AGENDA

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

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.
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.
Executive Secretary Report
1-15-70

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.
January 15, 1970

GEOLOGIST'S REPORT

FROM: JAMES CURDLOCK
TO: COMMISSIONERS

APACHE COUNTY

Consolidated Oil & Gas #1-1 Navajo (226)
T41N, R28E, G & SRM
Sec. 1: SW/4 SW/4
Permit #526
Location

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

Union #1-4 Navajo (8833)
T36N, R28E, G & SRM
Sec. 4: SE/4 SE/4
Permit #521
Location. Contractor has dropped the lease.

Union #1-17 Navajo (2346)
T36N, R28E, G & SRM
Sec. 17: SW/4 SW/4
Permit #522
DST 4742-4880'. Recovered 120' of drilling mud. No cores taken.
Formation tops:
Navajo 521'
Keyenta 871'
Windgate 1100'
Chinle 1453'
Shinarump 2452'
De Chelly 2588'
Supai 3176'
Hermosa 4283'
Molas 4937'
Redwall 5039'
Total Depth 5587'
Plugged and abandoned 12-7-69.
Page 2
Geologist's Report
January 13, 1970

APACHE COUNTY (Cont.)

Mesa Petroleum #1 Navajo (8888)
T3S N, R30E, G & SRM
Sec. 4: NW/4 NW/4
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)
T3S N, 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 2234-2880' (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 2332'
- Cambrian 2424'
- Pre-Cambrian 2460'
- Total Depth 2482'

Plugged and abandoned 12-24-69.
APACHE COUNTY (Cont.)

Thoureen #1 Santa Fe
T21N, R26E, G & SRM
Sec. 27: NE/4 SW/4
Permit #504
Wildcat
"TIGHT HOLE"
Total depth 1237' in Coconino.
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
T36N, R7W, G & SRM
Sec. 29: NW/4 NE/4
Permit #502
Wildcat
Drilling at 1010'.

GILA COUNTY

Kerber #1 Federal (A-2719-A)
T4N, R13E, G & SRM
Sec. 5: SE/4 NW/4
Permit #516
Wildcat
Drilling at 1505'. Apparently the well has penetrated bedrock
beneath the valley gravels.
This is primarily a Devonian shot.
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 an-
other 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 en-
gaged 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 dis-
couraging 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 un-
desirable 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 opera-
tion. 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 & Scissor 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
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.
<table>
<thead>
<tr>
<th>CLAIMS PAID YEAR TO DATE</th>
<th>OBJECT CODE NO.</th>
<th>DISTRIBUTION OF EXPENDITURES</th>
<th>CLAIMS PAID MONTH OF Dec., 1969</th>
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<td>Salaries, wages: employees</td>
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<td>150</td>
<td>2 Per diem: board members</td>
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<td>211</td>
<td>4 Postage</td>
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<td>212</td>
<td>5 Telephone, telegraph</td>
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<td>222</td>
<td>6 Travel - State meals and lodging</td>
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<td>222</td>
<td>7 Mileage reimbursed</td>
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<td>222</td>
<td>8 Fares for planes, trains, etc.</td>
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<td>224</td>
<td>9 State-owned auto expense</td>
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<td>225</td>
<td>10 Telephone, taxi, etc.</td>
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<td>226</td>
<td>11 Registration fees at meetings</td>
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<td>231</td>
<td>12 Travel-out of State meals and lodging</td>
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<td>14 State-owned auto expenses</td>
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<td>235</td>
<td>15 Telephone, taxi, etc.</td>
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<td>236</td>
<td>16 Registration - meetings</td>
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<td>240</td>
<td>17 Professional services</td>
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<td></td>
<td>262</td>
<td>18 Collateral repairs to office equip., furniture</td>
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<td>294</td>
<td>19 Legal advt., notary, court, recording fees</td>
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<td>295</td>
<td>20 Transportation of things (well samples)</td>
<td>20</td>
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<td>299</td>
<td>21 Miscellaneous (blueprint service, Ariz. Bu.</td>
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<td>299</td>
<td>22 Hines, Museum &amp; Arizona</td>
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<tr>
<td></td>
<td>310</td>
<td>23 Office supplies</td>
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<td>360</td>
<td>24 Scientific supplies</td>
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<td>370</td>
<td>25 Office supplies (duplicate keys)</td>
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<td>390</td>
<td>26 Other supplies (film)</td>
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<td></td>
<td>391</td>
<td>27 Rent, office equip: copy machine</td>
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<td>392</td>
<td>28 Bond (notary public)</td>
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<td>430</td>
<td>29 Subscription/organization dues</td>
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<td>440</td>
<td>30 Office equipment/furniture</td>
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<td>450</td>
<td>31 To create revolv fund</td>
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**TOTAL** | 995 | 4,641.67 |
### MONTHLY FINANCIAL REPORT

#### RECEIPTS

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<th>MONTH OF</th>
<th>RECEIPTS</th>
<th>CLASSIFICATION</th>
<th>APPROPRIATED RECEIPTS</th>
<th>UNAPPROPRIATED RECEIPTS</th>
<th>TOTAL ALL RECEIPTS YEAR TO DATE</th>
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**TOTAL CURRENT MONTH RECEIPTS**

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<tr>
<th>TRANSFERS IN/OUT</th>
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**BALANCES BROUGHT FORWARD**

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<tr>
<th>TOTALS – MONTH AND YEAR TO DATE</th>
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<tr>
<td>$XXXXX</td>
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#### EXPENDITURES

<table>
<thead>
<tr>
<th>FUND TITLES</th>
<th>TOTAL AMOUNT AVAILABLE YEAR TO DATE</th>
<th>CLAIMS PAID YEAR TO DATE</th>
<th>OUTSTANDING ENCUMBRANCES</th>
<th>ENCUMBERED BALANCE</th>
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<td>1. Personal Services:</td>
<td>22,869.00</td>
<td>20,388.00</td>
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<td>2. General Fund</td>
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<td>3. Conservation Fund</td>
<td>6,554.60</td>
<td>1,772.67</td>
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<td>4. Current Expenditures</td>
<td>3,966.63</td>
<td>2,615.45</td>
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<td>5. Travel – State</td>
<td>6,238.00</td>
<td>2,399.53</td>
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<td>6. Travel – Out of State</td>
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<td>7. Current Fixed Charges</td>
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<td>8. Professional Services</td>
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<td>1,786.80</td>
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<td>9. Capital Outlay</td>
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<td>10. Museum N. Arizona</td>
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<td>11. Arizona Bureau Mines</td>
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**TOTALS**

|                             | 44,964.64 | 33,887.36 | 3,185.83 | 7,924.31 |

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

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*FORM 12-A POST AUDITOR*
<table>
<thead>
<tr>
<th>Position</th>
<th>Total</th>
<th>Personnel Salaries</th>
<th>Operating Expenses - General Fund</th>
<th>General Fund Approp.</th>
<th>General Fund Total</th>
<th>Amount Authorized</th>
<th>Request</th>
<th>Estimate</th>
<th>Actual</th>
</tr>
</thead>
</table>

Note: The table details the financial breakdown for various positions, including personnel salaries and operating expenses, with amounts authorized, requested, estimated, and actual figures provided.
ANALYSIS: Other Operating Expenditures - It is anticipated that a balance of $1,770 will be maintainable at the end of the fiscal year. However, funds may be needed for administrative expenses. The D.C. Clerk recommends that $1,770 be appropriated for other operating expenditures.

<table>
<thead>
<tr>
<th>Item</th>
<th>Budget</th>
<th>Actual</th>
<th>Difference</th>
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<td>Other Op. Exp.</td>
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<td>Total</td>
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Expenditures

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<th>Item</th>
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<th>Actual</th>
<th>Difference</th>
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<td>Salaries and Wages</td>
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<tr>
<td>Total</td>
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Net of P.E.'s, pos. $0

Mean of Financing

<table>
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<tr>
<th>Year</th>
<th>Recap</th>
<th>Exec. Rec.</th>
<th>DC Rec.</th>
<th>Request</th>
<th>Budget</th>
<th>Estimate</th>
<th>Actual</th>
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</table>

ORL. GAMS CONSERVATION COMMISSION - CONSERVATION FUND
<table>
<thead>
<tr>
<th>Day</th>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>00</td>
<td>09:00</td>
<td>Departure from Olympic village</td>
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<tr>
<td>00</td>
<td>10:00</td>
<td>Opening ceremony</td>
</tr>
<tr>
<td>00</td>
<td>11:00</td>
<td>First competition</td>
</tr>
<tr>
<td>00</td>
<td>12:00</td>
<td>Lunch</td>
</tr>
<tr>
<td>00</td>
<td>13:00</td>
<td>Second competition</td>
</tr>
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</table>

**Preparation and Coordination**

- Coaches and athletes are to arrive at the Olympic village by 09:00.
- The opening ceremony will take place at 10:00.
- The first competition will begin at 11:00.
- Lunch will be served from 12:00 to 13:00.
- The second competition will take place from 13:00 to 17:00.

**Schedule**

- Departure from the Olympic village: 09:00
- Opening ceremony: 10:00
- First competition: 11:00
- Lunch: 12:00
- Second competition: 13:00
- Return to the Olympic village: 17:00
<table>
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<tr>
<th>Year</th>
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<tr>
<td>1972-73</td>
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<td>1973-74</td>
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<td>1975-76</td>
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<td>1976-77</td>
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**Summary of Expenditures**

- **Capital Outlay**
- **Other Operating Expenditures**
- **Employee Relative Expenditures**
- **Personal Services**

**Petroleum Commission**

**Oil and Gas Conservation Commission**

**Appointed Heads**

- Attorney General
- Secretary of State
- Commissioner of Insurance
- Commissioner of Agriculture
- Commissioner of Social Security
- Commissioner of Administration
- Commissioner of Education
- Commissioner of Health

**Appointed Boards**

- Board of Education
- Board of Health
- Board of Social Security
- Board of Administration
- Board of Health
- Board of Education
- Board of Social Security
- Board of Administration

**Petroleum Commission**

- Director
- Assistant Director

**Oil and Gas Conservation Commission**

- Director
- Assistant Director
LOOKING AHEAD

Four Corners Area is a 1970 Question Mark

By John Oakson
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 Paul's "Cowboy Field" has been discouraging after two dry holes and one marginal producer. Gulf's discovery at Wilson Canyon has not developed.

On the optimistic side, thousands of open state and federal lands were leased during midyear of 1969 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 tectonic activity, Utah will show a substantial increase in exploration for 1970.

Southwestern Colorado activity is expected to slow down. Failures by Union Oil in its Pine Canyon Unit and the Northwest extension of Andy's Mesa, along with Mountain Paul'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 assurance in exploration in Utah could affect Southwestern Colorado.

In Northwestern Arizona, exploration was limited to Apache County where 15 wildcats were dry. The attempt to extrude the Dinah Bivins Field to the Northwest and Southeast failed.

Globe Minerals completed two good oil wells in the active Boundary Butte Field. Bidding on the competitive Arizona land sales was light. Incentives and 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 1969 and early 1970.

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

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WOGA Economic Report
Covers Five States
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.

J. A. Masters, President, Kerr-McGee of Canada, Ltd., and Kerr-McGee of Canada, Northwest, Ltd., Calgary, Alta., Canada

15-second summary

Dinell hi 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 base occurrence of oil in an igneous sill marks Arizona's Dinell hi 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 2,800-3,400 feet.

Production is from a syenite sill that intruded Lower Pennsylvaniaian rocks. The sill is of Tertiary age and contains both intercrystalline and fracture porosity. Permeability and oil saturations are similar to those in many oil producing carbonate rocks. The sill covers about 3,000 acres.

STRUCTURE

Dinell hi Keyah field is located near the southwestern end of the Toadlena anticline (Fig. 1), a doubly plunging asymmetric fold which interrupts the Defiance monocline (O'Sullivan and Rekanen'). 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 5-6 miles wide. On the east side of the fold, maximum structural relief is about 3,000 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'). Post-Laramide erosion leveled the fold and the Miocene Chuska condensate 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 3,664 feet in granite. The well was abandoned after the Permian DeChelle was tested from perforations 590 to 893 feet. While drilling, an oil show was noted in a metasomatic or igneous rock at 2,850 feet. The show was not considered good enough to justify a dilution test and electric log analysis was negative.

Mineralogists later examined the cuttings and, although they did not...
The host rock is dark gray, finely crystalline Basaltic andesite with inclusions of gray, calcareous shale. Contact between sill and host basalt is well-defined, 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 plagioclase, biotite, orthopyroxene, glass, and minor magnetite. Glass is abundant and is believed to be the primary containing agent.

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

Generally, center of the sill is coarsest 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.

**CORE ANALYSIS**

Sill porosity is intergranular, vuggy and fracture. By core analysis, porosity ranges from 3.1% to 5.1% and averages 10%, permeability is from less than 0.01 to 0.24 md, residual oil saturation from 0-25%, and water saturation from 25% in permeable sections to 1% 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 outcrop in the area (Fig. 1). However, exposure of igneous rocks is very fine-grained and dense with little, if any, porosity.

Samples from two cores plugs, silt and shale exposing outcrop at Rount Batte, one mile southeast of Navajo 1, are difficult to distinguish from core chips from dense porosity 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 (Oligracene). The sill intruded lower Hermosa (Pennsylvanian) beds.

**TOCITO FIELD**

In Torito field, 20 miles east of Dineh bi Kevah, oil is produced from porous algal bank limestones that correlate with the interval intruded by the sill. Torito 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 sand body, i.e., the oil or dike was in contact with a porous limestone reservoir, and oil migrated out of the primary reservoir into the igneous rock.

However, to date, tests that found the sill intruded encountered only tiny limestone and shale at the stratigraphic level intruded by the sill. While there is no evidence that the sill "flushed" 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 Pennsylvanian 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. John Hunt 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 dikes of the time of intrusion, but that decane 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 close up on the DeChelly is acquired by presence of the sill.

Kerr-McGee's Navajo 1 "B" is 115 feet high to the Navajo 2 "B", 1/2 mile east. The sill is 81 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. 2). 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 oil.

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.
ed. Thus, along the west side of the field, the silt 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 silt is unknown but the increased thickness and splitting on the southwest side of the field suggests a nearby source.

ACKNOWLEDGEMENT


LITERATURE CITED