OILFIELD RESEARCH LABORATORIES
536 NORTH HIGHLAND · CHANUTE, KANSAS 66720 · PHONE (316) 431-2650

December 13, 1979

Somerset Energy, Incorporated
1203 Iowa Street
Lawrence, Kansas 66044

Gentlemen:

Enclosed herewith is the report of the analysis of the rotary core taken from the Hansen Lease, Well No. S-111, Miami County, Kansas, and submitted to our laboratory on November 16, 1979.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Benjamin R. Pearman

Benjamin R. Pearman

SAM/tem
5 c to Lawrence, Kansas

# Oilfield Research Laboratories

## GENERAL INFORMATION & SUMMARY

Company Somerset Energy, Inc. Lease Hansen Well No. S-111

Location 1300' SNL & 2040' EWL

Section 29 Twp. 16S Rge. 24E County Miami State Kansas

| | |
|---|---|
| Name of Sand | Big Lake |
| Top of Core | 342.0 |
| Bottom of Core | 377.5 |
| Top of Sand | 342.0 |
| Bottom of Sand | 372.9 |
| Total Feet of Permeable Sand | 19.1 |
| Total Feet of Floodable Sand (Tested) | 2.8 |

| Distribution of Permeable Sand: Permeability Range Millidarcys | Feet | Cum. Ft. |
|---|---|---|
| 0 - 200 | 3.5 | 3.5 |
| 300 - 600 | 10.2 | 13.7 |
| 600 - 1500 | 2.1 | 15.8 |
| 1500 - 2000 | 2.6 | 18.4 |
| 2000 & Above | 0.7 | 19.1 |

| | |
|---|---|
| Average Permeability Millidarcys | 831.1 |
| Average Percent Porosity | 19.9 |
| Average Percent Oil Saturation | 26.0 |
| Average Percent Water Saturation | 58.3 |
| Average Oil Content, Bbls./A. Ft. | 380. |
| Total Oil Content, Bbls./Acre | 7,830. |
| Average Percent Oil Recovery by Laboratory Flooding Tests | 13.3 |
| Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft. | 204. |
| Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre | 572. |
| Total Calculated Oil Recovery, Bbls./Acre | See "Calculated Recovery" Section. |
| Packer Setting, Feet | |
| Viscosity, Centipoises @ | |
| A. P. I. Gravity, degrees @ 60 °F | |
| Elevation, Feet | |

The core was sampled and the samples sealed in plastic bags by a representative of the client. Fresh water mud was used as a drilling fluid.

## FORMATION CORED

The detailed log of the formation cored is as follows:

| Depth Interval, Feet | Description |
|---|---|
| 342.0 - 342.8 | Light brown laminated slightly calcareous sandstone. |
| 342.8 - 345.8 | Gray limestone. |
| 345.8 - 346.7 | Light brown laminated slightly calcareous sandstone. |
| 346.7 - 347.8 | Gray sandy limestone. |
| 347.8 - 348.2 | Light brown slightly calcareous sandstone. |
| 348.2 - 349.0 | Gray sandy limestone. |
| 349.0 - 351.0 | Gray and light brown laminated slightly calcareous sandstone. |
| 351.0 - 354.7 | Brown slightly calcareous sandstone. |
| 354.7 - 355.8 | Light brown laminated slightly calcareous sandstone. |
| 355.8 - 356.9 | Gray limestone. |
| 356.9 - 358.9 | Brown slightly calcareous sandstone. |
| 358.9 - 359.9 | Gray limestone. |
| 359.9 - 360.1 | Brown slightly calcareous sandstone. |
| 360.1 - 360.9 | Gray limestone containing thin streaks of oil saturated sandstone. |
| 360.9 - 361.2 | Light brown slightly calcareous sandstone. |
| 361.2 - 362.3 | Gray limestone containing thin streaks of oil saturated sandstone. |
| 362.3 - 364.2 | Light brown slightly calcareous sandstone. |

| | |
|---|---|
| 364.2 - 364.8 | Gray limestone. |
| 364.8 - 367.2 | Brown sandstone. |
| 367.2 - 368.0 | Gray limestone. |
| 368.0 - 370.0 | Hard brown calcareous sandstone. |
| 370.0 - 372.9 | Light brown laminated slightly calcareous sandstone. |
| 372.9 - 377.5 | Gray shale. |

## LABORATORY FLOODING TESTS

At the request of the client, four samples were selected for floodpot testing. These samples responded to laboratory flooding tests, as a total recovery of 572 barrels of oil per acre was obtained from 2.8 feet of sand. The weighted average percent oil saturation was reduced from 33.6 to 20.3, or represents an average recovery of 13.3 percent. The weighted average effective permeability of the samples is 95.46 millidarcys, while the average initial fluid production pressure is 5.0 pounds per square inch (See Table V).

## CALCULATED RECOVERY

The results of the laboratory tests indicate that efficient primary and waterflood operations in the vicinity of this well should recover approximately 260 barrels of oil per acre foot.

This recovery value was calculated using the following data and assumptions:

| | |
|---|---|
| Original formation volume factor, estimated | 1.03 |
| Reservoir water saturation, percent, estimated | 45.0 |
| Average porosity, percent | 22.5 |

| | |
|---|---|
| Oil saturation after flooding, percent | 20.3 |
| Performance factor, percent, estimated | 45.0 |
| Net floodable sand, feet, tested | 2.8 |

**Oilfield Research Laboratories**

**RESULTS OF SATURATION & PERMEABILITY TESTS**

**TABLE 1-B**

Company Somerset Energy, Incorporated Lease Hansen Well No. S-111

| Sample No. | Depth, Feet | Effective Porosity Percent | Percent Saturation | | | Oil Content Bbls. / A Ft. | Perm., Mill. | Feet of Sand | | Total Oil Content | Perm. Capacity Ft. X md. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Oil | Water | Total | | | Ft. | Cum. Ft. | | |
| 1 | 342.2 | 18.2 | 22 | 59 | 81 | 311 | 44. | 0.8 | 0.8 | 249 | 35.20 |
| 2 | 346.5 | 20.7 | 22 | 62 | 84 | 353 | 322. | 0.9 | 1.7 | 318 | 289.80 |
| 3 | 348.0 | 20.8 | 23 | 38 | 61 | 371 | 306. | 0.4 | 2.1 | 148 | 122.40 |
| 4 | 349.2 | 21.6 | 27 | 49 | 76 | 452 | 509. | 1.0 | 3.1 | 452 | 509.00 |
| 5 | 350.8 | 22.6 | 28 | 50 | 78 | 491 | 509. | 1.0 | 4.1 | 491 | 509.00 |
| 6 | 351.5 | 20.1 | 33 | 45 | 78 | 515 | 49. | 1.0 | 5.1 | 515 | 49.00 |
| 7 | 352.5 | 28.1 | 33 | 51 | 84 | 719 | 1226. | 1.0 | 6.1 | 719 | 1226.00 |
| 8 | 353.9 | 25.1 | 24 | 59 | 83 | 467 | 584. | 1.7 | 7.8 | 794 | 992.80 |
| 9 | 355.0 | 24.8 | 14 | 60 | 74 | 269 | 645. | 1.1 | 8.9 | 296 | 709.50 |
| 10 | 357.0 | 13.3 | 39 | 49 | 88 | 402 | 383. | 1.0 | 9.9 | 402 | 383.00 |
| 11 | 358.0 | 18.9 | 19 | 57 | 76 | 279 | 350. | 0.5 | 10.4 | 140 | 175.00 |
| 12 | 358.8 | 20.1 | 23 | 55 | 78 | 359 | 438. | 0.5 | 10.9 | 180 | 219.00 |
| 13 | 360.0 | 25.6 | 33 | 49 | 82 | 655 | 472. | 0.2 | 11.1 | 131 | 94.40 |
| 14 | 361.0 | 17.8 | 29 | 50 | 79 | 401 | 0.64 | 0.3 | 11.4 | 120 | 0.19 |
| 15 | 362.5 | 30.4 | 25 | 67 | 92 | 590 | 1752. | 0.9 | 12.3 | 428 | 1576.80 |
| 16 | 363.5 | 26.7 | 23 | 60 | 83 | 476 | 341. | 1.0 | 13.3 | 476 | 1752.00 |
| 17 | 365.2 | 21.9 | 36 | 59 | 95 | 612 | 423. | 1.0 | 14.3 | 612 | 341.00 |
| 18 | 366.0 | 12.8 | 41 | 50 | 91 | 407 | 1887. | 0.7 | 15.0 | 285 | 1320.90 |
| 19 | 367.0 | 36.8 | 17 | 78 | 95 | 485 | 4716. | 0.7 | 15.7 | 340 | 3301.20 |
| 20 | 368.1 | 5.1 | 36 | 50 | 86 | 142 | 511. | 1.0 | 16.7 | 142 | 511.00 |
| 21 | 369.9 | 2.9 | 26 | 68 | 94 | 59 | 1533. | 1.0 | 17.7 | 59 | 1533.00 |
| 22 | 371.0 | 3.2 | 19 | 61 | 80 | 47 | Imp. | 1.5 | 19.2 | 71 | 0.00 |
| 23 | 372.5 | 25.0 | 17 | 80 | 97 | 330 | 160. | 1.4 | 20.6 | 462 | 224.00 |

## Oilfield Research Laboratories

### SUMMARY OF PERMEABILITY & SATURATION TESTS

### TABLE III

Company Somerset Energy, Incorporated Lease Hansen Well No. S-111

| Depth Interval, Feet | Feet of Core Analyzed | Average Permeability, Millidarcys | Permeability Capacity Ft. x Md. |
|---|---|---|---|
| 342.0 - 355.8 | 8.9 | 499.2 | 4,442.70 |
| 356.9 - 372.9 | 10.2 | 1,120.7 | 11,431.49 |
| 342.0 - 372.9 | 19.1 | 831.1 | 15,874.19 |

| Depth Interval, Feet | Feet of Core Analyzed | Average Percent Porosity | Average Percent Oil Saturation | Average Percent Water Saturation | Average Oil Content Bbl./A. Ft. | Total Oil Content Bbls./Acre |
|---|---|---|---|---|---|---|
| 342.0 - 355.8 | 8.9 | 22.9 | 25.2 | 53.9 | 447 | 3,982 |
| 356.9 - 372.9 | 11.7 | 17.6 | 26.7 | 61.6 | 329 | 3,848 |
| 342.0 - 372.9 | 20.6 | 19.9 | 26.0 | 58.3 | 380 | 7,830 |

# Oilfield Research Laboratories

## RESULTS OF LABORATORY FLOODING TESTS

### TABLE IV

Company Somerset Energy, Incorporated Lease Hansen Well No. S-111

| Sample No. | Depth, Feet | Effective Porosity Percent | Original Oil Saturation | | Oil Recovery | | Residual Saturation | | | Volume of Water Recovered cc* | Effective Permeability Millidarcys** | Initial Fluid Production Pressure Lbs./Sq./In. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | % | Bbls./A. Ft. | % | Bbls./A. Ft. | % Oil | % Water | Bbls./A. Ft. | | | |
| 13 | 360.0 | 26.0 | 33 | 666 | 15 | 303 | 18 | 74 | 363 | 515 | 85.54 | 5 |
| 15 | 362.5 | 29.9 | 25 | 580 | 6 | 139 | 19 | 73 | 441 | 446 | 77.46 | 5 |
| 17 | 365.2 | 21.5 | 36 | 600 | 14 | 234 | 22 | 66 | 366 | 187 | 140.25 | 5 |
| 18 | 366.0 | 13.3 | 41 | 423 | 21 | 217 | 20 | 73 | 205 | 398 | 57.47 | 5 |

**Notes:** cc—cubic centimeter.

*—Volume of water recovered at the time of maximum oil recovery.

**—Determined by passing water through sample which still contains residual oil.

## Oilfield Research Laboratories

### SUMMARY OF LABORATORY FLOODING TESTS

### TABLE V

Company Somerset Energy, Incorporated Lease Hansen Well No. S-111

| | |
|---|---|
| Depth Interval, Feet | 356.9 - 372.9 |
| Feet of Core Analyzed | 2.8 |
| Average Percent Porosity | 22.5 |
| Average Percent Original Oil Saturation | 33.6 |
| Average Percent Oil Recovery | 13.3 |
| Average Percent Residual Oil Saturation | 20.3 |
| Average Percent Residual Water Saturation | 70.6 |
| Average Percent Total Residual Fluid Saturation | 90.9 |
| Average Original Oil Content, Bbls./A. Ft. | 544. |
| Average Oil Recovery, Bbls./A. Ft. | 204. |
| Average Residual Oil Content, Bbls./A. Ft. | 340. |
| Total Original Oil Content, Bbls./Acre | 1,524. |
| Total Oil Recovery, Bbls./Acre | 572. |
| Total Residual Oil Content, Bbls./Acre | 952. |
| Average Effective Permeability, Millidarcys | 95.46 |
| Average Initial Fluid Production Pressure, p.s.i. | 5.0 |

NOTE: Only those samples which recovered oil were used in calculating the above averages.

# Oilfield Research Laboratories

## RESULTS OF WATER DIFFERENTIATION TESTS

## TABLE VI

Company Somerset Energy, Inc. Lease Hansen Well No. S-111

| Sample No. | Depth, Feet | Chloride Content of Brine in Sand ppm | Percent Water Saturation | | |
|---|---|---|---|---|---|
| | | | Connate | Drilling & Foreign | Total |
| 1 | 342.2 | 12,821 | | | |
| 2 | 346.5 | 12,308 | | | |
| 3 | 348.0 | 18,364 | | | |
| 4 | 349.2 | 17,131 | | | |
| 5 | 350.8 | 13,347 | | | |
| 6 | 351.5 | 14,245 | | | |
| 7 | 352.5 | 12,328 | | | |
| 8 | 353.9 | 14,085 | | | |
| 9 | 355.0 | 14,663 | | | |
| 10 | 357.0 | 21,733 | | | |
| 11 | 358.0 | 14,858 | | | |
| 12 | 358.8 | 17,648 | | | |
| 13 | 360.0 | 12,274 | | | |
| 14 | 361.0 | 14,449 | | | |
| 15 | 362.5 | 8,553 | | | |
| 16 | 363.5 | 14,226 | | | |
| 17 | 365.2 | 10,083 | | | |
| 18 | 366.0 | 15,881 | | | |
| 19 | 367.0 | 7,298 | | | |
| 20 | 368.1 | 14,147 | | | |
| 21 | 369.9 | 16,523 | | | |
| 22 | 371.0 | 15,471 | | | |
| 23 | 372.5 | 10,431 | | | |

Note: ppm — parts per million