LITHOLOGIC DESCRIPTION OF SAMPLES SUBMITTED FOR ASSAY[1/]

Core samples of the Green River Formation from U.S. Geological Survey's Massacre Hills No. 1 corehole drilled in 1963 in sec 6, T 16 N, R 108 W, Sweetwater County, Wyoming

Surface elevation: 6040 feet (approx.)
Sampled section: 44.3 to 248.8 feet

From	To	Description
44.3	49.8	Marlstone: light to medium gray and some white (N 8-6, some 4-9; some slight brown tint); some brownish-gray oil-shale laminae (10YR 4/2-5/2). Irregular distorted and some contorted laminae and bands. Slightly irregular and some very irregular thick parting; irregular to conchoidal fracture. A 3/4-inch noncalcareous chalky white band at 45.2 feet.
49.8	53.7	Marlstone: medium to light gray (N 5.5-7.5; common slight brown tint); very common dark to light brownish-gray oil-shale laminae (10YR 4/2-6/2). Very irregular distorted and broken laminae with common loop structures; some thick faintly bedded bands in middle part. Regular to irregular thick parting; slightly irregular fracture.
53.7	59.0	Siltstone: buff (7.5YR 6/2-8/2; almost neutral) and some light to rare medium gray (N 6-7, rare 5.5-4), slightly calcareous. Very faint irregular distorted stringers to very faint distorted to smooth bedding and some laminae. Regular to very irregular thick parting; slightly irregular to conchoidal fracture. Very rare fine irregular black streaks with pyrite in lower part. Some medium to thin yellowish-gray ostracod (?) bands near base.
59.0	60.1	Oil shale: medium and some dark brownish gray to buff (10YR 4/2-7/2, some 3/2-2/2; some very slight olive tint). Fairly distinct to faint slightly irregular and distorted to smooth laminae. Slightly irregular thick shaly parting; some very slight hackly fracture. Common very fine disseminated gray crystals and crystalline streaks in upper part. A 1-1/2-inch light gray silty-textured band at 59.5 feet. Sample of shale with fine disseminated crystals from 59.3-59.4 feet: X-ray - dolomite, quartz, analcite, feldspar, biotite.

1/ By L. G. Trudell

Illustration No. SBR-4074P (Sheet 1 of 19)

Laramie Petroleum Research Center, Laramie, Wyoming July 17, 1967

LITHOLOGIC DESCRIPTION OF SAMPLES SUBMITTED FOR ASSAY

Core samples from Massacre Hills No. 1 corehole--Continued

From	To	Description
60.1	63.0	Oil shale: medium to light and rare dark brownish gray (10YR 5/2-6/2, rare 4/2-3/2; common slight olive tint), very calcareous. Very faint slightly irregular and distorted to very smooth laminae; common to rare very fine buff streaks and stringers. Very regular thick to medium shaly parting; conchoidal fracture. Some medium to dark olive gray zones in lower part.
63.0	65.0	Oil shale: medium to light and some dark brownish gray (10YR 4/2-6/2, some 3/2; common slight olive tint) and some thin zones of medium to dark olive gray (5Y 4/2-3/2), very calcareous. Faint fine smooth laminae. Very regular to slightly irregular, thick to medium shaly parting; conchoidal to irregular fracture. A very thin gray crystalline calcite band at 63.1 feet.
65.0	71.1	Oil shale: medium to dark and some light brownish gray (10YR 5/2-3/2, some 2/2 and 6/2; common slight olive tint), very calcareous. Faint and rare distinct fine smooth laminae; rare to some very fine buff streaks. Regular to some irregular thick shaly parting; conchoidal fracture. Rare thin to fine gray cyrstalline calcite stringers.
71.1	72.1	Oil shale: light to some dark brownish gray (10YR 6/2-4/2, some 3/2-2/2), very calcareous. Faint to distinct, smooth to some slightly irregular and distorted laminae; common very distinct fine buff streaks and laminae in lower part. Regular thick to thin shaly parting (common parting on buff laminae); irregular to slight hackly fracture. Two thin stringers and a 1-inch band of light gray limestone at top.
72.1	74.3	Oil shale: dark to medium brownish gray (10YR 2/2-5/2), very calcareous. Fairly distinct to faint fine slightly irregular and distorted to smooth laminae; common to occasional fine distinct buff laminae and streaks; rare small loop structures in upper part. Regular and some irregular, thick to rare thin shaly parting; irregular to some very slight hackly fracture. A thin light gray limestone band at 73.6 feet.
74.3	78.6	Oil shale: medium to dark brownish gray (10YR 5/2-2/2), very calcareous. Distinct slightly irregular, distorted, and rare displaced to smooth laminae; some very distinct fine buff

LITHOLOGIC DESCRIPTION OF SAMPLES SUBMITTED FOR ASSAY

Core samples from Massacre Hills No. 1 corehole--Continued

From	To	Description
		laminae and streaks. Regular to slightly irregular, thick to rare thin shaly parting; slightly irregular to very slight hackly fracture. Rare thin light to dark gray crystalline limestone bands in upper part; a 0.1-foot buff limestone band with rare fine oil-shale stringers and shreds at 75.0 feet; common medium to light gray marlstone laminae in lower 0.7 foot. A massive earthy buff band at 76.7 to 77.4 feet. Sample of thick massive earthy buff band from 77.1 feet: X-ray - dolomite, quartz, feldspar, analcite, illite.
78.6	82.0	Marlstone and oil shale: light to medium gray (N 6.5-5.0) and buff to dark brownish gray (10YR 7/2-2/2). Faint to distinct smooth laminae. Very regular thick to medium shaly parting; slightly conchoidal to some slight hackly fracture. Very rare thin gray crystalline calcite stringers. A 1-1/2-inch buff-white massive silty-textured band with rare very fine dull black specks at 81.5 feet. Sample of buff-white band from 81.5 feet: X-ray - quartz, feldspar, analcite, calcite, dolomite, illite.
82.0	84.1	Oil shale: dark to medium brownish gray and rare buff (10YR 2/2-5/2, rare 6/2-7/2), very calcareous to slightly calcareous. Fairly distinct to very faint fine smooth laminae. Very regular thick shaly parting; conchoidal to irregular fracture. Rare to fairly common, thin to very fine gray laminae. A 1-1/4-inch yellowish buff (2.5Y 7/3) slightly calcareous earthy band with some very fine gray to black partings at 82.1 feet.
84.1	91.1	Oil shale: medium to dark and some light brownish gray (10YR 5/2-3/2, some 6/2, rare 2/2; some very slight olive tint), calcareous. Faint and some moderately distinct fine smooth and rare slightly distorted and displaced laminae. Very regular to some slightly irregular, thick to rare thin shaly parting; conchoidal to slightly irregular and rare slight hackly fracture. Rare very fine buff streaks and laminae. Some ostracod-covered parting surfaces. A 1-inch broken and displaced gray crystalline calcite band at 86.3 feet.
91.1	92.8	Siltstone: light gray (N 5.5-6.5; some very slight brown tint), calcareous. Massive with common to rare, fine to large internally laminated shreds and irregular fragments of light to dark brownish gray oil shale. Irregular parting and fracture. Sharp smooth contact at top; very irregular wavy contact at base.

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Core samples from Massacre Hills No. 1 corehole--Continued

From	To	Description
92.8	94.1	Oil shale: medium to dark brownish gray (10YR 4/2-2/2, rare 5/2). Faint broadly curved and displaced to slightly irregular and distorted laminae; common distinct fine buff-white laminae in middle part. Slightly irregular to very regular, curved to flat shaly parting; irregular fracture. (93.3-94.0 missing)
94.1	100.0	Marlstone and oil shale: medium and rare dark brownish gray to very light buff (10YR 4/2-8/2, some 6/3-8/3, rare 3/2-2/2; some slight olive tint in upper part). Distinct to faint slightly irregular and distorted laminae to very irregular, contorted and displaced laminae, stringers, and streaks. Slightly irregular to very irregular thick parting; conchoidal to very irregular fracture. Some medium to thin dense brownish gray dolomite bands, stringers, and lenses. A very peculiar marlstone-in-marlstone "injection" with large dolomite lenses and some very small yellowish crystal lined vugs at 94.8-95.2 feet. A thin finely porous gray to brownish gray limonite-stained silty-textured band with some very fine gray veinlets at base of marlstone-in-marlstone "injection;" a similar 1-inch band at 95.4 feet. Sample of host and injecting marlstone with crystal lined vugs from marlstone-in-marlstone injection from 94.8 to 95.0 feet: X-ray - analcite; some quartz, feldspar. Sample of brownish gray host marlstone from 94.9 feet: X-ray - dolomite; some quartz, analcite. Sample of dense brownish gray dolomite lens from 95.0 feet: X-ray - dolomite; some quartz, analcite. Sample of buff injecting marlstone from 95.1 feet: X-ray - analcite, quartz; some feldspar, dolomite, illite. Sample of olive gray host marlstone from 95.2 feet: X-ray - analcite, quartz; some feldspar, dolomite. Sample of porous silty-textured band at base of marlstone-in-marlstone injection from 95.3 feet: X-ray - analcite, siderite; some quartz, feldspar.
100.0	100.6	Tuff: medium to dark gray (N 5.5-3.5; slight 5YR tint), calcareous. Massive, silty textured; common very fine interlacing black stringers (fracture fillings ?). Irregular parting and fracture. A 0.1-foot band of light to dark brownish gray oil shale with common loop structures near middle; irregular broken contact at top and fairly smooth contact at base. Tuff has fairly smooth contacts with oil shales at top and bottom.

LITHOLOGIC DESCRIPTION OF SAMPLES SUBMITTED FOR ASSAY

Core samples from Massacre Hills No. 1 corehole--Continued

From	To	Description
		Sample of tuff with fine fractures from 100.1 feet: X-ray - quartz, analcite; some calcite, illite, siderite?
100.6	103.6	Oil shale: light to dark brownish gray and some buff (10YR 6/2-3/2, some 7/3 and 2/2), slightly calcareous to noncalcareous. Distinct irregular, distorted, and displaced laminae; common very small loop structures. Slightly irregular to very irregular thick parting; irregular to conchoidal fracture.
103.6	104.9	Oil shale: buff to medium and rare dark brownish gray (10YR 7/3-5/2, rare 4/2-3/2), slightly calcareous to very calcareous. Faint to distinct slightly irregular, distorted, and displaced to fairly smooth laminae. Slightly irregular thick shaly parting; conchoidal fracture.
104.9	105.4	Marlstone: buff (10YR 7/2, rare 6/2 and 8/2). Very faint slightly distorted bedding with some very fine light to dark streaks. Slightly irregular parting; conchoidal fracture. Very irregular interfingering contact with oil shale below.
105.4	106.7	Oil shale: light to medium olive gray and some yellowish buff (2.5Y 6/2-4/2, some 7/3), some light to dark brownish gray near top (10YR 6/2-3/2), noncalcareous. Faint very irregular and contorted to very smooth laminae. Regular and some irregular thick shaly parting; some irregular papery parting near top; irregular to slightly conchoidal fracture. A thick band near top consists of dense dark gray crystalline material in upper part and oil-stained coarse equant crystal grains in lower part with very irregular stringers extending into shale below. Sample of dense dark gray crystalline material from 105.6 feet: X-ray - analcite, quartz, some feldspar. Sample of oil-stained granular crystalline material from 105.7 feet: X-ray - analcite; some dolomite, quartz, feldspar.
106.7	109.7	Oil shale: medium and rare dark olive gray in upper part (2.5Y 5/2-4/2, rare 3/2), medium to dark brownish-gray and olive-gray in lower part (10YR and 2.5Y 5/2-3/2, rare 2/2); slightly calcareous to very calcareous. Faint fine smooth to slightly

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Core samples from Massacre Hills No. 1 corehole--Continued

From	To	Description
		irregular and distorted laminae; common distinct fine buff laminae and streaks in lower part. Regular thick to thin shaly parting; conchoidal and some very slight hackly fracture. Some very thin buff crystalline calcite streaks and laminae in upper part--some slightly prismatic. A fine irregular (almost stylolitic) vertical fracture with dull black filling from 107.1 to 107.4 feet. Some small irregular gray calcareous injections in lower foot.
109.7	110.7	Oil shale: dark to rare medium olive gray and olive black (2.5Y 2/2-3/2, rare 4/2-5/2 and 1/2), slightly calcareous. Very faint slightly irregular and distorted laminae; a large very irregular gray (N 3.5-4; very slight brown tint) very fine silty-textured calcareous injection in upper half with some very fine black filled fractures and small angular shale inclusions (like 100.0 to 100.6 feet). Very irregular to slightly irregular, thick to thin parting; irregular to conchoidal fracture. Some thin to fine irregular light gray streaks and stringers in lower half. A 1-1/2-inch dark gray band at base (like injection). Shale next to injection is commonly discolored (olive black).
110.7	111.3	Marlstone and lean oil shale: yellowish buff to rare dark olive gray and olive black (2.5Y 7/2-4/2, rare 3/2-1/2 and 8/2), dolomitic to slightly calcareous. Faint to distinct irregular, distorted, and displaced to smooth laminae. Irregular to regular thick parting; conchoidal fracture. A thin slightly irregular gray fine grained crystalline analcite (?) stringer at 111.0 feet.
111.3	112.9	Oil shale: medium to dark and some light olive gray (2.5Y 5/2-3/2, some 2/2 and 6/2), noncalcareous to calcareous. Faint very fine slightly irregular and distorted to smooth laminae. Regular to slightly irregular, thick to thin shaly parting; slightly conchoidal fracture. Common very fine buff streaks in lower 0.5 foot. A very irregular gray injection extends laterally into core at 111.6 feet. A small irregular stringer of fine oil-stained granular crystals at 112.6 feet (like 105.7 feet?).
112.9	113.8	Oil shale: dark to medium brownish gray with common buff streaks (10YR 3/2-4/2, some 2/2 and 7/2; some slight olive tint), very calcareous. Faint fine slightly irregular and distorted to smooth laminae with common fine distinct chalky buff streaks. Regular

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Core samples from Massacre Hills No. 1 corehole--Continued

From	To	Description
		thick to thin shaly parting (commonly on buff streaks); some slight hackly fracture. Some very thin prismatic calcite streaks and laminae in lower part. A small dense brownish gray calcareous lens with laminae distorted around it at 113.1 feet.
113.8	114.6	Oil shale: dark brownish gray to brownish black (10YR 2/2-1/2) with a 0.3 foot zone of common yellowish-buff (2.5Y 7/3) and medium to dark brown (10YR 5/3-3/4) tuff and tuffaceous shale from 114.1 to 114.4 feet. Very faint distorted to smooth streaked bedding with faint to very distinct, smooth to very irregular, distorted and intricately displaced laminae, streaks, and bands in tuffaceous zone. Regular to slightly irregular, thin to thick shaly parting; conchoidal to irregular fracture. Common very fine interlacing veinlets in tuffaceous zone. Very rare very fine vitreous black organic streaks near base. Some very small black crystalline lenses at top of tuff band at 114.3 feet. Sample of yellowish buff tuff band from 114.3 feet: X-ray - dolomite; some quartz, analcite, feldspar.
114.6	117.0	Oil shale and marlstone (?): dark to medium greenish gray and olive gray (5BG 2/1-4/1 and 5GY 2/1-5/1), very calcareous. Moderately distinct to faint regular smooth to wavy laminae. Regular thick shaly parting; conchoidal fracture. Rare thin to fine, gray to buff calcareous crystalline bands--some with irregular stringers extending into shale. A 2-inch band of buff marlstone with common very fine brown partings at top. Sample of thin gray crystalline band from 115.0 feet: X-ray - calcite; some analcite, feldspar, quartz.
117.0	121.8	Oil shale: dark to some medium brownish gray and rare brownish black (10YR 3/2-2/2, some 4/2, rare 1/2; some slight olive tint in upper part), common fine buff streaks and laminae in middle part; calcareous to slightly calcareous. Faint to very faint, smooth to slightly irregular and distorted laminae with distinct buff streaks and laminae in middle part. Regular to slightly irregular, thick to rare thin shaly parting; conchoidal to some irregular fracture. Rare fine prismatic calcite laminae and streaks. A regular thin dark gray calcareous crystalline band with chalk buff material at top at 119.6 feet. A 3/4-inch yellowish brown to buff oil-stained crystalline band at 121.5 feet with very irregular thin stringers extending into shale below. (1.6 feet missing)

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Core samples from Massacre Hills No. 1 corehole--Continued

From	To	Description
121.8	127.0	Marlstone: yellowish-buff to medium and rare dark olive gray (2.5Y 7/2-4/2 and 5Y 6/1-4/1, rare 3/1) and some buff to medium brownish gray (10YR 7/2-5/2), some dark brownish gray to brownish black oil shale near top (10YR 3/2-1/2); dolomitic to slightly calcareous. Distinct and some faint very irregular, distorted, and displaced to some regular, smooth laminae and bands; contorted laminae, stringers, and lenses with some fine marlstone breccia in lower 0.5 foot. Irregular to slightly irregular thick parting; irregular to conchoidal fracture. Common small irregular gray to yellowish brown oil-stained crystalline stringers and lenses in locally contorted marlstone at 123.6 feet. A very irregular 1/2- to 1-inch dark gray to dark olive gray silty-textured band at 124.5 feet with common irregular thin stringers extending as much as 2 inches into yellowish buff marlstone below.
127.0	129.0	Oil shale: medium to some light and dark olive gray (2.5Y 5/2-4/2, some 6/2 and 3/2-2/2; some almost neutral), noncalcareous to calcareous. Moderately distinct to very faint fine smooth laminae; some fine distinct chalky buff streaks and laminae in lower half. Regular to slightly irregular thick shaly parting; conchoidal fracture. A 0.2-foot zone of contorted yellowish buff to olive black stringers and lenses at 127.4 feet. A very thin gray crystalline band at 128.9 feet.
129.0	135.0	Oil shale: medium to dark olive gray (2.5Y and 5Y 4/2-3/2, some 2/2; some 2.5Y 5/2 from 132.4 to 133.5 feet), slightly calcareous to dolomitic. Very faint to some moderately distinct, fine, smooth to rare slightly distorted laminae. Very regular to slightly irregular thick shaly parting; very conchoidal fracture. A thin gray crystalline band at 130.3 feet (like 115.0 feet). Some fine chalky buff laminae and streaks from 132.4 to 133.5 feet; very rare in other parts.
135.0	136.0	Oil shale: medium to dark and rare light olive gray (2.5Y and 5Y 5/2-3/2, some 2/2, rare 6/2), calcareous. Faint fine smooth laminae; some very fine buff streaks and laminae. Very regular thick shaly parting (commonly on buff laminae); irregular to conchoidal fracture.

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Core samples from Massacre Hills No. 1 corehole--Continued

From	To	Description
136.0	137.0	Oil shale: medium to dark olive gray and brownish gray (2.5Y 4/2-3/2 and 10YR 4/2-2/2), calcareous. Faint fine smooth laminae; rare distinct fine chalky buff laminae and streaks. Regular to slightly irregular thick shaly parting; conchoidal and rare very slight hackly fracture. Rare thin to fine gray crystalline laminae--one at 136.4 feet has an abruptly broken end.
137.0	137.7	Oil shale: medium to dark greenish gray (5BG 4/1-2/1) and brownish gray to brownish black (10YR 4/2-1/2), calcareous. Faint smooth laminae with some to very common fine distinct chalky buff laminae and streaks. Very regular thick to thin shaly parting (on buff laminae); conchoidal to hackly fracture. Sample of dark greenish gray oil shale with some very fine buff laminae from 137.1 feet: X-ray - quartz, analcite, dolomite, feldspar, calcite.
137.7	138.7	Oil shale: medium to dark brownish gray and olive gray (10YR 5/2-3/2 and 2.5Y 5/2-3/2, some 2/2), very calcareous. Faint to very faint smooth laminae with common to rare distinct fine buff laminae and streaks. Regular thin to thick shaly parting; slight hackly to conchoidal fracture. A 1-inch yellowish gray silty-textured band with fine black organic partings at 138.6 feet with a thin gray crystalline band below.
138.7	139.5	Oil shale: dark to medium olive gray (5Y 3/1-5/1), calcareous. Faint smooth laminae. Regular to slightly irregular, thick to thin shaly parting; conchoidal fracture. Some thin to fine buff crystalline calcite laminae near base.
139.5	145.4	Oil shale: dark brownish gray and some brownish black in upper part (10YR 3/2-2/2, some 1/2), medium to dark brownish gray in lower part (10YR 4/2-2/2; some very slight olive tint), slightly calcareous to noncalcareous. Faint to very faint, slightly irregular and distorted to smooth laminae. Very regular to some slightly irregular, thick to rare thin shaly parting; conchoidal and rare hackly fracture. Rare thin to fine buff crystalline calcite laminae and streaks. Rare thin to fine gray crystalline laminae (like 115.0 feet). A 0.3-foot dark gray (N 3.5) massive fine silty-textured band at 141.7 feet, with a large

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Core samples from Massacre Hills No. 1 corehole--Continued

From	To	Description
		shredded yellowish buff marlstone stringer in middle and some very tight irregular vertical fractures; smooth contact at top and very wavy contact at base. Very rare small brownish-gray dolomite lenses near top. (144.8 to 145.3 feet missing)
145.4	149.6	Marlstone and lean oil shale, tuffaceous (?): buff to olive gray and brownish gray (2.5Y 7/3-4/2 and 10YR 6/3-4/2, rare 3/2-1/2; some 5Y 6/2-4/2). Fairly distinct to faint irregular distorted and some fairly smooth laminae, streaks, and stringers; truncated (unconformable) laminae at 148.8 feet. Slightly irregular to some very irregular thick parting; conchoidal fracture. Some thin dark brownish gray to black porous to vuggy crystalline stringers, streaks, and patches. Rare thin dense brownish gray dolomite stringers and lenses. A 1- to 2-inch zone of large yellowish brown to dark brown (10YR 5/5-3/4) tuff (?) lenses at 147.8 feet (strong petroliferous odor on fresh break). Sample of yellowish brown tuff (?) lens from 147.8 feet: X-ray - dolomite.
149.6	151.7	Mudstone: medium to rare light and dark olive gray (2.5Y 5/2-4/2, rare 6/2 and 3/2), dolomitic. Very faint streaked bedding and some irregular, distorted and displaced laminae and stringers. Irregular thick parting; slightly irregular to conchoidal fracture. Some thin porous oil-stained crystalline stringers.
151.7	162.2	Oil shale: dark to some medium brownish gray (10YR 3/2-2/2, some 4/2-5/3; slight olive tint to almost neutral), dolomitic. Very irregular distorted to contorted and displaced laminae and stringers. Very irregular thick parting; irregular to conchoidal fracture. Some medium to light gray limestone laminae and stringers. Some porous to vuggy oil-stained crystalline patches and stringers. Some lenses and stringers of dense gray chert at 154.9 to 155.3 feet. Very irregular dark gray to brownish gray crystalline stringers at 158.5 and 161.1 feet. Sample of oil shale with oil-stained crystalline stringers from 152.0 feet: X-ray - quartz; some analcite, feldspar, calcite, dolomite, pyrite.

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Core samples from Massacre Hills No. 1 corehole--Continued

From	To	Description
		Sample of very irregular thin dark gray to black crystalline stringers from 158.5 feet: X-ray - analcite, feldspar, quartz, dolomite. Sample of very irregular thick granular crystalline stringer from 161.1 feet: X-ray - analcite; some feldspar, quartz, pyrite.
162.2	165.7	Marlstone and some oil shale: light to some dark gray and olive gray (N 6-4.5 and 2.5Y 6/3-4/2, some 3/2); some light to dark brownish gray (10YR 6/3-3/2, rare 2/2). Intricately contorted and displaced laminae and stringers; some internally laminated lenses and shreds. Very irregular parting; irregular to conchoidal fracture. A very irregular 1- to 1-1/2-inch oil-stained granular crystalline band at 162.9 feet (like 161.1 feet) with thin irregular stringers extending upward into oil shale above. A thin irregular broken dense dark gray chert stringer at 163.7 feet.
165.7	169.4	Oil shale: dark to some medium brownish gray (10YR 3/2-2/2, some 4/2-5/3; some 5YR 3/2-2/2). Faint to moderately distinct, slightly irregular and distorted to smooth laminae. Slightly irregular to regular, thick to thin shaly parting; conchoidal to irregular and some very slight hackly fracture. Some to very common fine buff to brownish gray calcite laminae and streaks. A 1/2-inch marly buff bedded tuff (?) band at 169.2 feet.
169.4	170.8	Oil shale: dark to medium gray (N 3-4; very slight brown tint), dolomitic. Very faint slightly distorted bedding and some laminae. Slightly irregular to very regular, medium to thin shaly parting; conchoidal to irregular and some hackly fracture. Rare thin to very fine, milky white to dark brownish gray noncalcareous streaks and stringers.
170.8	173.5	Oil shale: dark brownish gray (10YR 3/2-2/2; almost neutral near top), noncalcareous. Very faint slightly distorted to smooth bedding and some laminae. Slightly irregular to regular, thick to thin shaly parting; conchoidal to some hackly fracture. Rare thin to fine, medium to very light gray noncalcareous stringers. Some resinous to waxy luster near base.
173.5	174.6	Mudstone: medium to dark olive gray (5Y 5/2-3/2), dolomitic to slightly calcareous. Faint irregular distorted laminae to massive. Slightly irregular to very irregular parting; conchoidal

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Core samples from Massacre Hills No. 1 corehole--Continued

From	To	Description
		to very irregular fracture. Some thin olive black oil-shale stringers near top. Some small yellowish buff to dark gray chert lenses and stringers in massive part. Sample of chert lenses from 174.0 feet: X-ray - quartz, some dolomite. Sample of massive mudstone from 174.2 feet: X-ray - dolomite, quartz, feldspar, calcite, analcite.
174.6	180.5	Oil shale: dark and rare medium to light olive gray (2.5Y 2/1-3/1, rare 4/1-6/2; almost neutral), calcareous. Faint irregular distorted to contorted laminae and streaked bedding. Irregular to some slightly irregular thick parting; conchoidal to slight hackly fracture. Common thin to fine gray crystalline calcite streaks. A 0.1-foot spongy to earthy zone at 175.5 feet. A 0.2-foot contorted porous zone with common crystalline calcite streaks and some light gray to white gritty stringers (like 182.1 feet). Sample of dark to light olive gray oil shale with common calcite streaks from 180.2 feet: X-ray - calcite, quartz; some analcite, feldspar, dolomite, illite.
180.5	181.6	Oil shale: olive black to dark olive gray (2.5Y 1/2-3/2; almost neutral), calcareous. Faint fine smooth to irregular distorted laminae. Slightly irregular thick shaly parting; conchoidal to some hackly fracture. Some thin to fine calcite streaks and stringers. Rare thin very light gray gritty stringers (like 182.1 feet).
181.6	185.3	Oil shale: dark olive gray (2.5Y 3/1-2/1) and dark to some medium brownish gray and rare buff (10YR 2/2-3/2, some 3/3-5/3, rare 6/3), calcareous. Moderately distinct to some faint, slightly irregular and distorted to smooth laminae. Slightly irregular to regular, thick to medium shaly parting; conchoidal and some very slight hackly fracture. Very rare thin dense very dark gray bands. Some to very rare thin to fine very light gray calcite stringers and laminae. A 2-inch light gray slightly calcareous gritty band at 182.1 feet. Sample of light gray gritty band from 182.1 feet: X-ray - dolomite, analcite; some quartz, feldspar, calcite.

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Core samples from Massacre Hills No. 1 corehole--Continued

From	To	Description
185.3	188.5	Oil shale: dark olive gray (2.5Y 2/1-3/1; almost neutral), some dark to medium brownish gray in upper part (10YR 2/2-5/3), calcareous to dolomitic. Faint to very faint, smooth to slightly irregular and distorted laminae; some very faint streaked bedding near base. Very regular to some irregular thick shaly parting; conchoidal to some irregular fracture. Some ostracods on parting surfaces. Common very irregular thin vuggy calcite stringers and rare fine calcite-filled fractures in lower 1/2 foot. A very thin vertical vermiform gritty stringer in lower 3 inches.
188.5	189.0	Mudstone: dark to medium gray (N 3-4, rare 5; very slight olive tint), dolomitic. Massive to very faintly bedded. Irregular parting; irregular to conchoidal fracture. An irregular gray calcareous silty-crystalline stringer with fine dark lacy stringers near middle. Irregular finely interfingering contact with oil shale below. Rare very fine calcite-filled fractures.
189.0	194.0	Oil shale and siltstone: medium to dark brownish gray and some buff oil shale (10YR 5/2-2/2, some 6/2-7/3; some slight olive tint), medium to light gray siltstone (N 5-6). Very irregular and contorted laminae, streaks, and stringers. Very irregular parting and fracture. Common buff to light gray crystalline calcite stringers. Some fracture zones in upper part with vitreous black organic fillings.
194.0	194.9	Mudstone: light gray (N 7.5-6), slightly calcareous. Faint contorted stringers. Very irregular parting and fracture.
194.9	196.2	Oil shale: medium to dark brownish gray (10YR 4/2-2/2, rare 5/2, some very slight olive tint), calcareous. Very faint irregular distorted laminae. Very irregular to slightly irregular, thick to thin parting; irregular to conchoidal fracture. Very common irregular buff calcite stringers and some fracture fillings.
196.2	199.3	Mudstone and oil shale: medium to dark and some light brownish gray mudstone (10YR 5/1-3/1, some 6/2-4/2; some almost neutral), dark brownish gray oil shale (10YR 2/2-3/2). Thick very irregular bands of massive to faintly bedded mudstone and thick to medium oil-shale zones with contorted laminae; light colored gritty to vuggy collapse zones on oil shale in upper 0.7 foot. Very irregular parting and fracture. Oil shales in lower half have very common fine crystalline calcite laminae and streaks. Rare very irregular and contorted, medium to thin gray calcareous stringers.

LITHOLOGIC DESCRIPTION OF SAMPLES SUBMITTED FOR ASSAY

Core samples from Massacre Hills No. 1 corehole--Continued

From	To	Description
199.3	200.8	Oil shale: dark to rare medium brownish gray (10YR 2/2-3/2, rare 4/2-5/2; some slight olive tint to almost neutral). Faint to very faint, irregular and contorted to smooth laminae. Irregular to very regular, thick shaly to papery parting; irregular to hackly fracture. Common very fine disseminated calcite crystals in upper part. Rare thin dense to silty-textured dark gray stringers--one at 199.8 feet has small fine grained pyrite patches and medium to light yellowish green (7.5Y 4/3-6/3) stains on parting surfaces at top. Sample of dark gray stringer with pyrite and yellowish green stains from 199.8 feet: X-ray - pyrite, feldspar, some quartz.
200.8	201.7	Oil shale: dark to medium gray (N 3-4; very slight brown tint). Thin to thick, very faintly bedded to massive gray bands with common to rare thin stringers and irregular laminae of dark brownish gray to brownish black oil shale. Slightly irregular to very irregular thick parting; slightly irregular to slightly conchoidal fracture. Some thin light brownish gray silty-textured tuff (?) stringers and rare injections. Common fine crystalline calcite streaks in some oil shales.
201.7	203.4	Mudstone: medium and rare light brownish gray (10YR 5/2-4/2, rare 6/2), dolomitic, silty. Very faint streaked bedding. Very irregular parting; slightly conchoidal and some irregular fracture. Common very fine and rare thin dark brownish gray oil shale shreds and streaks. Very sharp slightly irregular contacts at top and bottom. Sample of mudstone from 202.6 feet: X-ray - feldspar; some quartz, dolomite, calcite.
203.4	207.5	Mudstone and silty marlstone: dark to rare medium gray (N 2.5-3.5, rare 4; slight brown tint) and rare brownish gray to buff (10YR 5/2-7/2). Massive to faint irregular streaked bedding with some streaks, stringers, and bands of dark brownish gray to brownish black oil shale. Slightly irregular to very irregular thick parting; conchoidal to very irregular fracture. Rare fracture fillings and thin irregular stringers of vitreous black brittle gilsonite-like organic material. Some fine crystalline calcite streaks and stringers in oil shales. Some very irregular light gray silty calcareous injections in lower half. Uneven sample split.

LITHOLOGIC DESCRIPTION OF SAMPLES SUBMITTED FOR ASSAY

Core samples from Massacre Hills No. 1 corehole--Continued

From	To	Description
		Sample of dark gray silty marlstone from 204.6 feet: X-ray - quartz, feldspar, dolomite, calcite, illite, extra peaks.
207.5	210.8	Oil shale: dark to some medium and rare light brownish gray (10YR 2/2-3/2, some 4/1-5/1, rare 6/1-6/3), very calcareous. Moderately distinct to faint, irregular and distorted to smooth laminae. Slightly irregular to regular, medium to thick shaly parting; slight hackly to irregular fracture. Some very irregular to vermiform light gray to buff limestone injections and stringers; a 0.3-foot limestone band with fine oil-shale shreds at 209.0 feet. Some very fine calcite streaks, especially in lower part. A very regular 0.3-foot massive light brownish-gray mudstone band at 210.1 feet. Rare medium to dark gray silty marlstone bands (like 204.6 feet).
210.8	212.1	Marlstone: medium gray (N 4-4.5). Massive to very faint streaked bedding. Irregular parting; very conchoidal fracture. A thin dark brownish gray to brownish black oil-shale band near middle. Very rare very fine black streaks or shreds. A very regular 2-inch light brownish gray calcareous mudstone at top with common fine dark oil-shale shreds.
212.1	214.6	Marlstone and oil shale: medium to light and rare dark olive gray (2.5Y to 5Y 4/2-6/2, rare 3/2) and some medium to light greenish gray (7.5Y 4/2-6/2, rare 7/1; some almost neutral), dolomitic to slightly calcareous. Faint to distinct, irregular and distorted to some smooth laminae. Regular to slightly irregular, thick to medium shaly parting; very conchoidal to some irregular fracture. Some medium to thin, buff to buff-white porous silty-textured calcareous crystalline stringers. Two small buff radiating crystal masses in distorted shale at 213.1 to 213.2 feet. A 1-inch massive gray siltstone band at 213.6 feet. Sample of radiating crystal mass from 213.1 feet: X-ray - quartz; some calcite, dolomite.
214.6	216.0	Oil shale: dark to medium olive gray and brownish gray (2.5Y 3/2-5/2 and 10YR 2/2-4/2, rare 5/3), dolomitic. Fairly distinct contorted laminae to faint distorted streaks and stringers. Irregular thick parting; irregular to conchoidal and some slight hackly fracture. Common thin buff crystalline stringers and some

LITHOLOGIC DESCRIPTION OF SAMPLES SUBMITTED FOR ASSAY

Core samples from Massacre Hills No. 1 corehole--Continued

From	To	Description
		partly dissolved radiating vugs (like 213.1 feet) in upper half. Rare very thin gritty white stringers in lower half.
216.0	219.7	Oil shale and marlstone: dark and rare medium olive gray to olive black (2.5Y 3/2-1/2, rare 4/2; almost neutral) and rare dark to medium brownish gray (10YR 3/2-4/3) oil shale; dark to medium gray marlstone (N 3-4). Very faint distorted and some very contorted to smooth laminae in oil shale; medium to very thick, faintly bedded to massive bands of marlstone. Slightly irregular to very irregular, thick to medium parting; very irregular to conchoidal and some smooth fracture. Common very fine calcite streaks and disseminated crystals in some oil shales. An irregular vertical fracture with brown varnish-like coatings from 217.1 to 218.4 feet.
219.7	223.0	Oil shale: medium and dark to rare light olive gray and olive black (2.5Y 5/1-3/1 and 5/2-2/2, rare 5/3-6/3 and 1/2; some almost neutral) rare brownish gray to brownish black (10YR 4/3-1/2), very rare resinous luster, calcareous to very calcareous. Very irregular and distorted laminae, stringers, and streaked bedding in upper part to smooth laminae in lower part. Irregular to very regular, thick to medium parting; irregular to conchoidal fracture. Common very fine disseminated calcite crystals and some very thin stringers and patches in upper part. Some medium to thin bands and laminae of yellowish buff to dark brownish gray, dense to fine granular crystalline tuff (?) at 222.1 to 222.4 feet--lower band is strongly oil stained in lower part. Fish fossil on parting surface at 222.5 feet (vertebrae, ribs, scales and tail).
223.0	223.9	Tuff (?): grayish brown (10YR 5/3), dolomitic. Massive, silty textured; very rare fine oil-shale stringers at top and irregular tuff injection in dark to medium olive gray oil shale in lower 2 inches. Irregular parting; conchoidal fracture.
223.9	225.3	Oil shale, mudstone and marlstone: dark olive gray oil shale (2.5Y 2/1-3/1; almost neutral), medium to dark brownish gray mudstone (7.5YR 4/1-3/1; almost neutral) and dark gray marlstone (N 3-3.5). Very faint irregular distorted stringers to fairly smooth laminae in oil shale, a 0.4-foot band of mudstone with streaked bedding in middle, and thick bands of massive to very faintly bedded marlstone at top and bottom. Very irregular to some regular thick parting; irregular to conchoidal fracture. Common fine prismatic calcite streaks and some very fine disseminated crystals in oil shale.

LITHOLOGIC DESCRIPTION OF SAMPLES SUBMITTED FOR ASSAY

Core samples from Massacre Hills No. 1 corehole--Continued

From	To	Description
225.3	225.8	Tuff: yellowish buff to light brownish gray (2.5Y 7/3 to 10YR 6/2), dolomitic. Very faintly bedded to massive, silty textured. Irregular parting; conchoidal fracture. Very slightly oil stained in upper 1/2-inch; strongly oil stained in lower 1/2 inch. Some very fine dark flecks in lower part. Common very fine disseminated sparkly crystals in lower 1/4 inch. Sample of tuff from 225.7 to 225.8 feet: X-ray - feldspar, quartz, biotite; some analcite, calcite.
225.8	228.2	Oil shale: medium and rare light olive gray to olive black (2.5Y 4/1-1/2, some 5/1-6/3; some almost neutral) and dark brownish gray to brownish black and some buff (10YR 3/2-1/2, some 5/2-7/2), very calcareous. Faint to some fairly distinct, irregular and distorted to smooth laminae. Regular to slightly irregular, thick to rare thin shaly parting; conchoidal to some slight hackly fracture. Common buff laminae from 226.8 to 227.0 feet. Two gray calcareous medium to fine grained crystalline laminae at 227.5 feet--some very fine black grains. Sample of gray crystalline laminae with black grains from 227.5 feet: X-ray - analcite, calcite; some quartz, feldspar.
228.2	231.5	Oil shale: dark to medium brownish gray (10YR 2/2-4/2) and some dark to medium olive gray (2.5Y 2/2-5/2; some almost neutral), very calcareous. Faint to very faint, irregular and distorted to fairly smooth laminae. Regular and some irregular, thick to medium shaly parting; slightly conchoidal to some irregular fracture. A 1-inch gray to yellowish gray calcareous dense crystalline band at top. A 2-inch dark gray faintly bedded marlstone band with some very fine oil-shale streaks and partings at 229.9 feet. Very rare very small dark brown radiating crystal masses and thin stringers in lower foot.
231.5	235.0	Oil shale: dark and rare medium brownish gray to brownish black (10YR 3/2-1/2, rare 4/2-5/3; some slight olive tint to almost neutral), very calcareous. Faint to very faint, smooth to some very irregular and distorted laminae. Regular to some irregular, thick to medium shaly parting, slightly conchoidal to irregular and some hackly fracture. Some thin to rare medium, buff to yellowish gray and brownish gray, dense to granular crystalline laminae and bands (probably like 227.5 feet). Rare thin to medium marlstone dark gray stringers and bands.

LITHOLOGIC DESCRIPTION OF SAMPLES SUBMITTED FOR ASSAY

Core samples from Massacre Hills No. 1 corehole--Continued

From	To	Description
235.0	236.7	Oil shale: dark brownish gray to some brownish black, some grayish brown to tan in upper 0.3 foot (10YR 3/2-2/2, some 1/2 and 4/3-5/3), calcareous. Moderately distinct to very faint fine slightly irregular and distorted to smooth laminae. Slightly irregular to very regular, thick to rare thin shaly parting; slightly irregular to some hackly fracture. Rare thin dark gray to yellowish gray and brownish gray crystalline laminae and stringers.
236.7	238.1	Oil shale and marlstone: dark and some medium brownish gray to brownish black (10YR 3/2-1/2, some 3/3-4/3; almost neutral in lower part) oil shale with two thick bands of dark to medium gray (N 3-4) marlstone at 236.7-239.0 and 239.2-239.5 feet. Faint to very faint, smooth to very irregular and distorted laminae. Regular to very irregular, thick to medium parting; conchoidal to some very irregular fracture. A very irregular 1- to 2-inch gray to yellowish gray, fine grained crystalline stringer with very common black grains at 237.7 feet and some thin stringers near base. Sample of gray to yellowish gray crystalline stringer from 237.7 feet: X-ray - quartz, feldspar, hornblende, biotite, analcite.
238.1	240.3	Oil shale: medium and rare dark olive gray (5Y 4/1-5/1 and 2.5Y 4/2-5/2, rare 3/2). Faint to very faint, smooth to irregular distorted laminae and some very faint streaked bedding. Slightly irregular to very irregular thick parting; very conchoidal to irregular fracture.
240.3	242.1	Oil shale: medium to dark brownish gray (10YR 4/2-3/2, some 2/2, common slight olive tint), very calcareous. Faint streaked bedding to moderately distinct irregular and distorted to some smooth laminae. Slightly irregular thick to thin shaly parting; irregular to hackly fracture. Common fine buff calcite streaks in lower part.
242.1	243.3	Marlstone: yellowish tan to olive yellow and rare olive gray (2.5Y 6/4-5/3, rare 7/2-6/2). Very faintly bedded and some faint irregular and distorted laminae. Irregular thick parting; irregular to conchoidal fracture. Common to rare, thin to very fine calcite stringers and streaks.

LITHOLOGIC DESCRIPTION OF SAMPLES SUBMITTED FOR ASSAY

Core samples from Massacre Hills No. 1 corehole--Continued

From	To	Description
243.3	245.2	Marlstone and limestone: medium to light olive gray marlstone (5Y 4/2-6/2) with some to very common thin irregular light gray limestone stringers. Very faint bedding to distinct very irregular and distorted stringers. Irregular thick to thin parting; very hackly to irregular fracture.
245.2	247.4	Limestone and marlstone: medium to light gray limestone (N 5-6) with very common irregular laminae and stringers of dark to light olive gray marlstone (5Y 3/1-6/2; some almost neutral). Very irregular and distorted stringers and laminae. Irregular to slightly irregular thick parting; very hackly to conchoidal fracture.
247.4	248.4	Marlstone: light olive yellow to yellowish buff and rare light olive green (2.5Y 6/3-7/4, rare 6/2-2/2?). Very faint bedding to faint irregular distorted stringers and some fairly smooth laminae. Slightly irregular to very irregular thick to thin parting; very irregular to very hackly fracture. Some thin to fine irregular limestone stringers and streaks.
248.4	248.8	Tuff: white to light gray (N 9-7), calcareous. Massive, chalky to gritty. Common very fine black specks in lower part. Very irregular medium to dark gray pyritic crystalline stringers at top and bottom--some small irregular patches throughout. Sample includes some marlstone at top and bottom. Sample of massive white tuff from 248.6 feet: X-ray - quartz, analcite, feldspar. Sample of gray pyritic stringer from 248.7 feet: X-ray - pyrite; some analcite, calcite, feldspar, quartz.

Bottom of core.