Core Tests

Simpson Area, Alaska

EXPLORATION OF NAVAL PETROLEUM RESERVE NO. 4 AND ADJACENT AREAS, NORTHERN ALASKA, 1944–53

PART 5, SUBSURFACE GEOLOGY AND ENGINEERING DATA

GEOLOGICAL SURVEY PROFESSIONAL PAPER 305-L

Prepared and published at the request of and in cooperation with the U.S. Department of the Navy, Office of Naval Petroleum and Oil Shale Reserves

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By FLORENCE M. ROBINSON

With a section on Temperature Measurement Studies
By MAX C. BREWER

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CORE TESTS, SIMPSON AREA, ALASKA

By FLORENCE M. ROBINSON

ABSTRACT

The Simpson oil seeps were a major factor in leading to the establishment and exploration of Naval Petroleum Reserve No. 4 in northern Alaska. During the years 1945 to 1951 a total of 33 holes ranging in depth from 115 to 2,505 feet were drilled by the U.S. Navy and by Arctic Contractors under contract to the Navy on the Simpson peninsula in an attempt to obtain structural and stratigraphic information and to determine the origin of the oil. In the course of exploration, Simpson oil field was discovered and a few holes were drilled to delimit its extent.

The Seabee, Seabee and Ninuluk undifferentiated, and Grandstand Formations of Early and Late Cretaceous age, consisting of clay shale and alternate clay shale and sandstone, were penetrated.

The oil was found in several places at shallow depths trapped in very porous sandstone beneath an erosional unconformity of considerable relief. Two flowing wells were completed and oil was bailed from several other holes. Initial production from the discovery well, Simpson core test 26, was 110 barrels per day through a 2½-inch line from perforations between 289 and 325 feet. The oil is 20° gravity API, has a paraffin base and a high pour point, and is difficult to handle in cold weather. Some trouble was experienced because of permafrost.

INTRODUCTION

Oil seeps found on the Arctic coast of Alaska were a major factor leading to the establishment and exploration of Naval Petroleum Reserve No. 4 in northern Alaska (fig. 52). Of the various seeps reported, the four Simpson seeps are the largest and are located within an area about 10 miles long and a few miles wide near Cape Simpson, 50 miles southeast of Point Barrow (fig. 53). These seeps have been known to white men since the late 1800's, and in the early 1920's were the locale of some land speculation. They were set aside from public development in 1923, by executive order, as a part of Naval Petroleum Reserve No. 4. During the exploration program from 1944 to 1953, conducted by the Navy and its contractors, 12 shallow holes (1–12) were drilled on the west side of the peninsula and 21 (13–31 plus 14A, 30A, and Minga velocity test 1) on the east side. These core tests ranged in depth from 115 to 2,505 feet.

In the summer of 1945 core holes 1 through 12 (fig. 54) were drilled 10 miles west of Cape Simpson, by Navy Construction Battalion Detachment No. 1058 to obtain subsurface information on structure, lithology, and age and to check results gained from other exploration methods. Seismic and gravity parties were working in the Simpson area concurrently.

The first six core holes were drilled within a radius of less than 1 mile from Camp Simpson, which had been established previously. Unfamiliarity with the frozen ground of the region resulted in mechanical difficulties and the loss of drill pipe in the first two attempts to obtain a deep hole so core tests 1, 2, and 3 resulted from skidding the drilling rig three times.

Core test 4 was located east-northeastward of 2 and 3 as one of two additional holes located at the apices of a triangle to determine the local dip of the beds. Core test 5 was to complete the triangle. No reliable correlation was obtained, but there was a suggestion of southeasterly dip. Therefore test 6 was located west of the camp to see if such dip could be picked up in the near-surface beds between 4 and 6. Core tests 7 through 10, drilled for further information, penetrated much the same section of alternate soft sandstone and clay shale of Cretaceous age. Test 11, however, the northernmost of the holes, revealed a predominantly clay shale column. The presence of slickensides and steep dips suggested faulting, so at the end of the season, test 12 was hurriedly drilled at an intermediate position between 10 and 11. Clay shale was penetrated. Much later the anomaly was explained as an unconformity. Difficulty with icing was found in almost all the tests.

Core holes 6, 8, 9, and 10 had shows of oil, and an oil trap was indicated. On the basis of the information from the core tests and to a larger extent on seismic evidence, Simpson test well 1 was drilled in 1947 and 1948 (Robinson, 1959b).

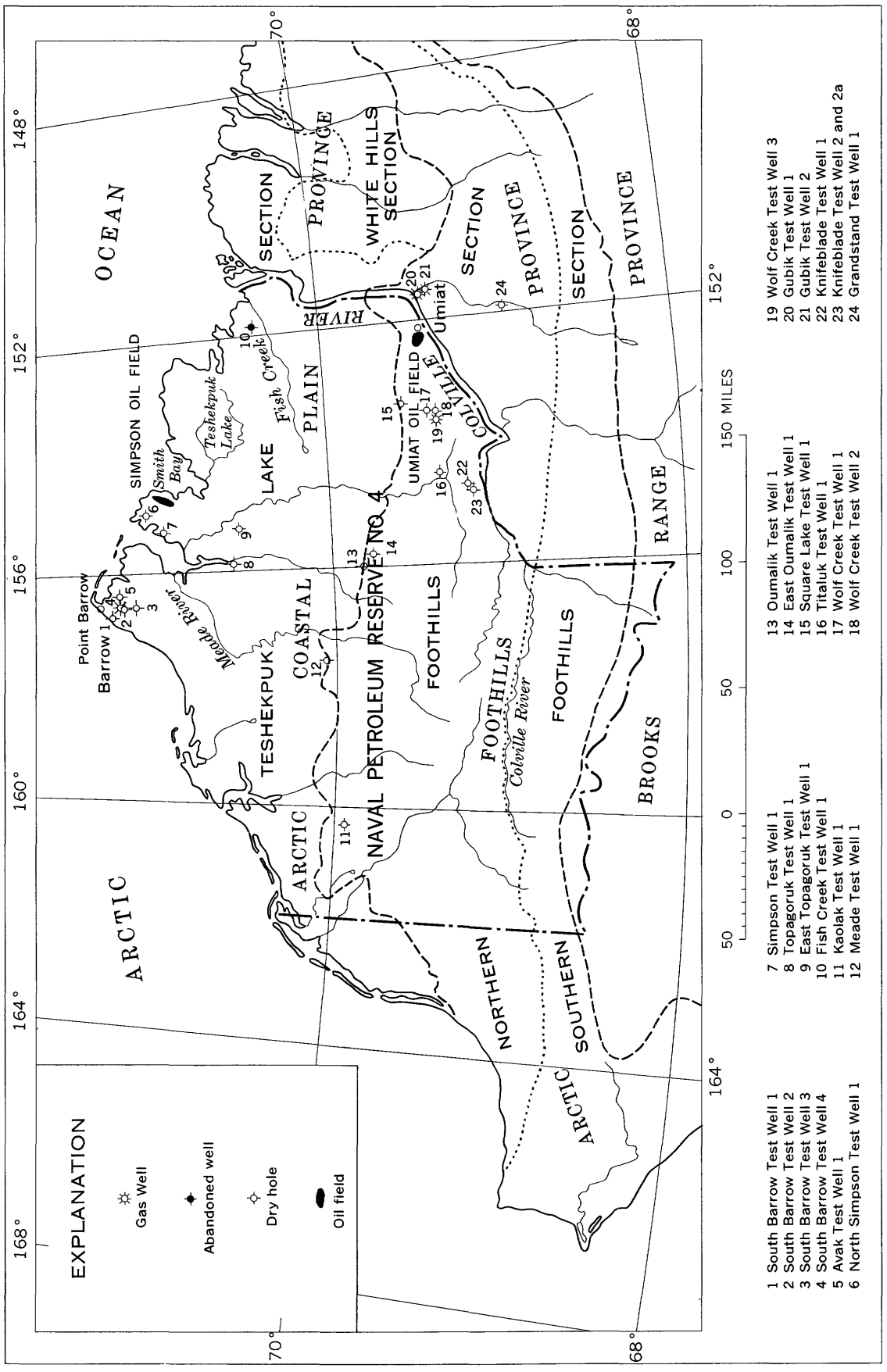

FIGURE 52.—Index map of Naval Petroleum Reserve No. 4 showing location of test wells and oil fields.

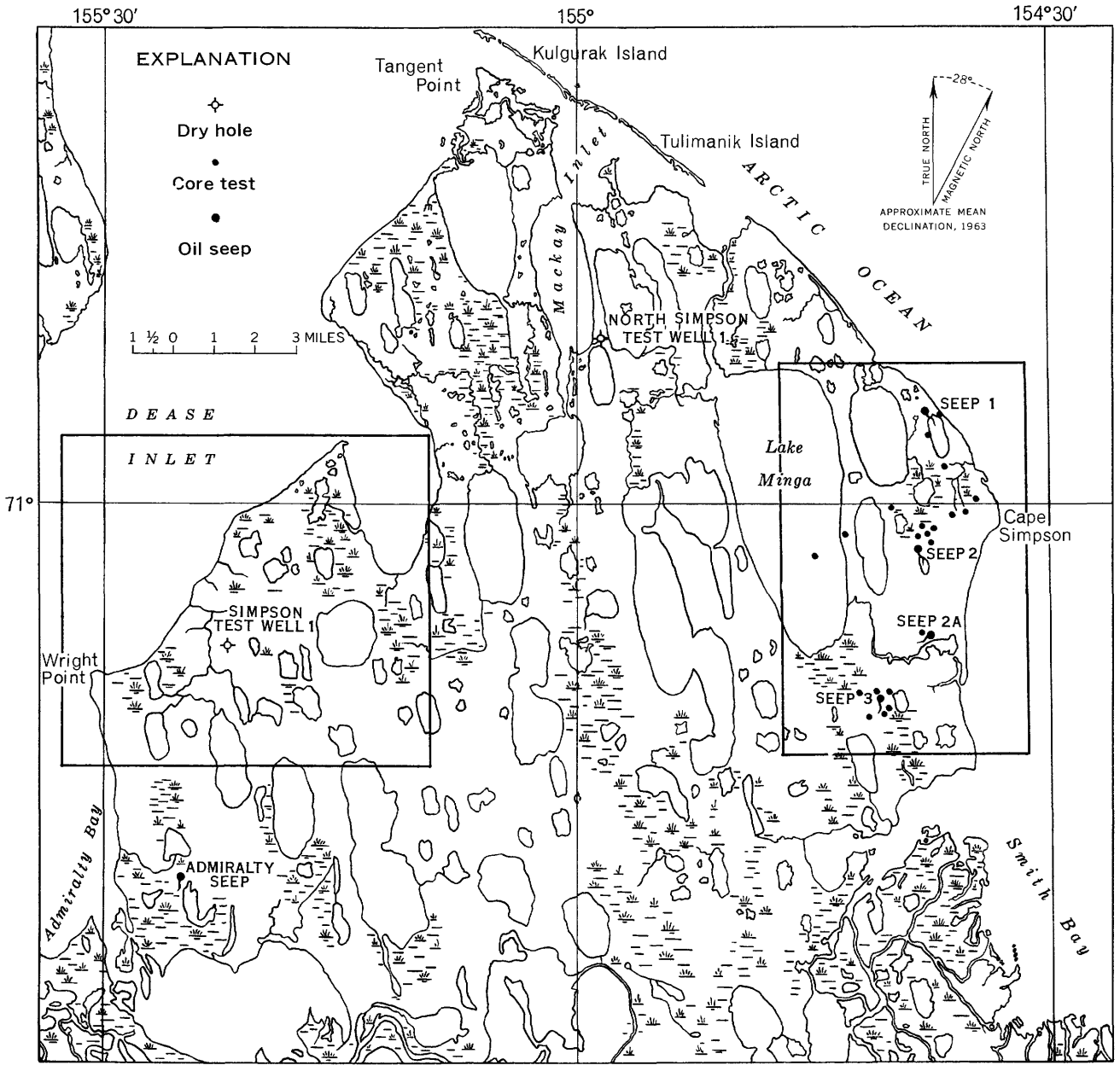

FIGURE 53.—Map showing the Cape Simpson area. The insets represent figures 54 and 55, which show the location of the Simpson core tests.

In 1949 Arctic Contractors (who drilled the rest of the core tests) began an expanded drilling program for the Navy on the east side of the peninsula near Cape Simpson to determine the origin of the big oil seeps. This area eventually became the location of the greatest concentration of subsurface studies in Naval Petroleum Reserve No. 4.

Test 13, drilled near seep 2 (fig. 55), was completely cored except for the last 200 feet and penetrated a section of Cretaceous clay shale to 661 feet and one of alternate Cretaceous clay shale and sandstones to a total depth of 1,438 feet. Core tests 14, 15, and 16, which were also drilled near seep 2 and penetrated alternate sandstone and clay shale, correlated with each other and with the section below 661 feet in test 13. When Simpson core test 14 was junked with a fish in the hole, the rig was skidded 70 feet west and 14A was drilled to check on a paleontologic marker near the upper part of the section.

Simpson core test 17, which is north of but also close to seep 2 and the preceding tests, was similar to test 13 in penetrating a thick upper clay shale section but with proportionately little sandstone. Tests 18 and 19—step-out holes farther to the west—reached no sandstone at all. Test 20 to the northeast also penetrated almost all clay shale where sandstone might have been

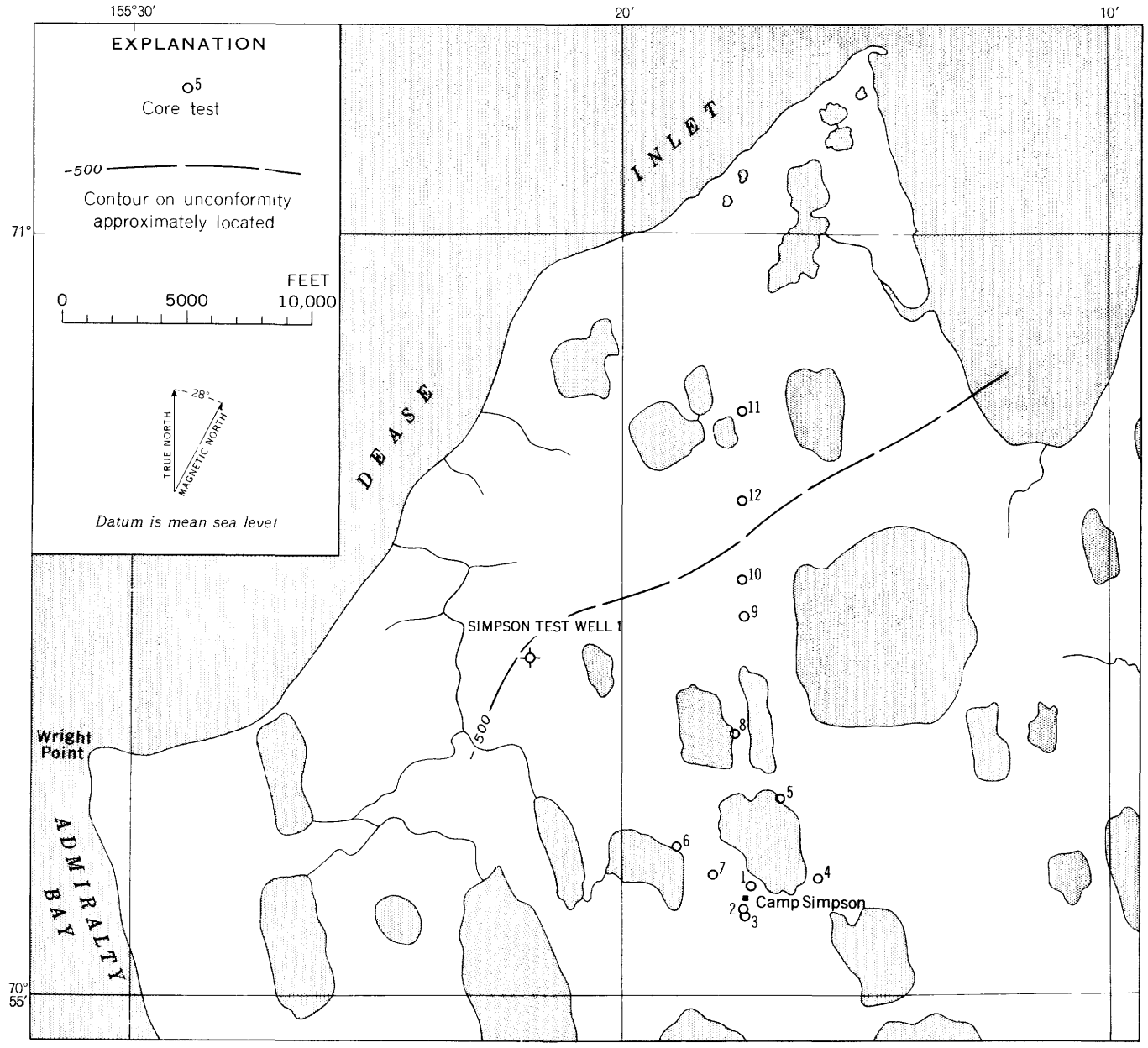

FIGURE 54.—Location of Simpson core tests 1–12. The country is flat, marshy, and only a few feet above sea level.

expected. Moving farther away from seep 2, the contractors drilled hole 21 and reached sandstone at about 1,270 feet. Tests 13 through 17 had shows of oil, the best being in 14 and 15. Core test 16 produced some gas.

While the results of drilling in the vicinity of seep 2 were being studied, two tests, 23 and 24, were drilled near seep 1, the northernmost seep. Both tests penetrated approximately 580 feet of clay shale and went into a sandy section below, but test 23 had no shows and test 24 only a very poor one. Operations were suspended for the winter with the completion of Simpson core test 24.

In the spring of 1950 a rig was moved out onto the ice of Lake Minga (fig. 56), and a test hole was drilled to enable a seismograph crew to run a velocity test (see p. 724) and to determine whether the ground under the lake was frozen. (It was not.) This test penetrated 740 feet of the clay shale section and went into alternate sandstone and shale below.

Drilling near seep 3, the southernmost seep, started in July with Simpson core test 25. After drilling through 20 feet of breccia, Simpson 25 penetrated the sandy section at 832 feet. Core tests 26 and 27 were very similar to core tests 14–16 with a long sandstone-shale section topping at 200 feet and like those core

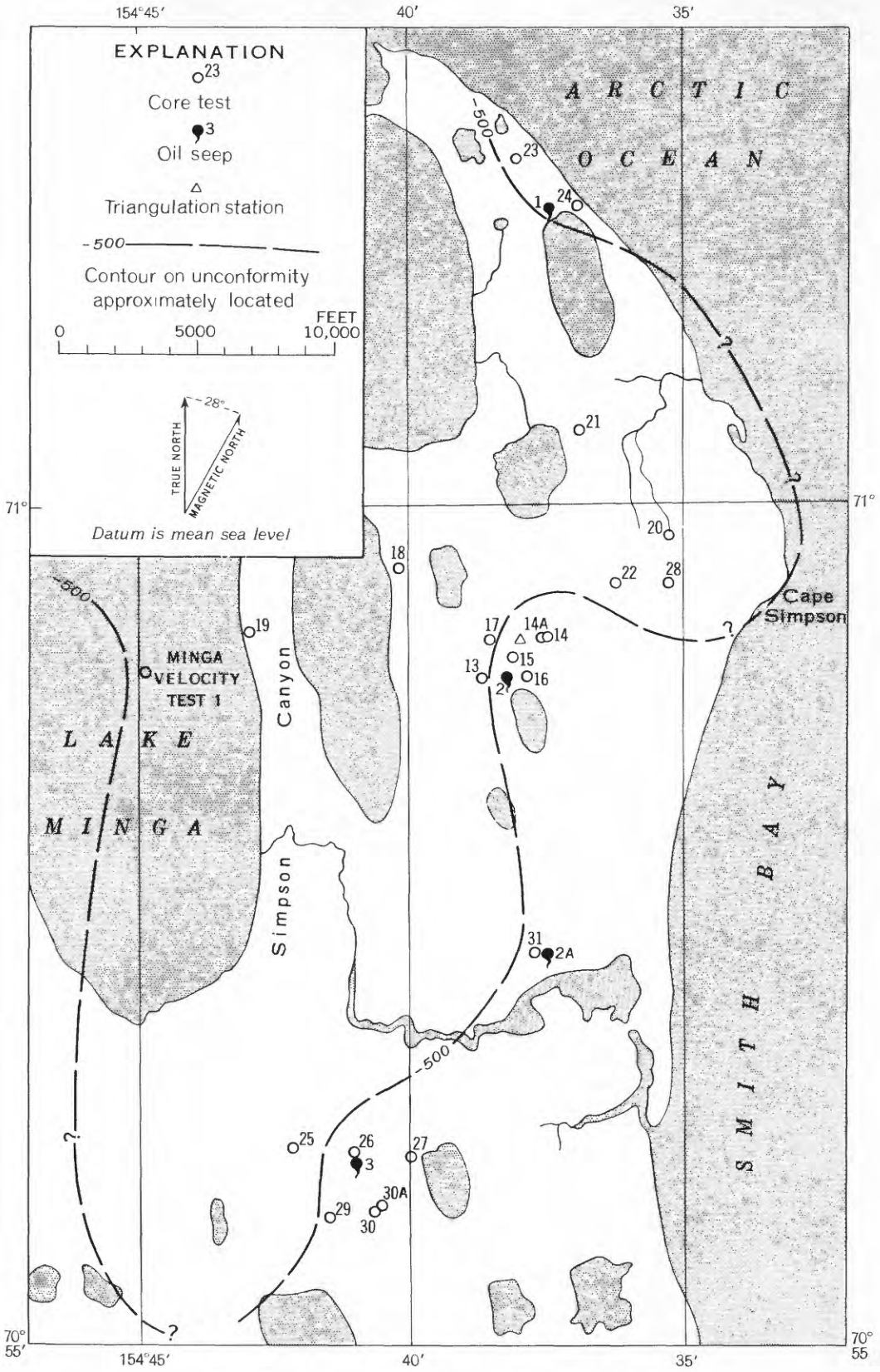

FIGURE 55.—Location of Simpson core tests 13-31 and Minga velocity test 1.

FIGURE 56.—Minga velocity test 1 and camp.

tests had good shows of oil. Simpson core test 26 was completed in October 1950 and was the discovery well of the Simpson oil field, flowing at the initial rate of 110 barrels of oil and a small amount of gas per day through a 2½-inch line from perforations between 289 and 325 feet. The gravity was 20° API, the oil temperature 21°F, and the casing pressure 47 psi (pounds per square inch). Oil was bailed from core test 27 at the rate of 3 barrels per day, but the hole was abandoned.

Simpson 28 (see below) was drilled in October 1950 at the same time as Simpson 26. Drilling continued through the winter and into 1951. Simpson core tests 29 and 30 were put down to determine the limit of productive area and to gain more information on structure. Test 29 went through a breccia to the sandstone section at about 450 feet and was dry. Test 30 reached the sandstone at 200 feet and was bailed at the rate of 6 barrels of oil a day containing a very small amount of gas. Test 30 was abandoned on a fishing job before running an electric log, so the rig was skidded 100 feet southwest and 30A was drilled. The strata were virtually the same in both holes and 5 barrels of oil was bailed per day from 30A. There was also a slight show of gas in 30A.

Core test 31 was drilled near a small seep (2A) between seeps 2 and 3. At 355 feet oil started to flow at an estimated rate of 120–125 barrels with 2,000–4,000 cu ft of gas per day. The hole froze, however, before a definitive production test was made.

With the exception of core test 28, all the holes were drilled with a Failing rotary rig. In order to check a possible fault between core tests 14 and 22 and in an attempt to penetrate the sandy section, core test 28 was drilled with a Cardwell rotary rig to a total depth of 2,505 feet. The test reached the sandy beds at 1,020 feet and had not completely penetrated them at total depth. There were no shows and faulting was not clearly demonstrated.

Some statistics on the core tests are listed in table 1.

STRUCTURE

The gravity surveys made by the Navy and the reflection seismograph profiles made by United Geophysical Co. covered the entire peninsula, but emphasis was originally not directed toward an interpretation of the shallow beds. The results of drilling, plus an evaluation of the uppermost part of the seismic profiles indicated that the Simpson seeps field is a stratigraphic trap or a series of traps formed by an erosional inconformity within the Seabee Formation of the Colville Group (Upper Cretaceous). The oil occurs in the first sandstone, either in the basal part of the Seabee and Ninuluk Formations undifferentiated (Upper Cretaceous) or in the Grandstand Formation of the Nanushuk Group (Lower Cretaceous), appearing beneath the unconformity. The highly porous sandstone regionally dips very gently east and is truncated by a deep canyon on a north-south line just west of the seeps. The oil is trapped on topographic highs on a ridge above the east wall of the canyon under the shaly Seabee Formation. The oil, found only about 300 feet below the surface, is seeping up, probably through cracks or fissures in the frozen ground.

Figure 55 shows the −500-foot contour drawn on the unconformity, based on seismic and subsurface data. There is a total of more than 1,000 feet of relief. In 1949, T. G. Payne, of the U.S. Geological Survey, suggested that the canyon to the west of the seeps is similar in origin to present-day submarine canyons (Payne, oral communication). The slickensides, breccia, and other features formerly considered as indication of faulting are probably the result of slumping on the canyon walls, although a few small normal faults may be present. Steep dips, where not involved with slump blocks, probably represent initial dip on the surface of the unconformity.

A similar stratigraphic trap exists on the west side of the peninsula near Simpson test well 1 and the first 12 core tests, although there is also some evidence of a shallow anticlinal structure in this area. Figure 54 shows the −500-foot contour on the unconformity, which was detected in North Simpson test well 1, located about 9 miles northwest of Simpson seep. The seismic profile (Robinson, 1959b, pl. 37) clearly shows its relief.

Permafrost made drilling difficult in many of the core tests, particularly the first twelve. Except under large lakes and probably under the ocean, the permafrost in the Simpson area extends to a depth of 800–900 feet (Brewer, 1958). Therefore the Simpson oil field producing horizons are wholly within the permanently frozen zone.

TABLE 1.—*Statistics on the Simpson core tests and Minga velocity test 1*

[Latitude and longitude have been adjusted to the 1:250,000 Alaska Reconnaissance Topographic Series, Teshekpuk and Barrow quadrangles, but are subject to correction. Elevations are approximate. Many elevations given for kelly bushings may have been of the derrick floor. This distinction was not made in some of the records available to the author]

Core test	Latitude (north)	Longitude (west)	Elevation (feet)		Spudded	Completed	Total depth (feet)	Status
			Ground	Kelly bushing				
1	70°55′42″	155°17′22″	21	27	June 25, 1945	June 29, 1945	116	Dry and abandoned.
2	70°55′39″	155°17′30″	21	29	June 30, 1945	July 2, 1945	226	Junked and abandoned.
3	70°55′38.5″	155°17′30″	?	29	July 3, 1945	July 7, 1945	368	Do.
4	70°55′46″	155°15′52″	12	14	July 8, 1945	July 10, 1945	151	Dry and abandoned.
5	70°56′17″	155°16′45″	11	17	July 11, 1945	July 12, 1945	130	Do.
6	70°55′58″	155°18′33″	20	26	July 12, 1945	July 13, 1945	149	Do.
7	70°55′49″	155°18′09″	14	26	July 15, 1945	July 25, 1945	532	Do.
8	70°56′43″	155°17′38″	14	16	July 27, 1945	Aug. 3, 1945	580	Do.
9	70°57′27″	155°17′31″	8	11	Aug. 5, 1945	Aug. 7, 1945	320	Do.
10	70°57′43″	155°17′32″	7	11	Aug. 8, 1945	Aug. 15, 1945	500	Do.
11	70°58′49″	155°17′32″	1	3	Aug. 17, 1945	Aug. 26, 1945	580	Do.
12	70°58′19″	155°17′30″	1	6	Aug. 27, 1945	Aug. 29, 1945	460	Do.
13	70°58′58″	154°38′43″	27	33	June 9, 1945	July 20, 1945	1,438	Do.
14	70°59′12″	154°37′36″	29	34	July 21, 1949	Aug. 12, 1949	1,270	Junked and abandoned.
14A	70°59′12″	154°37′38″	27	3[illegible]	Aug. 13, 1949	Aug. 15, 1949	290	Do.
15	70°59′06″	154°38′09″	25	[illegible]	Aug. 16, 1949	Aug. 23, 1949	900	Do.
16	70°59′00″	154°37′52″	24	28	Aug. 24, 1949	Aug. 31, 1949	800	Abandoned (flowed some gas).
17	70°59′12″	154°38′33″	23	27	Aug. 31, 1949	Sept. 8, 1949	1,100	Dry and abandoned.
18	70°59′38″	154°40′13″	14	18	Sept. 10, 1949	Sept. 21, 1949	1,460	Do.
19	70°59′16″	154°42′57″	15	19	Sept. 23, 1949	Sept. 29, 1949	1,061	Do.
20	70°59′49″	154°35′19″	20	24	Oct. 5, 1949	Oct. 11, 1949	1,001	Do.
21	71°00′29″	154°36′54″	22	26	Oct. 13, 1949	Oct. 27, 1949	1,502	Do.
22	70°59′32″	154°36′15″	20	27	Oct. 29, 1949	Nov. 5, 1949	903	Do.
23	71°02′04″	154°38′02″	15	18	Nov. 8, 1949	Nov. 16, 1949	1,035	Do.
24	71°01′46″	154°37′01″	8	11	Nov. 22, 1949	Nov. 28, 1949	901	Do.
25	70°56′10″	154°42′12″	17	20	July 3, 1950	Aug. 12, 1950	1,510	Do.
26	70°56′08″	154°41′04″	20	23	Aug. 13, 1950	Oct. 23, 1950	1,171	Perforated 289–325 ft with 144 shots. Initial production 110 barrels of oil per day, no water. Casing pressure 47 pounds per square inch shut in.
27	70°56′07″	154°40′04″	24	29	Feb. 8, 1951	Mar. 14, 1951	1,500	Abandoned (bailed oil).
28	70°59′33″	154°40′16″	20	37	Sept. 5, 1950	Sept. 24, 1950	2,505	Dry and abandoned.
29	70°55′47″	154°41′31″	20	25	Oct. 31, 1950	Nov. 26, 1950	700	Dry and abandoned (bailed oil).
30	70°55′51″	154°40′35″	20	25	Nov. 30, 1950	Jan. 23, 1951	693	Junked and abandoned.
31A	70°55′49″	154°40′51″	20	25	Jan. 23, 1951	Feb. 5, 1951	701	Abandoned (bailed oil).
31	70°57′20″	154°37′44″	14	19	Mar. 20, 1951	Apr. 2, 1951	355	Initial production estimated 120 barrels per day, 2,000–4,000 cubic feet of gas, shut in.
Minga	70°59′00″	154°44′36″	0	5	Apr. 29, 1950	May 9, 1950	1,233	Dry and abandoned.

The oil discovered is a 20° API gravity parafin-base oil but has a high pour point and is not easily handled in cold weather. No estimates of reserves were made, as too little is known of the extent of the reservoirs, although closure seems to be measured in tens of feet and is of very local extent.

ACKNOWLEDGMENTS

The information presented in this report was derived from records of Arctic Contractors, the U.S. Navy, and the U.S. Geological Survey. These records include the geological and engineering reports of Construction Battalion Detachment No. 1058; the daily, weekly, and completion reports of Arctic Contractors; the geophysical reports of United Geophysical Co. and of the U.S. Geological Survey; and descriptions of cores and cuttings and analyses made by the Navy Oil Unit, Branch of Alaskan Geology of the U.S. Geological Survey, which maintained a laboratory in Fairbanks, Alaska for this purpose. Unless otherwise indicated, the samples were described by the author.

A few electric logs were run by Schlumberger Well Surveying Corp. but most were run with a Well Instrument Developing Company logger. A gas analysis was made by the National Bureau of Standards and the oil analyses by the U.S. Bureau of Mines.

The pelecypods and ammonites were identified by George Gryc, of the U.S. Geological Survey, and fish and fish scales by D.H. Dunkle of the National Museum; the microfossils were studied by H. R. Bergquist and

Helen Tappan Loeblich of the U.S. Geological Survey.

The heavy minerals were identified and zoned by R. H. Morris of the U.S. Geological Survey as a part of a study made of the whole reserve. S. T. Yuster, U.S. Geological Survey, made some core analyses of Simpson core tests 13, 14, and 16. T. G. Payne contributed much toward an interpretation of the structure in the Simpson area as a part of his regional studies of the reserve.

STRATIGRAPHY

The strata penetrated by the shallow core holes in the Simpson area consist of the Gubik Formation, the Seabee Formation, the Seabee and Ninuluk Formations, undifferentiated, and the Grandstand Formation. The thicknesses of these formations vary considerably because of the presence of at least one unconformity of considerable relief. Table 2 is a summary of the formation tops as found in the Simpson core tests and in Minga velocity test 1 as interpreted by the author. Refined paleontologic identifications might lead to some alterations, particularly to a division between the Seabee and Ninuluk Formations.

QUATERNARY DEPOSITS

GUBIK FORMATION

The Gubik Formation of Pleistocene age mantles the area. It ranges in thickness from 8 feet (Simpson test well 1) to 110 feet, but in most of the tests is 80–85 feet thick. The formation is made up of interbedded clay, silt, sand, and gravel; the color of the beds is olive gray or gray with a yellowish cast. The upper 50 feet of the formation commonly is soft clay, which has scattered thin beds of silt and sand. Rare limonitic and carbonaceous streaks are present. The formation grades to argillaceous sand and gravel near the base. The sand grains range in size from very fine to very coarse and a large proportion of them are well rounded. The larger the grain, the more apt it is to be rounded. The sand grains consist of clear, yellow, and white quartz plus a smaller amount of varicolored (green, red, and other) chert. Granules and pebbles of black, dark-gray, and yellow chert, quartz, limestone, and quartzite make up the gravel. In some places these pebbles are imbedded in clay or sand. White fragments of pelecypods and gastropods and calcareous Foraminifera and ostracodes are relatively common in the clay and silt beds.

TABLE 2.—*Formation tops and position of unconformity within the Seabee Formation in the Simpson core tests and in Minga velocity test 1*

Core tests	Formations (depth in feet)				
	Gubik Formation	Seabee Formation	Unconformity	Ninuluk and Seabee Formations undifferentiated [1]	Grandstand Formation (total depth)
1	6–83?				83?–116
2	8–77?				77?–226
3					80?–368
4	2–81				81–151
5	6–50?				50?–130
6	6–79				79–149
7	12–72				72?–532
8	2–65				65–580
9	3–83				83–320
10	4–63				63–500
11	2–80	[2,3] 80–580			
12	5–67?	[2,3] 67?–460			
13	20–87	87–661	661		661–1, 438
14 and 14A	25–85	85–250	250	250–550	550–1, 270
15	35–75	75–235?	235?	235?–555	555–900
16	4–80	80–250?	250?	250?–550	550–800
17	20–80?	80?–568	568	568–710	710–1, 100
18	10–90?	[3] 90?–1, 460			
19	20–80	[3] 80–1, 061			
20	4–85	[3] 85–1, 001?	(Possibly 980)		
21	10–85	85–1, 265	1, 320		1, 265–1, 502
22	7–85	[3] 85–903			
23	3–110	110–575	575		575–1, 035
24	3–85	85–580	580		580–900
25	10–110	110–832	832		832–1, 510
26	3–87		(Possibly 87)	87–420	420–1, 171
27	No samples	102–146	146	146–450	450–1, 500
28	No samples	120–1, 020	1, 020		1, 020–2, 505
29	?–85	85–490	490		490–700
30 and 30A	5–85	85–143	143	143–445	445–693
31	5–110?	110?–186	186	[3] 186–355	
Minga velocity test 1	5–85	85–610	610	610–740	740–1, 233

[1] Not readily identified in core tests 1–12, if present included in the Grandstand Formation.
[2] Or possibly Schrader Bluff Formation.
[3] Total depth.

Surficial material consisting primarily of the Gubik Formation was used for mud in drilling all the Simpson core tests, so contamination from this formation, particularly of the rounded sand grains and often of the microfossils, is present in most of the holes.

CRETACEOUS ROCKS

COLVILLE GROUP

SEABEE FORMATION

The youngest Cretaceous rocks in this area belong to the marine Seabee Formation of Late Cretaceous age. This formation is an unvarying sequence of soft light- to medium-light-gray clay shale or shaly clay containing rare thin beds and partings of siltstone. The clay shale has poor to excellent cleavage, also some hackly cleavage. Very rare very fine grained sandstone laminae and hard medium- to medium-dark-gray limestone beds up to about a foot thick are also present. Some of the limestone contains mica and carbonaceous flecks.

As this formation overlies an unconformity of considerable relief which forms a fossil submarine canyon, the basal beds contain some reworked material. This generally consists of sandstone beds that resemble those below except that they contain a large amount of micaceous (biotite, sericite, and chlorite) and argillaceous material. Some bentonite is present throughout the basal strata, ordinarily not in regular beds but finely disseminated.

The base of the formation in Simpson core tests 25 and 29 contains 20–40 or more feet of breccia. In core test 25 the breccia consists of angular fragments up to 2 inches in diameter of medium light-, medium-, and medium-dark-gray clay shale, bluish-gray clay shale, brownish-yellow clay ironstone, small coal chips, and exceedingly scarce small rounded black chert pebbles in a sandy matrix. In core test 29 the breccia has a claystone or sandstone matrix and consists of angular fragments up to an inch in diameter of dark-gray and black coaly material, medium-light-gray clay shale, light-gray bentonitic clay, grayish-yellow clay ironstone, medium-light-gray medium-grained sandstone, and scarce rounded black chert pebbles. These breccia fragments can be readily identified as having come from the immediately subjacent formations.

On the sides of the submarine canyon, large slump blocks of the Seabee and Ninuluk or Grandstand Formations are found. Slickensides and fault gouge are the result of minor faulting and slumping associated with these blocks. Dips up to 25° near the very base of the formation may represent deposition on the walls of the canyon.

The thickness of the Seabee Formation as determined in the core tests is extremely variable, depending on the relief of the unconformity below. More than 1,300 feet of the formation is present in the middle of the canyon (Simpson core test 18).

The age of the formation is probably early Late Cretaceous on the basis of the presence of the ammonite *Borissiakoceras* sp. in two different cores from Simpson core test 18. Should *Borissiakoceras* in northern Alaska prove to range into younger beds, the age of this formation could be younger accordingly. The microfossils present are characteristic of the Colville Group in general and not of the Seabee Formation in particular.

A few shows of oil were found in clastic basal beds of this unit.

NANUSHUK AND COLVILLE GROUPS

NINULUK AND SEABEE FORMATIONS, UNDIFFERENTIATED

At some time within the period of deposition of the Seabee Formation, sedimentation was interupted and erosion, probably under marine conditions, took place. The relief developed was of considerable magnitude in the Simpson seeps area. A canyon more than 1,300 feet deep was formed trending roughly north-south on a line west of the present seeps (fig. 55) near Cape Simpson. With such relief the sedimentary rocks underlying the unconformity vary considerably. In the east wall of this fossil canyon they consist of a series of beds ranging from a bentonitic clay shale at the top to fine-grained sandstone alternating with carbonaceous shale at the base. The bentonitic beds near the top form a very distinct lithologic unit approximately 50 feet thick. It is made up of light- to medium-dark-gray clay shale interbedded with thin beds of bentonite just a few inches thick. The bentonite is light colored—white, light gray, yellowish gray, bluish gray—and contrasts with the dark shale. Paper-thin interbeds of these rocks present a varved appearance through certain parts of the section. The clay shale is soft and breaks easily parallel to the bedding; the bentonite is relatively hard to crumbly when dry but swells tremendously in water. The bentonite may contain brown euhedral plates of biotite. Scarce layers of hard dense gray limestone a few inches thick are also characteristic of the bentonite zone. A very small amount of carbonaceous and coaly material is present as well as thin beds of siltstone and sandstone.

Several species of Late Cretaceous fossils are quite common. Flattened specimens of *Inoceramus labiatus* Schlotheim, an important index fossil in North America of the early Turonian (Jones and Gryc, 1960), and the ammonite *Borissiakoceras* sp. (Cobban and Gryc, 1961) are present. In addition, the darker shales are filled with brown fishbone fragments. Some large scales almost an inch in diameter and even a fish skeleton were found. The scales have been identified

as that of either *Portheus* (*Hypsodon*) or *Ichthyodectus* by D. H. Dunkle of the National Museum. Radiolaria are abundant and a few calcareous Foraminifera are found.

This particular bentonite-*Inoceramus* zone (or a series of such zones stratigraphically close to each other) is distinctive of the Seabee Formation and is one of the best horizon markers in the northeastern part of Naval Petroleum Reserve No. 4. On the surface at Umiat it has been correlated with the "black paper shale zone" by field geologists.

A 20-foot sandstone underlying the bentonite-*Inoceramus* zone is similar to the 40-foot sandstone described lower in the Seabee Formation, but the 20-foot bed is very "dirty" and has abundant biotite and some muscovite, chlorite, glauconite, and pyrite.

In the Simpson area, 100 feet below the bentonite-*Inoceramus labiatus* zone is another section approximately 30 feet thick containing similar bentonite and clay shale. But this section characteristically contains beds of dull black coal or lignite up to 2 feet thick and lacks the fossils (except for a few Radiolaria) in the zone above. Black plant fragments are present instead. This lower bentonite-coal zone seems lithologically more typical of the uppermost part of the Ninuluk Formation. (See the Ninuluk section in Titaluk test well 1, Robinson, 1959a, p. 378.)

Immediately below the second bentonite zone (a good example of this succession is to be seen in Simpson core test 27) is a 40-foot-thick sandstone, which is the major oil-producing horizon in the Simpson field. The sandstone is medium light gray, fine grained, and is made up of 75–85 percent white and clear quartz; the remainder is dark chert, biotite, pyrite, and rock fragments; grains are subangular to subrounded. The sandstone is very soft and friable. Grayish-yellow clay ironstone and black carbonaceous partings are present. Effective porosity of the sandstone was tested as 33 percent and the air permeability as 385 millidarcys. Simpson core test 26 was completed in this zone and it probably is the producing bed in Simpson 31. Core test 26 was completed in the coal-bentonite beds just short of the sandstone, but the oil is probably coming up from the sandstone.

At the base of the Ninuluk and Seabee sequence is a 70-foot section of soft medium-light- to medium-gray clay shale that has poor to fair cleavage. The clay shale contains carbonaceous partings, and dull black brittle coal in beds up to a foot thick are interbedded with it. Carbonaceous plant remains and grayish-yellow clay ironstone concretions are common. One 9-inch layer of very hard light-olive-gray dense limestone that contained minute micaceous and carbonaceous particles was noted. At the base of the sequence some thin beds of very soft sandstone were found.

The upper bentonite-*Inoceramus labiatus* part of this 300-foot section is without a doubt a part of the Seabee Formation. Farther down the section the sandstone becomes cleaner and coal and carbonaceous material appear. Coal in beds as thick as 1 foot have never, to the author's knowledge, been described in the Seabee Formation, but the bentonite-coal combination appears in the Ninuluk Formation in the upper part of Titaluk test well 1. The coal and associated ironstone concretions are also typical of the Nanushuk Group. Sandstone containing a considerable amount of biotite is found elsewhere in the subsurface of Naval Petroleum Reserve No. 4 in the Seabee Formation. Radiolaria ordinarily present in the Colville Group are found in the cutting samples as low as the base of the second bentonite zone, but considering the condition of the samples, they could be contamination from the prolific *Inoceramus labiatus* zone above.

In summary, this 300-foot section has characteristics of both the Seabee and the Ninuluk Formations and the author at this time cannot determine a break. Elsewhere in the Reserve there is evidence for an unconformity between the Nanushuk and Colville Groups. The possible Ninuluk Formation (the beds containing the coal?) in the Simpson area is unusually thin, so the unconformity may be present in this section, too.

A very small part of the Ninuluk and Seabee sequence is probably present in some of core tests 1–10, but samples are poor and no electric logs are available. Determination of the contacts is virtually impossible. All beds not clearly of the Gubik Formation or of the Colville Group have been placed in the Grandstand Formation.

NANUSHUK GROUP

GRANDSTAND FORMATION

The Grandstand Formation of Early Cretaceous age underlies the Ninuluk and Seabee sequence and appears to be conformable with it. Simpson core test 28, the "deep" test, penetrated 1,500 feet of the Grandstand Formation and was still in it at total depth. In this particular test, however, the uppermost 400 feet of the formation has been cut out by the unconformity. (See Structure, page 650.) The composite thickness of the Grandstand Formation drilled in the Cape Simpson area is then about 1,900 feet.

The formation consists of about half sandstone-siltstone and half clay shale. The clay shale is medium light gray to medium gray, is moderately soft, has fairly good cleavage and micaceous-carbonaceous partings, and is somewhat silty in places.

The sandstone is medium light gray, is very fine to medium grained, and is very soft. Often the cores

collapsed into piles of sand upon thawing. This is particularly true of the coarser grained sandstone beds near the top of the formation. The grains are subangular to subrounded and consist of 75 percent or more white and clear quartz; the remainder is dark gray and black chert, coal particles, and rock fragments. In parts of the section, garnet was abundant enough to be especially noticed, and in certain of the beds about 300 feet below the top of the Grandstand there are (in finer grained beds) yellow grains of quartz (or possibly siderite). Locally, in core tests 23 and 24 near seep 1, beds near the top of the formation are very fine to fine grained, contain muscovite (or sericite?), chlorite, and biotite. In the core tests near seeps 2 and 3, apparently correlative beds are unusually "clean" and are fine to medium grained. The larger the grain size, the larger the proportion of dark chert; the quartz and chert combination lends a typically salt-and-pepper appearance to the cores. As is true in the Grandstand Formation elsewhere, the grain size of the sandstone decreases with depth. The siltstone is identical to the sandstone but has a smaller grain size.

Because they were poorly consolidated, the sandstone cores did not lend themselves to testing for porosity and permeability. The one effective porosity test made at 699½ feet in Simpson 13 gave 28 percent, and two tests in Simpson 28 at 1,385 feet and 2,503 feet show 35 and 22.5 percent respectively. The permeability of the latter two plugs measured 700 and 71 millidarcys. The sample from 699½ feet was too soft to test. The porosity and permeability of the poorly consolidated beds must be considerably higher than those tested. Shows of oil were found in this sandstone but apparently it lies too low structurally to produce oil.

Carbonaceous material is not common in this formation. A few plant remains in the clay shale and very rare thin beds of lignite are present in the upper 200 feet. Some yellowish-gray clay ironstone occurs in both the sandstone and clay shale. Hard medium- to medium-dark-gray limestone was found very rarely. Bentonite may be present at one place in the section (1,720 ft in Simpson 28). Pale-green clay occurs at 2,320 feet in the same test.

The formation is marine as indicated by microfossils, sparsely distributed near the top of the formation and more abundantly below the *Verneuilinoides borealis* fauna (Tappan, 1960, p. 283). The highest occurrence of *Ditrupa* sp., a worm tube, is valuable in this area as a horizon marker. *Inoceramus* fragments and prisms are common. Gastropods and other pelecypods are present.

DESCRIPTION OF CORES AND CUTTINGS

Core holes 1–6 were described by Lt. J. S. Templeton and core holes 7–12 by Lt. G. O. Relf of the U.S. Navy at the time the hole was being drilled. The cores were then skeletonized and sent (in 1948?) to the Fairbanks laboratory of the U.S. Geological Survey in cloth sample bags. The samples (small pieces of each core) were later transferred to Washington, D.C., for microfaunal studies, and all were eventually used except for a few samples from Simpson core test 8. The author had the opportunity to examine some of the samples from this core test.

Judging from the original description and the condition of the cores from Simpson 8, the core samples were poor. Some of the cores had the quality of well cuttings; others were in better condition, particularly if the formation drilled was a little harder than average.

The following descriptions of core tests 1–12 are the originals, but sections that the author believes show contamination have been deleted, for the most part. The graphic logs on figures 6–8 were drafted from the edited descriptions.

The cores from Simpson core tests 13–31 and Minga velocity test that were described by the author were in fairly good condition unless otherwise indicated in the description, but the cuttings were very poor. The formations are soft and disintegrate easily in water and were ground up by the drill bit. In addition no shale shaker was used, most of the holes were not cased, many of the mud pits were bulldozed from the tundra, and the surficial material was used in the mud. The author made frequent use of the electric log as a guide in preparing the graphic lithology column. Possibly discrepancies between the graphic log and the written log may be explained by this fact.

Core tests 13–15 were cased and the cuttings were not badly contaminated by the Gubik Formation, but the cuttings from 18–20, 22, 24, and 25 were particularly poor. These holes penetrated soft thick shale sections. In test 26 the samples near the surface were badly contaminated by the Gubik Formation and by rocks below it, which consisted mostly of Cretaceous sand. In this test the flow of oil prevented sampling through some sections. In Simpson 27 the cutting samples below 800 feet were extremely poor. The samples from 28, which was drilled with a Cardwell rig, were of better quality although there are places in which the ditch lithology seemed to have a 10-foot lag compared to the electric log. The graphic log here was plotted to match the electric log, but the written lithology was described at the depth labeled on the sample can. Core tests 26–30, 30A, 31, and Minga 1 were cased.

All material from core tests 13–31 and Minga velocity test 1 was described dry; colors were determined by comparison with the National Research Council "Rock-color Chart" (Goddard and others, 1948). The term "trace" as used here is defined as less than 3 percent

and mostly less than 1 percent. Clay ironstone is a sideritic dense rather hard mudstone that generally effervesces very slowly in cold dilute hydrochloric acid.

The datum from which the depths are measured is the elevation of the top of the rotary drive bushing. However, the records are not clear, and the datum may have been the derrick floor. There is very little difference in elevation between derrick floor and kelly bushing.

The abundance of microfossil specimens listed at the beginning of the core descriptions is defined as follows: 1–4 very rare, 5–11 rare, 12–25 common, 26–50 abundant, and more than 50 very abundant. The process of examining the samples for microfossils in the earlier core tests was not as systematic as the methods developed later, and information on microfossil occurrence on some tests is not complete. The lack of mention of microfossils in cores should be understood to mean either (a) the sequence was not sampled for microfossils, or (b) the results were not available to the author at the time of this writing (1956). It does not necessarily mean that such fossils are absent.

DETAILED LITHOLOGIC DESCRIPTIONS

SIMPSON CORE TEST 1

[Location and other data given on plates 44–46. Where no core is listed, description is based on cutting samples]

Core	Depth (feet)	Description
	0–6	Peat and ice, also includes distance between kelly bushing and ground.
1	6–16	No recovery.
2	16–26	No recovery.
3	26–28	Recovered 6 in.: Clay, dark-blue-gray, locally mottled and streaked with yellowish gray; tough and massive; position doubtful; occurs between 26 ft and 28 ft.
	28–30	Sand, grayish-brown, very fine, silty, mostly angular, and well-sorted.
4	30–35	Recovered 5 ft: Clay, dark-blue-gray, locally mottled and streaked with yellowish gray; contains very small amount of silt and very fine sand; scattered rounded chert pebbles 1/16–1/4 in. in diameter; some carbonaceous streaks; tough and massive.
5	35–40	Recovered 5 ft: Clay, dark-blue-gray, locally mottled and streaked with yellowish gray; contains very small amount of silt and very fine sand, a few rounded chert pebbles 1/16–1/2 in. in diameter, some carbonaceous streaks, and small shell fragments; tough and massive.
6	40–45	Recovered 5 ft: Clay, same as above, except that pebbles are smaller (1/16–3/16 in.) and shell fragments rare.
7	45–55	Recovered 1 ft: Shale, gray, locally mottled and streaked with yellowish gray, slightly silty and sandy; a few rounded black chert pebbles as much as 1/8 in. in diameter; some carbonaceous streaks; firm and massive; probably recovered from 50 to 55 ft.

SIMPSON CORE TEST 1—Continued

Core	Depth (feet)	Description
8	55–65	Recovered 1 ft: Shale, as in core 7, but contains more silt and sand; much softer, and bentonitic.
9	65–72	Recovered 4 ft: Clay, dark- to yellowish-gray; contains a little silt and fine sand, a few small (1/16–3/16 in.) well-rounded polished chert pebbles, and some small shells; very tough and massive; pebbles of gray limestone, grayish-brown quartzite, and black and green chert were reported from the cutting samples.
10	72–76	Recovered 1 ft: 5 in., shale, yellowish-gray to gray; contains a little silt and very fine sand; bentonitic; soft and faintly laminated; locally contains a few small shell fragments and carbonaceous streaks. 7 in., quartzite, grayish-white, fine to medium grained, very hard and massive; probably recovered from a boulder or cobble.
11	76–83	No recovery.
12	83–86	Recovered 3 ft: Shale, gray; large amounts of silt and fine sand; in poorly defined beds 1/8–1 in. thick; very soft. Top of Grandstand Formation at about 83 ft.
13	86–89	No recovery.
14	89–101	No recovery.
15	101–116	No recovery.

SIMPSON CORE TEST 2

	0–18	Peat and ice (driller's description), includes distance between kelly bushing and ground.
	18–25	Sand, grayish-brown, fine (driller's description).
	25–30	Clay, light-gray, silty and sandy, soft and massive; contains numerous fragments of subbituminous coal, 3/4 in. in maximum diameter.
	30–35	Clay, slate-gray, lightly mottled with gray and olive gray; very tough, plastic, and massive; contains a very few small shell fragments and a very few sandstone pebbles 1/8 in. in maximum diameter.
	35–40	Clay, dark-bluish-gray, lightly mottled and streaked with yellowish gray; slightly silty and sandy; very tough and massive.
	40–45	Clay as above; mottled and streaked with yellowish gray and grayish cream; contains a few carbonaceous streaks and shell fragments and rare masses of soft earthy limonite as much as 1/4 in. in diameter.
	45–50	Clay as above; no carbonaceous streaks or small limonite masses.
	50–55	Clay, yellowish-gray, streaked with dark-bluish-gray; contains a very few chert pebbles, carbonaceous streaks, and small shell fragments.
	55–60	Clay, as above.
	60–65	Clay, dark-blue-gray, lightly mottled with yellowish-gray; sandy and silty; contains a few small pebbles and shell fragments; very tough and massive.
	65–70	Clay as from 60–65 ft, yellowish-gray, streaked and mottled with bluish gray; has less sand and silt and contains small fragments of subbituminous coal.

SIMPSON CORE TEST 2—Continued

Core	Depth (feet)	Description
	70–76	Clay, dark-slate-gray, lightly mottled with yellowish gray; bentonite; contains numerous rounded pebbles, mostly composed of dark chert as much as ¼ in. in diameter and sand, silt, and small shell fragments; tough and massive.
1	76–81	Recovered 5 ft: 1 ft 2 in.: clay, slate-gray to gray; in places lightly mottled with pale gray; contains a little silt and sand and a few small rounded pebbles of dark chert; tough, sticky, and massive. Top of Grandstand Formation at approximately 77 ft. 3 ft 10 in.: clay as above; layers of coal up to ¼ in. thick.
2	81–87	Recovered 5 ft: Clay as in core 1, lower interval; ranges from tough to soft and contains small shell fragments.
3	87–93	Recovered 5 ft: Clay as above; no pebbles.
4	93–101	Recovered 5 ft: 2 ft 10 in., clay as above; masses of greenish-gray very argillaceous and silty fine and mostly angular sand; contains numerous small coal fragments. 2 ft 2 in., clay and sand as above; no coal fragments.
5	101–106	Recovered 5 ft: 1 ft 4 in., clay, dark-slate-gray to gray, locally mottled with yellowish gray; contains a little intermixed silt and sand and numerous small coal fragments; tough, sticky, and massive. 3 ft 8 in., clay as above; no coal fragments.
6	106–111	Recovered 5 ft: 2 ft 6 in., clay as above, coal fragments. 2 ft 6 in., clay as above, no coal fragments.
7	111–115	Recovered 4 ft: 3 ft, clay, dark-slate-gray to gray, locally mottled with yellowish gray; contains a little intermixed silt and sand; tough, sticky, and massive. 1 ft, clay as above, coal fragments.
8	115–120	Recovered 5 ft: Clay as above; numerous small fragments of coal.
9	120–130	Recovered 5 ft: 10 in., coal, subbituminous. 9 in., clay as above; numerous small fragments of coal. 3 ft 5 in., clay as above; no coal fragments.
10	130–135	Recovered 5 ft: 11 in., clay as above; no coal fragments; numerous thin (1/16–½ in.) layers of pale gray soft and laminated silt. 3 ft 7 in., clay as above; no layers of silt. 6 in., clay as above; a few small coal fragments.
11	135–140	Recovered 3 ft 8 in: 2 ft, clay as above; no coal fragments. 1 ft, coal, subbituminous. 6 in., coal, subbituminous; thinly interbedded with greenish-gray argillaceous silty very fine to fine sand. 2 in., clay, blue-gray, silty, soft, laminated.
12	140–145	Recovered 3 ft 7 in.: 6 in., sand, gray, fine, slightly argillaceous, silty; mostly angular grains. 3 ft 1 in., sand, greenish-gray, fine, clayey and silty; contains numerous thin (± ½ in.) layers of bluish-gray silty and sandy soft and massive clay and subbituminous coal.

SIMPSON CORE TEST 2—Continued

Core	Depth (feet)	Description
13	145–155	Recovered 2 ft 11 in.: Sand, greenish-gray, very fine to fine, argillaceous and silty, and chiefly angular.
14	155–162	Recovered 4 ft 4 in.: 1 ft 11 in., sand as in core 13. 1 ft 6 in., clay, dark-gray; streaked and mottled with light-gray; silty and sandy, firm, tough, laminated to massive. 11 in., sand as in core 13, but dark-greenish-gray and has a higher clay and silt content.
15	162–170	Recovered 7 ft 4 in.: 2 ft 2 in., sand as in core 13; thin layers of pale-bluish-gray firm and laminated to massive silt; dark-gray slightly silty and sandy tough and massive clay and subbituminous coal. 5 ft 2 in., clay, dark-gray, locally very silty and sandy, or with streaks of silt and sand as above; ½-in. layer of coal present 1 ft below top of unit.
16	170–180	Recovered 7 ft: 5 ft, clay, dark-gray, silty and sandy; a few thin layers of pale-yellowish-gray firm and laminated to massive silt. 2 ft, sand, greenish-gray, very fine to fine, argillaceous and silty; mostly angular and finely laminated to massive.
17	180–190	Recovered 5 ft: 2 ft 3 in., sand, greenish-gray, very fine to fine, argillaceous and silty; mostly angular and finely laminated to massive. 6 in., sand as above but more argillaceous; numerous laminae of subbituminous coal. 2 ft 3 in., sand as above but very silty.
18	190–200	Recovered 8 ft: 3 ft, sand, greenish-gray, very fine to fine, argillaceous and silty; mostly angular and finely laminated to massive. 1 ft, clay, deep-gray, silty and sandy; thin streaks of fine sand, silt, and coal. 3 ft 4 in., clay, deep-bluish-gray, slightly silty and sandy, tough and massive; a very few thin streaks of very fine silty greenish-gray sand. 8 in., sand, as in first interval above but more argillaceous and silty and very fine grained.
	200–214	No sample; driller's recorded depth of 202 ft found to equal 216 ft.
19	214–226	Recovered 6 ft 3 in.: 3 ft, sand as in core above, heavily interbedded with thin layers of blue-gray soft massive to laminated silt; also contains a few thin beds of dark-blue-gray silty, sandy, massive clay; numerous thin laminae of subbituminous coal. 3 ft 3 in., sand and silt as in upper part of core, interbedded in about equal proportions.

SIMPSON CORE TEST 3

Core	Depth (feet)	Description
	0–228	No description made because core test 2, which was cored to a depth of 226 ft, was only 50 ft from core test 3. Top of Grandstand Formation may be at about 80 ft.
1	228–238	Recovered 5 ft: 3 ft 6 in., sand, gray, fine. 1 ft 6 in., shale, dark-gray, bentonitic(?), slightly silty and sandy, very soft and massive.
2	238–248	No recovery.

SIMPSON CORE TEST 3—Continued

Core	Depth (feet)	Description
3	248–258	Recovered 7 ft: 1 ft, shale, dark-gray, bentonitic(?), slightly silty and sandy, very soft and massive. 1 ft, sand, greenish-gray, fine, and argillaceous. 5 ft, shale as above; locally greenish-gray and sandy.
4	258–268	Recovered 5 ft 6 in: Shale, dark-gray, bentonitic(?), slightly silty and sandy, very soft and massive; locally greenish-gray and sandy.
5	268–278	Recovered 5 ft: 1 in., coal. 4 ft 11 in., shale as in core above.
6	278–288	Recovered 2 ft 6 in.: 1 ft, sand, gray, fine. 1 in., coaly zone. 1 ft 2 in., sand, gray, fine. 3 in., shale, gray.
7	288–298	Recovered 2 ft 7 in.: 8 in., sand, gray, fine, slightly argillaceous. 3 in., shale, dark-gray, bentonitic(?), slightly silty and sandy, very hard and massive. 2 in., shale, dark-gray, bentonitic(?), slightly silty and sandy, very soft and massive. 1 ft 2 in., sand, gray, coarse; coal streaks at base. 4 in., shale, dark-gray, bentonitic(?), slightly silty and sandy, very soft and massive.
8	298–308	Recovered 4 ft: 2 ft 6 in., sand, gray, fine, argillaceous. 1 ft, shale. 6 in., sand as above.
9	308–318	Recovered 6 ft, 6 in.: 5 ft, sand, gray, fine. 1 ft, shale as in core above. 6 in., shale as above but with a 2-in. zone of coal streaks 1 in. from top underlain by a 4-in. bed of sand.
10	318–328	Recovered 4 ft: Shale, as in core 8 above.
11	328–338	Recovered 10 ft: 4 ft, sand, gray, very fine, argillaceous. 4 ft, shale, dark-gray; traces of coal. 2 ft, sand as above with local shale streaks.
12	338–348	Recovered 10 ft: 2 ft, sand as in core above with local shale streaks. 2 ft, shale as in core above. 2 ft 6 in., sand as above. 3 ft 6 in., shale as above but locally darker.
13	348–358	Recovered 6 ft: 8 in., shale as in core 11 but locally darker. 4 ft 6 in., sand as in core 11. 10 in., shale as above.
14	358–368	Recovered 3 ft 6 in.: Shale, gray, silty and sandy; 2-in. coal bed 4 in. from base.

SIMPSON CORE TEST 4

Core	Depth (feet)	Description
	0–12	Peat, ice, and distance between kelly bushing and ground.
	12–40	Sand, grayish-brown, very fine to fine, very argillaceous, silty, and angular; locally contains streaks of dark-blue-gray clay; fossiliferous.
	40–55	Clay, gray to slate-gray; locally slightly silty and sandy; fossiliferous.
	55–62	Shale, yellowish-gray, slightly silty and sandy, soft and massive; some small chert pebbles.
1	62–71	Recovered 3 ft: 1 ft 6 in., shale, yellowish-gray, slightly silty and sandy, soft and massive; some small chert pebbles.

SIMPSON CORE TEST 4—Continued

Core	Depth (feet)	Description
1	62–71	1 ft, gravel, rounded, some shale. 6 in., shale, gray, sandy.
2	71–81	Recovered 1 ft: Gravel, rounded, in shale. Top of Grandstand Formation at 81 ft.
3	81–91	Recovered 3 ft 6 in.: 1 in., claystone, buff, dense, and hard. 2 ft 3 in., shale as above. 1 ft 2 in., shale, dark-gray, slightly silty and sandy; fragments of buff claystone.
4	91–98	Recovered 2 ft: 1 ft 10 in., shale, dark-gray, slightly silty and sandy; fragments of buff claystone. 2 in., claystone, buff, dense, and hard.
5	98–108	Recovered 1 ft, 6 in.: 1 ft 5 in., shale, gray, slightly silty and sandy, soft, massive. 1 in., sand, dark-gray, silty and argillaceous.
6	108–119	Recovered 10 ft: 2 ft, sand, gray, fine, argillaceous. 1 ft 4 in., shale, gray. 1 ft 2 in., coal, subbituminous; streaks of soft buff shale. 1 ft 2 in., shale, gray-brown to gray; streaks of coal. 4 ft 4 in., shale, dark-gray, sandy toward base.
	119–121	Sand.
7	121–131	Recovered 3 ft: 2 ft 6 in., shale as in core above. 6 in., sand, very fine, hard.
8	131–141	Recovered 6 ft: 1 ft, sand, gray, fine, argillaceous. 2 ft 1 in., shale; streaks of coal and buff claystone. 2 ft 4 in., sand, gray, fine, argillaceous. 7 in., shale, black, soft.
9	141–151	Recovered 2 ft: Shale, dark-gray.

SIMPSON CORE TEST 5

Core	Depth (feet)	Description
	0–6	Peat, ice, and distance between kelly bushing and ground.
	6–15	Sand, gray, fine, argillaceous, silty.
	15–20	Clay, gray, very sandy.
	20–30	Sand, gray, fine, argillaceous, and silty.
	30–40	Clay, dark-gray, sandy; becomes very sandy toward base.
	40–50	Clay, dark-gray, sandy; becomes very sandy at base, as above.
	50–60	Shale, gray to locally blackish-gray, slightly sandy and silty, soft and massive. Top of Grandstand Formation may be at about 50 ft.
1	60–70	Recovered 1 ft 6 in.: Shale, gray to locally blackish-gray, slightly sandy and silty, soft and massive.
2	70–80	Recovered 1 ft 6 in.: Shale as above; thin (6 in.) streaks of fine gray sand in places.
3	80–90	Recovered 2 ft: Shale as above; thin (6 in.) streaks of fine gray sand in places.
4	90–100	Recovered only small angular fragments of quartzite and chert (probably pebbles from the Gubik Formation, contamination).
5	100–110	Recovery as above.
6	110–120	Recovered 2 ft 6 in.: Sand, gray, fine, very argillaceous and silty; thin streaks of blue-gray clay as much as 6 in. thick and fragments of buff chert.
7	120–130	Recovered 2 ft 6 in.: Sand, as above; trace of coal.

SIMPSON CORE TEST 6

Core	Depth (feet)	Description
	0–6	Peat, ice, and distance between kelly bushing and ground.
	6–19	Sand, brownish-gray to grayish-brown, fine, argillaceous, silty; angular grains.
1	19–29	Recovered 8 ft: Sand as above; streaks and ½-ft–2-ft beds of blue-gray to black slightly silty and sandy, soft and massive shale; ¼-in. beds of coal between 25 ft and 29 ft.
2	29–39	Recovered 1 ft: Sand as in core above; streaks and 6-in.–2-ft beds of blue-gray to black slightly silty and sandy soft and massive shale.
3	39–49	Recovered 2 ft: Sand as in core 1 above; streaks and 6-in.–2-ft beds of blue-gray to black shale; slightly silty and sandy, soft and massive.
4	49–59	Recovered 8 ft: Sand, brownish-gray to grayish-brown, fine, argillaceous and silty, and angular with streaks; and 6-in.–2-ft beds of blue-gray to black slightly silty and sandy, soft, and massive shale.
5	59–69	Recovered 6 in: Sand as in core above.
6	69–79	Recovered 1 ft: Gravel, rounded; some gray shale. Top of Grandstand Formation placed at 79 ft.
7	79–89	Recovered 1 ft: 11 in., sand and shale. 1 in., sand, brown, fine, oil-saturated.
8	89–99	Recovered 3 ft: Shale, bluish- to yellowish-gray, slightly silty and sandy, soft and massive.
9	99–109	Recovered 2 ft: Shale, dark-gray, bentonitic.
10	109–111	Recovered 2 ft: 6 in., sand, brown, oil-stained; bleeding oil in part. 1 in., shale, dark-gray, hard, dense. 1 ft 5 in., sand, fine; good oil saturation.
	111–119	No sample.
11	119–129	Recovered 2 ft: 1 ft 4 in., sand, brown, medium, oil-saturated. 1 in., sand, fine, hard, dense. 7 in., sand, gray, fine.
12	129–139	Recovered 2 ft: Sand, gray, fine.
13	139–149	Recovered 1 ft: Shale, dark-gray-brown.

SIMPSON CORE TEST 7

Core	Depth (feet)	Description
	0–12	Tundra, peat, ice, and distance between kelly bushing and ground.
1	12–22	No recovery (sand, reddish-brown, iron stained, fine; argillaceous cuttings).
2	22–32	Recovered 1 ft, 6 in.: Clay, brown-gray, soft, slightly carbonaceous and sandy; streaks of gray bentonitic shale.
3	32–42	Recovered 1 ft: Shale, gray, bentonitic, sandy; streaks of brown, fine to medium sand and clay; carbonaceous streaks throughout.
4	42–52	Recovered 1 ft: 3 in., shale, gray, carbonaceous, sandy, soft, brittle. 9 in., sand, gray to brown, fine, massive, loose, argillaceous; carbonaceous streaks (fragments of coal).
5	52–62	Recovered 1 ft: Shale, gray, carbonaceous, sandy.

SIMPSON CORE TEST 7—Continued

Core	Depth (feet)	Description
6	62–72	Recovered 1 ft: 6 in., shale, gray, carbonaceous, fossiliferous. 6 in., shale, gray, sandy; brown clay and sand streaks.
7	72–82	Recovered 1 ft: Shale, dark-gray, bentonitic; a few hard dense yellowish-brown claystone fragments in top 3 in. Top of Grandstand Formation at about 72 ft.
8	82–92	Recovered 2 ft: 6 in., sand, gray, fine, medium well sorted, uncemented, porous. 1 ft, shale, medium-gray, bentonitic. 3 in., shale, medium-gray, bentonitic; angular coal fragments. 3 in., claystone, yellowish-brown, hard, dense, brittle.
9	92–102	Recovered 1 ft: Shale, dark-gray, bentonitic.
10	102–112	Recovered 1 ft: Shale, dark-gray, bentonitic; irregular to round marcasite concretions as large as ¼ in. in diameter in lower 4 in.
11	112–122	Recovered 2 ft 6 in.: Sand, gray, fine, well-sorted, porous.
12	122–132	Recovered 1 ft: Sand, gray, fine, well-sorted, porous.
13	132–142	Recovered 1 ft 6 in.: 4 in., sand, gray, fine, medium-well-sorted, loose, porous. 1 ft, 2 in., shale, dark-gray, bentonitic.
14	142–152	Recovered 1 ft 6 in.: 6 in., shale, gray, bentonitic, sandy; streaks of silty sand. 11 in., shale, dark-gray. 1 in., claystone, brown to brown-gray, hard, dense.
15	152–162	Recovered 3 ft 6 in.: Sand, gray, fine, medium-well-sorted, porous.
16	162–172	No recovery.
17	172–182	Recovered 4 ft: Sand, gray, fine, well-sorted, porous.
18	182–192	Recovered 1 ft, 6 in.: 6 in., sand, light-gray, argillaceous; angular fragments of brown hard dense claystone. 1 ft, sand, gray, fine, porous, medium-well-sorted.
19	192–202	Recovered 10 ft: 3 ft, sand, gray, fine well-sorted, uncemented porous. Frozen. 1 in., claystone, yellowish-brown to brown-gray, hard, dense. 6 ft, sand, gray, fine, well sorted, porous, uncemented; frozen with two ¼-in. layers or lenses of pure ice in core. 11 in., shale, dark-gray, brittle, friable.
20	202–212	Recovered 1 ft 6 in.: Shale, dark-gray, friable, brittle.
21	212–222	Recovered 8 ft: Shale, medium-gray, bentonitic; streaks of brown clay shale.
22	222–232	Recovered 1 ft 6 in: 1 in., broken material, limestone or dolomite with kaolinitic streaks(?). 1 ft 5 in., shale, dark-gray, bentonitic.
23	232–242	Recovered 7 ft: Shale, dark-gray, bentonitic, friable, brittle.
24	242–252	Recovered 2 in.: Sand, gray, fine, well-sorted, porous.
25	252–262	Recovered 4 ft: Sand, gray, fine, soft, porous, well-sorted.
26	262–272	Recovered 2 ft: Sand, gray, fine, well-sorted, porous.
27	272–282	Recovered 2 ft: Shale, dark-gray.

SIMPSON CORE TEST 7—Continued

Core	Depth (feet)	Description
28	282–292	Recovered 1 ft: Sand, gray, fine.
29	292–302	Recovered 1 ft 6 in: Sand, gray, fine.
30	302–312	Recovered 1 ft: Shale, dark-gray.
31	312–322	Recovered 8 in: Shale, dark-gray.
32	322–332	Recovered 1 ft 6 in.: Shale, dark-gray, slightly sandy.
33	332–342	Recovered 8 ft: 1 ft 6 in., sand, dark-gray, fine. 6 in., shale, dark-gray. 6 in., sand, dark-gray, fine, well-sorted, porous. 5 ft 6 in., shale, dark-gray.
34	342–352	Recovered 10 ft: 2 in., dolomitic limestone(?), white to colorless with grayish streaks, crystalline, massive, fractured; fractured surfaces resemble soapstone. Weathered in spots to chalky powder. 6 in., dolomitic limestone as above. 4 in., sand, grayish-brown, very fine, silty, shaly; thin shale partings; horizontal laminae. 1 ft, shale, gray to brownish-gray, brittle, medium hard; thin sand laminae throughout, fine, silty. 1 ft, clay shale, brown to gray; carbonaceous spots and carbonaceous plant remains throughout. 1 ft, clay shale with abundant thin sand laminae. 6 in., clay shale with carbonaceous plant stems and a ¼-in. streak of coal at base. 5 ft 6 in., shale, gray, medium-hard, brittle, sandy; streaks of clay and thin laminae of brown fine silty sand; 1 in. of yellowish-brown hard dense claystone at 351½ ft. Apparent dip in bedded intervals to 1°.
35	352–362	Recovered 8 ft: 3 ft, shale, brown-gray, medium-hard, brittle; rare streaks of brown fine silty sand. 2 ft, sand, gray, fine well-sorted, soft, uncemented, porous; slightly shaly in top 6 in. 1 ft shale, brown, friable, crumbly; carbonaceous streaks and thin sand laminae throughout; ¼-in. coal streak at 357 ft; 2-in. and 1-in. streak of carbonaceous shale, coal, and plant remains at 357 ft 10 in. Broken shell at 357 ft. 2 ft, shale, gray to grayish-brown; numerous pyritized (or marcasitic) plant remains throughout; 1½-in. streak of coal and shaly coal at base.
36	362–372	Recovered 10 ft: 9 ft, sand, gray, fine medium-well-sorted, porous, soft, uncemented. 1 ft, sand, brownish-gray, fine hard, porous, poorly cemented; slightly brackish taste.
37	372–382	Recovered 8 ft 6 in.: Sand, gray, fine to medium, medium-hard, firm, uncemented, very porous; rounded frosted to clear quartz grains. Coal and sandy coal 379–380 ft.
38	382–392	Recovered 7 ft 6 in.: Sand, gray, medium to fine, very porous, soft; brownish-gray streaks; rounded to subangular quartz grains; slight carbonaceous streaks and streaks with minute muscovite flakes. Wet. Slightly brackish taste.

SIMPSON CORE TEST 7—Continued

Core	Depth (feet)	Description
39	392–402	Recovered 9 ft: 8 ft 9 in., sand, gray, medium to fine well-sorted, porous; slight carbonaceous streaks brown to gray in parts. 3 in., shale, brown to brown-gray, soft, friable.
40	402–412	Recovered 2 ft: Shale, brown to brownish-gray, soft, broken; streaks of silty shale and very fine silty sand.
41	412–422	Recovered 8 ft: Shale, brown, friable, soft; rare silty streaks.
42	422–432	No recovery.
43	432–442	No recovery.
44	442–452	Recovered 1 ft 6 in.: Shale, brownish-gray, silty in streaks; very fine silty sand.
45	452–462	Recovered 4 ft: Shale, brown-gray, soft, broken, friable; few thin stringers of silty sand throughout. Very sandy in bottom 6 in.
46	462–472	Recovered 2 ft: 1 ft, shale, gray-brown, soft, friable; slightly silty sand streaks. 1 ft, sand, brown, fine, well-sorted, porous; small fragments of coal (rare) and carbonaceous streaks throughout.
47	472–477	Recovered 2 ft: 1 ft 9 in., sand, gray, soft, uncemented, porous; a streak of medium-firm medium-hard sand at 473 ft. 3 in., sandstone, grayish-brown, fine-grained very hard, well-cemented, medium-porous to tight, well-sorted, calcareous.
48	477–482	Recovered 2 ft: 6 in., shale brownish-gray, soft, friable, broken (may be cavings and cuttings). 1 ft. 6 in., sandstone, gray, very hard, well-cemented, calcareous.
49	482–492	Recovered 3 ft 6 in: 1 ft, sand, fine-grained, soft, porous, uncemented, well-sorted. 4 in., sandstone, light-yellowish-tan very fine grained, very hard, very well cemented, well-sorted; no taste or odor but suggestive oil color(?). 2 ft 2 in. sand, fine, friable, soft, porous, uncemented; a 3-in. streak of yellowish-tan very hard tight sandstone at 485 ft.
50	492–502	Recovered 3 ft: Shale, gray, sticky; silty brown sand streaks.
51	502–512	Recovered 5 ft: 1 ft 3 in., shale, brown to brownish-gray, broken, soft. 3 in., sand, gray fine, loose, porous, uncemented. 6 in., shale, gray to brownish-gray, broken; thin silty sand laminae; horizontal lamination in shale. 6 in., sand, gray, fine, loose, porous, uncemented. 6 in., shale, brown to brownish-gray, broken with silty streaks. 6 in., sand, gray, fine, loose, porous, uncemented. 1 ft 6 in., shale, brown to brownish-gray; silty sand streaks.
52	512–522	Recovered 2 ft 6 in.: Shale, gray to grayish-brown, soft, sticky; rare very silty sand streaks.
53	522–532	Recovered 2 ft 6 in.: 3 in., shale, gray to grayish-brown, sticky. 3 in., sand, fine, well-sorted, loose, crumbly porous.

SIMPSON CORE TEST 7—Continued

Core	Depth (feet)	Description
53	522–532	Recovered 2 ft 6 in.—Continued 6 in., shale, brown to brownish-gray. 6 in., sand, gray, fine, loose, well-sorted, porous. 1 ft, shale, brown-gray, friable, brittle, broken.

SIMPSON CORE TEST 8

Core	Depth (feet)	Description
	0–2	Tundra, peat, and distance between kelly bushing and ground.
	2–10	Clay, light-brown; sandy with carbonaceous streaks.
	10–15	Shale, gray, bentonitic, sandy.
	15–20	Sandy clay, brownish-yellow; carbonaceous streaks.
1	20–30	Recovered 3 ft: Shale, gray-black, bentonitic, sticky, soft; streaks of brown-gray to yellow soft clay.
2	30–40	Recovered 1 ft: Clay, light-gray, sticky, bentonitic; streaks of dark-gray bentonitic shale.
3	40–50	Recovered 5 ft: Shale, gray, bentonitic, soft, sticky; slight sandy streak at 44 ft and streaks of gray bentonitic clay throughout. Numerous black carbonaceous laminae in shale. Few small fossil shell fragments throughout.
4	50–60	Recovered 4 ft: 1 ft 3 in., shale, black, bentonitic, soft, sandy. 3 in., sand, gray, fine soft, loose, porous. 2 ft 6 in., clay shale, light-gray with yellow-brown streaks, soft, bentonitic. Slightly sandy at base.
5	60–70	Recovered 1 ft: 10 in., clay, light-gray with yellow-brown streaks, soft, bentonitic; few hard dense claystone, rounded black chert and white quartz pebbles included. 2 in., sand, fine, loose, soft, very porous, medium well saturated with light- to green-brown oil. Top of Grandstand Formation placed at about 65 ft.
6	70–80	Recovered 1 ft: Sand, fine, well-sorted, porous, uncemented; good oil color, bleeding in spots. Much free light-brown oil throughout. Few very thin shale laminae.
7	80–90	Recovered 2 ft, 6 in.: Sand, fine, porous, loose; with streaks of light brown free oil and bleeding throughout.
8	90–100	Recovered 7 ft: Sand, light-gray, fine, porous, soft, loose; good oil color and bleeding in spots.
9	100–110	Recovered 1 ft 6 in.: Sand, gray, fine, loose; porous with good odor, bleeding in spots, some free oil. Carbonaceous sand streaks throughout.
10	110–120	Recovered 2 ft 6 in.: 2 ft, sand, fine, loose, porous; bleeding throughout with spots of saturation. 6 in., shale, light-gray, and clay. Slight oil film on fracture surfaces in shale.
11	120–130	Recovered 1 ft 3 in.: Shale, gray, soft; silty streaks with oil film and few spots of free oil along fracture surfaces and on bedding surfaces.

SIMPSON CORE TEST 8—Continued

Core	Depth (feet)	Description
12	130–140	Recovered 2 ft: 6 in., sand, medium to fine, porous, loose, well-sorted; good oil color throughout, some free oil. 1 ft 6 in., shale, gray, streaky; silty streaks and some oil films along fracture surfaces. Rare spots of free oil.
13	140–150	Recovered 1 ft 3 in.: Sand, medium; speckled with white, gray, black, and brown rounded quartz grains, cherty grains, and carbonaceous fragments; streaks of coal; very soft, very porous, very good oil color, bleeding, streaks of free oil.
14	150–160	Recovered 10 ft.: Sand, medium to fine, well-sorted, very porous, loose, crumbly; good oil color throughout. Carbonaceous streaks near base and a 3-in. streak of carbonaceous shale and lignite at 159 ft 6 in. and 159 ft 9 in. Bleeding in spots. Dip of 3°–4° noted in laminated sand and carbonaceous shale.
15	160–170	Recovered 1 ft 1 in.: 6 in., sand, gray to yellow-brown, medium to fine, very loose, soft; good oil color and odor throughout with spots of free oil. 4 in., coal. 3 in., sand as above; two rounded very hard dense black chert pebbles ½ in. in diameter.
16	170–180	No recovery.
17	180–190	Recovered 6 ft: 5 ft, sand, fine, loose, porous, uncemented; slight carbonaceous streaks; very slight odor of oil and few thin streaks with oil color; argillaceous near base. 1 ft, sandy shale and clay, brown to brown-gray, soft.
18	190–200	Recovered 8 ft: 5 ft, sand, very fine, well-sorted, porous, argillaceous; very slight oil odor and color and with carbonaceous streaks and spots. Shaly in last 1 ft. 3 ft, shale, brown to brown-gray; sandy shale streaks Thin (¼ in.) lens of ice in core.
19	200–210	Recovered 2 ft: 1 ft, shale, brown to brown-gray, sticky; sandy streaks in last 3 in. 1 ft, sand, gray, fine, porous, soft; very slight oil odor.
20	210–220	Recovered 10 ft: 1 ft, shale, brown, friable. 1 ft, sand, gray, fine, well-sorted, porous, poorly cemented. 1 ft 6 in., shale, gray-brown, slightly carbonaceous; has sandy streaks. 2 ft, shaly sand and brown-gray soft sand; few thin lenses of gray-brown shale and some carbonaceous streaks. 1 ft, shale, gray-brown to brown, friable. 3 ft 6 in., shale, gray-brown; streaks of sandy silty shale.
21	220–230	No recovery.
22	230–240	Recovered 10 ft: Sandy shale, brown to brown-gray, soft, friable; streaks of very fine brown-gray silty sand and brown-gray shale. Few thin streaks of carbonaceous sand, shale, and lignite.
23	240–250	Recovered 1 ft 6 in.: 3 in., shale, brown-gray, friable. 6 in., sand, light-gray, very fine, silty. 9 in., shale, gray-brown to gray, friable sandy; silty sand streaks in top giving an irregular wavy banded appearance.

SIMPSON CORE TEST 8—Continued

Core	Depth (feet)	Description
24	250–260	Recovered 10 ft: 5 ft, shale, dark-gray, brittle, friable; slight silty streaks in top 1 ft. 1 ft, sandy shale, light-gray to black, streaks of sand. Fossiliferous. 3 ft, sand, light-gray, very fine, compact, porous, poorly cemented; few very thin shale laminae. Argillaceous in last 1 ft. 9 in., sandy clay, light-gray to buff. 3 in., clay, light-tan, medium-hard, brittle.
25	260–270	Recovered 2 ft: Shale, gray, brittle, medium-soft; light-gray bentonitic clay streaks through bottom 1 ft. 2 in.; streaks of light-gray fine sand starting from top of recorded section at 4 in.; numerous black carbonaceous laminae in the sand. Dip appears to be flat.
26	270–280	Recovered 9 ft: 3 in., sand, brown-gray, very fine silty, well-sorted, porous, with ½- in. streak of dark-gray shale at top. 3 in., claystone, light-buff, medium-hard, dense, brittle. 1 ft, clay-shale, light-tan-gray to gray, slightly silty. 4 ft 6 in., sandy shale, clay shale, and streaks of sand. Carbonaceous streaks and carbonaceous plant remains. 2 ft, shale, gray, brittle; few carbonaceous streaks and carbonaceous plant stem remains. 3 in., claystone, light-buff, dense, massive, brittle. 9 in., shale, gray to dark-gray and black, slightly carbonaceous; silty sand streaks.
27	280–290	Recovered 1 ft 6 in.: 1 ft 3 in., shale, gray to dark-gray, slightly carbonaceous, and sandy shale with irregular streaks of gray fine silty sand. 1 in., claystone, yellow tan, very hard, very dense, brittle. 2 in., sand, light-gray, fine, loose, well-sorted.
28	290–300	No recovery.
29	300–310	No recovery.
30	310–320	Recovered 9 ft: Sand, gray, fine, well-sorted, medium-firm, porous; slightly carbonaceous streaks from 316 to 317 ft and streaks of lignite at 316 ft. Brackish taste.
31	320–330	Recovered 4 ft 6 in.: 4 ft, sand, fine, soft, loose, porous, uncemented; streaks of coal and lignite in last 6 in. 6 in., shale, gray, sticky; yellow-brown, broken clay; ½-in. streak of hard dense brittle yellow claystone.
32	330–340	Recovered 10 ft: Shale, brown, soft, brittle, friable; a thin (3-in.) layer of silty sand at 333 ft.
33	340–350	Recovered 5 ft: Shale, brown, soft, brittle, friable; a streak of fine brown-gray sand near top of core; 3-in. streak of yellow claystone at top.
34	350–360	Recovered 7 ft: Shale, brown to brown-gray, soft, brittle, friable.
35	360–370	Recovered 5 ft 6 in.: Shale, brown to brown-gray, friable, sticky; a few streaks of brown-gray very fine silty sand.
36	370–380	Recovered 2 ft 6 in.: Shale, brown to brown-gray, soft, friable.
37	380–390	Recovered 3 ft: Shale, brown to brown-gray, soft, sticky.

SIMPSON CORE TEST 8—Continued

Core	Depth (feet)	Description
38	390–400	Recovered 8 ft 6 in.: 1 ft 6 in., shaly sand, sand, and shale, brown to brown-gray, soft, silty. 4 ft 8 in., sand, gray, fine, porous, well-sorted, poorly cemented. 1 ft, shale, brown, sticky. 4 in., sandstone, rusty-brown to gray, very fine-grained, well-sorted, well-cemented, tight to medium-porous, very hard calcareous (?). 1 ft, sand, gray, soft, loose, porous, uncemented.
39	400–410	No recovery.
40	410–420	Recovered 9 ft 6 in.: 3 ft, sand, gray-brown, fine loose, soft, very porous. 6 in., shale, brown, friable. 6 in., sand, gray-brown, fine, soft, loose; slight streaks of shale. 5 ft 6 in., shale, brown, soft, friable.
41	420–430	Recovered 2 ft: Shale, brown to brown-gray, sticky, friable; few thin silty sand streaks.
42	430–440	No recovery.
43	440–450	Recovered 2 ft: Shale, gray to gray-brown sandy shale, and streaks of brown-gray fine silty sand.
44	450–460	Recovered 6 ft 6 in.: Shale, gray, sticky; streaks of fine sandy shale and sand, silty throughout. One well-preserved fossil shell found at 456 ft
45	460–470	No recovery.
46	470–480	Recovered 2 ft: Shale, gray to gray-brown, very slightly silty sand streaks and streaks of sandy shale.
47	480–490	Recovered 6 ft: Shale, gray, sticky, silty; streaks of gray, fine silty sand. A 2-in. streak of brown hard dense brittle claystone at 482 ft 6 in.; streaks of yellow-brown soft clay at base.
48	490–500	Recovered 3 ft: Shale as above, and gray fine soft, porous sand, and streaks of sandy shale. Shell fragments found at 491 ft.
49	500–510	Recovered 2 ft 6 in.: Shale as above; some silty streaks and streaks of brown-gray very fine silty sand.
50	510–520	Recovered 5 ft 6 in.: Shale, brown to brown-gray, friable; medium-hard brittle clay shale.
51	520–530	Recovered 2 ft 6 in.: Shale as above; very slight silty streaks. Half an inch of brown-gray medium-hard firm fine-grained sandstone at base.
52	530–540	Recovered 7 ft: Shale, gray to gray-brown, brittle, friable; silty gray-brown shaly sand; seven streaks of fine brown-gray sand. A 3-in. streak of hard dense yellow-brown claystone at 533 ft 6 in.
53	540–550	Recovered 1 ft: Sand, light-brown, fine shaly, porous, medium-firm, well-sorted; streaks gray-brown shale laminae.
54	550–560	Recovered 2 ft: Shale, gray, friable; streaks of fine gray sand and sandy shale.
55	560–570	Recovered 10 ft: 6 in., sand, fine, soft, medium-firm, well-sorted, porous, uncemented. (Driller reported oil odor and color in top 2 in. of core. Unable to detect any trace of oil taste or odor.) 1 in. shale, brown to gray, friable.

SIMPSON CORE TEST 8—Continued

Core	Depth (feet)	Description
55	560–570	Recovered 10 ft—Continued 8 ft 6 in., sand, gray, fine very soft, uncemented; a 4-in. shale break at 564½ ft; sand is water bearing.
56	570–580	No recovery.

SIMPSON CORE TEST 9

Core	Depth (feet)	Description
	0–3	Tundra, ice, clay and distance between kelly bushing and ground.
	3–20	Peat; black to gray clay with brown sandy streaks.
1	20–30	Recovered 9 ft: 3 ft, clay, gray to black, carbonaceous; slight sandy streaks. 6 ft, sand, gray to dark-gray, fine, loose; slight streaks of clay and some black, carbonaceous streaks. Core frozen.
2	30–40	Recovered 10 ft: Sand, light-gray-brown, soft, very porous, unconsolidated to medium-firm; frozen. Six-in. streak of carbonaceous sand and coal at 34 ft.
3	40–50	Recovered 10 ft: Sand as above; no odor or taste of oil but a very slight light brown oil color on outside of core. Core frozen.
4	50–60	Recovered 10 ft: Sand as above, light-brown-gray, very soft, porous, loose; streaks of carbonaceous sand and sandy coal from 54 to 56 ft. Core frozen.
5	60–70	Recovered 10 ft: Sand, light-green-brown, fine, loose, very soft; a few hard round dense black chert pebbles. Very slight light-brown oil color on outside of core. No oil odor or taste. Core frozen.
6	70–80	Recovered 5 ft: Sand as above and ice (flakes). Most of the core consisted of thin clear ice flakes and shavings.
7	80–90	Recovered 10 ft: 2 ft 6 in., sand, brown-gray, fine, loose, well-sorted; good oil color and odor. Few hard dense round black chert pebbles. 7 ft 6 in., shale, brown to brown-gray, medium hard, brittle, friable; silty streaks. Streaks of yellow-brown clay and clay shale in upper 3 ft. Top of Grandstand Formation at 83 ft.
8	90–100	Recovered 7 ft: 4 ft. shale, brown-gray to brown; silty in streaks with some streaks of shaly coal at 92 ft. 3 ft, sand, soft, porous, loose, bleeding. Slight streaks of coal in upper 1 ft. Spots of oil saturation, good oil color, and odor throughout.
9	100–110	Recovered 6 in.: 2 in., shale, gray to gray-brown, friable. 4 in., sand, fine, well-sorted, porous, loose; some free oil and fair saturation in spots. Slight show of light-brown to brown-green oil on mud pit. No evidence of gas.
	110–115	Sand, gray to gray-brown, loose, well-sorted; show of light-brown oil. Thin streaks of shale in base.
	115–120	Sand, gray, soft; and gray soft bentonitic shale.
	120–130	Shale, gray, slightly silty; few irregular hard dense brittle gray claystone fragments.
	130–150	Shale, gray; streaks of fine silty sand and slight carbonaceous streaks.
	150–162	Shale, gray, hard; streaks of sand.
	162–165	Claystone and clay shale with streaks of coal.
	165–180	Shale, gray, hard; streaks of sand and clay.
	180–200	Shale, gray to brown-gray, medium-hard; sandy shale and streaks of fine silty brown-gray sand.
10	200–210	Recovered 9 ft: Clay shale, gray-brown to gray, hard, dense, brittle, indurated; some light silty sand streaks and shale.
11	210–220	Recovered 9 ft: Shale, gray-brown, crumbly, brittle; clay streaks in upper 3 ft. Streaks of fine brown silty shaly sand from 215 to 217 ft. Fossil shell at 216 ft 6 in.
12	220–230	Recovered 1 ft 6 in.: 3 in., sand, gray, fine to medium, soft, loose. 1 ft 3 in., shale, chocolate-brown to brown-gray, carbonaceous, crumbly; interbedded streaks of coal.
13	230–240	Recovered 9 ft: Sand, light-gray, fine, well-sorted, porous, poorly cemented.
14	240–250	No recovery.
15	250–260	Recovered 1 ft 6 in.: Sand, gray, fine, loose, soft, porous.
16	260–270	Recovered 6 ft: 9 in., sand, gray, fine, soft, loose, porous. 9 in., clay shale, light-gray, fine-textured, very hard, very dense, indurated; small rare round spots of marcasite. 4 ft 6 in., shale, brown to brown-gray, friable, soft, crumbly; silty brown sand streaks.
	270–280	Shale, gray to gray-brown; streaks of sand and fragments of gray hard dense claystone.
	280–284	Sand, gray, fine, soft, loose; streaks of shale.
	284–290	Shale, gray, sticky; numerous hard gray claystone fragments and streaks of sand.
	290–295	Sand, gray; and shale with streaks of hard dense claystone.
	295–300	Shale, gray to gray-brown, sticky.
	300–310	Sand, fine, soft, loose; and gray sticky shale.
17	310–320	Recovered 6 ft: Shale, brown-gray to gray, friable, s ilty streaks of fine gray porous sand.

SIMPSON CORE TEST 10

Core	Depth (feet)	Description
	0–4	Ice, tundra, peat, and distance between kelly bushing and ground.
	4–20	Ice; brown to red-brown clay; streaks of sand and peaty material.
1	20–30	No recovery.
2	30–40	Recovered 4 ft: Sand, gray to gray-brown, soft, loose, uncemented; round quartz and some cherty grains. Tundra plant remains.
3	40–50	Recovered 6 ft: Sand, gray to gray-brown, fine, well-sorted, soft, loose; a 4-in. streak of plant remains and black carbonaceous sand and peat at 44 ft.
4	50–60	Recovered 8 ft: Sand, brown-gray, fine, soft, loose, uncemented.
5	60–70	Recovered 1 ft 6 in.: 3 in., pebbles, round; smooth; hard dense brittle black to gray chert and claystone, up to 1 in. in diameter. 1 ft 3 in., clay, gray to yellow, sticky, soft, bentonitic. Top of Grandstand Formation at 63 ft.

SIMPSON CORE TEST 10—Continued

Core	Depth (feet)	Description
6	70–80	Recovered 1 ft 3 in.: 3 in., coal. 1 ft, clay and clay shale, gray to tan, sticky, soft, bentonitic; spots of light yellow-brown free oil along cleavage planes and fracture surfaces.
7	80–90	Recovered 9 in.: Clay and clay shale, gray to tan, soft, sticky, bentonitic; spots of free light-yellow-brown oil along cleavage planes and fracture surfaces.
8	90–100	Recovered 5 ft.: 6 in., sand, gray-brown, fine, loose, porous, soft, argillaceous; streaks of clay and carbonaceous material throughout. Oil odor and streaks of oil color. 4 ft 6 in., sand, brown-gray, fine, soft, very porous; good oil show throughout with abundant streaks of light-yellow-brown oil saturation. Bleeding core. Much free oil.
9	100–110	Recovered 7 ft.: 5 ft, oil sand; numerous thin irregular coal laminae; ½-in. clay streak at 104 ft 6 in. 9 in., sand, gray, porous, soft, loose, water-bearing; slight oil odor. 1 ft 3 in., shaly sand, brown-gray, very fine, silty, and silty shale.
10	110–120	Recovered 1 ft 3 in.: Shale, brown, soft, sticky; silty streaks and streaks of shaly sand in top 3 in.
11	120–130	Recovered 6 in.: Silty shale, brown-gray to gray; sticky streaks of sand; 1 in. of soft shaly sand at base.
12	130–140	Recovered 1 ft 3 in.: Shale, gray, soft, silty; streaks of soft fine gray silty sand.
13	140–150	Recovered 2 ft 6 in.: Shale, brown-gray, soft, silty; gray fine sand and silty shale. Streak of sand in base.
14	150–160	Recovered 3 ft 6 in.: 2 ft shaly sand, brown-gray, fine, silty, soft, porous. 1 ft 6 in., shale, sandy, gray-brown to brown; streaks of silty gray sand.
15	160–170	Recovered 1 ft 6 in.: Shale, gray-brown, sticky; slight streaks of silty sand.
16	170–180	Recovered 1 ft 6 in.: Shale, gray to dark-gray, silty in streaks. Numerous large round chert and quartzite pebbles maximum ½ in. in diameter. Pebbles black to gray, green, and white.
17	180–190	Recovered 1 ft 6 in.: Clay shale, gray, medium-hard, firm; very thin silty streaks.
18	190–200	Recovered 1 ft 3 in.: Shale, gray, silty; gray-brown silty clay shale; streaks of clay. Numerous large rounded smooth (½ in. in diameter) quartz, chert, and claystone pebbles.
19	200–210	Recovered 2 ft: Sand, gray, fine, soft, unconsolidated; a 4-in. streak of rotten soft brown coaly shale and carbonaceous sand at 202 ft 3 in.
20	210–220	Recovered 8 ft: Sand, fine, porous, loose to medium-firm, well-sorted, water-bearing.
21	220–230	Recovered 1 ft 3 in.: Sand as above.
22	230–240	Recovered 6 ft: Sand, gray, fine, soft, loose, porous; 3-in. streak of brown carbonaceous shale at 235 ft.

SIMPSON CORE TEST 10—Continued

Core	Depth (feet)	Description
23	240–250	Recovered 7 ft: 2 ft, sand as above, slightly shaly in base. ½-in. streak of brown shale at 241 ft. Numerous streaks of coal throughout. 5 ft, shale, gray-brown, soft, sticky, silty; in streaks with numerous ½-in. fine sand breaks and sandy shale streaks through lower 3 ft.
24	250–260	Recovered 8 ft: 1 ft 6 in., sand, brown-gray, fine, shaly. 2 ft, sandy shale, brown-gray soft. 3 ft, shale, gray-brown, soft, sticky. 1 ft 6 in., sand, brown-gray, fine, shaly in streaks.
25	260–270	Recovered 1 ft: Shale, brown-gray to brown, soft, sticky.
26	270–280	Recovered 5 ft: Shale, brown to brown-gray, sandy in last 6 in.
27	280–290	Recovered 1 ft 6 in.: Shale, gray, sticky; fine light-gray silty sand streaks (rare). Small black carbonaceous plant stem remains.
28	290–300	Recovered 10 ft: Shale, gray to light-gray-brown, firm, silty through upper 6 ft; 3-in. streak of hard dense brittle yellow-brown claystone at 297 ft 6 in.
29	300–310	Recovered 4 ft 6 in.: 4 ft, shale, gray-brown, and light-tan clay shale. 6 in., sand, brown-gray, fine, soft, loose, shaly; a 1-in. streak of hard dense brittle claystone at base.
30	310–320	Recovered 7 ft: Sand, gray, fine, loose, porous; few streaks showing considerable light-green free oil from 312 to 314 ft. Streak of shaly sand 314 ft 6 in.–315 ft. Soft sand with streak of light-green oil sand in last foot; ¼-in. streak very hard tight sandstone at 416 ft.
31	320–330	Recovered 10 ft: 2 ft 6 in., sand, gray, fine, soft, loose; free light-green oil in streaks. 6 in. sandstone, light tan, very hard, brittle, well-cemented, medium-porous to tight. 7 ft, sand, friable, soft, loose; ½-in. soft brown shale break at 326 ft and ½-in. gray shale break at base.
32	330–340	Recovered 10 ft: Shale, gray to dark-gray, medium-firm; few thin silty streaks throughout.
33	340–350	Recovered 7 ft 6 in.: Shale, gray-brown, medium-firm; silty in top 4 ft 3 in.; streak of coal, carbonaceous shale, and carbonaceous sand at base.
34	350–360	Recovered 2 ft: Shale, brown-gray; slightly silty streaks.
35	360–370	Recovered 1 ft: Shale, brown-gray, sticky; few hard dense chert and claystone fragments.
36	370–380	Recovered 1 ft 6 in.: Shale, gray to dark-gray, sticky.
37	380–390	Recovered 7 ft: Shale, gray-brown to gray and dark-gray; streaks of yellow-brown clay; thin carbonaceous streaks.
38	390–400	Recovered 1 ft 6 in.: 6 in., shale, brown-gray; slight silty streaks and thin wavy laminae of fine gray silty sand. 3 in., claystone, tan, medium hard. 9 in., sand, light-gray, fine, soft, porous; slight oil odor; gray-brown shale and streaks of sandy shale.

SIMPSON CORE TEST 10—Continued

Core	Depth (feet)	Description
39	400–410	Recovered 6 ft: Shale, gray to dark-brown, sandy in streaks; 6-in. streak of tan clay shale at 404 ft 6 in.; 3-in. streak of fine light-gray-brown silty shaly sand at base. Megafossil at 405 ft 6 in.
40	410–420	Recovered 2 ft 6 in.: Shale, gray, friable; sandy in streaks with a 2-in. streak of very hard, dense brittle light-tan claystone at base.
41	420–430	Recovered 7 ft: 3 ft 6 in., sand, brown to brown-gray, very fine, silty, slightly carbonaceous; well-sorted firm shaly sand streaks. 3 ft 6 in., shale, gray to dark-gray, friable; clay shale streaks and thin silty streaks in last 1 ft.
42	430–440	Recovered 3 ft: Shale, dark-gray to gray-brown.
43	440–450	No recovery.
44	450–460	Recovered 2 ft: Shale, gray, friable; 1-in. streak of dense, hard yellow-tan claystone at 451 ft 6 in.
45	460–470	Recovered 10 ft: 5 ft, shale, gray-brown, silty; and brown-gray fine silty sand; interbedded in thin irregular beds. 5 ft, shale, gray to gray-brown; a few silty streaks and streaks of clay.
46	470–480	Recovered 9 ft: 8 ft, shale, brown to brown-gray, friable; rare thin silty streaks but numerous thick streaks of fine sand in last 1 ft. Very slight light-green oil film along fracture and cleavage surfaces in the shale. 1 ft, sand, gray, fine, porous, soft, loose to medium firm.
47	480–490	No recovery.
48	490–500	No recovery.

SIMPSON CORE TEST 11

Core	Depth (feet)	Description
	0–2	Ice, tundra, and also distance between kelly bushing and ground.
	2–28	Sand, gray, fine, porous, loose, soft; black carbonaceous streaks.
	28–80	Sand, fine, well-sorted, uniform, loose uncemented; numerous black carbonaceous streaks and streaks with rusty brown iron stain. Streaks of tan clay from 70 to 75 ft. Top of Seabee Formation at 80 ft.
	80–85	Clay, light-brown to tan and gray, soft, bentonitic.
	85–90	Clay, gray-brown to tan and gray, bentonitic streaks; gray-black shale.
	90–100	Clay, brown to gray-brown, soft, bentonitic; streaks of gray shale.
1	100–110	Recovered 5 ft: Clay shale and shale, dark-gray to dark-brown-gray, carbonaceous, hard, brittle, dense; indurated with irregular spots and thin streaks of very fine silty sand.
2	110–120	Recovered 4 ft: Shale and clay shale as above, hard, indurated; very slightly silty in rare streaks.
3	120–130	Recovered 6 ft 6 in.: Clay shale, dark-gray, hard, brittle, fine-textured, indurated, slaty-appearing; very few thin fine-grained silty sand laminae showing dips from almost flat to 15°.
4	130–140	Recoverd 5 ft: Shale, dark-gray, brittle, hard, indurated; a few very thin regular laminae of very fine light-gray to white silty calcareous sand. Dips up to 15° noted (cross-bedding).

SIMPSON CORE TEST 11—Continued

Core	Depth (feet)	Description
5	140–150	Recovered 6 ft: Shale as above. Dips up to 10° (cross-bedding).
6	150–160	Recovered 5 ft: Shale as above, silty in streaks; streaks of very fine argillaceous shaly sand. Streaks of hard tan to gray claystone.
7	160–170	Recovered 8 ft: Shale, dark-gray, hard, brittle, indurated; smooth texture; slightly silty streaks; 1-in. streaks of white calcareous hard sandstone and sandy limestone at 160 ft 6 in. and 161 ft 6 in. Bottom 6 ft of core is solid hard brittle clay shale with very few slightly silty streaks.
8	170–180	Recovered 4 ft, 6 in.: Shale, gray-brown to dark gray, brittle, medium-soft to hard, friable; a 9-in. streak of hard indurated shale at 170 ft 6 in.
9	180–190	Recovered 10 ft: Shale, gray to dark-gray, very hard, brittle, indurated; silty streaks of white to gray calcareous sandstone.
10	190–200	Recovered 5 ft: Clay shale and shale, gray to dark-gray, smooth texture, hard, dense, brittle, indurated; irregular smooth fractures; silty in streaks; abundant very thin laminae of fine grained white to gray sandstone. Dip flat to 2°. (Core 98 percent clay shale.)
11	200–210	Recovered 10 ft: Clay shale and shale as above; breaks and parts in thin regular smooth flat disks along horizontal bedding planes.
12	210–220	Recovered 10 ft: Clay shale and shale as above.
13	220–230	Recovered 10 ft: Clay shale and shale as above.
14	230–240	Recovered 10 ft: Clay shale and shale as above.
15	240–250	Recovered 10 ft: Clay shale and shale as above; abundant fine-grained white to gray sandstone laminae; dip flat to 2° (core 15 percent sandstone).
16	250–260	Recovered 10 ft: 2 ft, shale, brown to brown-gray to gray, hard, dense, indurated, thinly laminated, brittle; silty in streaks. Fossil at 252 ft. 1 in., claystone, tan, very hard, brittle, dense. 7 ft 11 in., shale, gray to gray-brown, crumbly, medium-soft, broken and fractured.
17	260–270	Recovered 1 ft 6 in.: Shale, gray, hard to medium-soft, friable; and tan to gray very hard very dense fine smooth-textured claystone.
18	270–280	Recovered 10 ft: Shale, gray to dark-gray, hard, fractured; silty in streaks at base (lower 5 ft); streaks of hard claystone. Numerous irregular slickensided surfaces noted in upper 4 ft. Dips as high as 7°.
19	280–290	Recovered 9 ft: Shale as above; very slightly silty streaks. Bottom 1 ft of core (288–289 ft) is hard dense gray to light-gray silicified (cherty-looking) shale and clay shale. Dip as high as 10°.
20	290–300	Recovered 9 ft: 4 ft, clay shale, gray to light-gray, very hard, dense, brittle, silicified. 5 ft, shale, gray to dark-gray, brittle, medium-hard, fractured.

SIMPSON CORE TEST 11—Continued

Core	Depth (feet)	Description
21	300–310	Recovered 10 ft: 6 ft, shale as above. 4 ft, sandy shale and shale, dark-gray; numerous thin fine-grained light-gray uniform sandstone laminae through upper 2 ft, giving the core a striped or banded appearance.
22	310–320	Recovered 10 ft: Shale, gray to gray-brown, medium-hard, brittle, fractured, sandy, micaceous; regular thin fine-grained silty gray sandstone laminae and streaks. Dip as high as 7°.
23	320–330	Recovered 10 ft: Shale, gray, medium-hard, brittle, sandy; abundant thin regular laminae of fine-grained light-gray sandstone throughout. Dips to 4°.
24	330–340	Recovered 10 ft: 5 ft, shale, gray as above, slightly sandy streaks. 1 ft, sandstone, fine-grained, silty, argillaceous, very hard, tight to medium-porous, well-sorted and cemented; and hard, dense light-gray silicified clay shale. 4 ft, shale, gray to dark-gray; few thin silty sandstone laminae throughout.
25	340–350	Recovered 9 ft, 6 in.: Sandy shale, gray to dark-gray, medium-hard; irregular streaks and laminae of green-gray to gray; fine sand and green-gray medium-porous medium-well-cemented and sorted shaly sand; very slight odor and trace of oil. Interval from 340 to 345 ft is 75 percent shale. Interval from 345 to 349 ft 6 in. is 70 percent sand.
26	350–360	Recovered 10 ft: Shaly sandstone, gray-brown to brown, fine-grained, thinly bedded, porous, medium-hard; and dark-gray to brown-black, medium-hard, friable, brittle shale; and interlaminated shale and sandstone, 40 percent shale and 60 percent sandstone. Dip as high as 3°.
27	360–370	Recovered 10 ft: Sandy shale, gray, medium-hard, brittle; alternate laminae of gray silty shale and fine-grained light- to green-gray slightly micaceous sandstone; 4-in. streak of light-tan-gray fine-grained hard medium tight to porous sandstone; thin gray shale laminae. Core 60 percent sandstone. Dip horizontal to 3°.
28	370–380	Recovered 10 ft: Sandy shale and shaly sandstone, gray- to light-gray, medium-hard in alternate, thin well-developed laminae showing dips from flat to 3°; 60 percent sandstone.
29	380–390	Recovered 10 ft: Sandy shale; gray to brown-gray medium-soft friable shale; and brown-gray fine well-sorted sand and sandy shale in alternate laminae with 75 percent shale. Dips as high as 3°.
30	390–400	Recovered 10 ft: 75 percent sandstone; fine grained light- to green-gray and brown porous well-cemented shaly sandstone; and gray to brown-gray medium-soft interlaminated shale.

SIMPSON CORE TEST 11—Continued

Core	Depth (feet)	Description
31	400–410	Recovered 10 ft: Interlaminated shale, gray, medium-soft, brittle; and fine grained silty well-sorted light-gray sandstone; 1-in. streaks of very hard porous white to light gray-brown well-cemented (banded-appearing with irregular thin gray shale partings) sandstone at 406 ft 6 in., 408 ft, and 409 ft 6 in.; 40 percent shale and 60 percent sandstone in upper 6 ft, 70 percent shale in lower 4 ft of core.
32	410–420	Recovered 10 ft: Shaly sandstone and shale, gray to gray-brown, medium-hard interlaminated.
33	420–430	Recovered 10 ft: 3 ft, shaly sandstone, consisting of interlaminated gray to brown shale and light-gray sandstone. 7 ft, shale, gray to brown, silty; abundant regular thin light-gray sandstone laminae throughout. Dip as high as 5°.
34	430–440	Recovered 10 ft: Shale, gray to gray-brown, brittle, medium-soft; parts along regular smooth well-developed bedding planes showing 5° dip. Slight streaks of gray soft porous medium well-cemented sand, and sandy shale in bottom 2 ft.
35	440–450	Recovered 6 ft 6 in.: 3 ft, shaly sand, gray to gray-brown, medium-hard. 6 in., sandstone, fine-grained, well-sorted, medium-hard, medium-well-cemented, porous; few thin shale partings. 3 ft, shale, gray to gray-brown, medium-soft, brittle, friable.
36	450–460	Recovered 10 ft: 6 ft, shale, gray, medium-hard, friable, brittle; parts along smooth, even well-developed bedding planes dipping as much as 5°. 1 ft, claystone and clay, light-tan-gray, friable, brittle, broken. 3 ft, shale, gray, as above with silty sand streaks in base; ½-in. streak of gray-tan clay at base.
37	460–470	Recovered 10 ft: Shale, gray to gray-brown, medium-hard; numerous silty streaks; 99 percent shale.
38	470–480	Recovered 10 ft: Shale, gray to dark-gray, medium-hard, brittle; parts along smooth well-developed flat bedding planes in upper 7 ft of core. Thin light-gray fine grained moderately well cemented porous sandstone laminae through lower 3 ft showing irregular and varied dips. Contorted laminae with dips from vertical to horizontal. Well-preserved plant remains noted in core at 472 ft. One section of core shows a V-shaped crumpled fold.
39	480–490	Recovered 10 ft: Shale, brown to brown-gray, medium-hard, brittle; smooth conchoidal fracture and parting surfaces in part.
40	490–500	Recovered 10 ft: Shale, gray to light-gray-brown medium-hard, brittle; and light-gray brittle medium-hard slightly arenaceous clay shale.

SIMPSON CORE TEST 11—Continued

Core	Depth (feet)	Description
41	500–510	Recovered 10 ft: 3 ft, shale, gray to gray-brown, brittle; streaks of clay shale and clay with rare silty streaks. 7 ft, clay shale and claystone, light-gray to gray, brittle, medium-hard; few fine silty sand streaks. Well-developed lamination showing dips to 12°.
42	510–520	Recovered 10 ft: Shale, light- to light-brown-gray, medium-soft, brittle, friable; flaky and crumbly in streaks. Numerous very thin regular fine grained light-gray silty sandstone laminae throughout. Plant remains noted at 512 ft. Dip to 15°.
43	520–530	Recovered 9 ft: Shale, gray, medium-hard, brittle, friable; core breaks along well-developed bedding planes showing 5° dip and parallel to sides of core in a vertical plane. Very rare, slightly silty streaks.
44	530–540	Recovered 5 ft 6 in.: Shale, gray, medium-hard, brittle, friable; fractured and broken streaks.
45	540–550	Recovered 10 ft: 2 ft, shale, gray, medium-hard, as above. 3 ft, shale as above; carbonaceous plant remains, well-preserved wood fragments, and cephalopod shells. 5 ft, shale, gray, as above; very rare slightly silty streaks.
46	550–560	Recovered 10 ft: Shale, gray to brown-gray, medium hard, brittle; a few rare small poorly preserved plant fragments at 556 and 559 ft.
47	560–570	Recovered 10 ft: 9 ft 6 in., shale, brown to light-brown-gray, medium-hard, brittle, friable; streaks of clay shale and slightly silty streaks. 6 in., sandstone, fine grained, silty, porous, well-cemented, firm; thinly laminated with very slight thin shale partings.
48	570–580	Recovered 10 ft: Shale, gray, medium-hard, brittle, friable; horizontal to 3° dip. Abundant thin fine grained silty brown-gray sandstone laminae throughout. Rare poorly preserved plant stems and leaves.

SIMPSON CORE TEST 12

Core	Depth (feet)	Description
	0–5	Tundra, ice, and distance between kelly bushing and ground.
	5–16	Ice, peat, and streaks of sand.
	16–20	Sand, light-gray-brown, fine; ice and streaks of frozen clay and peat.
	20–25	Sand as above, frozen.
	25–40	Sand, fine, loose, soft, unconsolidated; slight carbonaceous streaks.
	40–45	Sand, black, fine, carbonaceous, loose, soft, and coal.
	45–50	Sand, light-gray, fine, well-sorted, loose, porous, uncemented; streaks of coal and light-blue-gray clay. Sand was frozen.
	50–55	Sand as above; abundant coal streaks and slight streaks of blue-gray clay; slight oil odor and color.
	55–60	Sand, fine, soft, loose; show of oil on mud pit.
	60–67	Sand as above; streaks of coal and very slight streaks of soft gray clay; slight show of oil.

SIMPSON CORE TEST 12—Continued

Core	Depth (feet)	Description
	67–73	Clay, light-gray, soft, and clay shale. Top of Colville Group at about 67 ft.
	73–78	Sand, light-gray, very fine, silty, well-sorted; carbonaceous streaks and streaks of clay.
	78–80	Clay, light-gray, soft, sticky, and light-gray shale.
	80–92	Clay, light-gray to light-brown, and gray to gray-brown medium-soft shale.
	92–97	Clay and clay shale, gray-brown to gray; streaks of fine loose sand.
	97–130	Clay, light-brown to brown-gray, and gray medium-soft sticky shale.
	130–168	Shale, gray, medium-soft, sticky; streaks of light-brown clay.
	168–169	Claystone, light-brown-gray, hard, dense; streaks of sand.
	169–174	Clay, light-brown and gray, and gray shale with streaks of fine loose silty gray-brown sand.
	174–190	Shale, gray, medium-soft; streaks of tan clay.
	190–195	Shale, gray, medium-hard; streaks of tan clay and slight streaks of coal.
	195–225	Shale, gray-brown; streaks of clay.
	225–237	Shale, gray-brown, medium-soft; slightly silty streaks and streaks of clay.
	237–242	Shale, gray-brown to gray, streaks of clay, and numerous streaks of fine, silty sand.
1	242–250	Recovered 8 ft: Clay shale, light-gray, soft; numerous thin laminae of fine well-sorted light-gray-brown silty sand and a few streaks of light-tan medium-hard clay and claystone.
2	250–260	Recovered 9 ft: Clay shale, light-gray-brown to gray, soft, friable; numerous thin regular flat-lying fine-grained brown to gray sand laminae in upper 3 ft and lower 2 ft. Few thin streaks of light-tan clay.
3	260–270	Recovered 10 ft: Shale, brown-gray, medium-hard, and clay shale with abundant regular thin fine sand laminae throughout. Dip to 4°. 98 percent shale and clay shale.
4	270–280	Recovered 10 ft: Shale, brown-gray, medium-soft, friable; interlaminated; thin regular fine silty brown-gray sand streaks and with streaks of slightly carbonaceous clay. Dips to 4°.
5	280–290	Recovered 10 ft: Clay shale, brown-gray, medium-hard, and light- to brown-gray shale; numerous thin streaks of fine silty sand. Dips from flat to 3°.
6	290–300	Recovered 9 ft: Clay shale, light-brown-gray, medium-hard, brittle; silty throughout, with thin regular laminae of fine well-cemented brown-gray silty sand; 3-in. streak of hard black indurated carbonaceous shale at 298 ft. Dips as high as 3°.
	300–305	Shale, gray, medium-hard, and light-gray-brown clay shale.
	305–360	Shale, gray, medium-hard; few streaks of hard claystone and clay shale. Numerous thin silty streaks.
	360–460	Clay shale, light-brown-gray to light-gray, medium-hard; slight silty streaks and few streaks of hard light-tan claystone.

SIMPSON CORE TEST 13

Core	Depth (feet)	Description
	0–6	Distance between kelly bushing and ground.
	6–20	No sample.
1	20–26	Recovered 6 ft: Microfossils present. 2 ft, drilling mud, yellowish- to medium-gray, containing scattered threads of tan rootlike organic material, possibly some gray clay. 4 ft, clay, yellowish-gray, friable, rare flecks of yellowish-brown noncalcareous limonite. Whole core very badly infiltrated with drilling mud.
2	26–32	Recovered 6 ft: Microfossils common. 1 ft 6 in., clay, light-gray with slight yellow cast; scattered patches of black carbonaceous material, noncalcareous; white fragments of pelecypod shells. 2 ft, silt and clay, light-gray very friable; slight yellow cast; mixed with drilling mud; noncalcareous; white pelecypod shell fragments. 10 in., sand and silt, light-gray very fine, extremely friable; yellow cast, some limonitic streaks, noncalcareous. 1 ft 8 in., clay, light-gray, friable, noncalcareous; yellow cast; white pelecypod shell fragments.
3	32–36	Recovered 6 ft: Microfossils abundant. Clay, light-gray; yellow cast, thin limonitic streaks, a few pelecypod shells, also a few small rounded black chert pebbles; noncalcareous; whole core infiltrated with drilling mud.
4	36–46	Recovered 10 ft: 9 ft, clay, light-gray; yellow cast, scattered silty and some dark-gray carbonaceous streaks and limonitic laminae; white pelecypod shell fragments; noncalcareous. Badly broken and infiltrated with drilling mud. 1 ft, silt, light-gray, argillaceous; yellow cast, contains numerous dark small rounded chert pebbles, sand grains, and pelecypod fragments; noncalcareous.
5	46–50	Recovered 4 ft: Silt, light-gray argillaceous; yellow cast; contains rare well-rounded siliceous pebbles, maximum diameter ½ in., also large amounts of well-rounded noncalcareous sand grains.
6	50–55	Recovered 3 ft 8 in.: 1 ft 2 in., sand, light-gray, fine; yellow cast; a few laminae of gray clay, patches of brown limonitic stain. 6 in., silt, light-gray; yellow cast, grades from sand above; scattered limonitic carbonaceous layers. 2 ft, clay, gray; yellow cast, white pelecypod shell fragments, some brown limonitic stain; noncalcareous.
7	55–62	Recovered 6 ft: Microfossils common. Clay as immediately above but no pelecypod fragments; fine sand in last few inches of core.
8	62–66	Recovered 4 ft: Microfossils common. 9 in., sand and clay interbedded, light-gray, fine; yellow cast; sand has brownish limonite stained blotches, pelecypod fragments; noncalcareous. 3 ft 3 in., clay, light-gray; yellow cast somewhat silty in spots; a few small (1½ in.) rounded black chert pebbles; noncalcareous.

SIMPSON CORE TEST 13—Continued

Core	Depth (feet)	Description
9	66–72	Recovered 6 ft: Clay, light-gray as immediately above but with pebbles as large as 2 in. in diameter; rare white pelecypod shell fragments.
10	72–77	Recovered 5 ft: Clay, light-gray, somewhat silty, a few dark-gray carbonaceous streaks, pebbles, and pelecypods present as above; noncalcareous.
11	77–82	Recovered 5 ft: Microfossils rare. 10 in., clay light-gray as immediately above. 3 ft 2 in., silt light-gray; interbedded with numerous layers of medium-gray very fine to medium sand and gravel. Pebbles of gravel up to 2 in. in diameter (mostly about ½ in. or less) consist largely of well-rounded black chert but also some well-rounded pale yellowish-brown quartzite; noncalcareous. 1 ft, clay, light-gray, silty streaks.
12	82–85	Recovered 3 ft 6 in.: Microfossils common. Clay and silt interbedded, light-gray, hard, 1¾ in. layer of yellowish-gray clay in top 6 in.; noncalcareous.
13	85–91	Recovered 5 ft 7 in.: Microfossils absent. Siltstone, fissile; interbedded with light-gray noncalcareous silt and clay. Top of Seabee Formation at 87 ft.
14	91–97	Recovered 5 ft 7 in.: Siltstone alternating with thin laminae of light-gray clay shale; cleavage parallel, bedding dips 10°, a few vertical fractures; noncalcareous carbonaceous fragments, mica plates, pyrite crystals.
15	97–105	Recovered 3 ft: Siltstone as immediately above.
16	105–111	Recovered 6 ft: Microfossils absent. Siltstone as above. Siltstone characterized by a very smooth break; clay shale a hackly break. Larger the proportion of silt, the smoother the break because the silt contains mica plates oriented parallel to the bedding; 10° dip; noncalcareous. Fishbone fragments found in washed microfossil samples.
17	111–116	Recovered 5 ft: Microfossils absent. Siltstone as above.
18	116–126	Recovered 6 ft: Microfossils very rare. Clay shale, light gray; siltstone laminae and parting; hackly fracture, siltstone slightly darker than clay shale because of minute flecks of carbonaceous material; noncalcareous.
19	126–133	Recovered 6 ft 6 in.: Microfossils absent. Clay shale and siltstone as above, 5° dip.
20	133–138	Recovered 2 ft 6 in.: Microfossils absent. Clay and clay shale with silty partings. Upper 1 ft infiltrated with drilling mud; noncalcareous.
21	138–143	Recovered 5 ft: Microfossils absent. Clay shale with light-gray silty partings; hackly fracture; one silty layer very slightly calcareous.
22	143–148	Recovered 5 ft: Microfossils absent. Clay shale as immediately above, 10° dip.

SIMPSON CORE TEST 13—Continued

Core	Depth (feet)	Description
23	148–158	Recovered 8 ft 8 in.: Microfossils absent. Clay shale, light-gray, hackly fracture; slightly darker siltstone laminae and partings; a 2-in. layer of very fine medium-light-gray friable sandstone at about 155 ft. Siltstone slightly calcareous in spots.
24	158–165	Recovered 6 ft 3 in.: Microfossils absent. Clay shale, light-gray; medium-gray (darker because of micaceous and carbonaceous flecks) silty parting. Silty partings slightly calcareous; 2° dip. Fishbone fragments.
25	165–172	Recovered 6 ft: Microfossils absent. Clay shale as immediately above. Fishbone fragments.
26	172–175	Recovered 3 ft: Microfossils absent. Clay shale, light-gray; medium-light-gray siltstone laminae and partings. Siltstone slightly calcareous. Fishbone fragments.
27	175–180	Recovered 5 ft: Microfossils absent. Clay shale as immediately above. Fishbone fragments.
28	180–185	Recovered 5 ft: Microfossils very rare. Clay shale as above. Fishbone fragments.
29	185–190	Recovered 5 ft: Microfossils very rare. Clay shale as above. Fishbone fragments.
30	190–195	Recovered 5 ft: Clay shale, light-gray; medium-light-gray siltstone laminae and partings. One layer of silty, medium-light-gray very fine sandstone; yellow cast. Sandstone slightly calcareous; 2° dip.
31	195–201	Recovered 5 ft 4 in.: Microfossils absent. Shaly clay, light-gray; medium-light-gray silty laminae and partings, 2° dip, noncalcareous.
32	201–206	Recovered 5 ft: Microfossils very rare. Shaly clay as above.
33	206–215	Recovered 9 ft: Microfossils very rare. Shaly clay as above.
34	215–221	Recovered 6 ft: Microfossils absent. Shaly clay as above, 3° dip.
35	221–226	Recovered 5 ft: Microfossils absent. Shaly clay, light-gray with silty partings; light-gray silt, yellow cast; noncalcareous.
36	226–227	Recovered 1 ft: Microfossils absent. 8½ in., shaly clay as above, 3° dip; noncalcareous 3¼ in., limestone, medium-dark-gray, hard, lithographic; conchoidal fracture, calcite filling minute fracture.
37	227–229	Recovered 1 ft 4 in.: Microfossils absent. 3 in., shaly clay, light-gray; silty partings. 4 in., limestone, dark-gray, argillaceous; not as hard or dense as that in core 36; irregular fracture. 9 in., shaly clay, light-gray; silty partings; silt light gray; yellow cast; noncalcareous.
38	229–236	Recovered 6 ft 6 in.: Microfossils absent. Shaly clay as immediately above, hackly fracture, 3° dip.
39	236–244	Recovered 8 ft: Microfossils absent. 1 ft 7 in., as above. 1 in., siltstone, brownish to yellowish-gray, hard, conchoidal fracture, moderately calcareous. 6 ft 4 in., shaly clay, light-gray; silty parting; silt light gray; yellow cast; noncalcareous.

SIMPSON CORE TEST 13—Continued

Core	Depth (feet)	Description
40	244–254	Recovered 10 ft: Microfossils absent. 1 ft 9 in., shaly clay as above, 5° dip. 2 in., limestone, medium-dark-gray, hard, irregular fracture. 8 ft 1 in., shaly clay, light-gray; silty partings; silt is light gray; yellow cast, noncalcareous. A fish scale at 252½ ft.
	254–274	No sample.
41	274–284	Recovered 10 ft: Microfossils absent. Shaly clay as above.
42	284–294	Recovered 10 ft: Microfossils absent. Shaly clay, light-gray; silty partings rare in contrast to above section; hackly fracture very conspicuous; slightly calcareous in spots.
43	294–304	Recovered 4 ft: Microfossils very rare. Clay and shaly clay, light-gray; badly broken and infiltrated with drilling mud; slightly calcareous in spots.
44	304–314	Recovered 4 ft: Microfossils very rare. Clay and shaly clay, light-gray. Clay is hard, nonfissile. Shaly clay fissile; hackly fracture; noncalcareous.
45	314–324	Recovered 8 ft: Microfossils absent. Shaly clay, light-gray; silty partings; silt light gray; yellow cast; contains numerous plates of mica (as with all other cores above with silty partings). Mica plates account for the fissile smooth break parallel to the bedding; silt slightly calcareous, 7° dip.
46	324–334	Recovered 10 ft: Microfossils absent. Shaly clay, light-gray; silty partings; silt light gray; yellow cast, noncalcareous; 10° dip.
47	334–344	Recovered 7 ft 6 in.: Shaly clay as above. Brown carbonaceous(?) material in silty partings, 5° dip.
48	344–354	Recovered 10 ft: Shaly clay as above. At 349½ ft and 352 ft layers 2–4 in. thick of light-gray shaly silt.
49	354–364	Recovered 8 ft: Shaly clay, light-gray; silty partings, light-gray; yellow cast; also several thin layers of shaly silt; silty layers slightly calcareous, 7° dip.
50	364–374	Recovered 10 ft: Shaly clay as above, thin (2 in.) shaly silty layers light-gray; yellow cast, slightly calcareous.
51	374–384	Recovered 7 ft 6 in.: Shaly clay as above.
52	384–394	Recovered 7 ft 8 in.: 6 ft 11 in., shaly clay as above. 9 in., siltstone, light-gray, a slight yellowish cast, hard; a few laminae grade to very fine sandstone, which contains carbonaceous (vitreous black coal?) micaceous and pyritic grains. Very calcareous cement.
53	394–402	Recovered 8 ft 6 in.: Shaly clay, light-gray; silty partings, hackly fracture where not silty, slightly calcareous.
54	402–412	Recovered 9 ft 6 in.: As above, some light-gray silty laminae.
55	412–422	Recovered 9 ft: Shaly clay, light-gray; brownish-yellow-gray silty partings; 3 in. of very calcareous light-gray siltstone at 414 ft 6 in.; 8° dip.
56	422–432	Recovered 10 ft: Shaly clay as above, some shaly silty laminae.

SIMPSON CORE TEST 13—Continued

Core	Depth (feet)	Description
57	432–442	Recovered 7 ft 6 in.: Shaly clay as above.
58	442–452	Recovered 4 ft 6 in.: Shaly clay as above, shaly silt laminae, slightly calcareous, last 2 ft infiltrated with drilling mud.
59	452–462	Recovered 5 ft 6 in.: Microfossils absent. Shaly clay, light-gray, yellow cast; laminae and partings of shaly silt.
60	462–472	Recovered 4 ft: Shaly clay as above.
61	472–482	Recovered 4 ft 2 in.: Shaly clay as above, 7° dip.
62	482–492	Recovered 5 ft: Shaly clay as above.
63	492–497	Recovered 4 ft 6 in.: Shaly clay as above.
64	497–502	Recovered 3 ft 10 in.: Shaly clay as above.
65	502–508	Recovered 4 ft: Shaly clay as above.
66	508–517	Recovered 3 ft 6 in.: Shaly clay as above.
67	517–524	Recovered 6 ft: Shaly clay as above.
68	524–528	Recovered 1 ft: Shaly clay as above, 3° dip.
69	528–533	Recovered 5 ft: 3 in., limestone, medium-dark-gray, dense; subconchoidal fracture. 4 ft 9 in., shaly clay, light-gray; silty partings and numerous shaly silt laminae, light-gray; yellow cast; noncalcareous.
70	533–538	Recovered 4 ft: Shaly clay, light-gray; silty partings and scattered light-yellowish-gray silty laminae; noncalcareous; 3° dip.
71	538–548	Recovered 7 ft 6 in.: Shaly clay as above.
72	548–558	Recovered 3 ft: 2 ft 9 in., as above. 3 in., siltstone, light-gray; yellow cast, moderately hard, slight tendency toward shaly cleavage; very calcareous.
73	558–563	Recovered 4 ft: Shaly clay, light-gray; silty partings (a few brownish in color—carbonaceous?) and laminae. Silt laminae slightly calcareous. Upper 1½ ft infiltrated with drilling mud.
74	563–569	Recovered 6 ft: Shaly clay and silt as above.
75	569–577	Recovered 7 ft: Shaly clay as above, 9° dip approximately.
76	577–583	Recovered 4 ft: Shaly clay as above.
77	583–588	Recovered 2 ft: Shaly clay as above.
78	588–592	No recovery.
79	592–594	Recovered 2 ft: Shaly clay and silt, as above, 18° dip.
80	594–599	Recovered 5 ft: Shaly clay and silt as above; one very fine sand parting. *Inoceramus* prism.
81	599–604	Recovered 2 ft: Shaly clay as above, but very fine sandy layers (up to ¼ in. thick) similar to those described as "silty partings and laminae" have faint oil odor and stain.
82	604–609	Recovered 4 ft 5 in.: Shaly clay as immediately above, very faint oil odor and stain.

SIMPSON CORE TEST 13—Continued

Core	Depth (feet)	Description
83	609–617	Recovered 5 ft: Microfossils very rare. 1 ft, shaly clay, light-gray; silty micaceous partings light-gray with yellow cast; noncalcareous. 1 ft 9 in., sand and shaly, silty clay, light-gray. Sand, yellow, fine to medium; difficult to estimate proportion of sand to clay because sand is so friable, broken, and mixed with and around clay lumps. Noncalcareous. Slight oil stain and fair oil odor, Yellow cut. A few small vitreous black pieces of coal noted. 5 in., shaly clay, light-gray; silty and sandy partings, slightly yellow. Clay has numerous small brown fish scales, bones, and other fragments; noncalcareous; dip 25°. 10 in., shaly clay and sand, light-gray, largely broken and infiltrated with drilling mud. Several fragments of clay have well-developed slickensides at directions random with respect to the cleavage. Fine to medium subangular friable slightly yellow sandstone; has a fair oil odor; noncalcareous. 1 ft, interbedded shaly clay and shaly silt, each about 50 percent, light gray; noncalcareous.
84	617–622	Recovered 1 ft 5 in.: Microfossils absent. Mixed and broken light- to medium-light-gray shaly clay, silt, sand, and drilling mud; noncalcareous. Sand as described in core 83, faint oil stain and odor.
85	622–627	Recovered 3 ft: Microfossils absent. 6 in., shaly clay, medium-dark-gray, fissile, silty; micaceous partings, tendency toward vertical fracture; numerous minute brown fish remains similar to those noted in core 83; noncalcareous; 20° dip. 3 in., bentonitic clay, light-bluish-gray, massive, moderately hard, waxy to the touch; irregular fracture; noncalcarerous. 2 in., silty bentonitic clay, very light gray, moderately soft; dark biotite flakes sprinkled throughout; astringent taste; noncalcareous. 4 in., bentonitic shaly clay, dark-gray; a few laminae of friable light-yellowish-gray silt to very fine sand; slight oil odor; noncalcareous. 4 in., limestone, dark- to light-bluish-gray, granular, hard. Fractures filled with minute columnar crystals of aragonite resembling satin spar. 2 in., bentonite, very-light-gray, massive, rather soft; chipped with fingernail; in water swells into an unctuous, gelantinous mass; noncalcareous. 8 in., drilling mud contains fragments of material described above—shale, bentonitic clay, sand, and bentonite. 7 in., bentonite as described above.
86	627–633	Recovered 4 ft: Microfossils common. 2 ft 4 in., mixed and broken drilling mud, medium-gray shaly clay, light- to medium-gray fine sand; slight oil odor and stain and very light gray bentonite. 1 ft 6 in., sandstone, medium-light-gray; yellow cast; grains range in size from silt to very fine sand; contains much subrounded quartz and some biotite; friable; slight oil stain and odor; noncalcareous. 2 in., bentonite, very-light-gray.

SIMPSON CORE TEST 13—Continued

Core	Depth (feet)	Description
87	633–640	Recovered 8 ft: Microfossils common. 7 in., shaly clay, dark- to medium-gray; a few very fine sand laminae with oil odor and stain; noncalcareous. 1 ft 8 in., shaly clay, medium-light- to medium-gray; silty and some sandy partings. Upper 3 in. grades from a very light gray silty bentonite into the clay; noncalcareous; dip 25°. 1 ft 5 in., bentonitic shaly clay, light-bluish-gray; flakes of dark-brown biotite common; noncalcareous. 4 ft 4 in., shaly clay, light- to medium-light-gray; silty partings; numerous small brown fish remains, one slickenside(?) noted; noncalcareous.
88	640–644	Recovered 3 ft: Microfossils rare. 10 in., shaly clay as immediately above. 6 in., broken section contains gray shaly clay, very light gray bentonite, and powdery and crystalline calcareous material. 1 ft 8 in., shaly clay, light- to dark-gray; contains layers up to 2 in. thick of light-gray bentonite; shaly cleavage, vertical fracture; dip approximately 15°.
89	644–649	Recovered 5 ft: Microfossils rare. 3 ft 2 in., shaly clay, light- to dark-gray; some silty partings, scattered streaks of bentonite; noncalcareous. Brown fish remains; vertical fracture. 1 ft 10 in., sandstone, light-gray; yellow cast, very fine to fine, friable, noncalcareous; fair oil stain and oil odor.
90	649–653	Recovered 3 ft: Microfossils very rare. 2 ft 10 in., interbedded sandstone and shaly clay. Sandstone, light gray; slight yellow cast (oil stain?), very fine to fine; slight oil odor. Shaly clay as described in core above, dip about 10°. One streak of slightly calcareous light-gray bentonitic clay at 650 ft. 2 in., bentonite, very-light-gray, massive, moderately hard; speckled with dark biotite flakes; noncalcareous.
91	653–661	Recovered 6 ft: Microfossils very rare. 10 in., shaly clay, medium- to dark-gray; bentonitic in the upper 3 in., next 4 in. mixed with white broken limey material as described in core 88. 1 ft 3 in., shaly clay, light-bluish-gray, silty, bentonitic, very slightly calcareous. 1 ft 5 in., clay light- to medium-gray, silty, shaly; contains numerous large white and yellow *Inoceramus* shell fragments (as large as 2½ in. in diameter); also contains the same small (nothing larger than 1¼ in.) brown fish scales and ribs; dip 6°. 2 ft 6 in., siltstone, in places grading into fine sandstone, medium-light-gray; yellow cast; massive, soft but not particularly friable; no oil odor; 5 in. from the bottom is a 2-in. layer of white chalky calcareous material.
92	661–663	Recovered 2 ft: Microfossils rare. Shaly clay, light- to medium-gray; first inch contains a round black nodule 1 by 1½ by 2 in., a piece of wood—concentric growth rings are plainly visible—altered to low-grade coal; noncalcareous. Top of Grandstand Formation at 661 ft.

SIMPSON CORE TEST 13—Continued

Core	Depth (feet)	Description
93	663–673	Recovered 10 ft: Microfossils rare. 6 ft 4 in., shaly clay, light-gray; uniform in content and texture (no silt, mica, bentonite, carbonaceous material, or fish remains), moderately hard; vertical fracture; noncalcareous; 5° dip; grades in last 4 in. to: 3 ft 2 in., sandstone, light-gray; yellow cast; grains range in size from silt to fine sand; contains micaceous and carbonaceous flakes; very slightly calcareous; very faint oil odor and stain. 6 in., silty shaly clay, light-gray.
94	673–681	Recovered 4 ft: Microfossils absent. Shaly clay, color ranges from light-gray to grayish-yellow to dark-gray; silty in places; noncalcareous.
95	681–690	No recovery.
96	690–696	Recovered 5 ft 6 in. Microfossils absent. Sandstone, light-gray; yellow cast, very fine to nearly medium; some very few laminae nearly black, containing large amounts of carbonaceous and micaceous flakes; friable; noncalcareous; oil stain and odor throughout, fairly good in spots, yellow cut.
97	696–706	Recovered 9 ft: Microfossils absent. Sandstone and some siltstone, medium-light- to medium-gray, yellow cast. Whole interval consists of alternate layers up to about 2 in. thick of siltstone and darker layers of friable sandstone; some laminae very slightly calcareous. Sandstone darker because it contains much vitreous black bitumen or low-grade coal plus much mica. Grains range up to the coarse-sand size, but cemented with much finer silt and siliceous material. Section has a faint oil stain and odor, a straw-colored cut obtained at 699½ ft. Porosity at this point approximately 28 percent; permeability not tested as core too soft.
98	706–711	Recovered 3 ft: Microfossils common. Shaly clay, medium- to medium-dark-gray; a few silty laminae, also a few dark carbonaceous laminae; noncalcareous; dips range from estimated 3°–5°. One very small (¼ in. long) shell found—*Lingula*?
	711–712	No sample.
99	712–718	Recovered 4 ft 6 in.: Microfossils common. 2 ft 5 in., shaly clay as above. 2 ft 1 in., siltstone, medium-light-gray; a few sandy partings containing carbonaceous and micaceous particles; also clay laminae; slightly calcareous; rather soft and mixed with drilling mud.
100	718–724	Recovered 3 ft: Microfossils common. 1 ft 9 in., the upper part of this core is broken and mixed with drilling mud but contains fragments of the following materials from top to bottom: dark-gray waxy bentonitic clay, hard silty grayish-yellow clay ironstone concretions, and light-gray calcareous soft siltstone. 1 ft 3 in., shaly clay, medium-light-gray; contains some silt, slightly calcareous. Last 2 in. of core are made up of a very hard reddish-gray-yellow clay ironstone concretion; conchoidal fracture; noncalcareous.

SIMPSON CORE TEST 13—Continued

Core	Depth (feet)	Description
101	724–731	Recovered 7 ft: Microfossils common. 5 ft 7 in., shaly clay, medium-light- to medium-dark-gray, upper 3 ft are quite uniform, lower 2 ft contains silt laminae; a few very small yellowish-brown pyrite nodules present; noncalcareous. 1 ft 5 in., siltstone and shaly clay interbedded; light-gray moderately hard siltstone contains thin beds (¼ in. thick) of shiny black coal; medium-dark-gray shaly clay contains small lenses of pyrite; noncalcareous.
102	731–738	Recovered 5 ft: Microfossils common. 2 ft 10 in., shaly clay, medium-gray, scattered yellow blotches; becomes silty and calcareous near the bottom and grades into: 2 ft 2 in., siltstone and very fine sandstone, medium-light-gray, moderately calcareous; sandy intervals have slight oil stain and odor. In last 2 in. of core a concretion of grayish-yellow calcareous dense clay ironstone.
103	738–744	Recovered 3 ft 6 in.: Microfossils common. 3 ft, shaly clay, medium-light-gray, slightly silty; noncalcareous; about 1 ft of the core contains numerous yellowish-white pelecypod shells. 6 in., siltstone with some very fine sand, medium-light-gray, very faint oil odor.
104	744–754	Recovered 2 ft 6 in.: Microfossils absent. Sandstone, medium-light-gray; grains range from very fine to nearly medium sand; very soft, poorly cemented. Most conspicuous constituent, estimated 80 percent, subangular quartz. Carbonaceous and micaceous particles common and average a little larger in size than quartz, a little bentonite(?) also present; noncalcareous. Some clay and silt included in sandstone. Mottled fair yellow oil stain and faint odor. Straw-colored cut from 745 ft.
105	754–760	Recovered 6 ft: 7 in., sandstone as above, grades at bottom to: 5 ft 5 in., shaly clay, medium-light-gray, rarely yellow, some silt laminae; noncalcareous.
106	760–767	Recovered 3 ft 6 in.: Microfossils absent. Shaly clay, medium-light-gray; some silty streaks; calcareous.
107	767–771	Recovered 3 ft 6 in.: Microfossils rare. 3 ft, shaly clay, medium-light-gray, a few minute grains of pyrite noted in partings; noncalcareous. 6 in., sandstone, medium-light-gray, fine, fairly good oil odor and stain; noncalcareous.
108	771–781	Recovered 10 ft: Sandstone, as described above in core 104. Very poorly or not at all consolidated, possibly a larger percentage of nearly medium-sized grains than in core 104; noncalcareous. Fairly good oil stain and good odor. Yellow cut from 778 ft.
109	781–791	Recovered 10 ft: Microfossils rare. Sandstone as immediately above; at 788 ft numerous very thick black carbonaceous and micaceous laminae. Fair oil stain and odor; noncalcareous.

SIMPSON CORE TEST 13—Continued

Core	Depth (feet)	Description
110	791–801	Recovered 10 ft: Microfossils absent. Sandstone, medium-light-gray; grains range in size from silt to fine sand with a predominance of the latter, made up primarily of subangular to subrounded grains of quartz plus some mica and carbonaceous material. At approximately 795 ft some clayey laminae contain many mica plates lying parallel to the bedding. Whole core is very soft or unconsolidated; noncalcareous; slight mottled oil stain and odor. No colored cut, using carbon tetrachloride as solvent, from sample taken at 798 ft, but a faint yellowish residue remained upon drying in an evaporating dish.
111	801–810	Recovered 7 ft: Microfossils absent. Soft sandstone as above, no shows.
112	810–812	Recovered 1 ft 6 in: Microfossils absent. 1 ft, soft sandstone as above, grades to siltstone at base of core. 6 in., siltstone, light-olive-gray, very calcareous, hard micaceous; some very dark carbonaceous partings, beds lie very nearly flat.
113	812–813	Recovered 1 ft: Microfossils absent. Siltstone and very fine sandstone, medium gray, hard, very calcareous; slight yellow cast.
114	813–823	Recovered 7 ft 6 in.: Microfossils absent. 1 ft 1 in., as immediately above; contains laminae with brown and black flecks of carbonaceous material. 6 ft 5 in., sandstone, medium-gray, very soft, noncalcareous; grain size ranges from very fine to fine sand, subangular to subrounded grains; quartz grains make up about 80 percent, also mica and carbonaceous material; no oil odor or stain.
115	823–833	Recovered 8 ft 9 in.: Microfossils absent. Sandstone as above, oil odor (?), no stain, no cut at 823 ft.
116	833–842	Recovered 9 ft: Microfossils absent. Sandstone as above, no oil odor or stain, slightly better consolidated than above two cores; noncalcareous.
117	842–852	Recovered 10 ft: Microfossils absent. Sandstone and siltstone, medium-light-gray, silt to very fine sand size grains subrounded; chief constituent is quartz; some micaceous and carbonaceous partings, friable; noncalcareous; 4°? dip; very slight oil odor (?), no cut or residue at 848 ft.
118	852–862	Recovered 8 ft 6 in.: Microfossils common. 10 in., sandstone and siltstone as above. 7 ft 8 in., interbedded shaly silt and c'ay, light-medium- to light-gray, hackly fracture in the clay, numerous *Ditrupa* sp. and a few pelecypod shells; noncalcareous; yellowish-gray moderately hard clay ironstone concretions at 853 and 862 ft, noncalcareous.
119	862–870	Recovered 8 ft: Microfossils abundant. Shaly clay, medium-light- to medium-gray, hackly fracture; numerous medium-light-gray silty laminae and partings; a layer of *Ditrupa* sp. and gastropod shells at 863 ft; yellowish-gray clay ironstone concretion at 862½ ft; several small pyritic nodules noted; noncalcareous.
120	870–877	Recovered 5 ft 6 in.: Microfossils abundant. Shaly clay as above, pelecypod shell at 871½ ft.

SIMPSON CORE TEST 13—Continued

Core	Depth (feet)	Description
121	877–884	Recovered 4 ft: Microfossils abundant. Shaly clay as above, considerable infiltration of drilling mud.
122	884–895	Recovered 8 ft 6 in.: Microfossils absent. 9 in., shaly clay as above, grades at base into sandstone. 7 ft 9 in., sandstone, medium-light-gray, between fine and medium sand, subangular to subrounded grains; 80 percent quartz; also some carbonaceous material. Sandstone very friable or practically unconsolidated; noncalcareous; no oil odor or stain.
123	895–904	Recovered 5 ft 6 in.: Microfossils absent. Sandstone as above.
124	904–910	Recovered 6 ft 6 in.: Microfossils absent. Sandstone as above, grains mostly of fine sand size.
125	910–920	Recovered 10 ft: Microfossils rare. Sandstone as immediately above, calcareous grayish-yellow ironstone concretion at 913 ft.
126	920–928	Recovered 8 ft: Microfossils common. 4 ft, as above. 6 in., shaly silt and clay interbedded; clay, medium gray; silt, medium-light-gray; slightly calcareous toward the base of the core. 3 in., limestone, medium- to medium-dark-gray, argillaceous, silty, moderately hard. 3 ft 3 in., shaly silt, medium-light-gray, numerous clayey partings and laminae; moderately calcareous in spots.
127	928–930	No recovery.
128	930–950	Recovered 20 ft: Microfossils rare. 2 ft 10 in., sandstone, medium-light-gray, fine-grained, subrounded to subangular; quartz, primary mineral; very friable, noncalcareous. 7 in., siltstone, yellowish-gray, very hard; irregular fracture; contains very small brown plant impressions; slightly calcareous. 6 ft 7 in., sandstone as above in this core. 3 in., sandstone, grayish-yellow, very fine, silty, slightly calcareous, moderately hard. 9 ft 9 in., sandstone, medium-light-gray, fine grained, soft; same as described in uppermost part of this core; slight oil odor but no cut or residue from 947 ft; dip 3°(?).
129	950–971	Recovered 17 ft: Microfossils rare. 8 in., shaly clay, medium-gray; hackly fracture, noncalcareous; small pyrite(?) nodule. 1 ft, limestone, medium-gray, hard and dense, rare black carbonaceous discolorations; irregular fracture; very fine calcite vein; grades at bottom of interval to: 1 ft 2 in., siltstone, medium-light-gray, moderately hard, noncalcareous; grades at bottom of interval to: 5 ft, sandstone, medium-light-gray, very fine grained, subrounded to subangular, primary mineral, quartz; very soft; noncalcareous. 9 ft. 2 in., sandstone as above but fine grained slight oil odor, no cut or residue from 967 ft.

SIMPSON CORE TEST 13—Continued

Core	Depth (feet)	Description
130	971–991	Recovered 20 ft: Microfossils absent. Sandstone, medium-light-gray; very fine to fine sand, rounded to subangular grains; quartz, primary mineral; a few micaceous and carbonaceous partings, very soft and practically unconsolidated; noncalcareous, no oil stain or odor. Crinoid fragment.
131	991–999	Recovered 6 ft 4 in.: Microfossils common. 2 ft, sandstone as above, black coaly carbonaceous laminae at 992 ft; grades at bottom to: 2 ft, siltstone, medium-light-gray; yellow cast in several laminae; soft but better consolidated than sandstone immediately above; noncalcareous; one small grayish-yellow slightly calcareous silty concretion at 993½ ft. Some *Ditrupa* sp. tubes at 993 ft. 2 ft 4 in., shaly clay, medium-gray, some medium-light-gray, silty laminae; noncalcareous; 3° dip.
132	999–1, 006	Recovered 2 ft: Microfossils abundant. Drilling mud contains chert pebbles from the Gubik Formation mixed with broken silty medium-gray shaly clay. One large (whole diameter of the core) tan broken shell in the middle of the core; noncalcareous.
133	1, 006–1, 014	Recovered 5 ft, 3 in.: Microfossils abundant. Shaly silt, medium-gray; numerous laminae of shaly clay, friable; noncalcareous, 2 in. of hard slightly calcareous grayish-yellow siltstone at about 1,010 ft.
134	1, 014–1, 019	Recovered 3 ft, 6 in.: Microfossils abundant. Interbedded shaly silt and clay, medium-light-gray, scattered yellowish-gray lenses and laminae in the silt; noncalcareous.
135	1, 019–1, 026	Recovered 5 ft, 3 in.: Microfossils abundant. Silt and clay as above, clay 75 percent, silt 25 percent; clay has hackly fracture.
136	1, 026–1, 030	Recovered 1 ft: silt and clay as above.
137	1, 030–1, 036	Recovered 2 ft 6 in.: Microfossils abundant. Silt and clay as above, silt is slightly lighter in color than clay, also silt is slightly calcareous.
138	1, 036–1, 038	Recovered 1 ft 5 in.: Microfossils abundant. Clay, medium-light-gray, slightly shaly; scattered silt laminae, slightly calcareous.
139	1, 038–1, 041	Recovered 1 ft 8 in.: Microfossils abundant. Clay as above, ¾ in. of grayish-yellow slightly calcareous siltstone at the bottom of the interval.
140	1, 041–1, 050	Recovered 6 ft: Microfossils abundant. Shaly clay, medium-gray; scattered silty laminae, silt slightly calcareous.
141	1, 050–1, 055	Recovered 4 ft: Microfossils common. Shaly clay as above, very little silt.
142	1, 055–1, 062	Recovered 2 ft 6 in.: Shaly clay, medium-gray, a lens of yellowish-gray clay at 1,059 ft; hackly fracture; noncalcareous.

SIMPSON CORE TEST 13—Continued

Core	Depth (feet)	Description
143	1, 062–1, 066	Recovered 3 ft: Microfossils common. 1 ft 6 in., shaly clay as above. 1 ft 6 in., silt, medium-gray, numerous clay laminae; laminae of black carbonaceous material and a few laminae of very fine friable sand. Sandy laminae, mostly at bottom of interval, have a slight oil stain and fair oil odor. An amber cut was obtained at 1,066 ft, and a yellowish-brown residue resulted; noncalcareous; beds lie virtually flat.
144	1, 066–1, 075	Recovered 7 ft: Microfossils common. Silt with clay laminae as above, very little sand, fair oil odor and faint stain. Straw-colored cut and yellow residue was obtained from 1,070 ft.
145	1, 075–1, 079	Recovered 1 ft: Microfossils common. Shaly clay, medium-gray, noncalcareous. One inch of very calcareous light-olive-gray siltstone near the bottom of the interval.
146	1, 079–1, 084	Recovered 5 ft: Microfossils common. Interbedded shaly silt and medium-gray noncalcareous shaly clay. Silt light-olive-gray, moderately calcareous in spots, soft, and in the lowest foot of the interval has a fair oil stain and odor. Dark carbonaceous partings present in the silt; beds lie flat.
147	1, 084–1, 087	Recovered 2 ft 2 in.: Microfossils common. Silt and clay as above, about 60 percent clay and 40 percent silt. Silt has fair oil stain and odor and moderately calcareous.
148	1, 087–1, 093	Recovered 3 ft 1 in.: Microfossils common. Shaly clay, medium- to medium-light-gray, hackly fracture; also a few slightly calcareous silty laminae.
149	1, 093–1, 098	Recovered 5 ft: Microfossils common. Shaly clay as above, very few silt laminae.
150	1, 098–1, 102	Recovered 4 ft: Microfossils common. Shaly clay as above, about 5 percent silt.
151	1, 102–1, 107	Recovered 4 ft 6 in.: Microfossils abundant. Shaly clay as above, virtually no silt; noncalcareous.
152	1, 107–1, 113	Recovered 4 ft 6 in.: Microfossils abundant. Shaly clay as above, silty toward bottom half of interval.
153	1, 113–1, 118	Recovered 5 ft: Microfossils abundant. 1 ft 9 in., siltstone, medium-light-gray, very soft; has yellow cast and slightly harder in lower 3 in. of interval; noncalcareous; very faint petroliferous odor, a faint straw-colored cut from 1, 113 ft and a very pale yellow residue. 3 ft 3 in., shaly clay, medium-light- to medium-gray, scattered silty laminae, noncalcareous; estimated 3° dip.
154	1, 118–1, 125	Recovered 6 ft: Microfossils abundant. Interbedded silty shaly clay and siltstone, medium-light-gray; noncalcareous. Silt at 1,119 ft has a very slight petroliferous odor.
155	1, 125–1, 133	Recovered 3 ft 7 in.: Microfossils rare. Shaly clay, medium- to medium-light-gray, hackly fracture, slightly calcareous.
156	1, 133–1, 135	Recovered 2 ft: Microfossils rare. Shaly clay as above.

SIMPSON CORE TEST 13—Continued

Core	Depth (feet)	Description
157	1, 135–1, 138	Recovered 3 ft: Microfossils rare. 2 ft, shaly clay as above. 1 ft, sandstone, medium-light-gray, very fine to fine; grains subrounded to subangular; quartz, primary mineral, about 75 percent; considerable amount of very fine silt between sand grains; noncalcareous; no oil stain but very faint oil odor (?).
158	1, 138–1, 148	Recovered 10 ft: Microfossils rare. 7 ft, sandstone as above, grains mostly in the fine sand range, practically unconsolidated. 1 ft, shaly clay, medium-light-gray, silty in the upper part of the interval, moderately calcareous; a ½-in.-thick grayish-yellow very calcareous layer in the middle of the interval. 6 in., limestone, medium-light-gray, moderately hard, very argillaceous; irregular fracture; grades back into: 1 ft 6 in., shaly clay as above in this core, dips up to 3°.
159	1, 148–1, 152	Recovered 3 ft: Microfossils rare. Shaly clay, medium-light- to medium-gray; considerable amount of drilling mud mixed with the clay; noncalcareous but scattered grayish-yellow calcareous streaks.
160	1, 152–1, 158	Recovered 4 ft: Microfossils rare. Shaly clay as above, silty at bottom of interval.
161	1, 158–1, 168	Recovered 10 ft: Microfossils absent. 5 in., as above. 9 ft 7 in., sandstone, medium-light-gray; grains between fine and medium sand size subrounded to subangular; quartz, primary mineral, 75 percent; very soft and practically unconsolidated; noncalcareous; no oil shows.
162	1, 168–1, 188	Recovered 20 ft: Microfossils absent. Sandstone as above, fine sand predominates in last 10 ft of interval; no stain cut or residue from 1,185 ft.
163	1, 188–1, 205	Recovered 6 ft 1 in.: Microfossils absent. Sandstone as above, very fine to fine, very soft; noncalcareous, no oil shows
164	1, 205–1, 210	Recovered 5 ft: Microfossils absent. Sandstone as immediately above.
165	1, 210–1, 212	No recovery. (Ditch sample had limestone in this interval.)
	1, 212–1, 240	Sandstone and silt.
	1, 240–1, 280	Clay.
	1, 280–1, 290	Sandstone, very fine.
	1, 290–1, 295	Clay.
	1, 295–1, 305	No samples received.
	1, 305–1, 325	Clay.
	1, 325–1, 345	Silt, coal at about 1,340 ft.
	1, 345–1, 385	Clay, coal at about 1,360 ft.
	1, 385–1, 410	Sandstone, very fine.
	1, 410–1, 420	Clay.
	1, 420–1, 438	Silt, some sandstone.

SIMPSON CORE TEST 14

	0–5	Distance between kelly bushing and ground.
	5–20	No sample. Ice reported by driller at 20 ft.
	25–65	Clay, yellowish-gray, silty; also varicolored-rounded to subangular fine sand grains, some well polished. Scattered well-rounded yellow and black chert pebbles. White pelecypod shell fragments, rare Gubik microfauna.

SIMPSON CORE TEST 14—Continued

Core	Depth (feet)	Description
	65–85	Sand, fine to very fine. Mollusk shell fragments, rare microfauna. Base of the Gubik Formation and top of the Seabee Formation at approximately 85 ft.
	85–90	Four inches of limestone, medium-dark- to dark-gray; sand contamination from the Gubik Formation.
	90–95	Limestone (probably from above) and sand contamination from the Gubik Formation.
	95–150	Clay, light-gray; some silt at 125–135 ft, much Gubik sand contamination.
	150–200	Clay and silt.
1	200–210	Recovered 8 ft: Microfossils absent. Siltstone, medium-light-gray; yellow cast; soft argillaceous minute mica flakes present; good shaly cleavage parallels the bedding, scattered laminae of clay shale, noncalcareous; 5° dip.
2	210–220	Recovered 4 ft: Microfossils absent. Interbeded siltstone and clay shale. Siltstone as above, shaly clay light gray, has hackly fracture but also has a few silty partings (with yellow cast). Noncalcareous; 5° dip.
	220–235	Clay and silt.
	235–240	Siltstone, light-gray, very calcareous.
	240–245	Clay and silt.
	245–285	Silt and clay, light- to medium-light-gray; lighter colored bentonitic clay and bentonite; hexagonal biotite flakes and brown fishbone fragments rare to abundant. The top of the Ninuluk and Seabee Formations, undifferentiated, is at 250 ft.
3	285–295	Recovered 9 ft: Microfossils abundant. 2 ft, drilling mud contains distorted (in drilling because all of core was very soft and wet when first received) fragments of gray clay shale. Light-gray massive rather soft bentonitic clay shale; swells to an unctuous mass in water; noncalcareous. 1 ft 6 in., clay shale, medium-light- to medium-gray, slightly silty, micaceous; has numerous small brown fish remains. Scattered bluish-gray bentonitic clay laminae; noncalcareous; dip 5°. 3 in., limestone, the middle inch is light-gray possibly bentonitic but changes abruptly on either end to medium-gray and hard; shows bedding because of color change and slightly crystalline appearance of the lighter part, very low dip. 2 ft 3 in., clay shale with fish remains as above, in the upper foot contains three layers of bentonite ½–1 in. thick, very light to light gray. 3 ft, bentonite, white to bluish and yellowish medium-light-gray; in part has a speckly appearance due to the presence of brown biotite flakes, fairly soft, interbedded with a little shaly medium-gray to black carbonaceous clay; noncalcareous.
4	295–305	Recovered 6 ft 6 in.: Microfossils very abundant. 1 ft 3 in., broken zone contains drilling mud mixed with fragments of dark carbonaceous clay shale, light bentonite, and bentonitic clay shale.

SIMPSON CORE TEST 14—Continued

Core	Depth (feet)	Description
4	295–305	Recovered 6 ft 6 in.—Continued 3 ft 8 in., clay shale, medium-light-gray; contains scattered brown fishbone fragments. Dip is approximately 17°, however, the core is only 1 in. in diameter, and the dip measurement may be in error. 1 ft 7 in., bentonitic clay and bentonite, color ranges from bluish-gray and yellowish-gray to white, fairly soft; some of core less than an inch in diameter; becomes slightly silty at base; noncalcareous.
5	305–315	Recovered 10 ft: Microfossils rare. Sandstone, medium-light-gray; yellow cast, very fine grained, silty, soft and friable; 80 percent quartz, also a considerable amount of biotite and pyrite present; grains subangular to subrounded; where not completely broken up the core tends to fracture parallel to the bedding, 5° dip; noncalcareous except for 4½ in. at approximately 307 ft, which is a hard highly calcareous very fine-grained medium-light-gray silty sandstone; very faint petroliferous odor but no cut or residue from 309 ft.
6	315–316	Recovered 1 ft: Microfossils absent. Sandstone, medium-light-gray; silt grains and very fine very calcareous cement; bedding faintly visible because of slight differences in color; small dip.
7	316–326	Recovered 10 ft: Microfossils absent. 11 in., limestone, olive-gray, silty; plus small amount of very calcareous medium-light-gray siltstone; yellow cast. Hard dense massive limestone has irregular fracture. 1 ft 4 in., silty sandstone, soft, as above in core 5. 7 in., sandstone, very calcareous, hard, silty, as in core 6. 7 ft 2 in., silty sandstone, soft, as above in core 5; noncalcareous; fair oil odor straw-colored cut, pale-yellow residue from 320 ft.
	326–340	Silt, medium-light-gray.
	340–360	Clay and silt.
	360–380	Silt.
	380–385	Siltstone, calcareous.
	385–395	Silt and very fine sand.
	395–405	Clay and silt.
	405–415	Sand, very fine to fine; 90 percent clear, white, and gray quartz, primarily subangular, some subrounded; pyrite, biotite, also some silt.
	415–435	Clay.
	435–440	Clay, silt, grayish-yellow; noncalcareous clay ironstone concretion.
	440–445	Siltstone, medium-light-gray, very calcareous.
	445–465	Sand, very fine to fine.
8	465–475	Recovered 10 ft: 5 ft, drilling mud mixed with a few fragments of gray clay shale, silty toward base of interval. 3 ft 9 in., sandstone, medium-light-gray; yellow cast, very fine to fine-grained; grains subangular to subround; primary mineral, quartz, 80–85 percent, biotite and pyrite also present, very soft and friable; noncalcareous; fair oil odor, yellow cut and brownish-yellow residue from 472 ft.

SIMPSON CORE TEST 14—Continued

Core	Depth (feet)	Description
8	465–475	Recovered 10 ft—Continued 9 in., sandstone, medium-gray; yellow cast, very fine to fine-grained, very calcareous, hard; irregular fracture. 6 in., sandstone, as in section 3 ft 9 in. in this core.
9	475–485	Recovered 10 ft: Microfossils very rare. 2 ft 9 in., sandstone as immediately above; 6 in. of upper foot moderately hard, rest very soft; noncalcareous; fair oil stain and odor throughout interval, amber cut with CCl_4 and yellowish-brown residue from 476 ft. 5 ft 8 in., clay shale, medium-light-gray, interbedded with light-gray siltstone laminae and a few partings of very fine sand. Partings have yellow stain or cast; no bentonite or fish remains; low dip; noncalcareous. 1 ft 7 in., sandstone, silty to very fine-grained, soft; fair odor and stain.
10	485–595	Recovered 10 ft: Microfossils absent. 7 ft 6 in., sandstone, medium-olive-gray (or medium gray with a strong yellow cast), very fine-grained, soft, and friable. An inch thick hard grayish-yellow clay ironstone concretion at 491 ft and another silty one near the bottom of the section. One sandy parting at bottom is rather coarse and contains two subangular black chert pebbles; noncalcareous; fair oil stain and odor throughout interval, yellow cut and brownish-yellow residue from 492 ft. 1 ft 3 in., sandstone, medium-gray, a yellow cast, very fine, grained, very calcareous, hard; irregular fracture. 1 ft 3 in., sandstone, as in the uppermost part of core.
11	495–505	Recovered 8 ft: Microfossils very rare. 2 ft 2 in., sandstone, soft, as immediately above, a grayish-yellow clay ironstone concretion in about middle of the section. Sandstone becomes harder in the last 3 in. of section; fair oil stain and odor, yellow cut and yellowish-brown residue at 496 ft. 4 ft 2 in., clay and clay shale, medium-light-gray; hackly fracture not well developed; becomes slightly silty and moderately hard in last few inches of the section; sandy partings. 1 ft 8 in., clay and clay shale, medium- to dark-gray, pyritic; similar to that described above but contains numerous coaly laminae. Coal (lignite or subbituminous) occurs in layers up to 1 in. thick, bedded, blocky fracture, and dull black. Noncalcareous.
12	505–515	Recovered 4 ft 3 in.: Microfossils very rare. (3 ft 6 in., ice reported drilled at top of core.) Clay shale, medium-light-gray; very little carbonaceous material; noncalcareous; hackly fracture; dip probably 5° or less.
	515–530	Clay and silt.
	530–550	Silt and some clay, coaly material, sand at 535 ft. Top of Grandstand Formation at 550 ft.
	550–565	Sand very fine to fine; much coaly material.

SIMPSON CORE TEST 14—Continued

Core	Depth (feet)	Description
13	565–575	Recovered 8 ft: Sandstone, medium-light-gray; very soft and practically unconsolidated "clean," between fine- and medium-grained; subangular grains. Grains primarily white quartz and gray chert, salt-and-pepper appearance. One thin (⅛ in.) layer of lignite at top of the section; noncalcareous; no stain, very faint petroliferous odor, no cut, greasy film as residue at 572 ft.
14	575–585	Recovered 9 ft: Sandstone, as immediately above, grain size gradually decreases to fine sand at base; no stain; very faint petroliferous odor, very pale cut and very pale-yellow residue at 577 ft.
15	585–595	Recovered 10 ft: Sandstone as above, very soft, fine-grained, micaceous, some salt-and-pepper light and dark grains. No oil shows.
16	595–605	Recovered 10 ft: Sandstone as above, one small grayish-yellow clay ironstone concretion at 600 ft; noncalcareous; faint petroliferous odor from 616 ft, no cut, no residue.
17	605–615	Recovered 10 ft: Sandstone as above, soft, fine-grained, micaceous; very faint odor(?), no cut, no residue at 606 ft.
18	615–625	Recovered 10 ft:
	625–635	Sandstone as above; no oil shows. Fine sand.
	635–655	Sand, very fine, grains subangular, mainly all clear quartz.
	655–665	Clay, with clay ironstone concretion, also small amount of calcareous siltstone.
	665–690	Clay, carbonaceous fragments, coal, pyrite, and marcasite.
	690–700	Sand, very fine to medium; coal.
19	700–710	Recovered 10 ft: Microfossils absent. Sandstone, medium-light-gray, very fine to fine-grained, subangular to subrounded grains, 95 percent quartz and chert, about ¾ white and ¼ gray, very soft and friable; slight tendency in the harder streaks to cleave parallel to bedding; a few dark carbonaceous-micaceous laminae. Beds lie virtually flat; noncalcareous; faint petroliferous odor (?), no cut, no residue from 707 ft.
	710–725	Sand, very fine to medium.
	725–750	Clay and some sand, medium-light-gray. Calcareous yellowish gray clay ironstone concretion; at 735 ft small amount of coal.
	750–770	Sand, fine to medium; subangular clear and white quartz, coal, biotite.
	770–775	Clay(?) and sand.
	775–785	Sand; calcareous siltstone at 780 ft.
	785–795	Sand and clay, fine; clay ironstone concretion at 790 ft.
	795–845	Sand, medium-light-gray, very fine to fine; grains subangular, clear, white, and gray quartz; clay ironstone concretions at 810 and 840 ft, silty toward bottom of interval.

SIMPSON CORE TEST 14—Continued

Core	Depth (feet)	Description
20	845–855	Recovered 10 ft: Microfossils absent. Sandstone, medium-light-gray, very fine grained, subrounded grains; 95 percent quartz; contains some yellow quartz and thereby differs somewhat from sandstone in core 19; very soft and friable; noncalcareous; faint petroliferous odor(?), no cut, no residue from 848 ft.
	855–870	Silt to very fine sand; mostly subangular white quartz but also some yellow quartz.
	870–895	Clay with some silt and very fine sand.
	895–906	Sand, fine; some sand contamination from the Gubik Formation.
21	906–916	Recovered 10 ft: Microfossils absent. 2 ft 5 in., clay, medium-gray, irregular hackly fracture; slightly silty, very slightly calcareous. 7 ft 7 in., sandstone, virtually the same as that described in core 19 but has no cleavage parallel to bedding. Last inch of sandstone in core is cemented with fine light-gray argillaceous(?) material; no oil shows.
	916–935	Sand, fine; *Ditrupa* sp. at 915 ft.
	935–945	Silt and some clay.
	945–955	Sand, very fine.
22	955–965	Recovered 10 ft: Sandstone, very fine grained and medium-light-gray siltstone; a layer of hard silty grayish-yellow clay ironstone at 956, 962, and 964 ft; noncalcareous; no oil shows. *Ditrupa* present.
	965–970	Clay and some very fine sand.
	970–974	Limestone or very calcareous siltstone, medium-gray, also very fine sand.
23	974–984	Recovered 10 ft: Microfossils absent. Sandstone, medium-light-gray, very fine to fine-grained; subangular to subrounded grains; primary mineral, white quartz; practically unconsolidated; noncalcareous; no oil shows.
	984–985	No sample.
	985–1, 015	Sand, very fine to fine; slightly calcareous in spots(?), some silt.
24	1, 015–1, 023	Recovered 4 ft: Microfossils common. Clay shale, medium-light-gray, silty, irregular and hackly fracture; noncalcareous.
	1, 023–1, 039	Clay and silt.
25	1, 039–1, 045	Recovered 6 ft: Microfossils common. 4 ft, clay shale, medium-light-gray, hackly fracture; slightly calcareous grayish-yellow clay ironstone concretion at 1,039½ ft. 2 ft, siltstone, medium-light-gray; yellow cast; a few laminae of clay shale as described immediately above; noncalcareous.
	1, 045–1, 072	Clay and silt.
26	1, 072–1, 075	Recovered 3 ft: Microfossils common. Clay shale, medium-light-gray, moderately hard, hackly fracture; noncalcareous.
	1, 075–1, 145	Clay and silt with some streaks of very fine sand containing a little clear pink garnet. *Ditrupa* sp.
	1, 145–1, 165	Sand, fine to medium; contains a little garnet.
	1, 165–1, 175	Clay.
	1, 175–1, 208	Sand, fine; clear, white, and gray quartz.

SIMPSON CORE TEST 14—Continued

Core	Depth (feet)	Description
27	1, 208–1, 218	Recovered 10 ft: Microfossils absent. Sandstone, medium-light-gray, very fine to fine-grained very soft, noncalcareous; 90 percent quartz, subangular to subrounded. No oil shows.
	1, 218–1, 255	Sand, fine.
	1, 255–1, 270	Sand, silt, and clay.

SIMPSON CORE TEST 14A

Core	Depth (feet)	Description
	0–3	Distance between kelly bushing and ground.
	3–200	No sample.
1	200–210	Recovered 10 ft: Microfossils absent. Clay and clay shale, light-gray; shaly cleavage not very well developed, but some medium-light-gray silty micaceous partings, scattered silty laminae and a tendency toward vertical fracture. Normal faulting on a minute scale with displacements up to ⅛ in. noted at approximately 203 ft; noncalcareous; estimated dip 6°.
2	210–220	Recovered 9 ft: Microfossils absent. Shaly clay and clay as above, hackly cleavage, dip 25°–30°.
3	220–230	Recovered 10 ft: Microfossils absent. Shaly clay as above, dips up to 30°, a black carbonaceous layer 1/10 in. thick at 226½ ft.
4	230–240	Recovered 10 ft: Shaly clay as above, a few silty laminae, particularly at bottom of interval, dip 15°, core badly broken and mixed with drilling mud in last 4 ft of section.
5	240–250	Recovered 10 ft: Microfossils absent. Siltstone, medium-light-gray, soft; shaly cleavage; contains a few laminae of clay shale and also laminae of very fine sandstone. A few partings of carbonaceous material present. Minor fractures present and filled with slightly darker clay material. Some of silt has biotite and carbonaceous flecks; noncalcareous; no shows. Top of Ninuluk and Seabee Formations, undifferentiated, at 250 ft.
6	250–258	Recovered 9 ft: Microfossils rare. 5 ft, interbedded siltstone and clay shale similar to above but in equal proportions, minor fractures filled with clay found in silt. Dips indeterminate; noncalcareous. 1 ft, clay shale, light- to medium-light-gray, bentonitic; larger the proportion of bentonite the lighter the color. Contains brown fish remains; noncalcareous; 5° dip. 6 in., a zone containing some clay shale plus several layers as much as ¾ in. thick of white prismatic crystals that effervesce vigorously with acid may be calcite or aragonite. These layers powdered by drilling to white chalky material around edges of the core. 2 in., shaly clay, light-gray, very bentonitic, fractured. 1 ft 11 in., clay shale, medium-light-gray; contains many brown fish remains, also white and yellow *Inoceramus* shells; noncalcareous; 5° dip. 5 in., clay, medium-gray with blue cast, shaly to massive; bentonitic, noncalcareous.
7	258–260	Recovered 1 ft 6 in.: Microfossils rare. Bentonitic clay as above, also some interbedded shaly clay with fish remains.

SIMPSON CORE TEST 14A—Continued

Core	Depth (feet)	Description
8	260–262	Recovered 1 ft 6 in.: Microfossils rare. Silty clay, light- to medium-gray, shaly to massive, bentonitic. In the middle of core is 4 in. of clay shale containing abundant carbonaceous flecks; noncalcareous.
9	262–266	Recovered 4 ft: Microfossils rare. Bentonitic silty clay as above, carbonaceous at 263 ft, 5° dip.
10	266–275	Recovered 8 ft 6 in.: Microfossils rare. Silty clay as above but even more bentonitic; laminae of very light gray and white, nearly pure bentonite up to 2 in. thick at approximately 270, 271, and 273 ft. Fish fragments in clay shale at 271½ ft and in last 9 in. of core. Last 9 in. also contains white and yellow *Inoceramus* and ammonite remains; noncalcareous.
11	275–283	No recovery.
12	283–290	Recovered 7 ft: 2 ft 6 in., clay shale, medium-light-gray; brown fish remains very abundant, light-colored bentonitic zones at 283 ft 4 in. and 284 ft 6 in.; noncalcareous. 10 in. clay, medium- to light-gray, massive, very bentonitic, waxy to the touch; noncalcareous. 2 ft 8 in. clay shale, medium-light-gray; similar to the first part of this core but with larger amount of finely disseminated bentonite and fewer fish remains. Dark carbonaceous layer at top and at bottom of section, a thin (1 in.) layer of dull black coal at 287 ft 9 in.; noncalcareous; dip 5°. 1 ft, clay, light-gray, very bentonitic, noncalcareous.

SIMPSON CORE TEST 15

Core	Depth (feet)	Description
	0–5	Distance between kelly bushing and ground.
	5–35	No sample.
	35–55	Sand, medium-light-gray, fine to medium, subangular to subrounded; some grains rounded and polished, predominantly quartz and chert of various colors. Some clay. Pelecypod fragments rare.
	55–75	Sand as above, plus rounded and polished granules and pebbles of black chert and light-brown quartzite. Some clay.
	75–95	Clay, light- to medium-light-gray; some pyrite plus sand of the Gubik Formation, which occurs as contamination in the ditch samples throughout the test. Gubik-Seabee Formation contact at approximately 75 ft.
	95–105	Limestone, medium-light-gray, also clay.
	105–225	Clay.
	225–235	Clay, also some white aragonite or calcite (prismatic crystals). Top of Ninuluk and Seebee Formations undifferentiated may be at approximately 235 ft.
	235–245	Clay, some white bentonite with hexagonal biotite plates, *Inoceramus* fragments.
	245–255	Clay, bentonite, and bluish-gray bentonitic clay.
	255–265	Clay, medium-light-gray; *Inoceramus* fragments.
1	266–268	Recovered 2 ft 6 in.: 1 in., limestone, light- to medium-light-gray; yellow cast, hard, crystalline; possibly dolomitic as it does not effervesce vigorously with dilute cold HCl unless powdered.

SIMPSON CORE TEST 15—Continued

Core	Depth (feet)	Description
1	266–268	Recovered 2 ft 6 in.—Continued 2 ft 5 in., interbedded clay shale, bentonite, and bentonitic clay. Clay shale medium-light-gray to medium-gray, slightly silty, contains brown fish remains all through the clay and *Inoceramus* fragments at 268 ft. Bentonite very light gray and occurs in layers as much as 1½ in. thick at 266½ and 267 ft and in thinner layers elsewhere. Stuck on the outside of the bentonite two pebbles, one of black chert and one of light-grayish-brown limestone(?); both well rounded and surrounded by a thin layer of mud—probably represent contamination from the Gubik Formation. Bentonitic clay bluish gray. One thin (⅛ in.) layer of dull black low-grade coal at 267½ ft; noncalcareous; dip 5°.
	268–275	Clay; *Inoceramus* fragments.
	275–285	Clay, bentonite, and bentonitic clay.
	285–303	Clay, some sand.
2	303–310	Recovered 5 ft: 1 ft 4 in., mud cake, contains pebbles from the Gubik Formation mixed with clay and shaly silt. 3 ft 8 in., sandstone, medium-light-gray; yellow cast or stain, moderately soft, very fine, silty; quartz, also a large amount of biotite and muscovite. Glauconite(?) grains are also quite abundant. Fairly good fracture is present (probably parallel bedding), dip is 8°; noncalcareous; faint oil odor, pale-straw-colored cut and pale-yellow residue at 309 ft.
	310–330	Sand, medium-light-gray, very fine to fine; primarily white and clear quartz, some dark-gray chert, biotite. Small amount of sand in interval 320–330 ft has a very calcareous cement. Some clay.
	330–360	Clay and sand.
	360–380	Clay, medium-light-gray.
	380–390	Clay and sand with biotite and pyrite.
	390–400	Clay.
	400–410	Sand, very fine, subangular white and clear quartz; biotite.
	410–420	Clay and sand.
	420–430	Clay.
	430–460	Sand, medium light-gray; some chlorite, a white-claylike mineral; a little coal at 430–440 ft.
	460–470	Clay and sand.
	470–490	Sand, very fine to fine.
	490–550	Sand, medium-light-gray, very fine to medium; 80 percent quartz, 10 percent dark chert, some coal 500–510 ft, clay ironstone concretion 510–520 ft. Some clay.
	550–620	Sand, medium-light-gray, fine to medium; presence of about 20 percent dark chert and other dark minerals slightly larger than the quartz gives a salt-and-pepper effect; mica. Top of Grandstand Formation at 555 ft.
	620–660	Sand, white quartz 85 percent, subangular, fine; small clay ironstone concretion 650–660 ft.
	660–670	Clay, medium-light-gray; a few dull black coal fragments, some sand.
	670–720	Sand, fine; medium coal rare at 680–690 ft; some clay 670–680 ft.
	720–750	Clay and sand; dull black coal 730–750 ft; grayish-yellow clay ironstone concretion 740–750 ft.
	750–760	Sand, 85 percent white and clear quartz; some biotite, coal, and brown and gray chert.
	760–780	Clay and sand.
	780–800	Sand and clay, medium-light-gray.
	800–810	Sand, very fine to fine.

SIMPSON CORE TEST 15—Continued

Core	Depth (feet)	Description
	810–830	Sand, darker particles medium grained and white quartz fine grained.
	830–840	Sand as above; abundant grayish-yellow clay ironstone; sand in part cemented by ironstone.
	840–860	Sand, very fine; grading to silt in lower part of interval; primarily white quartz, also some brownish-yellow quartz(?); coal fragments rare.
	860–880	Clay, some coal.
	880–900	Clay, medium-light-gray; *Ditrupa* fragments.

SIMPSON CORE TEST 16

Core	Depth (feet)	Description
	0–4	Distance between kelly bushing and ground.
	4–10	Clay, medium-light-gray; yellow cast, tundra, and sand.
	10–20	Clay and sand, light-olive-gray, very fine to fine subangular to subrounded; predominantly yellow and clear quartz.
	20–40	Clay, light-olive-gray, some sand.
	40–50	Clay and varicolored sand, very fine to medium, subangular to subrounded grains. Numerous white pelecypod fragments.
	50–80	Sand, medium-light-gray; yellow cast, fine to medium; subangular to rounded and polished grains of varicolored quartz and dark chert. Pelecypod fragments rare. Top of Seabee Formation at 80 ft.
	80–120	Clay, light-gray; also a small amount of light-gray silt (silt almost entirely subangular white quartz).
	120–250	Clay, light-gray; some silt at 220–250 ft.
	250–260	Clay, medium-light-gray, and silt; also crystalline (prismatic) aragonite or calcite, biotite, very small amount of coal, and *Inoceramus* prisms. Top of Ninuluk and Seabee Formations undifferentiated near 250 ft.
	260–270	Clay, silt, and a small amount of very light gray bentonitic clay or bentonite. *Inoceramus* prisms.
	270–280	Clay, very abundant aragonite, abundant *Inoceramus* prisms and abundant fish fragments (many of the fish fragments encased by marcasite).
	280–290	Clay, some silt, small amount of bentonite, fish fragments common.
	290–320	Sand, medium-light-gray, very fine, 95 percent white and clear quartz, subangular to subrounded; abundant biotite, pyrite common at 310–320 ft; some silt.
	320–330	Sand and silt, biotite, small amount of pyrite with very calcareous cement.
	330–338	Clay, medium-light-gray; sand and silt.
1	338–348	Recovered 5 ft: Drilling mud broken and mixed with fragments of medium-light-gray siltstone, medium-gray clay shale, and light-gray bentonitic clay shale. At 347 ft a rounded (diameter of core) cobble(?) of quartz monzonite or granodiorite. No other pebbles or sand noted.
	348–360	Clay, silt; very abundant pyrite, some biotite.
	360–400	Clay; some very fine sand in lowest part of interval, almost all quartz, biotite common.
	400–430	Clay, silt, and some sand.
	430–460	Sand as in interval 360–400 ft above but fine to medium; some dark chert and carbonaceous fragments.
	460–492	Sand, grading to silt at bottom of the interval; mica.

SIMPSON CORE TEST 16—Continued

Core	Depth (feet)	Description
2	492–498	Recovered 6 ft: 2 ft 7 in., siltstone, interbedded medium-light-gray, and medium-gray clay shale; laminae very thin—generally less than 1/16-in.; siltstone somewhat lenticular, has hackly fracture. One or two black carbonaceous stringers extend vertically through the core; shows structure which suggests they were originally plant material that remained upright during deposition. 1 ft 2 in., coal, dull to shiny black, subbituminous, thin-bedded; blocky fracture; contains much finely disseminated pyrite. A fine sandy streak at 493 ft has faint petroliferous odor, yellow cut, and brownish-yellow residue; noncalcareous; beds lie nearly flat. 2 ft 3 in., clay shale, medium-dark- to dark-gray, very carbonaceous; contains numerous very thin laminae of dull black coal.
	498–520	Clay, some pyrite.
	520–525	No sample.
3	525–535	Recovered 9 ft 6 in.: 2 ft 9 in., sandstone, medium-light-gray, fine- to very fine grained, subangular to subrounded, quartz 90 percent, clear and white, also gray chert; sandstone very soft and friable; noncalcareous; very good oil stain and odor from upper 2 ft of interval; amber cut and brown residue from 527 ft. Grades at bottom of section to: 6 ft 9 in., siltstone, medium-light-gray; yellow cast, shaly cleavage; interbedded with medium-gray clay shale; siltstone similar to sandstone above but contains mica; noncalcareous.
4	535–544	Recovered 7 ft: Interbedded siltstone and clay shale, similar to above but contains larger amount of argillaceous material in silt; laminae very thin; noncalcareous; fair to good oil odor at 539 ft, amber cut and yellowish-brown residue.
	544–575	Sand, medium-light-gray, fine to medium, salt-and-pepper texture—60 percent white and clear quartz; rest dark chert and other dark minerals in subangular to subrounded grains; dark grains tend to be slightly larger than light. Grayish-yellow clay ironstone concretions 545–555 ft. Top of Grandstand Formation at 550 ft.
	575–595	Sand, fine; as above.
	595–615	Silt to very fine sand, primarily light-colored quartz, subangular. Moderate amount of coal, 605–615 ft.
	615–625	Clay, silt to fine sand.
	625–635	Silt and sand, white quartz, small amount coal.
	635–645	Sand, fine, and clay ironstone.
	645–665	Sand and clay.
	665–675	Sand, very fine to fine; some garnet.
	675–705	Sand, fine; some dark chert grains slightly larger than quartz, very few coal grains.
	705–715	Clay and sand, medium-light-gray; fine sand.
	715–765	Sand, fine; a little coal at 715–725 ft.
	765–775	Sand and a small amount of clay.
	775–795	Sand, medium-light-gray, fine; quartz and some dark chert.

SIMPSON CORE TEST 17

Core	Depth (feet)	Description
	0–4	Distance between kelly bushing and ground.
	4–20	No sample.
	20–40	Clay, gray; yellow cast and varicolored fine subrounded sand grains, also a few polished black pebbles. Abundant white pelecypod shell fragments, brown periostracum still adhering. Common microfossils from the Gubik Formation.
	40–60	Sand, fine, subrounded, varicolored, a few pebbles. Very few pelecypods and microfossils.
	60–80	No lithology samples available, but microfossil samples suggest sand as above with change near 80 ft to the subangular white quartz silt characteristic of the Colville Group.
	80–100	Silt, light-gray; primarily subangular white and gray quartz. Much Gubik contamination.
	100–200	Clay, light-gray; some pyrite, becomes silty toward bottom of interval. Sand contamination from the Gubik Formation.
1	200–208	Recovered 7 ft 6 in.: Microfossils absent. Clay shale, light-gray; medium-light-gray soft silty laminae and partings; some hackly fracture in clay shale. Silty partings micaceous with flakes parallel to the bedding planes, silty beds up to 2 in. thick; noncalcareous; dip 2°.
	208–280	Clay and some silt. Very much tundra and sand contamination from the Gubik Formation.
	280–290	Limestone, medium-gray, probably thin; also clay and silt.
	290–300	Clay, yellow; also limestone from above.
	300–310	Siltstone, medium-light- to medium-gray, very calcareous; also light-gray clay.
	310–320	Silt and clay.
	320–330	Clay, light-gray.
	330–340	Limestone, medium-dark-gray; considerable amount, also clay and silt (?).
	340–350	Limestone, as above; 348–350 ft clay and silt.
	350–401	Clay.
2	401–407	Recovered 6 ft: Microfossils absent. 4 ft 2 in., clay shale as above, silty partings have yellow cast and slight petroliferous odor, noncalcareous; dip 1°. 7 in., limestone, medium-dark-gray, hard, massive; contains a few small discontinuous vertical fractures filled with white calcite. 1 ft 3 in., clay shale as in first part of this core; 1½ in. of grayish-yellow clay ironstone at top; noncalcareous.
	407–471	Clay and silt. Sand and tundra contamination from the Gubik Formation. Medium-dark-gray calcareous siltstone at 470 ft, 4 in. thick. Slight show of oil in ditch.
3	471–476	Recovered 5 ft: Microfossils absent. Clay shale with silty laminae and partings as above, dip ranges from 10° to 25°.
	476–535	Clay.
	535–545	Clay, some silt, show of gas.
	545–550	No sample.
	550–560	Tundra contamination; silt?
	560–581	Sand, medium-light-gray, very fine, subangular grains; 90 percent quartz, most white and clear; pyrite and biotite in hexagonal plates. Top of the Ninuluk and Seabee Formations undifferentiated at 568 ft.

SIMPSON CORE TEST 17—Continued

Core	Depth (feet)	Description
4	581–591	Recovered 10 ft: Microfossils absent. 8 ft 10 in., sandstone, medium-light-gray; good olive-green oil stain, rather soft and friable, very fine grained to silty; subrounded to subangular grains; about 60 percent quartz, both biotite and muscovite also conspicuous; noncalcareous; dip 25°, good odor, amber cut and yellowish-brown residue from 588 ft. 1 ft 2 in., limestone, medium-gray, hard, massive, silty; contains some mica. White pelecypod shell fragment at 590 ft.
	591–600	Sand, very fine, and silt.
	600–620	Clay and silt.
	620–624	Sand, white and gray, fine quartz.
5	624–628	Recovered 2 ft 6 in.: Microfossils absent. 11 in., sandstone, medium-light-gray, salt-and-pepper, between fine- and medium-grained, but containing considerable amount of soft silty and clayey cementing material; quartz is conspicuous, also biotite and muscovite; noncalcareous; fair odor, slight stain, yellow cut and yellowish-brown residue at 624 ft. 1 ft 7 in., sandstone, similar in grain size and constituents to upper part of this core but hard; has a very calcareous cement; about 4 in. from top a layer of grayish- and reddish-yellow noncalcareous ironstone concretions up to 1½ in. in diameter.
	628–640	Sand fine to medium.
	640–680	Sand and some clay (clay 640–650 ft); small amount of coal at 650–660 ft.
	680–690	Siltstone, medium-gray, very calcareous, also fine sand.
	690–710	Sand, medium-light-gray, very fine, subangular to subrounded, nearly all clear and white quartz. Top of Grandstand Formation at 710 ft.
	710–780	Sand, salt-and-pepper fine to medium; white quartz fine, gray quartz medium, subangular to subrounded; carbonaceous fragments from 740 to 780 ft; brown *Inoceramus* prisms start at 770 ft, also some silt.
	780–796	Sand as above; also grayish-yellow noncalcareous medium-light-gray sand.
6	796–803	Recovered 7 ft: Microfossils absent. 8 in., siltstone to very fine grained sandstone, medium-light-gray, very soft or practically unconsolidated; numerous laminae or partings contain black carbonaceous material and mica; noncalcareous; no odor, cut, or residue from 799 ft. 4 ft, limestone, light- to medium-light-gray, hard, silty; contains many thin carbonaceous partings, some have carbonaceous plant impressions; dip 3°. 9 in., sandstone, grayish-brown, silty; made up of grains of quartz, coal, and mica; noncalcareous, grades into: 1 ft 7 in., siltstone, medium-light-gray, friable, shaly cleavage, micaceous, noncalcareous.
	803–810	Sand, very fine to fine as in 9 in. section above.
	810–820	Sandstone, medium-light-gray, fine grained, calcareous; also fine sand.
	820–840	Sand, very fine to fine, primarily clear and white subangular quartz.

SIMPSON CORE TEST 17—Continued

Core	Depth (feet)	Description
	840–870	Clay and silt; ironstone concretion between 840 and 850 ft.
	870–890	Sand, very fine to fine sand, three-fourths white, one-fourth gray; carbonaceous particles.
	890–920	Clay and very fine to fine sand.
	920–930	Sand, fine; largely subangular white quartz, very little yellow quartz, some garnet.
	930–940	Clay, medium-light-gray; sand contamination from the Gubik Formation.
	940–980	Sand, very fine to fine sand; subangular quartz, white, some gray, also yellow. Very hard calcareous siltstone at 971–974 ft.
	980–1, 003	Silt (with yellow quartz) and clay.
7	1, 003–1, 013	Recovered 10 ft: Microfossils absent. 1 ft 3 in., drilling mud mixed with broken pieces of light-gray silt, medium-light-gray clay, and a very small amount of yellowish-gray clay. 5 ft 10 in., siltstone, light- to medium-light-gray; very soft and friable micaceous; clay 6 in. of slightly harder medium-light-gray clay at 1,008 ft; beds have very low dip or lie flat; noncalcareous; no oil shows. 2 ft 11 in., interbedded clay and silt, medium-light-gray; about 75 percent silt and 25 percent clay. *Ditrupa* sp.
	1, 013–1, 020	Siltstone, medium-gray, calcareous, also silt and clay?
	1, 020–1, 030	Clay and some fine sand.
	1, 030–1, 050	Sand, fine.
	1, 050–1, 070	Clay, possible grayish-yellow ironstone concretion between 1,050–1,060 ft.
	1, 070–1, 100	Silt; some very fine sand and clay.

SIMPSON CORE TEST 18

Core	Depth (feet)	Description
	0–4	Distance between kelly bushing and ground.
	4–10	No sample.
	10–20	Tundra, silt, and ice, one pelecypod fragment, microfossils present.
	20–55	Clay, light-gray, and a little sand. Scattered fragments of a bright-blue claylike material, possibly vivianite. Gubik microfossils abundant. Numerous white pelecypod fragments.
	55–80	Sand, varicolored (clear, white, gray, black, various shades of yellow, some green and red) grains, fine, subrounded, polished. Very few black chert pebbles.
	80–120	Sand and pebbles as above, probably mostly contamination. Top of Seabee Formation may be at approximately 90 ft.
	120–200	Clay, light-gray; sand from the Gubik Formation and tundra.
1	200–210	Recovered 9 ft: Microfossils absent. Interbedded siltstone and clay shale, siltstone light gray, very uniform in texture and color, good shaly cleavage, makes up about 80 percent of the interval. Clay shale medium light gray, silty, also has good cleavage; noncalcareous. Dip 6°.
	210–400	Clay, light- to medium-light-gray, much sand and fossil contamination from the Gubik Formation.

SIMPSON CORE TEST 18—Continued

Core	Depth (feet)	Description
2	400–410	Recovered 10 ft: Microfossils absent. Siltstone, 75 percent and clay shale 25 percent, very similar to above core but clay has hackly fracture and silty partings with a yellow cast; noncalcareous; dip 7°. An irridescent ammonite *Borissiakoceras* sp. about ½ in. in diameter found at 407 ft.
	410–450	Clay.
	450–470	Clay; small amount of silty medium-dark-gray limestone near 450 ft.
	470–500	Clay, silt, and tundra.
	500–510	Clay, slightly calcareous gray siltstone; brown tinge.
	510–520	Limestone, medium-dark-gray.
	520–560	Clay.
	560–570	Limestone, medium-dark-gray, 4 in. at 567 ft; also clay.
	570–610	Clay.
	610–620	Limestone, medium-gray, 10 in. at 610 ft.
3	620–630	Recovered 10 ft: Microfossils absent. Clay shale, medium-light-gray; with light- to medium-light-gray silty laminae and partings; some with a yellow cast; noncalcareous; 3° dip. Fragments of an irridescent *Borissiakoceras* sp. as above at 630 ft.
	630–690	Clay.
	690–700	Limestone, medium gray, at about 690 ft 10 in.
	700–750	Clay.
	750–760	Limestone, medium-gray, small amount.
	760–790	Clay.
	790–800	Limestone, medium-gray, fairly large amount.
	800–816	Clay.
4	816–826	Recovered 10 ft: Microfossils absent. Clay shale with silty partings as above, good shaly cleavage; noncalcareous; 3°–5° dip.
	826–920	Clay and a small amount of silt.
	920–930	Limestone, medium-gray; 6 in. at 923 ft, also clay.
	930–940	Clay and silt.
	940–950	Limestone, a small amount.
	950–1, 040	Clay with a small amount of silt, very rare fish fragments.
	1, 040–1, 050	Clay and limestone, medium-gray.
	1, 050–1, 150	Clay.
	1, 150–1, 160	Siltstone, medium-gray.
	1, 160–1, 330	Clay, light- to medium-light-gray.
	1, 330–1, 340	Calcareous micaceous siltstone, medium-gray at 1,335 ft.
	1, 340–1, 350	Clay.
	1, 350–1, 360	Limestone and calcareous siltstone.
	1, 360–1, 380	Clay.
	1, 380–1, 460	Tundra contamination; probably clay.

SIMPSON CORE TEST 19

Core	Depth (feet)	Description
	0–4	Distance between kelly bushing and ground.
	4–20	No sample.
	20–40	Tundra and clay, light-yellowish-gray, and some sand.
	40–50	Sand, varicolored, fine to medium, subrounded. Gubik microfossils, particularly ostracodes, common. Some white mollusk fragments.
	50–80	Sand and clay, some bright-blue fragments—vivianite(?) Rare microfossils.

SIMPSON CORE TEST 19—Continued

Core	Depth (feet)	Description
	80–90	Sand and clay, one radiolarian. Presence of radiolarian may mark top of the Seabee Formation of Colville Group. Cuttings themselves not good enough to mark break at base of Gubik Formation. First recognizable Colville sedimentary deposits (angular white quartz silt) appears at approximately 230 ft.
	90–100	Tundra contamination, silt, and clay.
	100–220	Clay, yellowish-gray and varicolored sand, probably mostly contamination from the Gubik Formation.
	220–270	Clay, yellowish-gray, and also light-gray sand and some angular white quartz silt from the Gubik Formation.
	270–360	Clay and sand contamination from the Gubik Formation.
	360–420	Clay and some silt.
	420–430	Siltstone, medium gray, very calcareous, very small amount at 429; also clay and some silt.
	430–450	Clay.
	450–470	Limestone, medium-dark-gray 12 in. at 460 ft; some medium-gray calcareous siltstone; also clay and silt.
	470–550	Clay and sand contamination from the Gubik Formation, fish fragments rare at 500–510 and 520–530 ft.
	550–570	Limestone, medium-dark-gray, 3 in. at 560 ft; also subangular white quartz, silt, fish fragments.
	570–580	Silt and clay.
	580–590	Siltstone, medium-dark-gray, very calcareous.
	590–600	Sand and silt, very fine, primarily white and clear subangular quartz.
	600–610	Limestone, medium-dark-gray, silty, also calcareous siltstone.
	610–680	Clay, silt, medium-light-gray; fish fragments at 610–620 ft.
	680–700	Considerable amount of medium-dark-gray limestone somewhere in this interval, also clay.
	700–730	Clay and silt, marcasite and pyrite; fish fragments 720–730 ft.
	730–740	Limestone, medium-dark-gray, also clay.
	740–770	Tundra contamination, clay, silt.
	770–790	Considerable amount of medium-dark-gray limestone, also clay and silt.
	790–840	Clay and sand contamination from the Gubik Formation.
	840–860	Limestone, medium-dark-gray; and a large amount of white crystalline calcite and (or) aragonite (not shell material); also clay and silt.
	860–890	Clay, abundant pyrite.
	890–950	Clay and silt, pyrite, and a small amount of medium-dark to dark-gray limestone near 910 ft; fish fragments at 900–940 ft.
	950–970	Silt.
	970–990	Clay(?) Much contamination from the Gubik Formation.
	990–1, 000	Silt and very fine sand, medium-light-gray, subangular to subrounded grains, primarily white and clear quartz.
	1, 000–1, 010	Limestone, medium-gray, small amount, and silt; fish fragments.
	1, 010–1, 040	Clay, abundant pyrite, fish fragments 1,010–1,030 ft.
	1, 040–1, 050	Limestone, dark-gray, 5 in. at 1,050 ft; also medium-light-gray clay, fish fragments.
	1, 050–1, 060	Clay and *Inoceramus* prisms.
	1, 060–1, 061	No sample.

SIMPSON CORE TEST 20

Core	Depth (feet)	Description
	0–4	Distance between kelly bushing and ground.
	4–20	Tundra, light-yellowish-gray clay, and sand; a few microfossils.
	20–40	Clay and sand, numerous white pelecypod fragments, common Gubik microfauna.
	40–90	Sand, fine to very coarse, and granules; grains varicolored (mostly yellow, white, and black) quartz and chert—particularly black chert, subrounded, some quartz grains frosted. Microfossils rare to absent. Occurrence of some light-gray clay from 80 to 90 ft suggests that Gubik-Seabee Formation contact occurs within this interval.
	90–130	Clay, light-gray; abundant pyrite.
	130–140	Limestone, medium-gray, very silty; grades to calcareous siltstone.
	140–180	Clay, light-gray; abundant pyrite.
	180–190	Limestone, medium- to medium-dark-gray.
	190–220	Clay with common pyrite.
	220–230	Siltstone, medium-gray; calcareous, 6 in. at 224 ft.
	230–350	Clay; silt 270–280 ft.
	350–360	Silt; primarily white and clear quartz, small amount of biotite and coal present.
	360–460	Clay and silt.
	460–470	Small amount of silty medium-gray limestone, also clay.
	470–510	Clay.
	510–520	Limestone, medium-dark-gray, fairly large amount.
	520–610	Clay and some silt.
	610–640	Clay, silt, and some very fine to fine sand.
	640–680	Clay.
	680–690	Limestone, medium-dark-gray, moderate amount.
	690–760	Clay and silt.
	760–830	Clay.
	830–840	Limestone, medium-gray, fairly large amount.
	840–910	Clay.
	910–920	Siltstone, medium-light-gray, very calcareous; also clay and silt.
	920–950	Clay.
	950–980	Clay and silt.
	980–990	Clay and very fine sand.
	990–1, 000	Siltstone, medium-light-gray, very calcareous.
	1, 000–1, 001	No sample.

SIMPSON CORE TEST 21

Core	Depth (feet)	Description
	0–4	Distance between kelly bushing and ground.
	4–10	No sample.
1	10–20	Recovered 10 ft.: Microfossils absent. Clay, light-olive-gray, very soft and crumbly; several yellowish-brown limonitic streaks, a thin soft dark brownish-gray peat layer at 15 ft. Core was about 30 percent ice when first received; noncalcareous.
2	20–30	Recovered 10 ft.: Microfossils abundant. Clay with limonitic streaks as above, also some light-gray silty clay, slightly harder and less crumbly than above; noncalcareous; white gastropod and pelecypod shells at 27 ft and broken pieces sparsely throughout interval.

SIMPSON CORE TEST 21—Continued

Core	Depth (feet)	Description
3	30–40	Recovered 10 ft; Microfossils rare. Clay as above; becomes increasingly siltier in the last 5 ft of the interval; scattered rounded and polished black chert pebbles up to ½ in. in diameter found particularly in the last 3 ft of the interval; one pale-yellowish-gray very fine to fine ¾ in. layer of sand at 39 ft; subround and a few subangular grains, primarily clear, white, and yellow quartz and gray and black chert; noncalcareous; rare white mollusk fragments.
	40–100	Sand, medium-light-gray, fine to medium (very coarse at 60–70 ft); yellow cast. Grains subrounded and polished, varicolored; primarily white, clear, and yellow quartz, also gray and black chert. Black chert pebbles and granules. Some medium-light-gray clay. Pyrite at 80–90 ft may mark the top of the Cretaceous Seabee Formation.
4	100–110	Recovered 10 ft: Microfossils absent. 4 ft 6 in., clay shale, light- to medium-light-gray, rather soft; silty laminae and partings, fairly good shaly cleavage, which parallels bedding; beds lie flat; micaceous flakes in silty partings; where silty partings are absent clay has hackly fracture. 1 ft 2 in., siltstone, light-gray, rather soft; made up primarily of subangular white quartz; shaly cleavage; noncalcareous. 4 ft 4 in., clay shale, as in first section of this core.
5	110–120	Recovered 10 ft: Microfossils absent. Clay shale as above; some of the silty partings slightly darker color than clay due to presence of small amount of minute carbonaceous particles; noncalcareous.
6	120–130	Recovered 10 ft: Microfossils absent. Clay shale as above, no dip measured.
7	130–135	Recovered 3 ft 6 in.: Microfossils absent. Claystone, light-gray, soft; shaly cleavage absent, silty partings rare, curly bedding present; very slightly calcareous.
8	135–145	Recovered 9 ft: Microfossils absent. Clay shale, light- to medium-light-gray; light-gray silty laminae and partings; some of partings have numerous black flecks and broken plant remains. Fairly good shaly cleavage; a few minute white pelecypods at 143 ft; very rare brown chitinous fish remains; noncalcareous; 2° dip.
9	145–150	Recovered 5 ft: Microfossils absent. Clay shale as in core immediately above.
10	150–158	Recovered 4 ft: Microfossils absent. Clay shale as above.
11	158–168	Recovered 10 ft: Microfossils absent. Clay shale as above, quite silty in middle part of interval.
12	168–178	Recovered 10 ft: Microfossils absent. Clay shale as above, hackly fracture present in clay shale where silty partings absent.
13	178–188	Recovered 10 ft: Microfossils absent. Clay shale as above.
14	188–198	Recovered 10 ft: Microfossils absent. Clay shale as above, dips range from 0° to 5°.

SIMPSON CORE TEST 21—Continued

Core	Depth (feet)	Description
15	198–208	Recovered 10 ft: Microfossils absent. Clay shale, light-gray; silty partings; some of partings have brown "stain" due to presence of very fine pyrite particles; good shaly cleavage; noncalcareous; beds lie flat.
	208–260	Clay, medium-light-gray; some silt; pyrite common.
	260–270	Limestone, medium-dark-gray, slightly silty; contains a few carbonaceous flecks; 8 in. at 264 ft.
	270–300	Clay, abundant pyrite, 6 in. of very calcareous siltstone at 273 ft.
16	300–307	Recovered 4 ft: Microfossils absent. Clay shale as above, fewer silty partings and more hackly fracture; beds lie flat.
	307–310	No sample.
	310–380	Clay, pyrite; 7 in. of medium-dark-gray very calcareous siltstone at 361 ft.
	380–390	Limestone, medium- to medium-dark-gray.
	390–400	Clay and tundra.
17	400–410	Recovered 10 ft: Microfossils absent. Clay shale, light-gray; silty partings; noncalcareous; beds lie flat.
	410–420	Limestone, medium-dark-gray, 10 in. at 418 ft; clay.
	420–440	Clay.
	440–450	Limestone, medium-gray; silt and pyrite.
	450–460	Silt, clay, pyrite.
	460–480	Clay.
	480–490	Limestone, medium-dark-gray, 6 in. at 481 ft; clay.
	490–500	Silt and clay.
18	500–508	Recovered 7 ft: Microfossils absent. Clay shale as in core 17 above; beds lie flat.
	508–560	Clay and silt, light- to medium-light-gray; some pyrite.
	560–570	Limestone, medium-dark-gray, and clay.
	570–600	Clay.
19	600–610	Recovered 8 ft 6 in.: Microfossils absent. Clay shale as in core 17 above; dips 0°–4°.
	610–700	Clay, light- to medium-light-gray; some pyritic fish fragments at 650–660 ft.
20	700–710	Recovered 2 ft 6 in.: Microfossils absent. Clay shale as in core 17 above; dip 10°.
	710–800	Clay, medium-light-gray; pyrite common to abundant.
21	800–810	Recovered 4 ft: Microfossils absent. Clay shale as in core 17 above; dips 10°–15°.
	810–890	Clay, pyrite.
	890–900	Limestone, medium-dark-gray; also clay, pyrite.
22	900–908	Recovered 8 ft: Microfossils absent. Clay shale as in core 17 above; dip 15°.
	908–1,000	Clay, medium-light-gray; a little medium-light-gray silt from 970–1,000 ft.
23	1,000–1,007	Recovered 5 ft: Microfossils absent. Clay shale, medium-light-gray, hackly fracture, rare silty partings, dip 12°; noncalcareous.
	1,007–1,010	No sample.
	1,010–1,100	Clay and silt, medium-light-gray.
24	1,100–1,107	Recovered 7 ft: Microfossils absent. Clay shale as in core 23 above, silty partings common, dip 15°.
	1,107–1,110	No sample.
	1,110–1,150	Clay and silt.
	1,150–1,160	Limestone, medium-gray, 6 in. at 1,151 ft; also clay.
	1,160–1,200	Clay.
25	1,200–1,209	Recovered 9 ft: Microfossils absent. Clay shale as in core 23 above, dip 15°.

SIMPSON CORE TEST 21—Continued

Core	Depth (feet)	Description
	1, 209–1, 220	Claystone (harder than clay in ditch above), medium-light- to medium-gray; noncalcareous. Also small amount of silty medium-gray limestone.
	1, 220–1, 270	Clay, some silt at 1,260–1,270 ft. Top of Grandstand Formation at 1,265 feet. Probably top of a slump block; real top may be at 1,320 ft.
	1, 270–1, 280	Sand, very fine to fine; primarily white and clear quartz, also dark chert, subrounded to subangular; a few hexagonal biotite plates.
	1, 280–1, 300	Clay and sand. *Ditrupa* sp. fragment in sample 1,290–1,300 ft.
26	1, 300–1, 305	Recovered 1 ft: Microfossils absent. Sandstone, light-gray, fine-grained, moderately hard, grains primarily quartz, but also a large amount of micaceous material (biotite and a fine white powdery cement which may be sericitic), also a small amount of interbedded medium-gray clay. Last 1½ in. of section is a hard light-olive-gray clay ironstone concretion; noncalcareous.
27	1, 305–1, 307	Recovered 1 ft, 9 in.: Microfossils absent. Claystone, medium-light-gray, hackly fracture, one (¼ in. in diameter) fragment of brown lignite; noncalcareous. Bedding dips 45°–50°. Numerous well-polished slickensided fracture surfaces dipping 70°.
	1, 307–1, 310	No sample.
	1, 310–1, 330	Clay, medium-gray.
	1, 330–1, 370	No samples received in laboratory. Well geologist reported medium sand; concretions at 1,351–1, 400 ft.
	1, 370–1, 400	Sand, medium-light-gray, fine; small amount of medium; composition as in core 26 above; some clay 1,380–1, 400 ft small amount of medium-grained composition as above. Small amount of coal, 1,390–1,400 ft.
28	1, 400–1, 410	Recovered 10 ft: Microfossils very rare. Sandstone, medium-light-gray, fine-grained, very soft and friable; primarily white and clear quartz, subangular to subrounded, also a little yellow quartz(?), dark chert and chlorite, in a matrix of white powdery material (a few fragments of same also mixed with sand); noncalcareous; no shows.
	1, 410–1, 420	Sand, some clay.
29	1, 420–1, 430	Recovered 10 ft: Microfossils very rare. Sandstone as in core 28 above, pale-yellow-brown clay ironstone concretion at 1,425 ft. No oil shows.
	1, 430–1, 460	Clay and sand, medium-light- to medium-gray, some chlorite. *Ditrupa* sp., 1,430–1,440 ft.
	1, 460–1, 470	Sand and clay.
	1, 470–1, 500	Clay and sand, small amount of garnet in in sand. *Ditrupa* sp., 1,480–1, 500 ft.
	1, 500–1, 502	No sample.

SIMPSON CORE TEST 22

Core	Depth (feet)	Description
	0–7	Distance between kelly bushing and ground.
	7–20	Ice, tundra, and gray clay; brownish-yellow cast; very fine to fine subangular to subrounded sand; primarily white and yellow quartz and dark chert. White pelecypod shell fragments and Gubik microfossils common.
	20–50	Clay, gray; brownish-yellow cast and some sand. Pelecypod fragments and Gubik microfossils rare.
	50–100	Sand, medium-light-gray, fine to medium, mostly subrounded and well-polished; varicolored but with much clear quartz. Well-rounded black chert and yellow quartzite granules and pebbles, some clay. Electric log suggests that break between Gubik Formation and Cretaceous Seabee Formation at 85 ft.
1	100–105	Recovered 1 ft 6 in.: Microfossils absent. Clay shale, light- to medium-light-gray, slightly silty; slightly micaceous partings; considerable infiltration of drilling mud; noncalcareous.
	105–200	Clay, light-gray; pyrite common to abundant.
2	200–207	Recovered 4 ft: Microfossils absent. Clay shale as above; dip 2°.
	207–210	No samples.
	210–230	Clay, pyrite common to abundant.
	230–240	Siltstone (or limestone), light-olive-gray, very calcareous, probably occurs near top of interval as a few chips occur in the sample above; also clay.
	240–280	Clay.
	280–290	Limestone, medium-gray, silty, also clay.
	290–300	Clay.
3	300–304	Recovered 4 ft: Microfossils very rare. Clay shale, medium-light-gray, rather soft and crumbly, hackly fracture, very rare silty partings; noncalcareous; dip 3°.
	304–310	No sample.
	310–400	Clay, light–gray; pyrite present.
4	400–408	Recovered 7 ft 6 in.: Microfossils absent. Clay shale as in core 3 above; silty partings; dip 9°.
	408–420	Limestone, medium- to medium-dark-gray.
	420–500	Clay shale.
5	500–510	Recovered 9 ft: Microfossils absent. Clay shale as in core 3 above, hackly fracture, silty partings rare, noncalcareous; dip estimated to be 4°.
	510–600	Clay.
6	600–610	Recovered 7 ft: Microfossils absent. Clay shale as in core 3 above; dip 4°.
	610–700	Clay, pyrite present.
7	700–710	Recovered 9 ft 6 in.: Microfossils absent. Clay shale as in core 3 above; dip 5°.
	710–800	Clay.
8	800–810	Recovered 7 ft: Microfossils absent. Clay shale, light- to medium-light-gray; slightly harder than above, less hackly fracture and more silty partings; noncalcareous; dip 8°.
9	810–815	Recovered 4 ft: Microfossils absent. 2 ft, clay shale as above; dip 9°. 1 ft 1 in., clay shale as in first part of this core but containing rounded pebbles up to 2 in. in maximum diameter of grayish-yellow clay ironstone and of medium-gray shaly clay; bedding distorted around these pebbles; also a few nearly vertical slickensided surfaces. 3 in., marl or very limey clay, medium-light-gray, fairly hard; contains crystalline calcite or aragonite, numerous biotite flakes scattered throughout. Small amount of slickensides. 8 in., clay shale as in first part of this core.
	815–900	Clay, some pyrite.

SIMPSON CORE TEST 22—Continued

Core	Depth (feet)	Description
10	900–903	Recovered 3 ft: Microfossils absent. Clay shale and breccia. Medium- to medium-dark gray shaly clay contains numerous noncalcareous medium-light-gray silty laminae toward the base of the interval. In upper foot, clay contains angular fragments of grayish-yellow ironstone concretions, grayish-black coal, medium-light-gray siltstone containing biotite and carbonaceous particles as well as pyrite, other fragments of medium-gray clay and light-bluish- to medium-bluish-gray bentonitic(?) clay. Several slickensided surfaces at high angles noted in this core. Bedding dips 60° in last foot of core.

SIMPSON CORE TEST 23

Core	Depth (feet)	Description
	0–3	Distance between kelly bushing and ground.
	3–10	Tundra, ice, and medium-light-gray clay; also some varicolored subangular to subrounded sand. Pelecypod shell fragments. Gubik Foraminifera rare.
	10–20	Sand, medium-light-gray; yellow cast, very fine to very coarse; subrounded to subangular varicolored quartz, dark chert, and carbonized wood or very low grade coal. Granules and pebbles of yellow sandstone; yellow, red, and green quartzite, and black chert. Pelecypod fragments common. Gubik Foraminifera rare.
	20–40	Sand and clay.
	40–100	Sand, medium-light-gray, very coarse to fine and granules and pebbles. Microfossils very rare to absent. Pelecypod fragments rare.
1	100–110	Recovered 6 ft: Gubik microfossils present. 4 ft 6 in., clay, medium-light-gray. Upper 1½ ft of core silty and contains rounded pebbles primarily of black chert—one gray limestone pebble is 2 in. in diameter; noncalcareous; also contains a few small shell fragments. 1 ft 6 in., silt, medium-light-gray, moderately hard, argillaceous, also sandy; contains subrounded to rounded granules and pebbles (up to ½ in. in diameter, generally smaller) of black chert; noncalcareous, a few small white shell fragments.
2	110–115	Recovered 2 in.: Entire recovery consists of a medium-gray very hard, dense noncalcareous claystone concretion(?). Contact between Gubik Formation and Cretataceous Seabee Formation probably is somewhere between 110–115 ft. Claystone not characteristic of Gubik Formation.
3	115–120	Recovered 4 ft: Microfossils absent. Clay shale, light- to medium-light-gray, hackly fracture; noncalcareous.
	120–140	Clay, light- to medium-light-gray.
	140–150	Limestone, medium-light- to medium-gray, 13 in. at approximately 140 ft; clay and some pyrite.
	150–200	Clay, very little pyrite.

SIMPSON CORE TEST 23—Continued

Core	Depth (feet)	Description
4	200–210	Recovered 2 ft: Microfossils absent. Clay shale, light- to medium-light-gray; hackly fracture, also a few medium-light-gray silty partings. Alternate beds, a fraction of an inch thick, show slight differences in color, rather like varves in the last few inches of the core; noncalcareous; beds lie approximately flat.
5	210–218	Recovered 8 ft: Microfossils absent. Clay shale as above.
	218–250	Clay, light- to medium-light-gray.
	250–260	Limestone, medium-dark-gray and light-olive-gray claystone.
	260–300	Clay; fish fragments 270–290 ft.
6	300–310	Recovered 10 ft: Microfossils very rare Clay shale as above, dip 12°.
	310–370	Clay; fish fragments 340–350 ft and 360–370 ft.
	370–380	Clay and a very small amount of white crystalline calcite.
	380–400	Clay; some light-gray silt.
7	400–405	Recovered 4 ft 6 in.: Microfossils absent. Clay shale, light- to medium-light-gray, rather soft, fair shaly cleavage, cleavage parallels bedding; noncalcareous; dip 5°.
8	405–408	Recovered 3 ft: Microfossils absent. Clay shale as above, rare micaceous partings, rare silty light-gray laminae; noncalcareous; dip 9°.
9	408–410	Recovered 2 ft: Microfossils absent. 1 ft 6 in. as above, dip 10°. 3 in., clay shale, very light gray; softer than shale above, a few small flecks of mica, resembles bentonite found in some of earlier Simpson core tests; however, it is not waxy and does not swell an unusual amount in water. Noncalcareous. 3 in., same as first part of this core.
	410–500	Clay, light- to medium-light-gray.
10	500–510	Recovered 10 ft: Microfossils absent. 5 ft, clay or probably mostly drilling mud, medium-light-gray. 5 ft, clay shale and clay, light- to medium-light-gray, hackly fracture; noncalcareous. Two in. of hard, dense medium-light yellowish-gray clay ironstone, very calcareous in part at 508 ft; dip 5°.
	510–540	Clay; fish fragments 510–520 ft.
	540–550	Claystone, medium-gray; small amount, very slightly calcareous, also clay.
	550–570	Clay.
	570–590	Sand, medium-light-gray, fine; primarily white and clear quartz, rare biotite plates, small amount of dull black-coal 580–590 ft. The top of the Grandstand Formation is at 575 ft.
	590–600	Sand and clay, fish fragments.
11	600–610	Recovered 10 ft: Microfossils absent. Sandstone, medium-light-olive-gray, very fine grained, nearly unconsolidated, subangular to subrounded; estimated 90 percent white and clear quartz; rest of material made up of highly altered rock or dark mineral particles, chlorite, and biotite; noncalcareous.
	610–620	Sand, medium-light-gray, fine; mostly white quartz, small amount with very calcareous cement. Also medium-light-gray claystone (concretion?).
	620–640	Sand, very fine; almost entirely quartz. Very rare *Inoceramus* prisms and fish fragments at 630–640 ft.

SIMPSON CORE TEST 23—Continued

Core	Depth (feet)	Description
	640–660	Clay and sand, a little coal at 650–660 ft.
	660–690	Sand, medium-light-gray, fine, subangular to subrounded; clear and white quartz 85 percent, coal and dark minerals 10 percent, mica.
	690–700	Clay and sand, yellowish-gray clay ironstone.
12	700–710	Recovered 10 ft: Microfossils absent. Clay shale, medium-light-gray, hackly fracture, rare laminae and partings of very fine sand. Thickest of these sandy layers (2 in.) at approximately 705 ft and contains numerous coal particles in addition to the quartz as described in core 11. Three grayish-yellow dense clay ironstone concretions at 706, 707, and 708 ft, each about an inch thick; noncalcareous; dip 3°.
	710–730	Clay and sand, clay ironstone concretion, and very rare *Inoceramus* prisms at 720–730 ft.
	730–750	Sand, fine; primarily clear and white quartz.
	750–760	Clay.
	760–770	Sand and clay.
	770–800	Sand, fine; quartz plus a little dark chert and some fragments of coal; darker grains slightly larger than quartz, mica.
13	800–810	Recovered 9 ft 6 in.: Microfossils absent. Sandstone, medium-light-gray, silty to very fine-grained, practically unconsolidated; primarily white and clear quartz, subangular to subrounded, also some yellow quartz(?), muscovite, and biotite. Several laminae with an abundance of vitreous black coal particles—particles slightly larger than rest of sand grains. Grayish-yellow clay ironstone concretions at 809 and at 810 ft; noncalcareous.
	810–860	Sand, medium-light-gray, very fine to fine; small amount of yellow quartz(?), also small amount of very calcareous medium-gray siltstone 830–840 ft; fish fragments 850–860 ft.
	860–870	Clay and sand, *Ditrupa* sp. fragments common.
	870–880	Sand and medium-light-gray clay.
	880–890	Clay and sand; *Ditrupa* sp.
	890–900	Sand, medium-light-gray, very fine to fine; white quartz, 90 percent. Some dark chert, subangular to subrounded; *Ditrupa* sp.
14	900–910	Recovered 10 ft: Microfossils very rare. Sandstone, medium-light-gray, fine-grained, practically unconsolidated; primarily subangular white quartz; some muscovite, chlorite, and darker minerals or rock grains; noncalcareous.
	910–920	Sand, *Ditrupa* sp., fish fragments.
	920–950	Sand, grading downward from fine sand to silt to clay; fish fragments 930–940 ft.
	950–990	Clay, clay ironstone, 960–970 ft. *Ditrupa* sp., 970–980 ft.
	990–1, 000	Sand, very fine to silt; approximately 9 percent white and clear quartz, 10 percent dark constituents (brown, gray and black), some pyrite.
15	1, 000–1, 010	Recovered 10 ft: Microfossils rare. 4 ft 6 in., siltstone, medium-light-gray, very soft and friable; almost entirely white quartz; noncalcareous. *Ditrupa* sp. and various pelecypods including *Inoceramus* at 1,003 ft.

SIMPSON CORE TEST 23—Continued

Core	Depth (feet)	Description
15	1, 000–1, 010	Recovered 10 ft—Continued 4 ft 6 in., clay shale and clay, medium-light-gray, silty; rather poor shaly cleavage. A 2-in. layer of dull black low-grade coal or lignite at 1,006 ft; lines suggest original plant structure; contains finely disseminated pyrite. Immediately below coal a layer of pelecypod shell fragments; noncalcareous clay. 1 ft, interbedded silt and clay. Thin layers of coal at 1,010 ft, dip estimated 3°.
	1, 010–1, 035	Clay, silt, and sand with mica, pyrite.

SIMPSON CORE TEST 24

Core	Depth (feet)	Description
	0–3	Distance between kelly bushing and ground.
	3–30	Tundra, ice, and medium-gray clay; yellow cast; small amount of sand.
	30–40	Sand, medium-light-olive-gray, fine to medium subangular to rounded and polished; varicolored quartz and chert; pelecypod fragments rare.
	40–80	Sand as above, fine to very coarse; granules and pebbles of chert, quartzite and dark igneous rock, angular to rounded, also some yellowish-gray (limonite stained?) clay; pelecypod fragments common in upper part of core.
	80–98	Clay, medium-light-gray; sand as above. Cretaceous contact (Seabee Formation) at about 85 ft. Volcanic glass shards present.
1	98–108	Recovered 1 ft: Microfossils very rare. Clay shale and clay, light-gray, poor shaly fracture; noncalcareous; dip 17°.
	108–110	No sample.
	110–296	Clay, light- to medium-light-gray; pyrite rare to common at 180–240 ft. Much tundra and contamination from the Gubik Formation.
2	296–306	Recovered 9 ft: Microfossils absent. Clay, shale, light-gray, soft; scattered medium-light-gray micaceous-silty partings, good hackly fracture; noncalcareous; dip 5°–10°.
	306–310	No Sample.
	310–320	Limestone, medium-dark-gray, slightly silty; contains mica and carbonaceous fragments. Some yellowish-gray clay ironstone, also medium-light-gray clay.
	320–440	Clay, light- to medium-light-gray; some pyrite at 340–400 ft.
	440–446	No sample.
3	446–456	Recovered 10 ft: Microfossils very rare. 1 ft, clay shale as above but with less hackly fracture and more silty partings, dark-brown "stain" in partings caused by a concentration of the minute pyrite grains in the silt. 3 in., limestone, medium-gray, hard, slightly silty; contains biotite and carbonaceous flecks. 8 ft 9 in., clay shale as in first part of this core; noncalcareous; dip 7°.
	456–460	No sample.
	460–560	Clay.
	560–580	Clay and very light to light-gray partly crystalline (partly powdery) calcite; calcite quite abundant 570–580 ft.

SIMPSON CORE TEST 24—Continued

Core	Depth (feet)	Description
	580–600	Sand, medium-light-gray, fine, subangular grains; approximately 80 percent white and clear quartz, 20 percent dark chert and other dark minerals. Top of Grandstand Formation at 580 ft.
4	600–610	Recovered 7 ft: Microfossils absent. Sandstone, medium-light-gray, fine-grained, practically unconsolidated; subangular to subrounded grains, approximately 90 percent white and clear quartz; rest a dark mineral, muscovite, biotite, chlorite, and other alteration products; noncalcareous. No shows.
	610–640	Sand, fine; 90 percent quartz, some clay.
	640–650	Sand, very fine to fine; subangular grains, mica.
	650–660	Sand, also dark-yellowish-brown clay ironstone concretion.
	660–680	Sand, small amount of clay, mica.
	680–690	Sand, fine, subangular; 80 percent quartz, dark-yellowish-brown clay ironstone concretion.
	690–700	Sand, some dull black coal.
5	700–710	Recovered 7 ft 6 in.: Microfossils absent. Sandstone as above, very fine- to fine-grained; some yellow "quartz," rare very carbonaceous partings; noncalcareous; beds lie flat or have very low dip. No shows.
	710–730	Sand, very fine; 75 percent white and clear quartz, 15 percent yellow quartz(?), dark minerals, mica, some clay.
	730–740	Clay, medium-light-gray; some sand.
	740–770	Sand, medium-light-gray, fine (and slightly larger), subangular to subrounded; white and clear quartz, dark chert, and coal particles.
	770–790	Sand, very fine to fine quartz 85 percent.
	790–800	Sand, quartz 80 percent, very small amount of garnet.
	800–840	Sand, quartz 75 percent, very fine to fine; grayish-yellow clay ironstone concretion 810–820 ft.
	840–850	Sand, very fine; primarily white quartz, also some yellow quartz(?) mica.
	850–870	Sand, very fine to silt; uppermost occurrence of *Ditrupa* sp. fragments at 850 ft.
	870–900	Sand, silt, and medium-light-gray clay. *Ditrupa* sp.

SIMPSON CORE TEST 25

Core	Depth (feet)	Description
	0–3	Distance between kelly bushing and ground.
	3–10	No sample.
	10–50	Sand and a small amount of yellowish-gray clay. Light-olive-gray sand, varicolored grains, fine to very coarse, well rounded to subangular; primarily yellow, clear, and white quartz, dark chert, and some pyrite. Well-rounded pebbles and granules of dark-gray, black, and yellow chert, gray quartzite, and fine-grained black igneous rock. White pelecypod and gastropod fragments, very rare Foraminifera and ostracodes.
	50–60	Clay and some sand.
	60–110	Sand, gravel, and a small amount of clay. Sand as above. Abundant well rounded black, dark-gray, green, yellow, and red chert pebbles. Also pebbles of white vein quartz, gray quartzite, and medium-gray limestone. Top of Seabee Formation at 110 ft.

SIMPSON CORE TEST 25—Continued

Core	Depth (feet)	Description
	110–508	Rest of ditch samples poor. Sand and pebbles from the Gubik Formation make up largest part of every sample and undoubtedly contamination from upper horizons. The section between 110–508 ft probably is predominantly a soft light- to medium-light-gray clay shale with rare silty partings. Traces of this clay remain in the ditch, but most of the clay probably washed out with the drilling mud in the laboratory. There are no indications in the cuttings of the calcareous streaks as suggested by the electric log at 230 and 420 ft.
1	201–206	Recovered 3 ft: Microfossils absent. Clay shale or shaly clay, medium-light-gray; scattered light-gray silty partings, one parting had brown finely disseminated pyrite, fairly good cleavage, and parallel bedding. Upper foot of recovered section is badly infiltrated with drilling mud; noncalcareous, dip of beds 3°.
2	508–518	Recovered 6 ft: Microfossils absent. Clay shale or shaly clay, medium-light-gray; silty partings, very rare sandy partings, and very rare sandy laminae. Sand very fine, approximately 60 percent subangular white and clear quartz; rest primarily of a dark mineral and a white clay mineral; noncalcareous; dip 4°.
3	518–528	Recovered 7 ft 6 in.: Microfossils absent. Clay shale, medium-light-gray; numerous silty and rare sandy partings as above; cleavage fair to poor; some hackly fracture; noncalcareous; dip 4°.
4	528–538	Recovered 10 ft: Microfossils absent. 1 ft 3 in., siltstone, light-gray, slightly sandy, medium-soft, fairly good cleavage, parallel bedding, very slightly calcareous; no shows; grades gradually into: 8 ft 9 in., clay shale, medium-light-gray; light-gray silty partings, fair to excellent cleavage; noncalcareous; dip 4°.
5	538–550	Recovered 8 ft: Microfossils absent. Clay shale, light- to medium-light-gray; good cleavage, numerous light-gray silty partings, very rare sandy partings; noncalcareous; dip 4°–6°.
6	550–560	Recovered 10 ft. Microfossils absent. Clay shale as above; dip 6°–15°.
7	560–570	Recovered 9 ft: Microfossils absent. Clay shale as above, some hackly fracture, numerous silty partings; dip 6°–10°.
8	570–572	Recovered 2 ft: Microfossils absent. Clay shale, medium-light-gray, poor hackly fracture, noncalcareous; dip difficult to determine, possibly up to 15°.
9	572–580½	Recovered 8 ft 6 in.: Microfossils absent. Clay shale and shaly clay, medium-light-gray; poor to fair hackly fracture, a few argillaceous silty laminae in the upper 2 ft of the section, rare silty partings elsewhere, a few biotite flakes in the silt; noncalcareous; dip 4°.
10	580½–591	Recovered 10 ft: Microfossils absent. Clay shale, medium-light-gray, medium-soft; fair hackly fracture, few silty partings, some silty laminae; noncalcareous; dip 5°.

SIMPSON CORE TEST 25—Continued

Core	Depth (feet)	Description
11	591–602	Recovered 10 ft 6 in.: Microfossils absent. Clay shale, medium-light-gray; partings and rare laminae of siltstone, fair to good cleavage parallel to bedding; noncalcareous; dip 4°–7°.
12	602–612	Recovered 6 ft: Microfossils absent. Clay shale, as above; silty partings but no silt laminae; dip 4°–6°.
13	612–623	Recovered 4 ft: Microfossils absent. Clay shale as above; dip 4°.
14	623–634	Recovered 6 ft: Microfossils absent. Clay shale as above; dip as high as 10°; approximately half of total recovery badly infiltrated with drilling mud.
15	634–644	Recovered 10 ft: Microfossils very rare. Clay shale, medium-light-gray; good cleavage parallel to bedding, silty partings, rare light-gray silty laminae; noncalcareous; dip 6°.
16	644–655	Recovered 10 ft: Microfossils very rare. Clay shale as above; dip 6°–9°.
17	655–665	Recovered 10 ft: Microfossils absent. Clay shale, medium-light-gray, soft; cleavage fair to poor, rare light-gray silty or slightly sandy partings; yellowish-gray clay ironstone layer 1 in. thick at 657 ft, slightly calcareous (probably sideritic); rest of the core is noncalcareous; dip 6°.
18	665–675	Recovered 7 ft: Microfossils absent. Clay shale, medium-light-gray; fair cleavage; noncalcareous, ½-in. layer of yellowish-gray clay ironstone at 673 ft; dip 6°–13°.
19	675–686	Recovered 6 ft: Microfossils absent. Clay shale as above; noncalcareous; dip 8°–11°.
20	686–696½	Recovered 10 ft 6 in.: Microfossils absent. Clay shale, medium-light-gray, medium soft; cleavage fair to poor, irregular fracture, some light-gray silty partings; noncalcareous; dip 12°.
21	696½–708	Recovered 7 ft 6 in.: Microfossils absent. Clay shale, medium-light-gray; poor cleavage. Core badly infiltrated with drilling mud. One thin layer of clay ironstone at 698 ft; noncalcareous; dip 6°–10°.
22	708–718½	Recovered 9 ft: Microfossils absent. 1 ft, clay shale as in core 20 above. 6 ft, interbedded shaly clay, siltstone, and sandstone. Medium-light-gray shaly clay approximately 40 percent as above. Light-gray sandstone forms 35 percent and light-gray siltstone 25 percent; very fine to fine sand, rather soft and friable, made up of about 60 percent subangular to subrounded white and clear quartz. Rest of grains are made up of biotite, carbonaceous particles, dark chert, and rock fragments. Cement a very light gray argillaceous material, possibly slightly calcareous. Thin partings of coal or carbonaceous material are present. Core too soft for porosity and permeability test but appears quite porous from drop test; no shows. 5 in., claystone, dark-gray, brittle; subconchoidal fracture. 7 in., clay shale, medium-light-gray; dark sandy carbonaceous partings.

SIMPSON CORE TEST 25—Continued

Core	Depth (feet)	Description
22	708–718½	Recovered 9 ft—Continued 1 ft, breccia made up of medium-light-gray clay shale, fragments up to an inch in diameter in a light-gray sandy matrix, black streaks of carbonaceous material in sand. Sand contains particles of a soft white claylike mineral; 1 in. at the top of the section is a hard light-gray sandstone with a very calcareous matrix. Dip 12°, possibly higher.
23	718½–729	Recovered 1 ft: Microfossils absent. Recovery consists primarily of drilling mud, also a small amount of medium-light-gray clay shale; noncalcareous.
24	729–739½	Recovered 8 ft 6 in.: Microfossils absent. Clay shale, medium-light-gray; rare silty partings. Core badly mixed with drilling mud; noncalcareous; dip 7°.
25	739½–749	Recovered 8 ft 6 in.: Microfossils absent. Clay shale, medium-light-gray; good cleavage parallel to bedding, tendency toward conchoidal fracture, numerous light-gray silty partings, rare very fine sandstone laminae.
26	749–759½	Recovered 8 ft: Microfossils absent. Clay shale; a few silty and sandy streaks as above. First 2 or 3 in. of section a rather hard medium- to medium-dark-gray argillaceous silty limestone or very calcareous siltstone; dip 7°.
27	759½–770	Recovered 7 ft 6 in.: Microfossils absent. Clay shale, medium-light-gray, moderately soft; poor to fair cleavage, rare light-gray silty and sandy partings, a few slightly sandy laminae, some tendency toward vertical fracture; noncalcareous; dip undetermined.
28	770–780	Recovered 8 ft 6 in.: Microfossils absent. Clay shale and some sandstone. Core badly mixed with drilling mud. Approximately 90 percent of recovery medium-light-gray, clay shale; poor cleavage, silty and sandy partings. Remaining 10 percent a soft light- to medium-light-gray very fine "dirty" sandstone;—contains numerous particles of a soft white claylike material, which may be bentonite; contains biotite plates and carbonaceous particles. Both clay and sand contain rare dull black carbonaceous impressions and coal chips. Some finely disseminated pyrite also noted. One thin broken *Inoceramus* shell fragment at 776 ft and very rare fish remains; noncalcareous; dip undetermined. One piece of sandstone shows a possible dip to 35°, but may be crossbedding.
29	780–791	Recovered 8 ft 6 in.: Microfossils absent. Clay shale, medium-light-gray, medium soft; irregular fracture, very rare laminae of siltstone and sandstone, biotite plates, and carbonaceous flecks. Two-inch layer of waxy bentonitic medium-light-gray clay shale at 786 ft; a ¼ in. layer of white bentonite at the bottom, very rare brown fish fragments; noncalcareous; dip undetermined.
30	791–801	Recovered 8 ft 6 in.: Microfossils absent. Clay shale, rare stringers of dirty sand and silt as above, rare yellowish-gray clay ironstone concretions; non-calcareous; dip 7°?

SIMPSON CORE TEST 25—Continued

Core	Depth (feet)	Description
31	801–811½	Recovered 6 ft: Microfossils absent. Closely interbedded sandstone and clay shale, laminae 1/16–1 in., in thickness. Sandstone light-gray, rather soft and friable, fine-grained, made up of subangular to subrounded clear and white quartz, yellow quartz(?), mica plates, carbonaceous flakes, rock fragments, and a small amount of dark-gray chert. A large amount of soft white claylike material is present interstitially, rare partings in sand darker in color and more carbonaceous; noncalcareous. Shaly clay medium light gray, slightly harder than the sandstone, has poor cleavage; noncalcareous. Dip 22°–30°.
32	811½–822	Recovered 6 ft: Microfossils absent. 3 ft, clay shale and claystone, medium-light- to medium-gray, medium-hard; fair hackly fracture, very rare stringers of sandstone. Pale-yellowish brown 1½ in. clay ironstone nodules or concretions at top of section. Ironstone does not effervesce with cold dilute HCl. Dip 10°–20°. 3 ft, breccia, angular fragments up to 2 in. in diameter of medium-light-, medium-, and medium-dark-gray clay shale, bluish-gray clay shale, brownish-yellow clay ironstone, small coal chips, and exceedingly rare small rounded black chert pebbles in a matrix of medium-soft friable very argillaceous sand of the type described in core 31 above. Fragments apparently have random orientation. Dip of breccia undetermined. A 5-in. section of core at junction of upper and lower halves of this recovery shows a 1/16-in. thick layer of medium-dark-gray clay dipping 70°–75°. Clay shale with a dip of about 25° is on one side of this clay layer and the sandstone breccia with indeterminate dip is on the other; noncalcareous.
33	822–832	Recovered 1 ft: Microfossils absent. Breccia as above, slickensides at approximately 80° angle. Top of Grandstand Formation at 832 ft.
34	832–843	Recovered 10 ft 4 in.: Microfossils very rare. 2 ft 4 in., limestone (and clay shale) medium-light- to medium-dark-gray, argillaceous, hard, dense; grades at top and bottom of interval into somewhat softer very calcareous clay shale; the limestone fractures irregularly, the clay shale cleaves roughly parallel to the bedding; a thin lens of grayish-yellow clay ironstone at 832½ ft, dips 3°–4°. 8 ft, sandstone, medium-light-olive-gray, very soft, nearly unconsolidated; 90 percent white and clear quartz, also some black coal particles, grains subangular to subrounded, very fine grained to silty; noncalcareous; fair oil odor throughout the sandy section, yellow cut and brownish-yellow residue at 839 ft.
35	843–853½	Recovered 10 ft 4 in.: Microfossils common. 4 ft, clay shale, medium-gray; hackly fracture, one thin black coaly streak—carbonized wood(?); noncalcareous.

SIMPSON CORE TEST 25—Continued

Core	Depth (feet)	Description
35	843–853½	Recovered 10 ft 4 in.—Continued 6 ft 4 in., interbedded clay shale, 40 percent as in first part of this core and siltstone 60 percent. Light-olive-gray soft and friable siltstone made up almost entirely of quartz grains; noncalcareous, dip 3°; no shows.
36	853½–864	Recovered 6 ft 10 in.: Microfossils common. Interbedded clay shale, 80 percent and siltstone, 20 percent as immediately above; rare dark pyritic films, inch-thick grayish-yellow clay ironstone lenses or concretions at 856, 858 and 858 ft 6 in. Rare *Ditrupa* tubes, pelecypod, and gastropod shells in lower half of core; noncalcareous; dip 4°.
37	864–874	Recovered 9 ft 6 in.: Microfossils common. Clay shale and shaly clay, medium-gray; poor hackly fracture, a few laminae of medium-light-gray siltstone, rare stringers of black carbonaceous material, also very rare pyritic films; noncalcareous; dip 2°.
38	874–885	Recovered 7 ft 6 in.: Microfossils common. Claystone and clay shale, medium-gray; somewhat harder than shale above, hackly or no good cleavage, very slightly silty, yellowish-gray clay ironstone lens at 882 ft; noncalcareous; numerous brown and white pelecypod shell fragments throughout the core, an iridescent ammonite at 884 ft, *Ditrupa* also noted; dip 3°.
39	885–896	Recovered 10 ft: Microfossils very rare. 3 ft 6 in., claystone, medium-light-gray, silty, rather hard, very calcareous in the upper 7 in. of the section, irregular fracture; 2¼ in. thick very hard slightly calcareous grayish-yellow clay ironstone concretion at 888 ft. 2 ft, siltstone, light-olive-gray, medium-soft and friable, slightly sandy; also contains laminae of slightly calcareous, clay shale; a yellow ironstone concreton near bottom of section; silt contains some black carbonaceous stringers, probably plant remains. 4 ft 6 in.: claystone, medium-light-gray, quite silty, medium-hard, slightly calcareous in spots. Pelecypod at 896 ft, iridescent ammonite at 895 ft; dip approximately 3°.
40	896–906	Recovered 10 ft: Microfossils absent. Siltstone, medium-light- to medium-light-olive-gray, argillaceous, soft and friable to medium-hard; fractures at 60° angle or otherwise very irregularly, rare dull black carbonaceous stringers; core ranges from moderately to very calcareous; dip of beds obscure, probably lies nearly flat; no shows.
41	906–916	Recovered 5 ft: Microfossils very rare. Siltstone, medium-light-gray, very argillaceous, medium-hard; irregular fracture, in places grades into silty claystone, scattered black and brown carbonaceous stringers; moderately calcareous; bedding not evident.

SIMPSON CORE TEST 25—Continued

Core	Depth (feet)	Description
42	916–927	Recovered 10 ft 6 in.: Microfossils rare. Claystone and small amount of clay shale, medium-light-gray, slightly silty, medium-hard, hackly, irregular fracture but with some tendency to vertical fracture; contains scattered coaly stringers and carbonaceous flecks; slightly to moderately calcareous; dip 3°.
43	927–938	Recovered 11 ft: Microfossils common. 7 ft, clay shale, medium-gray, medium-hard; fair cleavage parallel to the bedding, rare silty laminae, rare micaceous and carbonaceous partings, carbonaceous plant remains, several grayish-yellow clay ironstone concretions; noncalcareous with exception of ironstone; pelecypod fragments at 932 ft. 4 ft, siltstone, medium-light-olive-gray, medium-hard to medium-soft and friable; some argillaceous streaks; silt is made up of subangular to subrounded clear and white quartz grains, carbonaceous particles and mica, an argillaceous matrix; fair cleavage parallel to bedding, trace of very fine sand; pelecypod fragments at 938 ft; noncalcareous; dip 4°.
44	938–948	Recovered 5 ft: Microfossils very rare. Clay shale, medium-light-gray; fair cleavage, rare laminae of siltstone, moderately calcareous. A 2-in. layer of hard medium-dark-gray limestone, 1½ ft from the top of the recovered section; 1 in. layer of very hard medium-grained grayish-yellow sandstone; 60 percent quartz, rest is of a variety of minerals including a very small amount of glauconite and a soft white claylike mineral, yellow color comes from sideritic(?) cementing material; dip 4°.
45	948–959	Recovered 10 ft 6 in.: Microfossils rare. Interbedded claystone, 60 percent and siltstone, 40 percent of the type as described in the cores above, poor or no cleavage; slightly to moderately calcareous; rare small pelecypod fragments; dip low.
46	959–969	Recovered 10 ft: Microfossils rare. Clay shale, fair to poor hackly fracture and medium-light-gray moderately hard claystone with irregular fracture at a steep angle; rare silty laminae; noncalcareous; dip 3°. *Ditrupa* in microfossil cut.
47	972–982	Recovered 10 ft: Microfossils rare. 3 ft 7 in., siltstone, argillaceous, interbedded; 80 percent siltstone and 20 percent clay shale. Siltstone slightly calcareous, medium-light-gray, medium soft and friable; rare vermicular stringers of light-gray sandstone. Clay shale as in lower part of this core. 6 ft 5 in., clay shale or claystone, medium- to medium-dark-gray; harder than siltstone above, poor hackly fracture; one slickensided surface dips 50° 6 in. from bottom of recovery; noncalcareous; beds lie flat or with very low dip. White pelecypod shell fragments in middle of recovered section.

SIMPSON CORE TEST 25—Continued

Core	Depth (feet)	Description
48	982–989	Recovered 5 ft: Microfossils absent. Clay shale, medium- to medium-dark-gray, medium-soft; contains numerous partings and laminae of softer siltstone, also rare streaks of dirty sandstone, very fine to fine-grained; slightly to moderately calcareous; dip 3°.
49	989–1, 000	Recovered 8 ft: Microfossils common. 1 ft 6 in., claystone, medium- to medium-dark-gray, silty, micaceous, carbonaceous, medium-hard; poor hackly fracture; noncalcareous. 2 ft 6 in., siltstone, medium-light-gray, very soft and friable; primarily quartz grains, some mica and carbonaceous flecks; noncalcareous. 4 ft, claystone as above in this core, numerous laminae of siltstone particularly near the bottom of the section. Several black carbonaceous plant impressions and very rare very thin (½ in.) streaks of dull black coal, with blocky fracture; dark color of claystone probably due to presence of finely disseminated carbonaceous material; noncalcareous; dip 3°.
50	1, 000–1, 011	Recovered 5 ft: Microfossils very rare. Sandstone, medium-light-gray, very soft and friable; some thin interbeds of clay shale; sand is very fine to fine-grained, subangular to subrounded, 80 percent white and clear quartz, some dark chert, carbonaceous particles and rock fragments; noncalcareous; low dip; no shows.
51	1, 011–1, 014	Recovered 2 ft: Microfossils common. Clay shale, medium-gray, medium-soft; fair to poor cleavage; noncalcareous; dip 3°.
52	1, 014–1, 024	Recovered 5 ft: Microfossils rare. 5 in., clay, medium-light-gray. 1 ft, sandstone, medium-light-gray, very soft and friable; clean; made up of 80 percent white or clear quartz, rest dark chert, carbonaceous material, and other rare very fine to fine-grained, slightly silty minerals at the base of the interval; noncalcareous; no shows. 2 ft, clay shale, medium-dark-gray, moderately hard; fair cleavage parallel to bedding, numerous medium-light-gray slightly micaceous silty partings, also dark-gray carbonaceous partings; noncalcareous; dip 3°. 1 ft 2 in., sandstone, fine-grained, as above, practically unconsolidated; no shows. 5 in., clay shale as above in this core.
53	1, 024–1, 034	Recovered 4 ft: Microfossils common. 1 ft 6 in., clay shale, medium-dark-gray to medium-gray, moderately hard; fair cleavage numerous partings and laminae of light-gray siltstone, rare irregular fracture; noncalcareous; dip 4°. 8 in., siltstone, medium-light-gray, sandy, soft, and friable; noncalcareous. 1 ft 10 in., clay, medium-gray, moderately hard; irregular fracture, a slightly calcareous grayish-yellow clay ironstone concretion at the top of the section.

SIMPSON CORE TEST 25—Continued

Core	Depth (feet)	Description
54	1, 034–1, 044	Recovered 6 ft: Microfossils abundant. 2 ft, clay shale and claystone, medium- to medium-dark-gray; poor to fair hackly fracture; contains numerous coaly brown and black plant remains. 4 ft, siltstone, medium-light-gray; softer than overlying shale; bedding not well defined, rare thin interbeds of clay at the base of the interval; slightly calcareous.
55	1, 044–1, 055	Recovered 10 ft: Microfossils absent. 5 ft, sandstone, medium-light-gray, very fine to fine-grained, very soft and friable, practically unconsolidated; 80 percent white and clear quartz, rest made up of dark minerals and (or) rock fragments, chalky white particles, small amount of yellow quartz(?) and mica, subangular to subrounded; no shows. 5 ft, interbedded clay shale 60 percent, sandstone 25 percent, and siltstone 15 percent. Clay, medium light-gray, fairly good cleavage, medium soft but harder than the sandstone and siltstone. Sandstone described in upper half of this core. Siltstone, medium light gray, rather soft, argillaceous, fair to poor cleavage; yellowish-gray clay ironstone concretions at about 1,045 ft. Clay shale, siltstone, and ironstone are moderately to very calcareous.
56	1, 055–1, 065	Recovered 5 ft: Microfossils very rare. Siltstone, medium-light-gray, very argillaceous, medium-soft; medium-gray clayey laminae, rare shaly cleavage, irregular fracture; moderately calcareous; dip 6°.
57	1, 065–1, 076	Recovered 1 ft: Microfossils absent. Siltstone as in core immediately above.
58	1, 076–1, 086	Recovered 10 ft: Microfossils rare. Interbedded claystone, clay shale, and siltstone with all gradations, medium-light-gray, medium-hard, fair to good cleavage; a few fractures which dip 80°, moderately calcareous, dip 4°–6°.
59	1, 086–1, 097	Recovered 11 ft: Microfossils common. 1 ft 10 in., interbedded claystone and siltstone as in core above, some hackly fracture. 9 ft 2 in., siltstone, medium-light-gray, medium-soft to very soft and unconsolidated; rare interbeds of clay shale, grayish-yellow clay ironstone concretions at 1,089 ft and 1,090 ft; slightly calcareous in spots; no shows; dip 7°–16°.
60	1, 097–1, 108	Recovered 11 ft: Microfossils common. 2 ft, clay shale, medium-gray, moderately hard; hackly fracture, slickensided surfaces dip 40° at 1,099 ft; noncalcareous; dip 2°(?). 9 ft, claystone, medium-light-gray, moderately hard, silty; irregular fracture; contains abundant pyritized and carbonized plant fragments and impressions; most of pyritized impressions flat, ⅓ in. wide and extend across core parallel to bedding, impression of fern like leaf noted at 1,100 ft; noncalcareous.
61	1, 108–1, 119	Recovered 1 ft: Microfossils very rare. Claystone, medium-light-gray, silty; black carbonaceous fragments, core badly infiltrated with drilling mud; slightly calcareous.

SIMPSON CORE TEST 25—Continued

Core	Depth (feet)	Description
62	1, 119–1, 129	Recovered 9 ft: Microfossils absent. 1 ft 8 in., siltstone, medium-light to medium-gray, soft and friable; a few interbeds of clay; noncalcareous. 10 in., coal, shiny black, rather soft and brittle; probably subbituminous; blocky fracture. 3 ft, siltstone, argillaceous and very silty, medium-light- to medium-gray micaceous claystone; black carbonaceous flecks and fragments; grayish-yellow clay ironstone concretion or nodule at 1,122 ft, 2-in. layer of coal at 1,123 ft. 3 ft 6 in., siltstone, light- to medium-light-gray, very soft—practically unconsolidated through parts of the interval, very slightly sandy; a few laminae of clay; noncalcareous.
63	1, 129–1, 140	Recovered 11 ft: Microfossils very rare. Clay shale and claystone, medium-light- to medium-gray, medium-hard; poor to fair cleavage parallel to the bedding, some hackly fracture, laminae as much as 4 in. thick of medium-light-gray siltstone; grayish-yellow clay ironstone concretion at 1,134 ft; clay shale noncalcareous, siltstone slightly calcareous; dip 3°.
64	1, 140–1, 150	Recovered 10 ft: Microfossils rare. Clay shale, medium-light-gray, medium-hard; hackly fracture, rare lighter silty partings and laminae, some claystone; slightly to moderately calcareous; dip 2°.
65	1, 150–1, 161	Recovered 9 ft: Microfossils very rare. 8 ft, clay shale as in core immediately above. 1 ft, sandstone, medium-light-gray, practically unconsolidated; primary mineral is white and clear quartz, 90 percent, also mica, carbonaceous flecks, rock fragments, rare white claylike particles and rare dark very fine to fine-grained, subangular to subrounded mineral; noncalcareous.
66	1, 161–1, 171	Recovered 10 ft: Microfossils absent. Sandstone, medium-light-gray, very soft to practically unconsolidated; 75 percent white and clear quartz, also dark minerals and (or) rock fragments, some orangish-yellow subangular to subrounded quartz(?) and mica; better consolidated parts of this core cleave easily parallel to the bedding; noncalcareous; dip 4°.
67	1, 171–1, 182	Recovered 10 ft: Microfossils absent. 2 ft, siltstone, medium-light-gray, very soft and practically unconsolidated; interbedded with a considerable amount of very fine sand; slightly calcareous. 1 ft, siltstone, medium-light-gray, hard, very dirty; contains mica, chlorite, carbonaceous and argillaceous material, some sand. Mica plates and carbonaceous flecks (broken plant fragments?) lie parallel to the bedding and make partings along which this rock cleaves easily; very calcareous; dip 3°. 7 ft, siltstone, mostly very soft, as in first part of this core, dark carbonaceous partings, rare very fine sand streaks, grayish-yellow clay ironstone concretion at approximately 1,181 ft; slightly calcareous in spots.

SIMPSON CORE TEST 25—Continued

Core	Depth (feet)	Description
68	1, 182–1, 192	Recovered 7 ft: Microfossils common. Clay shale, medium-gray, medium-soft; poor to fair hackly fracture, a small amount of claystone with no regular cleavage, 2½-in. thick grayish-yellow clay ironstone concretion at approximately 1,183 ft, very rare, slightly silty laminae; noncalcareous except for ironstone, which is moderately calcareous; dip 0°–2°.
69	1, 192–1, 203	Recovered 9 ft: Microfossils rare. Clay shale and claystone, medium-light- to medium-gray, medium-soft; poor to fair hackly fracture, rare lighter colored silty laminae and partings; rare slightly calcareous streaks; dip 4°.
70	1, 203–1, 213	Recovered 10 ft: Microfossils rare. Interbedded clay shale, shale, and all gradations of these, light-gray, medium-soft, poor to fair cleavage, tiny brown pectenlike pelecypods at 1,207 ft; silty laminae are slightly to moderately calcareous; dip 3°.
71	1, 213–1, 224	Recovered 10 ft: Microfossils common. Clay shale, medium-light-gray, medium-soft; fair cleavage parallel to the bedding, scattered silty laminae and partings, silty laminae are slightly calcareous in spots; beds lie flat or with low dip.
72	1, 224–1, 234	Recovered 7 ft: Microfossils common. Clay shale and claystone, medium-light-gray; poor cleavage, rare thin laminae and partings of silty shale; dark very rare carbonaceous plant impressions; silt is slightly calcareous; dip 2°.
73	1, 234–1, 245	Recovered 10 ft: Microfossils common. Clay shale, medium-light- to medium-gray; poor to fair cleavage, rare medium-light-gray silty laminae and partings; grayish-yellow clay ironstone concretion ½ in. in diameter at 1,238 ft; one *Ditrupa* tube at 1,243 ft; rare silty streaks calcareous, dip 2°.
74	1, 245–1, 256	Recovered 5 ft: Microfossils common. 1 ft, claystone and clay shale, medium-light-gray, medium-hard; becomes silty toward base of interval. 6 in., sandstone, medium-light-gray, very fine to fine-grained, practically unconsolidated, subangular to subrounded; made up 90 percent white and clear quartz; becomes silty toward base; noncalcareous. 3 ft 6 in., claystone and some siltstone, medium-light-gray; yellowish-gray clay ironstone near the base of the recovered section; noncalcareous.
75	1, 256–1, 266	Recovered 10 ft: Microfossils absent. Clay shale 80 percent and siltstone 20 percent. Clay shale is medium light gray to medium gray, moderately soft, fair to good cleavage. Siltstone is medium light gray, medium-soft; both are slightly to moderately calcareous; dip 2°–4°.

SIMPSON CORE TEST 25—Continued

Core	Depth (feet)	Description
76	1, 266–1, 277	Recovered 10 ft: Microfossils absent. Sandstone, medium-light-gray, very fine to medium-grained, very soft to practically unconsolidated; bulk of core is in the fine to medium range, 80 percent white and clear quartz, rest is dark chert, rock fragments, mica, and other minerals plus an opaque white mineral, subangular and in small part subrounded; noncalcareous; beds lie nearly flat; no cut, slight greasy film as residue from 1,275 ft.
77	1, 277–1, 287	Recovered 10 ft: Microfossils absent. Sandstone, medium-light-gray, fine- to medium-grained, practically unconsolidated, angular to subrounded; 70 percent white and clear quartz; carbonaceous and coaly particles are very abundant in streaks; rock fragments, dark chert, hard chalky white particles, and mica also present; poorly cemented fairly "clean" sand; noncalcareous; dip not determined; no shows.
78	1, 287–1, 298	Recovered 11 ft: Microfossils absent. Sandstone, exactly as above but sand grain size is more in the fine range than the medium; a few inches of clay shale at the top of the section; no shows.
79	1, 298–1, 308	Recovered 11 ft: Microfossils absent. Sandstone, medium-light-gray, fine-grained, very soft and in part nearly unconsolidated, subangular to subrounded; grains made up of about 75 percent white and clear quartz; rest are dark-gray, black, opaque white, and yellowish-brown mineral grains and rock fragments, very small amount of mica; core too poorly consolidated for porosity and permeability tests but appears very porous with drop test; noncalcareous; bedding indistinct, probably lies nearly flat; no shows.
80	1, 308–1, 319	Recovered 5 ft: Microfossils absent. Sandstone as described in core above, fine-grained; no shows.
81	1, 319–1, 330	Recovered 11 ft: Microfossils absent. Sandstone as above, slightly better consolidated, very fine to fine-grained, micaceous (muscovite?) partings; beds lie nearly flat; no shows.
82	1, 330–1, 340	Recovered 10 ft: Microfossils very rare. Sandstone, medium-light-gray, very fine to fine-grained, soft and friable; 85 percent white and clear quartz, also yellow quartz(?), carbonaceous and coaly particles, generally micaceous, a few silty laminae, very rare carbonized plant remains; 6 in. of medium-gray clay shale in about the middle of the core; noncalcareous; dip 3°; no shows.
83	1, 340–1, 351	Recovered 11 ft: Microfossils absent. 9 ft, interbedded siltstone and sandstone, medium-light-gray, soft and friable but not unconsolidated. Sandstone is very fine grained, similar to the sand described above, gradations throughout the section from sandstone to siltstone; noncalcareous; dip 3°. 2 ft, clay shale and claystone, medium-light-gray, medium-soft but harder than upper part of core; irregular fracture; noncalcareous.

SIMPSON CORE TEST 25—Continued

Core	Depth (feet)	Description
84	1, 351–1, 361	Recovered 10 ft: Microfossils very rare. Interbedded siltstone 70 percent and clay shale 30 percent. Siltstone, medium-light-gray, medium-soft and friable, fair to poor cleavage. Medium-gray medium-soft noncalcareous clay shale; poor cleavage; dip 3°.
85	1, 361–1, 372	Recovered 10 ft: Microfossils very rare. Interbedded siltstone, claystone, clay shale, and a small amount of sandstone. Siltstone, 70 percent, medium light gray, medium soft and friable, slightly calcareous, irregular fracture; claystone and clay shale, 20 percent, medium light gray; cleavage absent to fair hackly fracture, medium soft, rare black carbonaceous flecks, noncalcareous. Sandstone, 10 percent in last foot at the bottom of the core, medium light gray, medium soft, very fine-grained; sandstone stained with oil (possibly from an outside source during shipping); noncalcareous; dip 3°–6°.
86	1, 372–1, 383	Recovered 7 ft: Microfossils absent. 4 ft 6 in., interbedded siltstone, sandstone, and claystone as in core immediately above; carbonaceous particles present, fracture(?) cutting core with dips up to 45°, dip of beds up to 22°; noncalcareous. 2 ft 6 in., claystone, medium-light-gray; medium-hard, harder than all preceding cores, dark carbonaceous particles common, mica present, irregular fracture but not fractured as in upper part; very slightly calcareous; bedding indistinct.
87	1, 383–1, 393	Recovered 10 ft: Microfossils very rare. Siltstone, also small amount of sandstone and claystone, gradations between all of these, medium light gray, medium hard, slightly better consolidated than most of the cores described above, good to poor cleavage parallel to the bedding; numerous small brown and black plant fragments sandy streaks are very fine grained, micaceous; whole interval slightly calcareous; dip 5°.
88	1, 393–1, 404	Recovered 11 ft: Microfossils absent. Claystone, medium light gray; harder than most foregoing cores, bedding indistinct, black plant impressions, and carbonaceous flecks distributed with random orientation throughout; no cleavage but irregular fracture roughly at right angles to the walls of the core; silty and sandy streaks in about the middle of the interval. Concentration of dark carbonaceous particles at 1,400 ft in very steep dipping "swirly" streaks suggest rock flowage or contemporaneous deformation; slightly calcareous particularly in sandy-silty laminae.
89	1, 404–1, 414	Recovered 5 ft: Microfossils absent. Claystone and clay shale, very silty, similar to core 87 above, light gray to medium light gray, very silty; some medium-hard siltstone laminae, carbonaceous flecks, and fragmentary plant impressions scattered throughout the core; slightly to rarely moderately calcareous; dip 3°–5°.

SIMPSON CORE TEST 25—Continued

Core	Depth (feet)	Description
90	1, 414–1, 425	Recovered 10 ft: Microfossils absent. 9 ft 6 in., claystone and clay shale, light-gray, medium-hard; quite uniform of texture and color, tendency toward conchoidal fracture, brown and black carbonaceous flecks present sparingly; very slightly to very calcareous, increases with depth; dip 5°. 6 in., limestone, light-bluish-gray, medium-hard; tends to crumble into small chips. Cut with veins up to ¼ in. thick of white prismatic crystals, possibly aragonite.
91	1, 425–1, 435	Recovered 10 ft: Microfossils very rare. 4 ft. clay shale, medium-light-gray, medium-hard; fair to poor hackly fracture, numerous brown and black broken plant fragments; slightly calcareous; dip about 5°; broken brownish-white pelecypod fragments at 1,428 ft; grades gradually into: 6 ft, clay shale, medium-gray; less coherent and fractures more irregularly than upper part of core, cleavage poor, rare medium-light-gray silty laminae; slightly to very calcareous, particularly in silty streaks.
92	1, 435–1, 446	Recovered 11 ft: Microfossils very rare. 6 ft, claystone, medium-gray, medium-hard; irregular fracture, no shaly cleavage, gastropod fragment at 1,441 ft; noncalcareous; becomes silty at base and grades into: 5 ft, sandstone, medium-light-gray, fine-grained, soft and friable; subangular and rare subrounded grains; 75 percent white and clear quartz; coaly particles and mica common along partings, ½-in. thick coaly layer at the top of the section appears to be carbonized wood; sandstone is quite porous on drop test; noncalcareous; dip 6°–11°; no shows.
93	1, 446–1, 456	Recovered 10 ft: Microfossils absent. Sandstone, medium-light-gray as in lower part of core 92 above, very fine to fine-grained, very soft and practically unconsolidated; rare thin coal streaks; no shows.
94	1, 456–1, 467	Recovered 10 ft: Microfossils absent. 7 ft, sandstone as above, fine-grained, noncalcareous.
95	1, 467–1, 478	Recovered 10 ft: Microfossils absent. 3 ft, claystone, medium-gray, medium-hard; good shaly cleavage absent, irregular fracture; noncalcareous. 2 ft, siltstone, medium-soft, very calcareous; no good bedding evident. 5 ft, clay shale, slightly calcareous; identical with uppermost part of section except it has a suggestion of cleavage parallel to the bedding; dip not determined.
96	1, 478–1, 488	Recovered 10 ft: Microfossils absent. Claystone, and medium-gray clay shale; no cleavage in the upper half of the core to fair cleavage in the lower; also calcareous micaceous medium-light-gray silty laminae in the upper half; dip 3°–7°.
97	1, 488–1, 499	Recovered 10 ft: Microfossils absent. 5 ft, claystone, medium-light- to medium-gray, medium-soft; core fractured and broken, fractures cut core at very steep angles, nearly vertical; slightly to moderately calcareous.

SIMPSON CORE TEST 25—Continued

Core	Depth (feet)	Description
97	1, 488–1, 499	Recovered 10 ft—Continued 5 ft, clay shale, medium-gray, medium-soft; good shaly cleavage parallel to bedding, no fracturing; slightly to moderately calcareous; dip 6°.
98	1, 499–1, 510	Recovered 8 ft: Microfossils rare. Clay shale, medium-gray, medium-soft; fair cleavage parallel to bedding in a small part of the core. Numerous near-vertical fractures cut the core similar to upper section in core 97 above; slightly to moderately calcareous; dip 3°–4°.

SIMPSON CORE TEST 26

Core	Depth (feet)	Description
	0–3	Distance between kelly bushing and ground.
	3–20	Tundra, yellowish-gray clay, and dark-yellowish-orange, very fine to coarse, subangular to well-rounded sand, gray cast; primarily subrounded and polished; grains made up largely of resistant siliceous material—60 percent white and clear quartz, 20 percent yellow quartz, 10 percent black chert, and rest of miscellaneous varicolored grains.
	30–60	Clay, yellowish-gray, and granules of brown, yellow, and black chert and clear quartz sand; numerous pelecypod fragments, Gubik microfossils rare; asphalt-impregnated clay and sand.
	60–70	Sand, medium-light-gray, subangular to rounded; almost entirely clear glassy quartz; abundant granules and pebbles of black chert.
	70–80	Clay, sand, granules, pebbles—among them rare rock (quartzite) fragments, and asphalt-impregnated clay.
	80–90	Sand, clay, pebbles. Top of the Ninuluk-Seabee sequence, undifferentiated, at 87 ft.
	90–100	Primarily material from the Gubik Formation.
	100–117	No samples.
1	117–126	Recovered 8 ft: Microfossils abundant. 1 ft 3 in., clay, light- to medium-light-gray, soft; no cleavage, very irregular fracture. 1 ft 3 in., clay shale, medium-gray, soft; good shaly cleavage; contains abundant brown fish scales and other fragments, interbedded with medium-dark-gray very waxy bentonitic clay, also a ½-in. layer of very light yellowish gray bentonite in the middle of the section, abundant thin-shelled *Inoceramus labiatus* Schlotheim present in the clay shale. 5 ft 6 in., interbedded light-gray clay shale of various types; excellent cleavage; contains minute white specks, probably bentonite; contains rare fish scales. Medium-light-gray clay shale with rather poor cleavage. Medium- to medium-dark-gray clay shale that alternates with medium-light-gray in a varvelike fashion. Laminae extremely fine (1/64 in. or less); darker shale contains a few chips of coal and carbonaceous particles. Very rare waxy thin streaks of bentonitic clay. *Inoceramus* is present; noncalcareous; beds lie approximately flat.

SIMPSON CORE TEST 26—Continued

Core	Depth (feet)	Description
2	126–137	Recovered 10 ft: Microfossils abundant. 7 ft 2 in., clay shale, light- to medium-light-gray; upper half of section tends to crumble easily, whereas lower part is better indurated; contains abundant finely disseminated waxy bentonitic material, rare streaks with dark carbonaceous particles; noncalcareous. 1 in., bentonite or very bentonitic clay, white, very soft; crumbles easily into small pieces. 2 ft 9 in., clay shale, medium-light- to medium-gray, medium-soft; excellent cleavage parallel to bedding; 6 in. of very waxy bentonitic material in the middle of the section, medium-gray to yellowish-white. Shale contains abundant brown fish fragments, scales as much as an inch in diameter at 137 ft. Most fragments are ⅛ of an in. or less; noncalcareous; dip 1°.
3	137–148	Recovered 10 ft: Microfossils abundant. 1 ft, clay shale, medium-light-gray to white, bentonitic; good cleavage, most bentonitic parts crumble easily; noncalcareous. 4 ft, clay shale, medium-light- to medium-gray, medium-soft, slightly bentonitic; a ½-in. layer of yellowish-white bentonite at 139 ft. An outstanding feature of this section is the abundance of fishbone fragments and other megafossil remains. A well-preserved part of a fish showing vertebrae, ribs, and scales—probably a section of the fish just forward of the caudal fin—was found at 138 ft. Tiny white shell fragments as well as nearly complete shells are present—*Inoceramus labiatus* Schlotheim and *Borissiakoceras* sp. have been identified; noncalcareous. 1 ft 11 in., clay shale, medium-dark-gray to white, very bentonitic, crumbly, waxy; many alternate varvelike beds; in general not as fossiliferous as section above but one small ammonite (diameter ¼ in.) found at 142 ft; radiolaria noted imbedded in core close to the ammonite; noncalcareous. 1 in., clay shale, dark-gray; contains an abundance of tiny flat oolitelike marcasite concretions with fishbone fragments; this small section has an odor resembling hydrogen sulphide; noncalcareous. 3 ft, clay shale containing abundant fossils as described in second part of this core, very rare coaly plant remains; noncalcareous; beds lie approximately flat.
4	148–159	Recovered 11 ft: Microfossils present. Clay shale, medium-gray, medium-soft; excellent cleavage, abundant fish fragments, very rare *Inoceramus* fragments, also rare coaly chips, some micaceous partings; noncalcareous; interbedded with bentonitic layers as follows: at 149 ft is 2 in. crumbled, yellowish-white nearly pure bentonite plus 3 in. of waxy medium-dark-gray bentonitic shale; at 150 ft is 2 in. dark bentonitic clay shale; at 153 ft, dark and light bentonitic shale; at 154 ft is 2 in. of dark-gray bentonitic shale; at 155½ ft is 5 in. of medium-light-gray

SIMPSON CORE TEST 26—Continued

Core	Depth (feet)	Description
4	148–159	Recovered 11 ft—Continued bentonitic shale; and last foot of core is about 70 percent light-colored bentonitic shale; noncalcareous; beds lie flat or with 1° dip.
5	159–170	Recovered 11 ft: Microfossils present. Clay shale, medium-light- to medium-gray, moderately soft; good cleavage, fishbone fragments are abundant in streaks but in general are rarer in this core than in those above. 2 ft 6 in. of total recovery is bentonitic as follows: 6 in. at top of core is very light gray to yellowish white; 4 in. at 160 ft is light gray to very light gray; 11 in. at 166 ft is very light to medium-gray shale; 8 in. at 169 ft, medium-light-gray; 1 in. at 170 ft medium-light-gray. All bentonitic layers are soft and crumble easily when dried out; noncalcareous; beds lie flat or with very low dip.
6	170–180	Recovered 3 ft: Microfossils absent. 9 in., clay shale, medium-light-gray, moderately soft; good cleavage; noncalcareous; beds lie approximately flat. 2 ft 3 in., sandstone, medium-light-gray, very fine to fine-grained, soft and friable; strong olive-colored oil stain; subangular; 60 percent white and clear quartz, 20 percent soft green and gray rock fragments (clay shale?), abundant mica (biotite in part) rare pyrite and other minerals; noncalcareous; strong oil odor, brownish-yellow cut and yellowish-brown residue from the base of the interval.
7	180–190	Recovered 7 ft: Microfossils absent. 3 ft, sandstone, as described immediately above, very soft, oil stained. 1 ft 3 in., very calcareous sandstone grading to very sandy limestone, medium-gray with slight oil stain, very hard, irregular fracture, same type of sand as described above; slight oil odor. 3 ft 9 in., sandstone, soft as in first interval of core, oil-stained; has oil odor, yellow cut, and yellow residue from 188 ft.
8	190–201	Recovered 11 ft: Microfossils absent. 2 ft, sandstone, medium-light-gray, very fine-grained, practically unconsolidated; slight oil stain, grains as described for sands above; noncalcareous. Slight odor; grades into: 2 ft 6 in., sandy siltstone, medium-light-gray, medium-soft and friable; slight oil stain; cleaves parallel to the bedding. Contains abundant mica; noncalcareous; dip 1°; fair to good oil odor. 4 in., siltstone, medium-light-gray, very hard, very calcareous, micaceous. 1 ft 2 in., clay shale, medium-light-gray, soft, silty, micaceous; noncalcareous; breaks irregularly. 8 in., siltstone, medium-light-gray, very hard, very calcareous, micaceous. 4 ft 4 in., siltstone, medium-light-gray; sandy, very to medium-soft; noncalcareous; in part has good olive-colored oil stain; filled with abundant minute micaceous plates; very good oil odor, brownish-yellow cut, yellowish-brown residue from 200 ft.

SIMPSON CORE TEST 26—Continued

Core	Depth (feet)	Description
	201–232	Sand contamination from the Gubik Formation.
	232–242	No sample.
	242–253	Sand contamination from the Gubik Formation.
	253–260	Few chips of calcareous sandstone, medium-gray, very fine-grained, mica plates. Contamination from the Gubik Formation.
	260–263	No sample.
9	263–274	Recovered 11 ft: Microfossils absent. 7 ft 2 in., interbedded clay shale, 70 percent; and silt shale, 30 percent. Clay shale medium-light-gray, medium-soft, and silty, fair cleavage, very rare carbonaceous partings; siltstone occurs in beds up to 1 ft thick but generally in laminae of less than an inch; medium light gray but easily distinguished from clay shale by olive-colored oil stain, medium soft, micaceous, sandy, noncalcareous; beds lie approximately flat; good oil odor and stain, yellowish-brown cut, brown residue from 268 ft. 7 in., coal, dull black to brownish black, low-grade; blocky fracture; very thin beds visible because of slight changes in texture and luster. 3 ft 3 in., claystone, medium-light-gray, medium-soft; irregular fracture roughly parallel to bedding but no good cleavage, noncalcareous; beds lie approximately flat.
	274–285	Clay, medium-light-gray and medium-light-gray fine sand; white and clear quartz, some dark chert.
	285–300	Sand contamination from the Gubik Formation.
	300–306	No sample.
10	306–317	Recovered 10 ft: Microfossils absent. Sandstone, medium-dark-olive-gray, fine-grained, very soft and friable, subangular; pronounced oil stain; 60 percent white and clear quartz, rock fragments, biotite, and other dark minerals make up rest; black carbonaceous partings are present; last 6 in. of the recovery is a very hard dense grayish-yellow clay ironstone concretion filled with carbonaceous flecks and many sand grains; porosity and permeability not determined because formation is so soft; noncalcareous; dip 3°; very good oil odor, deep amber cut, brown residue from 309 ft.
	317–370	Sand, medium-light-gray, fine, subangular; 90 percent clear and white quartz, also black chert, carbonaceous fragments, and mica. Some contamination from the Gubik Formation.
	370–390	Clay(?); Sand from Cretaceous and Gubik strata.
	390–480	No sample. Top of Grandstand Formation at about 420 ft (based on the electric log and on correlation with nearby core tests).
	480	Sand, medium-light-gray, fine, 90 percent white and clear quartz, some dark chert, rock fragments (schist), mica.
	480–498	No sample.
11	498–509	Recovered 10 ft: Microfossils rare. Clay shale, medium-light- to medium-gray, medium-hard, slightly silty, noncalcareous; poor cleavage; dip 3°.
	509–530	No sample.

SIMPSON CORE TEST 26—Continued

Core	Depth (feet)	Description
	530–569	Silt and very fine to fine sand, probably some clay. Sand from the Gubik Formation.
12	569–580	Recovered 11 ft: Microfossils rare. Clay shale, medium-light- to medium-gray, medium-hard; fair to good cleavage, several medium-light-gray laminae, particularly in the upper half of the recovered section; rare laminae up to ½ in. thick of yellowish-gray clay ironstone, one ⅛ in. thick at 570 ft. Scattered mollusk fragments; noncalcareous; dip 2°.
	580–600	Sand, fine.
	600–630	Clay, medium-light-gray, and sand.
	630–690	Sand, medium-light-gray, fine, subrounded to subangular; 80 percent white and clear quartz, dark chert and rock fragments, mica, some brownish-yellow quartz 680–690 ft.
	690–720	Probably mostly clay, much contamination.
	720–730	Sand, medium-light-gray, fine to medium, subangular; 80 percent white quartz, 5 percent darker grains (salt and pepper); rest rock fragments and mica.
	730–760	Sand, fine, as above; some yellow quartz.
	760–780	Clay and sand, clay ironstone 770–780 ft.
	780–820	Sand, medium-light-gray, very fine; 90 percent white and clear quartz, trace yellow quartz, some dark minerals, mica becomes silty toward base.
	820–870	Silt, clay, sand; *Ditrupa* sp. first occurs at 820–830 ft.
	870–880	Sand, medium-light-gray, fine; angular white and clear quartz, gray chert, also much contamination from the Gubik.
	880–910	No sample.
	910–920	Clay, medium-light-gray, and sand. *Ditrupa* sp.
	920–930	No sample.
	930–950	Sand, medium-light-gray; mostly white and clear quartz, also fine gray chert. *Ditrupa* sp.
	950–960	Sandstone, medium-light-gray, calcareous, clay ironstone, *Ditrupa* sp.
	960–1, 050	Sand, medium-light-gray, fine to medium; mostly subangular white and clear quartz, dark chert. Some sand from the Gubik. Grayish-brown clay ironstone 960–970 and 1,020–1,030 ft. *Ditrupa* sp. 980–990, 1,010–1,020 and 1,030–1,040 ft.
	1, 050–1, 070	Clay, medium-light-gray, and sand.
	1, 070–1, 080	Sand; *Ditrupa* sp.
	1, 080–1, 090	No sample.
	1, 090–1, 100	Clay; *Ditrupa* sp. fragment.
	1, 100–1, 140	No sample.
	1, 140–1, 160	Clay, sand, clay ironstone. *Ditrupa* sp. fragment, 1,140–1,150 ft.
	1, 160–1, 171	No sample.

SIMPSON CORE TEST 27

Core	Depth (feet)	Description
	0–5	Distance between kelly bushing and ground.
	5–102	No samples received by the Fairbanks laboratory from this interval. Well geologist reported "silt and clay shale."
1	102–107	No recovery.
2	107–112	Recovered 2 ft: Microfossils rare. Clay shale, medium-light-gray, medium-soft, fair to good cleavage parallel to bedding, infiltrated with drilling mud; noncalcareous; dip 25°.
	112–113	No sample.
3	113–124	Recovered 3 ft: Microfossils rare. Clay shale, medium-light-gray, medium-soft; good to excellent cleavage, scattered medium-gray clay partings; noncalcareous; dip 20°–25°.
4	124–135	Recovered 10 ft: Microfossils common. Clay shale as immediately above, few laminae of light-gray siltstone, noncalcareous; dip 25°–30°.
5	135–146	Recovered 10 ft: Microfossils common. Clay shale, light- to medium-light-gray; fair cleavage; similar to core above, extremely rare coal chips; noncalcareous; dip 17°. Top of Ninuluk-Seabee Formations undifferentiated at 146 ft.
6	146–157	Recovered 10 ft: Microfossils abundant. 1 ft 8 in., clay shale, light-gray, medium-soft, silty, bentonitic; contains abundant minute brown biotite plates distributed throughout, some black carbonaceous particles; noncalcareous; dip 4°–8°. 4 ft, clay shale, light- to medium-dark-gray; lighter colored shale bentonitic as in upper part of this core and darker part (most of core) contains numerous carbonaceous flecks; cleavage good, rather soft and crumbly; noncalcareous; dip 3°–6°. 2 ft 10 in., clay shale, medium-gray; similar to section immediately above but contains abundant brown fish fragments. *Inoceramus labiatus* Schlotheim and *Borissiakoceras* sp. in the interval 154–155 ft. Up to an inch of soft very light gray bentonite at approximately the following depths: 153, 155, and 155½ ft; noncalcareous; dip 2°. 1 ft 6 in., claystone, light-gray; slightly harder than the rest of the core, no cleavage; fractures irregularly; contains irregular slightly silty laminae, rare black carbonaceous fragments; noncalcareous.
7	157–168	Recovered 10 ft: Microfossils abundant. 5 ft 5 in., clay shale, light-gray, medium-soft, bentonitic, silty; fair to good cleavage; contains abundant minute biotite plates; noncalcareous; dip 2°. 4 ft 7 in., clay shale, medium-gray, rather soft; excellent cleavage; light-gray bentonitic clay shale up to 3 in. thick at 163½, 164, and 165 ft. Very light gray bentonite at approximately 164½, 166, and 167 ft. A small *Borissiakoceras* sp. at about 166½ ft, abundant fishbone fragments; noncalcareous; dip 2°. *Inoceramus* prisms in microfossil sample.
8	168–179	Recovered 10 ft: Microfossils abundant. 2 ft 2 in., clay shale, medium-gray, medium-soft, thin-bedded; very good cleavage; very light gray partings of bentonite 3 in. from the top of the core; shale contains numerous *Borissiakoceras* sp., *Inoceramus labiatus* Schlotheim, and abundant brown fishbone fragments; noncalcareous.

SIMPSON CORE TEST 27—Continued

Core	Depth (feet)	Description
8	168–179	Recovered 10 ft—Continued 2 ft 3 in., interbedded clay shale and bentonite, medium-gray and very light gray; varvelike very thin interbeds, soft, crumbly, good cleavage; bottom 6 in. is almost all light-gray bentonitic clay shale. 7 in., clay shale; abundant fishbone fragments as in first part of this core. 4 in., limestone, light-gray, medium-hard; has acicular crystals and sheen similar in appearance to satin spar; very irregular fracture. 1 ft 2 in., clay shale, medium-gray as in first part of this core, abundant *Inoceramus* and fish fragments. 6 in., limestone, medium-dark-gray, hard, dense, lithographic; conchoidal fracture; contains brown fish fragments, one very thin vertical vein of white calcite that cuts a fish scale, also some very thin horizontal veins. 3 ft, clay shale; fishbone fragments as in first part of this core; noncalcareous.
9	179–190	Recovered 9 ft: Microfossils abundant. 6 ft, clay shale, medium-gray, medium-soft, thin-bedded; bentonitic partings and laminae; 3 in. of light-gray bentonitic shale at approximately 186 ft. Shale contains abundant fishbone fragments, 1 in. of medium-gray limestone at 182 ft. 3 in., bentonite, very light gray, waxy; but very soft and crumbly when dried out. 1 ft, limestone, medium-dark-gray, hard, dense, lithographic; with irregular fracture, laced with a few white calcite veins up to ⅛ in. thick. 3 in., bentonite, very light gray, almost white, very soft and crumbly. 1 ft 6 in., clay shale, exactly as in first part of this core; noncalcareous; dip 0–½°.
10	190–201	Recovered 10 ft: Microfossils abundant. 7 ft 6 in., clay shale, medium-gray, soft, thin-bedded; good cleavage; contains numerous fishbone fragments but not quite as abundant as in the two preceding cores. Bentonite occurs as follows: starting at 192 ft 7 in. of very light to light-gray very bentonitic shale and bentonite, crumbles when dried out; several light-gray very bentonitic shale laminae in the interval 193–194 ft; 1 in. medium-gray bentonitic shale at 196 and 196½ ft; 6 in. starting at 197 ft of silty medium-light gray bentonitic clay shale. 2 ft 6 in., sandy siltstone and silty sandstone, light-gray, soft and friable, silty and very fine grained, noncalcareous; primarily white and clear quartz but also abundant mica and pyrite, dip 1°; no shows.
11	201–211	Recovered 9 ft: Microfossils absent. Sandstone, light-gray, fine silty, soft and friable; subangular to subrounded, good cleavage parallel to the bedding; largely white and clear quartz, also abundant biotite and some chlorite, glauconite, and pyrite, loosely cemented with argillaceous material; noncalcareous; dip 3°; no shows.

SIMPSON CORE TEST 27—Continued

Core	Depth (feet)	Description
12	211–221	Recovered 9 ft: Microfossils absent. Sandstone, exactly as in core above; 5 in. of hard very calcareous sandstone at about 225 ft, composition same as above; the rest of the sandstone is noncalcareous; dip 3°; no shows.
13	221–231	Recovered 10 ft: Microfossils common. 5 ft, sandstone as above, silty to fine-grained; contains several medium-light-gray clay shale laminae up to several inches thick; no shows. 5 ft, interbedded clay shale 80 percent and siltstone 20 percent. Siltstone is light-gray similar to sandstone above. Clay shale is medium light gray, medium-soft, silty, poor to fair cleavage, contains abundant mica disseminated throughout. Noncalcareous; dip 2°.
14	231–242	Recovered 10 ft: Microfossils very rare. Siltstone, light- to medium-light-gray, soft and friable, argillaceous; poor or no cleavage, scattered sandy laminae; contains quite a bit of mica and pyrite; irregularly fractured; a 2-in. thick hard yellowish-gray clay ironstone concretion. Several white unidentified pelecypod fragments at 231½, 232½, 237½, and 238 ft; noncalcareous; dip unmeasured, low; no shows. *Inoceramus* prisms in microfossil sample.
15	242–253	Recovered 10 ft: Microfossils very rare. Siltstone, medium-light-gray, very argillaceous, very soft and friable; grades in places to clay shale; poor or no cleavage. Rock harder where larger proportion of clay present; micaceous, pelecypod fragments (various types) at 247 ft; noncalcareous; dips variable, probably because of crossbedding, at most not more than 5°.
16	253–264	Recovered 10 ft: Microfossils absent. Clay shale, medium-light-gray, medium soft, micaceous; very silty throughout, poor cleavage, several small coaly fragments; noncalcareous; dip 1°.
17	264–267	Recovered 2 ft 9 in.: Microfossils rare. Clay shale, medium-light-gray, medium-soft; silty partings and laminae, fair cleavage; noncalcareous; dip low.
18	267–278	Recovered 10 ft: Microfossils very rare. Clay shale as above, rare silty laminae and partings; thin (½ in.) band of yellowish-gray clay ironstone at 272 ft. A few small white pelecypod fragments at 273 ft; noncalcareous; dip 1½°.
19	278–289	Recovered 10 ft: Microfossils (one species) common. Sandstone and siltstone, medium-light-olive- and medium-light-gray, the olive-colored part (15 percent) is oil stained and fine grained; rest very fine grained, silty, and very argillaceous; grades in places to medium-light-gray clay shale, with poor cleavage; sand grains subangular, 85–90 percent white and clear quartz, rest made up of dark chert, carbonaceous particles, pyrite, and rock fragments (the latter are sand size). Stained parts of core very soft and friable, nearly unconsolidated, rest medium soft. A hard yellowish-gray clay ironstone concretion at 283 ft; noncalcareous; dip low. One con-

SIMPSON CORE TEST 27—Continued

Core	Depth (feet)	Description
19	278–289	Recovered 10 ft—Continued tinuous oil stained section of core of 1 ft 5 in., other stained parts consist only of thin laminae.
20	289–300	Recovered 10 ft: Microfossils very scarce. 6 ft 6 in., interbedded sandstone-siltstone 80 percent and clay shale 20 percent. The sandstone-siltstone is light gray to medium light gray, soft and friable, with poor cleavage, grains subangular to subrounded (mostly subangular), silty to fine-grained, 80 percent white and clear quartz, some black carbonaceous particles, mica, dark chert, glauconite(?) and much argillaceous material. The clay shale is medium light gray, silty, micaceous, fair cleavage. Thin layers of hard yellowish-gray clay ironstone at 289, 289½, 291, and 292 ft; noncalcareous; dip 3°; no shows. 1 ft 10 in., coal or lignite, dull black and shiny black, thin-bedded, very brittle; breaks into little blocky chips. 1 ft 8 in., clay, light-olive-gray, medium soft; breaks haphazardly, contains numerous black carbonaceous particles and plant impressions. Clay grades to medium light-gray clay shale at the base of the interval; noncalcareous.
21	300–311	Recovered 10 ft. Microfossils absent. 3 ft 5 in., composed of two-thirds interbedded sandstone and one-third clay shale, closely alternating. Light-gray medium soft very fine to medium-grained, subangular, sandstone; 75–80 percent white and clear quartz; rest primarily dark chert and mica; smaller the grain size, the larger the proportion of quartz. Matrix very argillaceous, some grading into clay shale, matrix possibly bentonitic. Medium-light-gray medium soft clay shale; fair cleavage. Partings of carbonaceous fragments and particles; dips variable up to 6°, probably crossbedding; no shows. 1 ft 6 in., clay shale, medium-light-gray, varvelike thin interbeds, and light-gray siltstone including scarce sandy laminae; black plant fragments in partings. 1 ft 5 in., clay, light- to medium-light-gray, medium-soft, brittle; when dried out crumbles into small blocky chips. 1 ft 9 in., clay shale, medium- to dark-gray, carbonaceous, soft; fair cleavage, 1 in. of light-yellowish-gray bentonite, 5 in. from bottom of section. 1 ft 7 in., bentonite, very light gray, soft, crumbly; speckled with hexagonal brown biotite plates. 4 in., clay shale, dark-gray, medium-soft; core is noncalcareous.
22	311–317½	Recovered 6 ft 6 in.: Microfossils absent. 4 ft, clay shale, dark-gray (dark color probably due to large amount of microscopic carbonaceous material), very soft, fissile in part, micaceous. Two 1- to 1½ in. layers of light-yellowish-gray bentonite at the bottom and 1½ ft from the bottom of the section; biotite not present in this yellowish bentonite; noncalcareous; dip 3°.

SIMPSON CORE TEST 27—Continued

Core	Depth (feet)	Description
22	311–317½	Recovered 6 ft 6 in.—Continued 2 ft 6 in., sandstone, light- to medium-light-gray argillaceous and silty; particularly at the top of the section; very fine grained subangular to subrounded (mostly subangular) sand; consists almost entirely of white and clear quartz; some mica and carbonaceous particles; very rare and thin-medium-gray clay shale laminae; noncalcareous; very faint oil odor near base of section.
23	317½–322½	Recovered 4 ft 6 in.: Microfossils absent. 1 ft, clay shale, medium-gray, rather hard; poor cleavage, slightly lighter colored silty laminae. 6 in., sandstone, light-gray, fine to medium-grained, very soft and friable; made up of white and clear quartz, 75 percent; medium-hard opaque white grains, 10 percent; black coal and dark chert particles, 10 percent; also mica. Has a clayey very light gray bentonitic matrix; noncalcareous; slight odor of oil; grades into: 1 ft, bentonite, medium-light-gray, clastic, soft; but slightly harder than above. A peculiar section consisting mainly of bentonite grains (or some similar clay material) in a matrix of bentonite. Bentonite grains very pale yellowish brown, medium-sized, subrounded, just slightly harder than the matrix and "pop out" easily when poked. Number of quartz grains associated with bentonite ranges from virtually none to the sandstone type as above. Black coal particles either in partings and (or) disseminated throughout constitute an important part of the rock. Coal grains in partings range up to very coarse size. Concentrations of carbonaceous material give a spotty appearance to parts of the core. Chlorite, muscovite, and biotite are abundant in rather large plates. Matrix is very light gray, soft, bentonitic. A chip of the clastic bentonite swells into a gelatinous mass when dropped in water; grades into: 2 ft, clay shale, medium-dark-gray; very silty particularly near the top; medium-light-gray silt laminae, poor cleavage, coaly and micaceous particles. Core is noncalcareous; dip 1°–3°.
24	322½–325½	Recovered 3 ft: Microfossils common. 2 ft 3 in., clay shale, medium- to medium-dark-gray, medium-soft; poor to fair cleavage, tendency toward conchoidal fracture; contains scattered black carbonaceous plant fragments and impressions, rare irregular silty stringers. One in. of soft very light gray bentonite a foot from the top of the core contains numerous hexagonal biotite plates. One in. of medium-olive-gray sandstone just below the medium-soft argillaceous fine- to medium-grained subangular to subrounded bentonite; ¼ in. of very light gray bentonite 3 in. from the bottom of the section; noncalcareous; dip 1°.

SIMPSON CORE TEST 27—Continued

Core	Depth (feet)	Description
24	322½–325½	Recovered 3 ft—Continued 9 in., sandstone, dark-olive-gray, fine to medium-grained very soft, nearly unconsolidated; see description of this type of sand in core below. In a saturation test of a sample from 324 ft, the petroleum content was 17.2 percent by volume, the basal sediment and water content was 15.9 percent. This implies an approximate porosity of 33.1 percent for this section; noncalcareous; dip not determined.
[1] 25	325½–336	Recovered 10 ft.: Microfosslls absent. Sandstone, dark-olive-gray, fine-grained, very soft and friable to nearly unconsolidated; includes a few medium grains made up of 80 percent white and clear quartz, rest dark-gray chert, dark rock fragment particles, and minerals; biotite very rare, primarily subangular, very loosely cemented with argillaceous material; noncalcareous; bedding obscure but beds probably lie very nearly flat.
26	336–347	Recovered 10 ft: Microfossils absent. Sandstone as above, fine to medium-grained; several partings contain black coaly material, several fragments of coal up to ⅛ in. thick, ½ in. thick yellowish-gray clay ironstone concretion at 337 ft, very rare clay laminae; noncalcareous; dip 1°, erratic dips up to 12° probably represent crossbedding; well geologist reported "oil stained but not saturated through core using oil as drilling fluid. Center of core light brown ether cut."
27	347–358	Recovered 10 ft.: Microfossils absent. Sandstone, dark-olive-gray, fine-graded very soft, practically unconsolidated, subangular to subrounded; 75–80 percent white and clear quartz; rest dark chert and rock particles; noncalcareous; dip undetermined; strong oil odor and stain.
28	358–369	Recovered 11 ft: Microfossils absent. Sandstone as above, very fine to fine-grained; noncalcareous; dip undetermined; oil stain slightly less than above.
29	369–380	Recovered 11 ft: Microfossils absent. 1 ft 8 in., sandstone, medium-light-olive-gray, as above, very fine grained to silty, noncalcareous; dip undetermined; slight oil stain. 9 in., limestone, light-olive-gray, very hard, dense, silty; tends to fracture roughly parallel to the bedding, also vertically; contains minute micaceous and carbonaceous particles. 8 ft 7 in., clay shale, medium-light-gray, medium-soft; fair hackly fracture; medium-light-gray silty partings and laminae up to 1½ in. in thickness; silt slightly softer than clay shale; slightly yellowish-gray hard clay ironstone concretion 2 in. from the top of the section; noncalcareous; ironstone is very slightly calcareous, dip 0°–3°.
30	380–391	Recovered 10 ft: Microfossils absent. 1 ft 3 in., clay shale as in lowest part of core above, dip 3°; grades into:

SIMPSON CORE TEST 27—Continued

Core	Depth (feet)	Description
30	380–391	Recovered 10 ft—Continued 2 ft 8 in., sandstone and siltstone, light-olive-gray, silty to very fine grained, medium-soft; fair cleavage parallel to bedding, rare larger grains subangular to very rare subrounded. Seventy-five percent white and clear quartz, also some dark chert and rock particles. Rare slightly carbonaceous partings. 4 ft, interbedded siltstone and clay shale, laminae up to 5 in. thick; noncalcareous. 2 ft 1 in., clay shale, medium-light-gray, medium-soft; fair cleavage, one very small nodule of pyrite near the top of the section; clay becomes medium gray at the very bottom of the core; noncalcareous.
31	391–402	Recovered 11 ft: Microfossils very rare. 3 in., clay shale, medium-gray, as immediately above. 5 in., coal or lignite, dull black, brittle. 8 ft 6 in., clay shale, medium-light-gray, medium-soft; good hackly fracture, very rare carbonaceous plant fragments; 2-in. thick hard grayish-yellow clay ironstone concretion at approximately 396 ft, noncalcareous; dip 3°. 1 ft 10 in., clay shale, medium-dark-gray, very carbonaceous, medium-soft; good cleavage, contains abundant black plant impressions and coaly partings; noncalcareous.
32	402–413	Recovered 10 ft: Microfossils absent. 4 ft 6 in., two-thirds interbedded siltstone and one-third clay shale, medium light gray, medium-soft; siltstone softer than clay. Siltstone mostly white and clear quartz has shaly cleavage, contains a few black coaly partings; yellowish-gray clay ironstone laminae up to an inch thick at 403½ and 405 ft, noncalcareous; beds lie flat. 5 ft 6 in., clay shale, medium-light-gray, medium-soft; fair cleavage, rare silty laminae; noncalcareous.
33	413–424	Recovered 10 ft: Microfossils absent. 7 ft, clay shale, medium-light- to medium-gray, medium-soft; poor cleavage; soft medium-light-gray silty laminae and partings; dark carbonaceous plant remains quite common, also some very thin layers of clay ironstone. Thin bands (up to ½ in.) of coal in the lowest foot of the section. Very rare cone-in-cone-like structures at the very bottom of the section, cone ⅓ in. deep; dip very low. 1 ft, coal, dull black, brittle; blocky fracture. 2 ft, sandstone, medium-light-gray, fine-grained, very soft, almost unconsolidated, subangular to rare subrounded; 90 percent white and clear quartz, rest dark chert; noncalcareous; dip undetermined.
34	424–435	Recovered 10 ft: Microfossils very rare. 1 ft 8 in., sandstone, medium-light-gray, fine- to rare medium-grained, unconsolidated; similar to that immediately above but with slightly larger proportion of dark materials, particularly dark chert.

See footnotes at end of table.

SIMPSON CORE TEST 27—Continued

Core	Depth (feet)	Description
34	424–435	Recovered 10 ft—Continued 8 ft, clay shale, medium-light-gray, medium-soft; slightly silty, noncalcareous, good hackly fracture; dip low. 4 in., sandstone as described immediately below; oil stained.
35	435–446	Recovered 10 ft: Microfossils very rare. 2 ft, sandstone, medium-olive-gray, fine- to rare medium-grained, very soft and practically unconsolidated, subangular; 85 percent white and clear quartz; rest mostly dark chert, noncalcareous; good oil stain and odor; grades into: 2 ft, siltstone and sandstone, medium-light-olive- to medium-light-gray; becomes better consolidated, finer, and has considerably less of an oil stain with depth; argillaceous partings and laminae; noncalcareous; grades into: 6 ft, clay shale, medium-light-gray, medium-soft; fair cleavage, some sandy or silty partings, 4 in. of grayish-brown very hard clay ironstone at the bottom of the core; noncalcareous; dip ½°.
	446–540	No samples taken. Top of Grandstand Formation at 450 ft (based on electric log and correlation with nearby tests).
	540–630	Clay, medium-light-gray. Varying amounts of light-gray fine to medium subangular to subrounded sand; 85 percent white and clear quartz, also dark chert, a few coaly particles, noncalcareous. A few dull black coal fragments 570–580, 590–600 ft.
	630–641	No sample.
36	641–651	Recovered 6 ft: Microfossils absent. 2 ft, clay shale, medium-gray, medium-soft; fair to good cleavage, in part hackly fractures, silty and sandy micaceous partings; noncalcareous; beds lie flat. 4 ft, sandstone, medium-light-gray, fine- to medium-grained, very soft and nearly unconsolidated, subangular to subrounded; 80 percent white and clear quartz, rest mostly dark-gray and black chert; chert in general seems to be of a slightly larger size than the quartz; noncalcareous.
37	651–661	Recovered 8 ft: Microfossils absent. Sandstone as above, very soft, some mica and soft chalky white particles; noncalcareous; dip undetermined.
	[2] 661–720	Sand, light- to medium-light-gray, fine to medium; 80 percent white and clear quartz, much of rest dark chert and coal particles. Becomes fine toward base of this section.
	720–750	Clay, medium-light- to medium-gray. Coal fragments rare 740–750 ft. *Ditrupa* sp. present.
	750–760	No sample.
	760–821	Sand, light- to medium-light-gray, fine, rare medium grains, 80–90 percent quartz, dark chert and a few coal particles. Fine in the lower part of the section. One small shark's tooth 810–820 ft.

See footnotes at end of table.

SIMPSON CORE TEST 27—Continued

Core	Depth (feet)	Description
38	821–831	Recovered 1 ft: Microfossils absent. Sandstone, medium-light-gray, fine-to medium-grained, very soft—practically unconsolidated, subangular; 90 percent or more white and clear quartz, rest mostly dark chert, some mica, matrix argillaceous; 2½ in. of sandstone hard, slightly calcareous matrix, also an inch of gray clay ironstone; most of core is noncalcareous; dip undetermined.
	831–1, 490	Interbedded clay shale, siltstone, and soft sandstone, possibly a few hard calcareous streaks and ironstone concretions. Samples badly contaminated.
39	1, 490–1, 500	Recovered 2 ft 3 in.: Microfossils abundant. Clay shale, medium-light- to medium-gray, moderately soft; poor to fair cleavage, some slightly silty laminae, rare broken pelecypod shells at the very bottom of the section, also one *Ditrupa* sp. noted; shale is noncalcareous; dip 1°.

[1] Cores 25 through 37 were drilled with an oil-base mud and probably do not represent true stain or oil content.
[2] Displaced oil and went back to water base mud at 661 ft.

SIMPSON CORE TEST 28

Core	Depth (feet)	Description
	0–17	Distance between kelly bushing and ground.
	17–120	No samples taken. Contamination in ditch samples of upper part of Simpson core test 28 indicates that sand from Gubik Formation in this test consists of subangular to well-rounded very fine to very coarse grains. Grains made up of clear quartz, dark-gray and black chert, also yellow, red, and greenish quartz and yellow chert. Granules and pebbles of well-rounded black chert, angular medium-light-gray siltstone, schist, and a granitic igneous rock are also present. Rare white pelecypod shell fragments.
	120–150	Probably clay with slightly silty partings. Pyrite common. Samples consist mostly of Gubik and cement contamination.
	150–160	Limestone, medium-light- to medium-gray, very silty; probably grades into calcareous siltstone, has white calcite veinlets, probably some clay.
	160–180	Contamination—limestone, sand, and pebbles from the Gubik Formation, probably actually clay.
	180–190	Large amount of medium-gray hard limestone; not so silty as above part, some clay, pyrite abundant.
	190–330	Clay, medium-light-gray; pyrite fairly common, much Gubik and cement contamination.
	330–340	Large amount of medium-light-gray very calcareous siltstone; biotite and carbonaceous particles.
	340–520	Clay, medium-light-gray.
	520–630	Clay, medium-light- to medium-gray.
	630–640	Limestone, medium-dark-gray, very finely crystalline.
	640–680	Clay, medium-light to medium-gray.

SIMPSON CORE TEST 28—Continued

Core	Depth (feet)	Description
	680–690	Clay, also possibly some very calcareous medium-light-gray siltstone.
	690–720	Clay, medium-light-gray.
	720–730	Clay, possibly some medium- to medium-dark-gray limestone.
	730–900	Clay, medium-light-gray, some medium-gray; fish fragments at 820–830, 870–880 ft.
	900–910	Clay and some sandy siltstone, very calcareous; contains carbonaceous particles and mica, also some sand.
	910–920	Clay.
	920–930	Clay, medium-light-gray; also white prismatic calcite or aragonite.
	930–940	Calcite or aragonite, clay, a few small chips of vitreous black coal, few pieces of very light gray (bentonitic?) clay; biotite flakes in it.
	940–950	Clay, medium-light-gray; small amount of very light bluish gray clay, rare chips of coal, very rare clay ironstone.
	950–1, 020	Clay, medium-light- to medium-gray, rare coal chips and ironstone; light-bluish-gray clay at 990–1,000 ft, pyrite 1,010–1,020 ft, clump of *Inoceramus* prisms 950–960 ft. Fish fragments 950–970 ft. Fish fragments in marcasite concretions 990–1,000 ft. Top of Grandstand Formation at 1,020 ft.
	1, 020–1, 030	Abundant ironstone, grayish- and yellowish-brown; some sandstone with sideritic cement; very fine grained, pyrite, coal chips rare, also sand.
	1, 030–1, 040	Sand, medium-light-gray, fine to medium, subangular; 60 percent white and clear quartz, numerous dark chert grains, coal grains.
	1, 040–1, 070	Sand as above, but mostly fine; chips of coal, ironstone, some clay; *Ditrupa* sp. 1,040–1,060 ft, *Inoceramus* sp. chunks 1,040–1,050 ft.
	1, 070–1, 089	Clay and sand; *Ditrupa* sp. 1,070–1,080 ft, *Inoceramus* prisms 1,080–1,089 ft.
1	1, 089–1, 095	Recovered 4 ft: Microfossils rare. Clay shale, medium-light- to medium-gray, moderately hard; fair to good cleavage, some hackly fracture, a few carbonaceous particles in the shale, near vertical fracture present, very rare micaceous silty laminae and partings; noncalcareous; beds lie nearly flat.
	1, 095–1, 140	Clay, medium-light- to medium-gray; clay ironstone 1,130–1,140 ft, coal 1,100–1,110 ft; *Ditrupa* sp. in all these samples.
	1, 140–1, 150	Sand, medium-light-gray, fine, subrounded to subangular; 85 percent white and clear quartz, also gray chert, coal grains, garnet.
	1, 150–1, 210	Clay, samples through this interval and irregularly to bottom of hole contain pyritic cylinders up to a few millimeters in length—possibly replaced organic matter or worm tubes.
	1, 210–1, 220	Sand, fine to medium.
	1, 220–1, 230	Clay.
	1, 230–1, 251	Sand, medium-light-gray, medium subrounded to subangular; mostly white and clear quartz.

SIMPSON CORE TEST 28—Continued

Core	Depth (feet)	Description
2	1, 251–1, 261	Recovered 10 ft: Microfossils absent. Sandstone, medium-light-gray, fine-grained, very soft and friable, subangular; 85 percent white and clear quartz, rest dark chert and other dark minerals, hard chalky white particles, mica, and rock fragments; porous to drop test; noncalcareous; dip not determined but beds possibly lie flat; no shows.
3	1, 261–1, 271	Recovered 10 ft: Microfossils absent. Sandstone, as above; fine-grained, no shows.
4	1, 271–1, 281	Recovered 10 ft: Microfossils absent. Sandstone as above, very fine to fine-grained, soft and friable but slightly harder than sandstone cores above.
	1, 281–1, 290	Sand.
	1, 290–1, 300	Clay, medium-light-gray.
	1, 300–1, 320	Sand, very fine to fine, clay, clay ironstone 1,300–1,310 ft.
	1, 320–1, 370	Clay, medium-light- to medium-gray.
	1, 370–1, 381	Sand, fine to medium (mostly fine), primarily quartz.
5	1, 381–1, 391	Recovered 4 ft: Microfossils absent. Sandstone, medium-light-gray, fine-grained, medium-soft and friable; rare medium grains, subangular; 85 percent white and clear quartz, also grains of dark gray and black chert dark rock fragments, very rare mica plates and medium-hard chalky white grains (possibly tripolitic chert), "clean" sandstone, apparently cemented by a very small amount of argillaceous material, tends to fracture at right angles to wall of core; noncalcareous; bedding indistinct, dip apparently low; very porous to drop test, no shows.
	1, 391–1, 410	Porosity 35 percent. Permeability 700 millidarcys at 1,385 ft. Clay, yellowish-gray; clay ironstone abundant, also small amount of dull black coal, *Inoceramus* prisms 1,400–1,410 ft.
	1, 410–1, 450	Sand, very fine, and clay.
	1, 450–1, 491	Clay.
6	1, 491–1, 496	Recovered 5 ft. Microfossils very rare. Clay shale, medium-light-gray, medium-soft; fair to good cleavage parallel to bedding, rare partings containing minute plates of mica; noncalcareous; dip 3°–5°.
	1, 496–1, 540	Clay, medium-gray.
	1, 540–1, 570	Sand, medium-light-gray, very fine to fine subangular to subrounded; 85 or 90 percent white and clear quartz, some dark chert and coal.
	1, 570–1, 580	Siltstone and silty limestone, medium-dark-gray, hard.
	1, 580–1, 590	Clay and silt.
	1, 590–1, 594	No sample.
7	1, 594–1, 604	Recovered 10 ft: Microfossils very rare. 4 ft, siltstone, medium-light-gray, very soft—core broken into many small friable pieces; fairly good cleavage; siltstone made up in large part of subangular grains of white and clear quartz, rare dark minerals and mica present, some very fine sandstone; no shows. 2 ft 10 in., clay shale, medium-light-gray, medium-soft; fair hackly fracture; contains numerous silt laminae, very rare very small fragments of mollusk shells; noncalcareous; dip 2°.

SIMPSON CORE TEST 28—Continued

Core	Depth (feet)	Description
7	1, 594–1, 604	Recovered 10 ft—Continued 3 ft 2 in., siltstone, as in first part of this core, slightly harder, thin clay shale laminae.
	1, 604–1, 610	No sample.
	1, 610–1, 620	Silt, medium-light-gray and clay; very small amount of coal.
	1, 620–1, 650	Clay, medium-gray, some sand, pyritic cylinders, clay ironstone 1,620–1,630 ft.
	1, 650–1, 660	Sand, medium-light-gray, very fine to fine; subangular, rare subrounded white quartz.
	1, 660–1, 700	Clay, medium-light-gray.
	1, 700–1, 704	No sample.
8	1, 704–1, 709	Recovered 3 ft: Microfossils rare. Clay shale, medium-light-gray, medium-soft; hackly fracture, silty partings, small black carbonaceous plant fragments, small brown ironstone concretions (½ in. in diameter); noncalcareous; dip 2°.
	1, 709–1, 720	Clay, medium-light to medium-gray, also about three chips of light-gray clay (possibly bentonitic?).
	1, 720–1, 809	Clay, medium-light- to medium-gray; pyrite, trace of coal at 1,790–1,800 ft.
9	1, 809–1, 814	Recovered 5 ft: Microfossils abundant. Clay shale, medium-light-gray, medium-soft; hackly fracture, medium-light-gray silty partings and laminae, very rare carbonaceous plant fragments, unidentified lustrous white pelecypod fragments at 1,813 ft; noncalcareous; dip 3°.
	1, 814–1, 820	No sample.
	1, 820–1, 910	Clay, medium-light- to medium-gray, pyritic cylinders, rare clay ironstone 1,870–1,880 ft. *Ditrupa* sp. 1,860–1,870 ft. *Inoceramus* prisms 1,900–1,910 ft.
	1, 910–1, 914	No sample.
10	1, 914–1, 919	Recovered 3 ft: Microfossils rare. Clay shale, medium-light- to medium-gray, medium-soft; fairly good cleavage, micaceous-carbonaceous partings, rather silty in last 6 in. of recovery; noncalcareous; beds lie nearly flat.
	1, 919–2, 010	Clay, medium-light- to medium-gray; clay ironstone, 1,930–1,940 ft. *Inoceramus* fragments 2,000–2,010 ft.
	2, 010–2, 019	No samples.
11	2, 019–2, 027	Recovered 5 ft: Microfossils common. 2 ft 4 in., sandstone, medium-light-gray, very fine to fine-grained, medium-soft very dirty-silty and argillaceous, numerous laminae of medium-gray clay; noncalcareous. 2 ft 8 in., clay shale, medium-gray, medium-soft; fair cleavage; scattered brownish-black carbonaceous and pyritic plant impressions up to ½-in. wide and longer than the diameter of the core (1½ in.); noncalcareous; low dip.
	2, 027–2, 030	No sample.
	2, 030–2, 050	Sand, very fine to fine, some clay, pyrite.
	2, 050–2, 060	Silt and clay.
	2, 060–2, 100	Clay, medium-light-gray, pyritic cylinders.
	2, 100–2, 110	Sand, medium-light-gray, very fine to fine, subangular grains; 90 percent white and clear quartz; some clay.
	2, 110–2, 127	Silt, practically all quartz, some clay.

SIMPSON CORE TEST 28—Continued

Core	Depth (feet)	Description
12	2, 127–2, 132	Recovered 5 ft: Microfossils common. Clay shale, medium-light- to medium-gray, medium-soft, fair to good cleavage parallel to bedding, dark carbonaceous and micaceous partings abundant in last few inches of section; dip 5°; noncalcareous.
	2, 132–2, 230	Clay, medium-light-gray; pyritic cylinders, *Ditrupa* sp. common, 2,160–2,230 ft.
13	2, 230–2, 239	Recovered 2 ft: Core not received by Fairbanks laboratory. Driller reported "shale."
	2, 239–2, 290	Clay, medium-light- to medium-gray; *Inoceramus* fragment 2,260–2,270 ft.
	2, 290–2, 310	Silt, medium-light-gray; all white and clear quartz; some very fine sand; clay.
	2, 310–2, 339	Clay, medium-light-gray; 2,320–2,330 ft is first occurrence of a pale-green clay that occurs as scattered chips down to at least 2,430 ft. *Ditrupa* sp. 2,330 ft—total depth.
14	2, 339–2, 344	Recovered 5 ft: Microfossils abundant. Clay shale, medium-light- to medium-gray, medium-soft; fair to good cleavage; small dark carbonaceous and a few micaceous particles distributed throughout, white mollusk fragments at approximately 2,341 ft; noncalcareous, dip 1°.
	2, 344–2, 350	No sample.
	2, 350–2, 440	Clay, medium-light-gray, some silt; *Inoceramus* prisms 2,360–2,370 ft.
	2, 440–2, 446	No sample.
15	2, 446–2, 453	Recovered 5 ft: Microfossils rare. 1 ft, limestone, medium-light to medium-gray, hard, dense; small amount of fracturing at 50°. 3 ft, interbedded clay shale and siltstone, medium-light-gray, very soft, micaceous; infiltrated with drilling mud; good cleavage; noncalcareous. 1 ft, clay shale, medium-light-gray, medium-soft; good cleavage; some micaceous carbonaceous partings; noncalcareous; dip 3°.
	2, 453–2, 470	Silt and siltstone, medium-light-gray, hard, very calcareous.
	2, 470–2, 490	Clay.
	2, 490–2, 500	Silt, some very fine sand; clump of *Inoceramus* prisms.
16	2, 500–2, 505	Recovered 4 ft: Microfossils common. 3 ft 6 in., sandstone, medium-light-gray, very fine grained, medium-soft, silty, argillaceous; grains subangular; primarily composed of white and clear quartz, mica and carbonaceous particles also quite abundant; excellent cleavage parallel to bedding in part, appears fairly porous; noncalcareous; dip 2°; no shows. 6 in., clay shale, medium-light- to medium-gray; micaceous and carbonaceous particles present; noncalcareous. Porosity 22.5 percent, permeability 71 millidarcys at 2,503 ft.

SIMPSON CORE TEST 29

Core	Depth (feet)	Description
	0–5	Distance between kelly bushing and ground.
	5–71	No samples received in Fairbanks. Well geologist reported: "Clay, very soft, gray to dark gray, sand and small chert pebbles scattered throughout."

SIMPSON CORE TEST 29—Continued

Core	Depth (feet)	Description
1	71–81	Recovered 10 ft: Gubik microfossils very rare. 4 ft 6 in., clay, medium-light-olive-gray; similar to lower section of this core but has smaller amount of sand and coarse material. Core is broken up. 5 ft 6 in., sandstone, medium-light-olive-gray, medium-soft, very argillaceous; cemented with clay; sand very poorly sorted; grain size ranges from very fine to very coarse, in general the smaller grains are angular and the larger are rounded to well rounded; about 70 percent is clear quartz; rest dark gray and black chert with a small admixture of varicolored materials; a few rock fragments present. Included also are granules and pebbles up to 1½ in. in diameter occurring at random throughout the section, made up for the most part of rounded black chert, rare pale-yellowish-brown chert, and limestone. Core tends to break irregularly parallel to bedding. Very rare thin laminae of carbonaceous material. Noncalcareous; rare white pelecypod shell fragments scattered through core.
2	81–91	Recovered 10 ft: Gubik microfossils rare. 3 ft 9 in., sandstone as in lower part of core 1, very argillaceous; grades to clay toward base. 6 ft 3 in., clay shale, medium-light-gray, soft; crumbles into little chips when dried out; silty partings, good cleavage parallel to bedding, tendency toward vertical fracture; noncalcareous; dip 7°–10°. Base of Gubik Formation-top of the Cretaceous Seabee Formation at 85 ft.
3	91–102	Recovered 11 ft: Microfossils absent. 5 ft, clay shale, medium-light-gray, medium-soft; excellent light-gray silty partings, brown finely disseminated pyrite in some of the partings; noncalcareous; dip 5°–8°. 1 ft., limestone, medium-light- to medium-gray, hard, argillaceous; contains mica; irregular fracture. 5 ft, clay shale, as in first part of this core, vertical fracture; noncalcareous; dip 4°.
4	102–112	Recovered 10 ft: Microfossils absent. Clay shale, medium-light-gray, medium-soft; light-gray silty partings, excellent cleavage, vertical fracture; noncalcareous; dip 2°–5°.
5	112–122	Recovered 10 ft: Microfossils absent. Clay shale as above, pyrite in partings; dip 4°–8°.
6	122–132	Recovered 10 ft: Microfossils absent. Clay shale as above, vertical fracture; dip 5°.
7	132–142	Recovered 10 ft: Microfossils absent. 3 ft, clay shale as above; dip 3°. 6 in., limestone, medium-gray, hard, argillaceous; irregular fracture. 1 ft 6 in., clay shale, light- to medium-light-gray, medium-soft; silty partings, excellent cleavage; noncalcareous; dip 3°–5°.
8	142–152	Recovered 8 ft 5 in: Microfossils absent. Clay shale, as in lowest part of core above; fewer silty partings, good to excellent cleavage, pyrite in partings; noncalcareous; dip 5°.
9	152–163	Recovered 11 ft: Microfossils absent. Clay shale as immediately above; noncalcareous; dip 0°–5°.

SIMPSON CORE TEST 29—Continued

Core	Depth (feet)	Description
10	163–173	Recovered 10 ft: Microfossils very rare. Clay shale, light- to medium-light-gray, soft; part of core tends to crumble into tiny chips when dried out, rare light-gray silty partings, fair cleavage parallel to bedding; much hackly fracture; noncalcareous; dip 2°.
11	173–183	Recovered 10 ft: Microfossils absent. Clay shale, light-gray, medium-soft; hackly and smooth fracture, silty partings; noncalcareous; dip 1°–2°.
12	183–193	Recovered 10 ft: Microfossils absent. Clay shale as immediately above; noncalcareous; dip 1°–2°.
13	193–203	Recovered 10 ft: Microfossils absent. Clay shale as above; noncalcareous; dip 2°.
14	203–213	Recovered 10 ft: Microfossils very rare. Clay shale, medium-light-gray, medium-soft; fair to excellent cleavage, some hackly fracture; noncalcareous; dip 0°–1°.
15	213–223	Recovered 7 ft: Microfossils very rare. Clay shale, medium-light-gray; poor to fair hackly fracture; noncalcareous; dip 1°.
16	223–233	Recovered 10 ft: Microfossils absent. Clay shale, light- to medium-light-gray; fair to excellent cleavage; noncalcareous; dip 0°–1°.
17	233–243	Recovered 10 ft: Microfossils absent. Clay shale as above, poor to fair cleavage, very rare silty partings; noncalcareous; dip 1°.
18	243–253	Recovered 10 ft: Microfossils absent. Clay shale, light- to medium-light-gray; fair to excellent cleavage, one small fish scale noted at 252 ft. Dip 0°–1°.
19	253–263	Recovered 10 ft: Microfossils absent. As immediately above, very rare bluish-gray clay partings; noncalcareous; dip 1°.
20	263–273	Recovered 10 ft: Microfossils absent. Clay shale, light- to medium-light-gray, medium-soft; excellent cleavage, a few partings with finely disseminated pyrite, very rare light-gray silty partings and laminae, two fishbone fragments noted; 6 in. of medium-dark-gray very hard dense limestone at 265 ft; shale is noncalcareous; dip 0°–1°.
21	273–283	Recovered 10 ft: Microfossils absent. Clay shale as above, very rare silty partings, exceedingly rare bluish-gray clay parting; noncalcareous; dip 0°–5°.
22	283–293	Recovered 9 ft: Microfossils very rare. Clay shale and claystone, medium-light-gray, medium soft; poor to fair cleavage, fracture at various angles, rare micaceous and carbonaceous flecks, very rare coaly fragments; very slightly calcareous; dip 13°–20°.
23	293–303	Recovered 10 ft: Microfossils very rare. Clay shale, medium-light-gray, very soft; cleaves excellently into very thin pieces; breaks into small chips when dried out; light-gray silty partings and laminae increase in number toward bottom of core, some very fine grained sandy partings with fair oil odor; noncalcareous; dip 0°.
24	303–313	Recovered 10 ft: Microfossils absent. Interbedded clay shale, 70 percent, and sandstone, 30 percent. Clay shale, medium-light-gray, and light-gray soft sandstone; not as soft as core above, excellent cleavage; except for 9 in. at 308 ft; sandstone layers not more than 1 in. thick. Sand grains about 60 percent white and clear quartz, 20 percent dark chert and carbonaceous fragments, numerous brown-

SIMPSON CORE TEST 29—Continued

Core	Depth (feet)	Description
24	303–313	Recovered 10 ft—Continued ish-yellow quartz grains and some opaque white grains; grains subangular, fine, cemented by light-colored argillaceous material; noncalcareous; dip 2°; fair odor, yellow cut and brownish-yellow residue from 308 ft.
25	313–323	Recovered 10 ft: Microfossils absent. Interbedded clay shale, 85 percent, and sandstone, 15 percent, medium soft, thin laminae; noncalcareous; 2° dip; very faint odor, yellow cut and brownish-yellow residue from 317 ft.
26	323–333	Recovered 10 ft: Microfossils very rare. Interbedded sandstone, 75 percent, and clay shale, 25 percent. Medium-light-gray medium-soft shale; light-gray fine sandstone, slightly softer than the shale; same constituents as in core 24, biotite abundant in certain layers, rare partings of carbonaceous material; noncalcareous; dip 2°; fair odor, yellow cut, brownish-yellow residue at 325 ft.
27	333–343	Recovered 10 ft: Microfossils absent. Interbedded sandstone, 60 percent, and clay shale, 20 percent, as immediately above; partings containing black carbonaceous material, some variable dips due to crossbedding; noncalcareous; dip 1°; fairly good oil odor, yellow cut, brownish-yellow residue at 342 ft.
28	343–354	Recovered 10 ft: Microfossils very rare. Interbedded clay shale, 70 percent, and sandstone, 30 percent, as above; noncalcareous; dip 1°; fair odor, yellow cut, brownish-yellow residue from 348 ft.
29	354–365	Recovered 10 ft: Microfossils absent. Sandstone, light-gray, medium-soft; contains numerous partings of dark carbonaceous material, some laminae of medium-light-gray clay shale; sand 80 percent white and clear quartz, also contains black carbonaceous fragments, dark chert and yellow quartz, some biotite; subangular and very fine to fine; cemented with very light colored argillaceous material; some crossbedding; noncalcareous; dip 1½°; fair odor, yellow cut and brownish-yellow residue from 364 ft.
30	365–375	Recovered 10 ft: Microfossils very rare. Interbedded clay shale, 75 percent, and sandstone, 25 percent, same as described in cores above, very thin laminae, no sandstone layers thicker than ½ in., numerous dark carbonaceous partings; rare crossbedding; noncalcareous; dip 1°; no shows.
31	375–386	Recovered 11 ft: Microfossils very rare. Interbedded sandstone, 60 percent, and clay shale, 40 percent. Clay shale, medium-light-gray, medium-soft, excellent cleavage. Sandstone, light-gray, very fine to medium, soft, 90 percent white and clear quartz, also dark chert, black coaly particles, yellow quartz, some biotite; subangular grains; cemented with very light gray argillaceous material, has fairly common black partings of coaly particles; very small amount of crossbedding; noncalcareous; dip 0°–4°; no odor, no cut; sandstone from 384 ft leaves a greasy film in evaporating dish.
32	386–396	Recovered 10 ft: Microfossils very rare. Interbedded sandstone, 70 percent, and clay shale, 30 percent exactly as in core above; noncalcareous; dip 4°; no shows.

SIMPSON CORE TEST 29—Continued

Core	Depth (feet)	Description
33	396–407	Recovered 11 ft: Microfossils very rare. Sandstone, light-gray, soft; composition similar to sandstone in core 31, quite a bit of biotite; fine-grained, rare medium grains, clayey matrix; carbonaceous partings, some medium-light-gray clay shale laminae; noncalcareous; dip 2°; no shows.
34	407–417	Recovered 5 ft: Microfossils absent. 6 in., sandstone as in core immediately above. 4 ft 6 in., clay shale and claystone, light- to medium-gray, soft; poor to good cleavage; 1 ft from the top of the recovery is a 1/16-in.-thick layer of very light gray bentonitic clay; noncalcareous, dips variable 3°–25° or higher.
35	417–427	Recovered 5 ft: Microfossils abundant. Claystone and clay shale, medium-light-gray; poor to fair cleavage, slickensides dipping as much as 40° in first 6 in. of core, a small amount of breccia with fragments of coal and bluish-gray bentonitic clay near base of the core; a brown fish scale an inch in diameter in the top 3 in. of recovered section—similar to fish scales found in the Seabee Formation in Simpson core test 26; light-colored microfossils visible to naked eye in hand specimen; noncalcareous; dips variable, low to steep.
36	428–438	Recovered 6 ft: Microfossils common. Breccia with claystone matrix, medium-light- to medium-gray; core badly broken, numerous slickensides at various angles; claystone contains angular fragments up to an inch in diameter of dark-gray and black coaly material, medium-light-gray clay shale, light-gray bentonitic clay, grayish-yellow clay ironstone, rare rounded black chert pebbles, rare fish fragments, and pyrite. One large grayish-yellow clay ironstone concretion in about the middle of the core; noncalcareous; *Inoceramus* prisms in microfossil cut.
37	438–449	Recovered 10 ft: Microfossils very rare. Breccia with claystone matrix, as core immediately above, fewer slickensides and not quite as broken, fragments in clay are slightly larger—contains some chunks of medium-light-gray medium sand; a fragment of a pelecypod; noncalcareous; dips up to vertical but generally about 20°; *Inoceramus* prisms in microfossil cut.
38	449–459	Recovered 9 ft: Microfossils very rare. 6 ft 5 in., breccia with claystone matrix as above, core broken up, slickensides at base of interval, dip of beds up to 55°. 2 ft 7 in., sandstone and breccia with sandy matrix, medium-light-gray, very soft and friable; 50 percent white and clear quartz, 40 percent darker minerals and coal; subangular, medium-sized grains, some biotite, clayey matrix; last 6 in. at bottom of core is hard, has very calcareous cement; contains angular pieces of dark- and medium-gray clay shale and brownish-gray clay ironstone up to 2 in. in diameter.

SIMPSON CORE TEST 29—Continued

Core	Depth (feet)	Description
39	459–469	Recovered 10 ft: Microfossils absent. Sandstone, medium-light-gray, medium-soft and friable, massive, subangular to angular; most medium but a few coarse grains, 50 percent white and clear quartz, 30 percent dark rock fragments and chert, 10 percent medium-hard chalky white fragments, some biotite; loosely cemented by argillaceous material. The sandstone contains, particularly in upper 1½ ft and in a few other places in the core, angular fragments up to an inch in diameter of various shades of gray clay shale and siltstone, also yellowish-gray clay ironstone; 6 in. of medium-gray clay shale at approximately 466 ft has good cleavage, contains fishbone fragments, slickensides at steep angles; dip of beds 15°, bedding not visible in sandstone; sandstone very porous to drop test; noncalcareous; no shows.
	469–490	Sandstone, light- to medium-light-gray, medium to coarse-grained, subangular, in part hard and with very calcareous cement; about 75 percent white and clear quartz, also dark chert, rock fragments, coal particles, small amount of biotite. Top of Grandstand Formation at about 490 ft.
	490–500	Clay, medium-light-gray.
	500–530	Clay, medium-light-gray and medium-light-gray fine to medium sand; yellowish-gray clay ironstone 510–520 ft, several very coarse particles of coal 520–530 ft.
	530–550	Sand, medium-light-gray, fine to medium (more fine than medium); 80 percent white and clear quartz, rest mostly dark-gray chert, black coal particles and chalky white particles (possibly altered chert or feldspar).
	550–620	Clay, medium-light-gray, and sand.
	620–630	Sand, fine to medium.
	630–640	Clay and sand.
	640–650	Sandstone, medium-light-gray, medium to coarse, hard; has white very calcareous matrix, grains subangular; 65 percent white and clear quartz; also contains abundant dark-gray and black chert, black coal particles, a few rock fragments, abundant grayish-brown clay ironstone particles.
	650–660	Sand as above, fine to medium; but no calcareous cement.
	660–679	No sample.
40	679–689	Recovered 10 ft: Microfossils common. Claystone and clay shale, medium-light-gray, medium-soft; poor cleavage, breaks irregularly, contains numerous beds of medium-light-gray siltstone up to 1 ft thick at 686–687 ft. Upper half of the core has abundant *Ditrupa* sp. remains generally in clusters, also pelecypod shell fragments; noncalcareous; dip 7°.
	689–700	Clay and sand, fine.

SIMPSON CORE TEST 30 AND 30A

Core	Depth (feet)	Description
	0–5	Distance between kelly bushing and ground.
	5–102	No samples received by laboratory in Fairbanks. Well geologist reported as follows: "5–20 ft, clay, ice, and peat. 20–85 ft, clay, dark gray with sand and granules scattered throughout. Estimated Gubik-Seabee Formation contact at 85 ft. 85–102, shale, gray, soft, very slightly silty."

SIMPSON CORE TEST 30 AND 30A—Continued

Core	Depth (feet)	Description
1	102–112	Recovered 5 ft: Microfossils absent. Clay shale, medium-light-gray, medium-soft; poor to fair cleavage, some hackly fracture, rare partings with finely disseminated pyrite. Two in. of medium-light-gray very hard lithographic limestone in last foot of recovery; irregular to conchoidal fracture; shale noncalcareous; dip 1°.
2	112–122	Recovered 10 ft: Microfossils absent. Clay shale as above; noncalcareous; dip 1°.
3	122–133	Recovered 10 ft: Microfossils absent. 2 ft 7 in., clay shale as above, fair to good cleavage, some silty or slightly sandy partings; dip 0°–4°. 7 ft 5 in., clay or clay shale, medium-light-gray, medium-soft; poor cleavage where present; core fractured at various angles, pelecypod shell fragment at 126 ft, noncalcareous; dips up to 25° noted.
4	133–143	Recovered 3 ft: Microfossils absent. Clay shale as in lower part of core immediately above; noncalcareous; dip 5°–25°. Top of the Ninuluk and Seabee Formations, undifferentiated, at 143 ft.
5	143–153	Recovered 10 ft: Microfossils very abundant. 5 ft 5 in., clay shale, light-gray, soft; good cleavage and some indication of crossbedding with variable dip; very bentonitic; contains much biotite; noncalcareous; dip 0° 4 ft 7 in., clay shale and bentonite. Clay shale is medium gray, medium soft, has excellent cleavage, contains abundant brown fishbone fragments and scales, one scale an inch in diameter at 150 ft. Bentonite occurs as follows: at 149 ft, 1 in. of white bentonite; at 150 ft, 1 in. of light-gray bentonitic clay shale; at 151 ft, 3 in. of light-bluish-gray bentonitic clay shale and ¾ in. of white bentonite; at 153 ft, light-gray bentonitic shale and 2 in. of very light gray bentonite. Noncalcareous; dip 0°.
6	153–162	Recovered 9 ft: Microfossils abundant. 3 ft 6 in., clay shale, medium-gray, soft; good cleavage parallel to bedding, abundant brown fish fragments; *Borissiakoceras* sp. found at 154 and 155 ft, some *Inoceramus* shell fragments also; ¾ in. of very light gray bentonite at 154½ ft; 2 in. of bluish-gray bentonitic clay shale at approximately 155 ft. 1 ft 11 in., interbedded medium-gray clay shale and light-gray to white very soft and crumbly waxy bentonite; paper-thin varvelike interbeds. 9 in., bentonite and very bentonitic very light gray soft and crumbly waxy clay shale; contains abundant biotite plates. 2 ft 9 in., clay shale, medium- to medium-dark-gray, very soft and crumbly; good cleavage, abundant fish fragments, 3 in. of bluish-gray bentonitic clay and yellowish-white bentonite at approximately 161 ft.

SIMPSON CORE TEST 30 AND 30A—Continued

Core	Depth (feet)	Description
7	162–172	Recovered 8 ft: Microfossils abundant. Clay shale, medium-gray, medium-soft; good cleavage, common to abundant fish fragments, impressions of *Inoceramus* shells. Several bentonitic partings, light-gray bentonitic clay shale laminae in the section 167–168 ft, ½ in. of yellowish-gray bentonite at 170½ ft. At the very top of the section is 1 in. of very hard medium-dark-gray limestone, ¾ in. of dull grayish-black low-grade coal at 171 ft; shale is noncalcareous; dip 1°.
8	172–182	Recovered 6 ft: Microfossils abundant. Clay shale, medium- to medium-dark-gray, medium-soft; in part crumbly, has good cleavage; fish fragments rare to common, a few medium-light-gray silty partings. Two 3-in. layers of very light gray bentonite in the interval 177–178 ft, also 1 in. at 182 ft; noncalcareous; dip 1°.
9	182–192	Recovered 9 ft: Microfossils common. 2 ft 6 in., clay shale as in core immediately above, fish fragments rare to common, microfossils visible to naked eye in hand specimen, 2 in. of very light gray bentonite at 183½ ft; noncalcareous; grades gradually into: 6 ft 6 in., siltstone and medium-light-gray very fine soft and friable sandstone; 90 percent white and clear quartz, much pyrite, some mica, some dark minerals, a few glauconite pellets, grains subangular, core cleaves parallel to bedding, one 2-in. layer of very light gray silty bentonite at 186 ft, noncalcareous; dip 3°–4°; no odor, no cut, no residue from 188 ft.
10	192–202	Recovered 9 ft: Microfossils rare. Sandstone, medium-light-gray, very fine, soft and friable—similar to that in lower part of core 9—white quartz, pyrite, slightly more glauconite; noncalcareous; dip 2°, no shows.
11	202–212	Recovered 10 ft: Microfossils rare. Sandstone, medium-light-gray, very fine to silty, medium-soft and friable, subangular; good cleavage parallel to bedding; mostly white and clear quartz but pyrite common; also small number of glauconitic pellets, biotite present, loosely cemented by argillaceous material. Two in. of medium-light- to medium-gray clay shale at 211 ft; noncalcareous; dip 2°; no odor, no cut, no residue from 204 ft.
12	212–222	Recovered 10 ft: Microfossils very rare. 6 ft 3 in., silty clay shale, medium-gray, and argillaceous medium-light-gray medium-soft siltstone; poor to fair cleavage, closely interbedded and micaceous; 1½ in. hard yellowish-gray clay ironstone concretion at 218 ft. 3 ft 9 in., sandstone and siltstone, medium-light-gray, medium-soft, argillaceous; good cleavage, sand composition as in core 11; comparatively large biotite plates very abundant; noncalcareous; dip 5°; no shows.
13	222–233	Recovered 10 ft: Microfossils very rare. 7 ft, siltstone and sandstone as immediately above, slightly harder, white pelecypod remains at 224½ and 228 ft; noncalcareous; dip 3°–6°. 3 ft, interbedded siltstone and clay shale, medium-light, medium-gray, medium-soft, fair cleavage, pelecypod fragments at 231 ft, noncalcareous.

SIMPSON CORE TEST 30 AND 30A—Continued

Core	Depth (feet)	Description
14	233–243	Recovered 10 ft: Microfossils rare. Interbedded clay shale about 60 percent and 40 percent medium-light to medium-gray siltstone; in some places grades from one lithology to another, medium-soft, fair cleavage, noncalcareous; dip 0°–1°.
15	243–253	Recovered 10 ft: Microfossils very rare. Clay shale, medium-light-gray, medium-soft, very silty; some siltstone laminae, fair cleavage, micaceous, noncalcareous; dip 1°.
16	253–263	Recovered 10 ft: Microfossils very rare. Clay shale as above, silty partings, rare broken pelecypod fragments, less mica, noncalcareous; dip 1°.
17	263–273	Recovered 10 ft: Microfossils absent. 1 ft 3 in., clay shale, medium-light-gray as in core above; rare wormlike pyrite stringers up to ½ in. in length, poor cleavage. 1 ft 1 in., sandstone, medium-olive-gray, very fine to fine-grained oil-stained, very soft and friable, subangular; composed largely of white and clear quartz, some dark chert, other dark minerals and mica abundant, 3 percent pyrite (a gradual decrease from core 11 above), poorly cemented. 7 ft 8 in., interbedded siltstone 70 percent, sandstone 20 percent, and clay shale 10 percent. Sandstone same as described above in this core, has good oil stain. Medium-light-gray siltstone, similar to sandstone but harder and very micaceous, no oil stain. Clay shale, medium-light-gray, medium-soft, fair cleavage, silty, micaceous, rare very thin laminae of yellowish-gray clay ironstone; noncalcareous; dip 0°–2°; good odor, yellowish-brown residue from 265 ft.
18	273–283	Recovered 10 ft: Microfossils absent. 5 in., sandstone, medium-olive-gray, very fine to silty, oil stained; little or no pyrite. 3 ft, clay shale, medium-light-gray, medium-soft, fair hackly fracture, very micaceous (very minute plates give sheen to broken surfaces), silty; rare thin laminae of oil-stained sand. 3 ft 4 in., interbedded siltstone and sandstone, medium-light-gray, medium-soft; of type described in core immediately above, argillaceous, spotty oil staining, faint to good oil odor throughout. 1 ft 4 in., clay shale. 8 in., silty sandstone, medium-light-gray, medium-soft; faint odor. 1 ft, coal or lignite, very dark gray to dull-black, very soft and crumbly, tends to collapse into tiny chips, some blocky fracture; ⅛ in. diameter piece of clear yellow resinous material included in coal near top of section. 3 in., clay, very pale pinkish gray, medium-soft; very irregular fracture; contains a few coaly fragments; noncalcareous; dip 2°; fairly good odor, brownish-yellow cut, brown residue from 279 ft.
19	283–293	Recovered 10 ft: Microfossils absent. 2 ft 10 in., siltstone, light-gray, rather soft and friable, argillaceous; poor to good cleavage, some dark carbonaceous partings and plant fragments, biotite plates abundant throughout but in places concentrated along partings; noncalcareous; no shows.

SIMPSON CORE TEST 30 AND 30A—Continued

Core	Depth (feet)	Description
19	283–293	Recovered 10 ft—Continued 2 ft 2 in., 80 percent closely interbedded siltstone as above and 20 percent clay shale. Clay shale, medium-light-gray. Very rare coaly particles in partings. 1 ft, coal, low-grade, dull-black; cleaves parallel to bedding; fractures vertically. 4 ft, clay shale, medium-light-gray; poor cleavage, rare laminae of light-gray siltstone; noncalcareous; dip 0°–8°.
20	293–303	Recovered 4 ft 6 in.: Microfossils absent. 1 ft 2 in., bentonite, very light gray, soft and crumbly; but quite hard when dried out; contains abundant brown biotite plates. 2 ft 6 in., clay or clay shale, medium-dark-gray, moderately soft; poor cleavage, dark color probably comes from abundance of very finely disseminated carbonaceous material, slightly micaceous, rare bentonitic partings. 10 in., siltstone, medium-light-gray, very argillaceous; noncalcareous; dip low.
21	303–313	Recovered 5 ft: Microfossils absent. 2 ft 10 in., siltstone, light-gray, rather soft and friable; fairly common thin clay shale laminae, ½ in. yellowish-gray clay ironstone at very top of section containing coal fragment; fair oil odor. 2 ft 2 in., clay shale, medium-light- to medium-gray; noncalcareous; dip 0°–5°.
22	313–323	Recovered 5 ft: Microfossils absent. Sandstone, dark-olive-gray, fine-grained, very soft and friable, practically unconsolidated, subangular; pronounced oil stain, 75 percent white and clear quartz, rest dark chert and rock fragments; biotite rare. Fairly numerous partings containing abundant black coaly particles; noncalcareous; dip 5°; strong oil odor, yellowish-brown cut and brownish oil residue from about 318 ft.
23	323–333	Recovered 10 ft: Microfossils absent. Sandstone exactly as above, 1 in. of medium-light-gray clay shale at the very top of the core, noncalcareous; dip 4°; strong oil odor, brown cut and considerable amount of dark-brown oil as residue from 326 ft.
24	333–343	Recovered 10 ft: Microfossils absent. Sandstone as above, fine-grained, very soft, no carbonaceous partings, noncalcareous; dip undetermined; strong oil odor, yellowish-brown cut and brown oil residue from 340 ft.
25	343–353	Recovered 10 ft: Microfossils absent. 8 ft 10 in., sandstone as above, fine-grained soft and friable; but becomes very fine grained in the last 2 ft of the section. Oil stain decreases with grain size, no carbonaceous partings; noncalcareous; strong oil odor, brownish-yellow cut and yellowish-brown residue from 345 ft. 1 ft 2 in., clay shale, medium-light-gray, medium-soft; good cleavage; noncalcareous; dip 3°–4°
26	353–363	Recovered 10 ft: Microfossils absent. Clay shale, medium-light-gray, soft; good cleavage parallel to bedding, 3 in. of medium-light-gray clay ironstone at 355 ft, yellow cast; very hard, conchoidal fracture, noncalcareous; dip 2°–3°.
	363–367	No sample.

SIMPSON CORE TEST 30 AND 30A—Continued

Core	Depth (feet)	Description
27	367–377	Recovered 7 ft: Microfossils absent. 3 ft, clay shale as above, fair cleavage, silty. 4 ft, siltstone, medium-light-gray, medium-soft; fair to poor cleavage, argillaceous laminae, silt grains mostly subangular white and clear quartz, some dark chert and numerous carbonaceous particles, also some very fine sand, noncalcareous; dip low; faint petroliferous odor, straw colored cut and light-yellow residue from 376 ft.
28	377–387	Recovered 10 ft: Microfossils absent. 3 ft, clay shale, medium-light-gray, moderately soft; fair to poor cleavage, rare coaly particles up to ⅛ in. thick imbedded at random in the shale, also rare cone-in-conelike structures with cones as much as ⅓ in. deep. 2 ft 6 in., clay shale, medium-light-gray to grayish-black, medium-soft, fair cleavage; contains abundant plant fragments, carbonaceous and coaly particles, thin laminae of dull-black coal. 4 ft 6 in., clay shale, as in first part of this core, very rare coaly particles, becomes silty toward base of core; noncalcareous; dip 5°.
29	387–398	Recovered 10 ft: Microfossils very rare. 2 ft, clay shale, medium-light-gray to medium-gray, moderately soft, cleavage good, rare carbonaceous particles. 1 ft 11 in., clay shale and coal. Clay shale, medium-light- and medium-dark-gray, medium-soft; fair cleavage, numerous carbonaceous and coaly particles. Coal, 6 in., dull-black, brittle. 2 ft 11 in., siltstone, light- to medium-light-gray, soft and friable, micaceous; good cleavage and argillaceous partings; noncalcareous; no shows. 3 ft 2 in., clay shale, medium-light- to medium-gray; good cleavage (in part hackly fracture), medium-light-gray silty partings, six concretions or laminae of clay ironstone, yellowish- and brownish-gray, up to 1½ in. thick; no shows; noncalcareous; dip 2°.
30	398–408	Recovered 8 ft: Microfossils absent. Clay shale, medium-light-gray, medium-soft; poor cleavage, rare dark carbonaceous particles; ½-in. thick yellowish-gray clay ironstone concretion at very top of the section; noncalcareous; dip undetermined.
31	408–419	Recovered 10 ft 6 in: Microfossils absent. 4 in., clay ironstone concretion, yellowish-gray, very hard; conchoidal fracture; contains a few carbonaceous fragments; effervesces slightly with cold acid. 1 ft 6 in., clay shale, medium-gray, rather soft; fair cleavage, rare coaly particles along partings; dip low. 10 in., coal, grayish-black to black, very low grade, flaky and brittle, argillaceous. 2 ft 2 in., siltstone, medium-light-gray soft and friable, argillaceous; quite micaceous; contains carbonaceous particles; noncalcareous. 3 in., coal as above in this core.

SIMPSON CORE TEST 30 AND 30A—Continued

Core	Depth (feet)	Description
31	408–419	Recovered 10 ft 6 in.—Continued 5 ft 5 in., sandstone, medium-light- to medium-gray, very soft and friable; ranges from very fine grained at top of section to nearly medium grained toward the base; finer material is mostly white and clear quartz, quantity of dark-gray and black chert increases with grain size, up to 40 percent chert; part of core with the larger grains looks "clean" and very porous, grains subangular to subrounded—mostly subangular; noncalcareous; very slight oil odor, possibly from outside of hole contamination.
32	419–429	Recovered 7 ft 6 in.: Microfossils rare. Clay shale, medium-light- to medium-gray, moderately soft; poor to fair cleavage, some medium-light-gray silty laminae and partings; 5 in. of hard sandy micaceous siltstone at the base of the core cemented with gray clay ironstone; yellow cast; noncalcareous; dip 1°–3°.
33	429–440	Recovered 6 ft: Microfossils rare. Clay shale, medium-light-gray, medium-soft; poor to fair cleavage, some hackly fracture, topmost foot of recovered section has numerous laminae of lighter-gray siltstone and a few of sandstone; noncalcareous; dip 3°–5°.
	440–450	Sand, medium-light-gray, fine to medium; 75 percent white and clear quartz, rest mostly dark chert, subangular to subrounded, trace grayish-brown clay ironstone. Also some medium-light-gray clay shale. Top of Grandstand Formation at about 445 ft.
	450–453	No sample.
34	453–460	Recovered 3 ft: Microfossils absent. 2 ft 6 in., sandstone, medium-dark-olive-gray, very soft and friable; subangular grains; strong oil stain; 70–80 percent white and clear quartz, 20–30 percent dark-gray and black chert, salt and pepper; noncalcareous, bedding indistinct; fairly strong oil odor, amber cut and brown oil residue from approximately 455 ft. 6 in., clay shale, medium-light-gray, medium-soft, noncalcareous; low dip.
35	460–471	Recovered 6 ft: Microfossils absent. Sandstone, light-gray (no oil stain), soft and friable; in part has good cleavage parallel to the bedding; numerous partings contain abundant black coal particles and fine subangular sand; 80 percent white and clear quartz, rest mostly dark chert, coal particles, and a few rock fragments; coal particles range in size up to medium-grained; very loosely cemented, probably with argillaceous material; noncalcareous; dip 4°–7°; faint odor, very pale straw-colored cut, very pale yellow residue from 468 ft.
	471–480	Sand and clay shale, medium-light-gray; cement contamination.
	480–520	Clay shale, medium-light-gray; some sand also some pyrite. A few shiny black coal particles 510–520 ft. Cement contamination.
	520–530	Sand, medium-light-gray, fine to medium, subangular to subrounded; 85 percent white and clear quartz; rest dark-gray or black chert, scattered coaly particles.
	530–560	Clay shale, medium-light-gray; some sand, rare black coal chips.
	560–566	No sample.

SIMPSON CORE TEST 30 AND 30A—Continued

Core	Depth (feet)	Description
36	566–577	Recovered 1 ft 6 in.: Microfossils very rare. Clay shale, medium-light-gray, medium-soft; poor cleavage; contains light-gray silty laminae, inch-thick hard light-olive-gray clay ironstone concretion a foot from the top of the recovery; noncalcareous; dip not determined.
37	577–588	Recovered 10 ft: Microfossils common. 6 ft 9 in., clay shale, medium-light-gray, medium-soft; fair to poor cleavage, 1-in. layer of dull to shiny black low-grade coal at about 579 ft; coal contains finely disseminated pyrite and little nodules of clear yellow resin or amber, another dark slightly coaly streak at the bottom of the section; some siltstone laminae in the shale; noncalcareous; dip about 3°. 1 ft, siltstone light-olive-gray, soft and friable; grains almost all white and clear quartz, several black coaly partings; slightly calcareous; slight oil odor. 2 ft 3 in., clay shale as in first part of this core; grayish-yellow clay ironstone concretion near top.
38	588–599	Recovered 11 ft: Microfossils absent. Clay shale, medium-light-gray (in upper half of core) to medium-gray (in lower half), silty, medium-soft; fair cleavage; contains fairly common yellowish-white mollusk fragments in the lower 5 ft of the core; silty parts of the core are slightly calcareous; dip 2°.
39	599–609	Recovered 8 ft: Microfossils rare. 3 ft, clay shale and clay, medium-light- to medium-gray, moderately soft; poor cleavage where present, some medium-light-gray silty laminae, abundant small (½–¼ in. diameter) white gastropod and pelecypod shell fragments at about 603 ft; noncalcareous. 2 ft, siltstone, medium-light-gray, moderately soft; poor cleavage, slightly micaceous, very argillaceous, noncalcareous; dip probably less than 2°. 3 ft, clay shale or clay as in first part of this core, three grayish-yellow clay ironstone laminae up to an inch thick near the top of the interval, a few small mollusk fragments near 607 ft; noncalcareous.
40	609–620	Recovered 9 ft: Microfossils common. Clay shale, medium-light-gray, medium-soft; fair to poor cleavage; streaks of light-gray siltstone, hard yellowish-gray clay ironstone concretion at 614 ft; noncalcareous; dip 0°.
41	620–630	Recovered 7 ft: Microfossils absent. 6 in., sandstone as described below. 6 in., clay shale, medium-light-gray, moderately soft; good cleavage; noncalcareous; dip 2°. 6 ft, sandstone, olive-gray fine- to medium-grained, very soft and friable, nearly unconsolidated, subangular; has pronounced oil stain; about 60 percent white and clear quartz, rest made up of dark chert and miscellaneous rock fragments, a few medium-soft white chalky particles, scattered black partings contain abundant coaly particles; hard grayish-yellow clay ironstone concretion at 626½ ft; noncalcareous; dip up to 10°; strong oil odor, yellowish-brown cut and brown oil residue from 627 ft.

SIMPSON CORE TEST 30 AND 30A—Continued

Core	Depth (feet)	Description
42	630–640	Recovered 10 ft: Microfossils absent. Sandstone, medium-dark-olive-gray, soft and friable; 60 percent white and clear quartz; rest mostly dark-gray chert, coal particles, and some rock fragments; a few subangular fine- to medium-grained dull white particles (salt-and-pepper sand); noncalcareous; dip undetermined; good oil odor, yellowish-brown cut, brownish oil residue from 638 ft.
43	640–651	Recovered 11 ft: Microfossils absent. Sandstone as in core immediately above; some black coaly partings; dip 3°; fairly good odor, brownish-yellow cut and brownish oil residue from 648 ft.
44	651–662	Recovered 10 ft: Microfossils very rare. Sandstone, medium-light-gray, fine-grained, subangular, soft and friable; breaks parallel to bedding, very porous; approximately 80 percent white and clear quartz, 5–10 percent brownish-yellow quartz, less than 10 percent dark chert and rock fragments; mica quite abundant, also some rather hard chalky white particles, all loosely cemented by argillaceous material; noncalcareous; dip 3°; a few laminae with olive-colored oil stain, fair odor, yellow cut, yellowish-brown residue from 660 ft.
45	662–673	Recovered 11 ft: Microfossils absent. Sandstone as above but very fine; noncalcareous; no oil stain, no odor, no cut, but pale-yellow residue 665 ft.
46	673–683	Recovered 10 ft: Microfossils absent. Sandstone as above, very fine to silty, at least 10 percent brownish-yellow quartz; noncalcareous; dip not determined because bedding obscure; very faint odor, no cut, pale-yellow residue at 681 ft.
47	683–693	No recovery.

The following cores were taken in Simpson core test 30A. Because of the proximity of 30 to 30A no cuttings were taken in the latter.

1	680–691	Recovered 11 ft: Microfossils absent. Siltstone, 70 percent, and sandstone, 30 percent, medium-light-gray, soft and friable; good cleavage parallel to bedding; sandstone is very fine grained and grades into siltstone; numerous black partings of coal particles in the upper half of the core, some micaceous partings; grains are subangular to subrounded, almost entirely white and clear quartz with the exception of about 5 percent of a dull-yellowish mineral, possibly siderite (effervesces slightly with cold HCl). Core becomes quite argillaceous in the last few inches of the recovery. Grayish-yellow clay ironstone concretion at 680½ ft. Pelecypod remains and *Ditrupa* sp. fragments present in the lowest foot of the core; noncalcareous; dip 1°–4°; no odor, no cut, faint greasy film in evaporating dish at 688 ft.
2	691–701	Recovered 10 ft: Microfossils abundant. Clay shale, medium-light-gray, medium-soft; poor cleavage, very rare silty laminae, several inch-thick streaks of grayish-yellow clay ironstone notably at 694–698 ft, a few pelecypod and *Ditrupa* fragments; ironstone is slightly calcareous but shale is not; dip undetermined, but low.

SIMPSON CORE TEST 31

Core	Depth (feet)	Description
	0–5	Distance between kelly bushing and ground.
	5–20	Tundra, yellowish–gray clay and sand. Sand, light-olive-gray, made up of white, clear, and yellow quartz, yellow and black chert, other grains rare, fine to coarse and subangular to well rounded.
	20–40	Clay, olive-gray, and some sand as above. Ostracodes and Foraminifera rare, also a few pelecypod fragments.
	40–50	Sand, medium-light-gray, very coarse, subangular to well-rounded; about 60 percent clear quartz, 30 percent dark-gray and black chert, also various other colored grains, some pyrite. Yellowish-gray clay, rare microfossils.
	50–90	Clay, yellowish-gray; about 50 percent sand.
	90–100	Sand as of type in interval 40–50 ft above; also contains a few rock fragments, particularly limestone, slightly larger grain size than in sand above.
	100–110	Much cement contamination. Top of Seabee Formation probably near 110 ft.
	110–115	No sample.
1	115–125	Recovered 9 ft 6 in.: Microfossils absent. Clay, light-gray, soft, cleavage absent except in lowest part of core where very poor cleavage is indicated. One-half in. rounded black chert pebble imbedded in clay at 118 ft. Rare patches of silt—mostly subangular white quartz, also biotite, carbonaceous particles, and pyrite. Scattered black carbonaceous fragments in the clay. One pelecypod shell at the very top of the section, very small shell fragments scattered very rarely throughout the core; noncalcareous; dip undetermined.
2	125–132	Recovered 4 ft: Microfossils absent. Clay and clay shale, light-gray, soft; very poor or no cleavage, rare silty partings, small amount of pyrite in clay; noncalcareous, dip 18°–30°.
3	132–144	Recovered 8 ft 4 in.: Microfossils absent. Clay and clay shale, medium-light-gray, soft; poor to no cleavage, rare silty-micaceous partings; noncalcareous; bedding indistinct; dip 20°–30°.
4	144–155	Recovered 10 ft: Microfossils absent. Clay shale, medium-light-gray; poor cleavage, soft and crumbly, a few laminae and partings of light-gray siltstone; noncalcareous; dip 15°–45°, no slickensides noted.
5	155–166	Recovered 8 ft: Microfossils absent. Clay shale as above but slightly harder, rare silty laminae; noncalcareous; dip 18°–35°.
6	166–175	Recovered 8 ft 6 in.: Microfossils absent. Clay shale, medium-light-gray, medium-soft; poor to no cleavage; noncalcareous; dip 5°–20°.
7	175–186	Recovered 9 ft: Microfossils absent. Clay shale, medium-light-gray, soft and crumbly; numerous laminae of light-gray slightly micaceous noncalcareous siltstone, dip 5°–15°. Top of Ninuluk and Seabee formation undifferentiated, may be near 186 ft.
8	186–197	Recovered 10 ft: Microfossils very rare. 8 ft, clay shale, light- to medium-light-gray, very soft and crumbly; poor to no cleavage, silty—grades into siltstone in places, micaceous; noncalcareous; dip 3°–10° grades into:

SIMPSON CORE TEST 31—Continued

Core	Depth (feet)	Description
8	186–197	Recovered 10 ft—Continued 2 ft, clay shale, medium-gray, medium-soft. One in. of soft very light gray bentonite at 196½ ft and ½ in. of soft yellowish-white very calcareous material at 196 ft. Also partings of bentonite present. Shale has abundant brown fishbone fragments in the lower part of the section; shale is noncalcareous; dip as much as 10°.
9	197–208	Recovered 8 ft: Microfossils abundant. 1 ft 5 in., clay shale, medium-gray, noncalcareous; fish fragments as in core immediately above; one fish scale ¾ in. in diameter. 5 in., bentonite, very light gray, waxy, very soft and crumbly when dry. 8 in., clay shale, medium-gray, some bluish-gray and bentonitic, very soft; very good cleavage, some fishbone fragments; noncalcareous; grades into: 2 ft 3 in., bentonite plus about 15 percent clay shale laminae. Bentonite is very light gray, small amount blue and yellow tinge. Contains numerous biotite plates. Some interbeds of medium-gray clay shale with good cleavage. 1 ft 2 in., clay shale, medium-gray, soft; excellent cleavage—"paper shale"; noncalcareous. 4 in., bentonite, very light gray, as above. 1 ft 9 in., clay shale, medium-gray; fairly good cleavage, a few fishbone fragments, some scales quite large; inch of bentonite at very base of section; noncalcareous; dip of beds in core 4°–7°.
10	208–219	Recovered 7 ft: Microfossils rare. 4 ft 4 in., clay shale and siltstone, medium-light- to medium-gray. Extremely soft—this entire section has crumbled into little pieces; has about 5 in. of light-gray bentonite at about a foot from the top. 2 ft 8 in., sandstone, medium-light-gray, very fine to fine-grained, medium-soft, silty; grains subangular to subrounded, about 50 percent white and clear quartz, 50 percent biotite, chlorite, glauconite, and clay minerals, some carbonaceous particles and pyrite, matrix argillaceous; noncalcareous; dip 4°; very slight oil odor, no cut, greasy stain in evaporating dish from 217 ft.
11	219–230	Recovered 9 ft: Microfossils absent. Sandstone, medium-light-gray, fine-grained, medium-soft to very soft; same composition as sand in core immediately above but pyrite quite common; tends to cleave parallel to bedding; noncalcareous; dip 4°–7°; no shows.
12	230–241	Recovered 7 ft 8 in: Microfossils very rare. 5 in., siltstone, medium-light-gray, very calcareous, very hard; some sand-size grains, same composition as described below. 2 ft 9 in., sandstone and siltstone, medium-light-gray, silty to very fine, soft, subangular; 70 percent white and clear quartz, rest is glauconite, biotite, chlorite, brown grains (sideritic?), dull white grains, some dark chert and pyrite loosely cemented by argillaceous material. 8 in., siltstone, medium-light-gray, very calcareous, very hard, sandy; dip 12°. 3 ft 10 in., sandstone and siltstone, soft; exactly as in second part of this core; noncalcareous; dip 13°; very faint oil odor, no cut but at 237 ft slightly yellow greasy stain in evaporating dish.

SIMPSON CORE TEST 31—Continued

Core	Depth (feet)	Description
13	241–252	Recovered 10 ft: Microfossils very rare. 4 ft 1 in., clay shale and siltstone, medium-light-gray, very soft; grades from silt to clay, small amount of sand; dip 11°. 7 in., siltstone, medium-light-gray, very hard, very calcareous; contains quite a bit of biotite; one very thin vein of white calcite cuts core at 45°. 5 ft 4 in., interbedded sandstone, siltstone, and clay shale—mostly silty and sandy, medium-light-gray, soft to very soft; sand is 50 percent white and clear quartz; glauconite, pyrite, and biotite abundant, also clay minerals and dark chert; noncalcareous; dip 12°; no shows.
14	252–263	Recovered 10 ft: Microfossils very rare. Siltstone and some sandstone, medium-light-gray, very soft, very argillaceous; 2 in. of hard very calcareous siltstone at 258 ft. Broken pelecypod shells at 257½ and 262 ft. The one at 262 ft strongly resembles those found at 228 ft in core 13 in Simpson core test 30; noncalcareous; dip 7.° *Inoceramus* prisms in microfossil cut.
15	263–274	Recovered 10 ft: Microfossils absent. Siltstone, light- to medium-light-gray, soft laminae and partings of slightly darker gray clay shale; silt contains quartz, glauconite, mica, pyrite, and other minerals. One silty grayish-yellow clay ironstone concretion 2 in. thick at 267 ft. Several unidentifiable pelecypod fragments in the core; noncalcareous; dip 4°; no shows.
16	274–285	Recovered 11 ft: Microfossils rare. Interbedded clay shale, 60 percent, and light- to medium-light-gray medium-soft siltstone 40 percent, slightly softer than the clay; fair to poor cleavage, very rare white pelecypod shell fragments; noncalcareous; dip 10°.
17	285–296	Recovered 10 ft 6 in.: Microfossils absent. Clay shale, medium-light-gray, medium-soft; fair cleavage, rare lighter colored and softer silty laminae; noncalcareous; dip 4°.
18	296–307	Recovered 9 ft 1 in.: Microfossils very rare. Clay shale as in core immediately above, slightly more silt which makes the clay shale softer and crumbly; noncalcareous; dip 4°.
19	307–318	Recovered 10 ft: Microfossils very rare. 1 ft, clay shale, silty, crumbly as in core above. 3 ft, siltstone, light-olive-gray, very soft and friable, argillaceous, micaceous; 3 in. of hard silty grayish-yellow clay ironstone at 310 ft, noncalcareous; dip 3°; slight oil stain and odor; grades at the base into: 6 ft, sandstone, medium-light-olive-gray, very fine to fine-grained, rather soft and friable; cleaves parallel to bedding, subangular to subrounded—mostly subangular; 85 percent white and clear quartz, rest dark-gray chert, carbonaceous particles, some mica and other dark minerals; noncalcareous; dip as high as 10°; oil stain ranges from fair to very good; good odor, brownish-yellow cut, and brownish-yellow residue at 316 ft.

SIMPSON CORE TEST 31—Continued

Core	Depth (feet)	Description
20	318–329	Recovered 7 ft: Microfossils absent. Sandstone, light-olive-gray, very fine to fine-grained, medium-soft and friable; also silty in spots, composition same as immediately above, 1-in.-thick yellowish-gray clay ironstone concretion at 327 ft; ironstone contains coaly chips; noncalcareous; dip 6°; very faint odor, no cut; slight greasy stain at 327 ft.
21	329–340	Recovered 10 ft: Microfossils absent. 4 ft, sandstone, light-olive-gray, as described in core immediately above, dip 10°–15°. 9 in., lignite and coal, dull-grayish-black, flaky; fairly good cleavage, blocky fracture in part; contains stringers of shiny black coal, plant fragments visible, rare patches of amber resinous material; dip 10°. 5 ft 3 in., interbedded silty sandstone and clay shale in equal proportions, medium-light- to medium-gray, medium-soft; fair cleavage, numerous partings contain black coaly particles, two thin grayish-yellow clay ironstone concretions at 336 and 337 ft; noncalcareous; dip 8°; very faint odor, no cut, greasy stain in evaporating dish at 331 ft.
22	340–351	Recovered 10 ft: Microfossils absent. 1 ft 10 in., clay shale, medium-dark- to dark-gray, very carbonaceous, soft and rather brittle; fair to good cleavage; noncalcareous. 2 ft 3 in., bentonite, very light gray; medium-hard when throughly dry; contains abundant hexagonal biotite plates; a few thin laminae of clay shale. 3 ft 10 in., clay shale, dark-gray to grayish-black, very carbonaceous, medium-soft; poor cleavage, tendency toward conchoidal fracture. Two in. of very light yellowish-gray bentonite at 347 ft. 5 in., coal, dull to shiny black; blocky fracture, several interbeds of clay shale. 1 ft 8 in., clay shale, light- to medium-dark-gray, medium-soft; poor cleavage, ranges from bentonitic to carbonaceous, also slightly silty toward base.
23	351–355	Recovered 3 ft 10.: Microfossils absent. 1 ft 5 in., closely interbedded clay shale, medium-light-gray, and very light gray medium-soft bentonitic clay shale; fair cleavage; dip 7°. 8 in., bentonite, medium-olive-gray—really very light gray with strong oil stain and odor. 1 ft 9 in., claystone, medium-light-gray, rather hard, silty, micaceous; irregular fracture roughly parallel to bedding; noncalcareous.

MINGA VELOCITY TEST 1

Core	Depth (feet)	Description
	0–5	Elevation of kelly bushing above sea level.
	5–10	Ice.
	10–12	Water and clay.
	12–30	Clay medium-light-olive-gray very fine to medium subangular to subrounded sand, made up of varicolored quartz (largely clear, white, and yellow) and chert. White mollusk shell fragments, microfossils abundant.

MINGA VELOCITY TEST 1—Continued

Core	Depth (feet)	Description
	30–60	Sand and clay, medium-light- to medium-olive-gray. Some of the sand is very coarse to granule-size quartz and dark chert. Mollusk fragments.
	60–85	Sand, subrounded to well-rounded grains, granules, and pebbles; clear quartz, gray quartzite, and dark-gray and black chert. Numerous shell fragments. Base of the Gubik Formation—top of the Seabee Formation at approximately 85 ft.
	85–100	Clay, medium-light-gray.
	100–110	Small amount of limestone, medium-gray, very silty. Also clay and some subangular white and clear quartz sand grains.
	110–130	Clay, trace limestone 120–130 ft.
	130–140	Limestone or very calcareous medium-gray siltstone (50 percent of washed sample).
	140–230	Clay, medium-light-gray. Rare fish fragments 170–180 ft.
	230–250	Clay up to 40 percent and very silty limestone or very calcareous medium-gray siltstone. Rare fish fragments 240–250 ft.
	250–280	Clay, medium-light-gray. Rare fish fragments 260–270 ft.
	280–290	Siltstone, very calcareous and medium-gray limestone (30 percent of washed sample), also clay. Rare fish fragments 280–290 ft.
	290–310	Clay.
	310–330	Limestone, medium-gray, silty (25 percent of washed sample 310–320 ft), also clay. Rare fish fragments 310–320 ft.
	330–460	Clay, medium-light-gray, "sticky," possibly bentonitic; also streaks of silt. Trace brownish-gray clay ironstone 430–440 ft. Rare fish fragments 400–410 ft.
	460–470	White crystalline calcite or aragonite and clay (6 in. of calcite at 465 ft).
	470–570	Clay, medium-light-gray, rare fish fragments 530–550 ft.
	570–580	White crystalline calcite or aragonite, small amount; also clay. Rare fish fragments.
	580–620	Clay; bentonite very rare 610–620 ft. (In unwashed sample.) Rare fish fragments 610–620 ft. Top of Ninuluk and Seabee Formations undifferentiated probably near 610 ft.
	620–630	Abundant white crystalline calcite or aragonite, rare flakes of biotite imbedded in the calcite, some yellowish-brown clay ironstone. White bentonitic material noted in unwashed lithology sample.
	630–650	Clay, calcite, clay ironstone, and some white soft slightly calcareous claylike material containing flakes of biotite. Some very fine to fine sand, subangular to subrounded grains, primarily white quartz, trace of coal and pyrite.
	650–660	Clay, sand, and pyrite.
	660–670	Crystalline calcite or aragonite, quartz sand, and trace of coal; pyrite common.
	670–740	Clay and sand, primarily fine white quartz but some medium-grained dark chert; pyrite common, trace coal 710–740 ft. Top of Grandstand Formation at about 740 ft.
	740–750	Pyritized sandstone and some clay. Sandstone fine-grained quartz with a pyrite matrix, pieces of pyrite abundant.
	750–810	Sand, medium-light-gray, very fine, subangular to subrounded; primarily white and clear quartz.

MINGA VELOCITY TEST 1—Continued

Core	Depth (feet)	Description
	810–960	Probably clay with streaks of sand. A large amount of rounded varicolored grains of sand contamination from the Gubik Formation particularly from 890 to 960 ft. Gubik microfossils and mollusk shell fragments are also present. Sand penetrated is same as in section immediately above. Pyrite abundant 810–870 ft. Clay ironstone concretions 830–840 and 870–880 ft. Rare fish fragments 840–850 and 860–870 ft. Pyritic *Ditrupa* sp. (top occurrence) 860–870 ft.
	960–980	Clay and sand, up to 25 percent (of washed sample) of medium-dark-gray very dense limestone plus a small amount of white calcite.
	980–1, 010	Sand, medium-light-gray, very fine to fine; primarily white quartz, some dark chert.
	1, 010–1, 050	Sand, some clay, nothing in ditch except about three chips of limestone at 1,030–1,040 ft (which could be contamination from above) to account for strong "kick" on electric log.
	1, 050–1, 225	Clay with some sand stringers, medium-light-gray, fine; some grains slightly larger; primarily white subangular to subrounded quartz; some dark chert. Clay ironstone 1,070–1,080 ft. Trace coal 1,130–1,140 ft; *Ditrupa* sp. fragments.
1	1, 225–1, 233	Recovered 7 ft: Microfossils abundant. Clay shale, medium-light-gray; hackly fracture, fairly soft and friable, rare carbonaceous flecks; dip approximately 3°; noncalcareous; very rare unidentified pelecypod and gastropod fragments. Total depth 1,233 ft.

CORE ANALYSES

POROSITY AND PERMEABILITY

No core analyses were made on Simpson core tests 1–12. Most of the sandstone in cores taken in Simpson core tests 13–31 is unconsolidated, or nearly so; therefore, very few porosity and permeability analyses were made in the Fairbanks laboratory as equipment was not available to make tests on such samples. The porosities and permeabilities listed in table 3 probably represent the lowest readings that could be obtained from the sandstone as a whole. By their very consolidation these samples are from beds with the most cementing material and are, for that reason the least porous and permeable.

TABLE 3.—*Porosity and permeability of samples from Simpson core tests 13, 14, and 28*

Core test	Core No.	Depth (feet)	Effective porosity (percent)	Air permeability (millidarcys)
13	97	6991½	[1] 28	Too soft.
14	9	476	33.95	348
28	5	1,385	35.00	700
28	16	2,503	22.5	71

[1] Approximately.

The following report on some samples from Simpson core tests 13, 14, and 16 was made by S. T. Yuster, U.S. Geological Survey.

TABLE 4.—*Porosity, permeability, and fluid saturation of samples from Simpson core tests 13, 14, and 16*

[Analysis by S. T. Yuster]

Core test	Core No.	Depth (feet)	Porosity (in percent)	Oil saturation (in percent)	Water saturation (in percent)	Permeability (millidarcys)	Remarks
13	143	1, 062–1, 066		None	100		Unconsolidated sand.
	144	1, 066–1, 075					Clay.
	144	[1] 1, 066–1, 075		None	100		Do.
	144	[2] 1, 066–1, 075					Thick mud.
	145	1, 075–1, 079					Do.
	146	[2] 1, 079–1, 084		5	95		Friable shale.
	146	1, 079–1, 084		None	100		Do.
	147	1, 084–1, 087		None	100		Do.
	158	1, 138–1, 148		7.5	92.5		Unconsolidated sand.
	158	[2] 1, 138–1, 148		63.0	35.2		Do.
14	8	465–475	33 (assumed)	7.5	85.7		Do.
	8	465–475	36.8	5.3	68.5		Poorly consolidated sand.[3]
	9	475–485	33 (assumed)	12.4	46.0		Unconsolidated sand.[3]
	9	475–485					Clay-sand mixture.
	9	475–485		6.7	93		Unconsolidated sand.[3]
	9	475–485		34.8	65.1		Poorly consolidated sand.[3]
	10	485–495		18.5	81.5		Unconsolidated sand.[3]
	10	485–495		5.1	94.8		Do.
	10	485–495	10.9	40.3	36.8	0.29	Consolidated sandstone.
	11	495–505					Coal and black shale.
	11	495–505		14.4	84.1		Unconsolidated sand.[3]
	11	495–505					Clay and sand.
16	3	525–535		82	18		Unconsolidated sand.

[1] Middle. [2] Bottom. [3] Plus clay.

CORE ANALYSES OF SIMPSON CORE TESTS 13, 14, AND 16

By S. T. Yuster

Most of the core samples obtained from Simpson core tests 13, 14, and 16 were very poor due to the generally poor consolidation of the sandstone in the Simpson area and in some cores to the interbedding of shale and sand. It was possible to run only two porosities and one permeability test from a total of 23 samples. For some samples, a porosity assumption was made and an average grain density of 2.65 assumed in order to calculate a grain volume and to obtain a pore volume for saturation calculations. For others it was assumed that the pore volume was 100 percent saturated, and the oil and water had been extracted. Coring is very unsatisfactory in unconsolidated or poorly consolidated sands, and flushing by the drilling fluid would be aggravated under such conditions. The saturation data would therefore be more questionable than usual.

The only noteworthy sample from Simpson core test 13 is from core 158 which bottomed at 1,138–1,148 feet (table 4). This sample was an unconsolidated sand that for some reason retained a high oil saturation. The best criterion of the productivity of this section would be in the well behavior, providing a mud or water block had not been created during the drilling operation. From its texture, it is believed that the sand has a fairly high permeability.

Two samples from the interval between 475–495 feet in Simpson core test 14 have oil saturations that might represent productive sands. One having an oil saturation of 40.3 percent, however, has a permeability of 0.29 millidarcys, which would give a productivity too low to be of practical significance. This low permeability would, in fact, minimize flushing and account for a higher saturation than is present in neighboring samples. Because of the shallow depth of this section, it is likely that the formation pressure is low, and if in addition the sand is in the permafrost, the productivity may be disappointing.

The only sample submitted for analysis from Simpson core test 16 had the highest oil saturation of all samples analyzed. Oil had bled into the sample can from the core; its richness was such as to appear that it had been "salted." This sample was unconsolidated and had a texture that indicated high permeability. As in Simpson core test 14, the depth was shallow and the productivity probably would be low.

SIEVE ANALYSES

Sieve analyses (table 5) were run on the same sandstone in the Ninuluk and Seabee Formations, undifferentiated, from core tests 26 and 30 near seep 3. This is the producing sandstone in Simpson core test 26 and the equivalent beds in 30.

Table 5.—*Sieve analyses, in percent, Ninuluk and Seabee Formations, undifferentiated, Simpson core tests 26 and 30*

[Using American Society for Testing Material sieves]

Wentworth scale	Core test 26	Core test 30
	Core 22 (313 feet)	Core 10 (315 feet)
Very coarse sand (plus 18 mesh)		
Coarse sand (plus 35 mesh)	Trace	0.03
Medium sand (plus 60 mesh)	0.4	1.6
Fine sand (plus 120 mesh)	68.9	76.5
Very fine sand (plus 230 mesh)	18.1	11.9
Silt and clay (plus 325 mesh)	7.8	5.35
Clay (pan)	4.2	4.16
Total	99.4	99.54

HEAVY MINERALS

R. H. Morris examined many samples from the Simpson core tests as a part of his study of the heavy-mineral suites in the rocks of northern Alaska. A preliminary discussion of various zones may be found in the "Geology of the Arctic Slope of Alaska" (Morris and Lathram, 1951). Two heavy-mineral zones are recognized in some of the Simpson core tests on the west side of the Simpson peninsula. The thin surficial deposits of the Gubik Formation are marked by the rounded-grain zone and the underlying Cretaceous strata are represented by the glaucophane zone. To the east, Simpson core tests 13–31 are characterized by the rounded-grain zone in the Gubik Formation, and the biotite, the glaucophane, and the zoned-zircon zones in the Cretaceous. Table 6 summarizes the occurrences of these zones in the Simpson core tests as determined by Morris, and plates 47–49 show the relative abundance of the heavy minerals.

Table 6.—*Heavy-mineral zones in the Simpson core tests*

[Determined by R. H. Morris. Depths in feet]

Core test	Rounded-grain zone	Biotite zone	Glaucophane zone	Zoned-zircon zone
1	45		228	
2			170	
3			278–338	
4			81–121	
5		No samples		
6	29–45		129	
7			372	
8	50		210–530	
9	20–40		70–230	
10	50		90–320	
11		No samples		
12		do		
13		610	692–1, 113	
14		309	320–1, 213	
14A		No samples		
15		309		
16			493–539	
17		588–624	799	
18		No samples		
19		do		
20		do		
21		do		
22		do		
23			606–902	
24			603–702	
25		700	820–1, 460	
26		170–262	300	
27		279		
28			1, 260–1, 400	2, 502
29	78	325	400–461	
30		318–344	627	
30A			683	
31		240		
Minga 1		No samples		

OIL AND GAS

OIL AND GAS SHOWS

The first analyses (table 7) of oil collected from the seeps in the Cape Simpson area were made by the U.S. Bureau of Mines (McKinney and others, 1959, p. 6). These samples were taken by a Bureau of Mines reconnaissance field party, which spent the summer of 1943 in Alaska studying oil seeps.

Many gas and oil shows were found in the Simpson core tests. These all occur in the Seabee, in the Ninuluk and Seabee Formations, undifferentiated, or in the top of the Grandstand Formation. Table 8 includes all the shows noted by (a) the geologist or engineer at the test site, and by (b) the geologist at the Fairbanks laboratory where the cores were taken for analysis and description. No analyses were made in Fairbanks of the first 12 core tests. Table 9 is a list of the cuts from the later tests.

TABLE 7.—*Characteristics of Cape Simpson seepage samples obtained in 1943*

[Determined by U.S. Bur. Mines, Bartlesville, Okla.]

Oil seep	Original sample			Extracted material [1]			
	Specific gravity, 60°/60° F	Gravity, °API	Characteristics	Specific gravity, 60°/60° F	Gravity, °API	Characteristics	
						Color	Consistency
3			Black, semisolid	0.975	13.6	Black	Viscous.
1			do	.965	15.1	do	Do.
1			Brown, liquid	.949	17.6	do	Do.
2			Black, asphaltic	.941	18.9	do	Do.
2	0.937	19.5	Brownish-green liquid.	No extraction made			

[1] Mixture of benzene and chloroform was used as extraction solvent.

TABLE 8.—*Oil and gas shows, Simpson core tests*

[A, Noted by the U.S. Navy geologist at the test site; B, noted by the U.S. Geol. Survey Fairbanks laboratory]

Core test	Recorded by	Depth (feet)	Show
6	A	79–89	1 in. brown oil-saturated sand.
		109–119	6 in. brown oil-stained bleeding sand.
		119–129	1¼ ft brown oil-saturated sand. A little gas noticed in ditch before abandonment.
	B		No analyses.
8	A	60–70	2 in. sand saturated with brown to green-brown oil.
		70–80	1 ft good oil color, bleeding.
		80–90	Streaks with free oil, bleeding throughout.
		90–100	Good oil color, bleeding in spots.
		100–110	Good odor; bleeding in spots.
		110–120	Bleeding throughout, spots of saturation.
		120–130	Spots of free oil.
		130–140	Good oil color, some spots of free oil.
		140–150	Very good oil odor, bleeding.
		150–160	Good oil color throughout, bleeding in spots.
		160–170	Good oil color and odor.
		180–190	Slight oil odor and few streaks with oil color.
		200–210	Very slight oil odor.
		310–320	Brackish taste.
		560–570	Water bearing sand.
	B		No analyses.
9	A	40–50	Light-brown oil color on outside of core.
		60–70	Very slight light-brown oil color. No oil odor or taste.
		90–100	Good color and odor, bleeding oil.
		100–110	Slight show of oil.
		110–115	Slight show of light-brown oil.
	B		No analyses.
10	A	80–90	Light-yellow-brown oil along cleavage and fracture planes.
		90–100	Oil odor and color, bleeding core.
		100–110	Slight oil odor.
		310–320	Streaks with light-green oil.
		320–330	Light-green oil in streaks.
	B		No analyses.
13	A	609–617	Slight show oil.
		690–706	Ether cut.
		1,062–1,066	Gas and a little oil.
		1,075–1,079	Stringers of gas sand.
		1,093–1,098	Very little gas sand.
		1,138–1,148	Gas sand.
	B	599–604	Faint oil odor and stain.
		604–609	Do.
		609–617	Fair odor, slight stain.
		617–622	Faint odor and stain.
		617–622	Do.
		622–627	Slight odor.
		627–633	Slight oil odor and stain.
		633–640	Oil odor and stain.
		644–649	Fair oil odor and stain.
		663–673	Very faint oil odor and stain.
		690–696	Oil odor and stain.
		731–738	Slight oil stain and odor.
		738–744	Very faint oil odor.
		744–754	Mottled yellowish stain, faint odor.
		771–781	Fairly good oil stain, good odor.
		791–801	Slight odor and stain.
		930–950	Slight odor.
		950–971	Do.
		1,062–1,066	Slight stain, fair oil odor.
		1,066–1,075	Fair oil odor, faint stain.
		1,084–1,087	Fair oil stain and odor.
		1,113–1,118	Faint odor.
		1,118–1,125	Very faint odor.
14	A	316–326	Faint show gas and oil.
		395–465	Oil and gas showing in ditch.
		475–505	Gas and oil.
		535–540	Good show of gas and oil in ditch.
		565–605	Faint gas and oil show.
		605–615	Very faint gas and oil show.
	B	316–326	Fair odor.
		465–475	Fair oil odor.
		475–485	Fair oil stain and odor.
		485–495	Do.
		565–575	Very faint odor.
		575–585	Do.
		595–605	Faint odor.
		700–710	Do.
		845–855	Faint odor.
15	A	303–310	A little gas in sand.
		310–331	Sand streaks containing gas and oil.
		331–360	Fair gas and oil show.
			Oil globules appeared on the surface of the mud in the casing until the hole froze up.
	B	303–310	Faint oil odor.
		530–610	Scum of oil in cans of cutting samples received in the laboratory.
16	A	305	Show of gas.
		325	Do.
		492	Show of oil.
		492–498	Oil shale.
		525–527	Oil sand.
			This hole made gas intermittantly for more than a year.
	B	492–498	Faint oil odor.
		525–527	Very good oil stain and odor.
		539	Good oil odor.
17	A	530	Gas show below 530 ft.
		577–589	Oil sand.
		624	Straw-yellow cut.
	B	581–591	Good odor, good olive-green oil.
		624–628	Fair odor, slight stain.
24	A	605	Oil fluorescence, no odor or cut.
	B		No analyses.
25	A	905	Visible green showing of oil, good odor, some gas.
		1,123–1,129	Sand saturated with light-green oil, very small amount of gas bubbling from hole.
	B	835–843	Fair odor.
26	A	100	Few bubbles of gas on ditch.
		130	Slight show of oil on ditch.
		170	Good continuous flow of gas from hole. Shows of oil in all sands below 170 ft.
		300–306	Flow of oil suspended drilling; estimate 15 bbls in first hr, flow diminished as result of freezing to only a few gas bubbles in 48 hrs.
	B	170–180	Strong oil odor.
		180–190	Oil odor, oil stain.
		190–201	Fair to good odor and stain.
		263–274	Good odor and stain.
		306–317	Very good odor, stain.
27	A	278–291	Interbedded shale and sand showing oil.
		315–318	Faint odor, pale oil cut.
		324–325	Sand, saturated with oil.
	B	278–289	Oil stain.
		317	Faint oil odor.
		324	Good show oil.

TABLE 8.—*Oil and gas shows, Simpson core tests*—Continued

Core test	Recorded by	Depth (feet)	Show
29	A	283	Very pale ether cut.
		293–303	Good fluorescence, very pale ether cut.
		303–313	Do.
		313–323	Good fluorescence, very pale cut.
		323–333	Good fluorescence, pale cut.
		333–343	Fluorescence, very weak CCl_4 cut.
		343–354	Good fluorescence.
		354–365	Good fluorescence, very pale ether cut.
	B	293–303	Fair oil odor.
		303–313	Fair odor.
		313–323	Very faint odor.
		323–333	Fair odor.
		333–343	Fairly good oil odor.
		343–354	Fair odor.
		354–365	Do.
30	A	263–273	Good show oil.
		273–283	Do.
		283–293	Fair to good fluorescence, pale ether cut.
		293–303	Do.
		308–350	Good oil odor and stain, excellent fluorescence.
		408–419	Slight show gas.
		451–471	Fair show oil.
		584–590	Do.
		620–630	Slight to fair show oil.
		630–670	Slight show of oil. The drilling fluid contained much oil, and the oil shows are suggestive of core contamination. It is believed that the sands contain some oil but also considerable water (ice).
	B	266–273	Good odor.
		273–283	Oil stain and odor.
		303–313	Fair oil odor.
		318	Strong oil odor.
		323–333	Do.
		333–343	Do.
		343–353	Do.
		367–377	Faint oil odor.
		453–460	Good oil odor.
		460–471	Faint odor.
		620–630	Strong oil odor.
		630–640	Good oil odor.
		640–651	Fairly good odor.
		651–662	Olive-colored stain, fair odor.
		673–683	Very faint odor.
30A	A	310	Slight show oil on ditch.
		340	Show of gas.
		423	"Considerable gas," surge lasted 12 hr, mud weight was 76 lb per cu ft prior to surge.
	B	----------	No analyses.
31	A	196–208	Slightly oil soaked, fluorescent zones.
		307–318	Oil stained, strong odor, good fluorescence.
		318–329	Poor and spotty fluorescence, no odor.
		355	Flowed oil.
	B	307–318	Fair to very good stain, good odor.
		327	Very faint odor.
		331	Do.

TABLE 9.—*Cuts made with CCl_4 on Simpson core tests, in the Fairbanks laboratory*

Core test	Core	Depth (feet)	Cut	Residue
13	110	798	None	Very pale yellow.
	115	823	do	None.
	117	848	do	Do.
	128	947	do	Do.
	129	967	do	Do.
	143	1,066	Amber	Yellowish brown.
	144	1,070	Straw colored	Yellow.
	153	1,113	Pale straw colored	Very pale yellow.
	162	1,185	None	None.
14	5	309	do	Do.
	7	320	Straw colored	Pale yellow.
	8	468	Yellow	Brownish yellow.
	9	476	Amber	Yellowish brown.
	10	492	Yellow	Brownish yellow.
	11	496	do	Yellowish brown.
	13	572	None	Greasy film.
	14	577	Very pale straw colored	Very pale yellow.
	17	606	None	None.
	18	616	do	Do.
	19	707	do	Do.
	20	848	do	Do.
15	2	309	Pale straw colored	Pale yellow.
16	2	493	Yellow	Brownish yellow.
	3	527	Dark amber	Brown.
	4	539	Amber	Yellowish brown.
17	4	588	do	Do.
	5	624	do	Do.
	6	799	None	None.
25	34	839	Yellow	Brownish yellow.
	76	1,279	None	Slight greasy film.

TABLE 9.—*Cuts made with CCl_4 on Simpson core tests, in the Fairbanks laboratory*—Continued

Core test	Core	Depth (feet)	Cut	Residue
26	6	180	Brownish yellow	Yellowish brown.
	7	188	Yellow	Yellow.
	8	200	Brownish yellow	Yellowish brown.
	9	268	Yellowish brown	Brown.
	10	309	Deep amber	Brown oil.
29	24	308	Yellow	Brownish yellow.
	25	317	do	Do.
	26	325	do	Do.
	27	342	do	Do.
	28	348	do	Do.
	29	364	do	Do.
	31	381	None	Greasy film.
30	9	188	None	None.
	11	204	do	Do.
	17	265	Yellowish brown	Yellowish brown.
	18	279	Brownish yellow	Brown.
	22	318	Yellowish brown	Brown oil.
	23	326	Brown	Dark brown oil.
	24	340	Yellowish brown	Brown.
	25	345	Brownish yellow	Yellow brown
	27	376	Straw colored	Light yellow.
	34	455	Amber	Brown oil.
	35	468	Very pale straw colored	Very pale yellow.
	41	627	Yellowish brown	Brown oil.
	42	638	do	Do.
	43	646	Brownish yellow	Do.
	44	660	Yellow	Yellowish brown.
	45	665	None	Pale yellow.
	46	681	do	Do.
30A	1	688	do	Faint greasy film.
31	10	217	do	Greasy stain.
	12	236	do	Slightly yellow greasy stain.
	19	316	Brownish yellow	Brownish yellow.
	20	327	None	Slight greasy stain.
	21	331	do	Greasy stain.

Core tests 1–5, 7, 11, 12, 14A, 18–23, and Minga velocity test 1 had no shows. Samples of a sandstone from the Ninuluk and Seabee Formations, undifferentiated, cored in core tests 26 and 27, were tested for saturation (table 10).

TABLE 10.—*Saturation tests, Ninuluk-Seabee Formations undifferentiated, Simpson core tests 26 and 27*

Core test	Core	Depth (feet)	Petroleum (percent)	Basal sediment and water (percent)	Total (percent by volume)
26	10	310	25.0	16.4	41.4
	10	316	14.5	27.3	41.8
27	24	324	17.2	15.9	33.1

FORMATION AND PRODUCTION TESTS

Simpson core test 8.—After coring to 160 feet, the hole was bailed dry to 120 feet. The hole was allowed to stand open for 2 hours, but no oil accumulated except for a faint oil color on the mud.

Simpson core test 16.—When at the total depth of 800 feet, the hole was bailed down to 692 feet. A few gallons of oil were recovered. The hole was bailed again 6 hours later; 1 quart of mud and no oil was recovered. The hole made a small amount of gas, which ignited and burned for several days. The hole continued to make some gas for more than a year.

Simpson core test 26.—Upon reaching a depth of 306 feet, the well flowed at an estimated rate of 60 barrels of oil per day for 36 hours (that is, until the hole froze).

After the casing was set at 350 feet, the side of the hole was scratched from the bottom of the casing to 550 feet. The hole was bailed to 550 feet. The results of a 4-hour test showed that the well was producing 5 gallons of water and a trace of oil per hour. The casing was perforated with 144 shots from 289 to 325 feet. The well flowed oil through 210 feet of 2½-inch line pipe at an average rate of 110 barrels of oil per day, gravity 20° API, oil temperature 21° F, and casing pressure 47 psi. The well was shut in.

On a 13-day test made 5 months (end of March 1951) after the completion of drilling, the well produced at an average rate of 92 barrels of oil and 2,500–3,000 cu ft of gas per day. The bottom-hole pressure ranged from 195 to 215 psi, and the well-head pressure was about 25 psi. The oil temperature was 14°–17°F and the bottom-hole temperature 13.7°F.

The following is a summary of another production test made at the beginning of May 1951:

Type of flow	slug
Time of flow	116 hours
Total production	597 bbls per day [1]
Maximum rate of production	176 bbls per day
Mean rate of production	120 bbls per day
Weight of crude	21.6° API at 60°F
Formation pressure (static)	250 psig
Formation pressure (flowing)	155 psig
Temperature of crude	14°F
Basal sediment and water	negligible

[1] 48-gallon barrels.

The well was again shut in.

Simpson core test 27.—When the hole was at a depth of 380 feet, it was bailed to the bottom and was bailed every 3 hours for 24 hours. Oil was recovered at the rate of 3 barrels per day.

Simpson core test 30.—When the hole was at a depth of 350 feet, it was bailed dry and a 48-hour production test was run. The hole produced oil at the rate of about 6 barrels per day with a very small amount of gas.

Simpson core test 30A.—When the hole was at a depth of 350 feet, it was bailed dry and a 24-hour production test was run. Oil was bailed at the rate of 5 barrels per day. When the hole was at a depth of 423 feet, gas blew up to the top of the derrick but decreased considerably thereafter. When the hole was at a total depth of 701 feet, it was bailed to 365 feet, where the bailer stopped on an ice bridge. After reaming out, the hole was bailed to 701 feet. No oil came in and only a slight amount of gas.

Simpson core test 31.—While coring at 355 feet, the well began to flow oil. On a 65-hour test the well flowed an estimated 120–125 barrels of oil and 2,000–4,000 cu ft of gas per day. There was some difficulty in preventing the well and meters from freezing. After the well began to flow, the shut-in wellhead pressure was 60 psi and dropped to 0 psi when flowing. No actual gage was made on this well because it froze up and shut off the flow before gaging facilities could be installed. An Amerada bomb was stopped at only 5 feet below the casing head. If this well had been cased as was Simpson core test 26, it would probably be capable of producing 120–125 barrels per day. The oil from this well tested 21° API, and no water was indicated.

GAS AND OIL ANALYSES

The following results were obtained in analyses made by the National Bureau of Standards from a gas sample taken at a 395–400 foot depth in Simpson core test 14:

	Percent
Methane	98.4
Ethane	0.07
Propane	0.02
Nitrogen	1.40
Carbon dioxide	0.10
Total	99.99

Three samples of crude oil from Simpson core test 26 were tested (table 11).

TABLE 11.—*Crude-oil analyses from Simpson core test 26*

[Analyses by U.S. Bur. Mines, Bartlesville, Okla.]

Depth (feet)	300	300–306	289–325
Date sampled	Aug. 19, 1950	Aug. 19, 1950	Oct. 26, 1950
API gravity (in degrees)	19.5	21.0	20.7
Pour point (° F)		<5	<5
Saybolt viscosity at 100° F	1,020	480	
Color	Greenish black	Brownish green	Brownish green
Sulfur (percent)	.41	.40	.36
Gasoline and naphtha	.0	.0	.0
Kerosene distillate	.0	.0	.0
Gas oil	.5	19.2	16.9
Lubricating distillate	39.6	35.6	37.7
Residuum	48.6	44.9	44.7

A more detailed analysis of a crude sample from Simpson core test 31 at 354 feet made by the U.S. Bureau of Mines is given in table 12.

Simpson crude is less desirable than that found at Umiat (Collins, 1958) because it has a somewhat higher sulfur content and an API gravity of only 19.5°–21°. The viscosity is so high (480–1,020 sec. Saybolt at 100°F.) that it would require special treatment to ship through a pipeline. The pour point is less than plus 5°F, as there is no gasoline-naphtha content and very little gas oil; it contains a fair quantity of good lubrication stock.

The sample contained no gasoline. Inspection data on a 629°F diesel fuel prepared from the crude oil by the Bureau of Mines are tabulated in table 13.

TABLE 12.—*Crude-oil analysis from a depth of 354 feet, Simpson core test 31*

[Analyses by U.S. Bur. Mines, Bartlesville, Okla.]

[General characteristics of sample: Sp gr, 0.932; sulfur 0.44 percent; Saybolt Universal viscosity at 100°F, 670 sec; at 130°F, 290 sec. A.P.I. gravity, 20.3° Pour point (°F) here below 5 Color, green]

Distillation by Bureau of Mines routine method

Fraction	Cut at—		Percent	Sum (percent)	Specific gravity [1]	Gravity at 60°F	Correlation index	Aniline point, °C	Saybolt Universal viscosity 100°F	Cloud test, °F
	°C	°F								
Stage 1.—Distillation at atmospheric pressure, 749 mm Hg. First drop, 211°C (412°F).										
1	50	122								
2	75	167								
3	100	212								
4	125	257								
5	150	302								
6	175	347								
7	200	392								
8	225	437	1.5	1.5	0.864	32.3				
9	250	482	5.4	6.9	.881	29.1	57	59.8		
10	275	527	7.7	14.6	.892	27.1	58	60.4		
Stage 2.—Distillation continued at 40 mm Hg.										
11	200	392	3.2	17.8	0.907	24.5	61	61.3	49	Below 5
12	225	437	9.2	27.0	.914	23.3	60	62.2	63	Do.
13	250	482	8.1	35.1	.927	21.1	63		110	Do.
14	275	527	8.2	43.3	.931	20.5	62		225	Do.
15	300	572	8.7	52.0	.936	19.7	61		More than 400	Do.
Residuum [2]			47.4	99.4	.951	17.3				

[1] Specific gravity at 60°F, compared to water at 60°F.
[2] Carbon residue of residuum, 3.8 percent; carbon residue of crude, 1.8 percent.

Approximate summary

Constituent	Percent	Specific gravity	Gravity, °API	Viscosity
Total gasoline and naphtha				
Kerosene distillate				
Gas oil	21.8	0.893	27.0	
Nonviscous lubricating distillate	7.5	.913–.924	23.5–21.6	50–100
Medium lubricating distillate	8.2	.924–.930	21.6–20.7	100–500
Viscous lubricating distillate	14.5	.930–.939	20.7–19.2	Above 200
Residuum	47.4	.951	17.3	
Distillation loss	.6			

TABLE 13.—*Data on diesel fuel from Simpson crude oil, Simpson core test 31*

[Analysis by U.S. Bur. Mines, Bartlesville, Okla.]

Distillation (° F):	
Initial boiling temperature	446
Percent evaporated:	
5	484
10	496
20	509
30	522
40	535
50	550
60	563
70	576
80	587
90	598
95	621
End point	629
Gravity, specific	0.90
Gravity, API	25.7
Cetane number	35.5
Aniline point (° F)	140.4
Flash point (° F)	205
Viscosity (seconds Saybolt Universal at 100° F)	48
Viscosity (seconds Saybolt Universal at 77° F)	57
Sulfur (wt percent)	.087
Corrosion, copper strip	negative

The cetane number is rather low but a fuel of slightly higher cetane number can be obtained from the crude oil by making a fuel with a higher end point. The viscosity of such a fuel would be rather high as indicated by the viscosity of the 629° F end-point fuel, which exceeds the maximum viscosity of Navy Department Specification 7–0–2e. The high viscosity is attributable to the absence of low-boiling material and the resulting high initial boiling temperature of 446° F.

LOGISTICS

Transportation.—The first tractor train left the camp at Barrow for the Simpson area, 75 miles to the east, late in January 1945. The train consisted of three D–8 caterpillar tractors which pulled eight sleds each, and a weasel served to scout pressure cracks in the ice. Total travel time for the round trip was 110 hours. Two other trips were made in February; two or three tractors hauled four or five sleds, preceded by a tractor which bulldozed the trail and pulled four wanigans as well. These round trips, made almost entirely on ice, took 56 and 71 hours, respectively. A fourth even quicker trip was made in the middle of April, when a tractor pulled two core rigs (housed and mounted on sleds), one completely stocked galley, and a sled load of drill rods to the camp site, making the round trip in 50 hours. In all, 4,600 tons of supplies were brought to the area by tractor train. These supplies were used to drill Simpson core tests 1–12 in the summer of 1945.

Four years later, drilling began on the east side of the peninsula. Supplies for this group of holes (Simpson core tests 13 through 27, 29 through 31, and Minga velocity test 1) were also transported by tractor train and averaged a little less than 500 tons per hole. Core test 28, which was drilled with a larger rig, required 1,000 tons of material. Men and some perishable goods were brought from Barrow camp by light planes, which were mounted on floats in the summer and on skiis in the winter.

Personnel and housing.—The first 12 holes were drilled by Construction Battalion Detachment No. 1058 of the U.S. Navy. Housing for the group consisted of nine tents, which had wooden frames and floors and were 16 feet square; each was equipped with an oil heater. Food was prepared and served in two wanigans.

Crews of holes drilled in 1949 included two drillers, four drillers' helpers, one heavy-duty-equipment mechanic, one power-equipment operator, two cooks, and a petroleum engineer, who also acted as timekeeper, storekeeper, and first-aid man. A geologist was present at the drill site of all but the first two tests (core tests 13 and 14). A portable camp was used which consisted of sled-mounted wanigans and a Jamesway hut. The wanigans housed a powerplant and shop, utilities, a 1,200-gallon water supply, geologist's office, store and radio, mess hall, galley, and food storage. Two wanigans and the hut were used for sleeping quarters.

In 1950 and 1951 the personnel varied slightly. At every test except core test 28, a geologist, two drillers, four floormen, a heavy-duty-equipment mechanic, a bulldozer operator, and two cooks were employed. Core tests 25, 26, 29, and 30 had a petroleum engineer at the site and lacked a tool pusher, but the reverse was true at tests 27, 30–A, and 31. The latter three holes and core test 30 had a second bulldozer operator, and core test 31 had a derrickman. Temporary personnel, employed for special jobs, included a crane operator, rig builders, a carpenter, a storekeeper, and extra bulldozer operators, floormen, and derrickmen. Housing was similar to that used in 1949, except for the addition of two wanigans for pump and generator and another for sleeping.

Simpson core test 28, which had a bigger rig, needed a different crew. It consisted of a drilling foreman, petroleum engineer, and geologist as supervisory personnel, and two drillers, two derrickmen, six floormen, and two firemen in the rig crew. Two cooks, two bulldozer operators, and one oiler made up the rest of the permanent personnel. The camp consisted of buildings mounted on sleds. Wooden wanigans housed the geology office, the shop, the electrical control gear, a boiler, a generator, utilities, cementing materials, an oilfield warehouse, food storage, and a lavatory. Four Jamesway huts were used for sleeping and one each for a galley and mess hall. When the camp and rig were moved to the site, a crew of 12 men, including rig buiders, moved and set up the camp and rig.

Vehicles and heavy equipment.—The Construction Battalion used a Failing model 314 core rig, which had a Chrysler 6-cylinder model 108–503 motor and a Gardner-Denver 4- by 5-inch pump. A Caterpillar D–8 tractor was used for transportation.

Vehicles used in 1949 included a Caterpillar D–8 tractor, an International T–9 cherrypicker crane, an Athey wagon, and two weasels. In the next 2 years a second Athey wagon and Micheler go-devil sled were also used. Drilling equipment used by Arctic Contractors in 1949 and the two subsequent years (except for core test 28) included a Failing 1500–S drill rig, which had an automatic pulldown and a Gardner-Denver 4½- by 6-inch mud pump. An auxiliary Gardner-Denver 5- by 10-inch mud pump was run by a Caterpillar D–8800 engine. Two mud tanks having a total capacity of 1,200 gallons, enclosed and mounted on a Micheler sled, were used for most of the tests. Core tests 16 through 24, however, used mud pits blasted in the ground, to avoid having to set surface casing.

Core test 28 was drilled with Cardwell model H drawworks and an 87-foot Ideco derrick having a crown and finger. The drawworks was run with a Caterpillar D–8800 engine. Other equipment included two 7½- by 10-inch Gardner-Denver mud pumps, two Caterpillar D–13000 engines for the pumps, 4-inch Marlow pump, Kewanee 32-horsepower boiler with feed pump, 125-barrel mud tank, Baash-Ross traveling block, and Emsco AB–4 swivel, and a 17½-inch Ideal rotary table. Vehicles used around the drill site were two weasels, a

Northwest crane, a "cherry picker" crane, and a D–8 Caterpillar tractor with blade.

Fuel, lubricant, and water consumption—The fuel, lubricant, and water used for drilling core tests 13–31 and Minga velocity test 1 are shown in table 14; such data

TABLE 14.—*Fuel, lubricant, and water consumed (in gallons) in drilling the Simpson core tests on the east side of the peninsula*

Core test	Diesel (35 cetane)	Gasoline (80 octane)	Lubricating oil (No. 9170)	Water
13	512	1,597	40	39,600
14	635	837	31	20,100
14–A	38	45	1	700
15	327	348	12	5,000
16	166	220	8	4,600
17	284	335	16	4,500
18	424	502	19	13,400
19	260	337	11	8,000
20	245	235	11	7,500
21	650	690	31	15,000
22	428	423	17	7,500
23	824	618	18	11,000
24	424	265	11	5,000
25	926	1,437	15	30,000
26	742	1,587	32	41,000
27	13,717	[1] 2,693	203	70,000
[2] 28	4,100	[1] 225	55	200,000
29	189	[1] 954	13	34,000
30	1,802	[1] 1,749	26	36,000
30–A	585	[1] 518	13	17,000
31	4,187	[1] 1,113	106	14,500
Minga velocity test 1	315	365	6	11,200

[1] 72 octane.
[2] Simpson core test 28 also used 25 gallons of 9110 lubricating oil, 80 gallons of 9500 oil, 75 pounds of grease, and 35 pounds of thread lubricant.

are not available for core tests 1–12. Table 14 does not include any material used for heating the buildings, or other uses. Some minor quantities of lubricants, such as about 10 pounds of grease used in the first few wells, are not shown in the table, which is limited to items used throughout the drilling operations.

DRILLING OPERATIONS

FOUNDATIONS

Although it was difficult to travel over the tundra in the Simpson area in the summer because of the thawing permafrost, drilling conditions were good with an abundant water supply, level ground, and hard frozen foundation for the rig below the top 1-foot thawed zone. The author is not certain what type of rig foundation was used in drilling the first 12 core holes, but it probably was similar to that of the later holes in which the rig was skidded up on 12- by 12-inch timbers with a D–8 tractor using overwind on the winch. When conductor pipe was used, 24 inches of block was necessary; without it, 12 inches was sufficient. The pump house was placed on either 12- by 12-inch or 3- by 12-inch timbers, depending on the condition of the ground (fig. 57). The rest of the camp buildings were placed on scrap lumber to prevent their freezing in.

Minga velocity test 1 was set up on lake ice.

FIGURE 57.—Portable enclosed Failing drill rig and pump house at the site of Simpson core test 17.

The Cardwell rig with which Simpson core test 28 was drilled was unitized into two portable sections. The derrick-drawworks section was mounted on three sled-type runners. When set up at the test site, four prefabricated pedestals were installed under the four corners to lessen vibration. The four pedestals were set upon timber mats laid flush with the surface of the tundra. The cellar was walled with 3- by 12-inch timbers. The pump section, which was mounted on Athey tracks, was supported by timber mats under the tracks.

NOTES FROM DRILLING RECORDS

Simpson core test 1

[The following brief notes on the drilling operations were recorded by the Navy and by Arctic Contractors]

Depth (feet)	*Remarks*
35	Set 36 ft 7 in. of 4¼-in. outer diameter (3⅞-in. inner diameter, 5¼-in. outer diameter coupling) casing, the last 19 in. being driven into soft clay with the hydraulic on the rig. Packer screwed on for reverse circulation.
43	Casing seal broke loose permitting circulation outside of casing. The reverse-circulation method of coring would not work, so 2-ft section of casing was added and pressed in with the hydraulic to 38 ft. Casing seal broke again at 49 ft and at 55 ft.
67	Casing run to 67 ft partly by pressing in with the hydraulic machine.
71	Seal broke. Pulled casing. Difficult to keep hole reamed because of fine sand settling back in hole.
96	Ran casing but pulled again. Reran casing, Repulled casing.
116	Ran casing, spudding it through sand and gravel Could not retain seal. Constant running in and out of hole dept agitating formations and caused much caving. Hole abandoned.

Simpson core test 2

Depth (feet)	*Remarks*
76	Set 4½-in. outer diameter casing (3⅞-in. inner diameter, 5¼-in. outer diameter coupling), last 6 ft pushed with hydraulic. Before pushing casing in place a burlap packer was wire wrapped around casing below a coupling 7 ft down from top of casing. Packer outer diameter, 7 in. Packer soaked with water and allowed to freeze. Hooked up for reverse circulation.
226	Drill rods froze in hole, circulation ceased. Backed off at 37 ft and went in with a new drill string along side of stuck string to bottom, hoping to free fish by circulation. Went in with overshot but was unable to free fish. Hole abandoned.

Simpson core test 3

67	Set 4½-in. outer diameter casing (3⅞-in. inner diameter, 5¼-in. outer diameter coupling), placing two wire-wrapped packers at the top. Seal did not hold. No cement was available for cementing the casing.
368	Was necessary to ream ice from hole constantly. Ice shavings would clog pump. Bit and three joints (which were external flush) slipped through the slips and down the hole. 3¾-in. overshot would not pass through ice-encrusted hole, Reamed and finally reached fish with overshot but were unable to recover. Casing circulated loose and hole abandoned.

Simpson core test 4

61	Set 4½-in. outer diameter (3⅞-in. inner diameter, 5¼-in. outer diameter couplings) casing. Two runs made before casing would go to bottom.
151	Casing pulled and hole abandoned.

Simpson core test 5

No casing was set. No unusual conditions were reported by the driller.

Simpson core test 6

No casing was set. Core hole 6 was abandoned from fear of a possible blowout from the oil zone found. Some gas was seen in the mud returns. No well-control equipment was available.

Simpson core test 7

Coring time increased with depth. Point was reached where upper part of hole iced in above the bit before bottom of hole could be reamed. Several times it was necessary to rotate out of hole. By the time the bit was rotated out, the hole below had refrozen. Ice shavings clogged the pump. Worst freezing seemed to be between 12 and 160 ft. Hole was abandoned at 532 ft as it became too dangerous to try to pull through the tight place formed by an ice bridge at 332 ft.

Simpson core test 8

Depth (feet)	*Remarks*
	This hole was spudded in on July 27 and it was not until August 1 that ice began to give trouble. Core test 8 was abandoned at 580 ft due to hazardous drilling conditions.

Simpson core test 9

Ice formed so badly in the hole that the mud pit and drilling mud became largely flaked ice. After cutting core 17 from 310 to 320 ft it was found that the bottom five joints and core barrel were filled with solid ice. Circulation was practically shut off by ice and the hole was abandoned. This hole had more trouble with icing than any one drilled up to that point.

Simpson core test 10

The hole was virtually ice free to a depth of 400 ft and drilling conditions were excellent. As coring continued ice began showing in the drilling mud and the hole was abandoned at 500 ft when further work seemed unduly hazardous.

Simpson core test 11

Ice was not found much lower than 50 ft. It was reamed once and ceased to give further trouble.

Simpson core test 12

Ice was a serious problem right from the surface in the drilling. Ice formed in considerable quantities in the drilling mud throughout the operations. The hole was abandoned at 460 ft because of icing.

Simpson core test 13

20	Cemented 25 ft., 8 in. of 8⅝ in. casing with two sacks of Portland cement.
563	Ice in well to this depth necessitated frequent reaming. Mud was heated to prevent formation of ice on the walls of the hole.
824	Continued to heat mud.
1,188	Continued to heat mud.
1,212	Lost circulation, shut down 73½ hr waiting for mud materials.
1,307	Lost circulation again, mixed mud of high viscosity.
1,438	Total depth. Hole left full of rotary mud. Thermistor cables were installed to depths of 500 and 1,438 ft. Top of 8⅝ in. casing is 6 in. above ground level.

Simpson core test 14

20	Cemented 8⅝ in. casing with two sacks of Portland cement.
36	Mud returned to surface between casing and ground. Recemented with 2 sacks of cement and 30 gunny sacks. Did not plug leak. Pulled the 8⅝ in. casing and reran to 32 ft using eight sacks of Portland cement.

Simpson core test 14—Continued

Depth (feet)	*Remarks*
1,195	Dropped slip in hole. Sidetracked successsfully.
1,270	Bit hit lost slip while reaming at 1,082 ft. Drove to 1,214 ft. Unable to recover fish. Hole abandoned. Hole was left open and full of rotary mud. Top of casing is at ground level.

Simpson core test 14A

No casing set. Completed at 290 ft. Uncased hole left full of rotary mud.

Simpson core test 15

23	Cemented 18 ft of 8⅝ in. outer diameter casing with 3½ sacks of Portland cement.
900	Hole left full of rotary mud. 8⅝ in. casing open at top and projects 8 in. above ground level.

Simpson core test 16

No casing set.

800	Gas ignited accidentally on Aug. 31, 1949. Pumped 600 gal water into hole but most of it blew out. Equipment moved. Melting of ice and sloughing around hole made funnel-shaped cavity 25 ft in diameter. Flame went out Sept. 2, 1949, although gas was still flowing (fig. 13). Water in hole was allowed to freeze, but the gas continued to flow.

Simpson core test 17

No casing set.
Completed at 1,100 ft. Hole was left full of drilling mud.

Simpson core test 18

No casing set.
Completed at 1,458 ft. Hole was left full of drilling mud.

Simpson core test 19

No casing set.
Completed at 1,061 ft. Hole was left filled with drilling mud.

Simpson core test 20

When moving rig to site of core test 20, the kelly jarred off its block, fell through the drain hole and was bent 70° by dragging. Cut kelly in two places with oxyacetylene torch and removed it. Had to wait for new kelly before drilling.
No casing set.
Completed at 1,002 ft. Hole was left filled with drilling mud.

Simpson core test 21

No casing set.

975	Rotary hose split. Repaired hose but could not drill because repaired hose too short. Installed new hose.
1,502	Hole was left full of drilling fluid and thermistor cables were installed to depths of 650 and 1,200 ft.

Simpson core test 22

Depth (feet)	*Remarks*
	No casing set.
200	Cleaned ice from suction hose and pump.
903	Total depth. Hole was left filled with drilling mud.

Simpson core test 23

No casing set.

120	Reamed ice above 100 ft.
1,035	Total depth. Hole left filled with drilling mud.

Simpson core test 24

No casing set.

108	Low rate of mud circulation and −10°F. Temperature and 50 mph wind caused mud pit to freeze solid. Drilling stopped while thawing pit with prospect boiler.
901	Total depth. Hole left filled with drilling mud.

Simpson core test 25

590	Low rate of mud circulation while coring allowed mud to freeze on hole walls, necessitating reaming from the surface to keep the desired hole diameter.
916	Below 800 ft mud warmed up from 32° to 33° F., and thawed and enlarged top of hole. Installed surface casing to prevent further enlargement, but mud returned outside the casing. It was removed, and 8-in. pipe laid from the top of the hole to the mud ditch, which served to confine the flow.
969	Dropped ball peen hammer in hole while removing core bit, which stuck core barrel in hole and broke sandline while trying to get hammer out. Recovered sandline and core barrel.
	Spent 4½ days repairing drawworks engine. After reaming and cleaning out ice, mud froze on walls and made it difficult to get bit out of hole.
972	Homemade junk basket did not recover hammer, which was apparently sidetracked, as it caused no difficulty and no trace of it was found.
1,510	Total depth. Hole left filled with drilling mud.

Simpson core test 26

306	Hole flowed oil which filled mud pit and covered area around rig with about a foot of fluffy gas-cut oil. Mud in pipe was partly frozen, and fairly large ice crystals were present in the oil. Oil flow decreased as hole froze. After reaming the hole to 295 ft, heavy (95-lb) mud killed the well for an hour, but it then began to flow again. Drilling was shut down 7 days while installing cementing equipment, and repairing rig engine. Thirty-five barrels of 106-lb mud was pumped in but the well continued to flow some gas-cut oil. When gas and oil mixed with and lightened the mud, the flow increased. The pump could not circulate gas and oil cut mud properly, and as circulation got bad the hole started to freeze. After reaming, the hole was drilled deeper.
509	The hole flowed oil during drilling, and 90-lb mud was pumped into it.

Simpson core test 26—Continued

Depth (feet)	Remarks
887	The drill pipe parted at 634 ft, just below a tool joint, but the fish was recovered in 12 hr.
895	The drill pipe twisted off at 652 ft, and the drill collar and 22 joints of pipe were not recovered in 37 hr of fishing. Ice was reamed from the surface preparatory to setting casing, but the hole continued to freeze and made it difficult to pull the tools out. After rereaming to 350 ft (water was used in all reaming operations, and oil continued to flow from the hole), 70 bbl of heavy mud was pumped in.
	No heavy mud returned, but the oil flow ceased. Set 33 joints of 8⅝-in., 29-lb casing at 350 ft, with 110 sacks of Cal-Seal. Two days later the space around the top of the hole was filled in with a mixture of five sacks of Cal-Seal and five sacks of cement. Oil and gas continued to contaminate new mud made with Aquagel, so the mud pit was cleaned out and more mud mixed.
913	The hole was reamed to 895 ft and drilled to 913 ft without finding the top of the fish at 652 ft.
1,090	Nearly 3 days were spent circulating with the bottom of the pipe near the top of the fish, without locating it or washing it loose.
1,171	Drill pipe twisted off at 780 ft, and 4 days of fishing did not recover the drill collar and 36 joints of pipe. The wall hook and four joints of pipe came unscrewed and could not be recovered. The hole began to freeze, and ice was reamed from the surface to 442 ft. The following day the rig and pump house were moved from the site with some difficulty caused by their being partly frozen in. The rig site was bulldozed flat and the rig replaced and raised 26 in. to permit clearance over well-head connections.
	After reaming ice from the surface to 370 ft, the hole was alternately bailed and reamed of ice, producing a little water and a trace of oil. Perforating of casing was delayed for 2 weeks by bad weather, which prohibited air transportation of necessary equipment. After perforating (described in more detail on p. 716) a tubing head was installed and the well was shut in.

Simpson core test 27

102	Cemented 10 joints of 8⅝-in., 24-lb casing at 102 ft with 430 sacks of Portland cement treated with 750 lb of calcium chloride.
325	Replaced drilling mud with 10 bbl of crude oil from Simpson core test 26 and 5 bbl of diesel fuel. Drilling fluid temperature was 28°F, and flow lines often clogged from water, mud, and paraffin in the fluid.
380	After a bailing test, 7 bbl of crude oil and 3 bbl of diesel fuel were added to maintain viscosity.
661	Displaced oil in hole with water-base mud.
961	Shut down 24 hr waiting for water; blizzard with high winds made the 20-mile round trip for water hazardous.
1,320	Bearing in drawworks engine burned out; mud was circulated 4 days while waiting for parts and overhauling engine. Drill pipe stuck, and two front derrick legs collapsed below the 4-ft extension while attempting to free pipe. After

Simpson core test 27—Continued

Depth (feet)	Remarks
	2 days spent installing a new derrick and circulating and working the pipe, the drilling mud was replaced with 73 bbl of crude oil and 23 bbl of diesel oil and the pipe was worked free.
1,490	Total depth. The hole was left filled with drilling mud; the top of the open casing 6 in. above the ground.

Simpson core test 28

110	Two attempts to set casing at 110 ft failed because it stuck at 90 ft each time; after reaming the hole from 17½ to 20 in., between 90 and 110 ft, four joints of 13⅜-in.-54.5 lb-range 2-T and C-8-round-thread casing was set at 110 ft. The two middle joints were jacketed with 16¾-in. Western Pipe and Steel welded ⅜-in. plate casing. Cement was 100 sacks of Cal-Seal and 75 cu ft of water.
2,505	Total depth. Installed five thermistor cables (to 196, 616, 956, 1,191, and 2,416 ft) in base plate 16 ft below kelly bushing.

Simpson core test 29

283	Mud temperature, which was quite variable, was unusually high part of the time and prevented the hole from freezing up. After waiting 2 days for cement and reaming the hole, 8⅝-in. 28-lb casing was set at 152 ft with 50 sacks of Cal-Seal.
503	Core barrel with lifting plug on top dropped in hole to 212 ft and was recovered after 2½ days of fishing.
700	While waiting for electric logging engineer, hole froze and had to be reamed open. After pulling the casing out, two thermistor cables were installed, to 250 and 700 ft, and the hole left filled with drilling mud.

Simpson core test 30

283	After waiting 6 days for cement, the hole was reamed free of ice and 8⅝-in. 28-lb casing was set at 150 ft with 63 sacks of Cal-Seal. The hole was bailed to the bottom of the casing to prevent freezing, while the cement set.
429	Ice formed in the hole and had to be reamed out several times. Spent 2½ days freeing drill pipe stuck at 80 ft because of a loose double, jammed between drill collar and casing.
630	Ice continued to make the hole tight, in spite of intermittent heating of the mud.
693	Twisted off drill pipe at 300 ft, leaving core barrel and drill pipe in hole. Fished 2 days, circulated mud 6½ days waiting for tools from Barrow camp. Set plug of six sacks of Cal-Seal at 285–315 ft and drilled past fish, but the bit followed the old hole and would not drill past the fish at 388 ft. Mixed 12 sacks of Cal-Seal but cement flash-set in mixing tank and pump. Spent 6 days circulating, while cleaning and repairing pumps. Attempts to whipstock were unsuccessful because the bit hit the fish, and the hole was abandoned. Open casing projects 6 in. above ground level, and the hole is filled with drilling mud.

Simpson core test 30–A

Depth (feet)	*Remarks*
423	Gas blew most of the drilling fluid out of the hole. After reaming, 100 ft of 8⅝-in. 28-lb casing was set at 100 ft with 25 sacks of Portland cement treated with 5 percent calcium chloride.
701	Ice necessitated reaming. Hole was abandoned after making electric log.

Simpson core test 31

101	Set 8⅝-in. casing at 101 ft with 26 sacks Cal-Seal.
186	Spent 4 days overhauling rig.
355	Well started flowing oil while coring at 355 ft, and after flowing 18 hr well was shut in to prepare for production test.

Minga velocity test 1

27	Set two 15-ft joints of 8⅝-in. casing through 4½ ft of ice and 2 ft of water, with four sacks of construction cement.
891	Lost circulation but regained it with Aquagel-Fibertex mud.
1,233	Total depth. Hole abandoned and site cleared of large pieces of metal and wood to prevent fouling floats of seaplanes during the summer. Top of casing was 5 ft below ice with rubber hose extension to house thermistor cable terminals. After the ice went out, the hose was missing and had probably been pulled away by the ice.

CORE AND DRILL BITS

Core tests 1 through 12 were drilled with fish tail bits 3⅞, 4½, or 5⅞ inches in diameter (except for the first 150 ft of core test 7, which was reamed with a 7⅞-in. bit). Coring was done with 3-inch bits and conventional core barrels.

Footage drilled in 1949 (core tests 13 through 24) totalled 13,661 feet, of which 2,103 feet was cored. Coring was done with Reed hard-formation bits and 24 Reed soft-formation bits, which have a diameter of 5⅞ inches. Core recovery was 87.6 percent for the hard-formation bits, which did slightly less than half of the coring and 76.3 percent for the others. In 1950 and 1951, 2,679 feet of cores were taken by the same bit types but using a much larger proprotion of hard-formation bits, (24 of them, which did nearly 95 percent of the coring, and 7 soft-formation bits) which resulted in greater core recovery, an average of 85.6 percent of the rock.

Thirty-one 5⅞-inch Reed T drill bits and a few bits of other types ranging in size from 5⅞ to 10⅝ inches were used in 1949. In 1950 and 1951, sixteen 6⅛-inch Hughes OSQ–2 bits did most of the drilling, and the other 16 bits used, which were of various types and sizes (from 12½ to 5⅞ in. in diameter) made only a quarter of the 7,863 feet drilled. Both core and drill bits reamed a great deal of ice from the holes, 3,676 feet of it in core tests 13–24 alone.

Eight bits, ranging from the 20-inch Security hole opener to four 9⅝-inch Security OB–1 bits, were used in Simpson core test 28. The 107 feet of cores from the test were taken with two 7⅝-inch Reed wire-line hard-formation core bits, which recovered 84.1 percent of the rock. Four feet was recovered from one additional 6-foot core, which was taken with a conventional 6¼-inch Reed bit.

Core and drill bits used in the tests are shown in detail in the graphic logs, plates 1–3.

DRILLING MUD

Except for core test 1, all the holes made good mud naturally, and very little material had to be added. Baroid was used in core test 1, and in core tests 13 and 14, tundra moss and Aquagel were mixed in to regain circulation. In core test 26, heavy Baroid-Aquagel mud was tried, unsuccessfully, in an attempt to stop the flow of oil. Oil was used as drilling fluid from 327 to 641 feet in core test 27, to prevent sealing off any possible oil-producing beds, but no oil was produced.

Particles of ice in the mud, particularly in the mud pit, caused trouble in most of the first 12 holes. Particles too fine to strain out clogged the pumps. In drilling the later wells, steam was intermittently injected into mud pits to prevent freezing.

Table 15 gives details of mud properties of core tests 13 through 31, and Minga velocity test.

TABLE 15.—*Drilling-mud characteristics in Simpson core tests 13 through 31 and Minga velocity test 1*

Core test	Depth (feet)	Weight (lb per cu ft)	Viscosity (sec API)	Temperature (°F)	Remarks and additives
13	20–84				3½ sacks Aquagel.
	84–201	71	39		
	201–563	71–76	38–45	33–45	Heated to prevent ice forming; added slight amount Stabilite–8.
	563–824	76–79	36–46	32–44	Heated.
	824–1,036	75–79	39–45	32–43	Made new mud with 6 sacks Aquagel.
	1,036–1,188	75–83	41–48	33–40	Temperature mostly 34°; added 5 lb Stabilite–8; used 3 sacks Aquagel in new mud.
	1,188–1,307	82–70	54–40	40–34	Lost circulation twice; 32 sacks Aquagel, 27 lb Stabilite–8, 7 cu yd local clay, tundra moss added to regain circulation.
	1,307–1,438	73–76	47–54	40–42	8 lb Stabilite–8.
14	0–143	71	34–36	34–36	1 sack Aquagel.
	143–615	74–84	39–46	38–45	1 sack Aquagel, 13 sacks Baroid, 31 lb Stabilite–8. Heated mud 1½ hr.
	615–1,218	81–84	43–50	35–40	2 sacks Aquagel, 24 lb Stabilite–8.
	1,218–1,270	70–85	35–50	32–40	Lost circulation, regained it with 18 sacks Aquagel, 3 cu yd clay, tundra moss.
14–A	0–290	75–78	41–47	32–39	
15	0–718				3 sacks Aquagel, 50 lb Stabilite–8.
	718–900	75–77	40–46	34–35	6 lb Stabilite–8.
16	0–733	74–78	36–41	33–37	14 lb Stabilite–8.
	733–800	74–76	36–41	33–37	
17	0–659	71–79	37–41	33–35	14 lb Stabilite–8.
	659–1,100	76–79	41–44	34–36	25 lb Stabilite–8.
18	0–360	71–72	36–44	34–35	5 sacks Aquagel, 25 lb Stabilite–8.
	360–1,224	74–81	38–43	35–39	77 lb Stabilite–8, 10 lb tetrasodium pyrophosphate.
	1,224–1,458	72–80	42–44	38–39	
19	0–572	70–78	39–44	36–38	10 lb Stabilite–8.
	572–1,061	78–80	40–47	38	
20	0–862	70–82	36–48	32–37	29 lb Stabilite–8.
	862–1,002	82	41–42	37–39	10 lb Stabilite–8.
21	0–562	70–75	38–40	32–35	
	562–1,270	78–80	38–42	32	5 lb tetrasodium pyrophosphate.
	1,270–1,502	80–82	43–49	32–34	
22	0–320	72–74	41–42	32	5 lb tetrasodium pyrophosphate.
	320–903	75–81	41–45	33–35	27 lb tetrasodium pyrophosphate.

TABLE 15.—*Drilling-mud characteristics in Simpson core tests 13 through 31 and Minga velocity test 1*—Continued

Core test	Depth (feet)	Weight (lb per cu ft)	Viscosity (sec API)	Temperature (°F)	Remarks and additives
23	0–718	68–76	34–41	32	1 sack Aquagel, 8 lb tetrasodium pyrophosphate.
	718–1,035	75–77	42–43	33–34	
24	0–901	64–83	34–46	32–34	8 lb Stabilite-8.
25	0–602	70–80	39–60	32	
	602–916	70–79	39–45	32–33	Temp 32° above 800 ft, 33° below 800 ft.
	916–969	70–72	37–40	33	
	969–1,097	69–74	34–38	32	1 sack Aquagel.
	1,097–1,360	73–79	37–46	32–40	
	1,360–1,510	72–78	34–46	40–43	
26	0–306	68–95	33–75	32–40	Mud froze in hole; 88 sacks Baroid, 11 sacks Aquagel, 50 lb tetrasodium pyrophosphate.
	306	105	45	38	New heavy mud of 6 sacks Aquagel, 122 sacks Baroid.
	306–860				Used water for drilling mud, but put in 90-lb 46 Marsh funnel second mud to kill well before running electric log; well not killed.
	860–895				Used water for drilling; used 108-lb 50-Marsh funnel second 34° F mud when cementing casing. Used 203 sacks Baroid, 15 sacks Aquagel.
	895–913	64–78	36–55	32–39	50 sacks Baroid in killing well; 15 sacks Aquagel in drilling.
	913–1,171	69–79	36–44	34–39	
	1,171				Put 500 bbl salt water, 14 bbl fresh water in hole to displace mud from 350 to 650 ft. Used water for reaming, and returns consisted of ice chips.
27	0–115				Temperature kept above freezing by putting steam in mud tanks.
	115–380	65–77	37–60	32–42	10 bbl crude oil, 5 bbl diesel fuel, used as drilling fluid below 325 ft.
	380–641				Oil used as drilling fluid.
	641–961				Oil displaced with drilling mud.
	961–1,320	68–71	45–48	37–42	
	1,320–1,385				8 sacks Aquagel added to clean out sand from hole. Mud displaced by 73 bbl crude oil and 23 bbl diesel to free stuck drill pipe.
	1,385–1,500				Oil was replaced by mud again gradually, but some oil remained in hole on completion.
28	515	75	35		
	687	71	32	40	
	917	71	36	42	7.8 cc per 30 min filtration loss.
	1,088	71	34	42	7.5 cc per 30 min filtration loss.
	1,125	72	34	42	
	1,250	72	34	44	
	1,283	73	37	44	
	1,382	73	34	44	7 cc per 30 min filtration loss.
	1,490	75	34	46	7 cc per 30 min filtration loss.
	1,570	76	36	46	7 cc per 30 min filtration loss.
	1,605	74	35	46	
	1,704	76	35	46	6.5 cc per 30 min filtration loss.
	1,915	74	34	46	6.5 cc per 30 min filtration loss.
	1,965	76	35	45	6 cc per 30 min filtration loss.
	2,030	79	40	45	
	2,212	78	37	45	6.5 cc per 30 min filtration loss.
	2,240	79	37	48	7 cc per 30 min filtration loss.
	2,312	79	40	48	
	2,345	78	37	50	6.5 cc per 30 min filtration loss.
	2,445	78	35	49	
	2,475	77	36	48	6.5 cc per 30 min filtration loss.
	2,127–2,505				9 sacks Aquagel.
29	0–283	66–80	36–55	32–43	
	283–303	75–79	38–45	30–32	400 lb salt.
	303–648	70–76	38–48	32–33	
	648–700	68–74	38–49	30–32	500 lb salt.
30	0–283	69–74	39–47	32–36	
	283–303	71–72	39–41	32	
	303–429	65–69	36–42	32	
	429–630	67–68	37–45	32–36	Mud heated with prospect boiler for 49 hr during week.
	630–693	67–69	40–53	32–45	Mud heated frequently.
	693	65–67	37–38	35–37	Mud heated with fire pots.
30-A	0–423	66–78	38–63	32–38	800 lb salt added, to drill through oil sand, 300 lb in clear water to wash oil sand; 18 sacks Baroid. Mud heated with fire pots.
	423–701	64–82	40–53	32–34	65 sacks Baroid, 18 sacks salt.
31	0–186	70	35–44	40	
	186–355				25 lb tetrasodium pyrophosphate.
Minga velocity test 1	0–76	85	40	32	2 sacks Aquagel.
	76–1,233	79	40	37	Lost circulation at 891 ft and mixed 40 bbl new mud, using 22 sacks Aquagel, 40 lb Fibertex, 175 lb tetrasodium pyrophosphate, 25 lb Stabilite-8; regained circulation.

HOLE-DEVIATION RECORD

All the holes except core test 28 were too shallow to need deviation surveys. In 2,505-foot core test 28, deviation as measured by a Totco (Technical Oil Tool Co.) recorder was variable but was always less than 1° except at 917 feet where it was 1°55′. Measurements are shown on the graphic log of the test (pl. 46).

ELECTRIC LOGGING

The first electric log made in the Simpson core tests was run in core test 7, but it, as well as logs run in tests 8 and 10, was unsuccessful because of mechanical difficulties. A Schlumberger electric log was also made in core test 11 and is shown on the graphic log (pl. 44). No logs were attempted in the other early core tests.

In Simpson core test 13, manually operated Schlumberger equipment that had a shop-made reel and makeshift cable recorded an adequate log, but the equipment was hard to handle. It was replaced by a Widco (Well Instrument Development Co.) Logger, which was used, with few exceptions, on the other core tests. Core test 28 was logged by Schlumberger Well Surveying Corp.; core test 30 was abandoned because of a fishing job that prevented making an electric log; and no attempt was made to get an electric log of core test 31. Widco equipment logs total resistance and the quality of the log is improved by having surface casing (as in tests 13–15) or a piece of drill pipe suspended in the upper part of the hole (as in core tests 22–24). Holes 16 through 21 had no metal in the hole and have less distinctive curves than the others.

VELOCITY SURVEY

Minga velocity test 1 was drilled to check the effect of permafrost variations on seismic velocities. Average vertical velocity from the surface to 900 feet measured 6,000 fps (feet per second) in Minga velocity test, although a typical average velocity in frozen ground is at least 8,400 fps. The velocity survey suggests, therefore, that an apparent seismic "low" under the lake, which has 300 feet of relief, is the result of lower velocities in lake-covered areas lacking permafrost, compared to adjacent land areas, which are frozen to a depth approximating a thousand feet.

TEMPERATURE SURVEY

After Simpson core test 11 was completed and the electric log made, fluid was bailed down to a bridge at 125 feet and Meade and Northrop electrical resistance thermometers belonging to the National Bureau of

Standards were installed in the hole. Fifteen hours later readings were as follows:

Depth (feet)	Temperature (° F)
Surface	34
10	32
25	25
50	26
75	25
100	23
110	27
120	30

Twenty-four hours later one element, left in the hole at 100 feet, recorded 22° F, indicating that the hole had not returned to equilibrium at the time the first readings were taken.

TEMPERATURE-MEASUREMENT STUDIES

By Max C. Brewer

SIMPSON CORE TEST 13

Simpson core test 13, approximately 55 miles southeast of Barrow camp, is uncased except for about 20 feet of near-surface conductor pipe. It was left full of drilling mud and water on July 20, 1949. The first deep thermistor cables penetrating through permafrost in NPR–4 were installed the following day, about 12 hours after the completion of drilling. Two cables that had 51 thermistors positioned at various depths between 3 and 1,430 feet were used in this installation. Readings were made infrequently until May 1953; no readings have been obtained since that date.

The breaks in the insulation of the cables caused by the insertion of thermistors were taped rather than vulcanized. Some of the taped seals at the greater depths were breached after installation and the resulting moisture contamination made some readings of no value. These were isolated, and did not interfere with the interpretation of the thermal data from this well.

Simpson core test 13 is a relatively shallow well and was drilled in a short time, so there was a relatively small amount of heat exchange in the surrounding rocks and a rapid return to a condition of approximate thermal equilibrium. Measurements made in April 1951 and May 1953, 2 and 4 years after drilling, showed a maximum cooling of 0.01°–0.07°C at all depths between 70 feet (below depth of measureable seasonal change) and 490 feet (maximum depth to which the thermistors were completely free of moisture contamination). The geothermal profile for this well on May 23, 1953, which is thought to approximate the equilibrium geothermal profile, is shown as plate 50.

The minimum temperature recorded below the depth of annual change was −9.87°C at 120 feet. This is within 0.1°C of the minimum temperatures measured at Simpson core tests 21, 28, 29, and South Barrow test well 3, all within 8 miles of the Arctic coast.

The depth of permafrost (temperature continuously below 0°C) at this well is 1,050 feet. Slightly erratic readings, perhaps due to moisture contamination at 632 feet and greater depths, suggest the possibility that not all the sedimentary rocks between 632 feet and 1,050 feet are frozen even though classed as permafrost by definition. Indications of unfrozen zones despite subfreezing temperatures have also been found within the permafrost near Barrow and at Umiat.

The inverse geothermal gradient at Simpson core test 13 is approximately 85 feet per degree centigrade from 200 to 632 feet and 95 feet per degree centigrade from 632 to 1,232 feet. These gradients are of the same order of magnitude as those found in other areas of Cape Simpson and near the coast at Barrow, which are influenced by the Arctic Ocean but are somewhat lower than the inverse geothermal gradients found in other permafrost areas in Alaska such as inland from Barrow and at Umiat.

SIMPSON CORE TEST 21

Simpson core test 21, approximately 55 miles southeast of Barrow Camp, is uncased except for a short section of surface pipe and was left full of drilling mud and water on October 27, 1949. Two cables, the longest reaching to a depth of 1,200 feet, were installed after the drilling and electric-logging operations were completed. Temperature measurements were made at irregular intervals until May 1953.

Leakage into, and the subsequent contamination of, the bottom thermistors by moisture became apparent after the cables had been in place for approximately a month, so it was impossible to determine the exact depth of the "defined bottom" of permafrost (0°C isotherm). A short extrapolation of the curve from depths unaffected by moisture contamination of the thermistors (0–650 ft) indicates, however, that the depth of permafrost is approximately 820 feet at this site. This extrapolation seems justified because of the similarity in shape of the thermal profiles to those in other wells in this area and other parts of NPR–4. Measurements before thermal equilibrium was approximated, except at the deeper positions in this 1,500-foot well, also indicate that the extrapolation of the curve from 650 feet to and deeper than 820 feet is justified.

The contamination of the thermistors in the lower cable indicates that the ground may be actually frozen only to a depth of approximately 650 feet. Otherwise the thermistors in the upper cables might also show the effects of contamination.

Because Simpson core test 21 is a relatively shallow well and was drilled in a short time, there was a relative-

ly small amount of heat exchange and the surrounding sedimentary rocks could rapidly return to a condition of approximate thermal equilibrium. Measurements made in April 1951 and May 1953, 1½ and 3½ years after drilling, showed an average cooling of less than 0.05°C at depths between 70 feet (below depth of measurable seasonal change) and 650 feet (maximum depth at which the thermistors were free of moisture contamination). The geothermal profile for 0–650 feet on May 22, 1953, combined with data for 700–1,200 feet on April 9, 1951, is thought to approximate the equilibrium profile, (pl. 50).

The minimum temperature recorded below the depth of annual change was −9.90°C at 100 feet. This is within 0.1°C of the minimum temperatures measured at Simpson core tests 13, 28, 29 and South Barrow test well 3, all of which are within 8 miles of the Arctic coast.

The depth of permafrost (temperature continuously below 0°C) at this well site is approximately 820 feet. The most probable explanation of the unusually thin layer of permafrost in this area is that the temperatures at depth are being influenced by nearby bodies of water. The most important of these are two lakes: one, 0.4 of a mile by 1.0 mile, within 1,000 feet of the well, and the second, about 2,500 feet in diameter, within about 1,700 feet of the well.

The inverse geothermal gradient at Simpson core test 21 is approximately 70 feet per degree centigrade from 200 to 1,200 feet. There is some indication that this inverse gradient decreases slightly with increasing depth. These gradients are lower than those found in other area of Cape Simpson and in other permafrost areas in Alaska such as Barrow and Umiat. The low inverse geothermal gradient, however, can be attributed to the influence of the nearby lakes.

SIMPSON CORE TEST 28

Simpson core test 28, approximately 55 miles southeast of Barrow Camp, is uncased except for 110 feet of surface casing. It was drilled to a total depth of 2,505 feet in 14 days after setting the surface casing and was left full of light-weight natural mud on September 21, 1950. Five heavy-duty thermal cables containing a total of 85 thermistors positioned at depths from 5 to 2,398 feet were installed the following morning. Readings were obtained at irregular intervals until May 1953.

A relatively small amount of heat was exchanged in surrounding rocks, even though the temperature of the rocks immediately surrounding the well was increased as much as 15°–20°C in the upper part of the hole. The departure from the original equilibrium temperature was smaller at greater depths except possibly near the bottom of the hole. The geothermal profile for this well on May 22, 1953, 32 months after the completion of drilling, is shown as plate 50. All available evidence suggests that this profile closely approximates the equilibrium geothermal profile for the well.

The minimum temperature recorded below the depth of annual change was −9.84°C at 90 feet. This is within 0.1°C of the minimum temperatures measured at Simpson core tests 13, 21, 29 and South Barrow test well 3, all within 8 miles of the Arctic coast. The depths at which the minimum temperatures occur at these wells cannot be correlated as closely as the temperatures, because the temperature gradient is very slight from 60 to 140 feet, and it is difficult to assign an exact depth to the point at which the minimum temperature occurs. This is well illustrated on plate 50. Surface conditions may also influence the depth at which the minimum temperature is found.

The depth of permafrost (temperature continuously below 0°C) at this well is 910 feet.

From the data on plate 50, an inverse geothermal gradient of 75 feet per degree is indicated. This is lower than gradients in other parts of the Cape Simpson area and in other permafrost areas in Alaska such as Barrow and Umiat. The low inverse gradient, however, is to be expected because the ocean, 3,160 feet to the east, influences the temperatures at depth. There is some indication that the inverse gradient decreases slightly with depth.

SIMPSON CORE TEST 29

Simpson core test 29, approximately 55 miles southeast of Barrow Camp, was drilled to a depth of 700 feet. It is cased to 150 feet and uncased below that depth and was left full of brine and mud on November 26, 1950, 4 weeks after the beginning of drilling operations. Two cables, the longest reaching to a depth of 690 feet, were installed after the drilling and electric-logging operations were completed. Readings were obtained at irregular intervals until May 1953.

This well did not reach the bottom of permafrost. It was drilled in a very short time to a shallow depth and hence allowed only a relatively small amount of heat exchange in the surrounding rocks and a rapid return to a condition of approximate equilibrium. Temperatures in the well dropped below freezing throughout its entire depth in less than 48 hours after circulation had been stopped. Measurements made in April 1951 and May 1953, 4½ months and 30 months after drilling, showed an average cooling of less than 0.19°C at depths between 70 feet (below depth of measurable seasonal change) and 690 feet. The geothermal profile in this well on May 22, 1953, (pl. 50) is thought to approximate the equilibrium geothermal profile.

Return drilling-mud temperatures 6°–11°F higher than would normally have been expected for this area were reported at Simpson 29. The thermal data show no heat source in the earth for these high mud temperatures. The local offset in the geothermal profile below 615 feet, which indicates a formation having a relatively higher thermal conductivity than the overlying material, can be correlated very closely with the high resistivity zone, shown on the electric log of the hole, which was logged as predominantly sandstone.

The minimum temperature recorded below the depth of annual change was −9.82°C at 90 feet. This is within 0.1°C of the minimum temperatures measured at Simpson core tests 13, 21, 28, and South Barrow 3.

An extrapolation of the goethermal profile (pl. 50) to its intersection with the 0°C isotherm, indicates a depth of permafrost of approximately 950 feet.

The inverse geothermal gradient at Simpson core test 29 is approximately 85 feet per degree centigrade from 200 to 690 feet, if the local offset at 615 feet is ignored. This is the same inverse gradient as that found over a similar range depth at Simpson core test 13. These gradients are the same order of magnitude as those in other parts of Cape Simpson and near the coast at Barrow but are somewhat lower than the inverse geothermal gradients in other permafrost areas in Alaska such as inland from Barrow and at Umiat.

LITERATURE CITED

Brewer, M. C., 1958, Some results of geothermal investigations of permafrost in northern Alaska: Am. Geophys. Union Trans., v. 39, p. 19–26.

Cobban, W. A., and Gryc, George, 1961, Ammonites from the Seabee formation (Cretaceous) of northern Alaska: Jour. Paleontology, v. 35, p. 176–190.

Collins, F. R., 1958, Test wells, Umiat area, Alaska: U.S. Geol. Survey Prof. Paper 305–B, p. 71–206.

Goddard, E. N., chm., and others, 1948, Rock-color chart: Washington, D.C., Natl. Research Council, reprinted by Geol. Soc. America, 1951.

Jones, D. L. and Gryc, George, 1960, Upper Cretaceous pelecypods of the Genus *Inoceramus* from northern Alaska: U.S. Geol. Survey Prof. Paper 334–E, p. 149–163.

McKinney, C. M., Garton, E. L., and Schwartz, F. G., 1959, Analyses of some crude oils from Alaska: U.S. Bur. Mines Rept. Inv. 5447, 29 p.

Morris, R. H., and Lathram, E. H., 1951, Heavy mineral studies, *in* Payne, T. G., and others, 1951, Geology of the Arctic Slope of Alaska: U.S. Geol. Survey Oil and Gas Inv. Map OM–126, Sheet 3.

Robinson, F. M., 1959a, Test wells in the Titaluk and Knifeblade areas, Alaska: U.S. Geol. Survey Prof. Paper 305–G, p. 377–422.

Robinson, F. M., 1959b, Test wells, Simpson area, Alaska: U.S. Geol. Survey Prof. Paper 305–J, p. 523–568.

Tappan, Helen, 1960, Cretaceous biostratigraphy of northern Alaska: Am. Assoc. Petroleum Geologists Bull., v. 44, p. 273–297.

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