BRIEF HISTORY AND RECENT DEVELOPMENTS IN TAR SAND DEPOSITS OF UINTA BASIN

ROBERT E. COVINGTON and KENNETH J. YOUNG

ABSTRACT

Commercial production of oil from bituminous sandstones, more commonly referred to as "Tar sands", is considered by many to be a viable project. These so-called "heavy oil" deposits represent a very considerable reserve of oil for the future. The Uinta basin is Mother Nature's storehouse of exotic but realistically very valuable solid hydrocarbons, tar sands and oil shale. The tar sands deposits located within the Uinta Basin contain very substantial reserves of oil which will prove to be of economic importance. Companies working on processes for the extraction of bitumen from the tar sands have encountered problems more complex than originally anticipated. Within the last ten years most of the exploration efforts have been concentrated in eight tar sand deposits in the basin. At least 17 companies have conducted geological and engineering studies on these deposits. Work done by the U.S. Geological Survey and the Utah Geological and Mineral Survey has aided in the initial phases of development of the tar sands. Areas considered to be of prime importance in development are Asphalt Ridge, Sunnyside, P.R. Springs, Whiterocks and South Rainbow. Three pilot plant extraction projects have been in operation for short periods of time during the last 15 years and two in-situ heavy-oil recovery projects have been undertaken within the last five years.

GENERAL DISCUSSION

The Uinta Basin of northeastern Utah contains 21 deposits (Fig. 1) of so-called "tar sands" which should be more properly termed oil impregnated rock deposits. This number is over half of all of the other known deposits in the rest of the state. The Asphalt Ridge, P. R. Spring (including Hay Canyon) and Sunnyside deposits have been classified as "Giants" which indicates oil reserves in place exceeding 500 million barrels each. Two deposits which have been of interest to oil companies are classified as "Very Large" and include the Raven Ridge and the Dragon-Asphalt Wash (including South Rainbow) deposits. Classification as "Very Large" indicates reserves of from 100 to 500 million barrels of in place oil. Deposits classified in the "Large" category include Myton Bench, Whiterocks, Chapita Wells, Deep Creek Nose and Rim Rocks. This category indicates reserves of in place from 10 to 100 million barrels. Deposits within the Uinta basin with reserves of the medium to small category lie within the range of 0.5 to 10 million barrels and include Hill Creek and Yellowstone Lake Fork deposits.

Three of the deposits lie on the north flank of the Uinta basin and include, from east to west, the Yellowstone Lake Fork, Whiterocks and the Deep Creek Nose deposits. Other minor occurrences are found on the north flank but are of academic interest. On the northeast flank is the Asphalt Ridge and Rim Rock deposits. On the east flank is the Raven Ridge deposit. All of these deposits lie north or northeast of the present structural axis of the

COMPANIES WHO HAVE DONE DEVELOPMENT WORK ON TAR SANDS IN UINTA BASIN

<table>
<thead>
<tr>
<th>Oil Impregnated Rock Deposit</th>
<th>Company</th>
</tr>
</thead>
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<tr>
<td>1. Whiterocks</td>
<td>Commodore Resources</td>
</tr>
<tr>
<td></td>
<td>Torginol (Western Industries)</td>
</tr>
<tr>
<td>2. Asphalt Ridge &amp; Asphalt Ridge, NW</td>
<td>SOHIO</td>
</tr>
<tr>
<td></td>
<td>Cities Service Company</td>
</tr>
<tr>
<td></td>
<td>U.S. Department of Energy</td>
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<td></td>
<td>Texaco</td>
</tr>
<tr>
<td></td>
<td>Gulf Oil Corporation</td>
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<td></td>
<td>Tom Brown</td>
</tr>
<tr>
<td>3. Raven Ridge</td>
<td>Enercor</td>
</tr>
<tr>
<td>4. South Rainbow-Asphalt Wash</td>
<td>T.J. Murphy</td>
</tr>
<tr>
<td></td>
<td>Big Horn Oil Company</td>
</tr>
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<td></td>
<td>Texaco</td>
</tr>
<tr>
<td>5. P.R. Spring</td>
<td>C &amp; A Company</td>
</tr>
<tr>
<td></td>
<td>Phillips Petroleum Company</td>
</tr>
<tr>
<td></td>
<td>Chevron Resources Company</td>
</tr>
<tr>
<td>6. Hay Canyon (West P.R. Springs)</td>
<td>Signal Oil &amp; Gas Company</td>
</tr>
<tr>
<td>7. Winter Ridge (NW P.R. Springs)</td>
<td>Shell Oil Company</td>
</tr>
<tr>
<td>8. Sunnyside</td>
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</tr>
</tbody>
</table>

Figure 1.—Companies who have done development work on tar sands in Uinta Basin.
Figure 2.—Geologic cross section, Asphalt Ridge area, from Covington, 1964.

Figure 3.—View of Asphalt Ridge looking northwest. Southwest dipping Duchesne River beds cap the ridge. Mesaverde Formation crops out in the lower slopes.
basin. The deposits on this flank therefore represent, conservatively, more than 650 million barrels of in place oil; this makes 1 "Giant" deposit, 1 "Very Large", 3 "Large" and 1 "Medium" deposit. The rest of the tar sand deposits listed above are located on the southeast, south and southwest flanks of the basin and include reserves containing, conservatively, more than 1 1/2 billion barrels in 2 "Giant" deposits, 1 "Very Large" deposit, 2 "Large" deposits and 1 "Medium-Small" deposit.

Exploration and evaluation work which is still underway today, together with more sophisticated refining techniques will combine to make economically viable these tremendous reserves of presently locked-in oil. Included in this report (Appendix) are a set of conversion tables for the conversion from percent by weight of bitumen to barrels per ton, gallons per ton, barrels per cubic yard and gallons per cubic yard.

The companies listed above are certainly not the only ones actively working on tar sand development in the Uinta Basin.

ASPHALT RIDGE DEPOSIT

The bituminous sandstone of the Asphalt Ridge and Northwest Asphalt Ridge deposits contains reserves that have been estimated in excess of 1 billion barrels of in place oil (Speiker, 1930) and has been classified as a "Giant" oil field. (Covington, 1957; Ritzma 1973 and 1974.) The deposits lie west of Vernal (Figs. 2 thru 5) along the topographic ridge known as Asphalt Ridge. Saturation is found in the basal part of the Cretaceous Mesaverde Formation and in the overlying Duchesne River Formation of Eocene-Oligocene age. (Fig. 4). During the 1930s a tar sand extraction plant was built by a "Doc Rehme" at the present site of the Uinta County asphalt pit (Fig. 5). The plant utilized a hot water separation process. In the early 1950s the Knickerbocker Investment Company and W. M. Barnes Engineering Company acquired a large block of patented and unpatented oil placer mining claims and began the first comprehensive core drilling, mapping and evaluation program on the ridge. Bituminous sand was shipped to...
California where Barnes had built a pilot extraction plant. The claims were later turned to Sohio Petroleum Company. Sohio has since done some very extensive mapping, drilling and logging on these claims and has acquired additional leases. Actual development of the tar sands has been undertaken by Uintah County at the County Pit (Fig. 6) where the material is being strip mined and used for paving the county roads. It is estimated that last year more than 400,000 cubic yards of material was mined for this purpose. Sun Oil Company drilled and cored a series of test holes on the south end of the ridge and Texaco and the Phillips Petroleum Company drilled test holes in the central part. Shell Oil Company and others drilled test holes on the north end of the ridge during the early 1970's. About the same time Major Oil Company obtained a working agreement with Sohio on a tract on the south end of the ridge and strip mined the tar sands and built an extraction plant. The material was crushed and conveyed into flotation cells where a hot water-solvent process was used to strip the bitumen from the sand. Several truck loads of the bitumen were shipped to the Major Oil Company (now the Plateau Refining Company) refinery at Roosevelt, Utah. Aminoil Company gave some technical assistance to the project during the later stages of development.

Several in-situ experiments have been conducted on the Northwest Asphalt Ridge tract in secs. 24, T 4 S, R 20 E. The U.S. Department of Energy and Research Development funded and operated both a fire flood and a steam injection oil recovery process during the late 1970's and concluded the experiments in 1982 (Merriam and Fahy, 1984). During the period 1980 thru 1982 the Illinois Institute of Technology drilled a series of test holes V mile to the north and using an in situ radio frequency (microwave) technique heated the oil impregnated Rim Rock sandstone member of the Mesaverde Formation to decrease the viscosity. The second planned step was to apply fluid replacement and bitumen stripping techniques to recover the bitumen from the sand. It is not believed that the second step was actually field tested.

West of the Department of Energy project Tom Brown drilled a series of core tests which showed good saturation in the Duchesne River Formation and in the underlying Rim Rock and Asphalt Ridge sandstones.
Cities Service Company, a wholly owned subsidiary of Occidental Petroleum Corporation, conducted extensive exploration work on these properties during 1982.

The objective of the operations was to delineate the tar sand resource, to collect core samples for reservoir studies and to collect environmental data for the evaluation of the site as a potential in situ recovery candidate. The area of interest covers approximately 960 acres in secs. 22, 23, T 4 S, R 20 E, SIM, Uintah County, Utah.

Using a combination of air and mud drilling operations, approximately 3.5 miles of hole were made, including approximately 1 mile of which was cored. The unit cored was the Mesaverde Formation and core recovery averaged 93%. The program included 9 new coreholes to complement six existing coreholes drilled previously by others. A tenth well was drilled offsetting one of the new coreholes as a test well. Selected wells were cased for future development.

As each core was recovered it was immediately packaged, boxed and transported to a core laboratory for a comprehensive analysis. Each well drilled was logged using an extensive suite of logging tools. A seismic survey was also completed as a part of the overall exploration program. A critical review and evaluation of this exploration program is now being undertaken to determine the future course of any possible development activity.

**WHITEROCKS DEPOSIT**

The Whiterocks deposit lies in secs. 17-19, T 1 N, R 1 E, U.S.M. and sec. 24, T 1 N, R 1 W, U.S.M. The geology of the area has been described by Covington (1964). The oil saturation occurs in the Jurassic Navajo Sandstone which dips to the southeast 63°. The Whiterocks River was cut down through the upper 200 feet of saturation exposing this part of the deposit on both the east and the west side of the river (Fig. 7). Mesozoic and Paleozoic formations are truncated and the Duchesne River Formation unconformably lies on top of their beveled edges (Figs. 6 to 8). The first known test of these tar sands was probably the Fulton Nos. 1 & 2 core tests which were drilled in the late 1950s. The data from these hole encouraged other operators to investigate...
the area. Caldwell & Covington drilled a core test in the SW VA, SE V* of sec. 18, T 1 N, R 1 E, U.S.M. and leased the property to Western Industries of Las Vegas, Nevada (now called Torginol). Western Industries built a pilot demonstration plant and strip mined the material from the outcrop on the east side of the river. The company also drilled 10 core tests on the lease. The extraction process involved a grinding and crushing operation combined with a hot water-solvent extraction technique. A small amount of bitumen was produced during the operation.

During the early 1970s Major Oil Company erected a pilot plant on the west side of the river and strip mined material which was fed into the plant utilizing an extraction method similar to Western Industries. In 1981 and 1982 Enercor did some investigative work on the deposit and acquired some leases and mineral interests. Commodore Resources offset the early Fulton wells and drilled a hole which encountered 530 feet of oil sand. The average oil saturation was 21 gallons per cubic yard or the equivalent of 800 barrels per acre foot. In 1982 Rocky Mountain Exploration Company drilled 2 holes on the prospect.

This tar sand deposit has been classified as "Large." In place oil reserves probably exceed 50 million barrels. Over 60% of the deposit is amenable to strip mining. Some potential exists for in situ recovery, especially on the southwest and northeast sides of the river.

RAVEN RIDGE DEPOSIT

The Raven Ridge deposit is located on the north and northeast side of the Uinta Basin and includes the Rim Rock deposit for purposes of this discussion. The saturation occurs in the Parachute Creek Member of the Green River Formation at Rim Rock and in the lower Green River and upper Wasatch (Eocene) Formation at Raven Ridge, covering parts of T 6-7 S, R 24-25 E. In the summer of 1980 Western Tar Sands Company commenced strip mining of a 22 feet bituminous sand in sec. 16, T 7 S, R 24 E (Fig. 9). The company had plans to build a pilot plant for the extraction of oil from the sands using a patented process to test its feasibility; however, the plant was never built and there has been no recent activity in the area. Strip mining potential is limited because of the steep dip of the formations and the relatively thin sand development.
Figure 8. — North-south cross profile, Whiterocks area, Covington, 1964.

Figure 9. — Location map of Raven Ridge area. The tar sands are partially correlative with the productive zones in the Red Wash (H7S-R24E) and Coyote Basin (T7-8S-R24E) oil fields. From Energy Land Research Co, 1982.
SOUTH RAINBOW AREA: DRAGON-ASPHALT WASH DEPOSIT

The South Rainbow deposit is a part of the larger Dragon-Asphalt Wash oil impregnated rock deposit which has been classified as having in place oil reserves from 100 to 500 million barrels and termed "Very Large". The oil occurrence is sandstones of the Douglas Creek Member of the Green River Formation of Eocene age. These deposits are located structurally on the east flank of the Uinta Basin. The old gilsonite mining camps of Black Dragon and Rainbow are areas of historical interest within the deposit area (Fig. 10).

In 1981, Enercor commenced an evaluation program which included core drilling, geologic mapping and feasibility studies for the development of a mining and tar sand processing facility which would lead to the development of a 2,000 barrel per stream day and an ultimate capacity phase of 5,000 barrel of bitumen per day, upgraded to crude oil quality. Enercor has submitted an Environmental Impact Statement for this project and is under consideration for government funding for the project. The process envisaged
would be a hot water separation method combined with a delayed coke processing plant. Seven core holes were drilled in sees. 29, 32, 33, T 12 S, R 25 E and in sees. 4, 5, 8, T 13 S, R 25 E. Geologic maps were constructed, including structure maps, isopach maps of overburden and material, cross profiles and all cores were analyzed. From these data estimates of reserves and over-burdened were calculated. To determine the efficiency of the proposed plant a pilot plant was constructed at Woods Cross, Utah, north of Salt Lake City. The overburden was removed by strip mining and the exposed tar sand material was trucked to Salt Lake City for processing. The plant was run in conjunction with the University of Utah and was shut down in the fall of 1982. This project was one of the largest scale operations for oil extraction from tar sands in the state. No data is as yet available on the amount of oil produced from this plant. We were in charge of the geologic work.

**P.R. SPRING-HAY CANYON-WINTER RIDGE AREA**

The tar sand deposits of the greater P.R. Spring area, which includes Hay Canyon and Winter Ridge, have been of great interest for many years to companies interested in their possible development. (Byrd, 1970; Picard and High, 1970; Picard, 1971). The very size of the deposit staggers the imagination. The deposit has been termed a "Giant", and well named it is, for the saturation occurs through large parts of 30 townships ranging from T12-17S, R21-25E, Uintah and Grand Counties. Estimates of oil reserves in place exceed 500 million. What portion of this giant oil deposit is economically viable is the main thrust of the companies who have been operating in the area (Fig. 11).

There has been very extensive mapping and measuring of the outcrops of tar sands in this deposit. There have also been a considerable number of core tests which have been drilled. Within the last two years more than 20 core tests were drilled. During the summer of 1982 a pilot plant was constructed in sec. 5, T 16 S, R 24 E, SLM, Grandy County, Utah. Strip mining was begun and the plant was in operation for a brief period when the operation was shut down due to lack of funding. The project was located on a patented tract of land by M & E Company of Roosevelt, Utah. The operations were later conducted by Big Horn Oil, Inc., U-Tar Division from Murray, Utah. The process utilized high temperature flotation in hot water with a chemical treatment and was designed to produce 100 barrels of oil per day.

A core hole which was drilled in sec. 32, T 15/2 S, R 24 E, SLM, Grand County, Utah showed the average thickness of the upper tar sand (Dahm's Bed "F") to be 20 ft. thick with oil saturation averaging 9% bitumen by weight. The bed which was actually mined by M & E Company was the "E" bed of Dahm which was 30 to 40 ft. in thickness with average saturations of 12% bitumen by weight. The ratio of overburden to material was 2:1 for the "F" zone and 3:1 for the "E" zone if the "F" zone is excluded. The high degree of oil saturation in the "F" zone made drilling difficult. A gas flow also made the drilling complicated. Along the outcrop of the "E" zone the brea flows have created large pools of tar which have net trapped insects, snakes, birds and perhaps even a geologist or two!

**HAY CANYON-WINTER RIDGE AREA**

West of the P.R.Spring area lies the Hay Canyon-Winter Ridge tar sand deposits (Fig. 12). This area is a sub-part of the greater P.R.Spring deposit. Because of the numerous outcrops exposed a very considerable number of test wells have been drilled to evaluate these sands. Mapping and measuring of sections is replete in the literature. During 1981 and 1982 core tests were drilled by C & A Company, Scottsdale, Arizona and by Enercor and partners, Salt Lake City, Utah. Holes were drilled in sees. 16 thru 18, T 16 S-R 23 E, Sees. 35 and 36, T 15 Vi S, R 22 E and in Sees. 32, 34 and 35, T 15 S, R 22 E.

The results of this drilling appear to show that the extreme lateral and vertical variations of both oil saturation and in bed thickness were discouraging from the standpoint of long range, large scale mining operations. The ratio of overburden to material was not very favorable over most of the areas. However, some of the area appears to offer good potential for in situ techniques.

**SUNNYSIDE AREA**

The Sunnyside tar sand deposits are located on the south edge of the Uinta basin in T 13 S, R 13 E and 14 E, SLM, Carbon County, Utah. The deposit is classed as a "Giant" and in place oil reserves have been estimated at more than 750 million barrels (Fig. 13). The deposit is located north of the town of Sunnyside, Utah on the south facing topographic escarpment known as the Book Cliffs. The oil saturation occurs in the lower Green River Formation and the upper Wasatch Formation of Eocene age. The geology of the area is discussed by Holmes (1956) and Covington (1976) (Figs. 14 & 15).

During 1982 Enercor did some preliminary studies of mining feasibility on their leases. In November of 1982, Chevron Resources Company, a wholly owned subsidiary of Standard Oil Company of California, signed an operating agreement with GNC Company of Dallas, Texas for the development of 2,000 acres of the Sunnyside deposit. Chevron is the operator and may acquire as much as 75% of the interest as the project matures.

Chevron believes that this project contains approximately 280 million barrels of recoverable oil reserves. In accordance with their development plan, core drilling was conducted during the latter part of 1982 to establish reserves. The companies believe that the production of 10,000 barrels of oil per day is a realistic goal. The total
Figure 12. — Location map, Hay Canyon — Winter Ridge area, from J. N. Dahm, 1980.
investment to achieve this production could be in excess of $1 billion according to Chevron.

Chevron thinks this is a viable project because of accessibility to highways, railroads, towns and general economic infrastructure, in contrast to more remote locations of other undeveloped tar sand projects. The area has good mining potential with excellent pay zone thickness, high bitumen content, low sulfur content and moderate overburden to pay ratios. The project is also in close proximity to other Chevron operations. Chevron has a refinery in Salt Lake City, a phosphate mine north of Vernal and a gilsonite mine at Bonanza. Chevron is Utah's largest gasoline marketer.

The recovery of oil from the tar sands involves two processes to treat the material after it has been crushed and before it reaches a coker-hydro-treater. The material first goes into an ambient temperature froth flotation circuit, identical to that used in hard rock mining which concentrates to about 30% bitumen. It is further concentrated to about 90-95% bitumen in a liquid leaching system. The material will then be subjected to a Chevron flotation and extraction process. A commercial plant will
Figure 14.—Geologic map of the Sunnyside area showing line of cross profile of Figure 15. Covington, 1978.
further upgrade the bitumen by delayed coking and hydrotreating, resulting in a high grade synthetic crude oil for petroleum refineries.

Ore is presently being shipped to the Company's Salt Lake pilot plant where the processes are now being perfected. The material being shipped will average 21 gallons per ton of bitumen.

The proposed plant site is the site of the old Utah Asphalt Company quarry at an elevation of 9,000 to 10,000 ft. Mining began in this area in 1942 and by 1945 more than 350,000 tons had been mined. These deposits are the largest in the United States. Signal Oil Company of California drilled horizontal holes into the quarry face in 1967 and attempted an in situ oil recovery using steam. The project was unsuccessful and later was abandoned. The Shell Oil Company drilled 6 core tests in Section 3, T 14 S, R 24 E about the same time. Signal also drilled a vertical core test downdip from the tar sands in the NE 1/4 NE/4 of sec. 4, T 14 S, R 14 E to determine if liquid oil existed in a downdip direction from the outcrop. Texaco also drilled 3 core tests, one in sec. 23, T 13 S, R 14 E, to a depth of 826 ft, one in sec. 31, T 13 S, R 15 E to a depth of 730 ft and a third in sec. 22, T 13 S, R 14 E to a depth of 455 ft. Gulf Oil Corporation also has had an interest in the area and drilled the No. 1 Nutter Ranch well in Sec. 24, T 13 S, R 14 E, again downdip from the outcrop. This well was cased and produced some heavy oil for a short time (Price, H., personal communication, 1983). The hole was drilled to a depth of 2638 ft, about 100 ft into the Wasatch Formation (Fig. 15).

CONCLUSIONS

The oil impregnated rock deposits (tar sands) of the Uinta Basin afford a very real challenge to producers of oil not only from the standpoint of mining, but also from the extraction and refining problems which can and will be met in the coming decade. Although crude oil price is of primary concern, the availability of water sources, terrain, logistical problems associated with the location of the deposits, environmental aspects, socio-economic impacts on the area, transportation facilities, interest rates on money for capital development, return on investment, markets and other considerations all will play a significant role in the determination of how soon these deposits will be developed. The reserves of oil which are contained in these deposits represent a very significant United States reserve of petroleum and warrant an in-depth approach which is, at the same time, realistic.

We believe the Sunnyside, Asphalt Ridge, parts of P.R. Spring and Whiterocks deposits have the most potential for economic development. The P.R. Spring deposits, especially immediately south and west of P.R. Spring itself has the advantage of good saturation with favorable overburden to
material ratios. A disadvantage is the remoteness of the area and lack of a good water supply. Asphalt Ridge has excellent potential in the Rim Rock sandstone member of the Mesaverde on the ridge proper and in the Rim Rock and Asphalt Ridge members of the North Asphalt Ridge tract from the standpoint of in situ recovery and, in part, for open pit mining, especially on the south part of the ridge. The area is close to transportation routes, with excellent accessibility and services, housing and labor markets. White-rocks offers a mining project with fairly good accessibility and with a massive oil saturated section which is amenable to strip mining operations. Also, a part of the deposit can probably be worked by in situ methods. The main disadvantage is the relatively small size of the deposit. However, this should not deter an independent operator. Sunnyside is in the process of development and would appear to be the first of the oil impregnated rock deposits of Utah to commercially mined and processed. The future will see many of these deposits undergo commercial development within the next five years.

REFERENCES


Covington, R. E., 1976, Oil impregnated rocks of Utah: in Brigham Young University Geology Studies, v. 22, p. 143-150.


APPENDIX

CONVERSION TABLE
(Covington, 1984 & Holmes, 1948)

<table>
<thead>
<tr>
<th>Percent by Weight</th>
<th>Barrels/ton</th>
<th>Gallons/ton</th>
<th>Barrels/ Yd.(^5)</th>
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The above figures are based on the following parameters: The specific gravity of the sandstone is 2.1. With bitumen content of 9% by weight, a cubic yard of bituminous sandstone weighs 1.77 tons and contains 318.8 lbs. of bitumen. A gallon of bitumen weighs 8.345 pounds.