OIL & GAS CONSERVATION COMMISSION
Meeting: January 21, 1970
Mr. John Bannister, Exec. Sec.

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OFFICE OF
Oil and Gas Conservation Commission
STATE OF ARIZONA
ROOM 202
1624 WEST ADAMS
Phoenix, Arizona 85007
PHONE: 271-5161

A G E N D A

Meeting
January 21, 1970
Room 204, Arizona State Office Bldg.

10:00 a.m. Call to order

1. Approval of minutes of meeting of December 17, 1969 OK
2. Executive Secretary report
3. Geologist report
4. Old Business
5. New Business
6. Adjourn

IF YOU ARE UNABLE TO ATTEND THIS MEETING, PLEASE NOTIFY THIS OFFICE AS SOON AS POSSIBLE.

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OFFICE OF
Oil and Gas Conservation Commission
STATE OF ARIZONA
ROOM 202
1624 WEST ADAMS
Phoenix, Arizona 85007
PHONE: 271-5161

January 15, 1970

Memo: Commissioners
From: John Bannister

Re: Report of Activity

The Executive Committee of the Interstate Oil Compact Commission met on December 10, 1969 in Salt Lake City. Mr. Dowd advised that approval by Congress of the extension of the Compact to Conserve Oil and Gas was expected shortly.

Due to a mix-up at the Health Department Laboratory and a change of personnel, the analyses of water wells in the vicinity of the salt project have just now been completed and the results submitted to Dr. Qashu of the University of Arizona and to Engineers Testing Laboratory. Dr. Qashu is compiling the accumulated data which will be distributed to the individuals concerned and another meeting will then be called to review the situation. At this point, everything is proceeding satisfactorily.

The only known legislation being prepared which has anything to do with oil and gas is a bill, probably to be sponsored by the House Natural Resources Committee, to remove any limitation on the holding of state acreage, which now is 15,360.

At a meeting held this date of the Oil and Gas Association of Arizona, it was determined that this organization would seek to introduce legislation concerning oil and gas taxes. Apparently the approach to be taken by the Oil and Gas Association is to expand the state tax now in existence, i.e., sales tax in the amount of 2-1/2% insofar as it pertains to oil and gas, to an all-encompassing tax of 5%, at the same time and in the same bill denying counties the right to impose any further taxes upon oil and gas production. It was also suggested that the organization again seek an incentive bill of $250,000 for the first discovery, however this motion was amended to allow the discoverer to have no taxation upon his well until such time as he had recovered 300% of the cost of his well.

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I personally doubt the success of this legislation, inasmuch as the organization behind it is an ineffective one and I will be much surprised as to its success in even getting the legislation introduced. However, should they be successful, both the bills would, in my opinion, have enough merit to rate backing of this Commission.

We have been advised of the death of John Anderson, Regional Oil and Gas Supervisor of the U.S. Geological Survey, in Roswell, New Mexico. A telegram of condolence was sent to Mrs. Anderson.

Permits are slow right now, undoubtedly due to the fact that oil companies are just getting their budgets established for the year and due to the weather situation in the north. Indications are that 1970 should be a good drilling year.

New Permits:

526 - Buttes Gas & Oil #1-31 Navajo (1576), NE/4 NE/4 31-35N-27E, Apache County.

527 - Not issued.

528 - Consolidated Oil & Gas #1-1 Navajo (226), SW/4 SW/4 1-41N-28E, Apache County.

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OFFICE OF
Oil and Gas Conservation Commission
STATE OF ARIZONA
ROOM 202
1624 WEST ADAMS
Phoenix, Arizona 85007
PHONE: 271-5161

January 15, 1970

GEOLOGIST'S REPORT

FROM: JAMES SCURLOCK
TO : COMMISSIONERS

APACHE COUNTY

Consolidated Oil & Gas #1-1 Navajo (226)
T41N, R28E, G & SRM — East Boundary Butte Field
Sec. 1: SW/4 SW/4 — Development Well
Permit #528
Location

Consolidated Oil & Gas #3 Navajo (227)
T41N, R28E, G & SRM
Sec. 11: SW/4 NE/4
Permit #524 — East Boundary Butte Field
Location. Contractor: Loffland Brothers.

Union #1-4 Navajo (8833)
T36N, R29E, G & SRM — Wildcat
Sec. 4: SE/4 SE/4 — "TIGHT HOLE"
Permit #521
Permit has been cancelled. Union has dropped the lease.

Union #1-17 Navajo (2346)
T36N, R29E, G & SRM — Wildcat
Sec. 17: SW/4 SW/4 — "TIGHT HOLE"
Permit #522
DST 4742-4880'. Recovered 120' of drilling mud.
No cores taken.
Formation tops:

Navajo	521'
Keyente	871'
Windgate	1100'
Chinle	1453'
Shinarump	2452'
De Chelly	2598'
Supai	3176'
Hermosa	4293'
Molas	4937'
Redwall	5038'
Total Depth	5057'

Plugged and abandoned 12-7-69.

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APACHE COUNTY (Cont.)

Mesa Petroleum #1 Navajo (8888)
T35N, R30E, G & SRM — Dineh bi Keyah Field
Sec. 4: NW/4 NW/4 — Development Well
Permit #525

Spud 12-9-69.
Drilled 13-3/4" hole to 852'.
Ran 9-5/8" casing at 850' with 300 sacks.
Drilled to a total depth of 3972'.
Ran 7" casing at 3865' with 50 sacks.
No cores, no tests.
Formation tops:

Chinle	770'
Coconino	1576'
Supai	2280'
Hermosa	3340'
Intrusive	3859'
Total Depth	3972'

Plugged and abandoned 1-5-70.
Note: This well, drilled on the edge of the igneous sill, penetrated only 3' of sill which was too thin and too impermeable to produce.

Buttes #1-31 Navajo (1576)
T35N, R27E, G & SRM
Sec. 31: NE/4 NE/4
Permit #526

Spud 12-13-69.
Set 8-5/8" casing at 229' with 125 sacks.
No cores.
DST #1 1907-1963' (Mississippian) recovered 3' of mud.
DST #2 2224-2280' (McCracken) recovered 240' of mud, 310' of mud cut salt water plus 90' of slightly gas cut salt water.
Formation tops:

Organ Rock	855'
Hermosa	1408'
Mississippian	1802'
Elbert	2012'
McCracken	2208'
Aneth	2352'
Cambrian	2424'
Pre-Cambrian	2460'
Total Depth	2482'

Plugged and abandoned 12-24-69.

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APACHE COUNTY (Cont.)

Thoureen #1 Santa Fe
T21N, R26E, G & SRM — Wildcat
Sec. 27: NE/4 SW/4 — "TIGHT HOLE"
Permit #504
Total depth 1237' in Coconino.
Well shut down. It has been temporarily abandoned.
Will attempt Shinarump completion.
No rig on location.

Eastern #1 Navajo (2601)
T20N, R28E, G & SRM
Sec. 30: NE/4 SW/4
Permit #523
Location. Well will be drilled with the company rig.

MOHAVE COUNTY

Harris #1 Federal 3758A
T38N, R7W, G & SRM
Sec. 29: NW/4 NE/4 — Wildcat
Permit #502
Drilling at 1010'.

GILA COUNTY

Kerber #1 Federal (A-2719-A)
T4N, R13E, G & SRM
Sec. 5: SE/4 NW/4 — Wildcat
Permit #516
Drilling at 1505'. Apparently the well has penetrated bedrock beneath the valley gravels.
This is primarily a Devonian shot.

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SCUTTLEBUTT:

It looks like activity is picking up in Cochise County. The ground rumors have it that Jim Pickett and three other men are leasing up three big blocks (mostly fee) for Gulf, Pure and another undisclosed company. Pickett and his men, we understand, are in turn working for E. R. Richardson (Albuquerque broker) who has a ticket from a major company. Understand there are six seismic crews working in Cochise.

Things appear encouraging for Virginia Gas & Oil which is engaged in promoting a well on their acreage on the old Guadalupe structure, extreme southeast Cochise.

We hear that Darby Hand (Tucson geologist) has farmed out some of his acreage on the Guadalupe.

Understand that Jim Pickett is introducing a bill aimed at eliminating the limit on State leases. At present the limit is set at 15,360 acres. No individual or company is supposed to hold more State land under lease. Pickett maintains that this limit is discouraging to the major companies who would prefer to hold larger blocks. I think he is probably right. Of course, a company can hold unlimited State acreage under option but this seems to be undesirable for the company from a legal standpoint since the company would have no way of knowing how the Attorney General might regard these optioned leases, possibly applying them against the State limit. (Incidentally, the limit on Federal acreage is 200,000 acres.)

We hear that Eastern is thinking about buying the Arizona Helium Corporation's plant at Navajo. Let's hope so. It would certainly appear that Arizona Helium can never salvage their operation. The company has, from the first, been misguided by a series of unfortunate decisions by management; further, there is a strong suggestion of possible malfeasance by some of the directors.

Fenix & Scisson of Tulsa tell us that plans are going ahead for a new salt project to be located at Holbrook. They are making the engineer estimates for Eagleton Engineering Company of Houston for a salt excavation project very much like that being developed by Southwest Salt Company at Litchfield. I believe the site is located

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SCUTTLEBUTT: (Cont.)

in the flats about a mile east of Holbrook on the north side of the railroad tracks. We will cover this operation. A series of wells are to be drilled by Eagleton for the purpose of storing liquified gas trucked in from the Four Corners and stored here for reshipment by rail during the winter to the west coast. Jerry Grott will market the salt, most of it going to the uranium refineries in Gallup.

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AGENCY Oil & Gas Conserv Commission

DIVISION _____ IDENTIFICATION CODE NO. 1-7-10-000-0000

1 CLAIMS PAID YEAR TO DATE	2 OBJECT CODE NO.	3 DISTRIBUTION OF EXPENDITURES CLASSIFICATION		4 CLAIMS PAID MONTH OF Dec. 1969
22,298 00	110	1 Salaries, wages: employees	1	3,248 00
1,175 00	150	2 Per diem: board members	2	150 00
		3	3	
122 24	211	4 Postage	4	122 24
698 53	212	5 Telephone, telegraph	5	130 97
850 35	221	6 Travel -State meals and lodging	6	103 06
627 10	222	7 mileage reimbursed private car	7	124 80
232 00	223	8 fares for planes, trains, etc.	8	32 00
754 33	224	9 State-owned auto expense	9	142 70
21 35	225	10 telephone, taxi, etc.	10	4 80
19 00	226	11 registration fees at meetings	11	—
		12	12	
		13	13	
551 49	231	14 Travel-out of State meals and lodging	14	205 08
990 00	233	15 fares for plane, train	15	170 00
	234	16 State-owned auto expense	16	
124 40	235	17 telephone, taxi, etc.	17	32 55
98 00	236	18 registration - meetings	18	80 00
		19	19	
349 00	240	20 Professional services	20	—
		21	21	
	262	22 Mntns/repairs to office equip., furniture	22	
290 34	294	23 Legal advt., notary, court, recording fees	23	—
—	295	24 Transportation of things (well samples)	24	—
2,502 07	299	25 Miscellaneous (blueprint service, Ariz Bu	25	—
		26 Mines, Museum N. Arizona)	26	
		27	27	
		28	28	
309 79	310	29 Office supplies	29	64 82
270 97	360	30 Scientific supplies	30	38 57
35 18	370	31 Mntns supplies (duplicate keys)	31	
10 05	390	32 Other supplies (film)	32	10 05
		33	33	
		34	34	
	411	35 Rent, office equip: copy machine	35	
		36	36	
	421	37 Bond (notary public)	37	
22 00	430	38 Subscription/organization dues	38	—
		39	39	
		40	40	
480 17	611	41 Office equipment/furniture	41	—
		42	42	
		43	43	
		44	44	
		45	45	
250 00	995	46 To create revolv fund	46	—
		47	47	
		48	48	
		49	49	
		50	50	
		51	51	
		52	52	
		53	53	
		54	54	
		55	55	
33,081 36		TOTAL		4,664 64

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MONTHLY FINANCIAL REPORT

1 RECEIPTS MONTH OF Dec. 1969		2 RECEIPTS CLASSIFICATION	APPROPRIATED RECEIPTS	4 UNAPPROPRIATED RECEIPTS	5 TOTAL ALL RECEIPTS YEAR TO DATE
50	00	1 Permits to drill		50 00	
		2			
		3			
		4			
		5			
		6			
		7			
		8			
		9			
		10			
		11			
		12			
		13			
		14			
		15			
		16			
		17			
50	00	TOTAL CURRENT MONTH RECEIPTS			
		TRANSFERS IN / Out		50 00	XXXXXX
XXXXXX		BALANCES BROUGHT FORWARD		(150 00)	
		TOTALS – MONTH AND YEAR TO DATE		3,220 25	XXXXXX
				3,120 25	525 00

6 CLAIMS PAID MONTH OF Dec. 1969		7 EXPENDITURES FUND TITLES	8 TOTAL AMOUNT AVAILABLE YEAR TO DATE	9 CLAIMS PAID YEAR TO DATE	10 OUTSTANDING ENCUMBRANCES	11 UNENCUMBERED BALANCE
		1 Personal Services:				
3,248	00	2 General Fund	22,864 00	22,298 00	–	566 00
150	00	3 Conservation Fund	1,500 00	1,175 00	–	325 00
366	65	4 Current Expenditures	2,980 63	2,143 87	221 44	615 32
457	36	5 Travel - State	6,090 00	2,399 43	737 69	2,952 88
442	63	6 Travel - Out of State	3,496 00	1,713 89	–	1,782 11
–		7 Current Fixed Charges	500 00	22 00	–	478 00
–		8 Professional Services	1,800 00	349 00	250 00	1,201 00
–		9 Capital Outlay	2,376 87	480 17	1,896 70	–
–		10 Museum N. Arizona	1,250 00	1,250 00	–	–
–		11 Arizona Bureau Mines	1,250 00	1,250 00	–	–
		12				
		13				
		14				
		15				
		16				
		17				
		18				
		19				
		20				
		21				
		22				
		23				
		24				
		25				
		26				
		27				
		28				
		29				
		30				
4,664	64	TOTALS	44,107 50	33,081 36	3,105 83	7,920 31

FORM 12-A POST AUDITOR

TO BE FILED WITH THE POST AUDITOR BY THE 15TH OF EACH MONTH

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OIL & GAS CONSERVATION COMMISSION - GENERAL FUND

	1968-69 Actual	1969-70 Estimate	1970-71 Request	1970-71 Exec. Rec.	1970-71 JBC Rec.	1970-71 Leg. Rec.
Means of Financing						
General Fund Approp.	$59,265	$70,979	$170,124	$84,605	$81,779	
Amount Reverted	- 3,709					
Total	$55,556	$70,979	$170,124	$84,605	$81,779	
Expenditures						
No. of F.T.E. Pos.	4	4.5	9	5	5	
Salaries and Wages	$36,064	$45,728	$85,188	$53,630	$52,651	
Employee Related Exp.			7,786	4,920	4,603	
Prof. & Outside Serv.	1,339	2,000	3,000	1,500	1,500	
Travel - State	4,842	6,090	10,000	6,100	6,090	
Travel-Out of State	2,139	3,496	6,500	3,500	3,500	
Other Opr. Exp.	5,654	6,515	42,494	7,155	5,635	
Capital Outlay-Equip.	518	2,150	15,156	2,800	2,800	
Other	5,000	5,000		5,000	5,000	
Total	$55,556	$70,979	$170,124	$84,605	$81,779	

ANALYSIS: Personal Services - Classified positions are recommended as proposed by the Personnel Commission, and the non-classified position with a 5% increase. Concur with the number of positions recommended by the Governor.

Operating Expenditures - $1,500 is recommended for Professional Services and Travel at the current estimated expenditure level. Other Operating Expenditures include an item of $1,500 for court reporters.

Capital Outlay-Equipment - We recommend the replacement of the 1965 automobile and two typewriters.

OIL & GAS CONSERVATION COMMISSION - CONSERVATION FUND

	1968-69 Actual	1969-70 Estimate	1970-71 Request	1970-71 Exec. Rec.	1970-71 JBC Rec.	1970-71 Leg. Rec.
Means of Financing						
Balance Forward	$ 11,445	$ 3,770	$ 1,770		$ 1,770	
Receipts	1,075	1,000	1,000		1,000	
Balance Forward	- 3,770	- 1,770	- 2,770		- 1,000	
Total	$ 8,750	$ 3,000	$ -0-		$ 1,770	
Expenditures						
No. of F.T.E. Pos.	1	.5				
Salaries and Wages	$ 8,750	$ 3,000			$	
Other Opr. Exp.					1,770	
Total	$ 8,750	$ 3,000	$ -0-		$ 1,770	

ANALYSIS: Other Operating Expenditures - It is anticipated that a balance of $1,770 will be available at the beginning of the next fiscal year, which funds may be used for administration expenses, subject to legislative appropriation A.R.S. 27-523. The J.B.C. Staff recommends that $1,770 be appropriated for Other Operating Expenditures.

RECEIVED JAN 1 1970 STATE O & G CONS. COMM.

OIL AND GAS CONSERVATION COMMISSION

A.R.S. 27-501

AGENCY PROGRAM:

Program Title	Actual 1968-1969 Amount	%	Estimated 1969-1970 Amount	%	Requested 1970-1971 Amount	%
1. Administration	38,583	60	44,388	60	85,062	50
2. Enforcement and Field Duties	19,292	30	22,194	30	51,038	30
3. Gather and Dissemination of Information	6,431	10	7,397	10	17,012	10
4. Development of New Geological Information					17,012	10
	64,306	100	73,979	100	170,124	100

1. The five appointed commissioners and executive secretary are involved in this function. The executive secretary is the working administrator.

2. Prime function is enforcing the statutes pertaining to oil and gas. Pursuant to A.R.S. 27-516 the commission has adopted rules and regulations to supplement and enforce the statutes. These rules and regulations pertain to the full life of a well from commencement through its productive life. Much of the time of the executive secretary and the geologist is spent in the field actually surveying the drilling, production, and/or plugging and abandoning of each well.

3. The commission is constantly gathering all available geological, technical and statistical data pertaining to Arizona's oil and gas industry and developing it into a useful form to supply the demands of major and independent oil and gas operators as well as mining and mineral and hydrology interests. Individual well files are maintained for public use; production and other activity reports are also disseminated. In response to requests the staff makes presentations of Arizona's oil and gas industry and potential to civic and fraternal groups and to industry orientated associations, both Arizona-based and out-of-state who come to Arizona specifically for the purpose of learning about Arizona. Good information is a prime source of encouragement for further exploration.

4. The commission, pursuant to A.R.S. 27-502.A.f, seeks to encourage the development of all natural resources, oil, gas and helium, by developing, printing, and distributing original geology on various areas of this state which, in its opinion, are potential producing areas for oil and/or gas. The information distributed seeks to give oil companies and individuals interested in the development of our resources new ideas and new thoughts in areas which may or may not heretofore have been considered by them. The commission is constantly engaged in correlation of the geological information contained in both its files and in its sample collections. The information to be published is quite technical in nature, however, it is also of great value to the layman. The information so published is of value to all people concerned with our state and its natural resources potential. The information is distributed not only to oil and gas companies but to people interested in mining operations, water users, and agriculturists.

OIL AND GAS CONSERVATION COMMISSION

BUDGETARY ANALYSIS:

PERSONAL SERVICES The amount recommended will allow appropriate merit increases in accordance with the State Personnel Commission's proposed salary plan and policies. One of the additional positions requested is undoubtably justified, however, the agency does not have sufficient office facilities to accommodate this position. If the position were recommended then funds would also have to be provided to rent new office space for the agency as a whole since no other state facilities are currently available. Rental cost for suitable quarters would exceed the cost of the added employee. Other employees requested would be desirable but the justification submitted does not place this in a position of priority.

OPERATING EXPENDITURES The amounts requested reflect the proposed expansion of this agency. In general the recommendations provide for continuation of the current level of services with a nominal allowance for price level changes. Professional and Outside Services appear to be recommended at a rate lower than that appropriated for the current fiscal year. Reporting costs of $500 formerly included in this category are now reflected under Other Operating Expenditures. An increase of $1,500 was requested for the services of a petroleum engineer. $625 was spent for this purpose during the 1968-1969 fiscal year and information provided in support of this request did not justify the increase.

Expenditures recommended for Travel, both State and Out-of-State, are recommended at the level established by current appropriations. An increase requested for State Travel costs in addition to that needed for new employees but the explanation of this increase did not substantiate the request.

CAPITAL OUTLAY - EQUIPMENT Funds are recommended for replacement of one automobile and two typewriters. At present the vehicle recommended for replacement has approximately 60,000 miles. The age and condition of the two typewriters justify replacement at this time. Items requested, but not recommended are supporting equipment for additional personnel and increased office space.

OTHER The Arizona Bureau of Mines and Museum of Northern Arizona catalog, store and lend well samples and cores on behalf of the Commission. These samples are examined and tested by industry personnel as well as personnel from state and federal agencies. The Commission requested both the personnel and facilities necessary to assume this function. By virture of the fact that the Commission's request did not receive approval, it is necessary to recommend funds for the continuance of such service.

OIL AND GAS CONSERVATION COMMISSION

GENERAL FUND	Actual 1966-1967	Actual 1967-1968	Actual 1968-1969	Estimated 1969-1970	Requested 1970-1971	Recommended 1970-1971
PERSONAL SERVICES						
Number of positions	3	3	5	5	9	5
Personal Services	29,499	29,355	44,814	48,728	85,188	53,630
Employee Related Expenditures					7,786	4,920
OPERATING EXPENDITURES						
Professional & Outside Services	818	1,743	1,339	2,000	3,000	1,500 *
Travel - State	4,739	4,254	4,842	6,090	10,000	6,100 *
Travel - Out-of-State	2,191	2,151	2,139	3,496	6,500	3,500
Other Operating Expenditures	4,695	5,730	5,654	6,515	42,494	7,155
CAPITAL OUTLAY						
Equipment	2,091		518	2,150	15,156	2,800
OTHER						
ARIZONA BUREAU OF MINES	2,500	2,500	2,500	2,500		2,500
MUSEUM OF NORTHERN ARIZONA	2,500	2,500	2,500	2,500		2,500
	49,033	48,233	64,306	73,979	170,124	84,605
SOURCE OF FUNDS						
Balance Forward	8,745	10,320	11,445	3,770		
Appropriation	54,450	52,105	59,265	70,979		
Appropriated Receipts	1,575	1,125	1,075	1,000		
	64,770	63,550	71,785	75,749		
DISPOSITION OF FUNDS						
Expenditures	49,033	48,233	64,306	73,979		
Amount Reverted	5,417	3,872	3,709			
Balance Forward	10,320	11,445	3,770	1,770		
	64,770	63,550	71,785	75,749		

* Request exemption from the provisions of Section 35-173, Arizona Revised Statutes, relating to quarterly allotments.

LOOKING AHEAD

Four Corners Area is a 1970 Question Mark

By John Oakason
Owner, Petroleum Investment and Research

The Four Corners area has been a quiet, sleeping giant. If the wildcats on the drawing board planned by the major oil companies do not pay off, our giant may well become a sleeping Rip Van Winkle.

In *Southwestern Utah*, Mountain Fuel's "Cowboy Field" has been discouraging after two dry holes and one marginal producer. Gulf's discovery at Wilson Canyon has not developed.

PETROLEUM INVESTMENT AND RESEARCH

Oil and Gas Properties in active areas in the Rocky Mountain States. Detailed maps sent upon request.

(801) 363-3941

654 So. 9th East Salt Lake City, Utah 84102

On the optimistic side, thousands of open state and federal lands were leased during midyear of 1968 by Independents in the southern portion of the Paradox Basin. This prelude has led to planned exploration. With Shell Oil as the fore-runner in leasing and seismic activity, Utah will show a substantial increase in exploration for 1970.

Southwestern Colorado activity is expected to slowdown. Failures by Union Oil in its Pine Canyon Unit and the Northwest extension of Andy's Mesa, along with Mountain Fuel's failure at Montrose Dome, has been discouraging. If Union's Martin Mesa well is dry, then exploration may come to a standstill. However, the upswing in exploration in Utah could affect Southwestern Colorado.

In *Northeastern Arizona*, exploration was limited to Apache County where 15 wildcats were dry. The attempt to extend the Dineh Bi Keyah Field to the Northwest and Southeast failed.

Globe Minerals completed two good oil wells in the active Boundary Butte Field. Bidding on the competitive Indian land sales was light. Incentives not known at this time will be needed to boost exploration here in 1970.

Northwestern New Mexico will have an increase in activity. Several companies are planning multi-well programs in San Juan and McKinley Counties, which was preceded by a surge of leasing in federal lands by Independents during the last part of 1968 and early 1969.

The Four Corners Giant may emerge from its shroud of sleepiness.

WOGA Economic Report Covers Five States

The oil industry in the five western states of Arizona, California, Nevada, Oregon and Washington paid nearly a quarter of a billion dollars in direct state and local taxes for 1968, according to a recently completed economic study by the Western Oil and Gas Association.

The state and local taxes of $235,520,000 in these states amounted to nearly one-third of the $760,861,000 paid in salaries and wages to some 80,900 persons employed directly by oil companies.

Total employment in the oil business in the area reached 248,800 by the end of 1968, including employees of service station dealers, bulk plant operators and oil field service companies.

The economic survey estimates that, considering the families of oil industry employees, 870,900 persons in the area obtained their livelihood from oil.

The original cost of the oil industry's physical assets in the five-state area at the beginning of 1969 amounted to $10.1 billion. As an illustration of the extent the oil industry is capital intensive rather than labor intensive, investment in assets per oil company employee averaged $124,800. This investment by states is Arizona—$61,000; California—$131,800; Nevada—$95,200; Oregon—$62,900; and Washington—$89,500.

In addition to wholesale plants and service stations, terminals, tank trucks and tank cars, the properties represented by this investment include: 41,400 oil wells and more than 1,000 natural gas wells that produced during the year 378.7 million barrels of oil, 692 billion cubic feet of natural gas and a billion cubic feet of helium; 39 refineries with a total daily capacity of 1,759,000 barrels of crude oil; more than 10,000 miles of crude oil and refined products pipelines that annually move oil and products valued at $2.5 billion. The replacement value of the pipelines is in excess of a half a billion dollars.

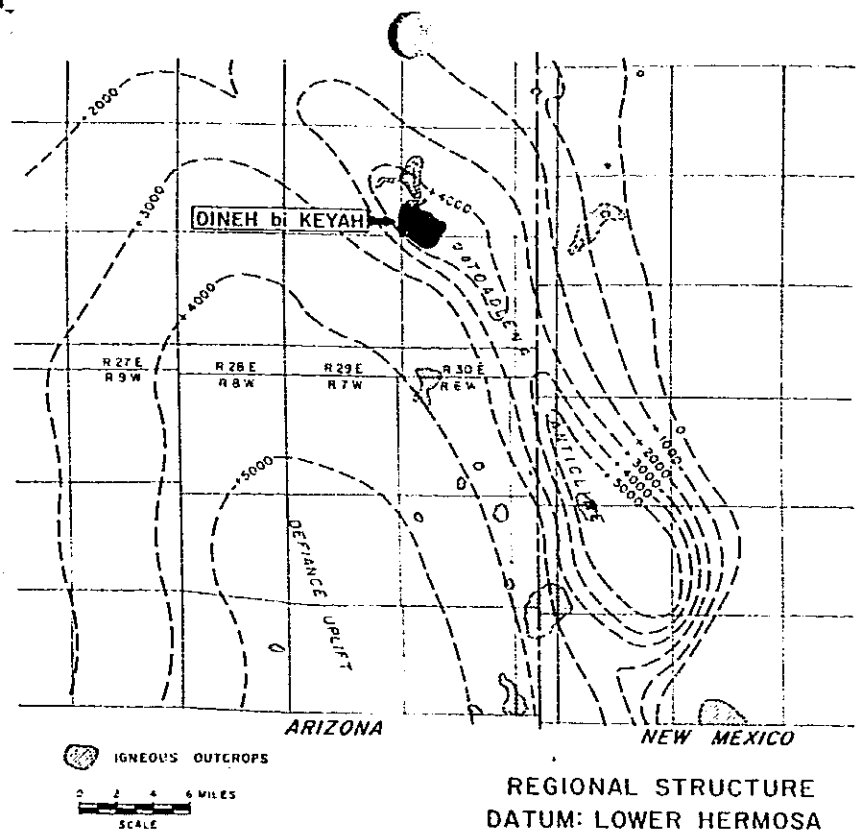

FIG. 1—Regional structure and igneous outcrops in the Dineh bi Keyah area. After O'Sullivan and Beikman, 1963.

In unusual Arizona field . . .

Limestone likely source of oil in igneous sill

J. W. McKenny, Vice President, Oil and Gas Exploration Division, Kerr-McGee Corp., Oklahoma City, Okla.

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15-second summary

Dineh bi Keyah field in Arizona is probably the world's largest current producer of crude from an igneous reservoir. Although production is from a syenite sill, it is probable that the oil originated in the surrounding sedimentary rocks. Here are results of an extensive geologic evaluation of this unusual oil field based on cumulative statistics at Nov. 1, 1969.

THE RARE OCCURRENCE of oil in an igneous sill marks Arizona's Dineh bi Keyah field unique among the world's producing areas. Discovered by Kerr-McGee Corp., the field produces from 17 wells spaced on a 160-acre pattern. Cumulative production is about 7.5 million barrels.

Sill pay thickness ranges from 60-160 feet with a 95-foot average. Sill depth varies from 2,800-4,400 feet.

Production is from a syenite sill which intruded Lower Pennsylvanian rocks. The sill is of Tertiary age and contains both inter-crystalline and fracture porosity. Porosity, permeability and oil saturations are similar to reservoirs of many oil producing carbonate rocks. The sill covers about 3,000 acres.

STRUCTURE

Dineh bi Keyah field is located near the northwestern end of the Toadlena anticline (Fig. 1), a doubly plunging asymmetric fold which interrupts the Defiance monocline (O'Sullivan and Beikman[1]). The Chuska syncline bounds the Toadlena anticline on the southwest and separates it from the Defiance uplift. The Defiance complex defines the San Juan basin on the southwest.

The northwest-southwest trending Toadlena structure is about 35 miles long and 3-6 miles wide. On the east side of the fold, maximum structural relief is about 5,000 feet over 5 miles. Separate structural closures are present at each end of the anticline. These are separated by a saddle located near the Arizona-New Mexico state line.

The culmination at the north end of the anticline, in the field area, has about 450 feet of structural closure. The highest structural point on the Toadlena anticline occurs at the south end where there is about 1,250 feet of structural closure.

The Toadlena anticline and the Defiance uplift were formed during the Laramide orogeny of late Cretaceous through early Tertiary time (Kelly[2]). Post-Laramide erosion beveled the fold and the Miocene Chuska sandstone was deposited unconformably on this erosional surface.

FIELD DISCOVERY

The discovery well was the Kerr-McGee Corp. Navajo 1, Apache County, Arizona. This test was drilled to 3,864 feet in granite. The well was abandoned after the Permian DeChelley was tested from perforations 590 to 880 feet. While drilling, an oil show was noted in a metamorphic or igneous rock at 2,860 feet. The show was not considered good enough to justify a drillstem test and electric log analysis was negative.

Mineralogists later examined the cuttings and, although they did not →

agree on rock type, they did agree that it could not be a reservoir [illegible]. Well log correlations indicated that the oil show was found to be in the interval of the approximate stratigraphic equivalent of the Pennsylvanian limestone which produces oil in the Tocito field, 20 miles east, in San Juan County, New Mexico.

Because of the correlation with the Tocito pay zone and large amount of acreage held in the area, Kerr-McGee re-entered Navajo 1 to test the oil show. The interval 2,860-2,885 feet was perforated and the well swabbed dry. After acidizing with 1,000 gallons, the hole was again swabbed dry with only a slight show of oil. The formation was then fractured with 10,000 gallons of oil and 10,000 pounds of sand and the well completed pumping 648 bpd of 45° gravity oil.

RESERVOIR CHARACTERISTICS

When the Navajo 1 was completed, lithology of the reservoir rock was an unknown. Kerr-McGee Corp. then moved ½ mile north and drilled Navajo 2. The producing interval was cored and found to be a dark gray igneous rock. Additional drilling proved the intrusive to be an igneous sill.

The host rock is dark gray, finely crystalline to dense limestone with interbedded gray, calcareous shale. Contact between sill and host limestone has a serrated and welded appearance, and host rock is altered only about 5 inches away from the contact.

Sill. The intrusive is a dark gray to greenish-gray syenite rock. Primary constituents are sanidine, biotite, diopsidic augite, glass and minor magnetite. Glass is abundant and is believed to be the primary cementing agent.

Texture varies from very dense and fine-grained to medium crystalline and coarsely crystalline. Small to large vugs (miaroles) are generally associated with the medium or coarsely crystalline rock. The miaroles are often lined with apophyllite. Large vertical and horizontal fractures (filled with apophyllite crystals) have been noted in some cores.

Generally, center of the sill is coarsely crystalline and top and bottom are finely crystalline and dense. This is attributed to slower cooling in the center, although presence of glass and sanidine indicates rapid cooling throughout.

About the authors

JERE W. MCKENNY, *formerly manager, oil and gas exploration, became a vice president of Kerr-McGee Corp. on July 1, 1969. He heads the newly designated Oil and Gas Exploration Division. A graduate of the University of Oklahoma with both bachelor of science and master of science degrees in geological engineering, McKenny joined Kerr-McGee as a geologist. He has held a number of positions in the Exploration Division including district geologist in Oklahoma City and manager of the Amarillo Division.*

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CORE ANALYSIS

Sill porosity is intergranular, vugular and fracture. By core analysis, porosity ranges from 5-17% and averages 10%; permeability is from less than 0.01 md-25 md; residual oil saturation from 0-25%; and water saturation from 25% in permeable sections to 93% in zones of very low permeability.

Oil saturation at various levels in the sill is generally related to porosity, permeability and fracturing. In some wells, intervals to 60 feet thick have no saturation. Oil apparently did not move into these intervals because of low permeability.

The sill is comparable in appearance and mineral composition to plugs, dikes and sills that out crop in the area (Fig. 1). However, exposed igneous rocks are very fine-grained and dense with little, if any, porosity. Samples from two igneous plugs cropping out at Roof Butte, one mile southeast of Navajo 1, are difficult to distinguish from core chips from dense portions of the producing sill.

Several laboratories have dated samples from the sill by the potassium-argon method. The age was determined to be 31 to 35 million years (Oligocene). The sill intruded lower Hermosa (Pennsylvanian) beds.

TOCITO FIELD

In Tocito field, 20 miles east of Dinch bi Keyah, oil is produced from porous algal bank limestones that correlate with the interval intruded by the sill. Tocito oil has the same general chemical and physical properties as that produced from the sill. Upon completion of the discovery well, it was postulated that the oil-producing igneous rock was incidental to the oil field, i.e., the sill or dike was in contact with a porous limestone oil reservoir, and oil migrated out of the primary reservoir into the igneous rock.

However, to date, tests that found the sill absent encountered only tight limestone and shale at the stratigraphic level intruded by the sill. While there is no evidence that the sill "robbed" the oil from a pre-existing limestone accumulation, the possibility still exists. If there was no pre-existing reservoir, oil must have remained in the Pennslyvanian source beds until emplacement of the sill.

There have been a number of occurrences of hydrocarbons and petroleum-like substances of probable sedimentary source in igneous rocks.[3] John Hunt[4] analyzed shale samples adjacent to igneous dikes in Colorado and South Africa and concluded that "organic matter in sediments is thermally decomposed to yield hydrocarbons similar to those found in crude oil."

He found the lowest hydrocarbon content in shale nearest the dike. Hydrocarbon content increased to a maximum within 2-3 feet of the dike and then decreased to a background level. Data indicates that hydrocarbons were

distilled from the shale near the dike at the time of intrusion, but that hydrocarbons did not move very far because of low permeability of the shale.

Information to date does not preclude the possibility Dineh bi Keyah oil may have been distilled from intruded shales and moved into the porous sill.

STRUCTURE

The DeChelly sandstone is the first reliable structural marker encountered in the field. Beds above the sill are elevated by the intrusion and closure on the DeChelly is accented by presence of the sill.

Kerr-McGee's Navajo 1 "B" is 145 feet high to the Navajo 2 "B," ½ mile east. The sill is 88 feet thick in the Navajo 1 "B" and absent in the Navajo 2 "B." Below the sill the Navajo 1 "B" is only 26 feet high to the Navajo 2 "B." The DeChelly structural map along with an isopachous map of the sill have been helpful in picking development locations.

Structural map on the sill generally reflects a northwesterly plunging nose (Fig. 2). The dip is not uniform because of the variation in thickness of the sill and its position in the stratigraphic section.

The sill is known to cover about 3,000 acres (Fig. 3). Minimum sill thickness is 36 feet in the Humble Navajo 4-88. In Humble's Navajo 1-138, the sill is split into five segments with an aggregate thickness of 174 feet (Fig. 3). Kerr-McGee's Navajo 1 "B," found the sill 181 feet above the black shale. It was oil saturated but non-productive and is either not connected to the main producing sill or lacks sufficient permeability to produce commercial quantities of oil (Fig. 4).

Humble's Navajo 1-88 encountered two sills, neither of which appears to be connected to the main field producing sill (Fig. 5). The first sill was found 180 feet above the black shale and contained gas. The second sill was found 145 feet below the black shale and produced only a small amount of

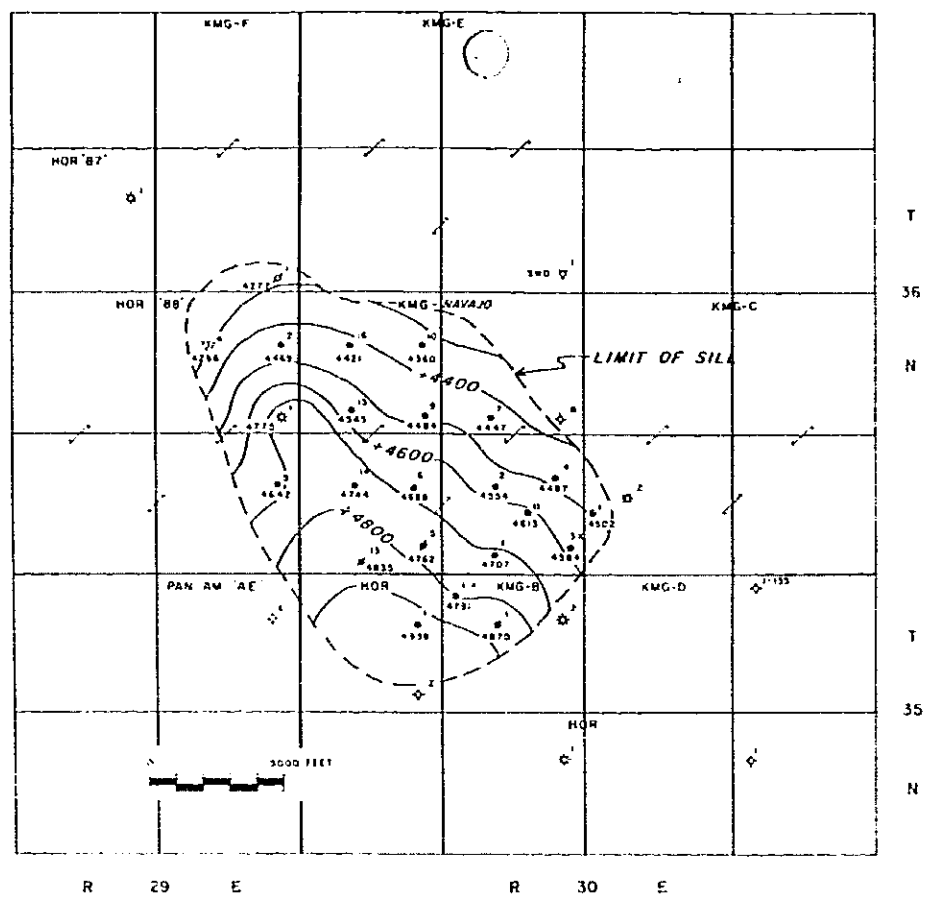

FIG. 2—Structural map of the Dineh bi Keyah field. Structural datum top of main oil producing sill.

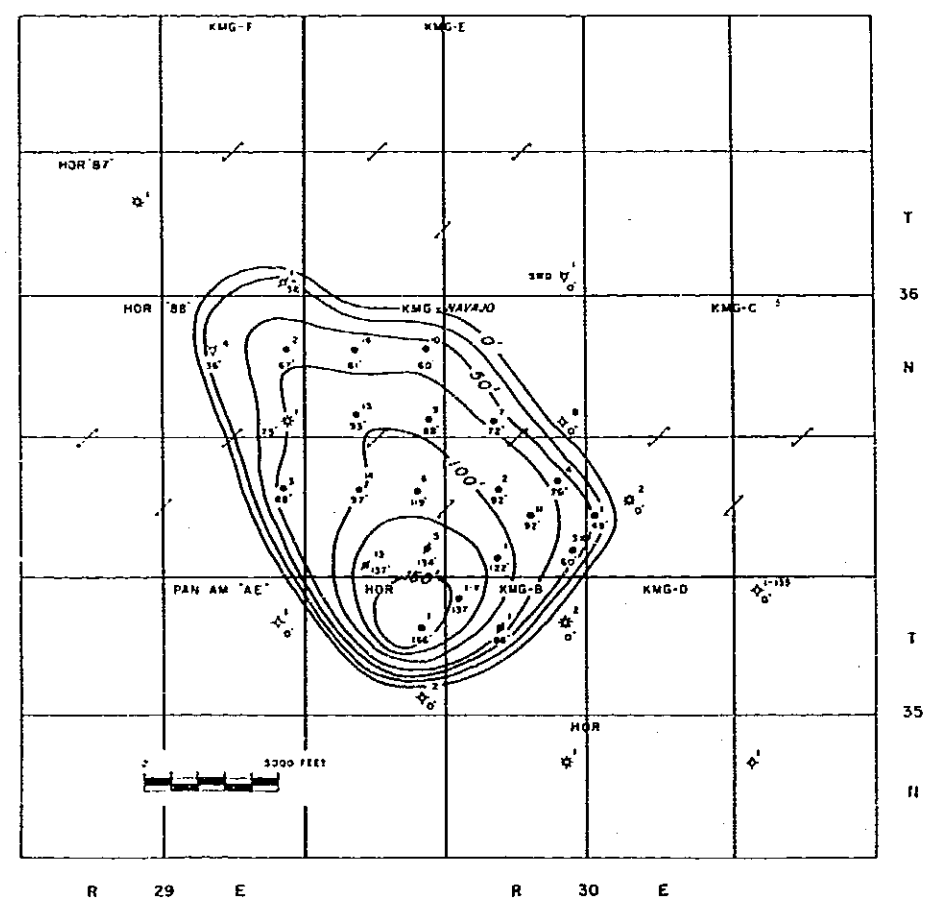

FIG. 3—Isopachous map of sill in Dineh bi Keyah field.

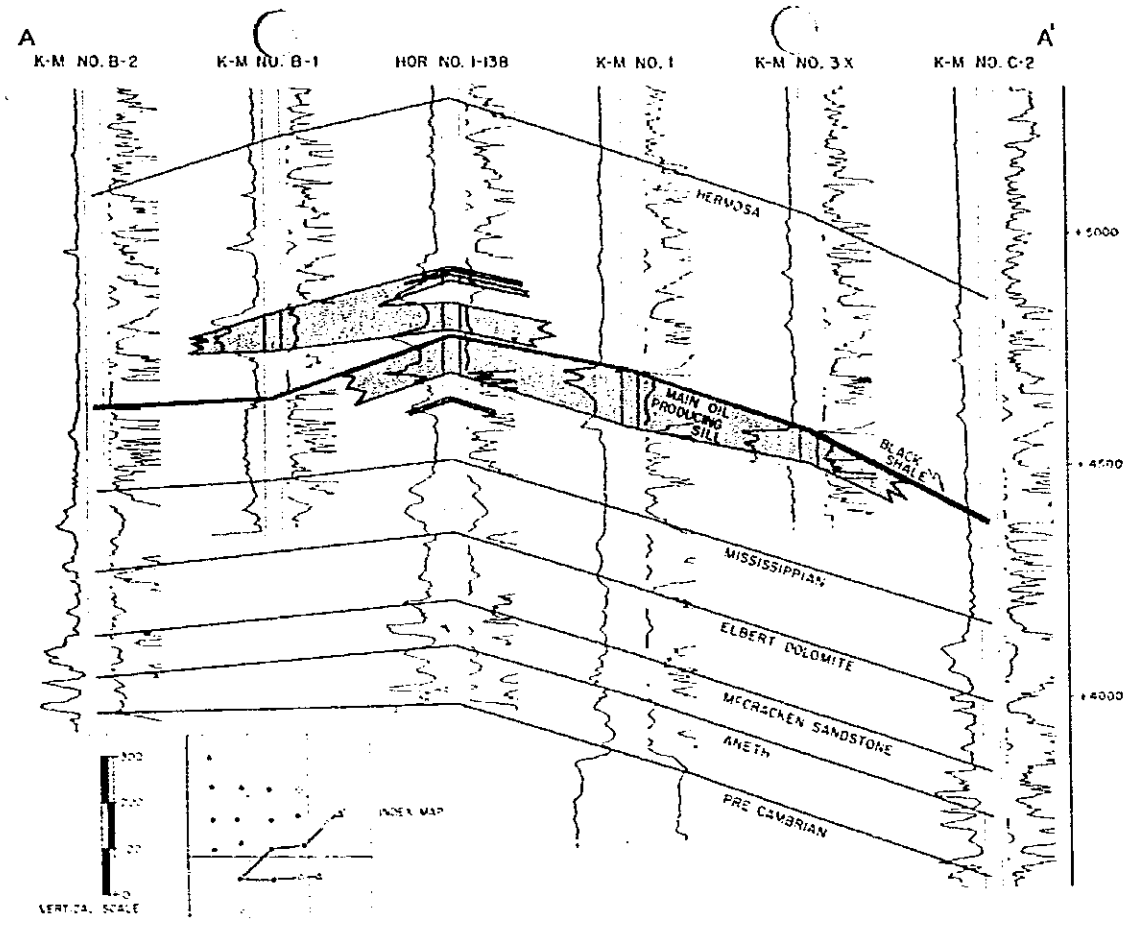

FIG. 4—Structural cross-section, Dineh bi Keyah field.

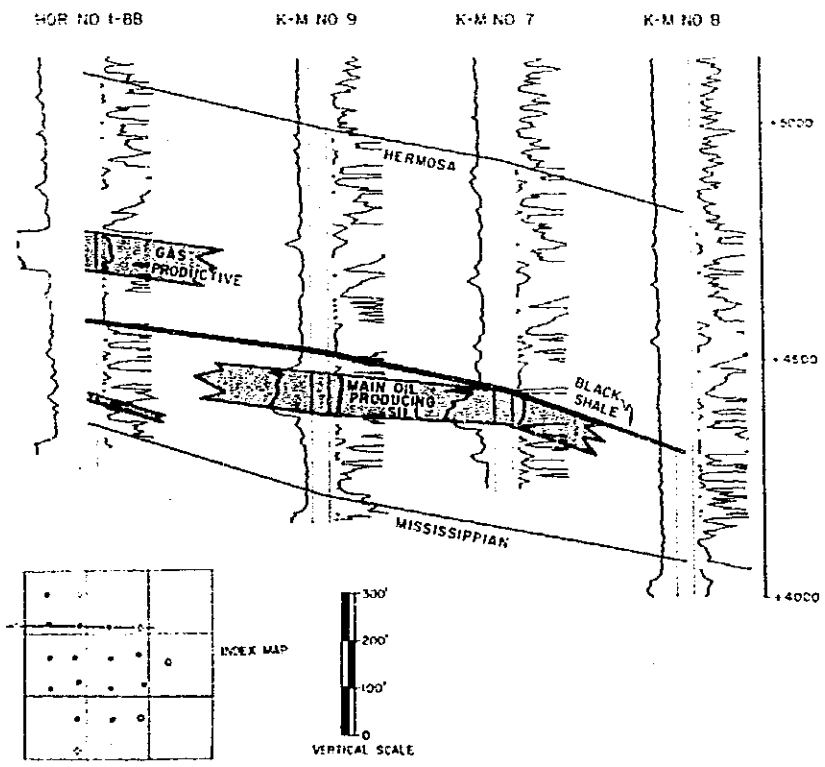

FIG. 5 (left)—Structural cross-section, Dineh bi Keyan field.

oil. Thus, along the west side of the field, the sill has intruded more than one level and at least one of the wells appears to have found sills other than the main producing unit. The source of the sill is unknown but the increased thickness and splitting on the southwest side of the field suggests a nearby source.

ACKNOWLEDGMENT

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