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UNITED STATES DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

Results of analyses for shale oil  
in the Phosphoria Formation of southwestern Montana

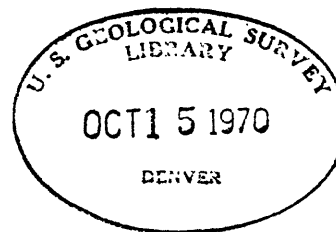
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Open-file report

1970

70-19



This report is preliminary  
and has not been edited or  
reviewed for conformity with  
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standards or nomenclature.

## OCCURRENCE

The occurrence of shale oil in southwestern Montana was first reported by Bowen in 1918. Although shale oil has been found in beds at eight stratigraphic horizons ranging in age from Late Devonian to Tertiary, only the analysis of those deposits in the Meade Peak and Retort Phosphatic Shale Members of the Phosphoria Formation of Permian age is discussed in this report. Detailed descriptions, measured geologic sections, the stratigraphy, and the petrology of the units of the Phosphoria are given by Cressman (1955), McKelvey and others (1959), and Cressman and Swanson (1964). Biostratigraphy is discussed by Yochelson (1968), and mineral resources are described by Swanson (1970).

## SHALE OIL ANALYSES

Analyses of samples that yielded oil on distillation tests have been published by Bowen (1918, p. 318), Condit (1919, p. 24-26), Winchester (1923, p. 85-87, 90, 91), and Cressman and Swanson (1964, p. 438, 439).

During the investigation of the western phosphate field under the direction of V. E. McKelvey starting in 1947, stratigraphic sections of Permian rocks were measured in considerable detail, and samples taken from the phosphatic members were analyzed for  $P_2O_5$  content and other materials. Logs of the measured sections and results of the sample analyses were published as U.S. Geological Survey Circulars 209, 260, 302, 303, 326, and 375. Later, most of this information was consolidated by Cressman and Swanson (1964). In November 1968, some of the samples from individual beds were combined to make 47 composite samples and were analyzed by the U.S. Geological Survey using the modified Fischer assay method.

Results of the analyses are shown in the following table, and the measured section localities are shown in figure 1.

| Locality                          | Lot No.       | Reference<br>Author and<br>year | Page<br>No. | Beds included<br>in sample <sup>1</sup>                        | Thickness<br>of interval<br>(ft)     | Oil <sup>2</sup><br>(gal/<br>ton) | Water <sup>2</sup><br>(gal/<br>ton) |
|-----------------------------------|---------------|---------------------------------|-------------|----------------------------------------------------------------|--------------------------------------|-----------------------------------|-------------------------------------|
|                                   |               |                                 |             |                                                                |                                      |                                   |                                     |
| Warm Springs Creek-----           | 1300          | Cressman and<br>Swanson, 1964   | 494         | Rt 26-19                                                       | 9.4                                  | None                              | 3.1                                 |
| Canyon Camp-----                  | 1311          | do.                             | 509         | Rt 73-58<br>Rt 56-50                                           | 20.5<br>10.7                         | 4.5<br>--                         | 3.8<br>--                           |
| Sliderock Mountain-----           | 1301          | do.                             | 496         | Rt 63-49                                                       | 16.0                                 | 6.4                               | 5.4                                 |
| Hogback Mountain-----             | 1299          | do.                             | 486         | Rt 161-146<br>Rt 145-131<br>Rt 130-109<br>Rt 108-86<br>M 66-59 | 19.3<br>22.8<br>21.9<br>17.3<br>10.9 | 1.2<br><1.0<br>1.2<br>1.1<br><1.0 | 4.1<br>2.0<br>4.9<br>5.5<br>2.0     |
| West Fork Madison River-          | 1318          | do.                             | 513         | Rt 13-1                                                        | 28.4                                 | <1.0                              | 2.5                                 |
| Sawtooth Mountain-----            | 1241          | do.                             | 444         | Rt 115-100<br>Rt 96-92                                         | 23.2<br>25.0                         | 2.1<br><1.0                       | 4.8<br>3.4                          |
| West Fork Blacktail<br>Creek----- | 1302          | do.                             | 500         | Rt 86-74<br>Rt 72-47<br>M 21-10                                | 26.6<br>33.5<br>10.8                 | None<br>3.6<br><1.0               | 7.2<br>8.1<br>4.1                   |
| Wadhams Springs-----              | 1246,<br>1247 | do.                             | 450         | Rt 110-97<br>Rt 96-73<br>M 34-30                               | 17.1<br>20.8<br>14.8                 | <1.0<br>--<br><1.0                | 6.1<br>--<br>2.4                    |
| Crooked Creek-----                | 1296,<br>1297 | do.                             | 481         | Rt 105-94<br>Rt 93-72<br>M 52-28                               | 31.3<br>37.3<br>13.6                 | 1.9<br>2.1<br>None                | 7.7<br>8.4<br>2.4                   |
| Little Sheep Creek-----           | 1294,<br>1295 | do.                             | 476         | Rt 108-99<br>Rt 97-81<br>M 59-45                               | 16.7<br>10.9<br>14.0                 | 3.1<br>None<br>None               | 10.8<br>4.8<br>4.8                  |

<sup>1</sup> Rt, Retort Phosphatic Shale Member; M, Meade Peak Phosphatic Shale Member; D, D member of Phosphoria of Klepper and others, 1953 (Retort Phosphatic Shale Member).

<sup>2</sup> --, insufficient sample for analysis.

| Locality                            | Lot No.                         | Reference                  |          | Beds included in sample <sup>1</sup>                            | Thickness of interval (ft)          | Oil <sup>2</sup> (gal/ton)      | Water <sup>2</sup> (gal/ton)     |
|-------------------------------------|---------------------------------|----------------------------|----------|-----------------------------------------------------------------|-------------------------------------|---------------------------------|----------------------------------|
|                                     |                                 | Author and year            | Page No. |                                                                 |                                     |                                 |                                  |
| Upper French Creek-----             | 1248                            | Klepper and others, 1953   | 27       | D 10-1                                                          | 14.5                                | <1.0                            | 7.0                              |
| Kelley Gulch-----                   | 1249                            | Cressman and Swanson, 1964 | 457      | Rt 80-62<br>Rt 55-27                                            | 24.6<br>24.9                        | <1.0<br><1.0                    | 5.0<br>5.0                       |
| South Greenstone Gulch--            | 1250                            | Klepper and others, 1953   | 14       | D 37-15<br>D 13-5                                               | 41.7<br>15.6                        | <1.0<br><1.0                    | 7.2<br>6.8                       |
| Cave Creek-----                     | 1257                            | Cressman and Swanson, 1964 | 473      | Rt 45-35<br>Rt 34-2                                             | 14.2<br>20.5                        | <1.0<br><1.0                    | 4.8<br>4.3                       |
| North Big Hole Canyon---            | 1358                            | do.                        | 537      | Rt 62-42<br>Rt 36-26                                            | 22.7<br>9.9                         | <1.0<br><1.0                    | 4.8<br>4.2                       |
| South Big Hole Canyon<br>No. 1----- | 1354-A                          | do.                        | 528      | Rt 23-16                                                        | 12.9                                | <1.0                            | 3.6                              |
| Daly's Spur-----                    | 1222,<br>1223                   | do.                        | 408      | Rt 85-69<br>Rt 68-54<br>Rt 52-35                                | 20.6<br>20.3<br>12.8                | 1.9<br>2.7<br><1.0              | 17.4<br>14.4<br>7.2              |
| Cedar Creek-----                    | 1256                            | do.                        | 470      | Rt 58-46<br>Rt 44-1                                             | 29.2<br>20.7                        | <1.0<br><1.0                    | 3.1<br>4.2                       |
| Big Sheep Canyon-----               | 1224,<br>1225,<br>1226,<br>1227 | do.                        | 414      | Rt 198-195<br>Rt 193-176<br>Rt 172-161<br>Rt 159-133<br>M 76-70 | 16.3<br>17.9<br>16.6<br>26.1<br>9.2 | 5.8<br>8.7<br>4.4<br>4.6<br>2.6 | 12.0<br>7.7<br>4.8<br>7.2<br>3.6 |
| Little Water Canyon-----            | 1341                            | do.                        | 519      | Rt 71-63<br>Rt 61-44<br>M 16-2                                  | 14.3<br>17.1<br>15.4                | <1.0<br>1.2<br><1.0             | 3.4<br>5.4<br>10.8               |

<sup>1</sup> Rt, Retort Phosphatic Shale Member; M, Meade Peak Phosphatic Shale Member; D, D member of Phosphoria of Klepper and others, 1953 (Retort Phosphatic Shale Member).

<sup>2</sup> --, insufficient sample for analysis.

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