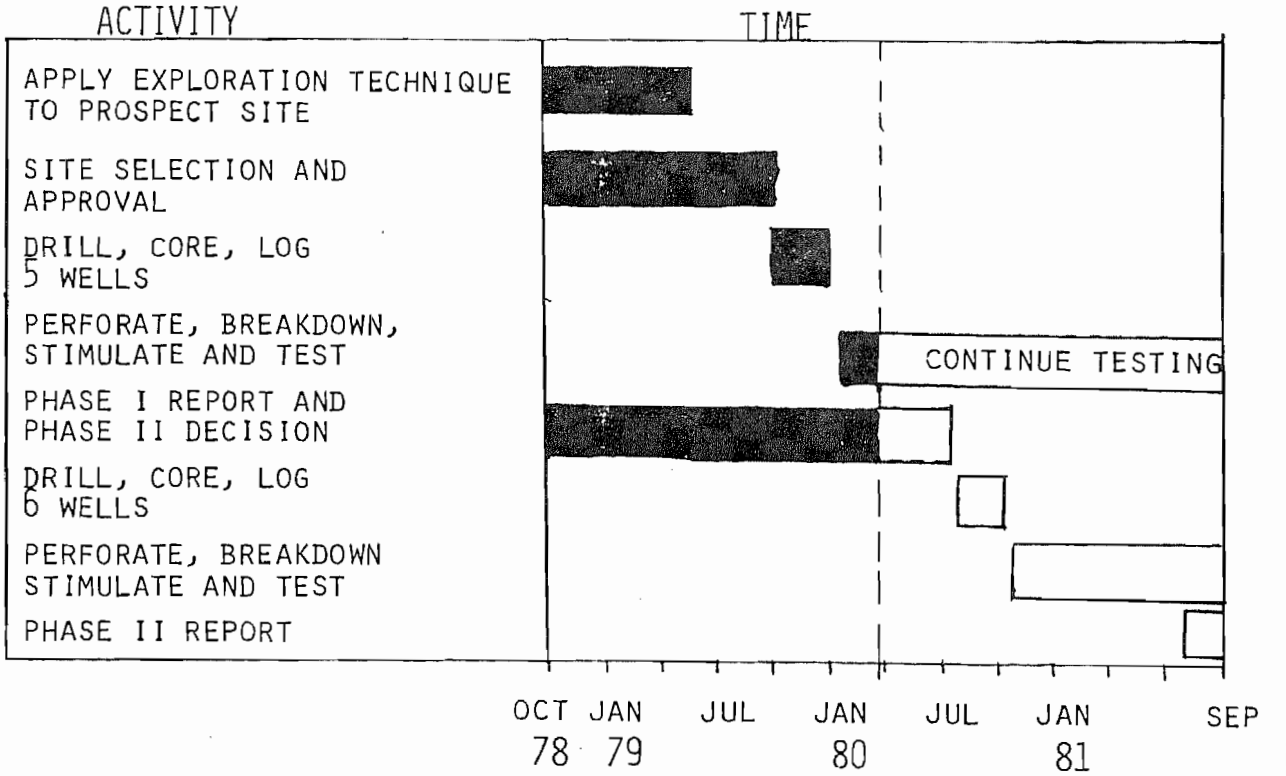
  - SITE SELECTION COMPLETED BASED ON EXPLORATION TECHNIQUE.
  - DRILLING, CORING AND LOGGING OF FIVE PHASE I WELLS.
  - EVALUATION OF CORES TAKEN INDICATED SEVERAL NATURAL FRACTURES TO SUPPORT EXPLORATION TECHNIQUE.
  - RE-EVALUATION OF ALL FIVE WELLS IN LIGHT OF DRILLED DEPTHS TO ASSESS EXPLORATION TECHNIQUE.
  - EVALUATION OF CORE AND GEOPHYSICAL DATA HAS BEEN USED TO COMPLETE STIMULATION DESIGN.
  - SELECTION OF PERFORATIONS, BREAKDOWN AND STIMULATION TEST DESIGN COMPLETED ON THE FIVE PHASE I WELLS.

- CRITICAL ITEMS:

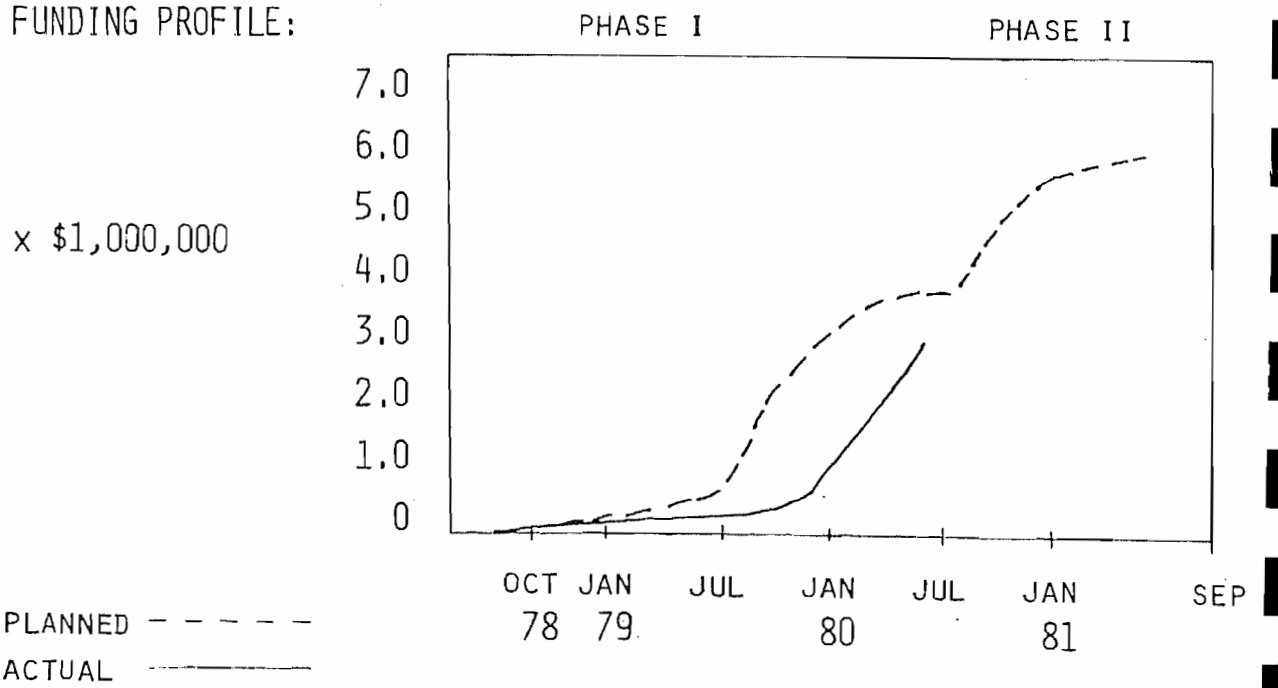
  - RE-EVALUATION OF EXPLORATION TECHNIQUE NECESSARY BEFORE PHASE II VERIFICATION WELLS BEGIN.

MITCHELL ENERGY CORP
DE-AC21-78MC08387

- MAJOR ACTIVITIES:



- FUNDING PROFILE:



- CONTRACT: NEW EXPLORATION CONCEPT FOR LOCATING FRACTURE ZONES IN THE DEVONIAN SHALE

  DONOHUE, ANSTEY, AND MORRILL
  DE-AC21-78MC08339

- CONTRACT DATE: FEBRUARY 23, 1979

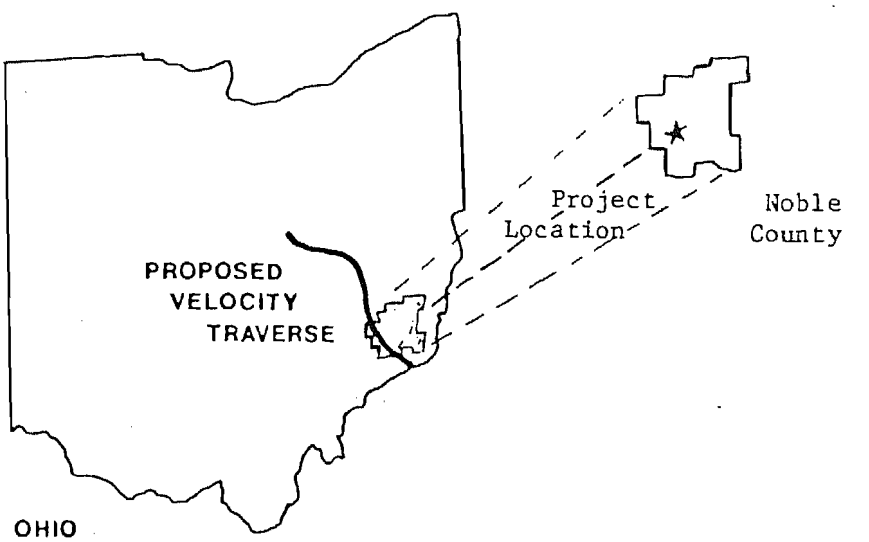
- ANTICIPATED COMPLETION DATE: OCTOBER 1980

- TOTAL COST: $855,000

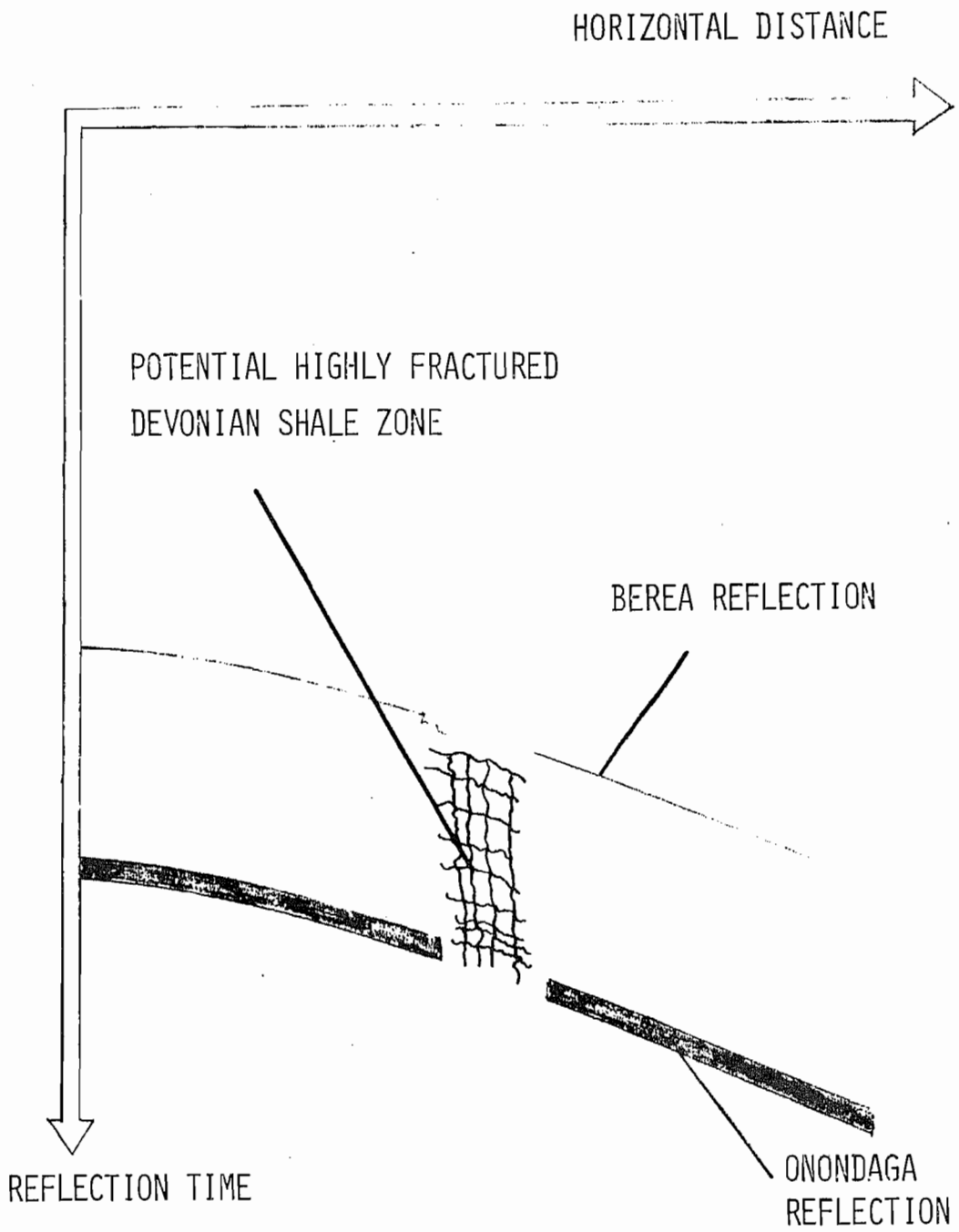
- DOE COST: $795,150

- OBJECTIVE: TO TEST A NEW EXPLORATION TECHNIQUE USING SURFACE MEASUREMENTS OF SEISMIC VELOCITY TO LOCATE ZONES OF NATURAL FRACTURES IN DEVONIAN SHALE IN OHIO

- LOCATION MAP:



LOW VELOCITY ANOMALY FROM SEISMIC DATA



- SUMMARY OF PROGRESS:

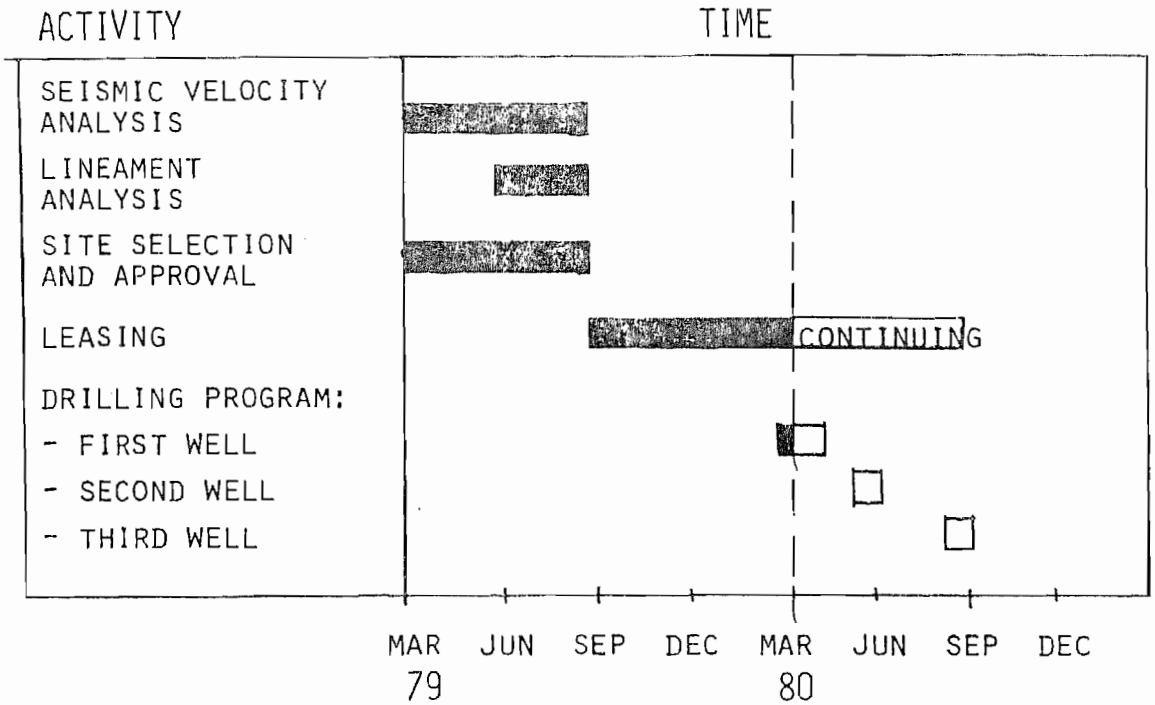
  - EVALUATION OF 125 MILES OF SEISMIC LINE RUNNING FROM LICKING TO NOBLE COUNTY, OHIO, TO DELINEATE LOW-VELOCITY ANOMALIES
  - EVALUATION OF LINEAR FEATURES ALONG THIS SEISMIC LINE
  - RECOMMENDATION OF TWO DRILLING PROSPECTS IN NOBLE COUNTY, OHIO, BASED ON VELOCITY LOWS.
  - APPROVAL GIVEN TO ACQUIRE LEASE, DRILL, CORE (1), LOG AND STIMULATE TWO WELLS IN NOBLE COUNTY, OHIO.
  - LEASE HAS BEEN ACQUIRED ON ONE PROSPECT AND DRILLING, CORING AND LOGGING ARE IN PROGRESS.

- CRITICAL ITEMS:

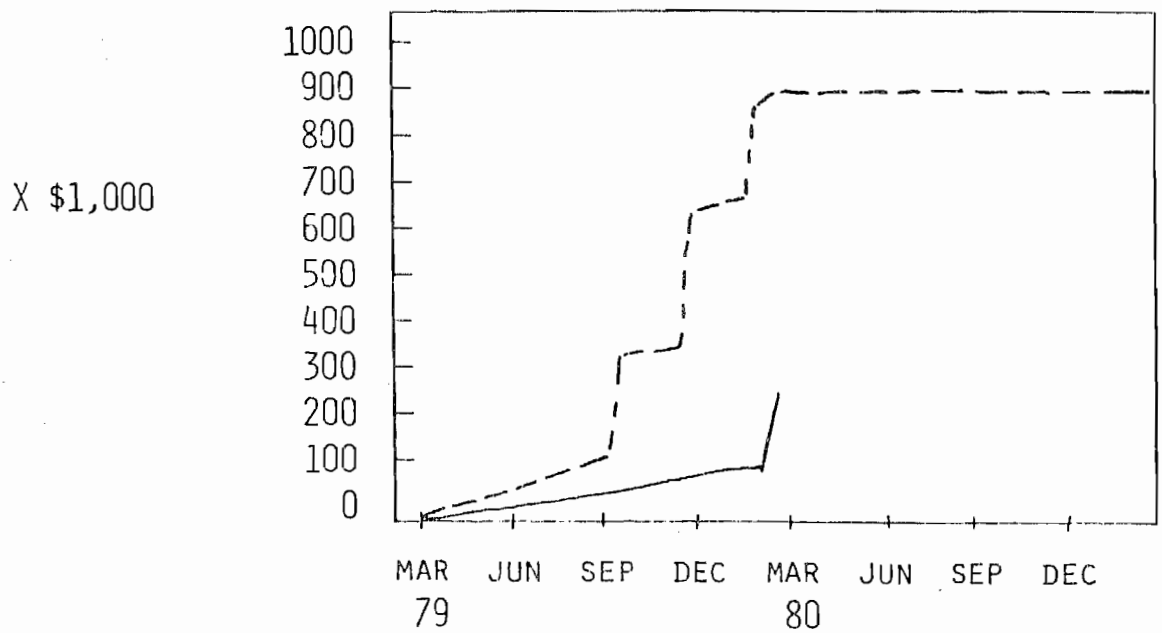
  - WITHOUT BEING ABLE TO ACQUIRE LEASE FOR THE OTHER SITE, IT MAY NOT BE TESTED.

DONOHUE, ANSTEY, AND MORRILL
DE-AC21-78MC08339

- MAJOR ACTIVITIES:



- FUNDING PROFILE:



PLANNED - - - - -

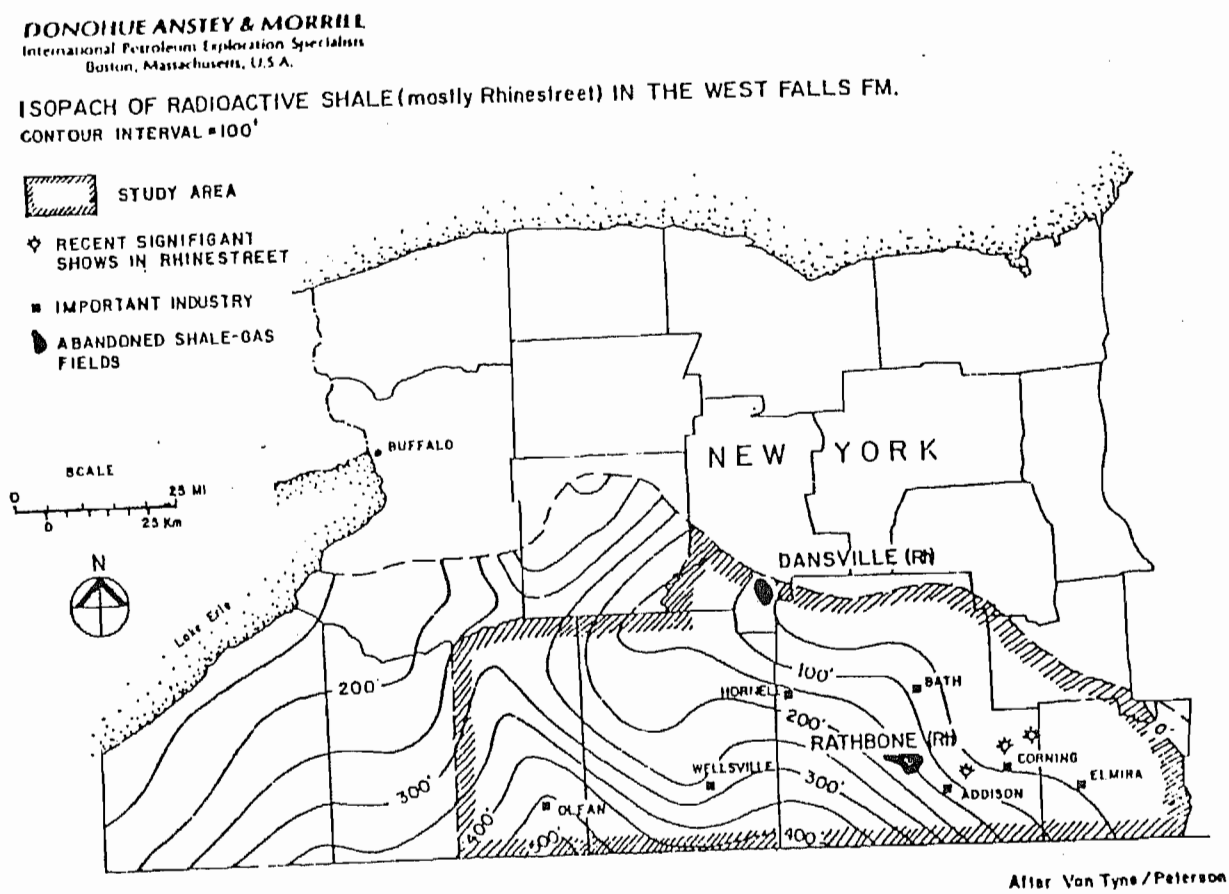
ACTUAL ————

- CONTRACT: SHALE TEST WELLS IN SOUTHERN TIER COUNTIES OF NEW YORK

  DONOHUE, ANSTEY, AND MORRILL
  DE-AC21-79MC12697

- CONTRACT DATE: SEPTEMBER 28, 1979
- ANTICIPATED COMPLETION DATE: SEPTEMBER 1981
- TOTAL COST: $1,560,000
- DOE COST: $765,000
- OBJECTIVE: TO LOCATE, DRILL, AND TEST BY STIMULATION METHODS THE PRODUCTIVE POTENTIAL OF EIGHT WELLS IN THE RHINESTREET/MARCELLUS FACIES OF THE DEVONIAN SHALE IN THE SOUTHERN TIER COUNTIES OF NEW YORK.

- LOCATION MAP:



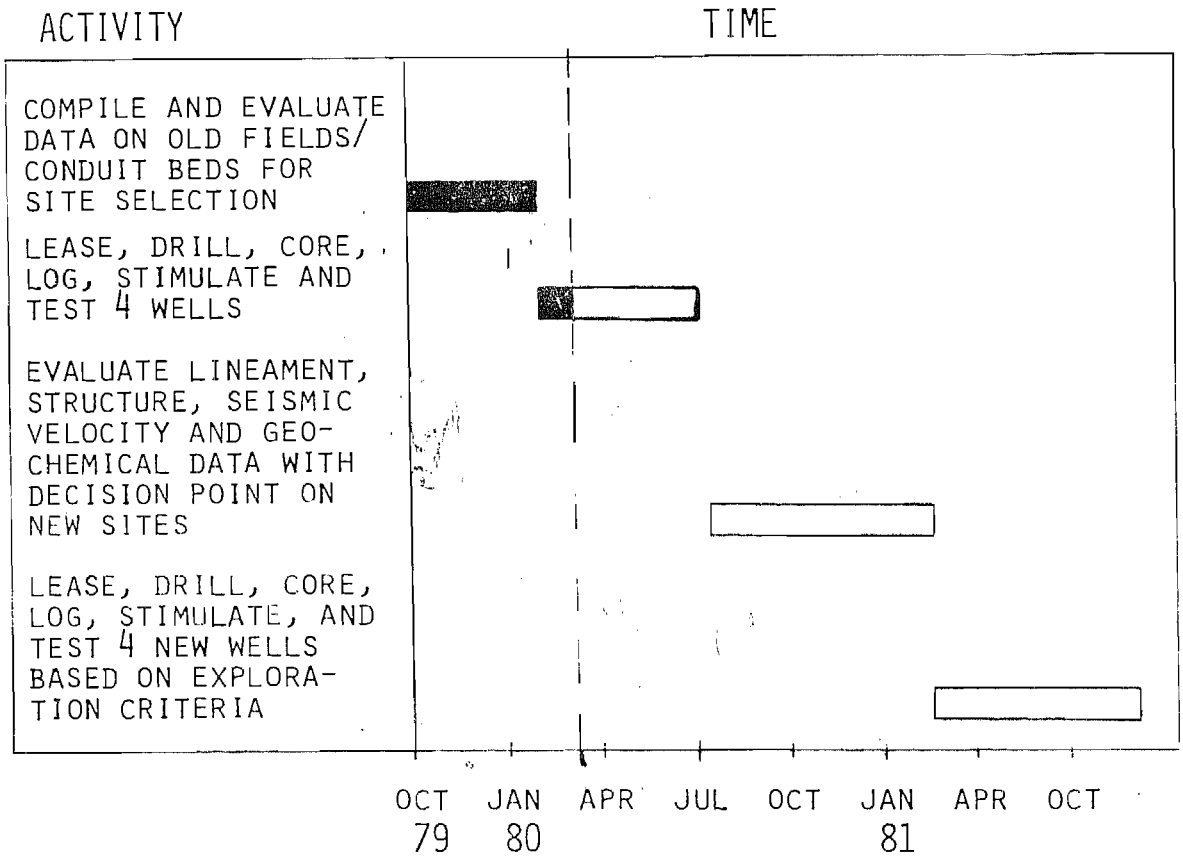
DONOHUE, ANSTEY, AND MORRILL
DE-AC21-79MC12697

- SUMMARY OF PROGRESS:
  - COMPILATION OF ALL AVAILABLE INFORMATION ON OLD SHALE-GAS FIELDS AND RECENT SHALE-GAS SHOWS IN THE RHINESTREET.
  - ANALYSIS OF SURFACE LINEAMENTS IN THE REGIONS OF THE OLD RATHBONE FIELD, THE OLD DANSVILLE FIELD, AND THE RECENT GAS SHOWS NEAR CORNING.
  - ANALYSIS OF SUBSURFACE STRUCTURE AND FAULTING IN THESE THREE REGIONS.
  - IDENTIFICATION OF ONE OR POSSIBLY TWO DRILLING LOCATIONS TO TEST MODERN FRACTURING TECHNIQUES IN ONE OR BOTH OF THE OLD FIELDS.
  - IDENTIFICATION OF ONE OR POSSIBLY TWO LOCATIONS TO TEST THE CONDUIT-BED HYPOTHESIS NEAR CORNING IS IN PROGRESS.
  - ENVIRONMENTAL IMPACT ASSESSMENTS ARE IN PROGRESS.

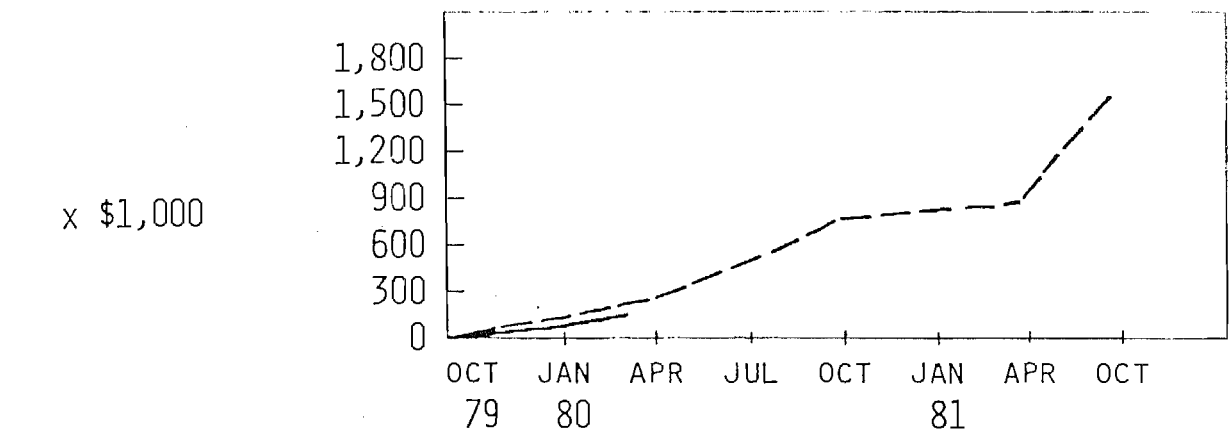
- CRITICAL ITEMS:
  - LACK OF PROGRESS TO COMPLETE FOUR WELLS BY AUGUST 1980 PRECLUDES COST-SHARING PARTICIPATION BY NY ERDA IN FY81.

DONOHUE, ANSTEY, AND MORRILL
DE-AC21-79MC12697

- MAJOR ACTIVITIES:



- FUNDING PROFILE:



PLANNED - - - - -
ACTUAL ———

- CONTRACT: ASSESSMENT OF THE ECONOMIC POTENTIAL OF DEVONIAN SHALE GAS PRODUCTION

  COLUMBIA GAS SYSTEM SERVICE CORPORATION
  DE-AC21-78MC08385

- CONTRACT DATE: SEPTEMBER 27, 1978

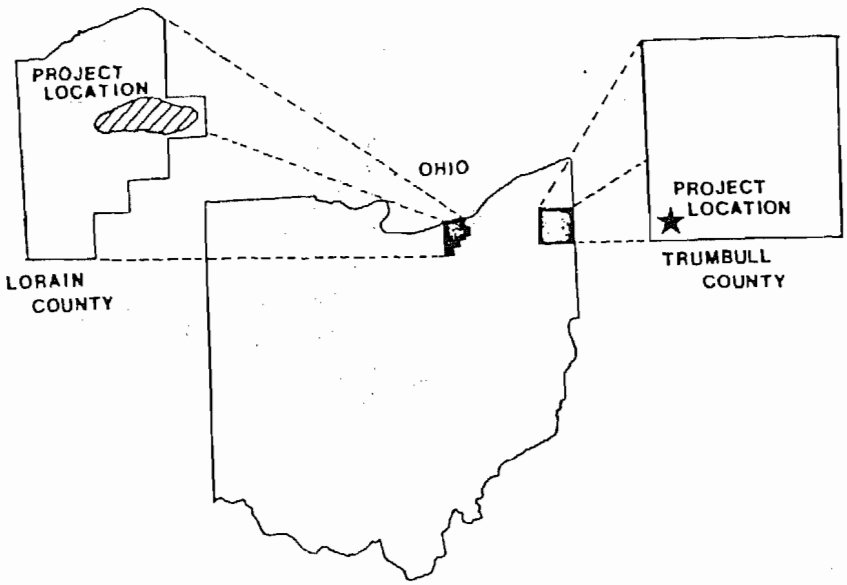
- ANTICIPATED COMPLETION DATE: JANUARY 1981

- TOTAL COST: $3,024,000
- DOE COST: $1,539,000

- OBJECTIVE: TO DEMONSTRATE THE GAS-PRODUCING POTENTIAL OF THE DEVONIAN SHALE OVER A WIDE AREA IN THE APPALACHIAN BASIN, AND TO DEMONSTRATE STATE-OF-THE-ART LOGGING AND STIMULATION TECHNIQUES IN RELATION TO GEOLOGIC AND STRESS CONDITIONS OF REGIONAL PROVINCES IN THE BASIN.

COLUMBIA GAS
DE-AC21-78MC08385

- LOCATION MAP:



- SUMMARY OF PROGRESS:

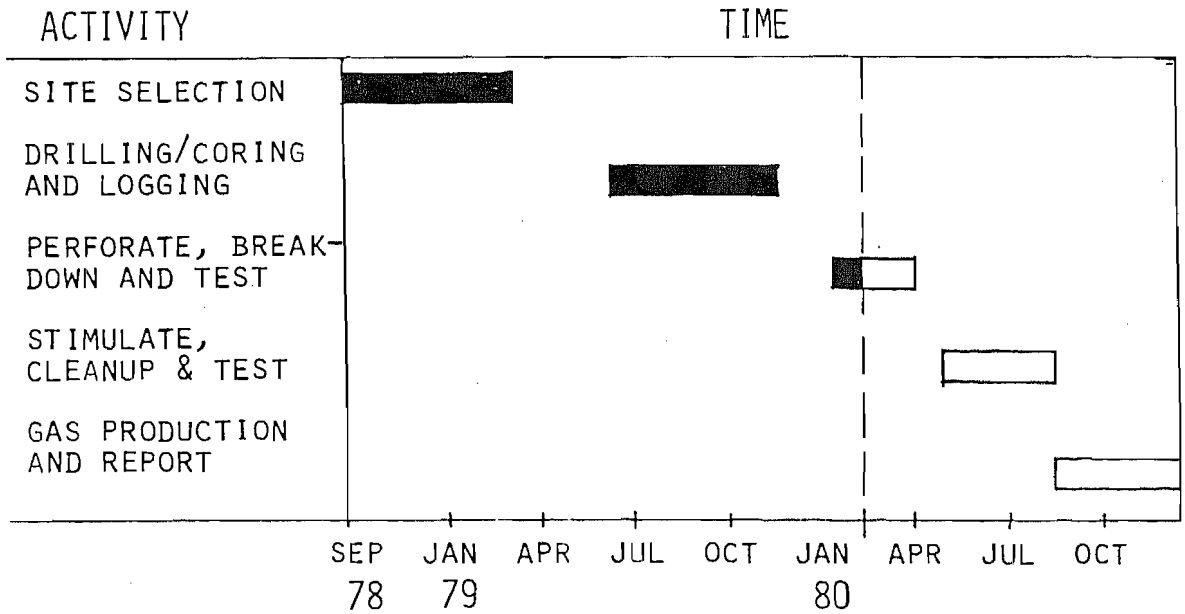
  - SITE SELECTION/ARCHEOLOGICAL APPROVAL COMPLETED
  - DRILLED/CORED, LOGGED AND CASED 5 WELLS IN TRUMBULL COUNTY, OHIO
  - DRILLED/CORED, LOGGED AND CASED 5 WELLS IN LORAIN COUNTY, OHIO
  - COMPLETED EVALUATION OF ALL GEOPHYSICAL WELL LOGS AND RECOMMENDED STIMULATION PLAN FOR ALL TEN WELLS.

- CRITICAL ITEMS:

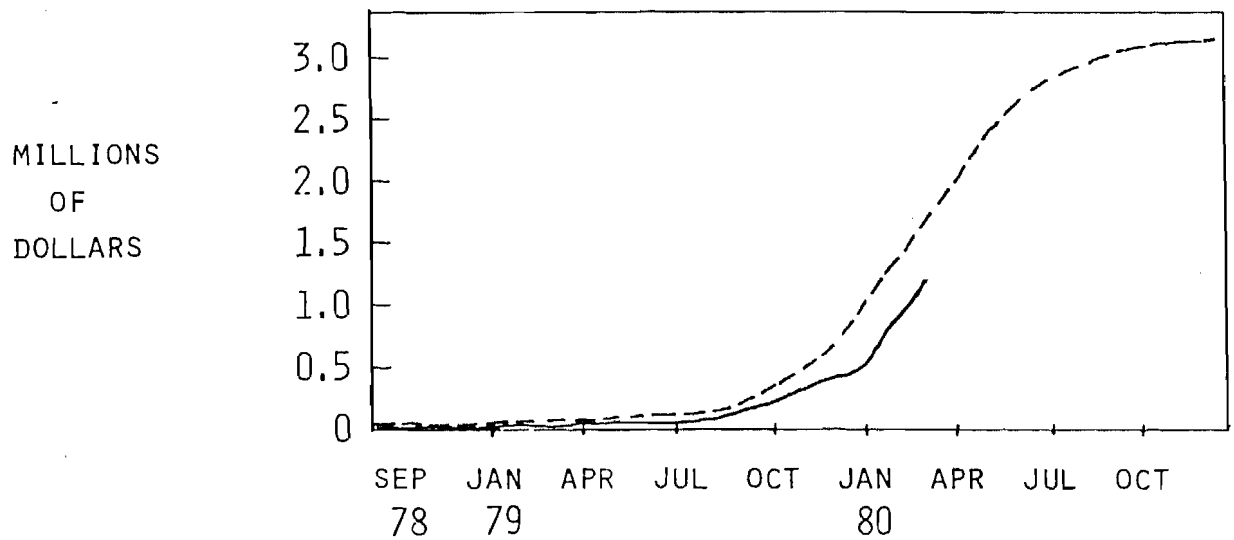
  - STIMULATION PLANS ARE NOT FINALIZED PENDING MUTUAL AGREEMENT BETWEEN COLUMBIA AND DOE.

COLUMBIA GAS
DE-AC21-78MC08385

- MAJOR ACTIVITIES:



- FUNDING PROFILE:



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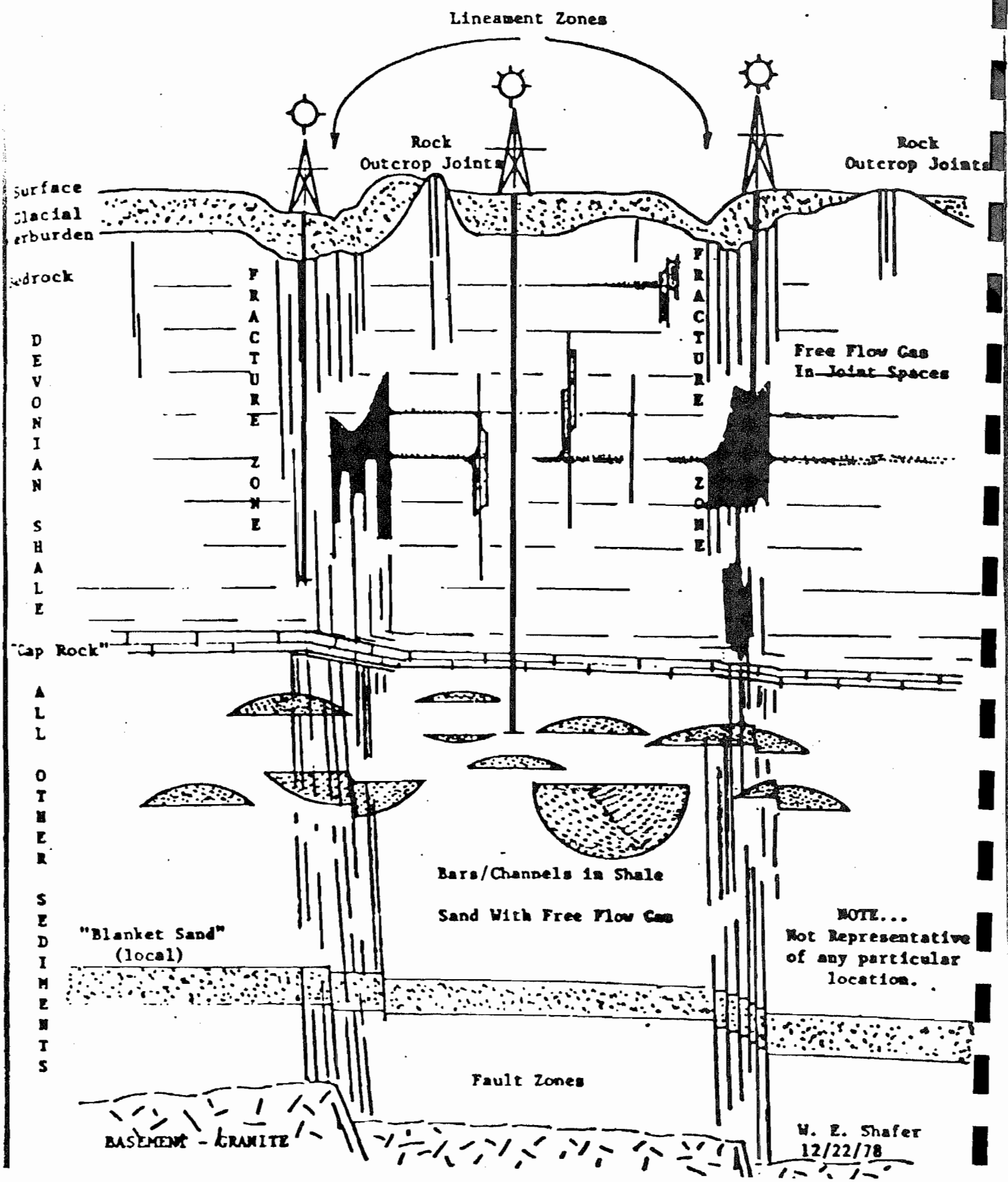
ACTUAL ————————

SKETCH OF THE IDEALIZED, WORKING HYPOTHESES - LINEAMENT/SUBSURFACE CORRELATION



- CONTRACT: TESTING PROGRAM FOR SHALE GAS PRODUCTION POTENTIAL

  THURLOW WEED AND ASSOCIATES, INC.
  DE-AC21-78MC08386

- CONTRACT DATE: SEPTEMBER 1978

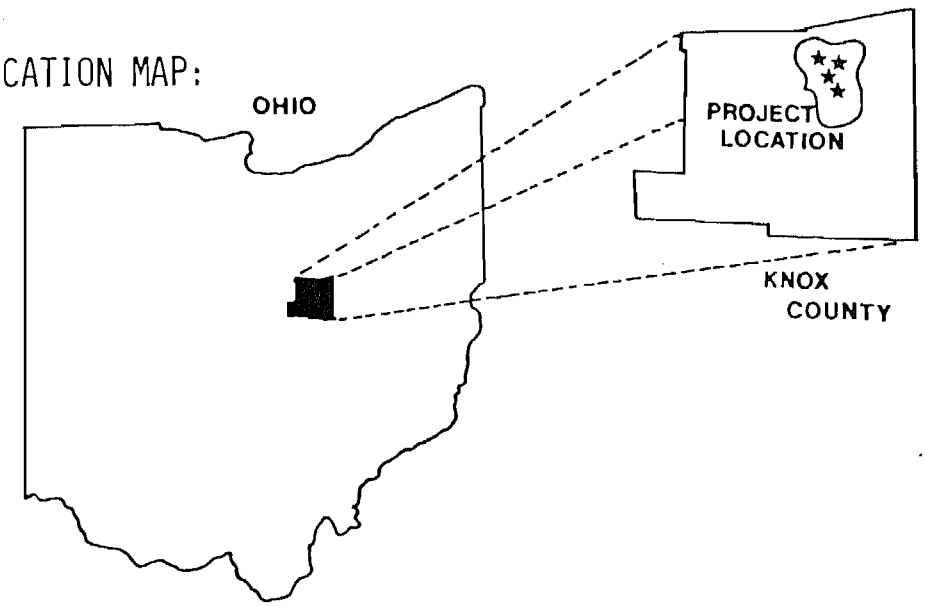
- ANTICIPATED COMPLETION DATE: SEPTEMBER 1980

- TOTAL COST: $432,000

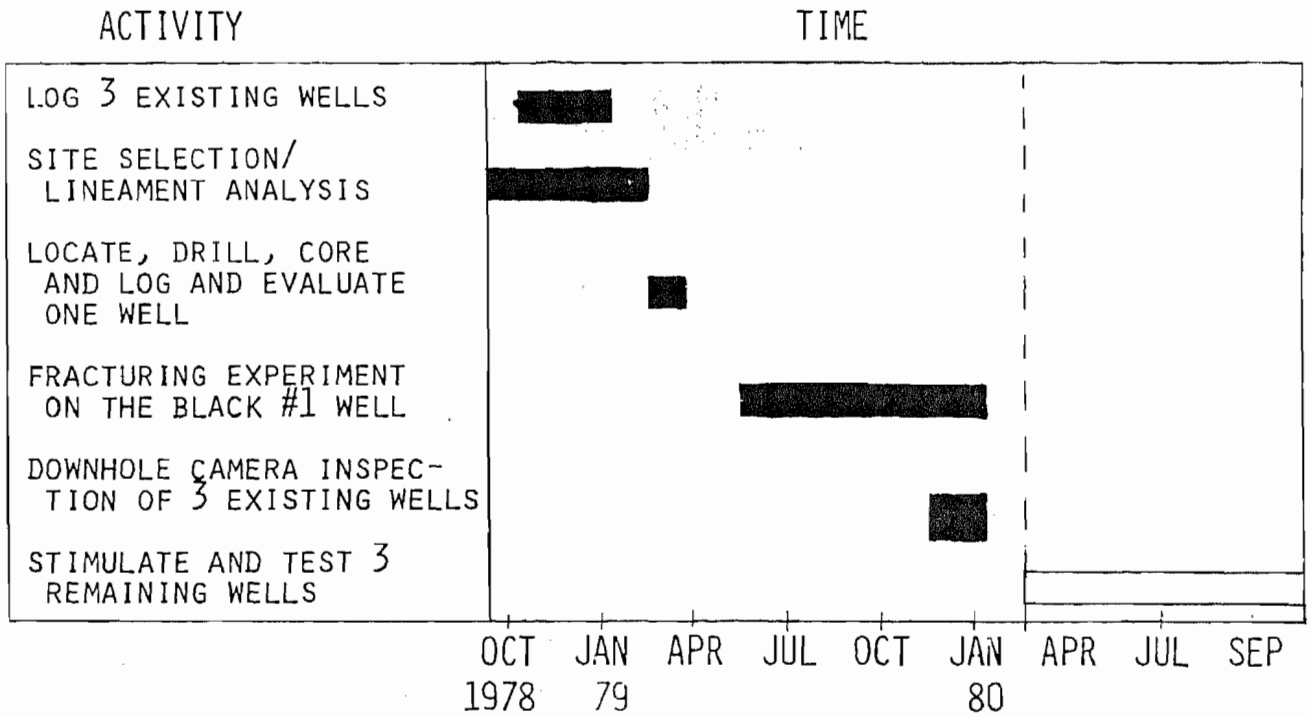
- DOE COST: $423,795

- OBJECTIVE: TO ACQUIRE DATA ON THE COMMERCIAL POTENTIAL OF VARIOUS STIMULATION TECHNIQUES, TO EVALUATE METHODS OF DETERMINING STIMULATION SELECTION. AND TO PROVIDE INFORMATION ON TECHNOLOGY DEVELOPMENTS THAT CAN HAVE AN IMPACT ON MARGINAL OPERATIONS IN THE DEVONIAN SHALE FORMATION OF OHIO.

- LOCATION MAP:



- MAJOR ACTIVITIES:



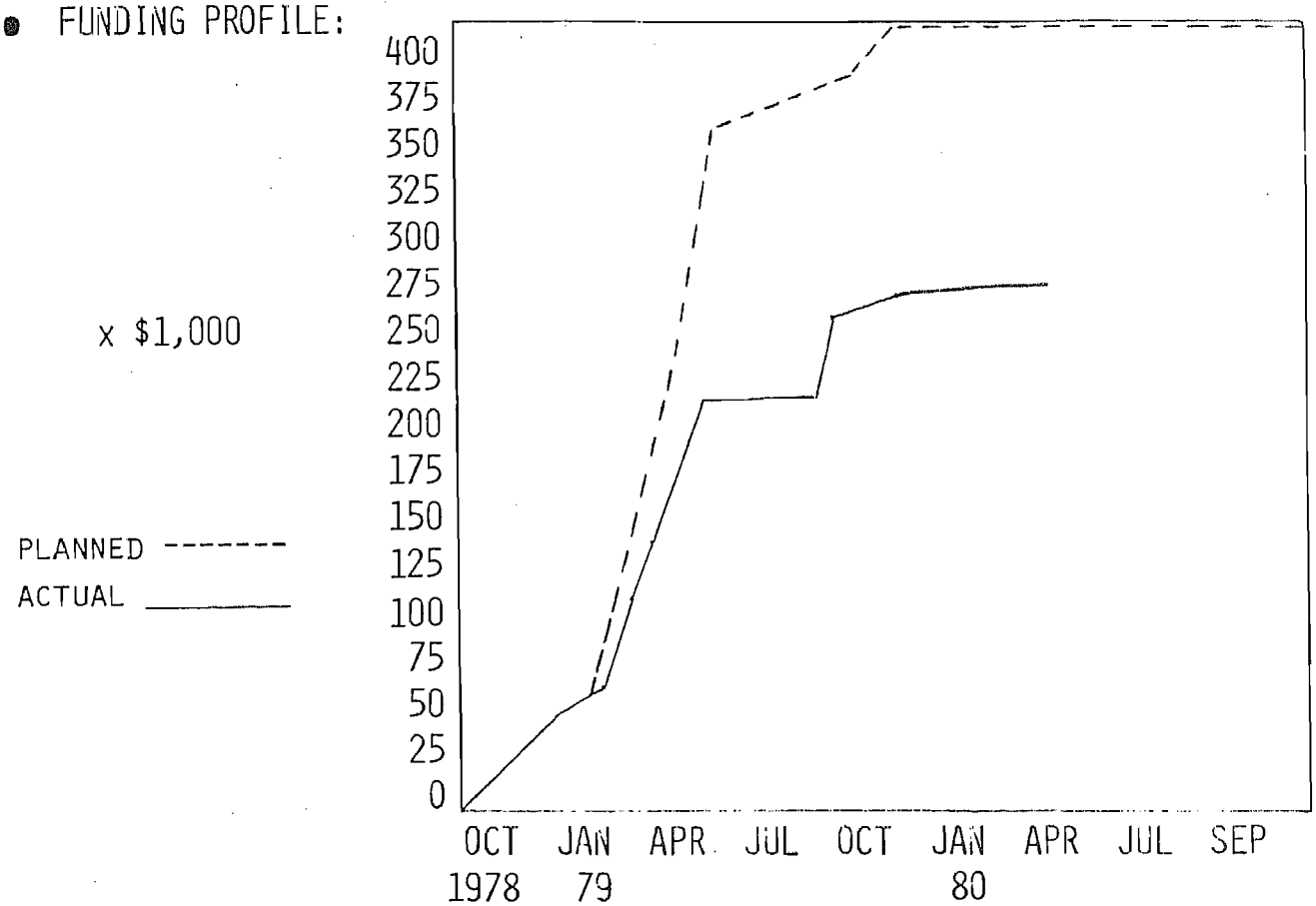
- SUMMARY OF PROGRESS:

  - DRILLED, CORED AND LOGGED ONE WELL IN THE PROJECT AREA.
  - PERFORMED A HIGHLY INSTRUMENTED FRACTURING EXPERIMENT ON AN EXISTING WELL USING A BOREHOLE SEISMIC AND SURFACE TILTMETER SYSTEMS TO EVALUATE THE INDUCED FRACTURE GEOMETRY.
  - EVALUATED ALL FOUR PROJECT WELLS WITH GEOPHYSICAL WELL LOGS.
  - PERFORMED DETAILED NATURAL FRACTURE ANALYSIS IN THE BOREHOLES OF ALL PROJECT WELLS USING A DOWNHOLE VIDEO CAMERA SYSTEM FOR INSPECTION.
  - PRESENTLY CONDUCTING DETAILED LABORATORY INVESTIGATION USING THE CORE FROM ONE PROJECT WELL TO INVESTIGATE WHICH FRACTURING FLUIDS ARE MORE SUITABLE FOR THE THREE REMAINING PROJECT WELLS.

- CRITICAL ITEMS:

  - RESULTS FROM LABORATORY INVESTIGATIONS WILL BE USED TO DESIGN THE FRACTURING EXPERIMENTS ON THE REMAINING PROJECT WELLS.

- FUNDING PROFILE:



- CONTRACT: DEVONIAN SHALE TEST WELL/HOUGHTON COLLEGE AREA OF NEW YORK

  HOUGHTON COLLEGE
  DE-AC21-79MC10640

- CONTRACT DATE: FEBRUARY 26, 1979

- ANTICIPATED COMPLETION DATE: DECEMBER 1979

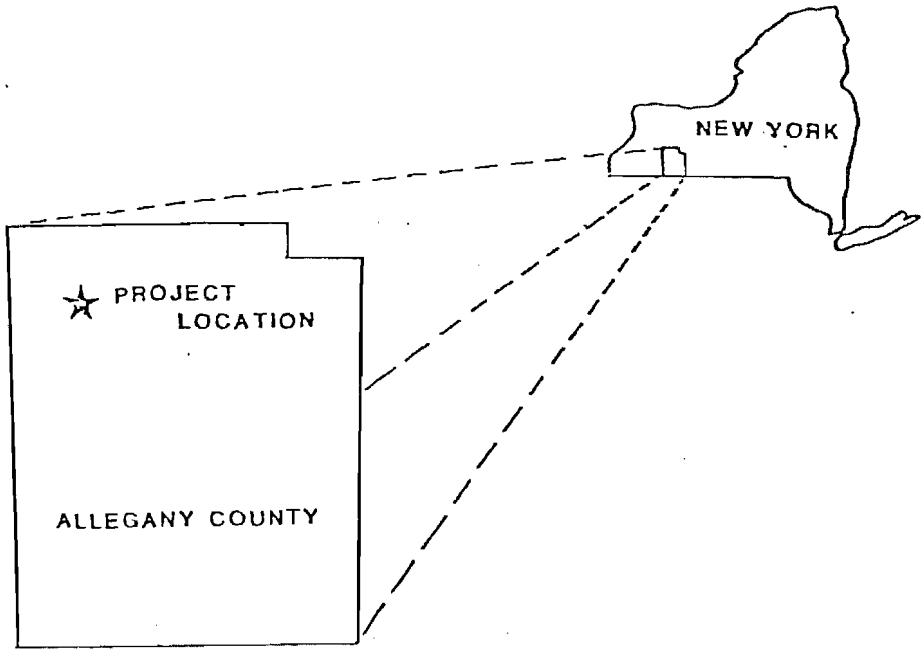
- TOTAL COST: $150,862

- DOE COST: $75,432

- OBJECTIVE: TO ACQUIRE COMPREHENSIVE GEOPHYSICAL WELL LOG DATA FROM THE DEVONIAN SHALE IN ALLEGANY COUNTY, NY; AND TO EVALUATE THE TECHNICAL AND ECONOMIC FEASIBILITY OF STIMULATING NATURAL GAS PRODUCTION FROM THE DEVONIAN SHALE BY HYDRAULIC FRACTURING.

HOUGHTON COLLEGE
DE-AC21-79MC10640

- LOCATION MAP:

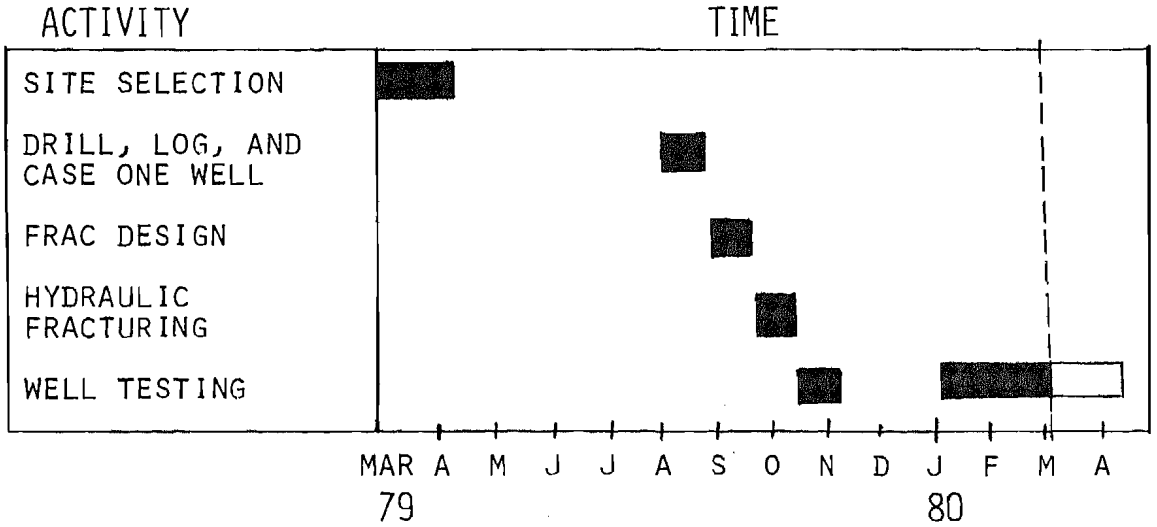


- SUMMARY OF PROGRESS:

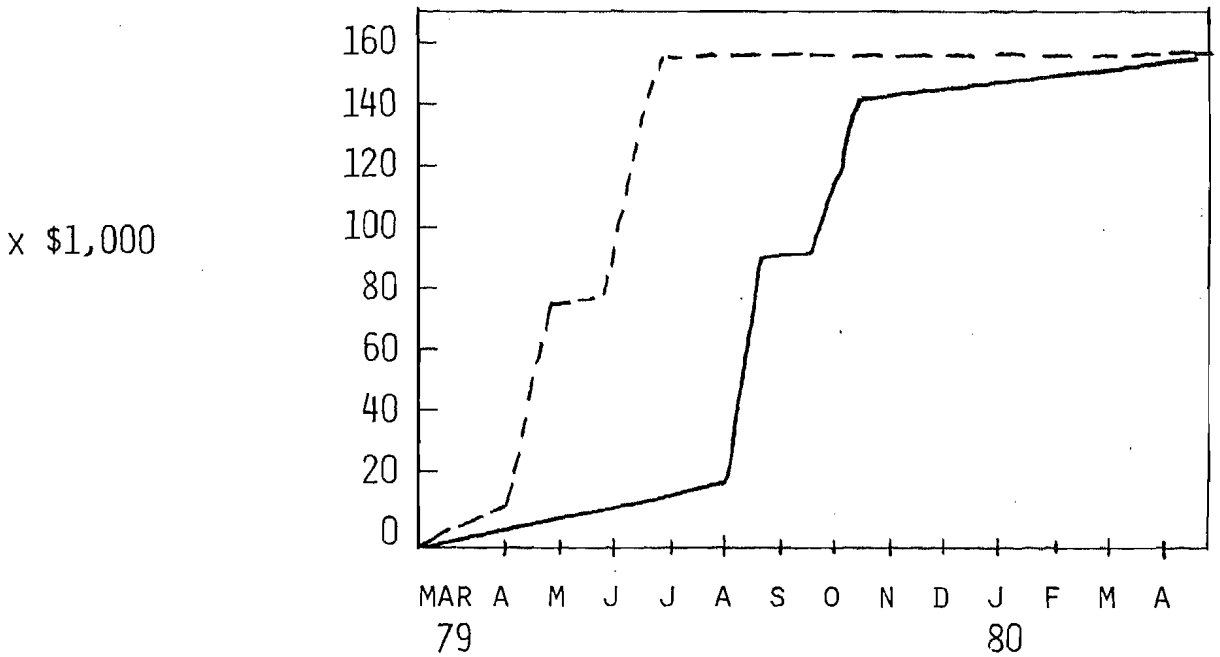
  - DRILLED, LOGGED, AND CASED ONE WELL ON THE HOUGHTON COLLEGE CAMPUS
  - EVALUATED COMPREHENSIVE GEOPHYSICAL LOGGING SUITE FOR SUITABLE STIMULATION INTERVAL AND RECOMMENDED STIMULATION DESIGN
  - STIMULATED THE WELL USING A 50,000-GALLON FOAM-FRAC TREATMENT
  - WELL IS BEING EXTENSIVELY TESTED FOR GAS PRODUCTIVITY
  - INITIAL RESULTS INDICATE THE WELL IS HIGHLY PRODUCTIVE BASED ON INITIAL OPEN FLOW AND BUILDUP TESTS.
  - PENDING FINAL WELL TEST RESULTS, OTHER WELLS IN SOUTHWESTERN NEW YORK WILL BE DRILLED, CORED, LOGGED AND STIMULATED TO UNDERSTAND WHAT AREAS WILL BE PRODUCTIVE.

HOUGHTON COLLEGE
DE-AC21-79MC10640

- MAJOR ACTIVITIES:



- FUNDING PROFILE:



PLANNED - - - - -
ACTUAL ————

EXPECTED PROJECT ACCOMPLISHMENTS

IN

FY 81

- COMPLETE DATA ACQUISITION FOR RESOURCE CHARACTERIZATION
- IDENTIFY FAVORABLE AREAS FOR PRODUCTION IN SOUTHERN APPALACHIAN, ILLINOIS, AND MICHIGAN BASINS
- COMPLETE FABRICATION OF IN SITU STRESS TOOL
- VERIFY EXISTENCE OF RESERVOIR ANISOTROPY IN AREA OF ESTABLISHED PRODUCTION
- COMPLETE MINING ACCESS TO EXPERIMENTAL TEST LEVEL IN THE DEVONIAN SHALE
- VERIFY SEISMIC VELOCITY LOW CONCEPT FOR EXPLORATION
- VERIFY PRODUCTION POTENTIAL IN NORTHEASTERN OHIO AND SOUTHERN TIER COUNTIES OF NEW YORK
- VERIFY DEPOSITIONAL RECONSTRUCTION CONCEPT OF RESERVOIR DELINEATION