

COMPARISON OF ROCK SECTION
IN THE PICEANCE BASIN, AND IN
THE TOSCO UTAH STATE NO. 1



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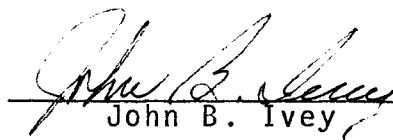
Attn: Mr. J. L. Moyer

Gentlemen:

This letter transmits ten copies of our short report, "Comparison of Rock Section in the Piceance Basin, and in the TOSCO Utah State No. 1." This report was requested by Mr. Moyer with instructions that general impressions formed by our staff members were to be set forth.

It has been a pleasure to prepare this report and we look forward to continued service to TOSCO.

Yours very truly,


John B. Ivey

JB I:rf

Encl.

INTRODUCTION

The TOSCO Utah State No. 1 in the NE 1/4, NE 1/4, sec. 26, T. 9S., R. 21E. (660' S. of north line, 800' W. of east line sec. 26) (Fig. 1), Uintah County, Utah was drilled to evaluate the oil shales of the Parachute Creek Member of the Green River Formation. The drill cuttings and cores were examined at the drill site to provide a record of the lithology of the total section penetrated. Lithologic zones and important marker beds were identified. Continuous coring took place in the interval 1570-2600'. In addition, the recovered cores were examined to provide information concerning the structure and physical properties of the rock for engineering purposes related to mining.

Amuedo and Ivey furnished the services of E. C. Mast and R. A. Lindvall to assist J. L. Moyer of TOSCO in the coring program from March 17 to April 3. Between March 30 and April 3 J. B. Hansen was also on the program. This short report was prepared, at the request of Mr. Moyer, to describe comparative impressions of the rock section previously observed in the Piceance Basin, and the section observed in the Uinta basin in this core program. Comparisons are made of lithology, and structure and physical properties of the rock.

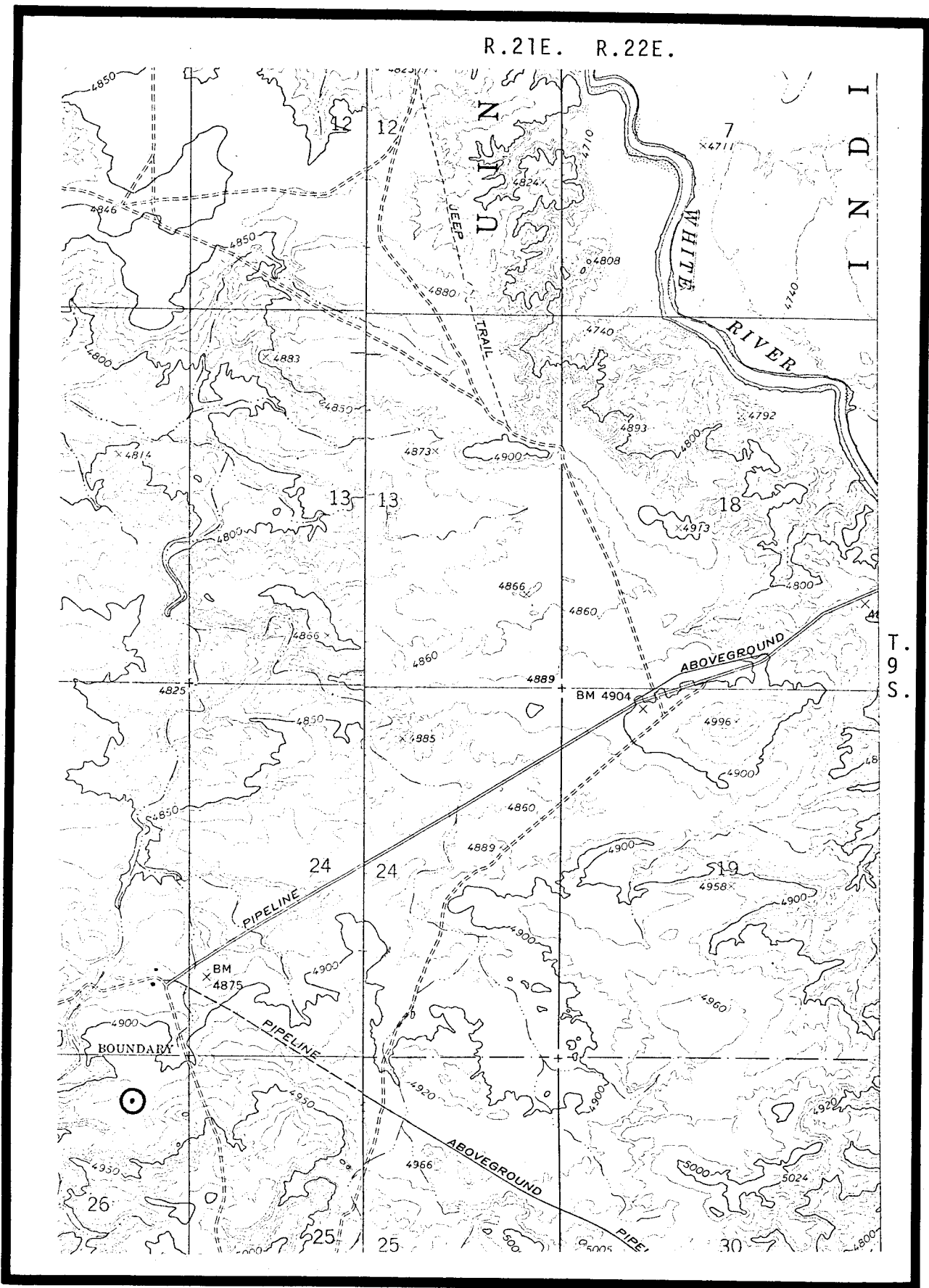


FIGURE 1
LOCATION MAP

LITHOLOGY

Some distinct differences were noted between the section cored in the Uinta basin and that found in the Piceance basin. In the cores from the Uinta there is a mineralized zone located 275' to 300' above the top of the "A" Groove. This mineralized zone is composed of vugs and stringers of nahcolite embedded in low grade oil shale and marlstone with disseminated nahcolite throughout the zone. The "A" Groove consists of 12'-16' of barren marlstone in both basins. The Mahogany zone in the two basins compares favorably, having a thickness ranging from 130' to 190' in the Piceance basin, and a total thickness of 106' in TOSCO Utah State 1. The "B" Groove showed the most distinct differences. In the Piceance basin the "B" Groove is a barren marlstone, 16' to 26' in thickness. In TOSCO Utah State 1, the "B" Groove is 82' thick and consists of barren marlstone, siltstone, dolomite and a few thin beds of sandstone.

The following lithologic markers and zones were identified in TOSCO Utah State 1 core hole on the basis of sample observation:

MARKER OR ZONE	SAMPLE	
	DEPTH	DATUM (MSL)
Bedrock	10.0	+4912.0
Top Parachute Creek	1510.0	+3412.0
Top of core	1570.0	+3352.0
Top Mineralized zone	1591.0	+3331.0
Base Mineralized zone	1965.0	+2957.0
Top "A" Groove	2261.0	+2661.0
Top Mahogany zone	2274.0	+2648.0
Mahogany marker	lost	---
Minus 4-foot key bed	2303.0	+2619.0
Top "B" Groove	2380.8	+2541.2
Base "B" Groove	2463.0	+2459.0
Base Parachute Creek	2565.0	+2357.0
TD	2600.0	+2322.0

The loss of the Mahogany marker resulted from having to drill through metal lost in the hole between 2296.8' and 2298.6'.

Core Recovery

Overall core recovery was excellent (see Table I), amounting to 99.9 percent. Intervals drilled to clear junk from the hole were not included in the computation of recovery and RQD.

Rock Quality

RQD-1 is based on runs obtained with a 60-foot core barrel and gives an averaged picture of predominantly excellent rock from 1570' to 2300' with generally good quality rock below.

RQD-2 was calculated for 10-foot core lengths and provides a more refined definition of the variations in rock quality throughout the entire cored interval. This calculation method gives a probable false result for those intervals at the end of a long core run. In this case, a short loss of core for mechanical reasons is lumped into one interval rather than averaged over the entire core run. This occurred at the end of core 16. The two intervals affected at this point, 2540'-2550' and 2550'-2560' were adjusted to 9' and 9.5' respectively.

The RQD-2 histogram shows generally excellent rock with a few good and fair sections down to 2320'. Fair and good intervals become increasingly prevalent in the lower part of the hole.

The variations in RQD in this core are the result almost entirely of variations in the abundance of partings. Relatively few fractures or joints were observed and the rock itself is mostly hard and unweathered.

Generally, the RQD of TOSCO Utah State 1 was of slightly better quality than those of the Shell- Utah State core holes

TABLE I. CORE RECORD -- TOSCO UTAH STATE 1

RUN	FROM	TO	CUT	RECOVERED	% RECOVERED
1	1570.0	1630.0	60.0	60.0	100.0
2	1630.0	1690.0	60.0	60.0	100.0
3	1690.0	1750.9	60.9	60.9	100.0
4	1750.9	1810.0	59.1	59.1	100.0
5	1810.0	1870.3	60.3	60.3	100.0
6	1870.3	1930.3	60.0	60.0	100.0
7	1930.3	1990.3	60.0	60.0	100.0
8	1990.3	2050.7	60.4	60.4	100.0
9	2055.0	2112.7	57.7	57.7	100.0
10	2112.7	2172.7	60.0	60.0	100.0
11	2175.6	2236.0	60.4	60.4	100.0
12	2236.0	2296.6	60.6	60.6	100.0
13	2298.6	2358.7	60.1	60.1	100.0
14	2358.7	2418.9	60.2	60.2	100.0
15	2418.9	2479.4	60.5	60.5	100.0
16	2479.4	2540.4	61.0	59.5	97.7
17	2540.4	2600.0	59.6	59.6	100.0
TOTAL			1020.8	1019.4	

OVERALL RECOVERY

99.9%
(99.86%)

(drilled, 1964--logged, 1973). Unnatural breaks in the Shell cores due to post-coring handling and transport, as well as dessication cracking during storage, might explain the discrepancy. In their pristine state the Shell cores could conceivably have been of the same quality as that of the TOSCO Utah State 1.

Cores examined from the Uinta basin presented a higher quality RQD than those cores drilled by TOSCO on the Federal Ca and Cb tracts in the Piceance Basin of Colorado. A major difference was noted in the "B" Groove. The Piceance basin "B" Groove RQD ranges from poor to very poor, while the TOSCO Utah State 1 RQD is excellent except for the first nine feet which is poor. Open fractures and partings with mineralized coatings are more numerous in the Piceance basin cores.

Partings, Joints & Fractures

Natural breaks logged consist of partings, joints and fractures. Partings occur on planes of weakness essentially parallel to the bedding and include breaks that occur along the tuff beds. Joints and fractures cross the bedding at various angles. Nahcolite cavities in the mineralized zone frequently produce natural breaks in the core; however, the overall rock quality should not be affected except possibly in concentrated zones of these cavities.

A new category, number 5 has been added to the fracture classification. Number 5 is a sealed fracture which did not open on coring.

A total of 95 fractures were recorded in coring from 1570' to 2600'. Eighty-nine of the recorded fractures have angles greater than 80°, while only six had angles less than 80°. Of the 95 fractures, 17 had lengths greater than one foot, and only four had lengths greater than three feet. Sixty-five of the fractures were of the number 5 category, 22 classified number 4, and eight in the other three categories.

Partings were logged at intervals varying from less than one inch to a maximum of 15.95' at 2242.1'-2258.05'.

As in the Shell cores logged previously, some distinct differences were observed between the section cored here and that found in the Piceance basin. The Parachute Creek Member above the Mahogany zone here is about 750 feet thick as compared to a maximum of about 400 feet in the Piceance basin. Direct correlations are probably not possible, but it may be that the upper part of the interval represents a later phase of lacustrine deposition that took place in the Uinta basin while the sandier beds of the Evacuation Creek Member were being deposited in the Piceance basin. The section between 1591 and 1965 feet in this upper Parachute Creek interval is characterized by relatively large amounts of nahocolite and other carbonate minerals that occur in vugs and cavities, are possibly bedded in some parts, and variously fill fractures and veins or are disseminated through the rock in pinpoint crystals. This "mineralized" zone has been observed in other cores from the immediate area but is not known elsewhere.

The Mahogany zone here is either much thinner than in the Piceance basin or the lower part was deposited in a radically different environment. The low-grade to barren "B" groove is much thicker in this area, and is composed of quite different

lithologies including sandstones, siltstones and some aphanitic to finely crystalline dolomite. It is possible that only the basal 14 feet (2440-54) constitutes "B" groove, and that the overlying 64 feet reflect a facies change in the lower part of the Mahogany zone. If this is the case, then the over-all Mahogany zone is comparable in thickness to that of the Piceance basin (± 180 feet).

The base of the Parachute Creek Member is only 184 feet below the top of the "B" groove. It is picked on the first major siltstone unit below the marlstones and oil shales in the lower part of the Parachute Creek. The rock is not comparable to the Garden Gulch of the Piceance basin.

There are several similarities to the rocks of the Piceance basin also observed in the cores here. "A" groove is present, but is not as well defined in this core hole as in the Shell core holes to the south. The Mahogany marker was lost in drilling up junk in the hole. However, it is known to be present in the area, and other markers and beds of the upper Mahogany zone are recognizable and present.

Rock Quality

Core recovery of almost 100 per cent from mostly full-barrel-length runs suggests good quality rock. RQD-1, based on run-length, was entirely good and excellent. RQD-2 was calculated for standard 10 foot intervals to better define the observed local variations in rock quality. Of 1030 feet cored and drilled 75 per cent was excellent, 15 per cent was good, and 10 per cent was fair quality. No rock was logged as poor or very poor quality. In general, the zones of reduced quality are the result of increased frequency of partings and frequently occur in marly or lower grade oil shale streaks.

In general reduction of RQD due to parting frequency will have relatively little effect on mine stability. However, if present in the roof stone section, such an interval could cause problems, and if accompanied by major joints or fractures in the rib zones, could cause some increased spalling.

Mining Zone

No specific mining section has been selected. However,

it will probably consist of some sequence of beds within the Mahogany zone. The rock in this interval is of lower over-all quality, having 54 per cent excellent, 27 per cent good, and 18 per cent fair quality. Most of the lower quality rock is in the lower-grade, bottom part of the zone. As in the rest of the core the variations in quality result mostly from increased numbers of partings, although an increased tendency to jointing is noticeable. Depending on the section chosen, a number of partings are present along which a mine back could be made. Roof stone stability will depend in large part on the thickness of the roof members, and additional consideration must be given to parting frequency in the zone above any selected roof parting.

Partings, Joints and Fractures

Natural breaks, on which the RQD is based, are classed as partings if they occur on planes of weakness parallel to the bedding or as joints or fractures if they cross the bedding at any angle. The angle of dip of bedding and inclination of joints are measured from a plane normal to the core axis. Periodic measurement of hole deviation

indicated that the hole was within one degree of vertical throughout the cored interval.

Partings occur at intervals varying from less than one inch to several feet throughout the core. The predominant spacing observed would be classed as wide to very wide.

A total of 95 joints and fractures were logged of which 88 were vertical or nearly so and seven were inclined at 55 to 60 degrees. A large number of the joints observed were either tightly sealed or were not broken in coring. A new category of fracture nature was introduced in logging this hole to cover these features. A class 5 joint is one that was obviously a natural break in the rock continuity, but which withstood the stresses of coring. These may or may not be mineralized. Mineral coatings were rarely present. However, asphaltic residues were common on both open partings and open joints and fractures.

Bedding was predominantly horizontal, although a few intervals had dips of 10 to 30 degrees. These zones were

mostly short and probably reflect irregular slumping around nahcolite cavities.

HYDROLOGY

Equipment was acquired and installed to monitor water encountered during drilling of this core hole. The results of the program are inconclusive because practically no water was found. A small volume influx was observed at about 1070 feet. The maximum flow was 32.3 gallons per minute (gpm) measured after a few hours when the flow had stabilized. The volume decline irregularly throughout the remainder of the drilling to about 13 gpm. The temperature of the produced water remained relatively constant between 53°F and 60°F although maximum recorded hole temperature was about 108°F at total depth. The water is relatively saline, measuring above the 8000 micromoh limit of the conductivity meter. Rocky Flats research center reports 18-24,000 ppm total dissolved solids.

One attempted jet-pump test failed because draw-down was substantial and recovery so slow that fluid levels

could not be measured during the recovery phase of the test. No further tests were run because no new water influx was observed. A Drill Stem Test was made across the Mahogany zone potential mining section and no formation water was found. A copy of the test report is included with this report.

This hole is essentially dry, however, this is considered anomalous in view of the large volumes reported from several previous holes in the area.

COMBUSTIBLE GAS

A gas detection unit was supplied by Sentry Engineering to monitor any gas flows, and a copy of the gas log is included with this report.

No flammable gas was observed above 1740 feet depth; 230 feet below the top of the Parachute Creek Member. A very slight bleeding of gas from pinpoint vugs was observed to continue for several hours from the cores around that depth, and also from the core around deeper gas shows. Additional

flows were recorded at 1855, 2010 - 2040, 2070 - 2120, and more or less continuously from 2300 to total depth. A strong gas flow was observed while drilling at 2318', and others occurred below that depth. The flow lasted about five minutes and died. Drill Stem Test #1 of the interval from 2303' to 2358' included the zone where this gas flow occurred. A weak blow, estimated at less than 3000 cubic feet per day, continued throughout the open phase of the test. No gas reached the surface, however, and only 1500 feet was recovered in the pipe. Extrapolated formation pressure is about 1200 psi.

The available data suggests that the gas occurs in low-permeability, low-volume, moderate-to-high-pressure zones that may be relatively extensive. These zones will probably bleed gas over relatively long periods of time from mine ribs and pillars.

A considerable amount of high pour-point crude oil is present throughout the cores, especially in the slightly porous tuffs and nahcoelite cavities. This material

bleeds from the core forming a black asphaltic coating.

It is expected that this material may give some erroneous values to the Fischer assays.