

CORE DESCRIPTIONS

COLORADO OIL SHALE

Corehole: OM7-74 (293' - 925')

NOTE: All footages between 293' and 690' are in feet and inches; thus 293.6' is 293' 6" and 678.10' is 678' 10". Footages from 691.5' to TD are in feet and tenths of feet.

CORE DESCRIPTIONS

COLORADO OIL SHALE

Corehole: OM7-74 (293 - 925')

- 293.0' -
293.6' Very fine grained whitish sandstone; massive, no apparent bedding, good porosity and permeability, non-calcareous, some small organic debris.
- 293.6' -
293.10' Thin tuff beds, somewhat distorted; very calcareous, interbedded with barren marlstone, finely laminated, poor porosity and permeability, calcareous, with small solution cavities.
- 293.10' -
294.9' Low-grade marlstone; calcareous, poor porosity and permeability, finely laminated, 293.10 - 293.11' solution cavity zone, with minor calcite present at 294.5', a pod filled with a white material (bicarbonate?), 294.7' - 294.9' very fractured.
- 294.9' -
295.0' 3" lost core assigned here, probably from solution zone at 293.10' or fractured zone at 294.8'.
- 295.0' -
301.8' Barren marlstone; calcareous, poor porosity and permeability, finely laminated, solution cavities up to 1" in size containing a white slightly calcareous mineral, at 295.3', 297.3', 299.11', and 301.3', 296.2 - 296.8' is a zone with very small solution cavities also containing the white mineral. Lowermost 5" have abundant small solution cavities, badly fractured zone around 300.0'.
- 301.8' -
301.11' Calcareous "mudstone(?)"; medium brown with thin barren marlstone interbeds, also some solution cavities, good porosity and permeability.
- 301.11' =
303.2' Barren calcareous marlstone; finely laminated, poor porosity and permeability, solution zone at 302.2'.
- 303.2' -
305.0' Lost core probably due to solution zones, and fracture zone at approximately 300' assigned here.
- 305.0' -
310.6' Barren marlstone; finely laminated, poor porosity and permeability, moderate to very calcareous, at 306.11', 307.11, 308.3' and 310.4' solution cavity zones, at 307.3' and 309.2' are ¼" tuff beds, at 309.11' is a ½" tuff zone with thin marlstone interbeds, fractured zone at 308.3'.

- 310.6' -
314.3' - Very fine-grained to fine-grained, medium to dark brown sandstone; slightly to moderately calcareous, good to very good porosity and permeability, mostly indistinct bedding, but with some contorted thin interbeds of non-calcareous siltstone at 313.11' and 311.11'. From 311.10' to 311.11' the sandstone has a bluish tinge to it. At 312.9' is a ¼" tuff bed.
- 314.3' -
315.0' - Lost core probably due to solution cavities assigned here.
- 315.0' -
315.6' - Medium to dark brown fine-grained sandstone; indistinct bedding, non-calcareous, good porosity and permeability, at 315.6' is a ½" white fine-grained tuff(?).
- 315.6' -
315.7' - Very calcareous barren marlstone; finely laminated, poor porosity and permeability.
- 315.7' -
316.1' - Medium brown fine-grained sandstone with lenticular stringers of marlstone; moderately calcareous, good porosity and permeability, indistinct bedding.
- 316.1' -
316.10' - Barren, calcareous marlstone; finely laminated, poor porosity and permeability, 316.3 - 316.5' very fractured.
- 316.10' -
317.8' - Same as 315.7 - 316.1'.
- 317.8' -
317.11' - Light colored "sandy marlstone"; moderately calcareous, poor porosity and permeability.
- 317.11' -
320.5' - Medium brown fine-grained sandstone with several thin interbeds of marlstone; slightly to moderately calcareous, good porosity and permeability, occasional solution cavities in the marlstone interbeds, 2" sandy marlstone at 319.4', 2" fractured zone at 319.6'.
- 320.5' -
322.6' - Barren marlstone; fine slightly disturbed laminations, poor porosity and permeability, slightly to moderately calcareous, solution cavity zones at 320.5', 321.11' and 322.5', last two with minor gilsonite.
- 322.6' -
325.0' - Lost core due to solution cavities and fractures assigned here.

325.0' -
326.9' Barren very fractured marlstone; fine even laminations, poor porosity and permeability, very calcareous, solution zones at 325.0' and 326.6'.

326.9' -
327.6' Greyish white (when dry) sandy, barren marlstone; very calcareous, moderate to good porosity and permeability.

327.6' -
330.0' Barren to low-grade marlstone; poor porosity and permeability, very calcareous, top 7" moderately fractured.

330.0' -
331.6' Same as above with abundant solution cavities and a large proportion of "mud" (it looks muddy).

331.6' -
332.11' Same as 327.6 - 330.0' only unfractured.

332.11' -
335.0' Lost core due to solution cavities and fracturing assigned here.

335.0' -
336.7' Barren to low-grade marlstone; fractured with solution cavities in upper 8", at 335.11' a ¼" tuff bed, poor porosity and permeability, very calcareous, indistinct laminations.

336.7' -
336.9' Very fine-grained sandstone; massive, moderately calcareous, moderate porosity and permeability.

336.9' -
341.11' Barren to low-grade marlstone; finely laminated, poor porosity and permeability, moderately calcareous to calcareous, relatively unfractured, 70° joint at approximately 338.6', vertical joint at approximately 339.6'.

341.11' -
344.1' Low to medium-grade marlstone; fine somewhat contorted laminations, moderately calcareous, poor porosity and permeability.

344.1' -
345.0' Lost core assigned here.

345.0' -
345.11' Low to medium-grade marlstone; finely laminated, somewhat contorted at bottom, moderately calcareous, poor porosity and permeability,

- 345.11' -
348.6' Barren marlstone; finely laminated, poor porosity and permeability, very calcareous.
- 348.6' -
349.6' Very fine-grained sandstone with marlstone stringers and small rip-up clasts; good porosity and permeability, slightly calcareous, small specks and stringers of gilsonite.
- 349.6' -
351.10' Same as 345.11 - 348.6'.
- 351.10' -
355.0' Interbedded very fine-grained sandstone and barren marlstone; sandstone- good porosity and permeability, marlstone- poor porosity and permeability, both calcareous, marlstone finely laminated, sandstone has indistinct somewhat disturbed laminations as well as abundant small flecks of organic debris.
- 355.0' -
359.0' Very fine-grained sandstone with abundant rip-up clasts; good porosity and permeability, slightly calcareous, slightly calcareous disturbed siltstone beds at 356.7' (1") and 357.2' (up to 1").
- 359.0' -
362.3' Barren marlstone; poor porosity and permeability, very calcareous, finely laminated.
- 362.3' -
365.0' Very fine-grained sandstone interbedded with barren marlstone; sandstone- good porosity and permeability, moderately calcareous, indistinct disturbed bedding, marlstone- moderately calcareous, poor porosity and permeability, finely laminated, some rip-up clasts.
- 365.0' -
370.5'* Very fine-grained sandstone with abundant rip-up clasts and organic debris, some seams of marlstone up to 1"; sandstone has disturbed indistinct bedding and marlstone is contorted and mostly in thin little stringers, sandstone- slightly calcareous, good porosity and permeability, lowest 10" very broken up.
- 370.5' -
373.2'* Barren marlstone; poor porosity and permeability, calcareous, finely laminated.
- 373.2' -
375.0'* Medium to high-grade oil shale; calcareous, low porosity and permeability, finely laminated.

374.0' -
374.5' Is a clay seam.

*This 10 feet of description is actually 12 feet of core which the driller had labeled as 10 feet, so I have removed several inches from the footage of each description with the star.

375.0' -
380.0' Barren marlstone; moderate to good porosity and permeability, somewhat indistinct laminations, very calcareous, some organic debris, there is an almost vertical thin bicarbonate seam in the lower 18" (this is really somewhere between a marlstone and a calcareous approximately fine-grained sandstone or siltstone).

380.0' -
381.4' Medium-grade oil shale; moderately to very calcareous, poor porosity and permeability, finely laminated.

381.4' -
383.11' Low-grade marlstone; poor porosity and permeability, very calcareous, solution cavity at 381.9', very fractured at 382.1'.

383.11' -
385.0' This "lost core" is probably due to the fact that there was 12' of core in the last storing of core.

385.0' -
391.5' Low to medium-grade marlstone; indistinct fine laminations, very calcareous, poor porosity and permeability, solution zone at 385.6' to 385.10', fractured zone at approximately 386.10', at 389.5 - 390.8' very fractured zone with abundant solution cavities.

391.5' -
395.0' Lost core assigned here, possibly due to solution cavities, or to excess of core in storing of 365' - 375'.

395.0' -
396.4' Low to medium-grade marlstone; very fractured at approximately 396', poor porosity and permeability, very calcareous, indistinct fine laminations.

396.4' -
398.6' Sandy clay-rich zone grading down into marlstone; very abundant solution cavities, very calcareous.

398.6' -
400.6' Low-grade to barren marlstone; finely laminated, moderate to poor porosity and permeability, moderately calcareous, 1/8" tuff at 399.6'.

- 400.6' -
402.5' - Barren silty marlstone; moderate to good porosity and permeability, moderately calcareous, very fractured in zone 401.3 - 401.9'.
- 402.5' -
403.0' - (actually 1.4' of core) Barren to low-grade marlstone; poor porosity and permeability, finely laminated, moderately calcareous.
- 403.0' -
408.0' - Low-grade marlstone; light brown to medium brown, finely laminated, calcareous, poor porosity and permeability, moderate-spaced parting, some medium-grade horizons.
- 408.0' -
408.5' - Hydrocarbon-impregnated claystone(?) or marlstone(?); dark brown, heavily granulated, not particularly odoriferous.
- 408.5' -
483.6' - Low-grade marlstone to medium-grade oil shale; moderately-spaced partings, tuff beds at 416.6' and 416.11' (both approximately 0.1' thick), 419.8' (approximately 4mm) and 425.6' (approximately 1cm), tuff at 419.8' has hydrocarbon in interstices, cut by widely-spaced joints dipping 45° - 75°, pyrite along some surfaces, beginning at approximately 427.0' high-grade laminae appear, organic debris and thin (mm) tuff beds present at intervals, at 457.3' a 2cm tuff, coarse rounded grains (perhaps reworked?), at 459.8' a 1cm tuff, finer-grained with hydrocarbon in interstices.
- 483.6' -
486.6' - High-grade oil shale; dark brown, calcareous, finely laminated, poor porosity and permeability, moderate to closely spaced parting.
- 486.6' -
494' - Low-grade marlstone to medium-grade oil shale with interlaminae of high-grade oil shale as above; fracture with 80° dip at 490.3' grades downward into:
- 494' -
498.9' - Barren to low-grade marlstone; light brown, finely laminated, moderate porosity and permeability, moderately spaced partings, thin (mm) tuff beds, silty in lower 2 feet.
- 498.9' -
500' - Medium-grade oil shale; moderate to good porosity and permeability, no parting, no fracture.

- 500' -
523.2' Low-grade marlstone to medium-grade oil shale, with some barren horizons; thin tuff beds, as above, steep (approximately 80°) fracture at 503' with pyrite along fracture surface, higher-grade with some "boudinage" in interval 509 - 511' and 516.4 - 518.4', approximately 80° fracture with pyrite crystals at 520.4'.
- 523.2' -
525.9' Medium to high-grade oil shale; medium dark brown, finely laminated, heavily fractured with steep fractures 524.3' - 525', moderate porosity and permeability.
- 525.9' -
547' Low-grade marlstone to medium-grade oil shale, as above; widely spaced parting, no appreciable fracturing, 0.1' thick reworked tuff bed at 526.5', hydrocarbon in interstices, thin (mm) tuff beds at approximately 1' intervals, at 539.9' - 540.0' a coarse siltstone or very fine-grained sandstone, pinch and swell tuff beds impregnated with a viscous fluid hydrocarbon, grades downward into:
- 547' -
549.11' Barren to low-grade marlstone; silty, good porosity and permeability, 0.1' thick tuff bed at 548.5', solution cavity partially filled with solid hydrocarbon at 548.11' and vertical fracture filled with same at 549.4' - 549.10'.
- 549.11' -
558.11' Interbedded low-grade marlstone and medium-grade oil shale; disturbed bedding, widely spaced parting, prominent tuff beds at 555.9 - 555.10', 556.5 - 556.6', 70° fractures at 558.4 - 558.11', though continuity puzzling, grades downward into:
- 558.11' -
564' Low-grade to barren marlstone; light brown, non to slightly calcareous, siltstone horizons at 559.10' - 560.1' and 560.2 - 560.5', grades downward into:
- 564' - 568'
640' Low-grade marlstone to medium-grade oil shale; thin tuff beds at intervals, widely spaced parting, locally barren, near-vertical fractures with pyrite and/or bicarbonate(?) at 584.1 - 584.6', 586.0' - 587.1', and 590.9' - 591.10', interbedded tuffs from 605.10 - 606.4', grades downward to:
- 640' -
642.3' Medium to high-grade oil shale; medium dark brown, finely laminated, calcareous, unfractured, unparted.

- 642.3' -
657' Low-grade to barren marlstone; light brown, finely laminated, calcareous, unfractured, unparted, fair porosity and permeability, medium-grade horizons 648.10 - 649.8' and 653.3 - 654.4', tuff beds at 653.6, 653.7' dry 654.4', grades downward to:
- 657' -
667.3' Low-grade to barren marlstone, but predominantly barren; light tan-brown, finely laminated, calcareous to slightly calcareous, moderately spaced parting, moderately spaced fractures, some sealed with pyrite(?), solution cavities, pyrite seams at ½" to 1" intervals, fair to good porosity and permeability.
- 667.3' -
674' Low-grade marlstone, as above; thin tuff beds, insect larvae(?) and pyrite seams at ½ - 3" intervals, tuff(?) bed with interstitial hydrocarbon at 670.6', moderately spaced parting, unfractured, grades downward to:
- 674' -
674.2' Tuff, irregular upper and lower contacts; partially impregnated with viscous hydrocarbon.
- 674.2' -
674.8' High-grade oil shale; only slightly calcareous or dolomitic, pinch and swell tuff at 674.3'.
- 674.8' -
675.1' Siltstone, tuffaceous(?); light tan-brown, slightly calcareous (or dolomitic?).
- 675.1' -
678.9' High-grade oil shale, with lower-grade interbeds; slightly to moderately calcareous, odoriferous, clayey zone 675.6' - 676', grade decreases in the last 10".
- 678.9' -
678.10' Tuff, impregnated with hydrocarbon and clay.
- 678.10' -
691.5' Low-grade to barren marlstone; light brown, finely laminated, calcareous, moderately to poor porosity and permeability, unfractured, very widely-spaced parting, thin interbedded tuffs, some welded, notably in the interval 679.8 - 680'. 4" tuff (gray) at 687 - 687' 4", part of tuff appears to be missing, may be mahogany marker. Is Mahogany Marker at 687'.

691.5' -
695.4' - High-grade to medium-grade oil shale; slightly to moderately calcareous, no parting, one high angle fracture at 693'.

695.4' -
696.0' - Mud; brown, calcareous, soluble.

696.0' -
717' - High-grade oil shale; slightly calcareous, one parting at 709.2', vertical fracture 708 - 709', thin (1") tuffaceous zone at 716'.

717' -
723' - Medium-grade oil shale; no partings or fractures.

723.0' -
725.0' - Barren gray marlstone; calcareous, no parting or fracture.

725.0' -
729.0' - Low-grade oil shale with minor medium-grade stringers; slightly calcareous, no partings or fractures.

729.0' -
735.0' - Medium-grade oil shale; slightly calcareous, no fractures, weathered parting at 734.8'.

735.0' -
748' - Very low-grade oil shale; slightly to moderately calcareous, washed out gray mud seams between 735.6' and 743.3' (recovered 6' core between 735' and 745' due to washed out mud seams), parting planes common between 735' and 748', no high angle fractures.

748' -
749.0' - Low-grade oil shale; slightly calcareous, parting plane at 748.5'.

749.0' -
751.0' - Medium-grade oil shale; moderately calcareous, parting plane at 749.5', tuff clastic dike at 750.5 - 751'.

751.0' -
755.0' - Low-grade oil shale; high angle fractures at 752' 752.8' and 754', parting planes at 751.6' and 752.2' and common between 754' and 755'.

755' -
762' - High-grade oil shale with some medium-grade; small solution cavities at 755.2', thin spaced partings at 756.5' and 757.0' and 758.1'.

- 762' -
765.5' Low-grade oil shale; abundant parting planes 762.0 - 763.2'.
- 765.5' -
768.0' High-grade oil shale; no partings or fractures.
- 768.0' -
769.9' Medium-grade oil shale; vertical fracture 768.5' - 769.3'.
- 769.9' -
772.0' Barren marlstone; tan, calcareous. In part low-grade oil shale in lower part of interval. Tuffs at 770.6 - 770.9' and 771.3 - 771.6'.
- 772.0' -
776' Medium-grade oil shale with some high-grade; 3 thin tuffs at 772.9 - 773.2', one oil impregnated tuff 774.0 - 774.6'.
- 776' -
789' Very low-grade oil shale to barren marlstone; 1" tuff at 776.8', oil impregnated tuff 777.0 - 777.3', parting planes at 778.0' and 778.9'. Near vertical fracture at 779', highly broken 779.3 - 779.6', small solution cavity zone 779.8 - 780.2', parting planes common 780 - 789', highly broken zone 781.0 - 780.5', high angle fracture at 783.4 - 783.7', one inch tuff at 788.0'.
- 789' -
804.5' Tuffaceous barren marlstone to very-low grade tuffaceous oil shale; common parting planes throughout interval; high angle fractures at 791', 794', 795', (broken zone at 795'), high angle fractures at 796' and 798', thin tuffaceous siltstone stringers starting at 794' and continuing to 798', 1½" tuff with pyrite layer at 791.2', 3 high angle fractures between 798 and 799', high angle fractures at 800', 802.5', 804' and 804.5', small solution cavities with partial pyrite fillings at 800.5', 801.2', 801.6' and 802.6', highly broken zone at 802.4' - 802.6'.
- 804.5' -
807' Barren marlstone to very low-grade oil shale; abundant broken up solution cavity zones 804.5' - 807'.
- 805' - 807' as marked in core box is actually 805' - 809' due to solution cavity voids with no recovery. Interval is in part tuffaceous.

(NOTE: 684.0' - 685.0' zone above
699.0' - 700.0' mahogany bed
714' - 715' rich oil shale

730' - 731' "low" oil shale
741.5' - 742.8' random sample
776' - 777' below mine zone
Sampled for strength tests)

Boxes 37A - 48 to be slabbed.

- 807' -
811.5' Very low-grade oil shale to barren marlstone; thin (less than 2cm) carbonaceous streaks, sulfide lens (pyrite) 2cm thick at 809', parting planes at approximately 2" intervals, near vertical fractures at 809.6', 810', and 810.8'.
- 811.5' -
812.5' Low-grade oil shale with less than 1" thick streaks of medium-grade oil shale.
- 812.5' -
813.5' Very low-grade oil shale to barren marlstone; tuffaceous.
- 813.5' -
817' Medium to low-grade oil shale; parting at 814' and 816.6', finely laminated except contorted bedding at 814 - 814.5', tuffaceous bed less than ½" (less than 4mm) at 815.8'. (NOTE: 817' conforms to drillers 819').
- 819' -
829' Medium to very low-grade oil shale; finely laminated with 6cm rich bed at 822.5', parting at 819.5', 820.8', 820.9, 821, 822.5, 824', contorted bedding at 828', abundant carbonaceous material on bedding planes, tuff bed (5cm) at 825', white.
- 829' -
832' Low-grade oil shale; finely laminated, parting at 829.5', 831.5, carbonaceous debris throughout.
- 832' -
832.3' Tuff; gray, finely crystalline.
- 832.3' -
833' Barren marlstone; tuffaceous, contorted bedding, silty(?).
- 833' -
837.4' Medium to low-grade oil shale; finely laminated, rich bed (2cm) at 834', parting at 834.4, 835, and 837'.
- 837.4' -
839' Medium-grade oil shale; parting at 838.4, 838.8', (grades richer at base).

839' -
840' Medium grading to rich oil shale; parting at 839.4', contorted bedding in richest zone at 840'.

840' -
849' Medium-grade oil shale; finely laminated with inter-laminations of carbonaceous material (less than 2mm), parting at 840.5, 842, 844, 846'.

849' -
850' Medium-grade oil shale, as above.

850' -
850.3' Tuff; gray, finely crystalline, broken.

850.3' -
851.5' Medium-rich oil shale; deformed beds at 851'.

851.5 -
856.5' Medium-grade oil shale; finely laminated, near vertical fracture at 853.5', lenticular tuff bed at 856', contorted beds at 856.2', parting at 853.2, 854, and 855.3'.

856.5' -
856.8' Tuff; tan, finely crystalline, with visible plagioclase laths.

856.8' -
858' Medium-grade oil shale; parting at 857, 858.5', tuff "nodule" at 856.8'.

858' -
861' Medium-grade oil shale; 4cm tuff bed at 859.3', healed fractures with offset at 859.5, 860.8', parting at 861.0'.

861' -
868' Medium grading to rich oil shale; rich zone from 863 - 864', near vertical fracture at 865.2', parting at 864, 864.5, 865.8', contorted bedding at 867'.

868' -
874.5' Medium-grade oil shale; finely laminated, with interlaminations of carbonaceous material less than 2cm thick, parting at 868.5', 867.8' and 871.2', contorted beds at 872'.

874.5' -
878' Low-grade oil shale to barren marlstone; plant debris on parting at 878'.

878' -
883' Low to medium-grade oil shale with small (less than 2mm) sandstone lenses at 882' and 882.2', parting at 880'.

- 883' -
884.5' Rich oil shale; vertical fractures at 883.2, 883.7',
parting at 884.2'.
- 884.5' -
888' Low to medium-grade oil shale; parting at 885',
30° fracture(?) at 886'.
- 888' -
897' Low-grade oil shale grading down to barren marlstone
at base, medium-rich zones (less than 6cm) at 890' and
893', near vertical fracture at 895.5 - 896'.
Abundant hydrocarbon dikes within gray marlstone.
- 897' -
907' Barren marlstone; finely laminated with small (1mm)
carbonaceous layers throughout, parting at 900, 901.8,
903, 904', 80° fracture at 906', mud pebbles at 905.5'.
- 907' -
912' Barren marlstone, as above.
- 912' -
916' Medium-grade oil shale; parting at 915' and 915.8',
contorted bedding at 915.5'.
- 916' -
925' (TD) Low-grade oil shale to barren marlstone; thinly lami-
nated with thin (less than 1mm) interlaminations of
carbonaceous material, parting at 917, 918.5, 922,
923.8'.