Cuttings Analysis Report

ALASKA MULTI-WELL

Iniskin Bay Association 1
Iniskin Beal 1
Iniskin Zappa 1
OCS Y—0097 Raven 1
OCS Y-0243 Falcon 1
COST Cook Inlet 1 DST07

Prepared for:

Hilcorp Energy LLC

Version 1

January 2021

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Introduction

Drill cuttings were submitted to NUTECH-PoroLab in two shipments, arriving October 15, 2020 and November 17, 2020, respectively. The first shipment included 60 samples from the Iniskin Bay Association 1, Iniskin Beal 1, and Iniskin Zappa 1 wells. The second shipment included 61 samples from the OCS Y-0097 Raven 1, OCS Y-0243 Falcon 1, and COST Cook Inlet 1 DST07 wells.

This report serves as technical documentation to outline sample preparation, measurement, data reduction, and analysis procedures for mercury injection capillary pressure (MICP) and x-ray diffraction (XRD) testing on the received sample material.

Sample Inventory

Sample #	Well	Top Depth (ft)	Bottom Depth (ft)	Median Depth (ft)
A-1	INISKIN BAY ASSOC 1	2501.00	2503.00	2502.00
A-21	INISKIN BAY ASSOC 1	3400.00	3400.00	3400.00
A-11	INISKIN BAY ASSOC 1	4540.00	4540.00	4540.00
A-2	INISKIN BAY ASSOC 1	4695.00	4706.00	4700.50
A-15	INISKIN BAY ASSOC 1	4800.00	4800.00	4800.00
A-3	INISKIN BAY ASSOC 1	4985.00	5000.00	4992.50
A-14	INISKIN BAY ASSOC 1	5020.00	5020.00	5020.00
A-4	INISKIN BAY ASSOC 1	5053.00	5066.00	5059.50
A-5	INISKIN BAY ASSOC 1	5711.00	5718.00	5714.50
A-6	INISKIN BAY ASSOC 1	5743.00	5757.00	5750.00
A-16	INISKIN BAY ASSOC 1	6050.00	6070.00	6060.00
A-7	INISKIN BAY ASSOC 1	6298.00	6318.00	6308.00
A-8	INISKIN BAY ASSOC 1	6339.00	6346.00	6342.50
A-9	INISKIN BAY ASSOC 1	6359.00	6380.00	6369.50
A-12	INISKIN BAY ASSOC 1	6510.00	6520.00	6515.00
A-13	INISKIN BAY ASSOC 1	6740.00	6750.00	6745.00
A-10	INISKIN BAY ASSOC 1	6803.00	6810.00	6806.50
A-17	INISKIN BAY ASSOC 1	6900.00	6910.00	6905.00

A-18	INISKIN BAY ASSOC 1	7380.00	7390.00	7385.00
A-20	INISKIN BAY ASSOC 1	8190.00	8200.00	8195.00
A-19	INISKIN BAY ASSOC 1	8016.00	8505.00	8260.50
B-1	INISKIN UNIT BEAL 1	2515.00	2515.00	2515.00
B-2	INISKIN UNIT BEAL 1	2517.00	2540.00	2528.50
B-9	INISKIN UNIT BEAU	5780.00	5810.00	5795.00
B-12	INISKIN UNFT BEAL 1	6290.00	6320.00	6305.00
B-3	INISKIN UNIT BEAL 1	6415.00	6420.00	6417.50
B-4	INISKIN UNIT BEAL 1	6420.00	6424.00	6422.00
B-13	INISKIN UNIT BEAL 1	6900.00	6920.00	6910.00
B-14	INISKIN UNIT BEAL 1	7000.00	7020.00	7010.00
B-15	INISKIN UNIT BEAL 1	7140.00	7160.00	7150.00
B-16	INISKIN UNIT BEAL 1	7280.00	7300.00	7290.00
B-17	INISKIN UNIT BEAL 1	7780.00	7800.00	7790.00
B-10	INISKIN UNIT BEAL 1	8020.00	8040.00	8030.00
B-11	INISKIN UNIT BEAL 1	8200.00	8220.00	8210.00
B-5	INISKIN UNIT BEAL 1	8683.00	8707.00	8695.00
B-6	INISKIN UNIT BEAL 1	9084.00	9098.00	9091.00
B-18	INISKIN UNIT BEAL 1	9140.00	9153.00	9146.50
B-19	INISKIN UNIT BEAL 1	9240.00	9250.00	9245.00
B-7	INISKIN UNIT BEAL 1	9282.00	9293.00	9287.50
B-8	INISKIN UNIT BEAL 1	9635.00	9647.00	9641.00
B-20	INISKIN UNIT BEAL 1	9690.00	9700.00	9695.00
C-6	INISKIN UNIT ZAPPA 1	540.00	540.00	540.00
C-11	INISKIN UNIT ZAPPA 1	2560.00	2560.00	2560.00
C-l2	INISKIN UNIT ZAPPA 1	2660.00	2660.00	2660.00
C-7	INISKIN UNIT ZAPPA 1	2800.00	2800.00	2800.00

C-8	INISKIN UNIT ZAPPA 1	2940.00	2940.00	2940.00
C-13	INISKIN UNIT ZAPPA 1	4080.00	4080.00	4080.00
C-9	INISKIN UNIT ZAPPA 1	4580.00	4580.00	4580.00
C-14	INISKIN UNIT ZAPPA 1	5520.00	5520.00	5520.00
C-10	INISKIN UNIT ZAPPA 1	5900.00	5900.00	5900.00
C-17	INISKIN UNIT ZAPPA 1	6060.00	6060.00	6060.00
C-15	INISKIN UNIT ZAPPA 1	6800.00	6820.00	6810.00
C-18	INISKIN UNIT ZAPPA 1	7820.00	7840.00	7830.00
C-1	INISKIN UNIT ZAPPA 1	8125.00	8140.00	8132.50
C-2	INISKIN UNIT ZAPPA 1	8302.00	8348.00	8325.00
C-16	INISKIN UNIT ZAPPA 1	9460.00	9460.00	9460.00
C-3	INISKIN UNIT ZAPPA 1	9728.00	9743.00	9735.50
C-4	INISKIN UNIT ZAPPA 1	9800.00	9817.00	9808.50
C-5	INISKIN UNIT ZAPPA 1	10039.00	10049.00	10044.00
C-19	INISKIN UNIT ZAPPA 1	10300.00	10300.00	10300.00
C-20	INISKIN UNIT ZAPPA 1	10640.00	10640.00	10640.00
D-1	OCS Y-0097 RAVEN 1	1770.00	1800.00	1785.00
D-2	OCS Y-0097 RAVEN 1	1800.00	1830.00	1815.00
D-3	OCS Y-0097 RAVEN 1	1920.00	1950.00	1935.00
D-4	OCS Y-0097 RAVEN 1	2040.00	2070.00	2055.00
D-13	OCS Y-0097 RAVEN 1	2070.00	2100.00	2085.00
D-14	OCS Y-0097 RAVEN 1	2130.00	2160.00	2145.00
D-15	OCS Y-0097 RAVEN 1	2400.00	2430.00	2415.00
D-5	OCS Y-0097 RAVEN 1	2720.00	2760.00	2740.00
D-16	OCS Y-0097 RAVEN 1	2850.00	2880.00	2865.00

D-6	OCS Y-0097 RAVEN 1	3120.00	3150.00	3135.00
D-17	OCS Y-0097 RAVEN 1	3150.00	3180.00	3165.00
D-7	OCS Y-0097 RAVEN 1	3150.00	3180.00	3165.00
D-18	OCS Y-0097 RAVEN 1	3180.00	3210.00	3195.00
D-19	OCS Y-0097 RAVEN 1	3210.00	3240.00	3225.00
D-20	OCS Y-0097 RAVEN 1	3240.00	3270.00	3255.00
D-8	OCS Y-0097 RAVEN 1	3270.00	3290.00	3280.00
D-9	OCS Y-0097 RAVEN 1	3660.00	3690.00	3675.00
D-10	OCS Y-0097 RAVEN 1	4090.00	4100.00	4095.00
D-11	OCS Y-0097 RAVEN 1	4290.00	4300.00	4295.00
D-12	OCS Y-0097 RAVEN 1	7080.00	7090.00	7085.00
E-1	OCS Y-0243 FALCON 1	1110.00	1140.00	1125.00
E-3	OCS Y-0243 FALCON 1	1450.00	1470.00	1460.00
E-14	OCS Y-0243 FALCON 1	1530.00	1560.00	1545.00
E-2	OCS Y-0243 FALCON 1	1170.00	2000.00	1585.00
E-15	OCS Y-0243 FALCON 1	1590.00	1620.00	1605.00
E-16	OCS Y-0243 FALCON 1	1620.00	1650.00	1635.00
E-17	OCS Y-0243 FALCON 1	1830.00	1860.00	1845.00
E-4	OCS Y-0243 FALCON 1	2010.00	2040.00	2025.00
E-5	OCS Y-0243 FALCON 1	2250.00	2280.00	2265.00
E-18	OCS Y-0243 FALCON 1	2250.00	2280.00	2265.00
E-6	OCS Y-0243 FALCON 1	2520.00	2550.00	2535.00

E-19	OCS Y-0243 FALCON 1	2550.00	2580.00	2565.00
E-7	OCS Y-0243 FALCON 1	2790.00	2820.00	2805.00
E-8	OCS Y-0243 FALCON 1	2880.00	2910.00	2895.00
E-9	OCS Y-0243 FALCON 1	3270.00	3300.00	3285.00
E-10	OCS Y-0243 FALCON 1	4200.00	4230.00	4215.00
E-11	OCS Y-0243 FALCON 1	4320.00	4360.00	4340.00
E-20	OCS Y-0243 FALCON 1	4440.00	4470.00	4455.00
E-12	OCS Y-0243 FALCON 1	4628.00	4628.00	4628.00
E-13	OCS Y-0243 FALCON 1	5070.00	5090.00	5080.00
F-15	COST COOK INLET 1 DST07	1356.00	1386.00	1371.00
F-14	COST COOK INLET 1 DST07	1390.00	1420.00	1405.00
F-13	COST COOK INLET 1 DST07	1480.00	1510.00	1495.00
F-12	COST COOK INLET 1 DST07	1630.00	1660.00	1645.00
F-11	COST COOK INLET 1 DST07	1690.00	1720.00	1705.00
F-10	COST COOK INLET 1 DST07	1780.00	1810.00	1795.00
F-9	COST COOK INLET 1 DST07	1840.00	1870.00	1855.00
F-16	COST COOK INLET 1 DST07	2020.00	2050.00	2035.00
F-8	COST COOK INLET 1 DST07	2080.00	2110.00	2095.00
F-17	COST COOK INLET 1 DST07	2200.00	2230.00	2215.00
F-21	COST COOK INLET 1 DST07	2470.00	2500.00	2485.00
F-18	COST COOK INLET 1 DST07	3010.00	3040.00	3025.00
F-7	COST COOK INLET 1 DST07	3400.00	3430.00	3415.00

F-6	COST COOK INLET 1 DST07	3460.00	3490.00	3475.00
F-19	COST COOK INLET 1 DST07	3550.00	3580.00	3565.00
F-5	COST COOK INLET 1 DST07	3670.00	3700.00	3685.00
F-20	COST COOK INLET 1 DST07	3970.00	4000.00	3985.00
F-4	COST COOK INLET 1 DST07	6490.00	6520.00	6505.00
F-3	COST COOK INLET 1 DST07	6550.00	6580.00	6565.00
F-2	COST COOK INLET 1 DST07	11860.00	11890.00	11875.00
F-1	COST COOK INLET 1 DST07	12160.00	12190.00	12175.00

Sample Preparation & Handling

- General Sample Preparation:
  - Inventory and evaluate viability and potential contamination on received samples.
  - Visually inspect the material and remove any ferrous metal with a hand magnet.
  - Pour sample into water-filled plastic beaker and place cup into ultrasonic bath to remove exterior mud contaminants. Decant any remaining water.
  - Fill beaker with Methanol until material is covered. Stir. Leave sample to extract under fume hood for 1-2 hours. Decant methanol from beaker.
  - Scoop sample material into metal tray and dry for 12 hours in 60C convection oven.
  - Split the cleaned sample using micro-splitter. Repeat for multiple passes until 10g yield for XRD and 10g yield for MICP is reached.
  - Remove fines from MICP material using +35 mesh sieve.

Mercury Injection Capillary Pressure (MICP)

- Sample Preparation
  - Prepared sample material is placed in a 60C oven for a minimum of 12 hours to remove excess moisture.
  - Queued samples are removed from oven 2 hours prior to testing and placed into desiccator.
  - Queued samples are weighed to thousandths of a gram and loaded into sample cup
    - Sample weight to load into sample cup is determined by the anticipated sample pore volume relative to the closure volume
- Measurement
  - Intrusion
  - Initial Filling Pressure: 1.5 psia
  - Equilibrium: Set by time of 30 seconds

- Data Reduction
  - Blank Correction
    - Non-porous, quartz blank data is used to correct for system compression, mercury compression, and mercury thermal expansion.
    - The incremental volumes from the mineral blank are subtracted from the incremental volumes of the sample at each pressure step

$$V_{blank\,corrected} = V_{sample} - V_{blank}(V_{system}, V_{Hg,P}, V_{Hg,T}, V_g)$$

  - Closure Correction
    - Closure corrections are applied to remove volumes associated with the conformance of mercury surrounding the bulk volume of the sample

$$V_b = \left[V_{pen} - \left(\frac{w_{assembly} - w_{pen} - w_{sample}}{\rho_{Hg}}\right)\right] - V_{closure}$$

    - Closure and intrusion pressures are selected by 'Bailey Method' using apparent pore compressibility plot

$$c_P = \frac{1}{V_P}\frac{\partial V_P}{\partial P}$$

  - Stress Correction
    - Stress corrections are applied to remove volumes associated with bulk, pore, and grain compression of the sample

$$V_{apparent} = V_{closure} + V_{blank} + V_{intruded} + \partial V_P + \partial V_g$$

    - Pore and grain compressibility are combined into a bulk compressibility model by the following formula:

$$c_b = (1 - \varphi)c_g + \varphi c_p$$

    - Grain compressibility is determined by XRD and assumed mineral compressibility

- Data Analysis
  - Pore Throat Distribution
    - Washburn's equation is used to convert measured pressure data to pore throat sizes using assumed contact angle and surface tension values

$$Diameter = \frac{-4\gamma cos(\theta)}{P_{Hg}}$$

    - Mercury/Air Contact Angle: 140^o
    - Mercury/Air Surface Tension: 485 dyne/cm
  - Capillary Pressure Conversion
    - Mercury/Air fluid system is converted to reservoir fluid systems

Fluid System	Lab Contact Angle	Lab Surface Tension
Gas/Water	0^o	70 dyne/cm
Gas/Oil	0^o	24 dyne/cm
Oil/Water	30^o	35 dyne/cm

$$\frac{P_c}{|\gamma_c cos(\frac{\pi\theta_c}{180})|} = \frac{P_{Hg}}{|\gamma_{Hg} cos(\frac{\pi\theta_{Hg}}{180})|}$$

    - To normalize the capillary pressure data, the Leverett J-Function curve is calculated

$$J = 0.217 * \frac{P_{Hg}}{\left|\gamma_{Hg}\cos\left(\frac{\pi\theta_{Hg}}{180}\right)\right|} * \sqrt{\frac{k}{\varphi}}$$

  - Porosity, Permeability vs. Pressure
    - The fitting of compressibility models via stress corrections allows for dynamic modeling of bulk, pore, and grain volumes with compression
    - Sample porosity compression is normalized into a compaction table format to show relative volume reduction due to stress
    - The reduction in pore volume over the sample's pore throat distribution is used to model the reduction in permeability due to stress

X-Ray Diffraction (XRD)

- Sample Preparation
  - Prepared sample material is ground into a fine, homogeneous powder using McCrone micro-ionizing mill for 12 minutes. Slurry is poured into plastic beaker.
  - Sample-filled beakers are moved to dry under vent hood until solid material is separated from solution. Any remaining liquid is decanted.
  - Material is dispersed within aqueous solution and loaded into sample cup attached to spray dry brush.
  - Sample is sprayed into heating chamber at a low pressure (10-15 psi) to allow the solution to form dry, spherical particles for collection underneath equipment.
  - Approximately 4-5g of material is allocated for bulk measurement.
  - Remaining material for clay measurement is dispersed within distilled water using sonic probe. Suspensions are size fractionated with centrifuge to isolate < 4-micron particles.
  - The < 4-micron material is vacuum deposited onto nylon membrane filter to produce oriented clay mounts.

- Bulk Measurement
  - Approximately 4g of spray dry powder is loaded into stainless-steel sample holder and scanned with X-Ray Diffractometer using Cu Kα radiation.
    - The unit is fitted with a "D/teX Ultra" high speed detector with a Ni filter to eliminate K-β peaks.
    - Samples are scanned from 5° to 70° 2θ with a step size of 0.02° 2θ and a scan rate of 5° 2θ per minute.

- Clay Measurement
  - The oriented clay mounts are scanned with X-Ray Diffractometer from 2° to 36° 2θ using Cu Kα radiation.
  - The clay fraction is treated with vaporized ethylene glycol for 12 hours. Additional heat treatments are done as needed.

- The glycol-treated, oriented clay mounts are scanned again with X-Ray Diffractometer from 2° to 36° 2θ using Cu Kα radiation.

- Data Analysis
  - Bulk diffractograms are analyzed using ICDD PDF2 2012 and NIST databases, along with in-house mineral standards, to identify the mineral phases present.
    - Mineralogy is quantified using Whole Pattern Profile Fitting (WPPF) software with Rietveld Refinement techniques.
    - Non-crystalline (amorphous) material, such as organic matter is not included within quantified composition.
  - Clay speciation and mixed-layer clay ordering are determined by comparing experimental diffraction data from the air-dried and glycol-solvated clay mounts.
    - Simulated one-dimensional diffraction profiles are generated using NEWMOD written by R.C. Reynolds.

Data Summary

Based on client-provided tops, MICP and XRD data are averaged and summarized by formation:

- Iniskin Bay Association 1

Formation	Ambient Porosity (%)	Grain Density (g/cc)	Permeability to Air (Swanson) (mD)	Median Pore Throat Radius (µm)	Quartz (%)	Total Carbonate (%)	Total Clay (%)
Gaikema	8.85	2.58	4.33E-04	8.81E-03	25.80	0.55	40.80
Red Glacier	6.66	2.70	1.76E-04	8.05E-03	23.70	7.50	33.00
Red Glacier Lower	5.83	2.66	1.42E-04	6.67E-03	40.92	11.96	23.36
Red Glacier Middle	6.85	2.68	7.71E-03	1.16E-02	33.10	8.77	27.65

- Iniskin Beal 1

Formation	Ambient Porosity (%)	Grain Density (g/cc)	Permeability to Air (Swanson) (mD)	Median Pore Throat Radius (µm)	Quartz (%)	Total Carbonate (%)	Total Clay (%)
Naknek	9.10	2.66	2.24E-03	9.64E-03	21.30	1.40	15.80
Red Glacier Lower	8.50	2.64	1.84E-01	4.19E-02	31.09	5.51	26.86
Red Glacier Middle	10.50	2.68	1.07E-02	1.88E-02	29.50	2.86	33.57
Talkeetna	5.24	2.64	1.31E-02	6.18E-02	23.96	4.91	28.48

- Iniskin Zappa 1

Formation	Ambient Porosity (%)	Grain Density (g/cc)	Permeability to Air (Swanson) (mD)	Median Pore Throat Radius (µm)	Quartz (%)	Total Carbonate (%)	Total Clay (%)
Cynthia Falls	9.40	2.53	1.56E-02	6.17E-02	7.70	11.30	18.60
Gaikema	8.53	2.64	8.44E-03	1.93E-02	16.45	4.77	27.88
Red Glacier Lower	5.39	2.68	8.76E-05	6.60E-03	32.88	8.35	26.60
Red Glacier Middle	8.30	2.69	2.85E-04	8.55E-03	33.10	7.47	21.62
Talkeetna	5.82	2.58	1.61E-01	2.40E-01	32.34	3.12	16.04

- OCS Y-0097 Raven 1

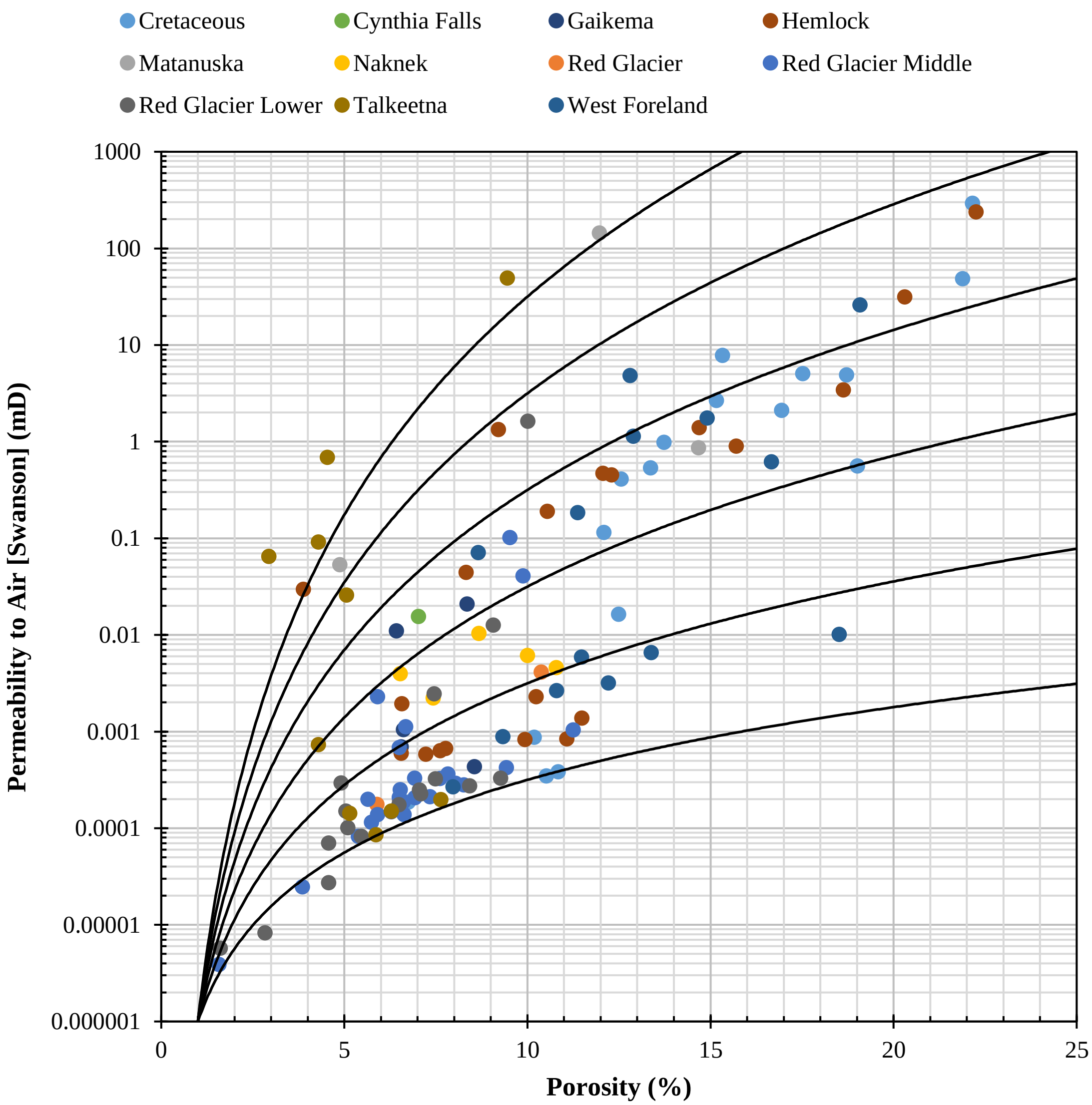
Formation	Ambient Porosity (%)	Grain Density (g/cc)	Permeability to Air (Swanson) (mD)	Median Pore Throat Radius (µm)	Quartz (%)	Total Carbonate (%)	Total Clay (%)
Cretaceous	19.37	2.56	3.59E+01	2.40E-01	28.60	2.22	23.88
Hemlock	10.69	2.52	4.97E-01	6.74E-02	31.23	1.40	33.27
Red Glacier	14.05	2.64	4.15E-03	1.33E-02	15.30	42.00	7.10
West Foreland	18.93	2.54	1.31E+01	3.21E-01	17.40	2.45	41.55

- OCS Y-0243 Falcon 1

Formation	Ambient Porosity (%)	Grain Density (g/cc)	Permeability to Air (Swanson) (mD)	Median Pore Throat Radius (µm)	Quartz (%)	Total Carbonate (%)	Total Clay (%)
Cretaceous	15.70	2.66	1.64E-02	1.84E-02	26.30	1.96	19.51
Hemlock	17.46	2.47	1.97E+01	1.24E-01	25.58	1.90	24.63
Matanuska	16.06	2.54	4.85E+01	5.14E-02	19.33	0.85	16.83
Talkeetna	16.05	2.57	4.96E+01	1.02E-01	12.30	1.34	12.10
West Foreland	20.86	2.76	6.22E-01	1.19E-01	42.60	6.10	24.86

- COST Cook Inlet 1 DST07

Formation	Ambient Porosity (%)	Grain Density (g/cc)	Permeability to Air (Swanson) (mD)	Median Pore Throat Radius (µm)	Quartz (%)	Total Carbonate (%)	Total Clay (%)
Cretaceous	17.94	2.55	1.43E+00	5.45E-02	27.57	1.77	19.89
Naknek	13.04	2.56	6.28E-03	1.44E-02	17.50	2.67	33.10
West Foreland	15.32	2.56	7.13E-01	3.01E-02	32.88	2.10	30.24



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