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Hydrocarbon Potential of Pre-Pennsylvanian Rocks in Roosevelt County, New Mexico

by William D. Pitt

New Mexico Bureau of Mines & Mineral Resources

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INTRODUCTION

The hydrocarbon potential of pre-Pennsylvanian rocks in Roosevelt County was appraised from data available in published reports, scout tickets, lithology logs, and other well data at the log libraries in Roswell and Socorro, New Mexico, and Midland, Texas. Elevations from lithology logs were used when differing from scout tickets or other sources. Thickness and data other than lithology logs were assumed to be sufficiently accurate if they fitted the control obtained by contouring. The author hopes this summary study will stimulate interest in prospecting for pre-Pennsylvanian hydrocarbons in southern Roosevelt County.

The author acknowledges the counsel of members of the Permian Log Library of Roswell, New Mexico, and of Mr. Darrell Willson, past President of the Roswell Geological Society. The conclusions stated, however, are the responsibility of the author.

GEOLOGIC STRUCTURES

Roosevelt County is located on the northwestern shelf of the Delaware basin of southeastern New Mexico. Most of the drilling and oil production is found in southern Roosevelt County, part of a 100-mile-long production trend, extending from Hockley County in West Texas, across Roosevelt County to eastern Chaves County. Splitting this 20-mile wide production trend is a major fault, herein called the Roosevelt County fault having a maximum throw of 4,500 ft, and upthrown on the north. A brief description of the fault follows.

Roosevelt County Fault

As shown on maps 1, 2, and 3 and the cross sections (in pocket) the Roosevelt County fault extends northwestward from a point near the southeast corner of the county. It cuts the Precambrian and all formations through the Permian; movement may be occurring intermittently today. Flawn (p. 30) believes that the fault extends much farther northward than shown with certainty on map 1, stating that it trends along a zone of "metamorphosed plutonic rock. . .about 50 miles long." He notes further that "the basement rocks along this fault show extensive cataclastic alteration and mylonitization." The straightness of the fault trend on his map suggests that its northern end might involve strike-slip motion; in fact, along the northern end of the fault the motion might be mostly strike-slip and, hence, show little throw north of the northern definable end of the fault. Complex subcrop patterns of Paleozoic rocks strongly suggest that there were two or more intervals of fault movement, a fact noted also by Flawn (p. 56). Its movement also helped to localize and to control oil migration and entrapment in Roosevelt County. The fault was an active controller of deposition, erosion, oil and gas migration; probably also it localized southeastward movement of ground water. As shown especially on cross section J-L, the sedimentary column is much thicker south of the fault.

Cross section J-L illustrates well the considerable throw of the Roosevelt County fault in southern Roosevelt County. Anticlines must have grown on both sides of the fault partly as the result of the fault movement. The fault also must have localized, or partly controlled, ground-water movement adjacent thereto; ground-water movement generally moved southeastward in southern Roosevelt County, as emphasized by Gratton in his study of groundwater dynamics in Roosevelt County. The location of this fault and my estimate of the maximum amount of throw is based solely on relief of the Precambrian surface (Map 1). Several of these elevations were obtained from the map by Foster and Stipp, (1961), as well as from lithology logs.

Elida Dome

The Elida dome is a structure having Precambrian rock exposed along its crest beneath the Pennsylvanian. This writer shows its Precambrian subcrop trending northwest-southeast, even though geophysical maps and the relief of the Precambrian surface suggest a north-south trend of the Elida dome. Pinchout production could be found along its flanks.

Portales Arch and Clovis Sag

The Precambrian surface of Roosevelt County may be a series of small, isolated domes (Leroy Corbitt, Eastern New Mexico University, personal communication, 1971) or a long, east-trending arch, the Portales arch, and possibly a Clovis sag (Robert H. Cress, Roswell, personal communication, 1972). If the large Portales arch is present, its flanks could provide stratigraphic pinchout traps.

Minor folding extends perpendicularly across the Roosevelt County fault, as strongly suggested by the contouring on all maps. One fold extends from about sec. 7, T. 6 S., R. 32 E. eastward through sec. 13, T. 6 S., R. 33 E., and probably at least as far east as sec. 7, T. 6 S., R. 34 E.

Minor faulting

Folding during minor faulting caused the entrapment of oil at the Squyres field in sec. 10, T. 6 S., R. 32 E., and at the South Prairie field in sec. 20, T. 8 S., R. 36 E. Both fields are located on the upthrown side of faults that trend at right angles to the Roosevelt County fault; possibly these minor faults are a kind of adjustment to the major block-fault motion of the Roosevelt County fault.

PRECAMBRIAN TERRANES

The terrane types described below are based largely on the work of Flawn (1956). Information from recent wells have slightly modified Flawn's map of Roosevelt County; these terranes are delineated on Map 1.

TABLE 1 – *Stratigraphic Succession in subsurface of Roosevelt County, New Mexico*

System (time unit)	Series (time-rock unit)	Informal usage	Maximum thickness (ft)	Hydrocarbon Indication	Summary Description (mostly from published sources)
Pennsylvanian	Virgilian	Cisco	300	Bough "C"	Brown to tan limestone and sub-angular quartz sandstone
	Missourian	Canyon	800		Micrites and some chert and dark shales
	Desmoinesian	Strawn	600		Dark-brown cherty limestone and green-gray shale
	Derryan (Atokan)	Atoka	400	Gas, oil in DST	Dark shales and cherty limestone
	Morrowan	Morrow	100		Dark shales and quartzose sandstones
Mississippian	Chesterian		150		Limestone, very finely crystal-line, "micritic"
	Meremecian	"Mississippian lime"	400	Gas, oil in DST	Limestone, cherty with local 3-foot sandstone
	Osagean		Not recognized		
	Kinderhookian		320		Limestone, cherty
Devonian	Upper	Woodford Shale	100		Brown to black bituminous shale with chert
	Middle to Lower	"Devonian"	Not recognized		Siliceous micrite and light-colored calcarenite
Silurian	Niagaran	"Upper Silurian"			Dolomite, dark, fine-grained and locally shaley
		Fusselman	450	Oil in Squyres, North Sawyer	Dolomite, light-colored, locally cherty, or porous
Ordovician	Cincinnatian	Montoya	350	Oil & gas shows in DST	Dolomite, tan or brown, suc-rosic to finely crystalline
	Chazyan	Simpson	50		Dolomite, sandy and quartzose sandstone
	Canadian	Ellenburger	350	Gas shows in DST	Dolomite, tan to brown, fine to medium crystallinity
Cambrian	Croixan &/or Canadian	Bliss	50		Sandstone, gray to white, coarse-grained quartzose

TABLE 2 – *Summary of data for key wells*
(lithologies from sample logs)

Location No.	Operator-Farm	Section T. & R.	Year completed	Basement lithology	Basis for picking tops: Insol. residue	Basis for picking tops: Lith.	Drilling tops and lithology: Cambrian-Ordovician	Drilling tops and lithology: Silurian
1	Austral-Sadler 1	29-4A-32E	1952			X	None	Ls, sdy, very porous
2	Gulf-Elida 1	10-6S-32E	1960	Rhyolite		X	No description--sample gap @ 7720-30	Dol, tan, finely x'lline
3	Lion-J. Slack 1	30-6S-33E	1953			X	Montoya 9520	Dol, gray to tan, cherty
4	Magnolia-Martin 1	29-6S-34E	1955	Rhyolite	X	X	Montoya 7900	Fusselman 7740
5	Magnolia-Whitehead 1	32-6S-34E	1956		X	X	Ellenburger 8940	Ls, white, med x'lline; overlies dol, white to tan
6	Amerada-Vincent 1	11-7S-32E	1954		X	X		Ls and dol, tan to white, finely x'lline cherty
7	Featherstone-Sun State A1	2-7S-36E	1971	Rhyolite		X	Dol, tan to gray, sucrosic, cherty; (Montoya Ls) fair interstitial porosity; basal sandstone 9310	Dol and ls, tan, fine to med x'lline
8	Felmont-Bluitt 5	27-7S-37E				X	Ellenburger 9100	Dol, tan to white, fine to med x'lline
9	Brown-Saunders 1	5-8S-37E						Congl, with felsite pebbles (20 ft) and dol, fine to coarsely x'lline (60 ft)
10	Ohio-Keller 1	21-7S-38E	1960		X	X	Montoya? 10,500 (insol.)	Silurian(?) 10,525 (lith.) 20 ft Dol, brn-tan, fine to med x'lline 70 ft ls, cherty 10 ft dol, tan-white coarsely x'lline
11	Shell-Bluitt 1	14-8S-37E		Rhyolite	X	X	Montoya 9250 Ellenburger 9370	Dol, tan-white, sdy, fine to coarsely x'lline and cherty
12	Texas-Heffle-finger 1	6-8S-35E	1958	Chloritic schist			Montoya: dol, tan, or brn, finely x'lline Ellenburger: dol, tan to brn, fine to med x'lline Simpson 10,935 Cambrian 10,950	Dol, tan to brn, fair porosity
13	Magnolia-Jacobs -Federal 1	18-8S-35E	1956	Schist	X	X	Montoya 11,540 Simpson 11,700 Cambrian 11,730	Dol, white to gry, fine to coarsely-x'lline
14	Shell-Bluitt 2	16-8S-37E	1956	Rhyolite		X	Montoya 12,090 Ellenburger 12,250	20 ft ls, sdy 20 ft ls, and dol, cherty 60 ft dol
15	Amerada-Federal C-1	10-7S-32E	1954			X	Montoya: dol, tan to brn, dense; finely x'lline	Ls, white, dense

Texas Craton

Flawn reports that the rocks of the Texas craton are Middle Precambrian; these rocks (which extend from Texas westward into New Mexico), therefore, are the oldest rocks subcropping beneath the sedimentary rocks of Roosevelt County. Flawn believes that the Texas craton likely was a continental area separate from the Canadian craton farther north. The belt of granitic rocks of the Texas craton in southern Roosevelt County is directly north of the Roosevelt County fault. The Texas craton everywhere is distinguished by its great volume of granite and granodiorite. Flawn reports that the rocks are rich in alkali elements (the potassium feldspar being mostly microcline) and microperthite. The granite is poor in iron and magnesium; the mafic minerals are mostly biotite and its alteration product, chlorite. Foster (1972, p. 19) shows the Texas craton subcrop area as belonging to the Torrance metamorphic group; he believes Precambrian granite subcrops are more limited in size, showing them as circular areas of about 4 square miles.

Panhandle Volcanic Terrane

Rocks, mostly rhyolite porphyry, are found at the northern end of Roosevelt County and also south of the Roosevelt County fault (see Map 1). The average rhyolite porphyry, according to Flawn, consists of about 65 to 95 percent quartz-alkali feldspar groundmass and are thought to be late Precambrian.

Swisher Gabbroic Terrane

A variety of compositions typify this terrane: gabbro, olivine gabbro, diabase, diorite, basalt, syenogabbro, and even iron ore (Flawn, p. 44). Diabase and gabbro are found in this terrane within Roosevelt County. These rocks, late Precambrian, are the youngest of the Precambrian rocks that lie beneath the sedimentary rocks of Roosevelt County; locally, in Texas, they intrude the rocks of the Panhandle volcanic terrane.

STRATIGRAPHY OF PRE-PENNSYLVANIAN SEDIMENTS

The lithology and reservoir potential of the systems of rock that subcrop beneath the Pennsylvanian System in Roosevelt County are summarized below (see also table 1).

Cambrian and Ordovician

The Cambrian and Ordovician systems (like the Silurian) in Roosevelt County are thin, effectively unfossiliferous, and similar in lithology. The section is mostly a dolomite that is fine to medium in crystallinity, having generally unpromising reservoir characteristics. Several wells, however, do contain porous Cambrian and Ordovician intervals. Tennessee Gas-Sunray State-1, sec. 16, T. 7 S., R. 35 E., for example, contains 20 ft of gray to white sandstone directly above the rhyolite. The grains of the sandstone are medium to coarse in size. Cambrian and Ordovician rocks, therefore, could contain commercial amounts of hydrocarbons within southern Roosevelt County (see cross section G-I).

The 1971 gas discovery in sec. 19, T. 5 S., R. 33 E., Amoco #1 Peterson, was reported having perforated producing horizon at well depth 7632 ft to 7766 ft, either in the Cisco (Pennsylvanian) or in granite wash beneath the Cisco. Calculated open flow was 7210 MCFGPD (million cu ft gas per day), gas-oil ratio of 27,700 cu ft gas per barrel of oil, with gravity of condensate 70.5. If the gas is coming from arkosic sandstone of pre-Pennsylvanian age, southern Roosevelt County and neighboring Chaves County may have several pre-Pennsylvanian "granite wash" gas fields remaining to be discovered.

Silurian

Rocks of Silurian age (called Devonian by some oil operators) are also fine-grained carbonates, mostly dolomite. McGlasson maps the Fusselman as being over 400 ft thick in southernmost Roosevelt County. Local descriptions of the Fusselman are given in table 2. Several commercial Silurian wells are found in Roosevelt County; in fact, some wells have yielded considerable oil (table 3). Proximity to faults may be a greater factor in their production than intergranular porosity; faulting near these wells, might well have caused enough fracture permeability to make Silurian wells in Roosevelt County commercial. The Amerada-Federal ("Devonian" well) in sec. 10, T. 7 S., R. 32 E., tested 8 to 10 percent porosity; the pay zone was described as white dolomite having vuggy porosity beginning 15 to 20 ft below the top of the dolomite (Roswell Geological Society, 1950, p. 330). The so-called Devonian wells of Roosevelt County actually are Silurian, because the Fusselman Dolomite (Silurian) generally directly underlies the Mississippian or the Pennsylvanian wherever present in Roosevelt County. Oil production came from 60-ft zone of dolomite (depth 9210-9270 ft) reported to have a horizontal permeability of up to 400 millidarcies—excellent permeability, whatever the cause. I examined the core of Austral-Sadler-1 (see table 2) and can testify that this reported Fusselman section also was quite porous and vuggy.

The Fusselman comprises the reservoir rock in two fields: the now-abandoned Squyres, and South Prairie; each is south of the Roosevelt County fault and near, and on, the upthrown side of another fault that strikes perpendicularly to the Roosevelt County fault, as shown on Map 3. North Sawyer, in the extreme southeast corner of the county, seems to be producing along a separate anticline south of the Roosevelt County fault, apparently on the crest of an anticline caused by the downward movement of the south block of the Roosevelt County fault.

One well on the upthrown side of the Roosevelt County fault contains a show of gas in the Silurian; there-

TABLE 3 — *Cumulative Silurian oil production for Roosevelt County*

	Section T. & R.	Production through 1970 (bbls)	Field
Anadarko #1 Anadarko State "A"	32-8S-38E	226,104	North Sawyer
Ingram #1 State	32-8S-38E	234,883	North Sawyer
Huber #1 Petrofina Federal	20-8S-36E	42,438	South Prairie
Huber #1 Lone Star	20-8S-36E	108,008	South Prairie
Amerada #1C Federal	10-7S-32E	7,887	Squyres
		619,320	

fore , commercial oil or gas wells could be found on the upthrown side of the Roosevelt County fault.

Probably more fields producing from the Silurian will be discovered in Roosevelt County and the discoveries will be based largely on geophysical prospecting that detects faults transverse to the Roosevelt County fault. The writer predicts that there is at least as much oil to be recovered from rocks of pre-Pennsylvanian age as already produced from the Silurian.

Mississippian

The lithology of the Mississippian in Roosevelt County is almost altogether a nonporous limestone or chert. One notable exception, making this system worth examining if penetrated, is a calcareous sandstone found in the Mississippian in Magnolia-Martin 1 (sec. 29, T. 6 S., R. 34 E.); the Mississippian, however, tested dry in this well (although this sand section was not tested). Cross section D-F shows that the Mississippian yielded 50 percent oil in gas-cut mud during drill-stem test of Magnolia #1 Whitehead (sec. 30, T. 6 S., R. 34 E.). Farther north, in northern Roosevelt County, Foster (1972, p. 16) reports thin subcrops of the Mississippian in the Tucumcari basin area: "About 100 ft of section can be expected although normally the interval would be somewhat thinner."

POSSIBLE AREAS OF HYDROCARBON ACCUMULATION

A series of pre-Pennsylvanian cross sections (see sheet in pocket) were constructed to show the gross lithology and possibly significant shows of hydrocarbons in these wells. Gas accumulations may occur updip from oil or gas shows, and oil accumulations may occur downdip from gas shows. Speculating whether or not untested areas warrant a test well is beyond the scope of this report. Formations having low shut-in pressures, for example, would discourage thorough testing. Apparent untested zones, as indicated on cross sections, are listed below. Probable pre-Pennsylvanian hydrocarbon accumulation zones are shown on Map 3.

Cross Section A-C

A strong "blow" in Texas Crude No. "3" 1 Tucker suggests that the Fusselman dolomite and older sediments might produce gas or oil (in the area depicted on map 3).

Cross Section D-F

A promising oil show in the Mississippian and a good "blow" in the Ellenburger indicates some hydrocarbon accumulation. No tests were recorded in the Montoya-Fusselman formations.

Cross Section G-I

An oil column might well exist between wells G and H (Featherston No. A 1 Sun State and Tennessee Gas—No. 1 Sunray-State, respectively) in the Fusselman-Montoya Formations or in the Bliss sandstone. A lensing-out of the Mississippian between wells G and H is also noteworthy.

Cross Section J-L

Cross section J-L illustrates well the considerable throw of the Roosevelt County fault in southern Roosevelt County. Anticlines must have grown on both sides of the fault, partly as the result of the fault movement. The fault also must have localized, or partly controlled, ground-water movement adjacent thereto; ground-water movement generally moved southeastward in southern Roosevelt County, as emphasized by Gratton in his study of groundwater dynamics in Roosevelt County.

Cross Section J-M

This cross section shows the probable onlap-pinchout of the Ellenburger, Montoya, and Fusselman Formations on a Precambrian high; all three had minor shows in drill-stem tests.

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PRECAMBRIAN SUBSURFACE RELIEF AND ROCK TERRANE
ROOSEVELT COUNTY, NEW MEXICO
by W. D. Pitt March, 1973
EXPLANATION
-2674
○ Control point showing elevation, in feet, of Precambrian
Fault, dashed where assumed; U, upthrown side; D, downthrown side
-3000 Contours on Precambrian, dashed where approximate
Datum, mean sea level
0 1 2 3 4 5 6 Miles
R-Rhyolite
RP-Rhyolite porphyry
D-Diabase
Ga-Gabbro, diorite
Gr-Granite, syenite
Volcanic (Panhandle)
Gabbroic (Swisher)
Cratonic (Texas Craton)
CLOVIS SAG
PORTALES ARCH
ROOSEVELT COUNTY FAULT
Portales
Elida
R. 29 E.
R. 30 E.
R. 31 E.
R. 32 E.
R. 33 E.
R. 34 E.
R. 35 E.
R. 36 E.
R. 37 E.
R. 38 E.
T. 4 N.
T. 3 N.
T. 2 N.
T. 1 N.
T. 1 S.
T. 2 S.
T. 3 S.
T. 4 S.
T. 5 S.
T. 6 S.
T. 7 S.
T. 8 S.
34° 30'
34° 00'

ISOPACH OF CAMBRIAN THROUGH MISSISSIPPIAN ROOSEVELT COUNTY, NEW MEXICO

by W. D. Pitt March, 1973

EXPLANATION

350 ● Control point showing thickness in feet

est – Estimated

6 Number for key well listed in table 2

500 Isopach contour dashed where approximate

0 Approximate wedge edge of Silurian

Approximate wedge edge of Mississippian

Silurian subcrop

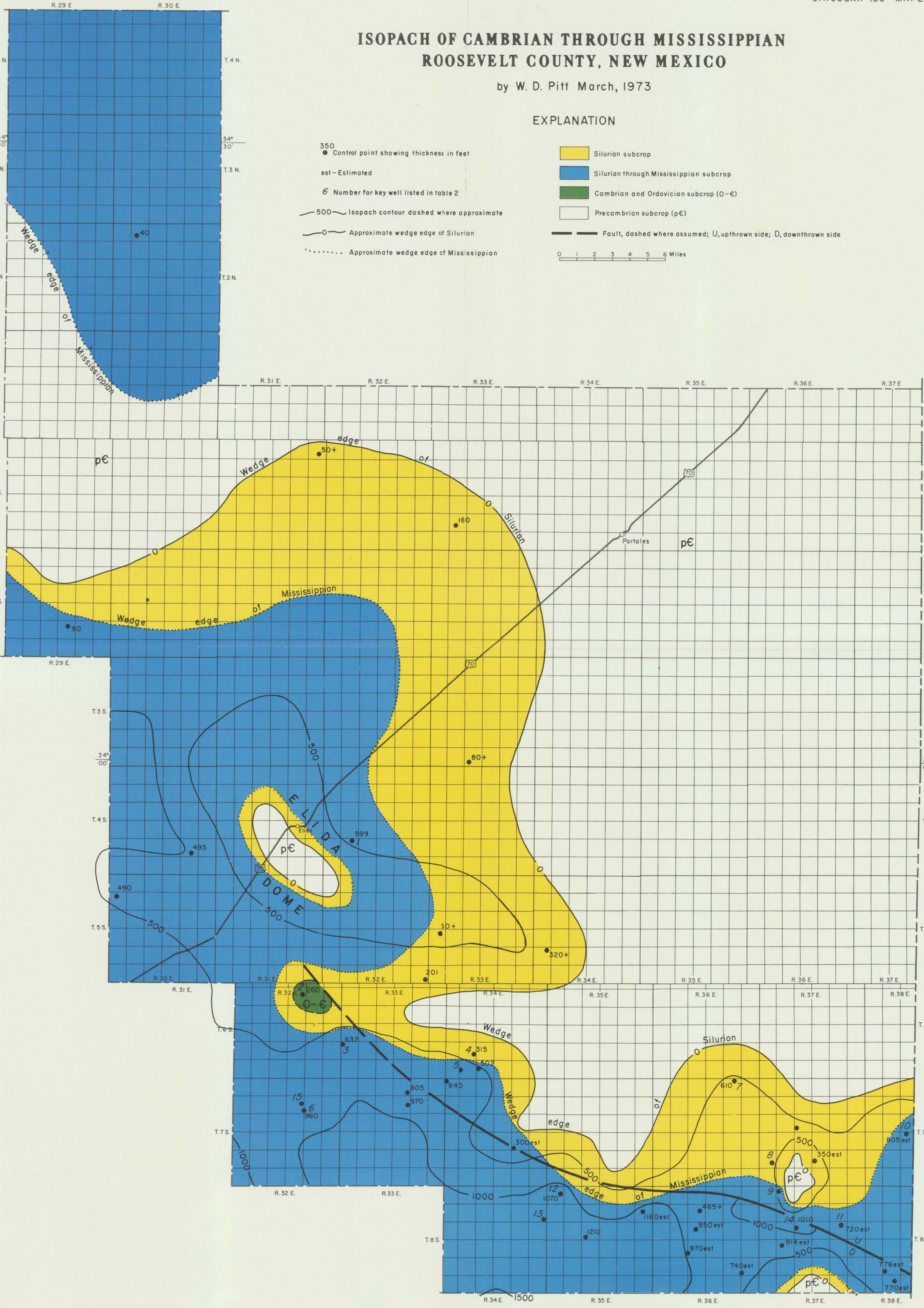
Silurian through Mississippian subcrop

Cambrian and Ordovician subcrop (O-€)

Precambrian subcrop (p€)

Fault, dashed where assumed; U, upthrown side; D, downthrown side

0 1 2 3 4 5 6 Miles



STRUCTURE CONTOURS ON TOP OF SILURIAN ROOSEVELT COUNTY, NEW MEXICO

by W. D. Pitt March, 1973

EXPLANATION

-5089 Control point showing elevation, in feet, top of Silurian

Silurian (Fusselman Dolomite) oil well

-3500 Contours on top of Silurian, dashed where approximate

Datum, mean sea level

Wedge edge of Silurian

0 1 2 3 4 5 6 Miles

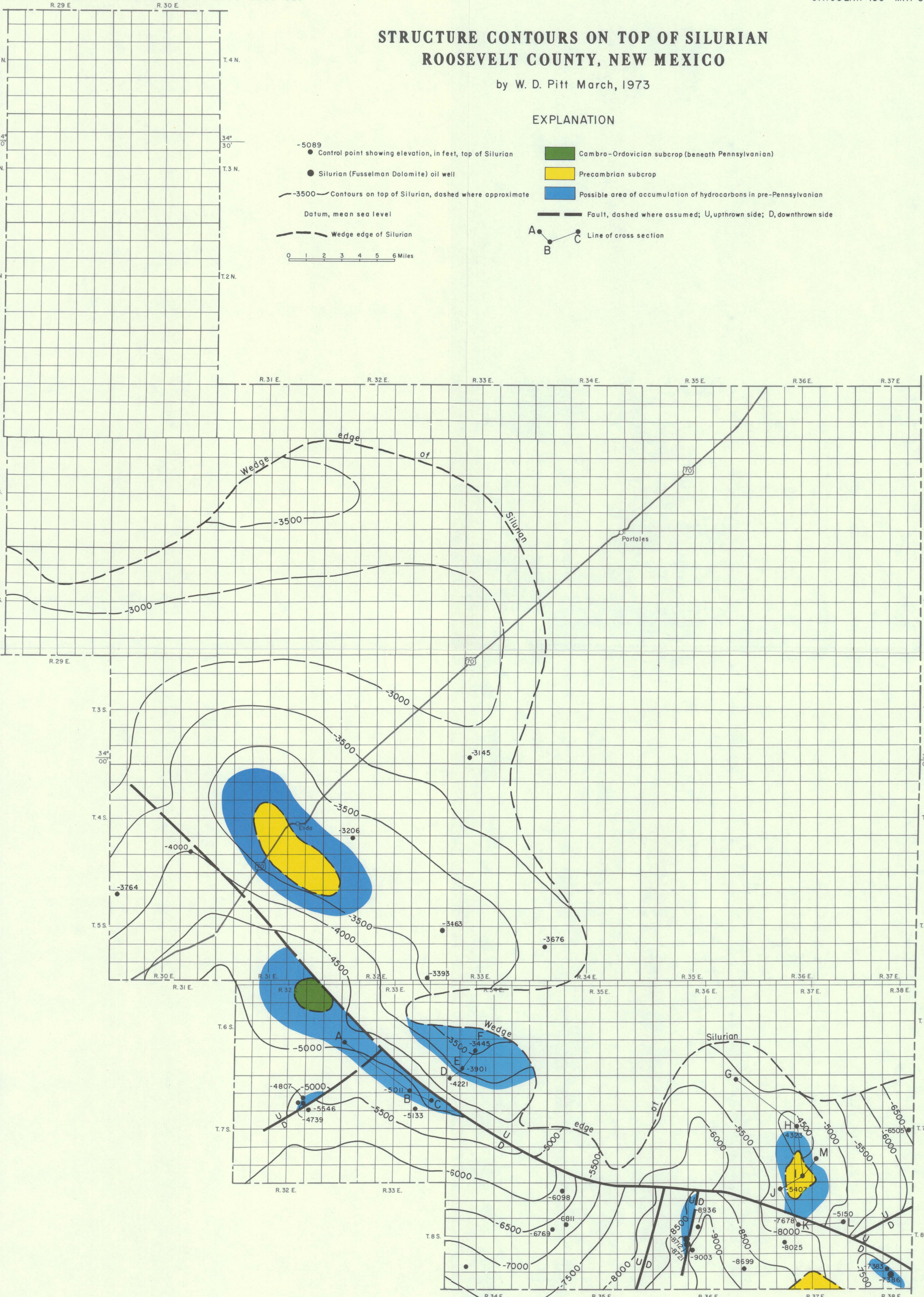
Cambro-Ordovician subcrop (beneath Pennsylvanian)

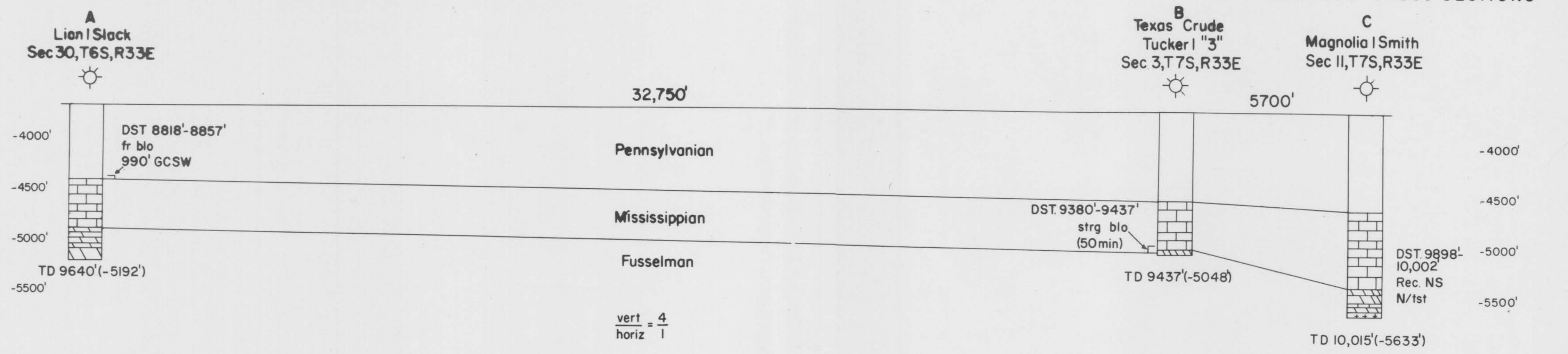
Precambrian subcrop

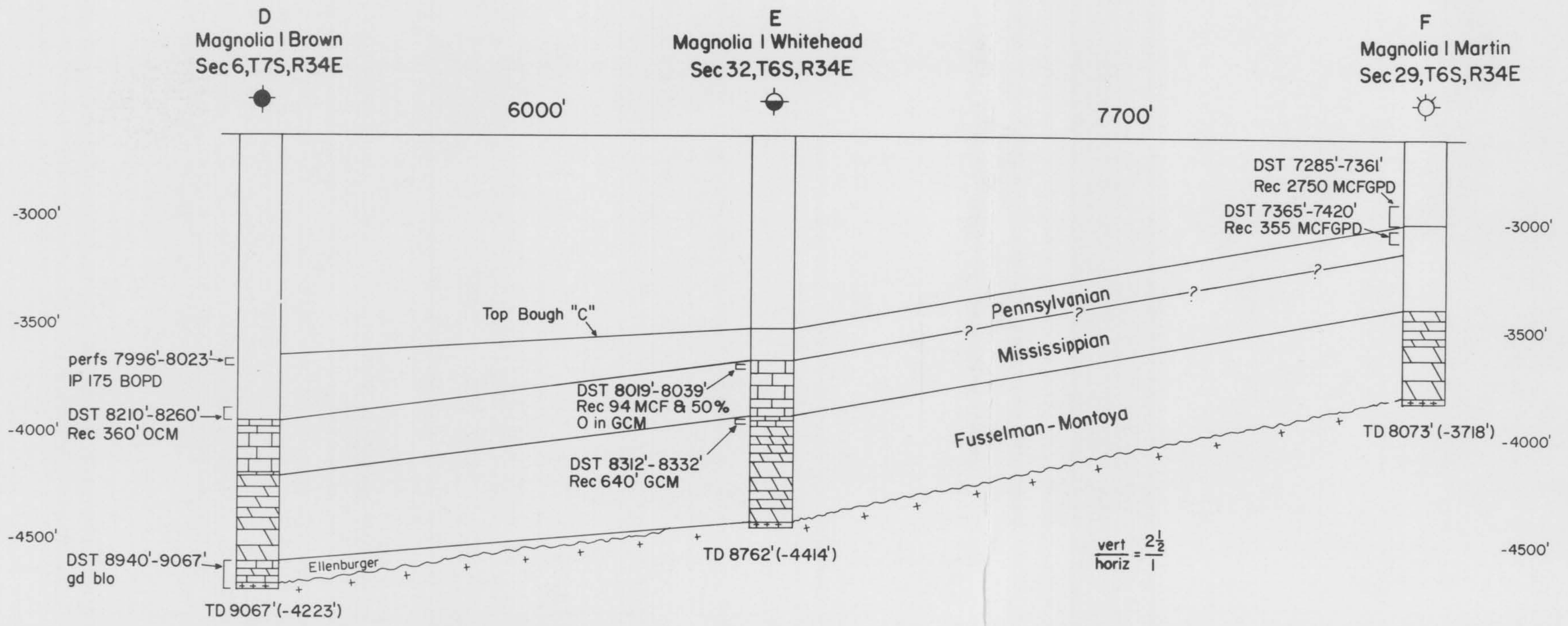
Possible area of accumulation of hydrocarbons in pre-Pennsylvanian

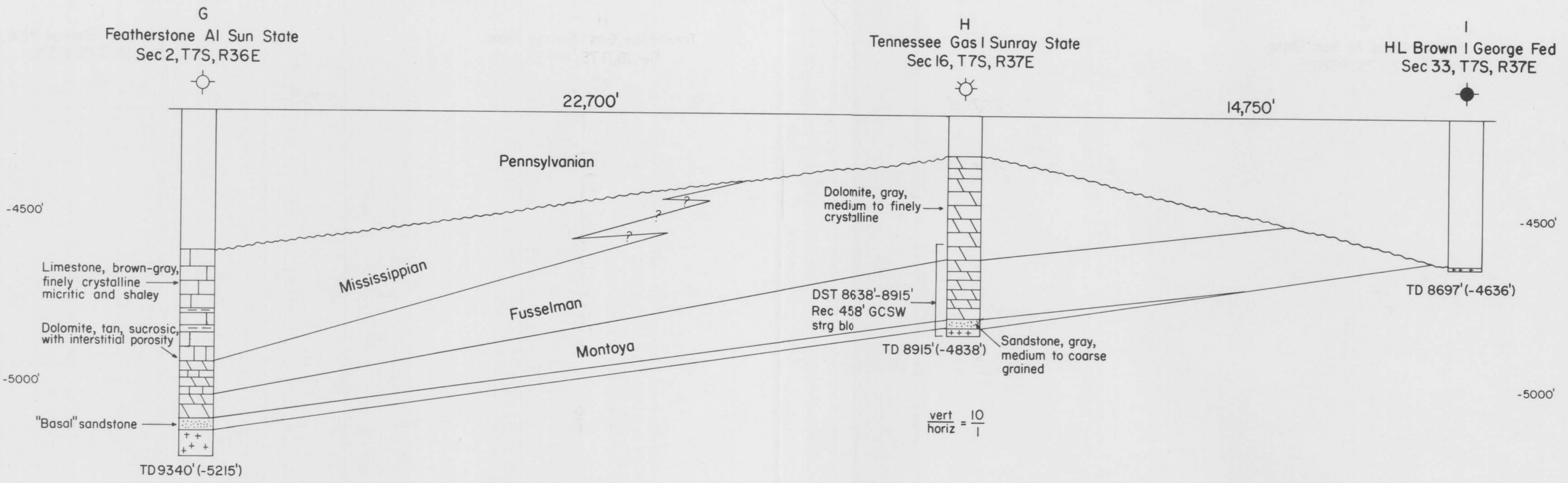
Fault, dashed where assumed; U, upthrown side; D, downthrown side

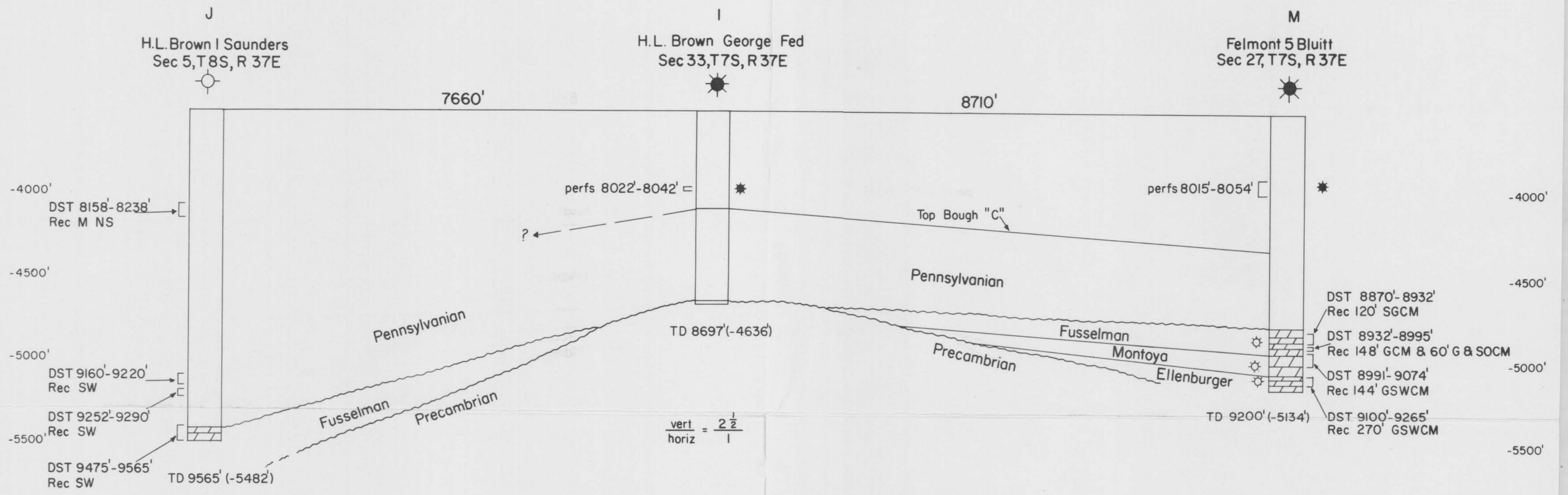
A B C Line of cross section

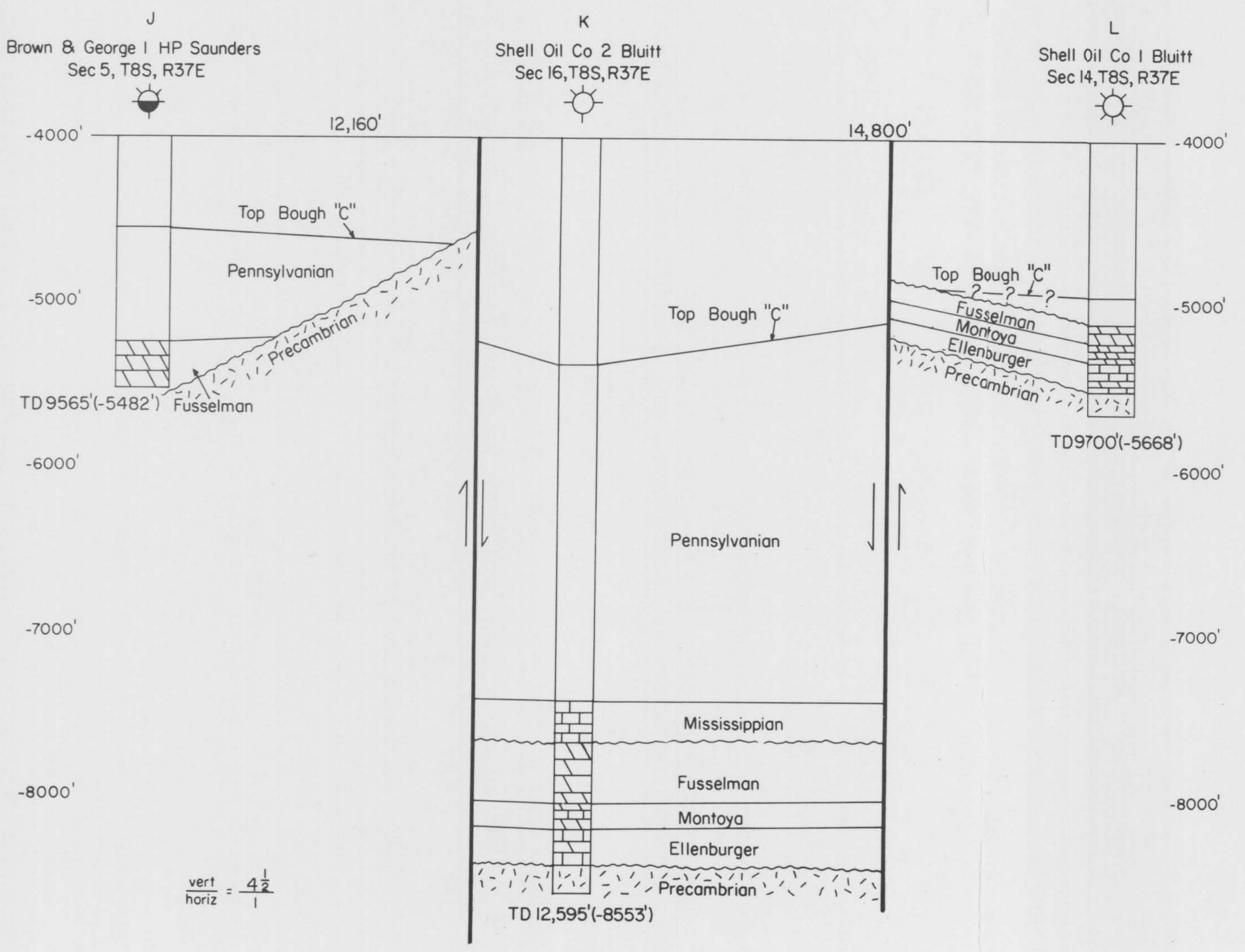












EXPLANATION

DST - Drill stem test
Rec - Recovered
M - Mud
NS - No show
SW - Salt water
perfs - Perforations
SGCM - Show of gas cut mud
SOCM - Show of oil cut mud
GSWCM - Gas salt water cut mud
strg blo - Strong blow
gd blo - Good blow
fr blo - Fair blow
GCSW - Gas cut salt water
MCFGPD - Thousand cubic feet of gas per day
IP - Initial production
BOPD - Barrels of oil per day
N/tst - No test
TD - Total depth