Oil and Natural Gas Technology

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3Q2007 Quarterly Progress Report

Twentieth Quarterly Report: July 2007 – September 2007

Resource Characterization and Quantification of Natural Gas-Hydrate and Associated Free-Gas Accumulations in the Prudhoe Bay – Kuparuk River Area on the North Slope of Alaska

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PROJECT ABSTRACT

Methane hydrate may contain significant offshore and onshore arctic gas resources. This study is helping to determine whether or not gas hydrate can become a technically and economically recoverable gas resource. Phase 1-2 desktop studies included reservoir characterization, development scenario modeling, and associated studies which indicated that 0-12 TCF gas may be technically recoverable from 33 TCF gas-in-place (GIP) Eileen trend gas hydrate beneath industry infrastructure within the Milne Point Unit (MPU), Prudhoe Bay Unit (PBU), and Kuparuk River Unit (KRU) areas on the Alaska North Slope (ANS). Modeled production methods involve subsurface depressurization and/or thermal stimulation of pore-filling gas hydrate into gas and water components.

Phase 2 studies included rate forecasts and hypothetical well scheduling, methods typically employed to evaluate the development potential of large conventional gas accumulations. This work helped quantify: 1. Potential to technically produce gas from the 33 TCF GIP Eileen trend gas hydrate resource using conventional petroleum technologies and 2. Range of 0-12 TCF possible recoverable resource based on potential schematic development schemes. Phase 2 studies culminated in recommendations to acquire Phase 3a reservoir data including 400-600 feet core, extensive wireline logs, and MDT wireline tests within the Mount Elbert intra-hydrate MPU prospect interpreted from the Milne 3D seismic survey. Phase 3b studies, if approved, would acquire additional static data and include production testing, likely from a gravel pad within production infrastructure.

Phase 2 production forecast and regional schematic modeling studies included downside, reference, and upside cases. Reference case forecasts with type-well depressurization-induced production rates of 0.4-2.0 MMSCF/D predict that 2.5 TCF of gas might be produced in 20 years, with 10 TCF ultimate recovery after 100 years; it is important to note that typical industry forecasts would not exceed 50 years. Downside cases envision research pilot failure and economic or technical infeasibility. Upside cases identify additional potential if Phase 3 data acquisition confirms reference case or upside modeling results of pressure-induced, thermally enhanced, and/or chemically stimulated gas hydrate dissociation into producible gas. Phase 3a field studies initiated in early 2007 and acquired data to help mitigate uncertainty in potential gas hydrate productivity. Successful Phase 3a MountElbert-01 stratigraphic test drilling and data acquisition was completed between February 3-19, 2007. Initial Phase 3b production test planning is underway with Phase 3a data evaluation, but a Phase 3b long-term production test is not currently approved by BP.

ACKNOWLEDGEMENTS

This cooperative DOE-BPXA research project has helped facilitate and maintain industry interest in the resource potential of shallow natural gas hydrate accumulations. This research could help determine whether or not methane hydrate may become an additional unconventional gas resource and DOE and BPXA support of these studies is gratefully acknowledged.

DOE National Energy Technology Lab staff Brad Tomer, Ray Boswell, Richard Baker, Edith Allison, Tom Mroz, Kelly Rose, Eilis Rosenbaum, and others have enabled continuation of this and associated research projects. Scott Digert, Gordon Pospisil, and others at BPXA continue to promote the importance of this cooperative research within industry. BPXA staff Micaela Weeks, Larry Vendl, Dennis Urban, Dan Kara, Paul Hanson, and others supported stratigraphic test well plans and execution for successful Phase 3a well operations and data acquisition. The State of Alaska Department of Natural Resources through the efforts and leadership of Dr. Mark Myers, Bob Swenson, Paul Decker, and others has consistently recognized the contribution of this research toward identifying a possible additional unconventional gas resource and actively supported the Methane Hydrate Act of 2005 to enable continued funding of these studies.

The USGS has led ANS gas hydrate research for nearly 3 decades. Dr. Tim Collett coordinates USGS partnership in this Alaska gas hydrate research and potential future development. Seismic studies accomplished by Tanya Inks at Interpretation Services and by USGS scientists Tim Collett, Myung Lee, Warren Agena, and David Taylor identified multiple MPU gas hydrate prospects. Support by USGS staff Bill Winters, Bill Waite, and Tom Lorenson and Oregon State University staff Marta Torres and Rick Colwell is gratefully acknowledged. Steve Hancock at APA (RPS Energy) and Peter Weinheber at Schlumberger helped design the Phase 3a wireline testing program. Scott Wilson at Ryder Scott has progressed reservoir models from studies by the University of Calgary (Dr. Pooladi-Darvish) and the University of Alaska Fairbanks (UAF). The Canadian Modeling Group (CMG) STARS program was adapted to an industry-standard production model of gas hydrate-bearing reservoir behavior and has helped assess the regional development potential of Alaska North Slope gas hydrate (if proven as a resource). Dr. Shirish Patil and Dr. Abhijit Dandekar have helped redevelop the UAF School of Mining and Engineering into an arctic regions gas hydrate research center. The University of Arizona reservoir characterization studies led by Dr. Bob Casavant with Dr. Karl Glass, Ken Mallon, Dr. Roy Johnson, and Dr. Mary Poulton have described the structural and stratigraphic architecture of Eileen trend ANS Sagavanirktok formation gas hydrate-bearing reservoir sands.

Current related studies of gas hydrate resource potential are too numerous to mention here. National Labs studies include Dr. Pete McGrail, CO_2 Injection, and Dr. Mark White, reservoir modeling, at Pacific Northwest National Lab and Dr. George Moridis, reservoir modeling, at Lawrence Berkeley National Lab. The Colorado School of Mines under the leadership of Dr. Dendy Sloan continues to progress laboratory and associated studies of gas hydrate. The significant efforts of international gas hydrate research projects such as those supported by the Directorate General of Hydrocarbons by the government of India and by the Japan Oil, Gas, and Metals National Corporation (JOGMEC) with the government of Japan are contributing significantly to a better understanding of the resource potential of natural methane hydrate. JOGMEC and the government of Canada support of the 2002 and current Mallik project gas hydrate studies in Northwest Territories, Canada are gratefully acknowledged. This cooperative DOE-BPXA research project builds upon the accomplishments of many prior government, academic, and industry studies.

TABLE OF CONTENTS

1.0 LIST OF TABLES AND FIGURES

2.0 PROJECT INTRODUCTION

The cooperative research between BP Exploration (Alaska), Inc. (BPXA) and the U.S. Department of Energy (DOE) is helping to characterize and assess Alaska North Slope (ANS) methane hydrate resource and is helping to identify technical and commercial factors that could enable government and industry to understand the future development potential of this possible unconventional energy resource. Results of Phase 1-2 reservoir characterization, reservoir modeling, regional schematic modeling, and associated studies culminated in approval to proceed into a 2007 Phase 3a stratigraphic test to acquire data designed to help mitigate potential recoverable resource uncertainty. Future Phase 3b production testing is a key goal of the Federal Research and Development program and may follow, but this is under evaluation. Collaborative research partners include U.S. Geological Survey (USGS), Arctic Slope Regional Corporation Energy Services, Ryder Scott Company, and APA RPS Engineering working with the University of Arizona, University of Alaska Fairbanks, Oregon State University, Pacific Northwest National Lab, Lawrence Berkeley National Lab (LBNL), and others.

Methane hydrate may contain a significant portion of world gas resources within offshore and onshore arctic regions petroleum systems. In the United States, accumulations of gas hydrate occur within pressure-temperature stability regions in both offshore and also onshore near-permafrost regions. USGS probabilistic estimates indicate that clathrate hydrate may contain a mean of 590 TCF in-place ANS gas resources (Figure 1a). Over 33 TCF in-place potential gas hydrate resources are interpreted within shallow sand reservoirs beneath ANS production infrastructure within the Eileen trend (Figure 1b). Gas hydrate accumulations require the presence of all petroleum system components (source, migration, trap, seal, charge, and reservoir). Future exploitation of gas hydrate would require developing feasible, safe, and environmentally-benign production technology, initially within areas of industry infrastructure. The ANS onshore area within the Eileen trend favorably combines these factors. The information and technology being developed in this onshore ANS program will be an important component to assessing the possible productivity of the potentially much larger marine hydrate resource. The resource potential of gas hydrate remains unproven, but if proven, could increase ANS, U.S., and world gas resources.

In 1972, the existence of natural methane hydrate within ANS shallow sand reservoirs was confirmed by data acquired in the Northwest Eileen State-02 well. Although up to 100 TCF in-place gas may be trapped within the gas hydrate-bearing formations beneath existing ANS infrastructure, it has been primarily known as a shallow gas drilling hazard to the hundreds of well penetrations targeting deeper oil-bearing formations and has drawn little resource attention due to no ANS gas export infrastructure and unknown potential productivity. Characterization of ANS gas hydrate-bearing reservoirs and improved modeling of potential gas hydrate dissociation processes led to increasing interest to study gas hydrate resource and production feasibility.

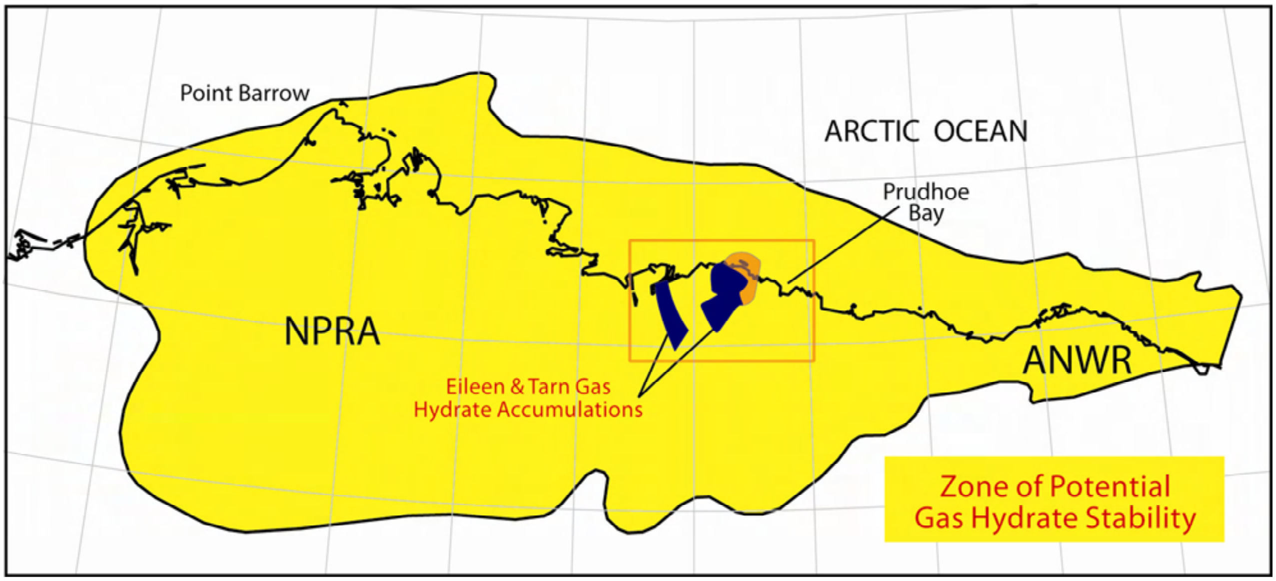


Figure 1a: ANS gas hydrate stability zone with Eileen and Tarn gas hydrate trends (Collett, 1993).

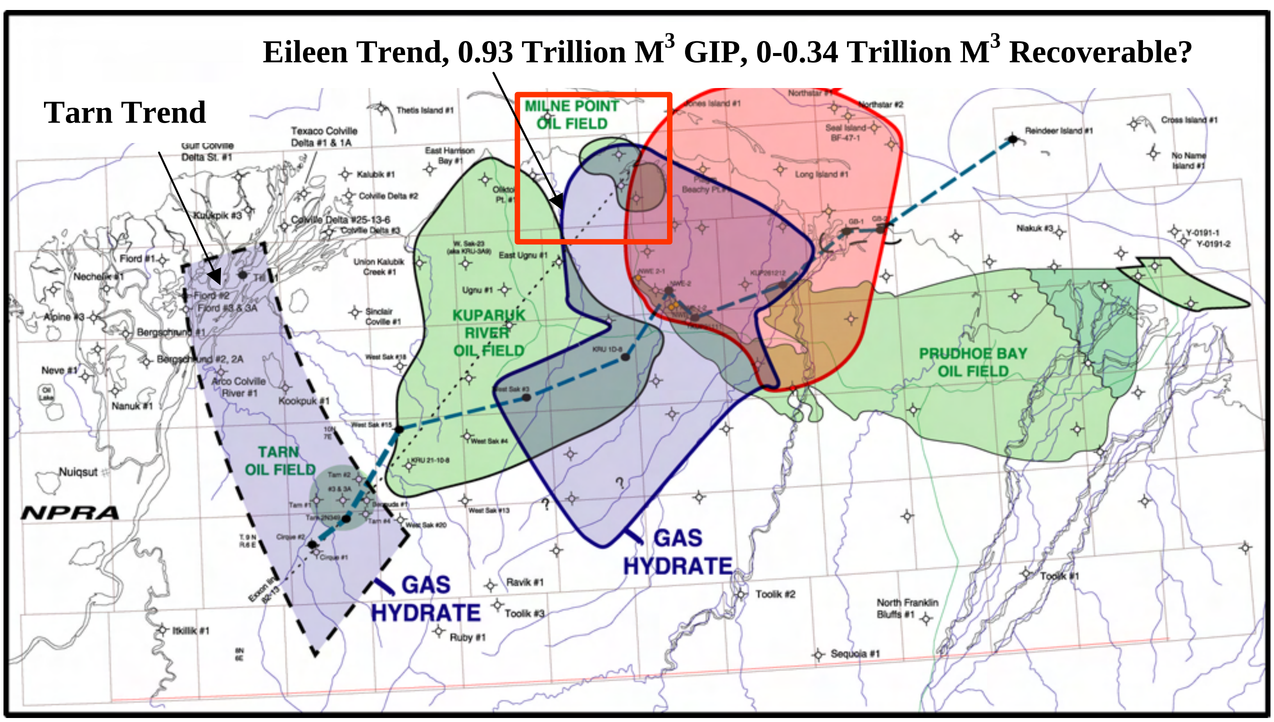


Figure 1b: Eileen and Tarn Gas Hydrate Trends and ANS Field Infrastructure (modified after Collett, 1998) and including potential Eileen trend gas-in-place (GIP) and recoverable resource.

As part of a multi-year effort to encourage these feasibility studies, the DOE also supports significant laboratory and numerical modeling efforts focused on the small scale behaviors of gas hydrate. Concurrently, the USGS has assessed the potential in-place resource potential and participated in field operations with DOE and others to acquire data within many naturally occurring gas hydrate accumulations throughout the world. There remain significant challenges in quantifying the fraction of these in-place resources that might eventually become a technically-feasible or possibly a commercial natural gas reserve. This study estimates this potential ANS prize within the Eileen trend and recommends additional research, data acquisition, and field operations.

A “chicken and egg” problem has hindered unproven resource research and development in the past; an “unconventional” resource commonly requires a few positive examples before it can generate stand-alone interest from industry. This was true for tight gas resources in the 1950-1960’s, Coal-Bed-Methane plays in the 1970-1980’s and the shale gas resources in the 1990-2000’s. In each case, the resource was thought to be technically infeasible and uneconomic until the combination of market, technology (new or newly applied), and positive field experience helped motivate widespread adoption of unconventional recovery techniques in an effort to prove whether or not the resource could be technically and commercially produced. In an attempt to bridge this gap, Phase 2 gas hydrate reservoir modeling efforts were coupled with a series of possible regional schematic models to quantify a suite of potential recoverable reserve outcomes.

These regional schematic modeling scenarios indicated that 0-12 TCF gas may be technically recoverable from 33 TCF in-place Eileen trend gas hydrate beneath ANS industry infrastructure within the Milne Point Unit (MPU), Prudhoe Bay Unit (PBU), and Kuparuk River Unit (KRU) areas. Production forecast and regional schematic modeling studies included downside, reference, and upside cases. Reference case forecasts with type-well depressurization-induced production rates of 0.4-2.0 MMSCF/D predict that 2.5 TCF of gas might be produced in 20 years, with 10 TCF ultimate recovery after 100 years (typical industry forecasts would not exceed 50 years). The downside case envisions research pilot failure and economic or technical infeasibility. Upside cases identify additional potential recoverable resource. Additional static data acquisition and possible future production testing could help validate whether or not these reference and upside model results might occur in a future potential development using depressurization-induced, thermally enhanced, and/or chemically stimulated dissociation of gas hydrate into producible gas. Modeled production methods involve subsurface depressurization and/or thermal stimulation of pore-filling gas hydrate into gas and water components. Phase 2 studies included rate forecasts and hypothetical well scheduling, methods typically employed to evaluate potential conventional large gas development projects. This work helped quantify: 1. Potential to technically produce gas from the 33 TCF GIP Eileen trend gas hydrate resource using conventional petroleum technologies and 2. Range of 0-12 TCF possible recoverable resource based on potential future development schemes. Phase 2 studies culminated in recommendations to acquire Phase 3a reservoir data including 400-600 feet core, extensive wireline logs, and MDT wireline tests within the Mount Elbert intra-hydrate MPU prospect interpreted from the Milne 3D seismic survey (Figure 3). Phase 3a field studies led to successful acquisition of critical data to help mitigate uncertainty in potential gas hydrate productivity. Successful Phase 3a MountElbert-01 stratigraphic test drilling and data acquisition was completed between February 3-19, 2007. Although potential Phase 3b production test planning is underway with Phase 3a data evaluation, a

Phase 3b production test is not currently approved by BP. Phase 3b studies, if approved, would acquire additional data and include production testing, likely from a gravel pad within production infrastructure.

3.0 EXECUTIVE SUMMARY

This Quarterly report encompasses project work from July 1, 2007 through end-September 2007. This research program is designed to determine whether the currently unproven gas hydrate resource may become a new unconventional gas reserve Major research objectives accomplished during this reporting period included project management, data analyses, project reporting, and cost auditing of data acquired in the February 2007 Phase 3a stratigraphic test well and tracking costs for this well. Acquired data included 430 feet core (100 feet gas hydrate-bearing), extensive wireline logs, and wireline production tests and samples using the Modular Dynamics Testing (MDT) downhole tool. Significant pre-well planning, inclusion of world hydrate experts, and onsite vigilance were key elements to safely drilling and acquiring this data on an ANS Milne Point Unit exploration ice pad. Chilled oil-based drilling fluid mitigated operational safety concerns and enhanced core and data acquisition by maintaining gas hydrate and borehole stability during openhole drilling and operations.

4.0 QUARTERLY RESULTS

The project accomplishments during the reporting time period from July 2007 through end-September 2007 included project management, data analyses, project reporting, and cost auditing of data acquired in the February 2007 Phase 3a stratigraphic test well (Project Task 8.0). The 1Q07 Technical Progress report completed June 27, 2007 provides a detailed review of Stratigraphic Test well drilling and data acquisition.

4.1 Project Management

Primary project management tasks accomplished during the reporting period included:

- Reviewed JIP documents discussed potential JIP formation in consideration of additional industry involvement; Distributed GOM JIP template for review
- Discussed authorized budget and report delivery with University of Arizona (UA)
- Reviewed project work plans, deliverables, budget and benefits with UAF
- Forwarded Korea gas hydrate program interest correspondence to USGS, BP, and DOE
- Forward DOE gas hydrate program merit review documents to UA, UAF, RS, PNNL
- Documented and planned remaining 2007 travel plans

4.2 Data Analyses

Data analyses tasks were delayed during the reporting period due to stratigraphic test drilling and data acquisition cost overruns documentation prior to obligation of additional funds to continue the work.

- Ensured infrared camera equipment returned to Joint Oceanographic Institutions by OMNI Laboratory
- Shipped thermal properties core subsamples to DOE NETL
- Arranged for high-resolution core scanning work delay until late 2007 and setup details
- Discussed CSM lab experiment to study MDT tool storage factor in tool response, produced gas estimates, and pressure measurements

- Tracked shipping of core samples from LBNL to additional labs for specialized core analyses and confirmed core samples received at LBNL, NRC, PNNL, CSM, USGS
- Secured Wireline log data release from Schlumberger
- Checked and maintained condition of core storage refrigerated unit located at ASRC Yard
- Maintained dialog with BP and ConocoPhillips for core sedimentologic description support
- Reviewed LBNL and OMNI core CTscans and evaluated core analyses recommendations
- Recorrelated core gamma to wireline log field prints in preparation for core analyses
- Reviewed gas analyses data from Isotech (Section 4.2.1, Table 1)
- Reviewed OMNI grain size analyses information from core analyses (Section 4.2.2)

4.2.1 Mud Gas Data Analyses

Depth 1 Feet	Gas Units	GC Date	O_2 + Ar ppm	CO_2 ppm	N_2 ppm	CO ppm	C_1 ppm	C_2 ppm	nC_4 ppm	iC_5 ppm	nC_5 ppm	C_6+ ppm	$\delta^{13}C_1$ per mil
1980	144	4/13/2007	219200	130	780400	0	241	0	1	1	1	5	
2010	0	4/13/2007	217700	420	781900	0	6	0	0	0	0	0	
2040	364	4/13/2007	207400	180	739800	0	52600	0	0	0	0	2	-49.5
2070	125	4/13/2007	210900	180	749600	0	39300	0	0	0	0	2	-48.9
2100	114	4/13/2007	215900	150	768000	0	15900	0	0	0	0	2	-47.5
2130	54	4/13/2007	218300	170	775000	0	6520	0	0	0	0	2	-47.5
2160	646	4/13/2007	200400	140	708300	0	91200	0	0	0	0	2	-49.0
2190	91	4/13/2007	218400	200	776000	0	5430	1	0	0	0	2	-49.4
2220	93	4/13/2007	217100	180	770700	0	12000	0	0	0	0	2	-49.0
2250	17	4/13/2007	219100	180	778300	0	2430	0	0	0	0	1	-48.4
2280	22	4/13/2007	218500	130	776900	0	4510	0	0	0	0	1	-48.4
2310	22	4/13/2007	219100	180	777800	0	2870	0	0	0	0	2	-48.9
2340	45	4/13/2007	218100	140	775900	0	5890	0	0	0	0	2	-50.1
2370	11	4/13/2007	219300	150	779200	0	1350	0	0	0	0	2	-49.2
2400	4	4/13/2007	219800	330	779800	0	52	0	0	0	0	2	
2430	20	4/13/2007	218100	140	779500	0	2260	0	0	0	0	2	-48.9
2460	21	4/13/2007	218700	130	778600	0	2570	0	0	0	0	2	-48.5
2490	39	4/13/2007	218400	180	777000	0	4420	0	0	0	0	2	-49.4
2520	45	4/13/2007	217300	130	774600	0	7950	0	0	0	0	2	-48.3
2550	81	4/13/2007	215600	130	772300	0	12000	0	0	0	0	2	-48.1
2580	73	4/13/2007	215600	130	773600	0	10700	0	0	0	0	2	-48.3
2610	70	4/13/2007	215900	130	774400	0	9570	0	0	0	0	2	-48.1
2640	56	4/13/2007	217200	130	774800	0	7840	0	0	0	0	2	-48.0
2670	124	4/13/2007	214000	140	770000	0	15900	0	0	0	0	2	-48.2
2700	95	4/12/2007	215600	220	771400	0	12800	0	0	0	0	2	-47.8
2730	389	4/12/2007	208000	140	743100	0	48800	0	0	0	0	2	-48.9
2760	152	4/13/2007	213400	140	766600	0	19900	0	0	0	0	2	-47.5
2790	208	4/13/2007	216700	230	772800	0	10300	0	0	0	0	2	-47.4
2820	152	4/13/2007	214200	150	765500	0	20100	0	0	0	0	2	-47.9
2850	212	4/13/2007	211100	130	761500	0	27300	0	0	0	0	2	-47.8
2850	133	4/13/2007	213300	130	768800	0	17800	0	0	0	0	2	-47.2
2910	147	4/13/2007	211900	140	768500	0	19500	0	0	0	0	1	-47.9
2940	105	4/13/2007	213800	140	772400	0	13700	0	0	0	0	2	-47.6
2970	55	4/13/2007	214300	130	773500	0	12100	0	0	0	0	2	-48.4
3000	61	4/13/2007	216500	130	775700	0	7690	0	0	0	0	2	-47.8

Table 1: Mount Elbert-01 shallow formation gas data analyses, Isotech Lab

Isotech Laboratory analyzed shallow formation gas samples collected in isotubes during drilling operations. Table 1 illustrates these gas analyses and confirms that the predominantly methane composition and carbon isotope data are consistent with gas hydrate-derived gasses.

4.2.2 Core Data Analyses

Core data analyses are ongoing. OMNI Laboratory coordinates conventional and special core analyses measurements, which will resume with funding in 4Q07. Certain subsamples were sent to special hydrate core laboratories at LBNL, NRC, PNNL, CSM, and USGS for various analyses.

4.2.2.1 Core Gamma

After transportation of the Mount Elbert-01 core to Anchorage for storage and additional subsampling, but prior to slabbing, OMNI Labs ran a core gamma ray and “gapped” the core gamma to account for gaps due to both non-recovery of core and onsite core subsampling. Figure 2 illustrates the core gamma results composite for 430 feet of 503 feet cored. The core gamma has been correlated to log field prints and only shows a discrepancy of zero to three feet throughout the cored intervals. When final logs have been completed by Schlumberger, the core gamma will be recorrelated to the final log dataset.

4.2.2.2 Core CTscans

Core plugs and whole core were analyzed by CTscan at OMNI laboratory and LBNL, respectively. The CTscanning revealed multiple processing-associated or drilling induced fractures that will complicate the planned mechanical rock property studies. Previous pressure-core studies by Geotek Labs (personal communication, December 2007) suggest that the “processing-associated” fractures likely propagated during dissolution of gas hydrate into free gas and water during core recovery operations at atmospheric temperatures and pressures. Figures 3-25 illustrate initial core plug and whole core scans performed at OMNI. Figures 26-35 illustrate whole core scans performed by LBNL prior to core sample distribution to labs at LBNL, NRC, PNNL, CSM, and USGS. The core slices shown in these scans illustrate the ubiquitous fractures that likely propagated during core acquisition and processing procedures due to dissolution of gas hydrate into free gas and water during core recovery operations at atmospheric temperatures and pressures.

4.2.2.3 Core Grain Size Studies

OMNI Lab completed grain size studies on core samples as illustrated in Figures 36-56. These figures show both sieve and laser derived grain size charts. Most of the reservoir sands from the core are very-fine to fine-grained. Minor exceptions include coarse-grained to pebbly probable transgressive lags present in less than one-inch to ten-inch thick beds. When core scanning is completed in December 2007, plans are to link these and other core analyses studies directly to the core scans for visualization and analyses.

4.2.2.4 Core Palynology Studies

In May, the core was sampled for Palynology studies by D. Houseknecht, USGS. Results from this work are not yet available.

4.2.2.5 Special Core Analyses Studies

Core analyses studies were temporarily placed on-hold during the reporting period pending funds availability due to cost-overruns in the Stratigraphic Test drilling and data acquisition.

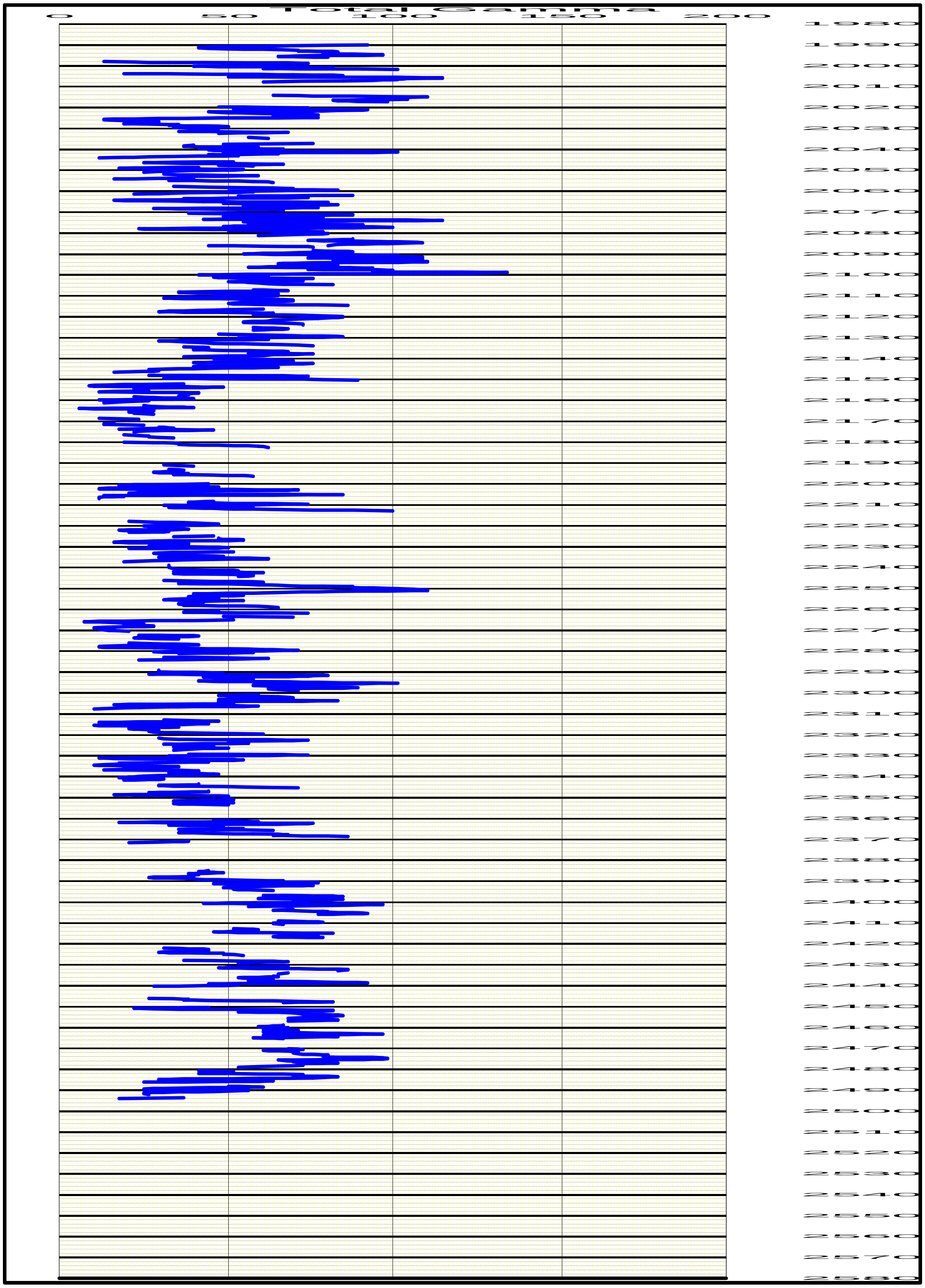


Figure 2: Core Gamma Ray results. Depth scale is 1980 through 3280 feet, bold lines are 10 foot intervals. Gamma scale is 0-200. Gaps in gamma correspond to core subsamples and non-recovery.

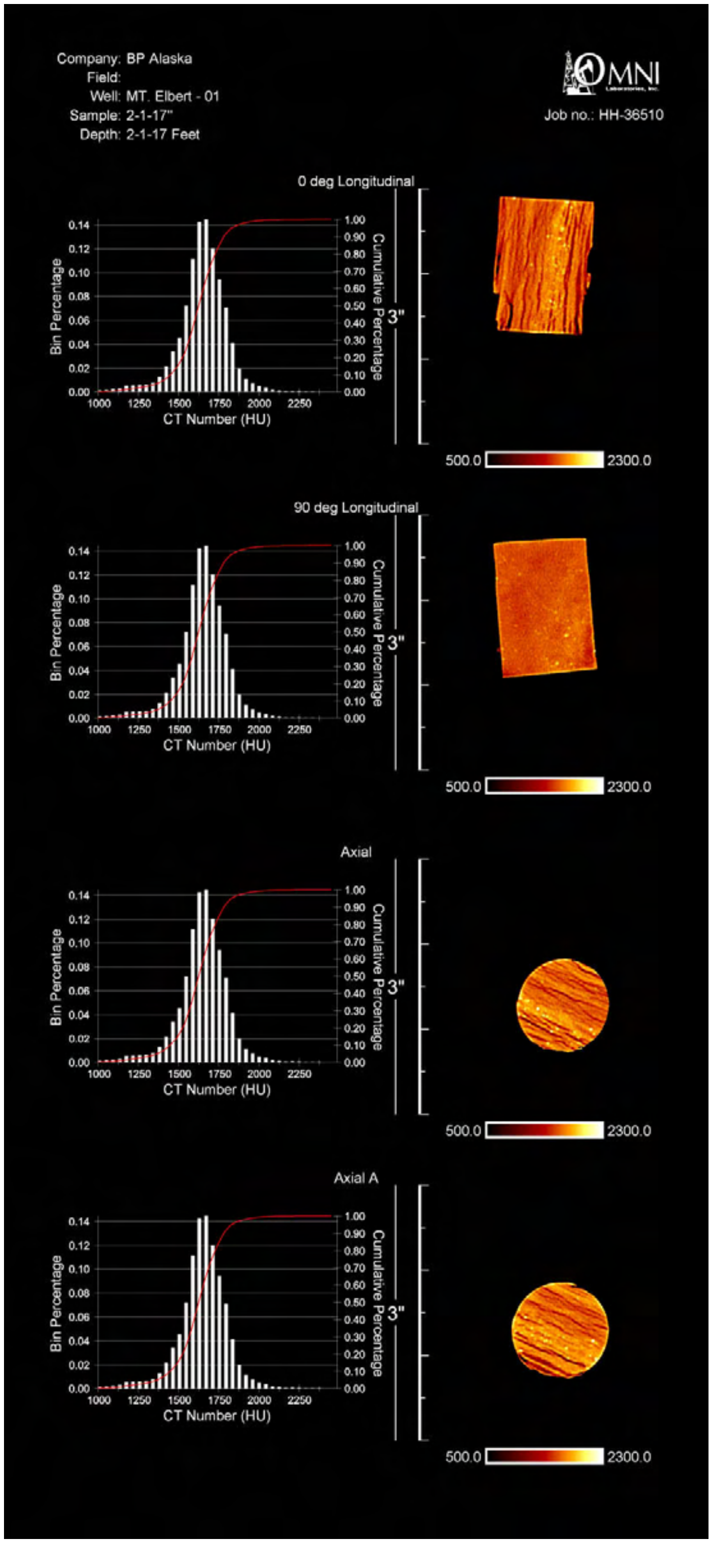


Figure 3: CTscan of core sample, Core 2, Section 1, 17 inches

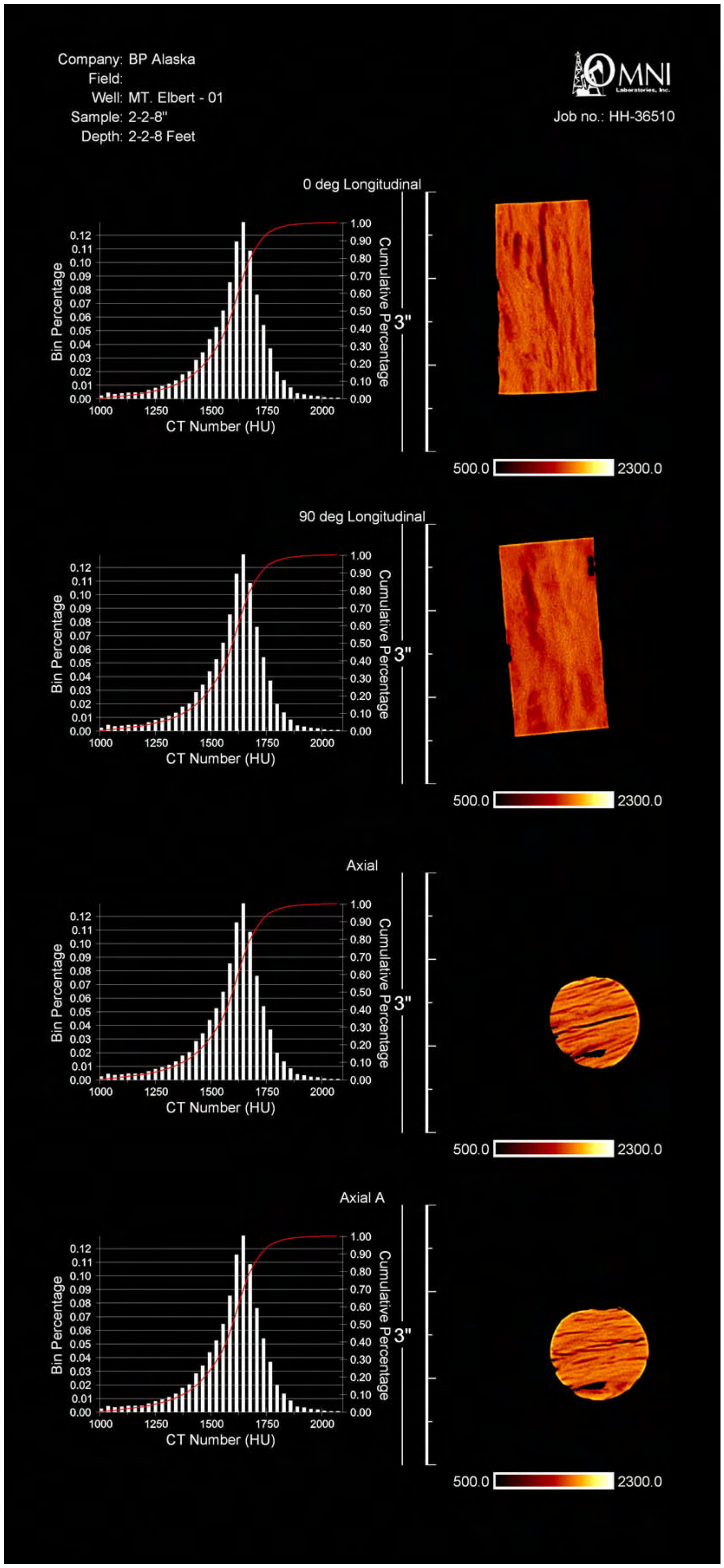


Figure 4: CTscan of core sample, Core 2, Section 2, 8 inches

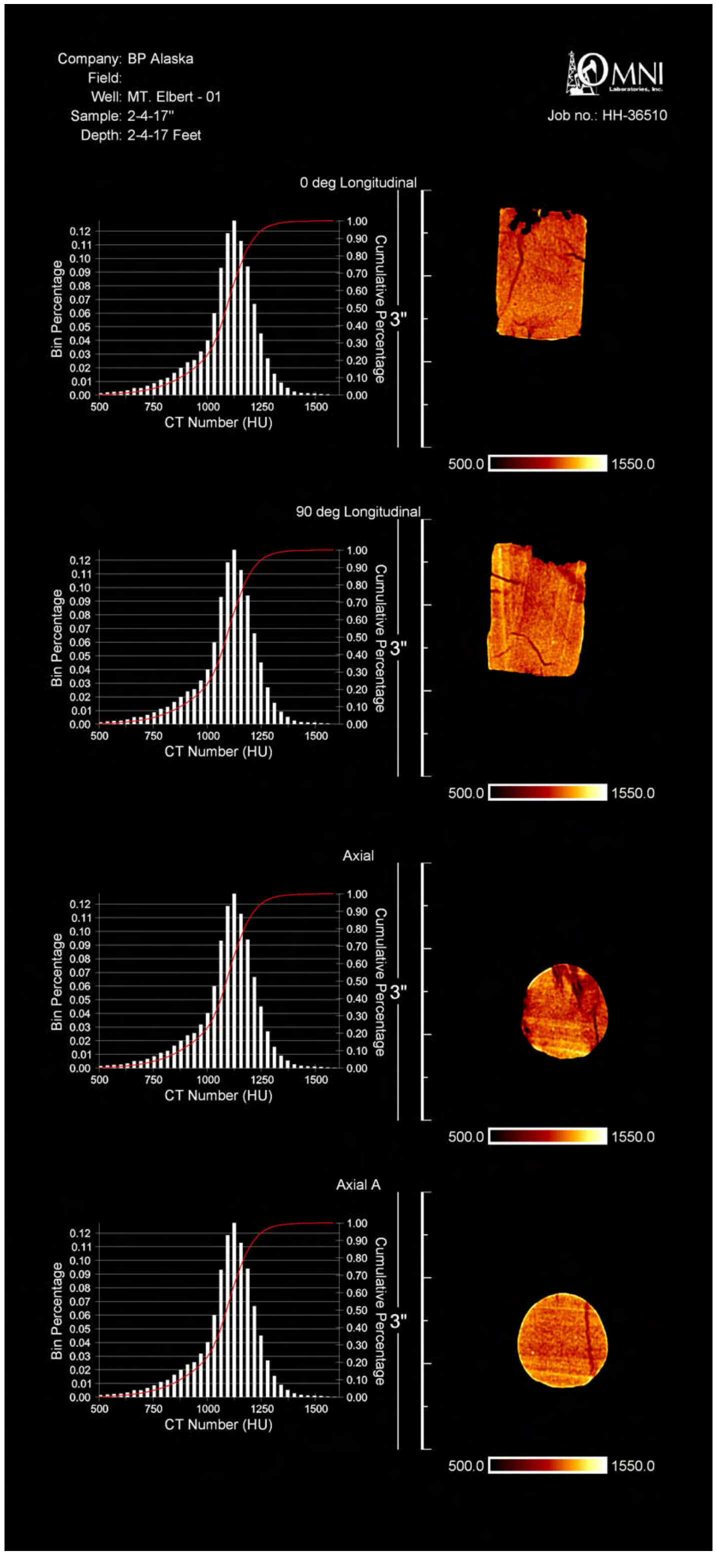


Figure 5: CTscan of core sample, Core 2, Section 4, 17 inches

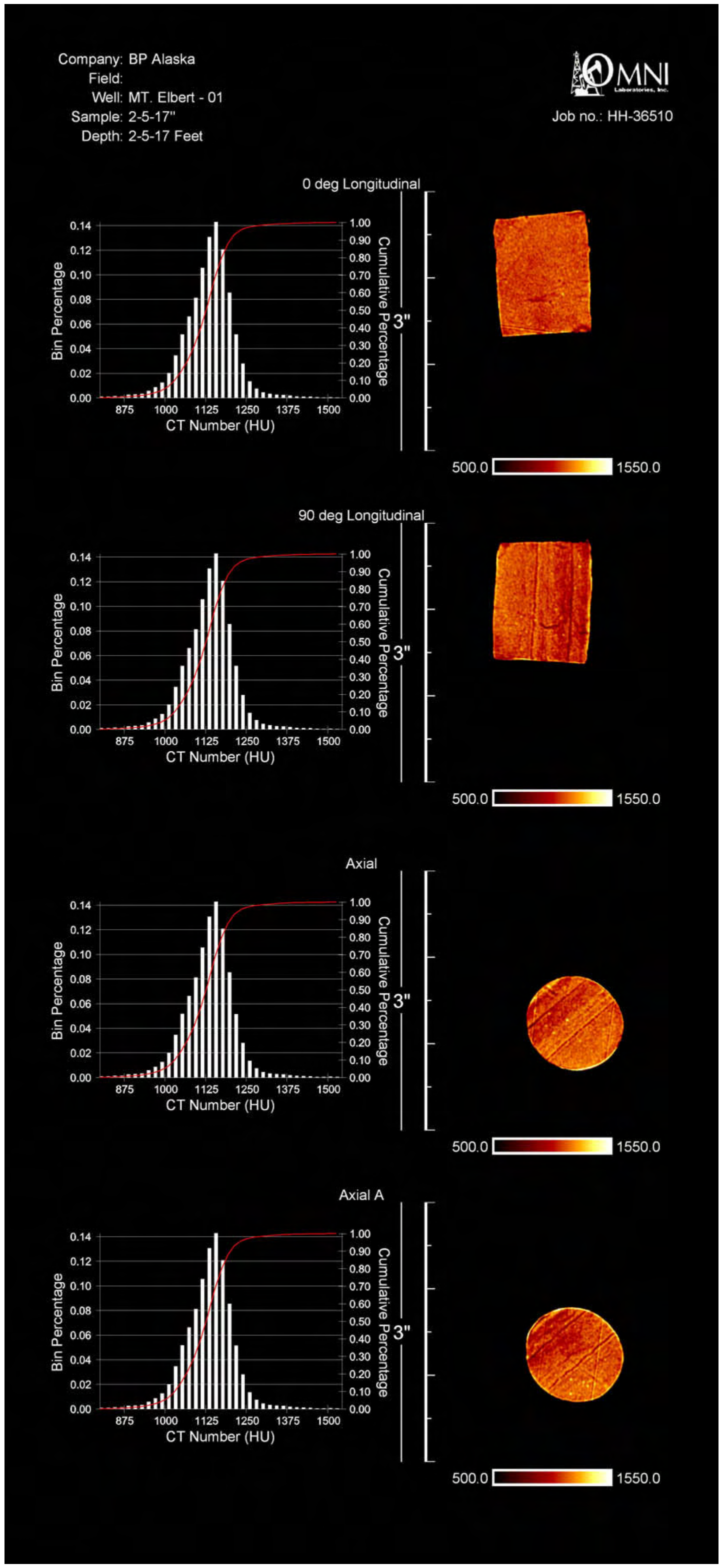


Figure 6: CTscan of core sample, Core 2, Section 5, 17 inches

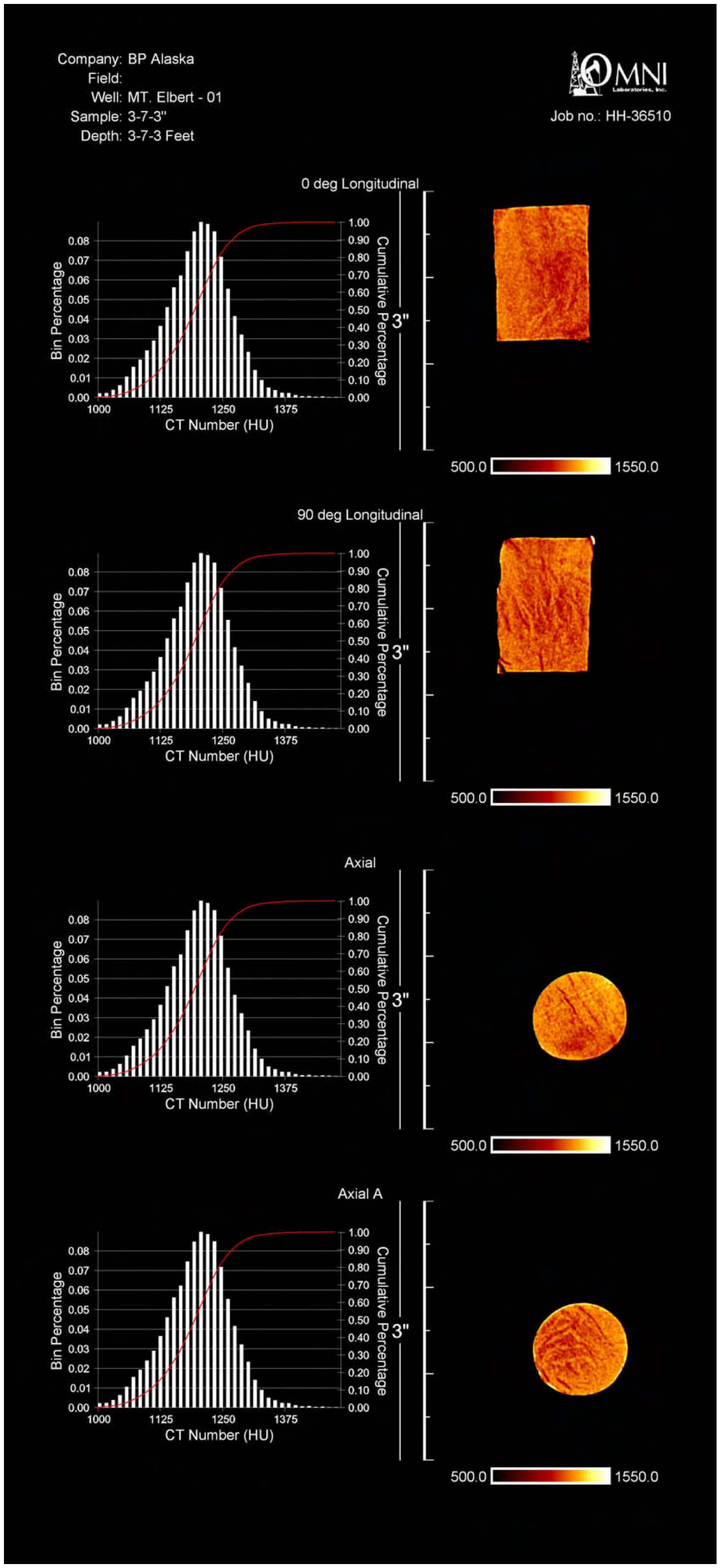


Figure 7: CTscan of core sample, Core 3, Section 7, 3 inches

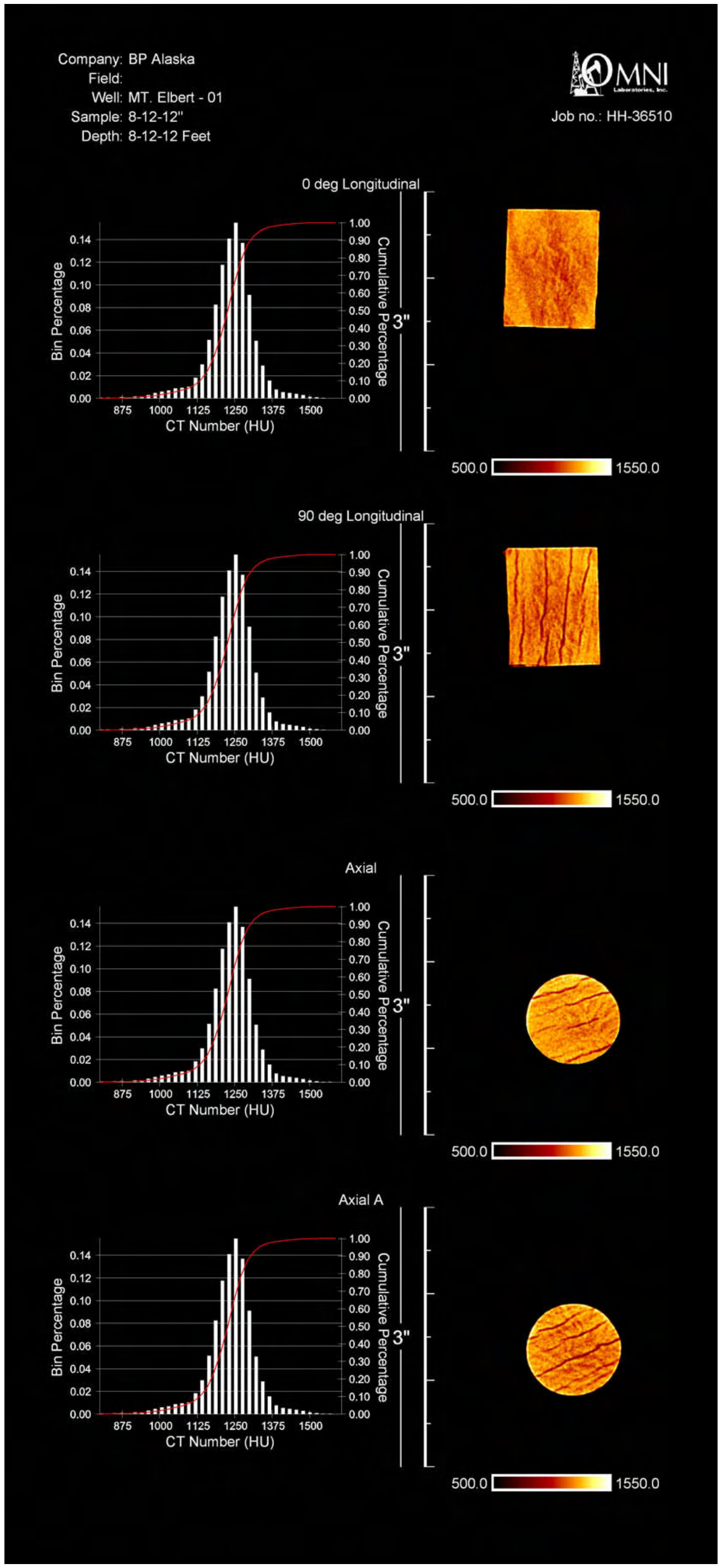


Figure 8: CTscan of core sample, Core 8, Section 12, 12 inches

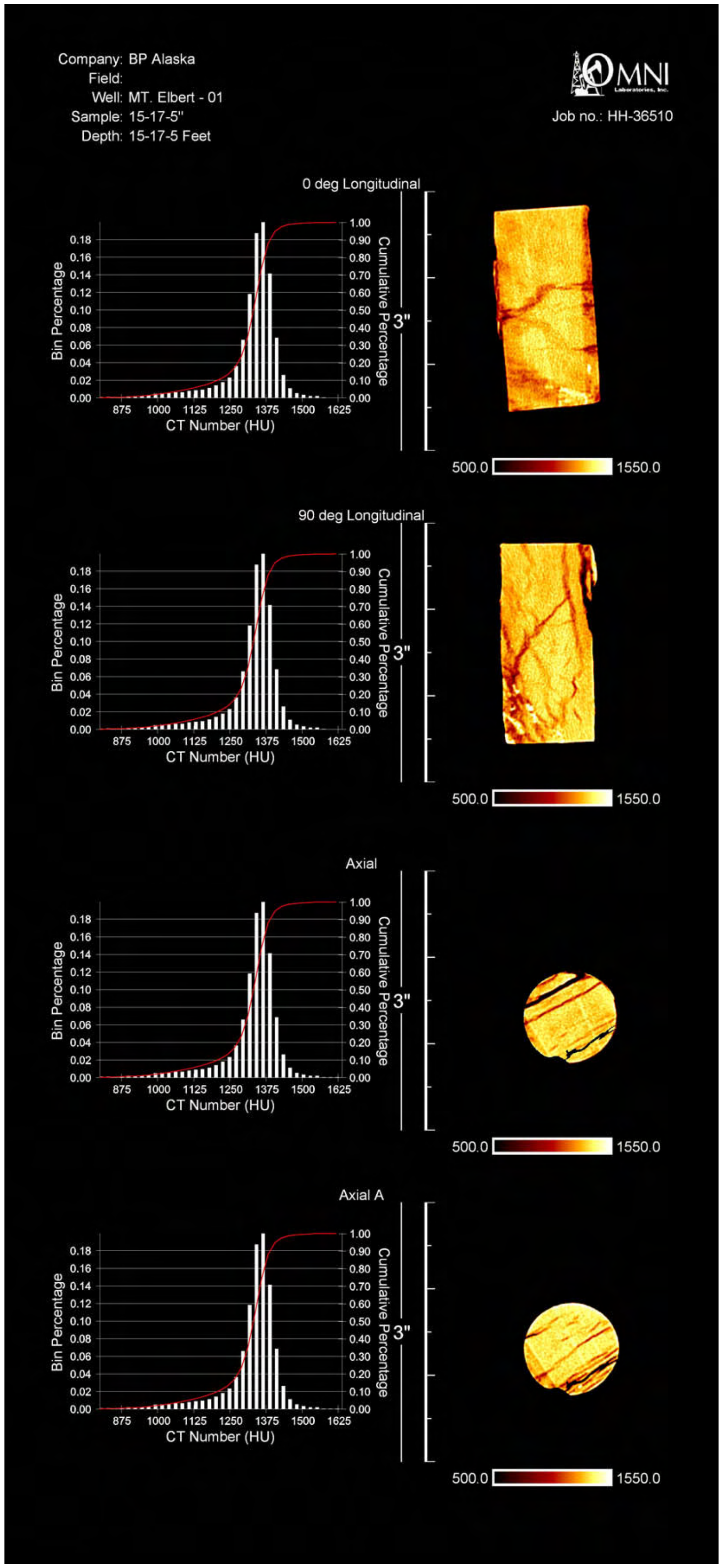


Figure 9: CTscan of core sample, Core 15, Section 17, 5 inches

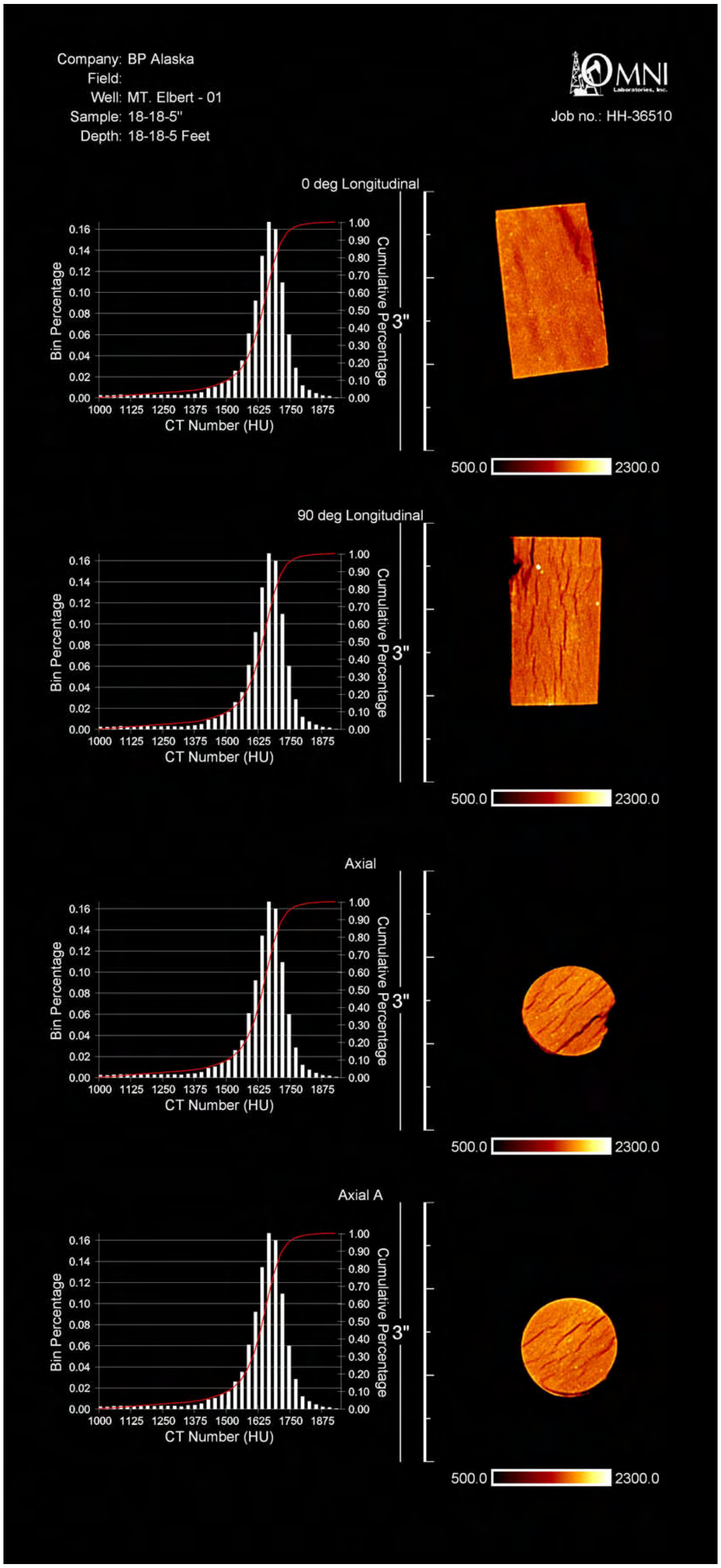


Figure 10: CTscan of core sample, Core 18, Section 18, 5 inches

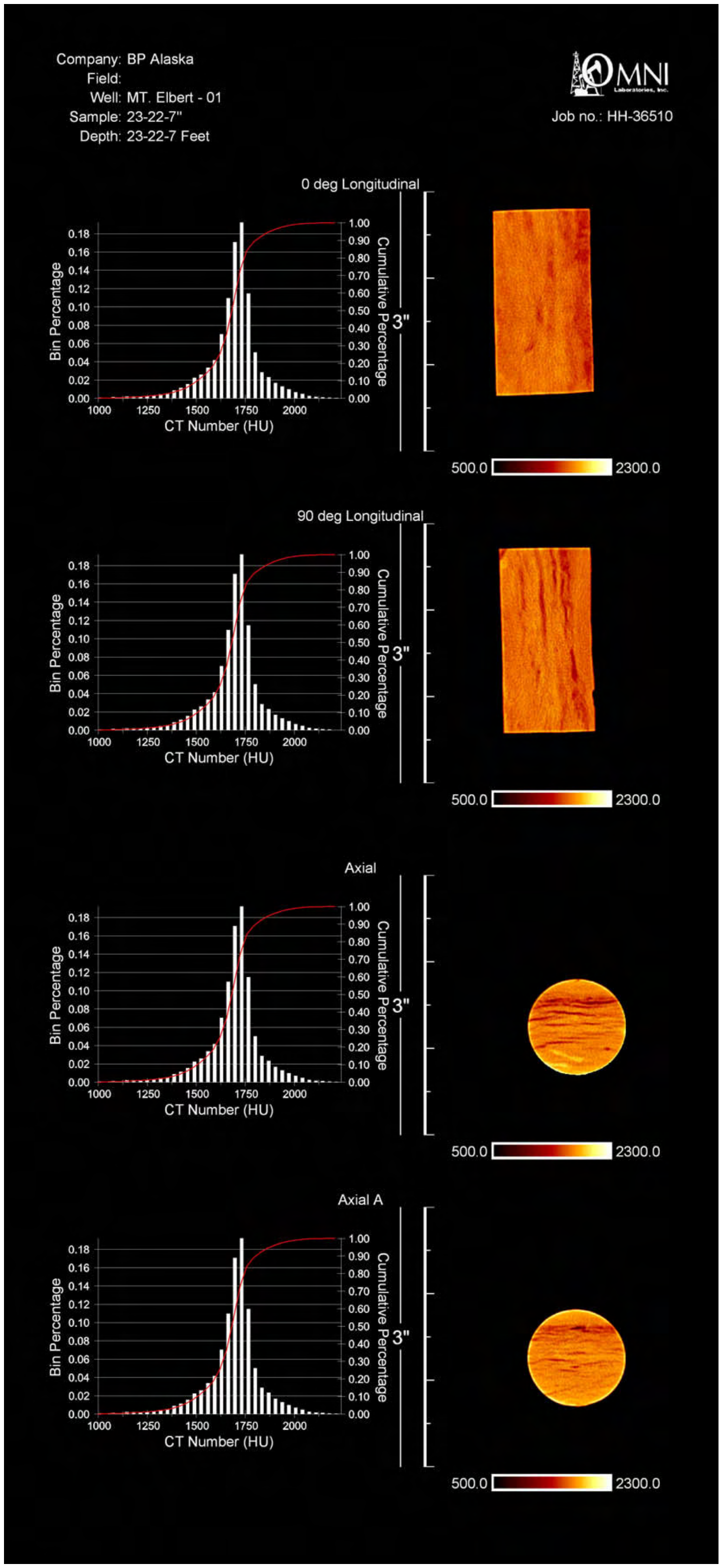


Figure 11: CTscan of core sample, Core 23, Section 22, 7 inches

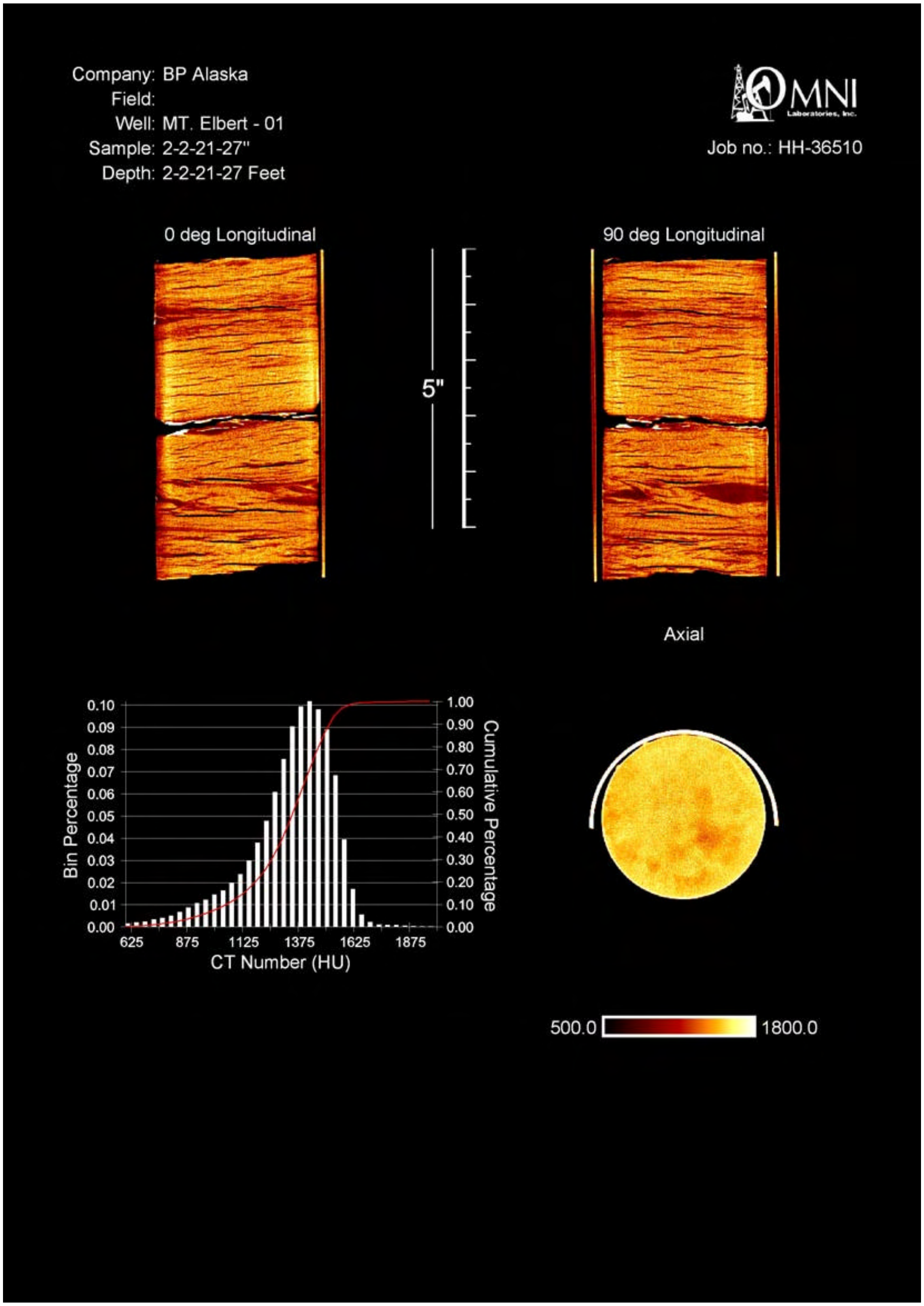


Figure 12: CTscan of core sample, Core 2, Section 2, 21 to 27 inches

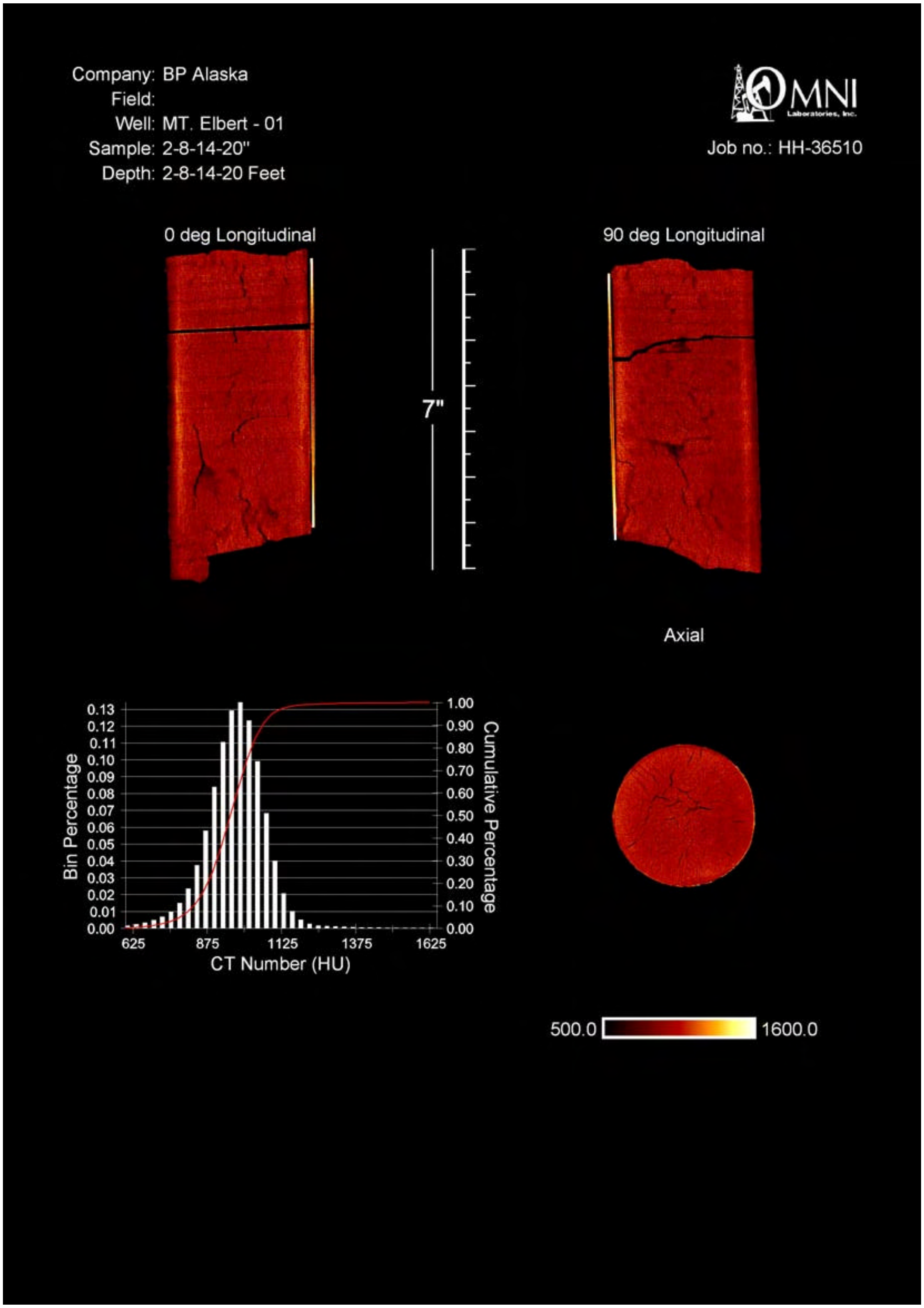


Figure 13: CTscan of core sample, Core 2, Section 8, 14 to 20 inches

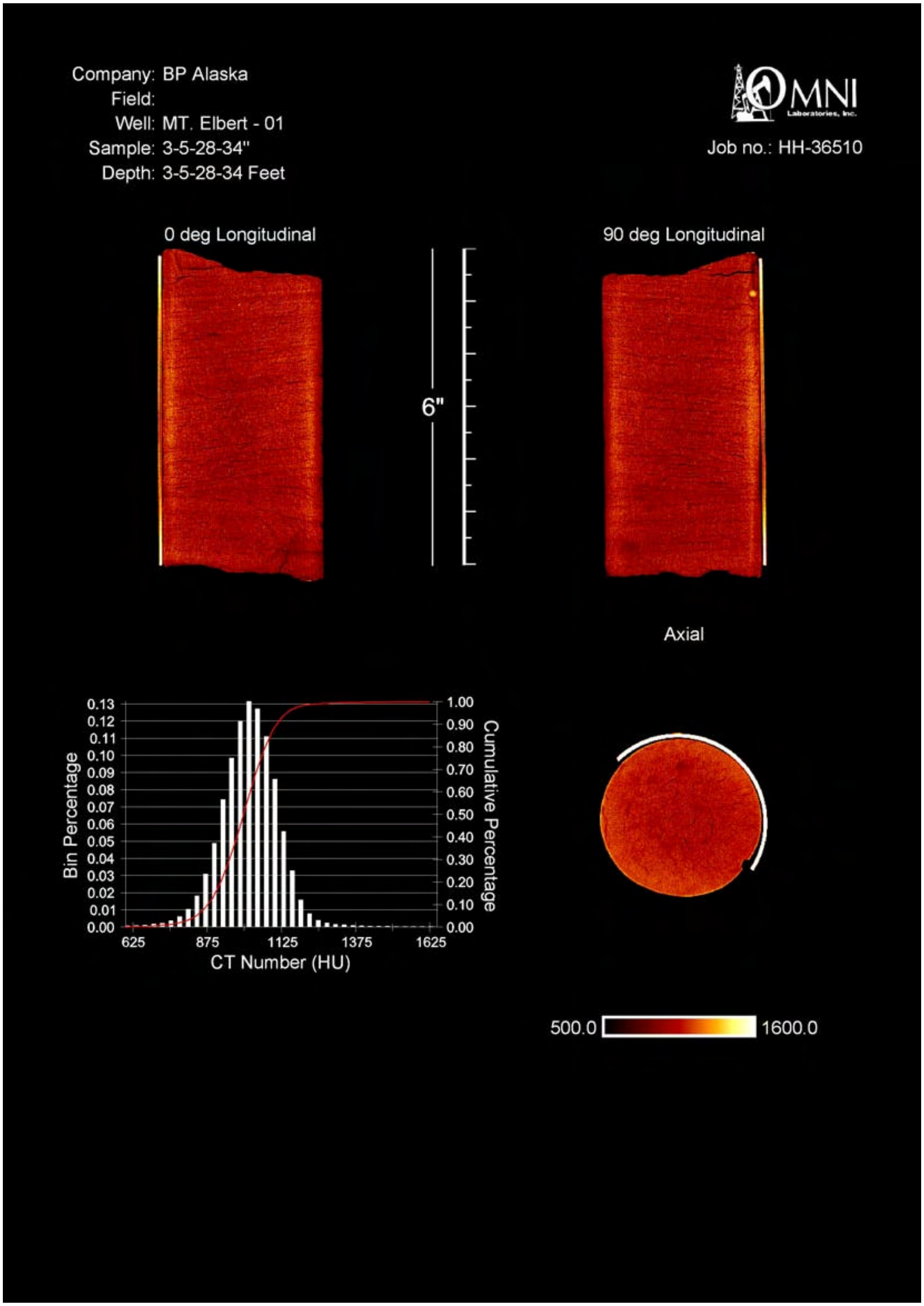


Figure 14: CTscan of core sample, Core 3, Sample 5, 28 to 34 inches

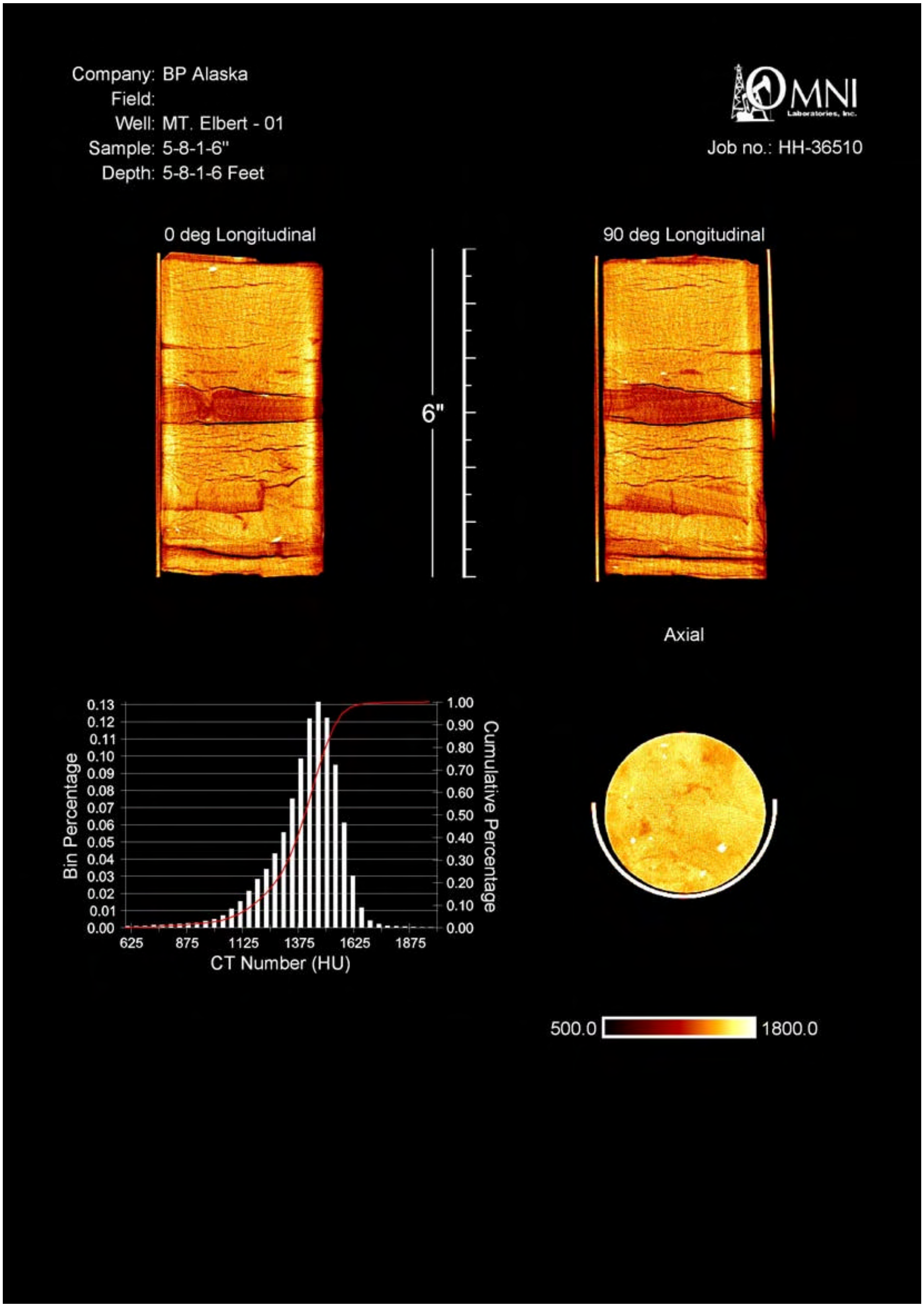


Figure 15: CTscan of core sample, Core 5, Section 8, 1 to 6 inches

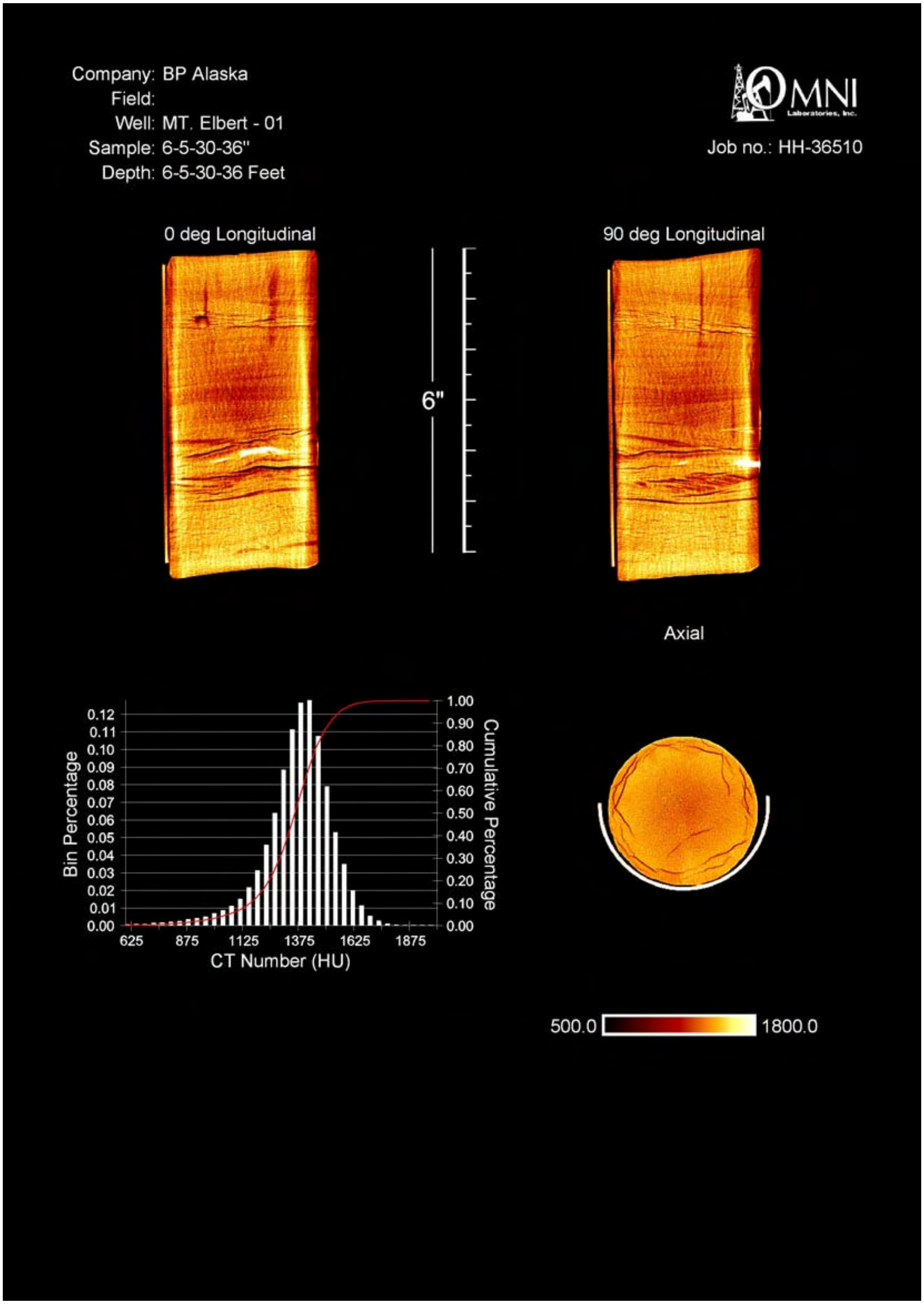


Figure 16: CTscan of core sample, Core 6, Section 5, 30 to 36 inches

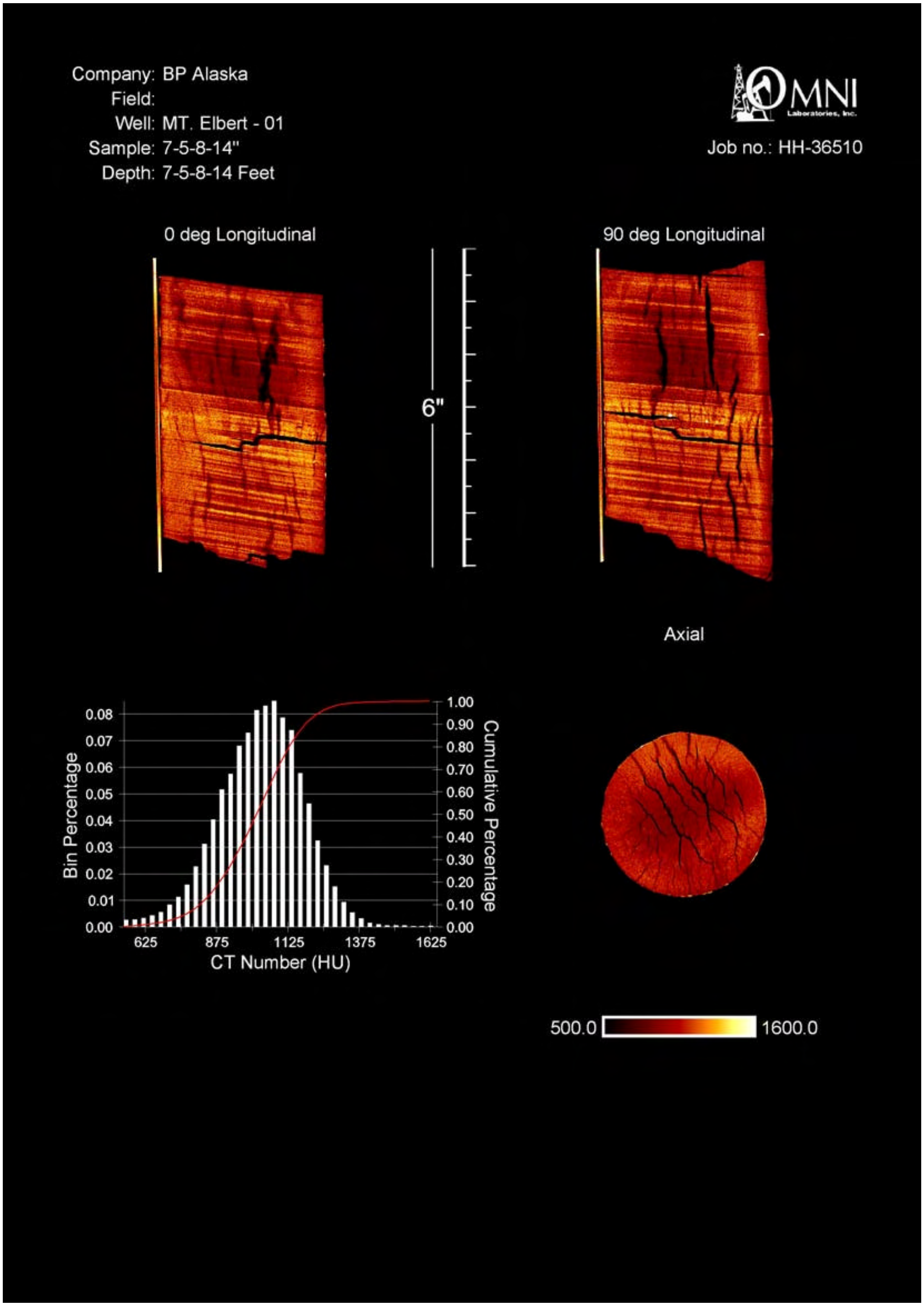


Figure 17: CTscan of core sample, Core 7, Section 5, 8 to 14 inches

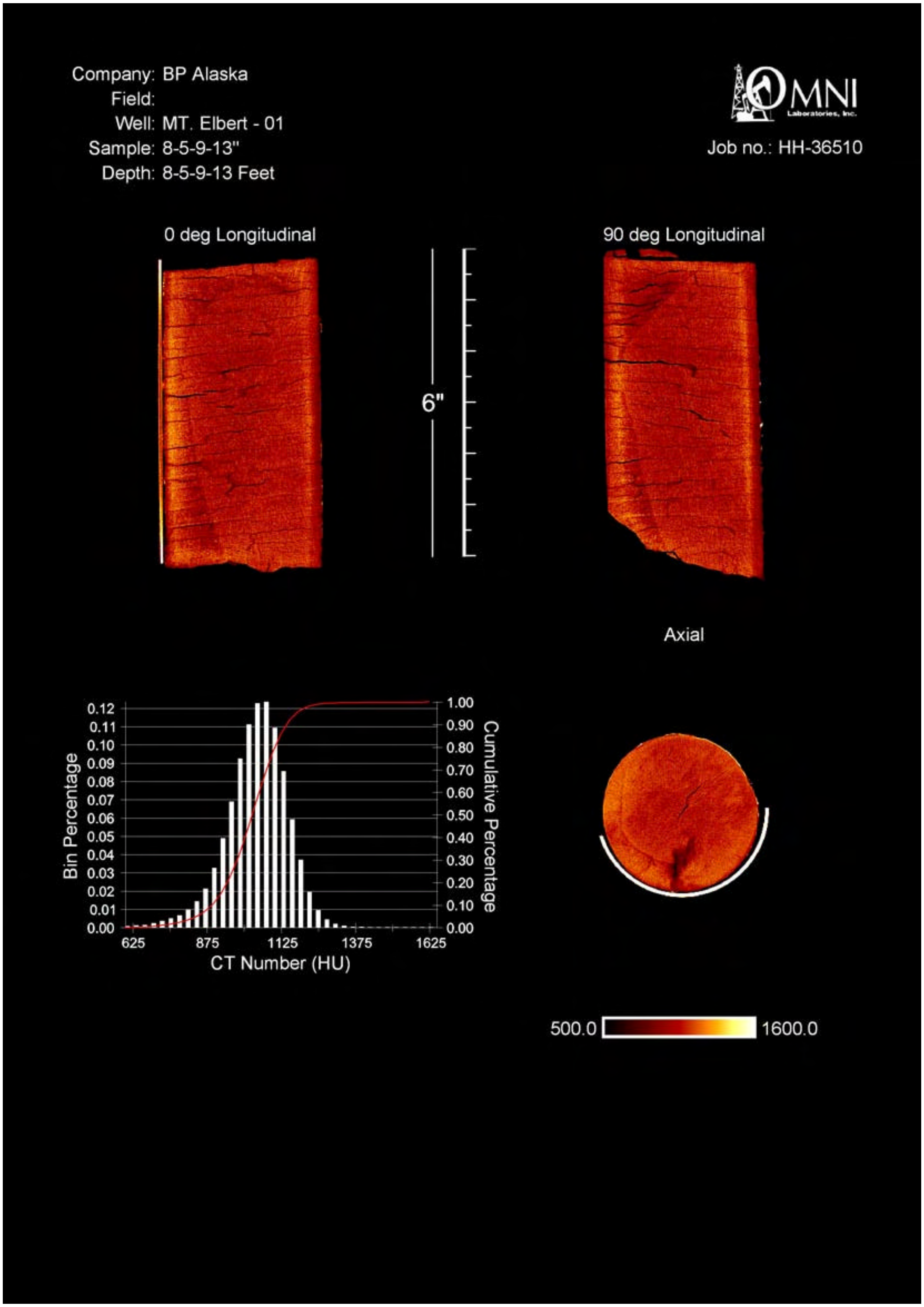


Figure 18: CTscan of core sample, Core 8, Section 5, 9 to 13 inches

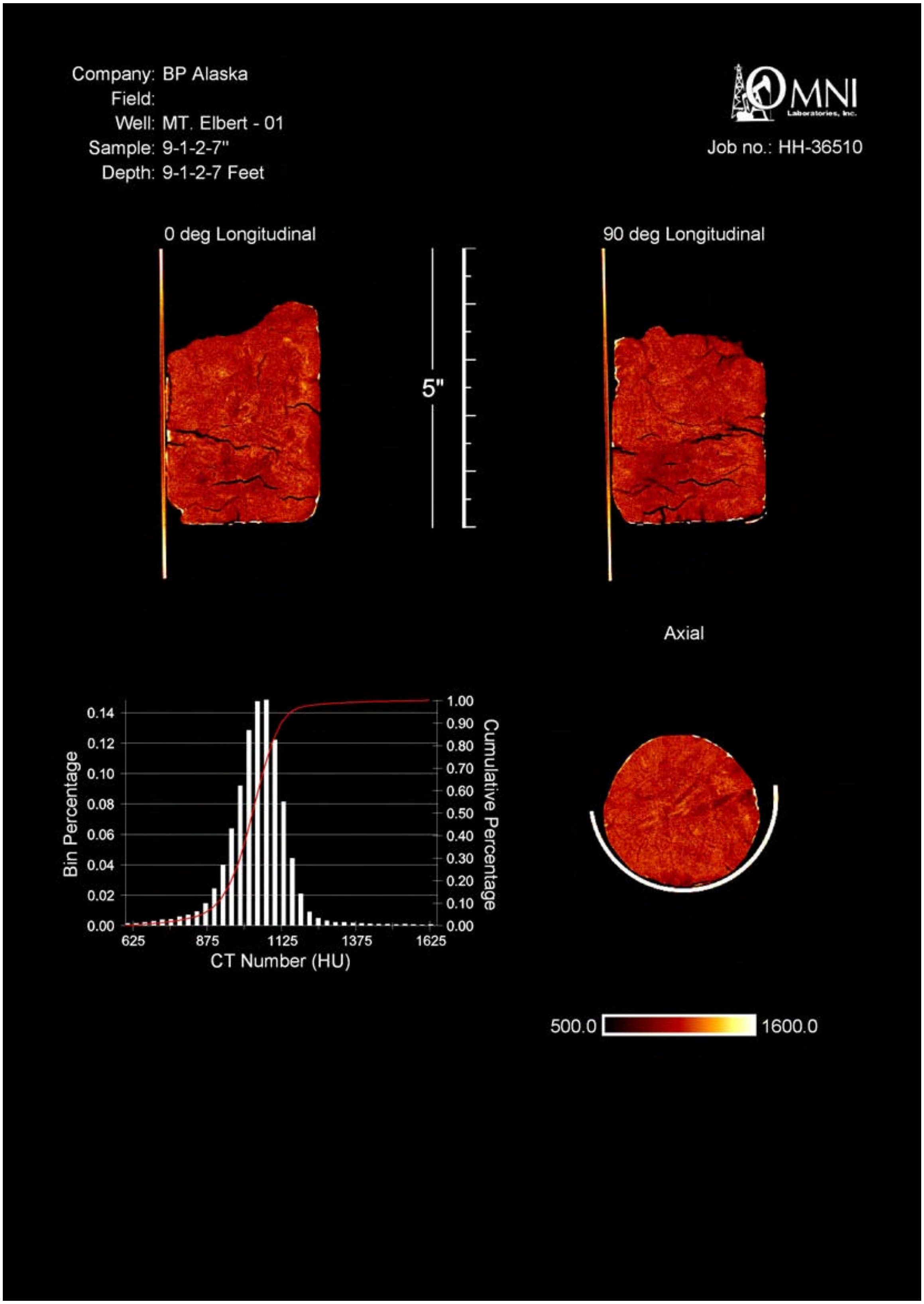


Figure 19: CTscan of core sample, Core 9, Section 1, 2 to 7 inches

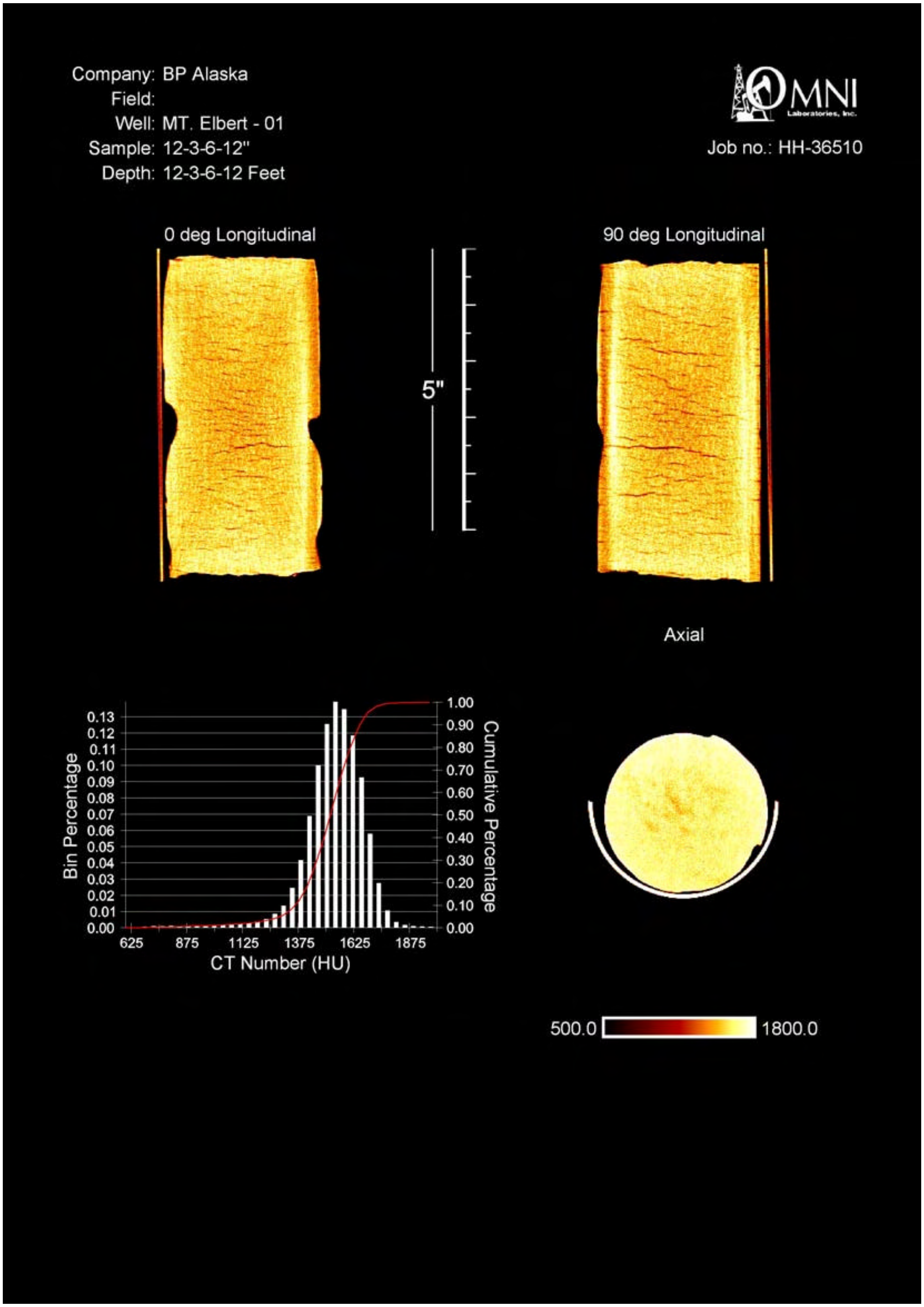


Figure 20: CTscan of core sample, Core 12, Section 3, 6 to 12 inches

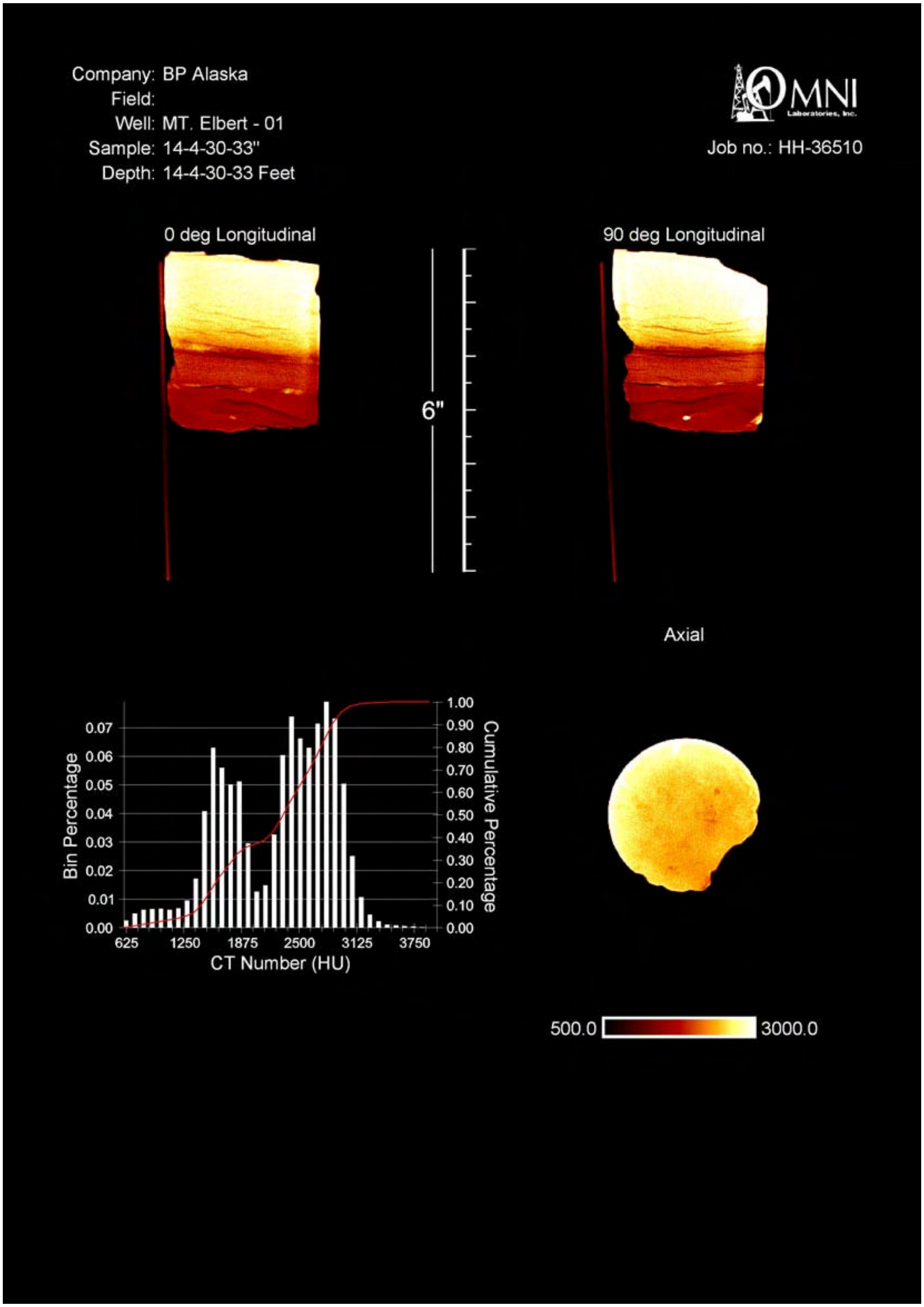


Figure 21: CTscan of core sample, Core 14, Section 4, 30 to 33 inches

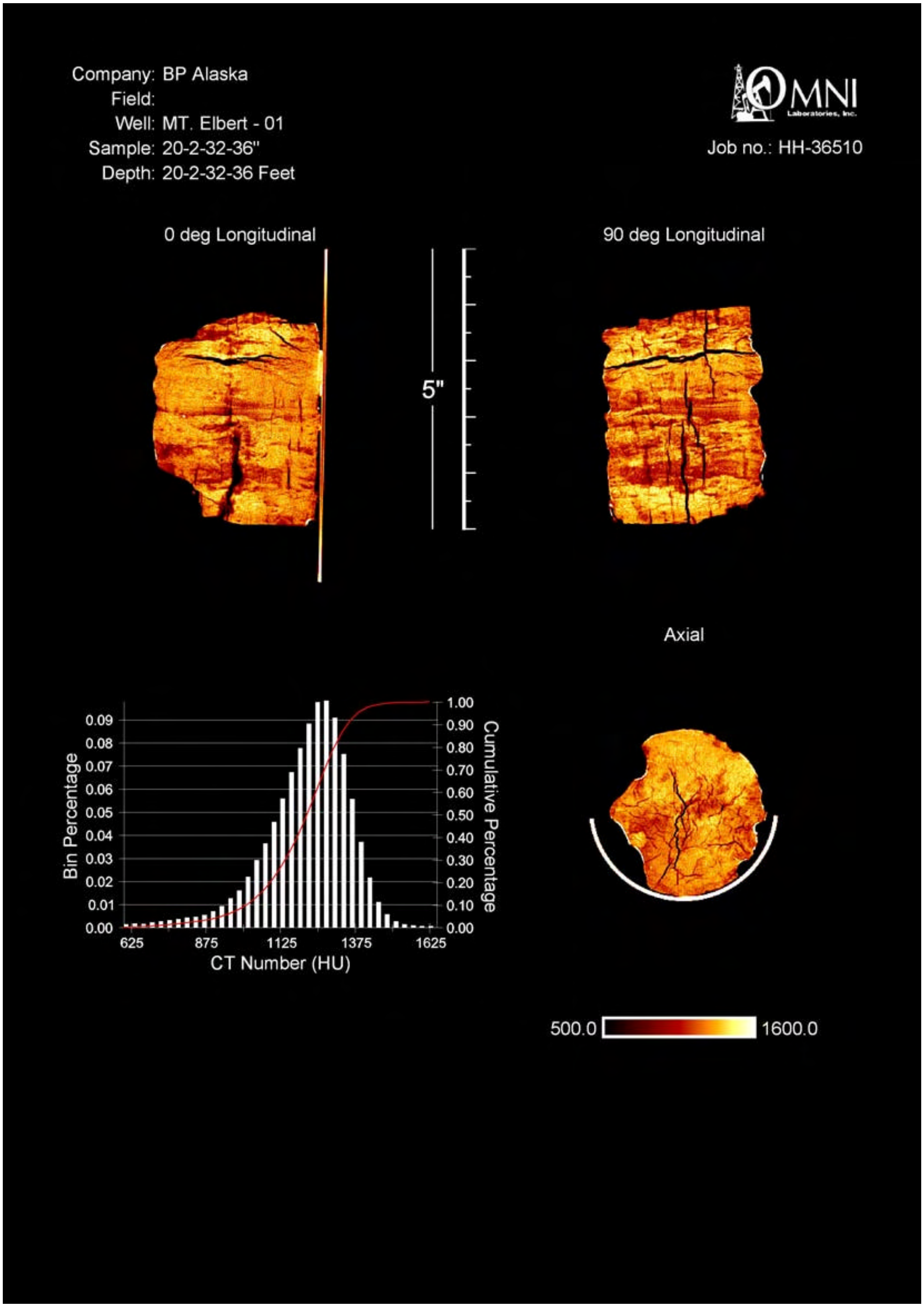


Figure 22: CTscan of sample, Core 20, Section 2, 32 to 36 inches

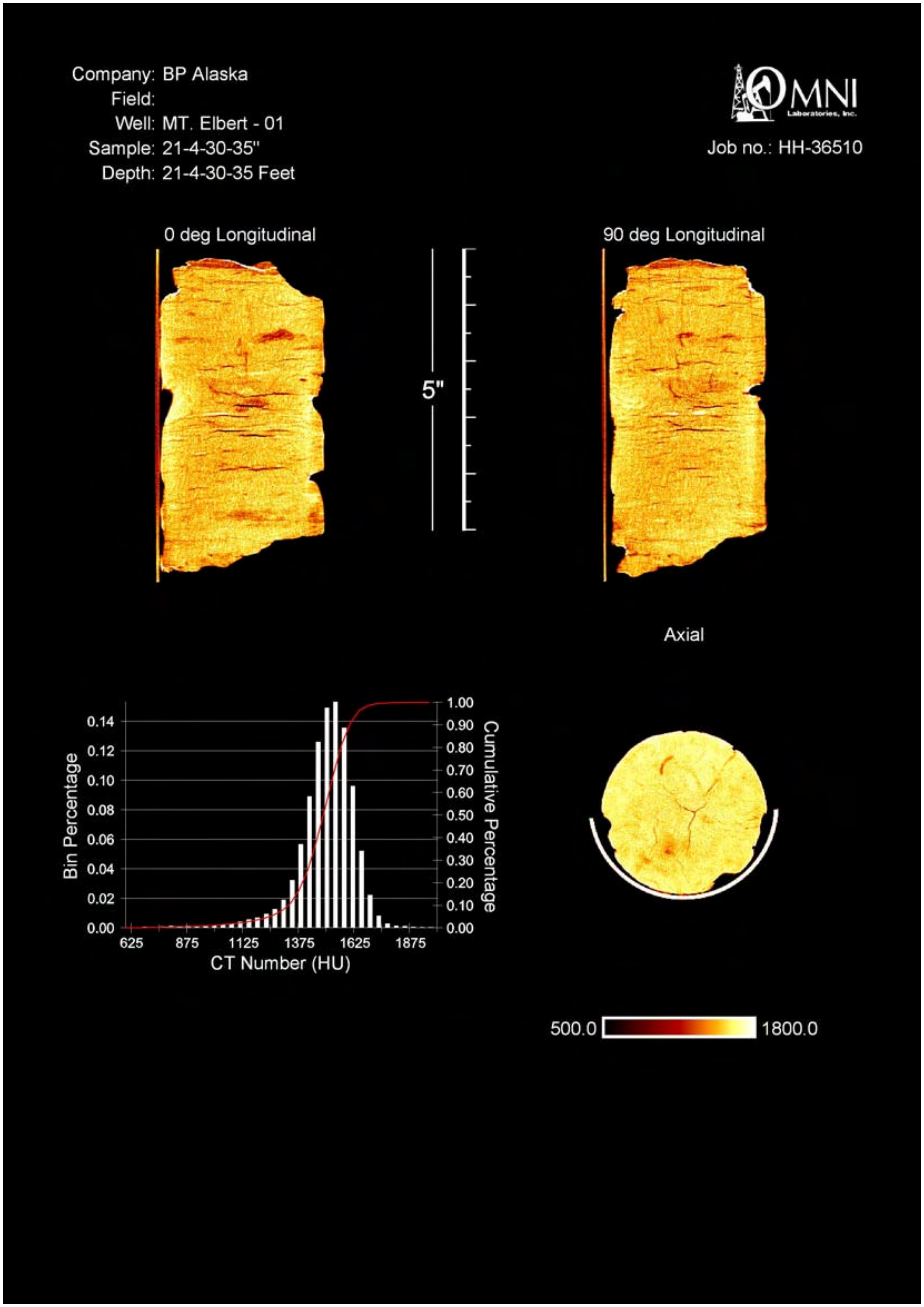


Figure 23: CTscan of core sample, Core 21, Section 4, 30 to 35 inches

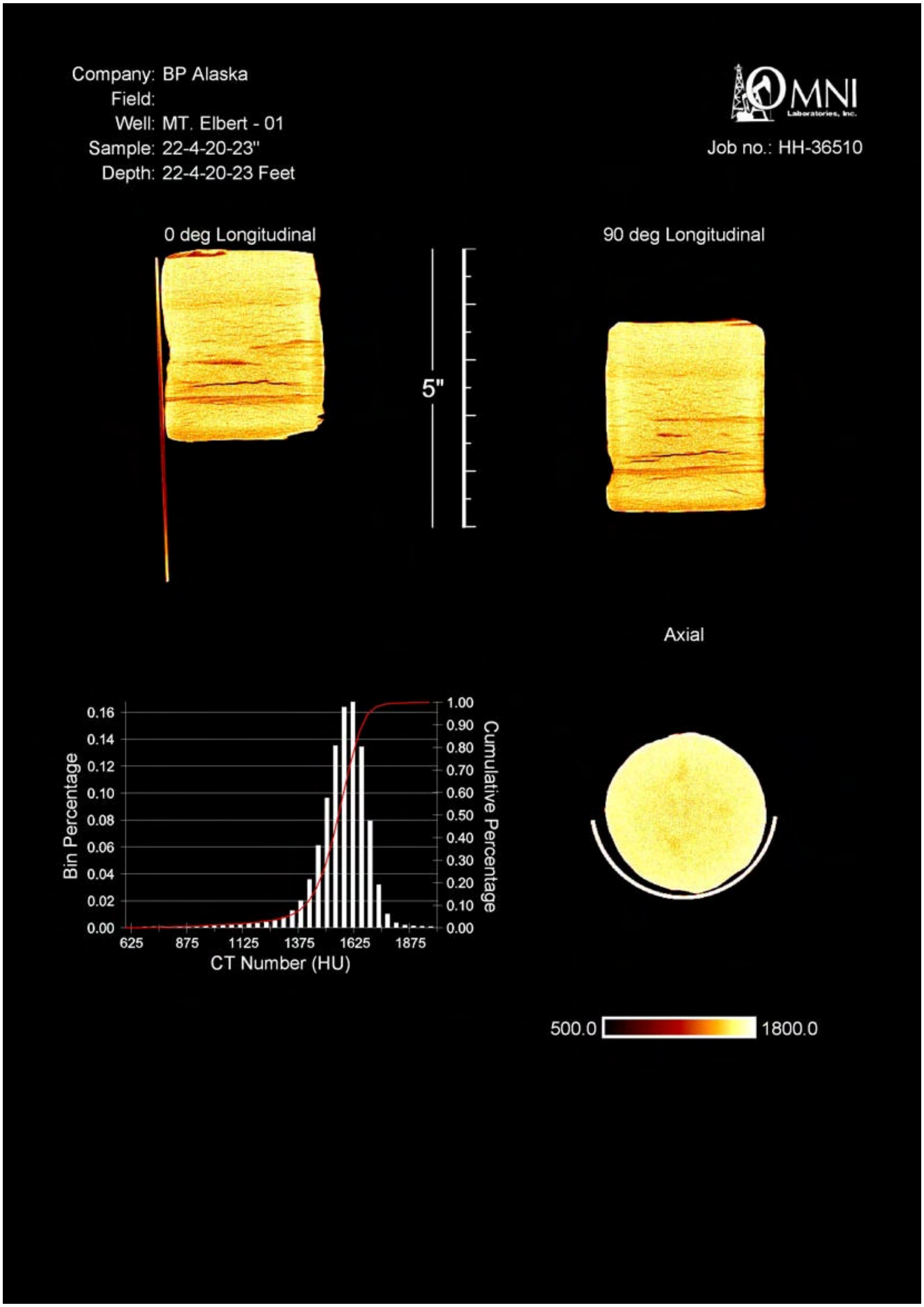


Figure 24: CTscan of core sample, Core 22, Section 4, 20 to 23 inches

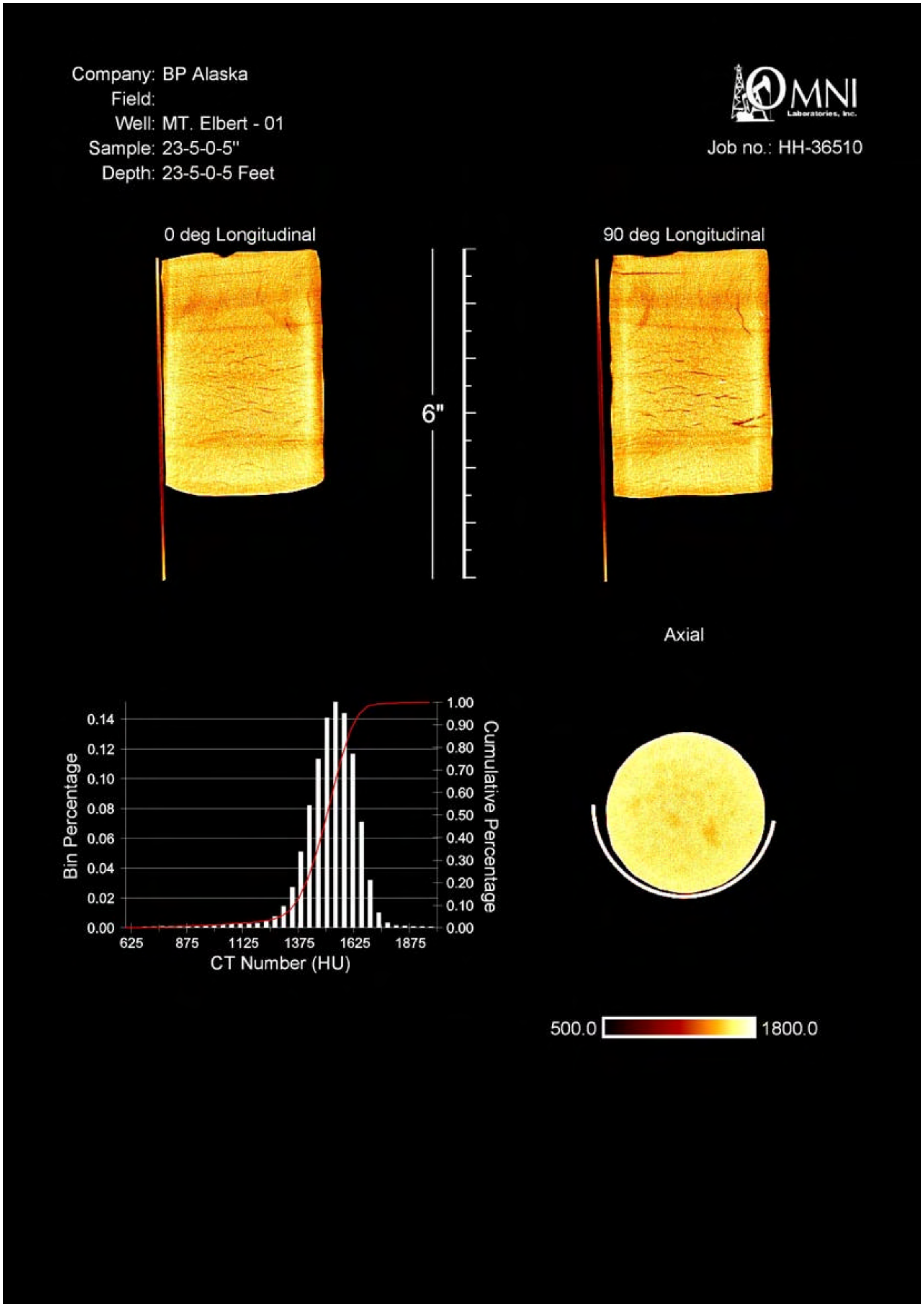


Figure 25: CTscan of core sample, Core 23, Section 5, 0 to 5 inches

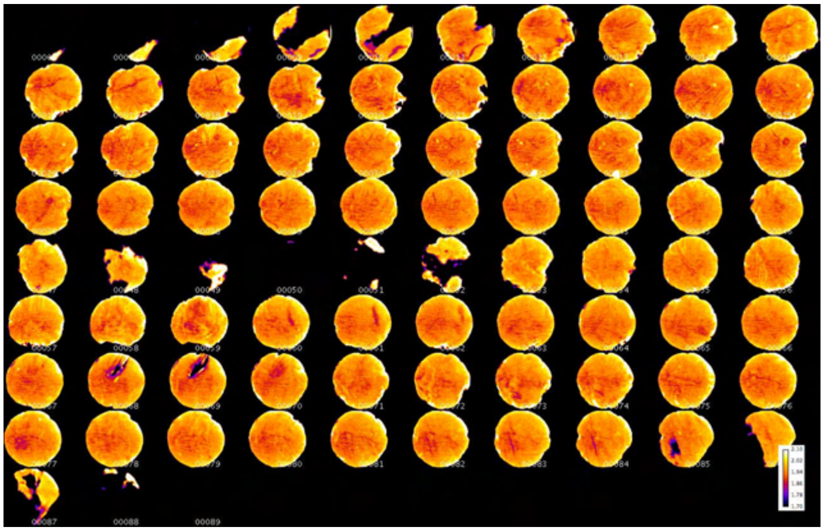


Figure 26: LBNL CTscan slices of Core 9, Section 1, 7 to 17 inches

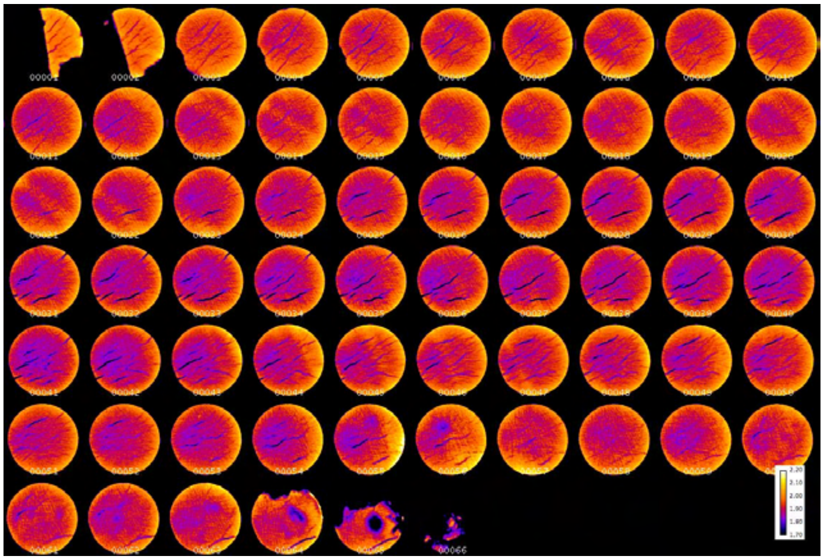


Figure 27: LBNL CTscan slices of Core 7, Section 5, 14 to 22 inches

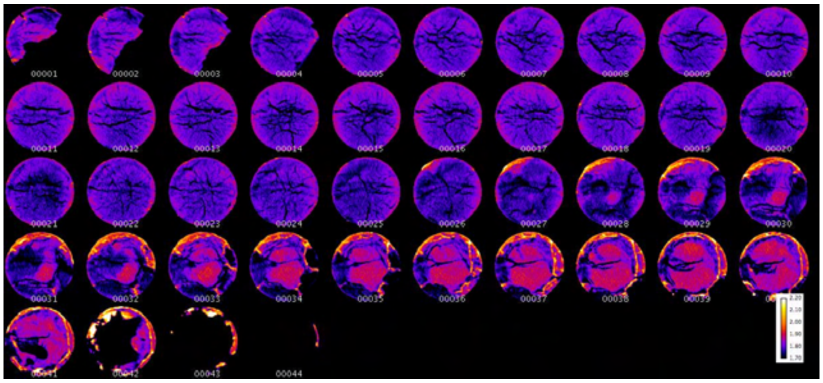


Figure 28: LBNL CTscan slices of Core 2, Section 8, 31 to 36 inches

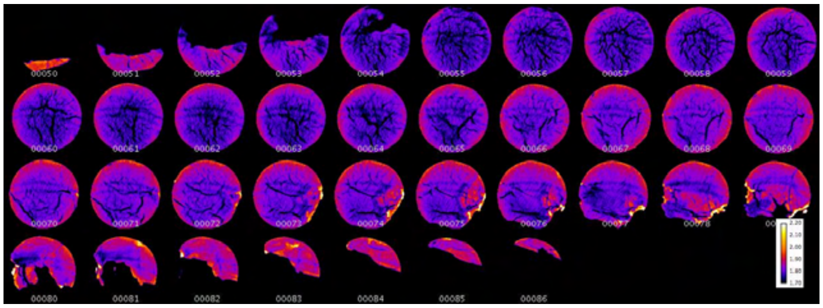


Figure 29: LBNL CTscan slices of Core 2, Section 8, 26 to 31 inches

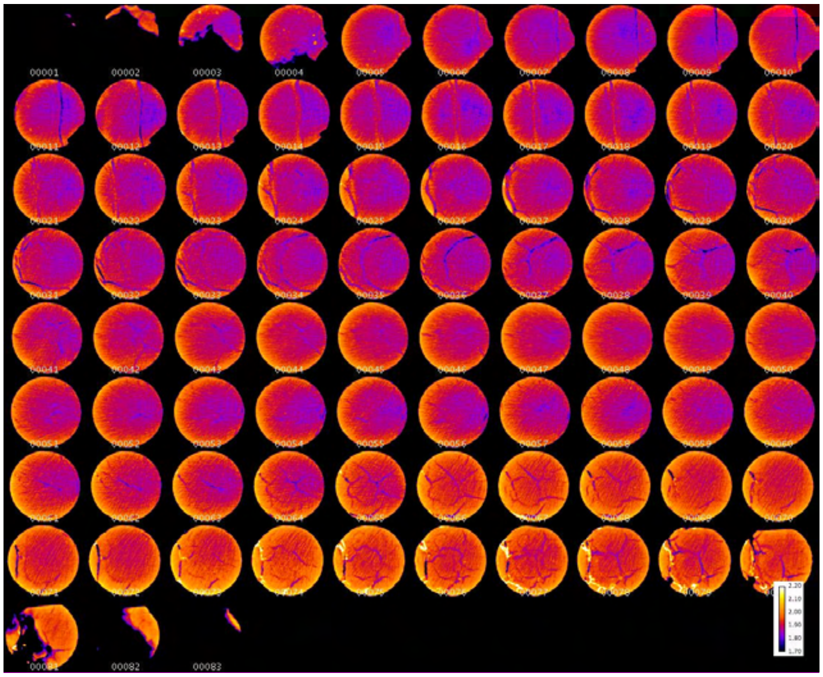


Figure 30: LBNL CTscan slices of Core 2, Section 7, 20 to 30 inches

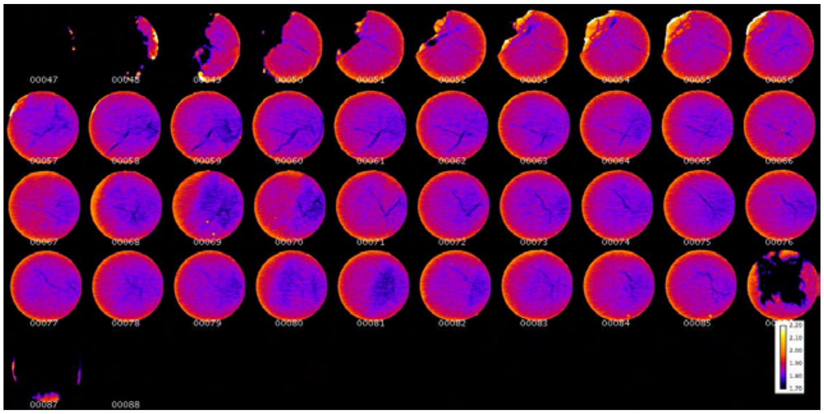


Figure 31: LBNL CTscan slices of Core 3, Section 4, 31 to 36 inches

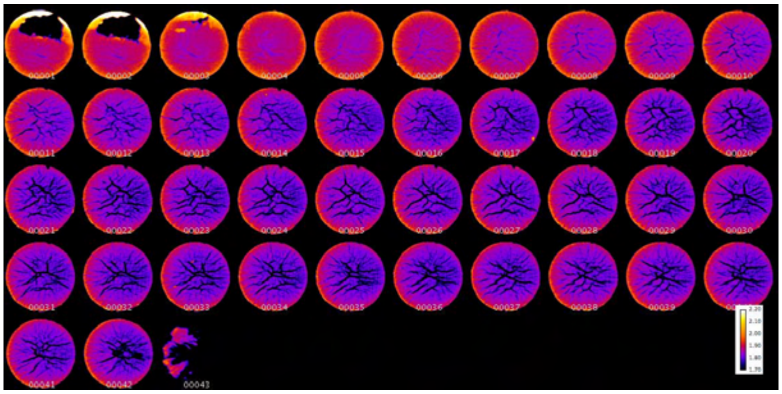


Figure 32: LBNL CTscan slices of Core 7, Section 6, 31 to 36 inches

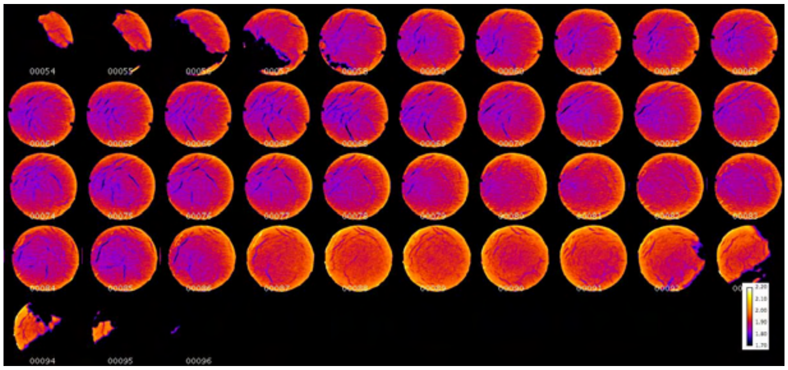


Figure 33: LBNL CTscan slices of Core 8, Section 5, 31 to 36 inches

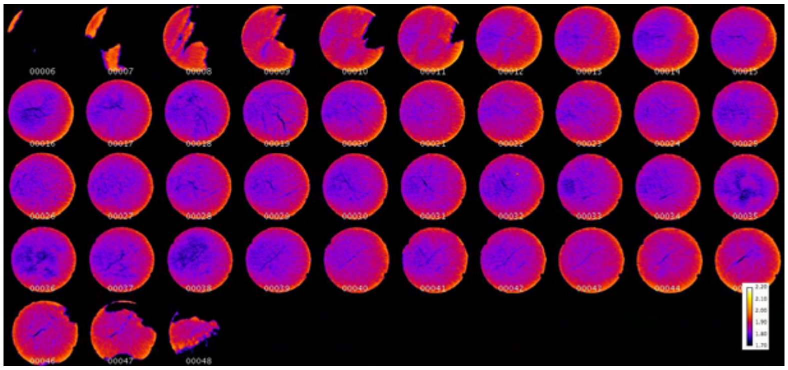


Figure 34: LBNL CTscan slices of Core 8, Section 4, 31 to 36 inches

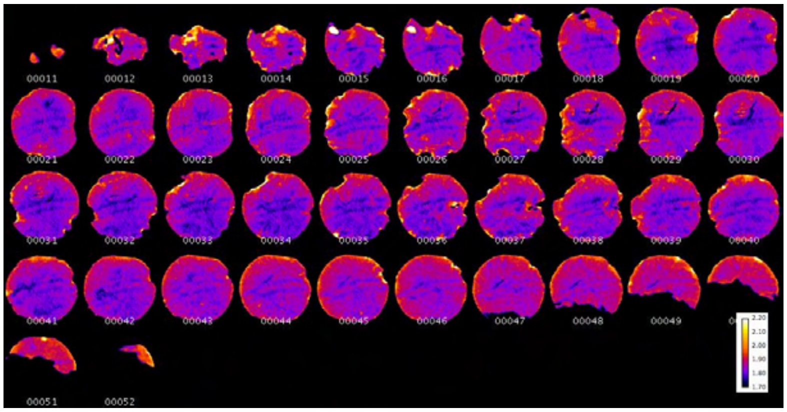
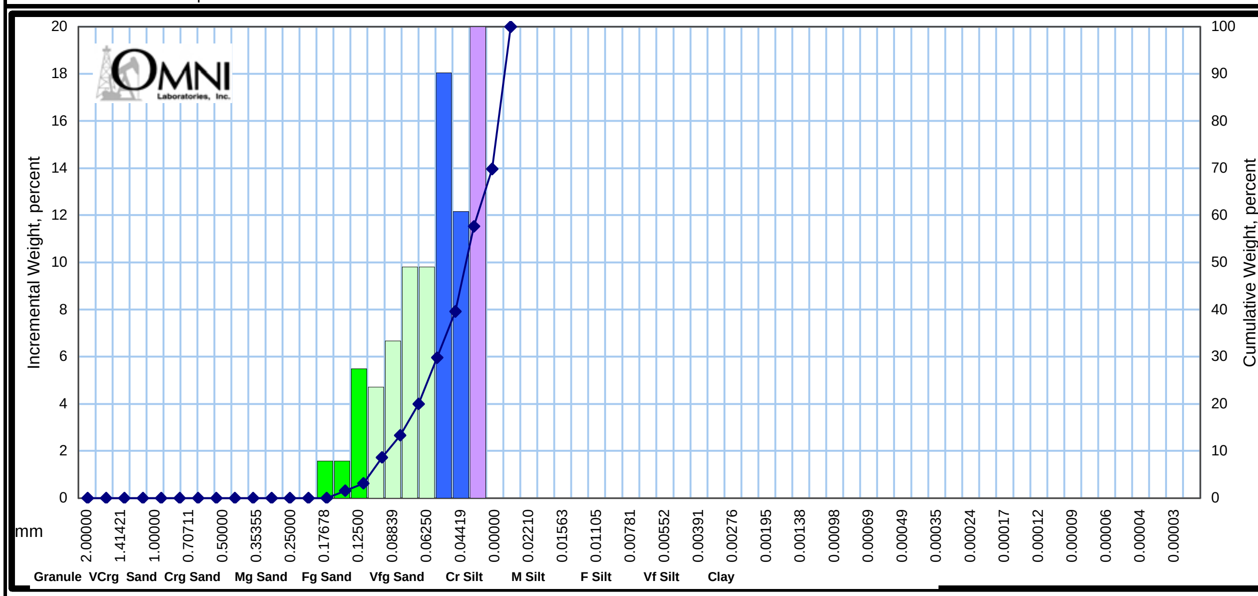


Figure 35: LBNL CTscan slices of Core 9, Section 1, 31 to 36 inches

SIEVE ANALYSIS
Conventional Core

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples

Core Run:	1
Core Section:	3
Sample Top-Bottom, In.:	33-36
File:	HH-36917



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Weight, percent	Cumulative Weight, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.0	0.0
	0.011705	0.29730	1.75	50	0.0	0.0
	0.009843	0.25000	2.00	60	0.0	0.0
Fg Sand	0.008277	0.21022	2.25	70	0.0	0.0
	0.006960	0.17678	2.50	80	1.6	1.6
	0.005852	0.14865	2.75	100	1.6	3.1
	0.004921	0.12500	3.00	120	5.5	8.6
Vfg Sand	0.004138	0.10511	3.25	140	4.7	13.3
	0.003480	0.08839	3.50	170	6.7	20.0
	0.002926	0.07433	3.75	200	9.8	29.8
	0.002461	0.06250	4.00	230	9.8	39.6
C Silt	0.002069	0.05256	4.25	270	18.0	57.6
	0.001740	0.04419	4.50	325	12.2	69.8
Pan				<325	30.2	100.0

Description	Sieve Size	Weight Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	0.0
Fine Sand	120	8.6
Very Fine Sand	230	31.0
Coarse Silt	0	30.2
Pan	<325	30.2

Cumulative Volume Percent greater than			
Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	2.8301	0.0055	0.1406
10	3.0686	0.0047	0.1192
16	3.3449	0.0039	0.0984
25	3.6221	0.0032	0.0812
50	4.1387	0.0022	0.0568
75	4.6043	0.0016	0.0411
84	4.8051	0.0014	0.0358
90	4.5422	0.0017	0.0429
95	4.6374	0.0016	0.0402

Measure	Trask, mm	Folk, phi	Inches
Median	0.0568	4.1387	0.0022
Mean	0.0612	4.0962	0.0024
Sorting	1.4055	0.6389	
Skewness	1.0360	-0.2677	
Kurtosis	0.2629	0.7541	

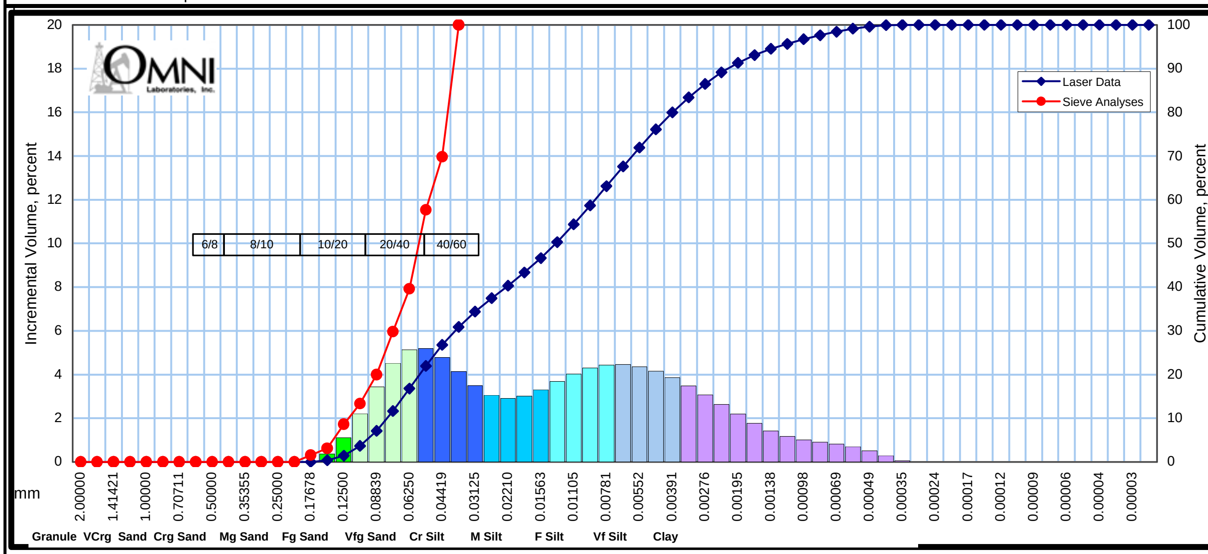
Figure 36: Grain Size Sieve Analysis, Core 1, Section 3, 33 to 36 inches

LASER GRAIN SIZE ANALYSIS

Conventional Core

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples

Core Run:	1
Core Section:	3
Sample Top-Bottom, In.:	33-36
File:	HH-36917



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Volume, percent	Cumulative Volume, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.0	0.0
	0.011705	0.29730	1.75	50	0.0	0.0
	0.009843	0.25000	2.00	60	0.0	0.0
Fg Sand	0.008277	0.21022	2.25	70	0.0	0.0
	0.006960	0.17678	2.50	80	0.0	0.0
	0.005852	0.14865	2.75	100	0.4	0.4
	0.004921	0.12500	3.00	120	1.1	1.5
Vfg Sand	0.004138	0.10511	3.25	140	2.2	3.7
	0.003480	0.08839	3.50	170	3.4	7.1
	0.002926	0.07433	3.75	200	4.5	11.6
	0.002461	0.06250	4.00	230	5.1	16.8
C Silt	0.002069	0.05256	4.25	270	5.2	22.0
	0.001740	0.04419	4.50	325	4.8	26.8
	0.001463	0.03716	4.75	400	4.1	30.9
	0.001230	0.03125	5.00	450	3.5	34.4
M Silt	0.001035	0.02628	5.25	500	3.1	37.5
	0.000870	0.02210	5.50	635	2.9	40.4
	0.000732	0.01858	5.75		3.0	43.4
	0.000615	0.01563	6.00		3.3	46.7
F Silt	0.000517	0.01314	6.25		3.7	50.3
	0.000435	0.01105	6.50		4.0	54.4
	0.000366	0.00929	6.75		4.3	58.7
	0.000308	0.00781	7.00		4.4	63.1
Vf Silt	0.000259	0.00657	7.25		4.5	67.6
	0.000217	0.00552	7.50		4.4	71.9
	0.000183	0.00465	7.75		4.2	76.1
	0.000154	0.00391	8.00		3.9	80.0

Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Volume, percent	Cumulative Volume, percent
Clay	0.000129	0.00329	8.25		3.5	83.4
	0.000109	0.00276	8.50		3.1	86.5
	0.000091	0.00232	8.75		2.6	89.1
	0.000077	0.00195	9.00		2.2	91.3
	0.000065	0.00164	9.25		1.8	93.1
	0.000054	0.00138	9.50		1.4	94.5
	0.000046	0.00116	9.75		1.2	95.7
	0.000038	0.00098	10.00		1.0	96.7
	0.000032	0.00082	10.25		0.9	97.6
	0.000027	0.00069	10.50		0.8	98.4
	0.000023	0.00058	10.75		0.7	99.1
	0.000019	0.00049	11.00		0.5	99.6
	0.000016	0.00041	11.25		0.3	99.9
	0.000014	0.00035	11.50		0.1	100.0
	0.000011	0.00029	11.75		0.0	100.0
	0.000010	0.00024	12.00		0.0	100.0
	0.000008	0.00021	12.25		0.0	100.0
	0.000007	0.00017	12.50		0.0	100.0
	0.000006	0.00015	12.75		0.0	100.0
	0.000005	0.00012	13.00		0.0	100.0
	0.000004	0.00010	13.25		0.0	100.0
	0.000003	0.00009	13.51		0.0	100.0
	0.000003	0.00007	13.74		0.0	100.0
	0.000002	0.00006	14.00		0.0	100.0
	0.000002	0.000051	14.26		0.0	100.0
	0.000002	0.000043	14.51		0.0	100.0
	0.000001	0.000036	14.76		0.0	100.0
	0.000001	0.000031	14.98		0.0	100.0
	0.000001	0.000026	15.23		0.0	100.0
	TOTALS				100.0	100.0

Description	Sieve Size	Volume Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	0.0
Fine Sand	120	1.5
Very Fine Sand	230	15.3
Coarse Silt	450	17.6
Medium Silt		12.3
Fine Silt		16.4
Very Fine Silt		16.8
Clay		20.0
	Total	100.0

Cumulative Volume Percent greater than

Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	3.3509	0.0039	0.0980
10	3.6590	0.0031	0.0792
16	3.9570	0.0025	0.0644
25	4.3977	0.0019	0.0474
50	6.2188	0.0005	0.0134
75	7.6721	0.0002	0.0049
84	8.2823	0.0001	0.0032
90	8.8316	0.0001	0.0022
95	9.5851	0.0001	0.0013

Measure	Trask, mm	Folk, phi	Inches
Median	0.0134	6.2188	0.0005
Mean	0.0262	6.1527	0.0010
Sorting	3.1106	2.0259	
Skewness	1.2904	0.0170	
Kurtosis	0.2763	0.7803	

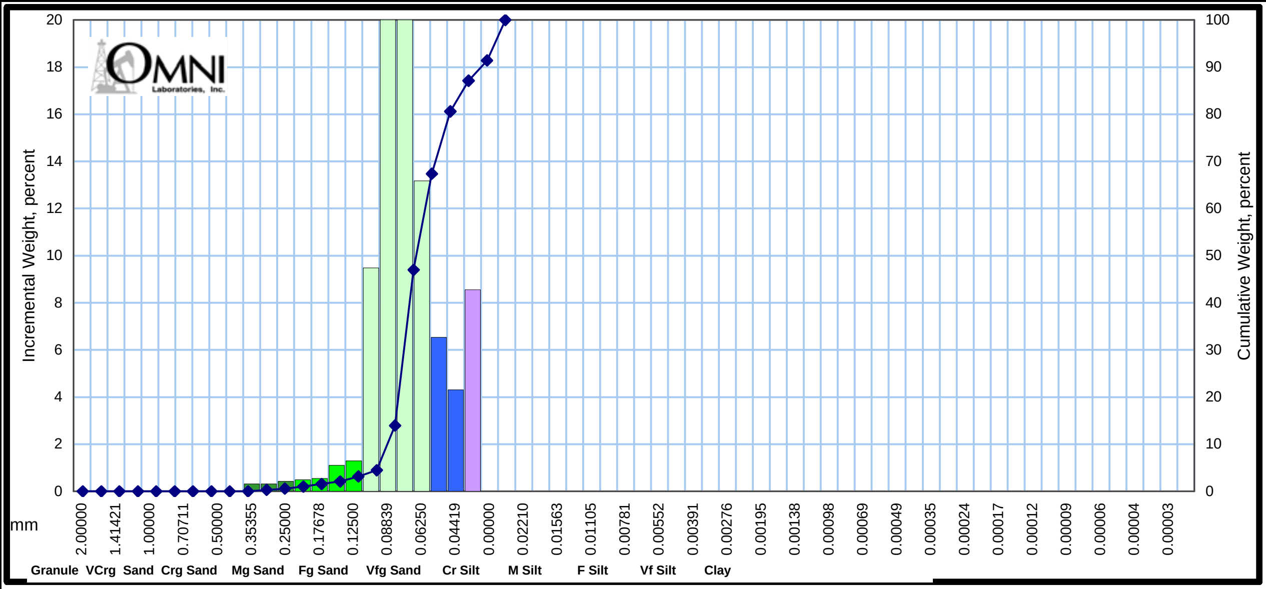
Figure 37: Grain Size Laser Analysis, Core 1, Section 3, 33 to 36 inches

SIEVE ANALYSIS

Conventional Core

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples

Core Run:	2
Core Section:	7
Sample Top-Bottom, In.:	33-36
File:	HH-36917



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Weight, percent	Cumulative Weight, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.3	0.3
	0.011705	0.29730	1.75	50	0.3	0.6
	0.009843	0.25000	2.00	60	0.4	1.0
Fg Sand	0.008277	0.21022	2.25	70	0.5	1.5
	0.006960	0.17678	2.50	80	0.6	2.1
	0.005852	0.14865	2.75	100	1.1	3.2
	0.004921	0.12500	3.00	120	1.3	4.5
Vfg Sand	0.004138	0.10511	3.25	140	9.5	14.0
	0.003480	0.08839	3.50	170	33.0	47.0
	0.002926	0.07433	3.75	200	20.4	67.4
	0.002461	0.06250	4.00	230	13.2	80.6
C Silt	0.002069	0.05256	4.25	270	6.5	87.1
	0.001740	0.04419	4.50	325	4.3	91.4
Pan				<325	8.6	100.0

Description	Sieve Size	Weight Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	1.0
Fine Sand	120	3.4
Very Fine Sand	230	76.1
Coarse Silt	0	10.8
Pan	<325	8.6

Cumulative Volume Percent greater than

Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	3.0123	0.0049	0.1239
10	3.1398	0.0045	0.1135
16	3.2641	0.0041	0.1041
25	3.3288	0.0039	0.0995
50	3.5343	0.0034	0.0863
75	3.8884	0.0027	0.0675
84	4.1247	0.0023	0.0573
90	4.5422	0.0017	0.0429
95	4.6374	0.0016	0.0402

Measure	Trask, mm	Folk, phi	Inches
Median	0.0863	3.5343	0.0034
Mean	0.0835	3.6410	0.0033
Sorting	1.2140	0.4614	
Skewness	0.9022	0.3649	
Kurtosis	0.2268	1.1902	

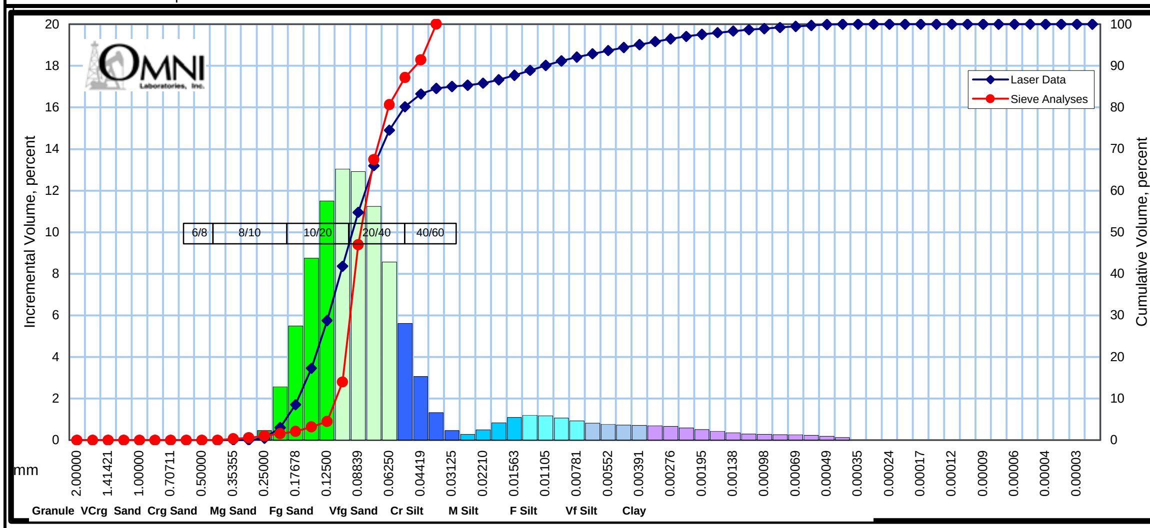
Figure 38: Grain Size Sieve Analysis, Core 2, Section 7, 33 to 36 inches

LASER GRAIN SIZE ANALYSIS

Conventional Core

Core Run:	2
Core Section:	7
Sample Top-Bottom, In.:	33-36
File:	HH-36917

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Volume, percent	Cumulative Volume, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.0	0.0
	0.011705	0.29730	1.75	50	0.0	0.0
	0.009843	0.25000	2.00	60	0.5	0.5
Fg Sand	0.008277	0.21022	2.25	70	2.6	3.0
	0.006960	0.17678	2.50	80	5.5	8.5
	0.005852	0.14865	2.75	100	8.7	17.3
	0.004921	0.12500	3.00	120	11.5	28.8
Vfg Sand	0.004138	0.10511	3.25	140	13.0	41.8
	0.003480	0.08839	3.50	170	12.9	54.7
	0.002926	0.07433	3.75	200	11.2	66.0
	0.002461	0.06250	4.00	230	8.6	74.5
C Silt	0.002069	0.05256	4.25	270	5.6	80.1
	0.001740	0.04419	4.50	325	3.1	83.2
	0.001463	0.03716	4.75	400	1.3	84.5
	0.001230	0.03125	5.00	450	0.5	85.0
M Silt	0.001035	0.02628	5.25	500	0.3	85.3
	0.000870	0.02210	5.50	635	0.5	85.8
	0.000732	0.01858	5.75		0.8	86.6
	0.000615	0.01563	6.00		1.1	87.7
F Silt	0.000517	0.01314	6.25		1.2	88.9
	0.000435	0.01105	6.50		1.2	90.1
	0.000366	0.00929	6.75		1.1	91.1
	0.000308	0.00781	7.00		0.9	92.0
Vf Silt	0.000259	0.00657	7.25		0.8	92.9
	0.000217	0.00552	7.50		0.8	93.6
	0.000183	0.00465	7.75		0.7	94.4
	0.000154	0.00391	8.00		0.7	95.1
Clay	0.000129	0.00329	8.25		0.7	95.8
	0.000109	0.00276	8.50		0.7	96.4
	0.000091	0.00232	8.75		0.6	97.0
	0.000077	0.00195	9.00		0.5	97.5
	0.000065	0.00164	9.25		0.4	98.0
	0.000054	0.00138	9.50		0.4	98.3
	0.000046	0.00116	9.75		0.3	98.6
	0.000038	0.00098	10.00		0.3	98.9
	0.000032	0.00082	10.25		0.3	99.2
	0.000027	0.00069	10.50		0.3	99.4
	0.000023	0.00058	10.75		0.2	99.7
	0.000019	0.00049	11.00		0.2	99.9
	0.000016	0.00041	11.25		0.1	100.0
	0.000014	0.00035	11.50		0.0	100.0
	0.000011	0.00029	11.75		0.0	100.0
	0.000010	0.00024	12.00		0.0	100.0
	0.000008	0.00021	12.25		0.0	100.0
	0.000007	0.00017	12.50		0.0	100.0
	0.000006	0.00015	12.75		0.0	100.0
	0.000005	0.00012	13.00		0.0	100.0
	0.000004	0.00010	13.25		0.0	100.0
	0.000003	0.00009	13.51		0.0	100.0
	0.000003	0.00007	13.74		0.0	100.0
	0.000002	0.00006	14.00		0.0	100.0
	0.000002	0.000051	14.26		0.0	100.0
	0.000002	0.000043	14.51		0.0	100.0
	0.000001	0.000036	14.76		0.0	100.0
	0.000001	0.000031	14.98		0.0	100.0
	0.000001	0.000026	15.23		0.0	100.0
	TOTALS				100.0	100.0

Description	Sieve Size	Volume Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	0.5
Fine Sand	120	28.3
Very Fine Sand	230	45.7
Coarse Silt	450	10.5
Medium Silt		2.7
Fine Silt		4.3
Very Fine Silt		3.0
Clay		4.9
	Total	100.0

Cumulative Volume Percent greater than			
Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	2.3534	0.0077	0.1957
10	2.5448	0.0067	0.1714
16	2.7141	0.0060	0.1524
25	2.9183	0.0052	0.1323
50	3.4010	0.0037	0.0947
75	4.0110	0.0024	0.0620
84	4.6099	0.0016	0.0410
90	6.4769	0.0004	0.0112
95	7.9593	0.0002	0.0040

Measure	Trask, mm	Folk, phi	Inches
Median	0.0947	3.4010	0.0037
Mean	0.0972	3.5750	0.0038
Sorting	1.4604	1.3233	
Skewness	0.9156	0.4508	
Kurtosis	0.2194	2.1025	

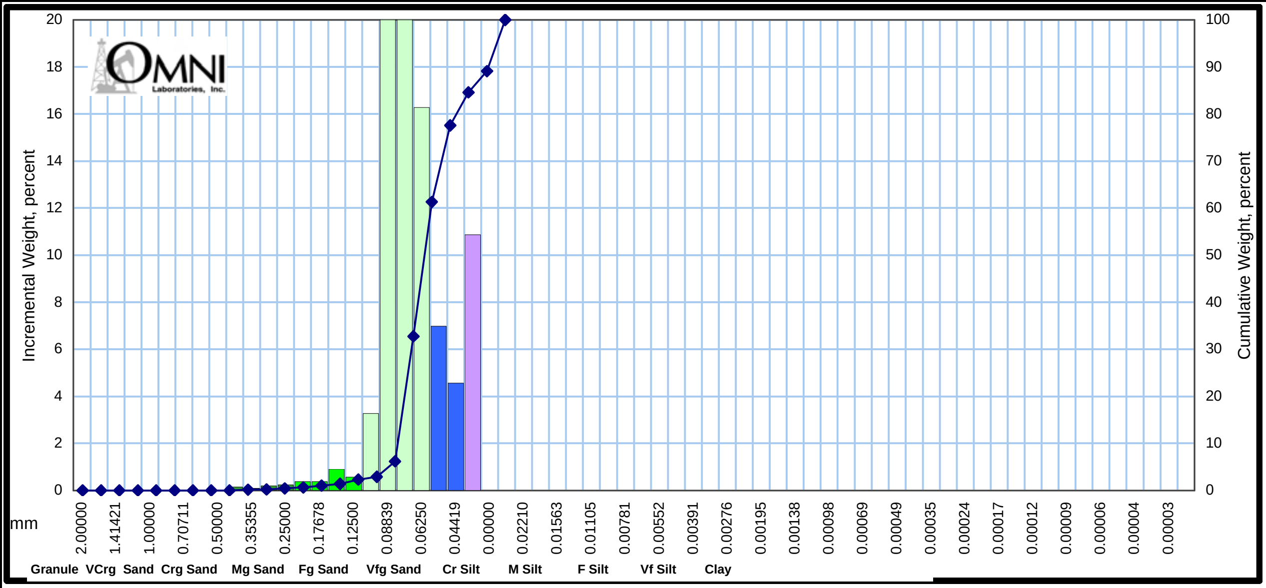
Figure 39: Grain Size Laser Analysis, Core 2, Section 7, 33 to 36 inches

SIEVE ANALYSIS

Conventional Core

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples

Core Run: 3
Core Section: 3
Sample Top-Bottom, In.: 34-36
File: HH-36917



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Weight, percent	Cumulative Weight, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.1	0.1
	0.013919	0.35355	1.50	45	0.1	0.2
	0.011705	0.29730	1.75	50	0.2	0.4
	0.009843	0.25000	2.00	60	0.2	0.7
Fg Sand	0.008277	0.21022	2.25	70	0.4	1.0
	0.006960	0.17678	2.50	80	0.4	1.4
	0.005852	0.14865	2.75	100	0.9	2.3
	0.004921	0.12500	3.00	120	0.6	2.9
Vfg Sand	0.004138	0.10511	3.25	140	3.3	6.2
	0.003480	0.08839	3.50	170	26.6	32.8
	0.002926	0.07433	3.75	200	28.5	61.3
	0.002461	0.06250	4.00	230	16.3	77.6
C Silt	0.002069	0.05256	4.25	270	7.0	84.6
	0.001740	0.04419	4.50	325	4.6	89.1
Pan				<325	10.9	100.0

Description	Sieve Size	Weight Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	0.7
Fine Sand	120	2.2
Very Fine Sand	230	74.7
Coarse Silt	0	11.5
Pan	<325	10.9

Cumulative Volume Percent greater than			
Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	3.1555	0.0044	0.1122
10	3.2834	0.0040	0.1027
16	3.3374	0.0039	0.0989
25	3.4224	0.0037	0.0933
50	3.6458	0.0031	0.0799
75	3.9573	0.0025	0.0644
84	4.2280	0.0021	0.0534
90	4.5422	0.0017	0.0429
95	4.6374	0.0016	0.0402

Measure	Trask, mm	Folk, phi	Inches
Median	0.0799	3.6458	0.0031
Mean	0.0788	3.7371	0.0031
Sorting	1.2037	0.4472	
Skewness	0.9407	0.3229	
Kurtosis	0.2416	1.1356	

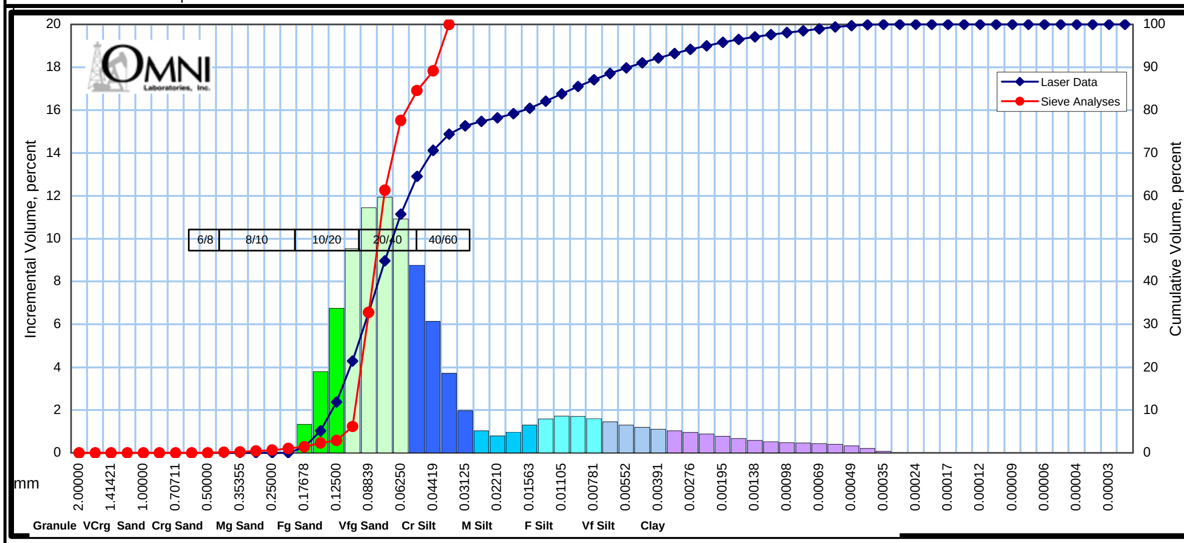
Figure 40: Grain Size Sieve Analysis, Core 3, Section 3, 34 to 36 inches

LASER GRAIN SIZE ANALYSIS

Conventional Core

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples

Core Run:	3
Core Section:	3
Sample Top-Bottom, In.:	34-36
File:	HH-36917



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Volume, percent	Cumulative Volume, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.0	0.0
	0.011705	0.29730	1.75	50	0.0	0.0
	0.009843	0.25000	2.00	60	0.0	0.0
Fg Sand	0.008277	0.21022	2.25	70	0.0	0.0
	0.006960	0.17678	2.50	80	1.3	1.3
	0.005852	0.14865	2.75	100	3.8	5.1
	0.004921	0.12500	3.00	120	6.7	11.9
Vfg Sand	0.004138	0.10511	3.25	140	9.5	21.4
	0.003480	0.08839	3.50	170	11.5	32.9
	0.002926	0.07433	3.75	200	11.9	44.8
	0.002461	0.06250	4.00	230	10.9	55.7
C Silt	0.002069	0.05256	4.25	270	8.8	64.5
	0.001740	0.04419	4.50	325	6.1	70.6
	0.001463	0.03716	4.75	400	3.7	74.4
	0.001230	0.03125	5.00	450	2.0	76.4
M Silt	0.001035	0.02628	5.25	500	1.0	77.4
	0.000870	0.02210	5.50	635	0.8	78.2
	0.000732	0.01858	5.75		1.0	79.2
	0.000615	0.01563	6.00		1.3	80.5
F Silt	0.000517	0.01314	6.25		1.6	82.1
	0.000435	0.01105	6.50		1.7	83.8
	0.000366	0.00929	6.75		1.7	85.5
	0.000308	0.00781	7.00		1.6	87.1
Vf Silt	0.000259	0.00657	7.25		1.5	88.6
	0.000217	0.00552	7.50		1.3	89.9
	0.000183	0.00465	7.75		1.2	91.1
	0.000154	0.00391	8.00		1.1	92.2

Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Volume, percent	Cumulative Volume, percent
Clay	0.000129	0.00329	8.25		1.0	93.2
	0.000109	0.00276	8.50		1.0	94.2
	0.000091	0.00232	8.75		0.9	95.1
	0.000077	0.00195	9.00		0.8	95.8
	0.000065	0.00164	9.25		0.7	96.5
	0.000054	0.00138	9.50		0.6	97.1
	0.000046	0.00116	9.75		0.5	97.6
	0.000038	0.00098	10.00		0.5	98.1
	0.000032	0.00082	10.25		0.5	98.6
	0.000027	0.00069	10.50		0.4	99.0
	0.000023	0.00058	10.75		0.4	99.4
	0.000019	0.00049	11.00		0.3	99.7
	0.000016	0.00041	11.25		0.2	99.9
	0.000014	0.00035	11.50		0.1	100.0
	0.000011	0.00029	11.75		0.0	100.0
	0.000010	0.00024	12.00		0.0	100.0
	0.000008	0.00021	12.25		0.0	100.0
	0.000007	0.00017	12.50		0.0	100.0
	0.000006	0.00015	12.75		0.0	100.0
	0.000005	0.00012	13.00		0.0	100.0
	0.000004	0.00010	13.25		0.0	100.0
	0.000003	0.00009	13.51		0.0	100.0
	0.000003	0.00007	13.74		0.0	100.0
	0.000002	0.00006	14.00		0.0	100.0
	0.000002	0.000051	14.26		0.0	100.0
	0.000002	0.000043	14.51		0.0	100.0
	0.000001	0.000036	14.76		0.0	100.0
	0.000001	0.000031	14.98		0.0	100.0
	0.000001	0.000026	15.23		0.0	100.0
	TOTALS				100.0	100.0

Description	Sieve Size	Volume Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	0.0
Fine Sand	120	11.9
Very Fine Sand	230	43.9
Coarse Silt	450	20.6
Medium Silt		4.1
Fine Silt		6.6
Very Fine Silt		5.1
Clay		7.8
	Total	100.0

Cumulative Volume Percent greater than

Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	2.7395	0.0059	0.1497
10	2.9362	0.0051	0.1307
16	3.1117	0.0046	0.1157
25	3.3266	0.0039	0.0997
50	3.8586	0.0027	0.0689
75	4.8051	0.0014	0.0358
84	6.5211	0.0004	0.0109
90	7.5182	0.0002	0.0055
95	8.7239	0.0001	0.0024

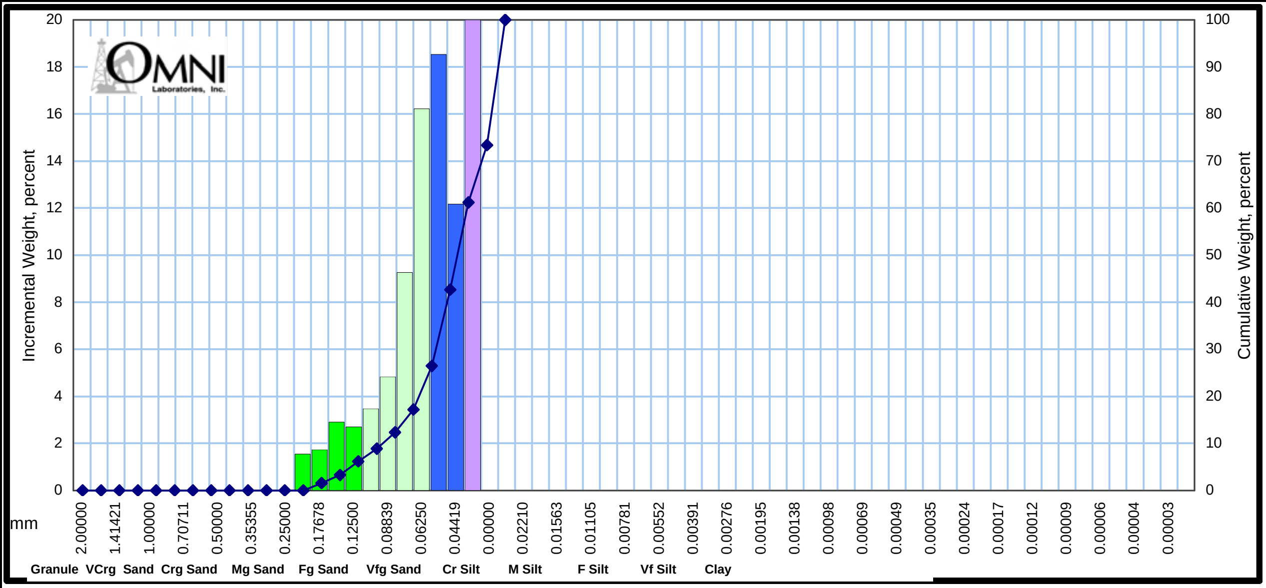
Measure	Trask, mm	Folk, phi	Inches
Median	0.0689	3.8586	0.0027
Mean	0.0677	4.4971	0.0027
Sorting	1.6693	1.7591	
Skewness	0.7502	0.5940	
Kurtosis	0.2552	1.6589	

Figure 41: Grain Size Laser Analysis, Core 3, Section 3, 34 to 36 inches

SIEVE ANALYSIS

Conventional Core

U.S. Geological Survey - MA	Core Run: 4
Mt. Elbert 01 PPMA Samples	Core Section: 7
	Sample Top-Bottom, In.: 34-36
	File: HH-36917



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Weight, percent	Cumulative Weight, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.0	0.0
	0.011705	0.29730	1.75	50	0.0	0.0
	0.009843	0.25000	2.00	60	0.0	0.0
Fg Sand	0.008277	0.21022	2.25	70	1.5	1.5
	0.006960	0.17678	2.50	80	1.7	3.3
	0.005852	0.14865	2.75	100	2.9	6.2
	0.004921	0.12500	3.00	120	2.7	8.9
Vfg Sand	0.004138	0.10511	3.25	140	3.5	12.4
	0.003480	0.08839	3.50	170	4.8	17.2
	0.002926	0.07433	3.75	200	9.3	26.4
	0.002461	0.06250	4.00	230	16.2	42.7
C Silt	0.002069	0.05256	4.25	270	18.5	61.2
	0.001740	0.04419	4.50	325	12.2	73.4
Pan				<325	26.6	100.0

Description	Sieve Size	Weight Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	0.0
Fine Sand	120	8.9
Very Fine Sand	230	33.8
Coarse Silt	0	30.7
Pan	<325	26.6

Cumulative Volume Percent greater than

Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	2.6431	0.0063	0.1601
10	3.0759	0.0047	0.1186
16	3.4347	0.0036	0.0925
25	3.7080	0.0030	0.0765
50	4.0938	0.0023	0.0586
75	4.5365	0.0017	0.0431
84	4.7549	0.0015	0.0370
90	4.5422	0.0017	0.0429
95	4.6374	0.0016	0.0402

Measure	Trask, mm	Folk, phi	Inches
Median	0.0586	4.0938	0.0023
Mean	0.0598	4.0945	0.0024
Sorting	1.3326	0.6322	
Skewness	0.9614	-0.2267	
Kurtosis	0.2209	0.9865	

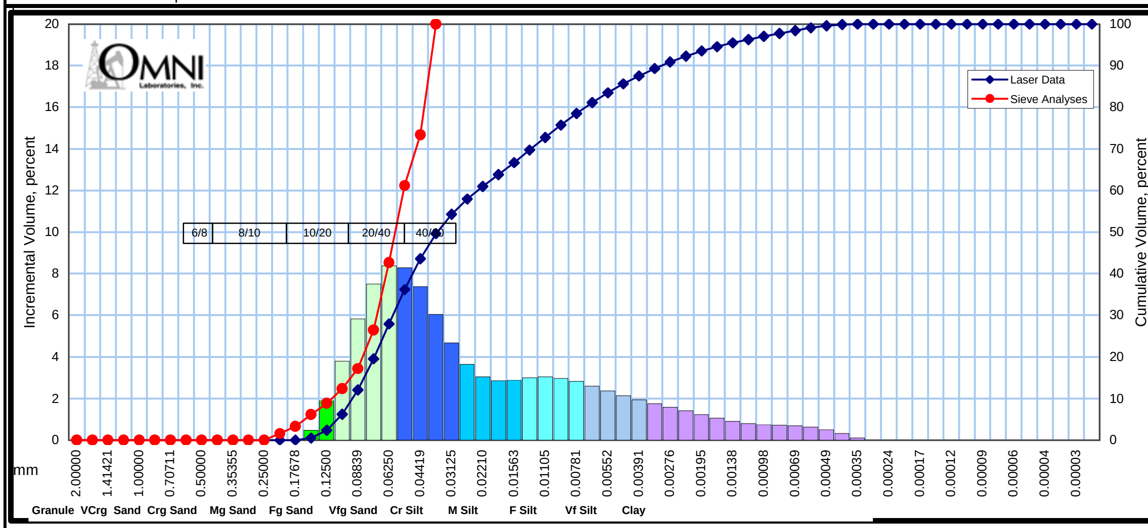
Figure 42: Grain Size Sieve Analysis, Core 4, Section 7, 34 to 36 inches

LASER GRAIN SIZE ANALYSIS

Conventional Core

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples

Core Run:	4
Core Section:	7
Sample Top-Bottom, In.:	34-36
File:	HH-36917



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Volume, percent	Cumulative Volume, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.0	0.0
	0.011705	0.29730	1.75	50	0.0	0.0
	0.009843	0.25000	2.00	60	0.0	0.0
Fg Sand	0.008277	0.21022	2.25	70	0.0	0.0
	0.006960	0.17678	2.50	80	0.0	0.0
	0.005852	0.14865	2.75	100	0.5	0.5
	0.004921	0.12500	3.00	120	1.9	2.4
Vfg Sand	0.004138	0.10511	3.25	140	3.8	6.2
	0.003480	0.08839	3.50	170	5.8	12.0
	0.002926	0.07433	3.75	200	7.5	19.5
	0.002461	0.06250	4.00	230	8.4	27.9
C Silt	0.002069	0.05256	4.25	270	8.3	36.2
	0.001740	0.04419	4.50	325	7.4	43.6
	0.001463	0.03716	4.75	400	6.0	49.6
	0.001230	0.03125	5.00	450	4.7	54.3
M Silt	0.001035	0.02628	5.25	500	3.6	57.9
	0.000870	0.02210	5.50	635	3.0	61.0
	0.000732	0.01858	5.75		2.8	63.8
	0.000615	0.01563	6.00		2.9	66.7
F Silt	0.000517	0.01314	6.25		3.0	69.7
	0.000435	0.01105	6.50		3.0	72.7
	0.000366	0.00929	6.75		3.0	75.7
	0.000308	0.00781	7.00		2.8	78.5
Vf Silt	0.000259	0.00657	7.25		2.6	81.1
	0.000217	0.00552	7.50		2.4	83.5
	0.000183	0.00465	7.75		2.1	85.6
	0.000154	0.00391	8.00		1.9	87.5

Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Volume, percent	Cumulative Volume, percent
Clay	0.000129	0.00329	8.25		1.7	89.3
	0.000109	0.00276	8.50		1.6	90.9
	0.000091	0.00232	8.75		1.4	92.3
	0.000077	0.00195	9.00		1.2	93.5
	0.000065	0.00164	9.25		1.1	94.6
	0.000054	0.00138	9.50		0.9	95.5
	0.000046	0.00116	9.75		0.8	96.3
	0.000038	0.00098	10.00		0.7	97.0
	0.000032	0.00082	10.25		0.7	97.8
	0.000027	0.00069	10.50		0.7	98.4
	0.000023	0.00058	10.75		0.6	99.1
	0.000019	0.00049	11.00		0.5	99.6
	0.000016	0.00041	11.25		0.3	99.9
	0.000014	0.00035	11.50		0.1	100.0
	0.000011	0.00029	11.75		0.0	100.0
	0.000010	0.00024	12.00		0.0	100.0
	0.000008	0.00021	12.25		0.0	100.0
	0.000007	0.00017	12.50		0.0	100.0
	0.000006	0.00015	12.75		0.0	100.0
	0.000005	0.00012	13.00		0.0	100.0
	0.000004	0.00010	13.25		0.0	100.0
	0.000003	0.00009	13.51		0.0	100.0
	0.000003	0.00007	13.74		0.0	100.0
	0.000002	0.00006	14.00		0.0	100.0
	0.000002	0.000051	14.26		0.0	100.0
	0.000002	0.000043	14.51		0.0	100.0
	0.000001	0.000036	14.76		0.0	100.0
	0.000001	0.000031	14.98		0.0	100.0
	0.000001	0.000026	15.23		0.0	100.0
	TOTALS				100.0	100.0

Description	Sieve Size	Volume Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	0.0
Fine Sand	120	2.4
Very Fine Sand	230	25.5
Coarse Silt	450	26.4
Medium Silt		12.4
Fine Silt		11.8
Very Fine Silt		9.0
Clay		12.5
	Total	100.0

Cumulative Volume Percent greater than

Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	3.1806	0.0043	0.1103
10	3.4172	0.0037	0.0936
16	3.6327	0.0032	0.0806
25	3.9089	0.0026	0.0666
50	4.7616	0.0015	0.0369
75	6.6813	0.0004	0.0097
84	7.5492	0.0002	0.0053
90	8.3480	0.0001	0.0031
95	9.3523	0.0001	0.0015

Measure	Trask, mm	Folk, phi	Inches
Median	0.0369	4.7616	0.0015
Mean	0.0382	5.3145	0.0015
Sorting	2.6139	1.9142	
Skewness	0.4773	0.4556	
Kurtosis	0.3138	0.9123	

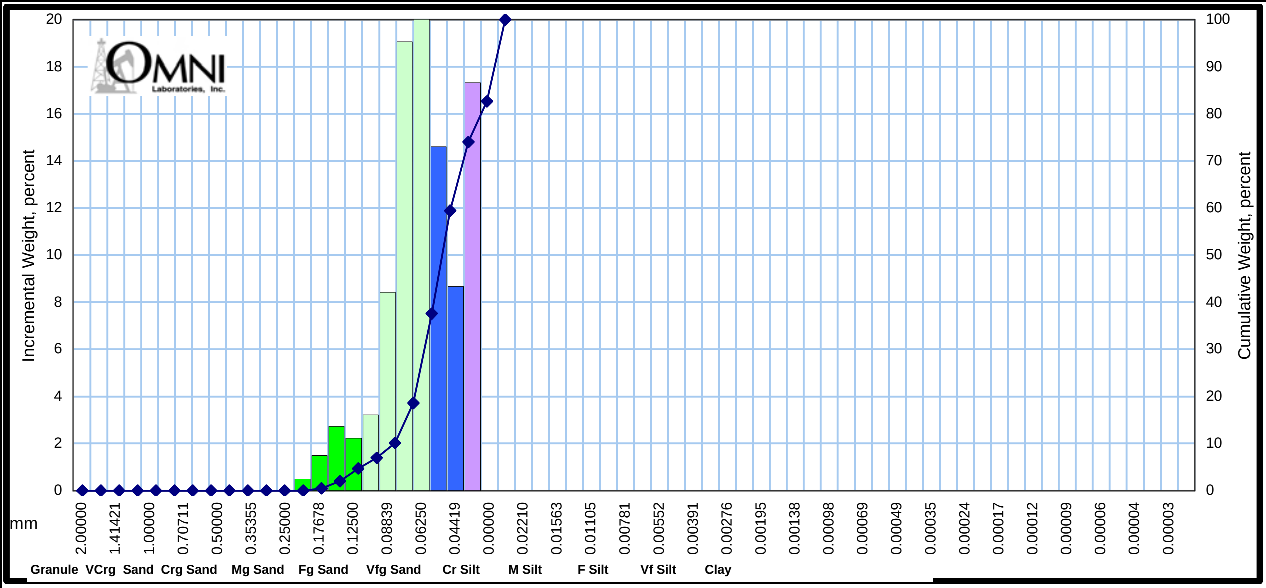
Figure 43: Grain Size Laser Analysis, Core 4, Section 7, 34 to 36 inches

SIEVE ANALYSIS

Conventional Core

Core Run:	7
Core Section:	2
Sample Top-Bottom, In.:	33-35
File:	HH-36917

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Weight, percent	Cumulative Weight, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.0	0.0
	0.011705	0.29730	1.75	50	0.0	0.0
	0.009843	0.25000	2.00	60	0.0	0.0
Fg Sand	0.008277	0.21022	2.25	70	0.5	0.5
	0.006960	0.17678	2.50	80	1.5	2.0
	0.005852	0.14865	2.75	100	2.7	4.7
	0.004921	0.12500	3.00	120	2.2	6.9
Vfg Sand	0.004138	0.10511	3.25	140	3.2	10.1
	0.003480	0.08839	3.50	170	8.4	18.6
	0.002926	0.07433	3.75	200	19.1	37.6
	0.002461	0.06250	4.00	230	21.8	59.4
C Silt	0.002069	0.05256	4.25	270	14.6	74.0
	0.001740	0.04419	4.50	325	8.7	82.7
Pan				<325	17.3	100.0

Description	Sieve Size	Weight Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	0.0
Fine Sand	120	6.9
Very Fine Sand	230	52.5
Coarse Silt	0	23.3
Pan	<325	17.3

Cumulative Volume Percent greater than

Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	2.7809	0.0057	0.1455
10	3.2375	0.0042	0.1060
16	3.4191	0.0037	0.0935
25	3.5797	0.0033	0.0836
50	3.8867	0.0027	0.0676
75	4.2765	0.0020	0.0516
84	4.5455	0.0017	0.0428
90	4.5422	0.0017	0.0429
95	4.6374	0.0016	0.0402

Measure	Trask, mm	Folk, phi	Inches
Median	0.0676	3.8867	0.0027
Mean	0.0676	3.9504	0.0027
Sorting	1.2731	0.5629	
Skewness	0.9443	-0.0107	
Kurtosis	0.2538	1.0919	

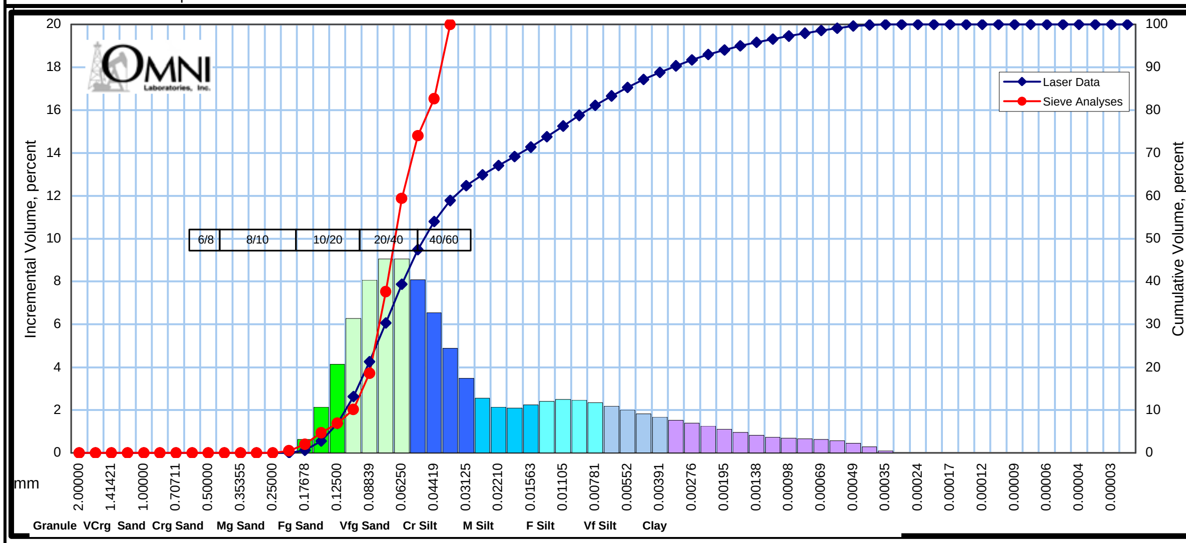
Figure 44: Grain Size Sieve Analysis, Core 7, Section 2, 33 to 35 inches

LASER GRAIN SIZE ANALYSIS

Conventional Core

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples

Core Run:	7
Core Section:	2
Sample Top-Bottom, In.:	33-35
File:	HH-36917



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Volume, percent	Cumulative Volume, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.0	0.0
	0.011705	0.29730	1.75	50	0.0	0.0
	0.009843	0.25000	2.00	60	0.0	0.0
Fg Sand	0.008277	0.21022	2.25	70	0.0	0.0
	0.006960	0.17678	2.50	80	0.6	0.6
	0.005852	0.14865	2.75	100	2.1	2.8
	0.004921	0.12500	3.00	120	4.1	6.9
Vfg Sand	0.004138	0.10511	3.25	140	6.3	13.2
	0.003480	0.08839	3.50	170	8.1	21.3
	0.002926	0.07433	3.75	200	9.1	30.3
	0.002461	0.06250	4.00	230	9.0	39.4
C Silt	0.002069	0.05256	4.25	270	8.1	47.5
	0.001740	0.04419	4.50	325	6.5	54.0
	0.001463	0.03716	4.75	400	4.9	58.9
	0.001230	0.03125	5.00	450	3.5	62.4
M Silt	0.001035	0.02628	5.25	500	2.6	64.9
	0.000870	0.02210	5.50	635	2.1	67.1
	0.000732	0.01858	5.75		2.1	69.2
	0.000615	0.01563	6.00		2.2	71.4
F Silt	0.000517	0.01314	6.25		2.4	73.8
	0.000435	0.01105	6.50		2.5	76.3
	0.000366	0.00929	6.75		2.5	78.8
	0.000308	0.00781	7.00		2.4	81.1
Vf Silt	0.000259	0.00657	7.25		2.2	83.3
	0.000217	0.00552	7.50		2.0	85.3
	0.000183	0.00465	7.75		1.8	87.1
	0.000154	0.00391	8.00		1.7	88.8

Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Volume, percent	Cumulative Volume, percent
Clay	0.000129	0.00329	8.25		1.5	90.3
	0.000109	0.00276	8.50		1.4	91.7
	0.000091	0.00232	8.75		1.3	93.0
	0.000077	0.00195	9.00		1.1	94.1
	0.000065	0.00164	9.25		1.0	95.0
	0.000054	0.00138	9.50		0.8	95.9
	0.000046	0.00116	9.75		0.7	96.6
	0.000038	0.00098	10.00		0.7	97.3
	0.000032	0.00082	10.25		0.7	98.0
	0.000027	0.00069	10.50		0.6	98.6
	0.000023	0.00058	10.75		0.6	99.2
	0.000019	0.00049	11.00		0.5	99.6
	0.000016	0.00041	11.25		0.3	99.9
	0.000014	0.00035	11.50		0.1	100.0
	0.000011	0.00029	11.75		0.0	100.0
	0.000010	0.00024	12.00		0.0	100.0
	0.000008	0.00021	12.25		0.0	100.0
	0.000007	0.00017	12.50		0.0	100.0
	0.000006	0.00015	12.75		0.0	100.0
	0.000005	0.00012	13.00		0.0	100.0
	0.000004	0.00010	13.25		0.0	100.0
	0.000003	0.00009	13.51		0.0	100.0
	0.000003	0.00007	13.74		0.0	100.0
	0.000002	0.00006	14.00		0.0	100.0
	0.000002	0.000051	14.26		0.0	100.0
	0.000002	0.000043	14.51		0.0	100.0
	0.000001	0.000036	14.76		0.0	100.0
	0.000001	0.000031	14.98		0.0	100.0
	0.000001	0.000026	15.23		0.0	100.0
	TOTALS				100.0	100.0

Description	Sieve Size	Volume Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	0.0
Fine Sand	120	6.9
Very Fine Sand	230	32.5
Coarse Silt	450	23.0
Medium Silt		9.0
Fine Silt		9.7
Very Fine Silt		7.7
Clay		11.2
	Total	100.0

Cumulative Volume Percent greater than

Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	2.8955	0.0053	0.1344
10	3.1282	0.0045	0.1144
16	3.3375	0.0039	0.0989
25	3.5996	0.0032	0.0825
50	4.3336	0.0020	0.0496
75	6.3610	0.0005	0.0122
84	7.3245	0.0002	0.0062
90	8.1838	0.0001	0.0034
95	9.2285	0.0001	0.0017

Measure	Trask, mm	Folk, phi	Inches
Median	0.0496	4.3336	0.0020
Mean	0.0473	4.9985	0.0019
Sorting	2.6039	1.9563	
Skewness	0.4080	0.5231	
Kurtosis	0.3170	0.9399	

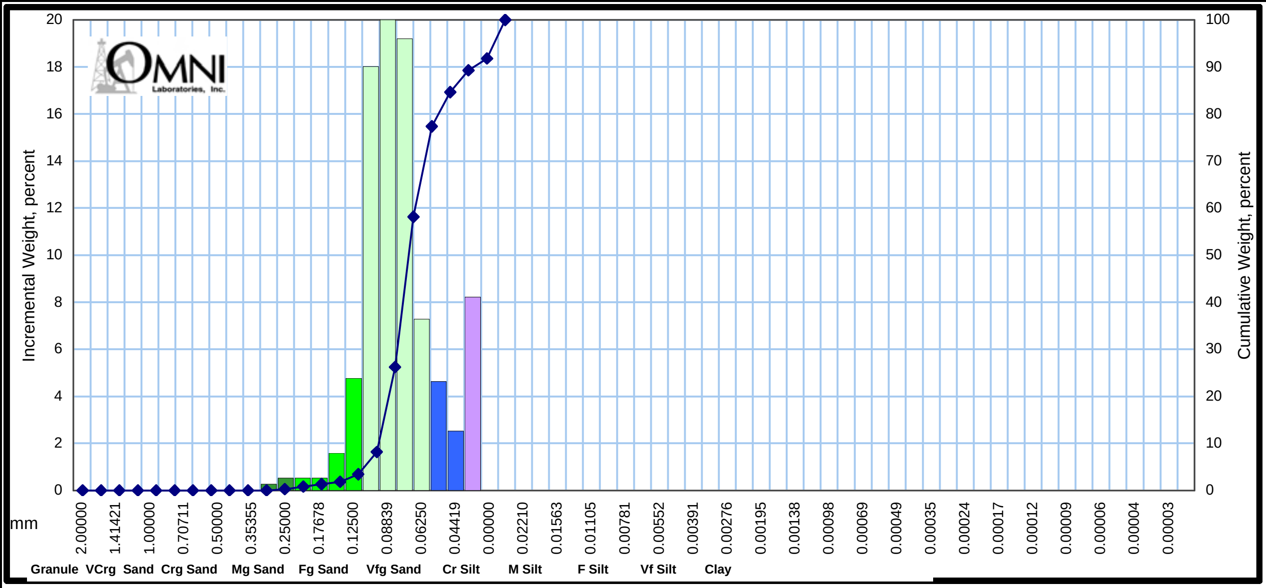
Figure 45: Grain Size Laser Analysis, Core 7, Section 2, 33 to 35 inches

SIEVE ANALYSIS

Conventional Core

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples

Core Run:	7
Core Section:	6
Sample Top-Bottom, In.:	24-26
File:	HH-36917



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Weight, percent	Cumulative Weight, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.0	0.0
	0.011705	0.29730	1.75	50	0.3	0.3
	0.009843	0.25000	2.00	60	0.5	0.8
Fg Sand	0.008277	0.21022	2.25	70	0.5	1.3
	0.006960	0.17678	2.50	80	0.5	1.9
	0.005852	0.14865	2.75	100	1.6	3.4
	0.004921	0.12500	3.00	120	4.8	8.2
Vfg Sand	0.004138	0.10511	3.25	140	18.0	26.2
	0.003480	0.08839	3.50	170	31.9	58.1
	0.002926	0.07433	3.75	200	19.2	77.4
	0.002461	0.06250	4.00	230	7.3	84.6
C Silt	0.002069	0.05256	4.25	270	4.6	89.3
	0.001740	0.04419	4.50	325	2.5	91.8
Pan				<325	8.2	100.0

Description	Sieve Size	Weight Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	0.8
Fine Sand	120	7.4
Very Fine Sand	230	76.4
Coarse Silt	0	7.2
Pan	<325	8.2

Cumulative Volume Percent greater than

Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	2.8269	0.0055	0.1409
10	3.0230	0.0048	0.1230
16	3.1028	0.0046	0.1164
25	3.2316	0.0042	0.1065
50	3.4320	0.0036	0.0927
75	3.7170	0.0030	0.0760
84	3.9764	0.0025	0.0635
90	4.5422	0.0017	0.0429
95	4.6374	0.0016	0.0402

Measure	Trask, mm	Folk, phi	Inches
Median	0.0927	3.4320	0.0036
Mean	0.0913	3.5037	0.0036
Sorting	1.1832	0.4927	
Skewness	0.9431	0.2890	
Kurtosis	0.1899	1.5286	

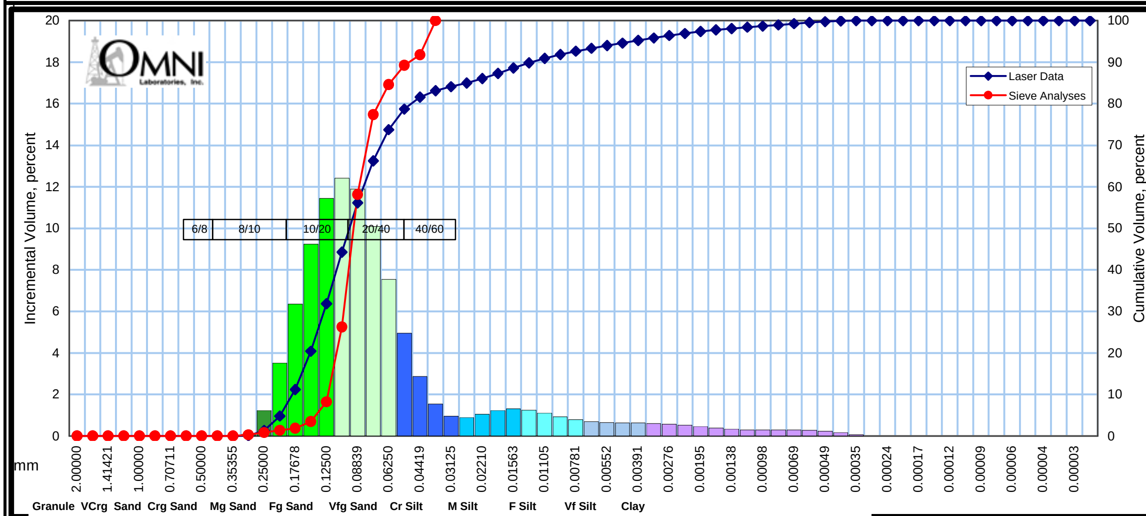
Figure 46: Grain Size Sieve Analysis, Core 7, Section 6, 24 to 26 inches

LASER GRAIN SIZE ANALYSIS

Conventional Core

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples

Core Run:	7
Core Section:	6
Sample Top-Bottom, In.:	24-26
File:	HH-36917



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Volume, percent	Cumulative Volume, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.0	0.0
	0.011705	0.29730	1.75	50	0.1	0.1
	0.009843	0.25000	2.00	60	1.2	1.3
Fg Sand	0.008277	0.21022	2.25	70	3.5	4.8
	0.006960	0.17678	2.50	80	6.3	11.2
	0.005852	0.14865	2.75	100	9.2	20.4
	0.004921	0.12500	3.00	120	11.4	31.8
Vfg Sand	0.004138	0.10511	3.25	140	12.4	44.3
	0.003480	0.08839	3.50	170	11.9	56.2
	0.002926	0.07433	3.75	200	10.1	66.2
	0.002461	0.06250	4.00	230	7.5	73.8
C Silt	0.002069	0.05256	4.25	270	5.0	78.7
	0.001740	0.04419	4.50	325	2.9	81.6
	0.001463	0.03716	4.75	400	1.5	83.2
	0.001230	0.03125	5.00	450	1.0	84.1
M Silt	0.001035	0.02628	5.25	500	0.9	85.0
	0.000870	0.02210	5.50	635	1.1	86.1
	0.000732	0.01858	5.75		1.2	87.3
	0.000615	0.01563	6.00		1.3	88.6
F Silt	0.000517	0.01314	6.25		1.2	89.8
	0.000435	0.01105	6.50		1.1	90.9
	0.000366	0.00929	6.75		0.9	91.9
	0.000308	0.00781	7.00		0.8	92.6
Vf Silt	0.000259	0.00657	7.25		0.7	93.3
	0.000217	0.00552	7.50		0.6	94.0
	0.000183	0.00465	7.75		0.6	94.6
	0.000154	0.00391	8.00		0.6	95.2

Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Volume, percent	Cumulative Volume, percent
Clay	0.000129	0.00329	8.25		0.6	95.9
	0.000109	0.00276	8.50		0.6	96.4
	0.000091	0.00232	8.75		0.5	96.9
	0.000077	0.00195	9.00		0.5	97.4
	0.000065	0.00164	9.25		0.4	97.8
	0.000054	0.00138	9.50		0.3	98.1
	0.000046	0.00116	9.75		0.3	98.4
	0.000038	0.00098	10.00		0.3	98.7
	0.000032	0.00082	10.25		0.3	99.0
	0.000027	0.00069	10.50		0.3	99.3
	0.000023	0.00058	10.75		0.3	99.5
	0.000019	0.00049	11.00		0.2	99.8
	0.000016	0.00041	11.25		0.2	99.9
	0.000014	0.00035	11.50		0.1	100.0
	0.000011	0.00029	11.75		0.0	100.0
	0.000010	0.00024	12.00		0.0	100.0
	0.000008	0.00021	12.25		0.0	100.0
	0.000007	0.00017	12.50		0.0	100.0
	0.000006	0.00015	12.75		0.0	100.0
	0.000005	0.00012	13.00		0.0	100.0
	0.000004	0.00010	13.25		0.0	100.0
	0.000003	0.00009	13.51		0.0	100.0
	0.000003	0.00007	13.74		0.0	100.0
	0.000002	0.00006	14.00		0.0	100.0
	0.000002	0.000051	14.26		0.0	100.0
	0.000002	0.000043	14.51		0.0	100.0
	0.000001	0.000036	14.76		0.0	100.0
	0.000001	0.000031	14.98		0.0	100.0
	0.000001	0.000026	15.23		0.0	100.0
	TOTALS				100.0	100.0

Description	Sieve Size	Volume Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	1.3
Fine Sand	120	30.5
Very Fine Sand	230	41.9
Coarse Silt	450	10.3
Medium Silt		4.5
Fine Silt		4.1
Very Fine Silt		2.6
Clay		4.8

Cumulative Volume Percent greater than

Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	2.2552	0.0082	0.2095
10	2.4577	0.0072	0.1820
16	2.6355	0.0063	0.1609
25	2.8505	0.0055	0.1386
50	3.3623	0.0038	0.0972
75	4.0454	0.0024	0.0606
84	4.9594	0.0013	0.0321
90	6.2774	0.0005	0.0129
95	7.8920	0.0002	0.0042

Measure	Trask, mm	Folk, phi	Inches
Median	0.0972	3.3623	0.0038
Mean	0.0996	3.6524	0.0039
Sorting	1.5130	1.4350	
Skewness	0.8880	0.4909	

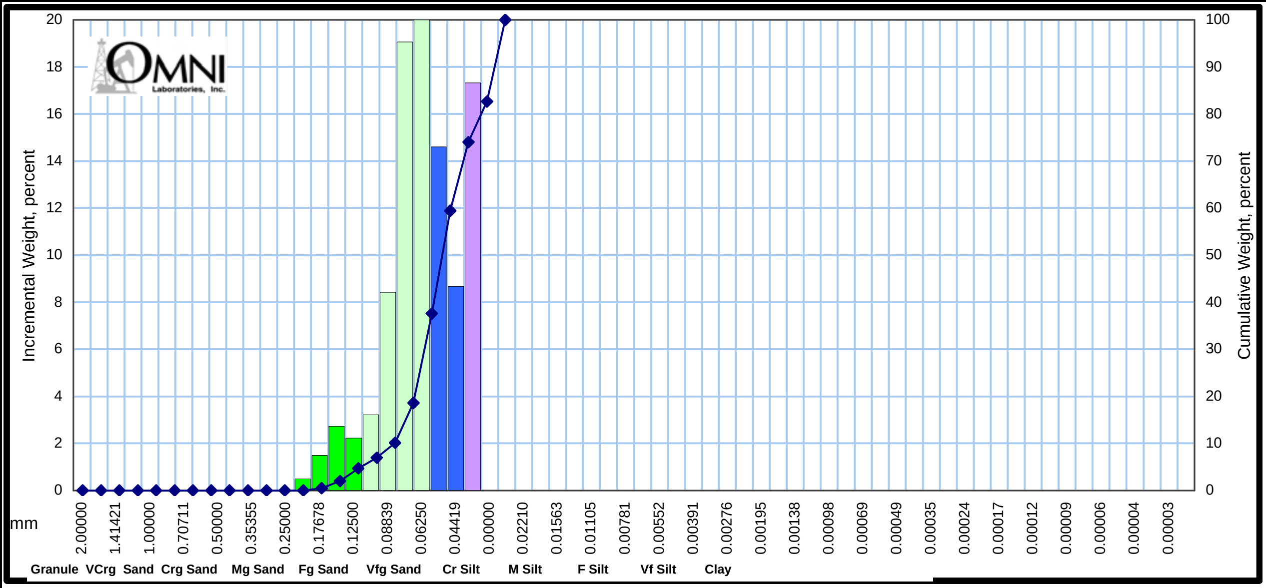
Figure 47: Grain Size Laser Analysis, Core 7, Section 6, 24 to 26 inches

SIEVE ANALYSIS

Conventional Core

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples

Core Run:	8
Core Section:	2
Sample Top-Bottom, In.:	35-37
File:	HH-36917



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Weight, percent	Cumulative Weight, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.0	0.0
	0.011705	0.29730	1.75	50	0.0	0.0
	0.009843	0.25000	2.00	60	0.0	0.0
Fg Sand	0.008277	0.21022	2.25	70	0.0	0.0
	0.006960	0.17678	2.50	80	0.4	0.4
	0.005852	0.14865	2.75	100	1.8	2.2
	0.004921	0.12500	3.00	120	1.6	3.8
Vfg Sand	0.004138	0.10511	3.25	140	2.8	6.5
	0.003480	0.08839	3.50	170	8.3	14.9
	0.002926	0.07433	3.75	200	14.5	29.3
	0.002461	0.06250	4.00	230	17.8	47.1
C Silt	0.002069	0.05256	4.25	270	18.0	65.1
	0.001740	0.04419	4.50	325	14.1	79.2
Pan				<325	20.8	100.0

Description	Sieve Size	Weight Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	0.0
Fine Sand	120	3.8
Very Fine Sand	230	43.4
Coarse Silt	0	32.1
Pan	<325	20.8

Cumulative Volume Percent greater than			
Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	3.1063	0.0046	0.1161
10	3.3490	0.0039	0.0981
16	3.5184	0.0034	0.0873
25	3.6709	0.0031	0.0785
50	4.0370	0.0024	0.0609
75	4.4205	0.0018	0.0467
84	4.6415	0.0016	0.0401
90	4.5422	0.0017	0.0429
95	4.6374	0.0016	0.0402

Measure	Trask, mm	Folk, phi	Inches
Median	0.0609	4.0370	0.0024
Mean	0.0626	4.0656	0.0025
Sorting	1.2967	0.5128	
Skewness	0.9881	-0.0697	
Kurtosis	0.2881	0.8371	

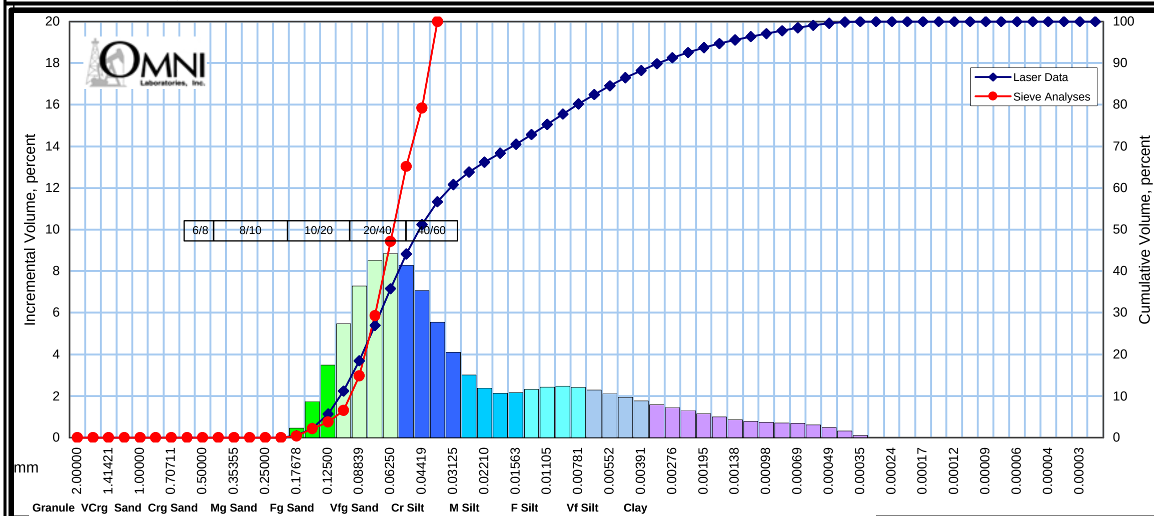
Figure 48: Grain Size Sieve Analysis, Core 8, Section 2, 35 to 37 inches

LASER GRAIN SIZE ANALYSIS

Conventional Core

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples

Core Run:	8
Core Section:	2
Sample Top-Bottom, In.:	35-37
File:	HH-36917



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Volume, percent	Cumulative Volume, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.0	0.0
	0.011705	0.29730	1.75	50	0.0	0.0
	0.009843	0.25000	2.00	60	0.0	0.0
Fg Sand	0.008277	0.21022	2.25	70	0.0	0.0
	0.006960	0.17678	2.50	80	0.5	0.5
	0.005852	0.14865	2.75	100	1.7	2.2
	0.004921	0.12500	3.00	120	3.5	5.7
Vfg Sand	0.004138	0.10511	3.25	140	5.5	11.2
	0.003480	0.08839	3.50	170	7.3	18.4
	0.002926	0.07433	3.75	200	8.5	26.9
	0.002461	0.06250	4.00	230	8.8	35.8
C Silt	0.002069	0.05256	4.25	270	8.3	44.1
	0.001740	0.04419	4.50	325	7.1	51.2
	0.001463	0.03716	4.75	400	5.5	56.7
	0.001230	0.03125	5.00	450	4.1	60.8
M Silt	0.001035	0.02628	5.25	500	3.0	63.8
	0.000870	0.02210	5.50	635	2.4	66.2
	0.000732	0.01858	5.75		2.1	68.4
	0.000615	0.01563	6.00		2.2	70.5
F Silt	0.000517	0.01314	6.25		2.3	72.8
	0.000435	0.01105	6.50		2.4	75.3
	0.000366	0.00929	6.75		2.5	77.7
	0.000308	0.00781	7.00		2.4	80.2
Vf Silt	0.000259	0.00657	7.25		2.3	82.4
	0.000217	0.00552	7.50		2.1	84.6
	0.000183	0.00465	7.75		1.9	86.5
	0.000154	0.00391	8.00		1.8	88.2

Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Volume, percent	Cumulative Volume, percent
Clay	0.000129	0.00329	8.25		1.6	89.8
	0.000109	0.00276	8.50		1.4	91.3
	0.000091	0.00232	8.75		1.3	92.6
	0.000077	0.00195	9.00		1.1	93.7
	0.000065	0.00164	9.25		1.0	94.7
	0.000054	0.00138	9.50		0.9	95.6
	0.000046	0.00116	9.75		0.8	96.4
	0.000038	0.00098	10.00		0.7	97.1
	0.000032	0.00082	10.25		0.7	97.8
	0.000027	0.00069	10.50		0.7	98.5
	0.000023	0.00058	10.75		0.6	99.1
	0.000019	0.00049	11.00		0.5	99.6
	0.000016	0.00041	11.25		0.3	99.9
	0.000014	0.00035	11.50		0.1	100.0
	0.000011	0.00029	11.75		0.0	100.0
	0.000010	0.00024	12.00		0.0	100.0
	0.000008	0.00021	12.25		0.0	100.0
	0.000007	0.00017	12.50		0.0	100.0
	0.000006	0.00015	12.75		0.0	100.0
	0.000005	0.00012	13.00		0.0	100.0
	0.000004	0.00010	13.25		0.0	100.0
	0.000003	0.00009	13.51		0.0	100.0
	0.000003	0.00007	13.74		0.0	100.0
	0.000002	0.00006	14.00		0.0	100.0
	0.000002	0.000051	14.26		0.0	100.0
	0.000002	0.000043	14.51		0.0	100.0
	0.000001	0.000036	14.76		0.0	100.0
	0.000001	0.000031	14.98		0.0	100.0
	0.000001	0.000026	15.23		0.0	100.0
	TOTALS				100.0	100.0

Description	Sieve Size	Volume Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	0.0
Fine Sand	120	5.7
Very Fine Sand	230	30.1
Coarse Silt	450	25.0
Medium Silt		9.7
Fine Silt		9.6
Very Fine Silt		8.1
Clay		11.8
	Total	100.0

Cumulative Volume Percent greater than

Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	2.9562	0.0051	0.1289
10	3.1992	0.0043	0.1089
16	3.4167	0.0037	0.0936
25	3.6891	0.0031	0.0775
50	4.4488	0.0018	0.0458
75	6.4635	0.0004	0.0113
84	7.4220	0.0002	0.0058
90	8.2653	0.0001	0.0033
95	9.3178	0.0001	0.0016

Measure	Trask, mm	Folk, phi	Inches
Median	0.0458	4.4488	0.0018
Mean	0.0444	5.0958	0.0017
Sorting	2.6157	1.9652	
Skewness	0.4190	0.5077	
Kurtosis	0.3133	0.9398	

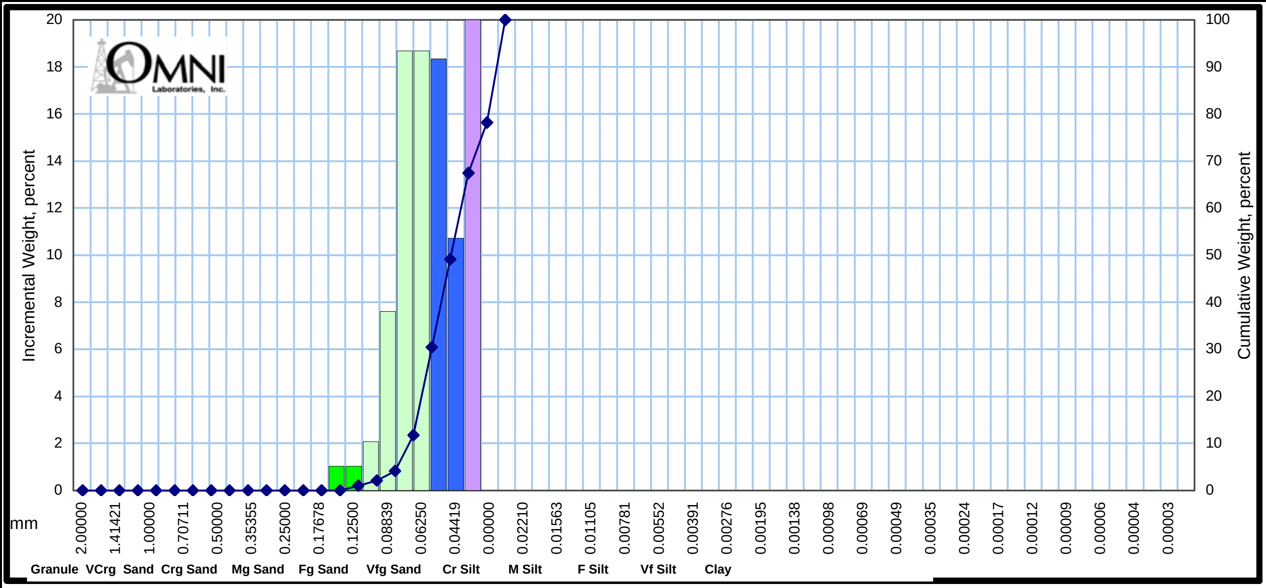
Figure 49: Grain Size Laser Analysis, Core 8, Section 2, 35 to 37 inches

SIEVE ANALYSIS

Conventional Core

Core Run:	8
Core Section:	4
Sample Top-Bottom, In.:	29-31
File:	HH-36917

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Weight, percent	Cumulative Weight, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.0	0.0
	0.011705	0.29730	1.75	50	0.0	0.0
	0.009843	0.25000	2.00	60	0.0	0.0
Fg Sand	0.008277	0.21022	2.25	70	0.0	0.0
	0.006960	0.17678	2.50	80	0.0	0.0
	0.005852	0.14865	2.75	100	1.0	1.0
	0.004921	0.12500	3.00	120	1.0	2.1
Vfg Sand	0.004138	0.10511	3.25	140	2.1	4.2
	0.003480	0.08839	3.50	170	7.6	11.8
	0.002926	0.07433	3.75	200	18.7	30.4
	0.002461	0.06250	4.00	230	18.7	49.1
C Silt	0.002069	0.05256	4.25	270	18.3	67.5
	0.001740	0.04419	4.50	325	10.7	78.2
Pan				<325	21.8	100.0

Description	Sieve Size	Weight Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	0.0
Fine Sand	120	2.1
Very Fine Sand	230	47.1
Coarse Silt	0	29.1
Pan	<325	21.8

Cumulative Volume Percent greater than

Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	3.2758	0.0041	0.1032
10	3.4381	0.0036	0.0923
16	3.5530	0.0034	0.0852
25	3.6725	0.0031	0.0784
50	4.0109	0.0024	0.0620
75	4.4208	0.0018	0.0467
84	4.6646	0.0016	0.0394
90	4.5422	0.0017	0.0429
95	4.6374	0.0016	0.0402

Measure	Trask, mm	Folk, phi	Inches
Median	0.0620	4.0109	0.0024
Mean	0.0626	4.0762	0.0025
Sorting	1.2961	0.4842	
Skewness	0.9516	0.0483	
Kurtosis	0.3216	0.7458	

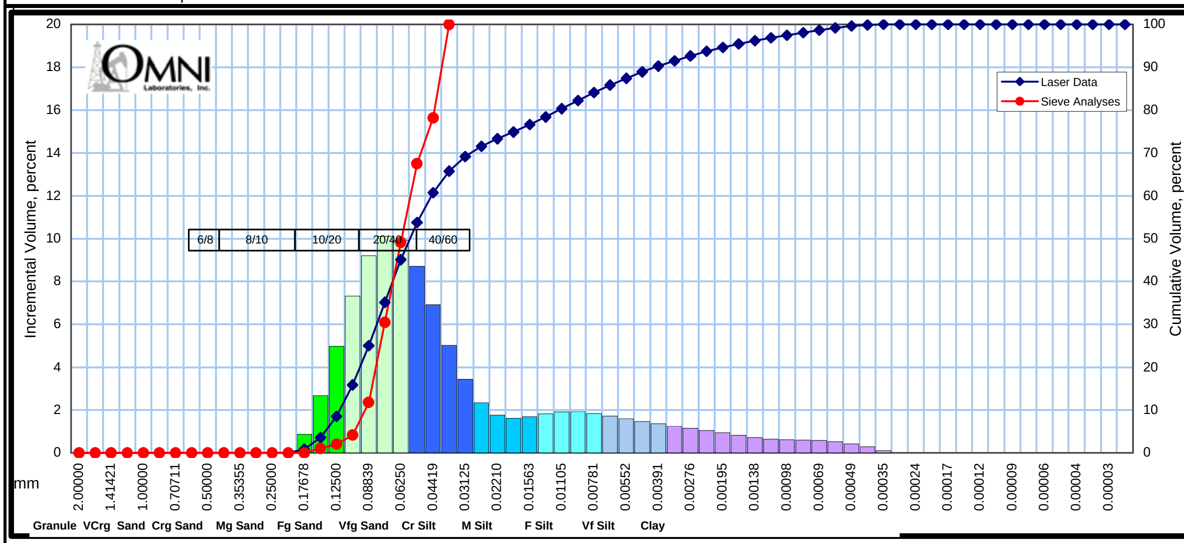
Figure 50: Grain Size Sieve Analysis, Core 8, Section 4, 29 to 31 inches

LASER GRAIN SIZE ANALYSIS

Conventional Core

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples

Core Run: 8
Core Section: 4
Sample Top-Bottom, In.: 29-31
File: HH-36917



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Volume, percent	Cumulative Volume, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.0	0.0
	0.011705	0.29730	1.75	50	0.0	0.0
	0.009843	0.25000	2.00	60	0.0	0.0
Fg Sand	0.008277	0.21022	2.25	70	0.0	0.0
	0.006960	0.17678	2.50	80	0.9	0.9
	0.005852	0.14865	2.75	100	2.7	3.6
	0.004921	0.12500	3.00	120	5.0	8.5
Vfg Sand	0.004138	0.10511	3.25	140	7.3	15.9
	0.003480	0.08839	3.50	170	9.2	25.1
	0.002926	0.07433	3.75	200	10.1	35.2
	0.002461	0.06250	4.00	230	9.9	45.1
C Silt	0.002069	0.05256	4.25	270	8.7	53.8
	0.001740	0.04419	4.50	325	6.9	60.7
	0.001463	0.03716	4.75	400	5.0	65.8
	0.001230	0.03125	5.00	450	3.4	69.2
M Silt	0.001035	0.02628	5.25	500	2.3	71.5
	0.000870	0.02210	5.50	635	1.8	73.3
	0.000732	0.01858	5.75		1.6	74.9
	0.000615	0.01563	6.00		1.7	76.6
F Silt	0.000517	0.01314	6.25		1.8	78.4
	0.000435	0.01105	6.50		1.9	80.3
	0.000366	0.00929	6.75		1.9	82.3
	0.000308	0.00781	7.00		1.8	84.1
Vf Silt	0.000259	0.00657	7.25		1.7	85.8
	0.000217	0.00552	7.50		1.6	87.4
	0.000183	0.00465	7.75		1.5	88.9
	0.000154	0.00391	8.00		1.4	90.3

Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Volume, percent	Cumulative Volume, percent
Clay	0.000129	0.00329	8.25		1.3	91.5
	0.000109	0.00276	8.50		1.2	92.7
	0.000091	0.00232	8.75		1.0	93.7
	0.000077	0.00195	9.00		0.9	94.7
	0.000065	0.00164	9.25		0.8	95.5
	0.000054	0.00138	9.50		0.7	96.2
	0.000046	0.00116	9.75		0.7	96.9
	0.000038	0.00098	10.00		0.6	97.5
	0.000032	0.00082	10.25		0.6	98.1
	0.000027	0.00069	10.50		0.6	98.7
	0.000023	0.00058	10.75		0.5	99.2
	0.000019	0.00049	11.00		0.4	99.6
	0.000016	0.00041	11.25		0.3	99.9
	0.000014	0.00035	11.50		0.1	100.0
	0.000011	0.00029	11.75		0.0	100.0
	0.000010	0.00024	12.00		0.0	100.0
	0.000008	0.00021	12.25		0.0	100.0
	0.000007	0.00017	12.50		0.0	100.0
	0.000006	0.00015	12.75		0.0	100.0
	0.000005	0.00012	13.00		0.0	100.0
	0.000004	0.00010	13.25		0.0	100.0
	0.000003	0.00009	13.51		0.0	100.0
	0.000003	0.00007	13.74		0.0	100.0
	0.000002	0.00006	14.00		0.0	100.0
	0.000002	0.000051	14.26		0.0	100.0
	0.000002	0.000043	14.51		0.0	100.0
	0.000001	0.000036	14.76		0.0	100.0
	0.000001	0.000031	14.98		0.0	100.0
	0.000001	0.000026	15.23		0.0	100.0
	TOTALS				100.0	100.0

Description	Sieve Size	Volume Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	0.0
Fine Sand	120	8.5
Very Fine Sand	230	36.6
Coarse Silt	450	24.1
Medium Silt		7.4
Fine Silt		7.5
Very Fine Silt		6.2
Clay		9.7
	Total	100.0

Cumulative Volume Percent greater than

Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	2.8320	0.0055	0.1404
10	3.0523	0.0047	0.1205
16	3.2495	0.0041	0.1052
25	3.4935	0.0035	0.0888
50	4.1294	0.0022	0.0571
75	5.7548	0.0007	0.0185
84	6.9759	0.0003	0.0079
90	7.9386	0.0002	0.0041
95	9.0869	0.0001	0.0018

Measure	Trask, mm	Folk, phi	Inches
Median	0.0571	4.1294	0.0022
Mean	0.0537	4.7849	0.0021
Sorting	2.1896	1.8793	
Skewness	0.5037	0.5564	
Kurtosis	0.3016	1.1336	

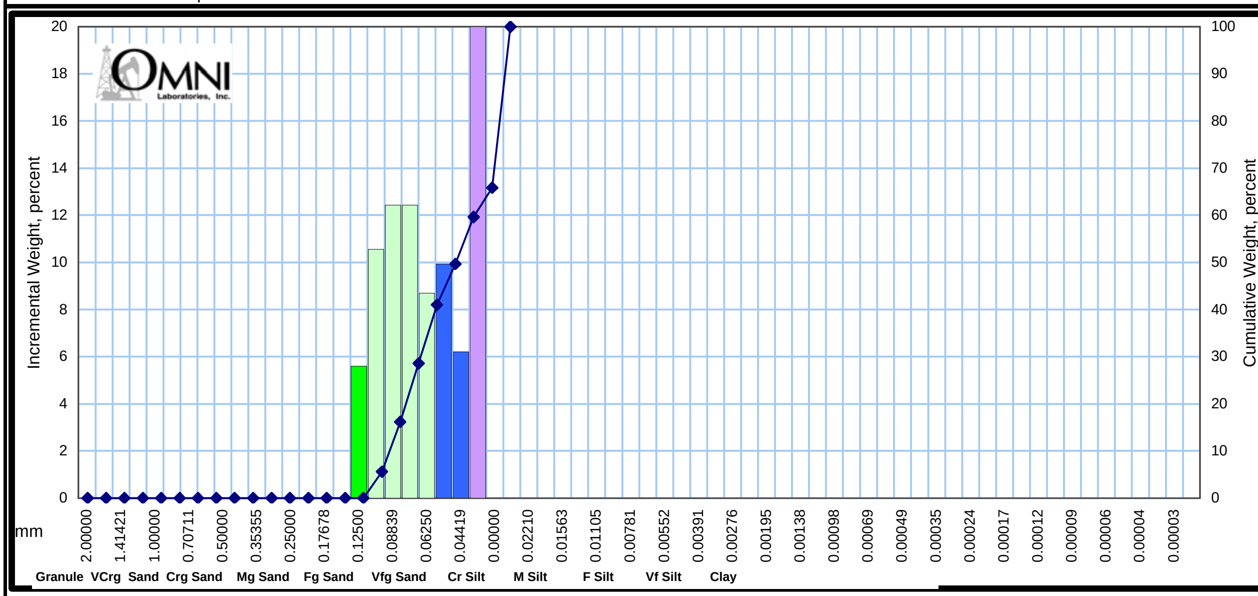
Figure 51: Grain Size Laser Analysis, Core 8, Section 4, 29 to 31 inches

SIEVE ANALYSIS

Conventional Core

Core Run:	12
Core Section:	3
Sample Top-Bottom, In.:	21-23
File:	HH-36917

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Weight, percent	Cumulative Weight, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.0	0.0
	0.011705	0.29730	1.75	50	0.0	0.0
	0.009843	0.25000	2.00	60	0.0	0.0
Fg Sand	0.008277	0.21022	2.25	70	0.0	0.0
	0.006960	0.17678	2.50	80	0.0	0.0
	0.005852	0.14865	2.75	100	0.0	0.0
	0.004921	0.12500	3.00	120	5.6	5.6
Vfg Sand	0.004138	0.10511	3.25	140	10.6	16.1
	0.003480	0.08839	3.50	170	12.4	28.6
	0.002926	0.07433	3.75	200	12.4	41.0
	0.002461	0.06250	4.00	230	8.7	49.7
C Silt	0.002069	0.05256	4.25	270	9.9	59.6
	0.001740	0.04419	4.50	325	6.2	65.8
Pan				<325	34.2	100.0

Description	Sieve Size	Weight Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	0.0
Fine Sand	120	5.6
Very Fine Sand	230	44.1
Coarse Silt	0	16.1
Pan	<325	34.2

Cumulative Volume Percent greater than			
Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	2.9715	0.0050	0.1275
10	3.0992	0.0046	0.1167
16	3.2462	0.0041	0.1054
25	3.4236	0.0037	0.0932
50	4.0072	0.0024	0.0622
75	4.6661	0.0016	0.0394
84	4.8502	0.0014	0.0347
90	4.5422	0.0017	0.0429
95	4.6374	0.0016	0.0402

Measure	Trask, mm	Folk, phi	Inches
Median	0.0622	4.0072	0.0024
Mean	0.0663	4.0345	0.0026
Sorting	1.5382	0.6534	
Skewness	0.9492	-0.0961	
Kurtosis	0.3647	0.5495	

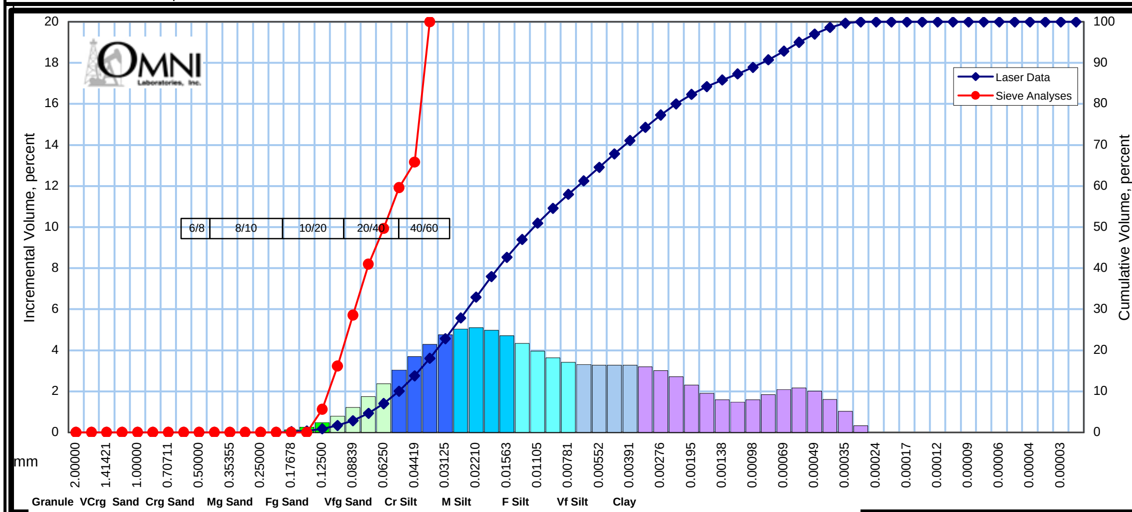
Figure 52: Grain Size Sieve Analysis, Core 12, Section 3, 21 to 23 inches

LASER GRAIN SIZE ANALYSIS

Conventional Core

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples

Core Run:	12
Core Section:	3
Sample Top-Bottom, In.:	21-23
File:	HH-36917



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Volume, percent	Cumulative Volume, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.0	0.0
	0.011705	0.29730	1.75	50	0.0	0.0
	0.009843	0.25000	2.00	60	0.0	0.0
Fg Sand	0.008277	0.21022	2.25	70	0.0	0.0
	0.006960	0.17678	2.50	80	0.1	0.1
	0.005852	0.14865	2.75	100	0.3	0.4
	0.004921	0.12500	3.00	120	0.5	0.9
Vfg Sand	0.004138	0.10511	3.25	140	0.8	1.7
	0.003480	0.08839	3.50	170	1.2	2.9
	0.002926	0.07433	3.75	200	1.8	4.6
	0.002461	0.06250	4.00	230	2.4	7.0
C Silt	0.002069	0.05256	4.25	270	3.0	10.0
	0.001740	0.04419	4.50	325	3.7	13.8
	0.001463	0.03716	4.75	400	4.3	18.1
	0.001230	0.03125	5.00	450	4.8	22.8
M Silt	0.001035	0.02628	5.25	500	5.0	27.9
	0.000870	0.02210	5.50	635	5.1	33.0
	0.000732	0.01858	5.75		5.0	37.9
	0.000615	0.01563	6.00		4.7	42.7
F Silt	0.000517	0.01314	6.25		4.3	47.0
	0.000435	0.01105	6.50		4.0	51.0
	0.000366	0.00929	6.75		3.6	54.6
	0.000308	0.00781	7.00		3.4	58.0
Vf Silt	0.000259	0.00657	7.25		3.3	61.3
	0.000217	0.00552	7.50		3.3	64.6
	0.000183	0.00465	7.75		3.3	67.9
	0.000154	0.00391	8.00		3.3	71.1

Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Volume, percent	Cumulative Volume, percent
Clay	0.000129	0.00329	8.25		3.2	74.3
	0.000109	0.00276	8.50		3.0	77.3
	0.000091	0.00232	8.75		2.7	80.0
	0.000077	0.00195	9.00		2.3	82.4
	0.000065	0.00164	9.25		1.9	84.3
	0.000054	0.00138	9.50		1.6	85.8
	0.000046	0.00116	9.75		1.5	87.3
	0.000038	0.00098	10.00		1.6	88.9
	0.000032	0.00082	10.25		1.8	90.8
	0.000027	0.00069	10.50		2.1	92.9
	0.000023	0.00058	10.75		2.2	95.0
	0.000019	0.00049	11.00		2.0	97.0
	0.000016	0.00041	11.25		1.6	98.6
	0.000014	0.00035	11.50		1.0	99.7
	0.000011	0.00029	11.75		0.3	100.0
	0.000010	0.00024	12.00		0.0	100.0
	0.000008	0.00021	12.25		0.0	100.0
	0.000007	0.00017	12.50		0.0	100.0
	0.000006	0.00015	12.75		0.0	100.0
	0.000005	0.00012	13.00		0.0	100.0
	0.000004	0.00010	13.25		0.0	100.0
	0.000003	0.00009	13.51		0.0	100.0
	0.000003	0.00007	13.74		0.0	100.0
	0.000002	0.00006	14.00		0.0	100.0
	0.000002	0.000051	14.26		0.0	100.0
	0.000002	0.000043	14.51		0.0	100.0
	0.000001	0.000036	14.76		0.0	100.0
	0.000001	0.000031	14.98		0.0	100.0
	0.000001	0.000026	15.23		0.0	100.0
	TOTALS				100.0	100.0

Description	Sieve Size	Volume Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	0.0
Fine Sand	120	0.9
Very Fine Sand	230	6.1
Coarse Silt	450	15.8
Medium Silt		19.8
Fine Silt		15.4
Very Fine Silt		13.1
Clay		28.9
	Total	100.0

Cumulative Volume Percent greater than			
Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	3.7870	0.0029	0.0724
10	4.2402	0.0021	0.0529
16	4.6279	0.0016	0.0404
25	5.1023	0.0011	0.0291
50	6.4290	0.0005	0.0116
75	8.2940	0.0001	0.0032
84	9.2011	0.0001	0.0017
90	10.1372	0.0000	0.0009
95	10.7344	0.0000	0.0006

Measure	Trask, mm	Folk, phi	Inches
Median	0.0116	6.4290	0.0005
Mean	0.0161	6.7527	0.0006
Sorting	3.0228	2.1959	
Skewness	0.6886	0.2259	
Kurtosis	0.2492	0.8921	

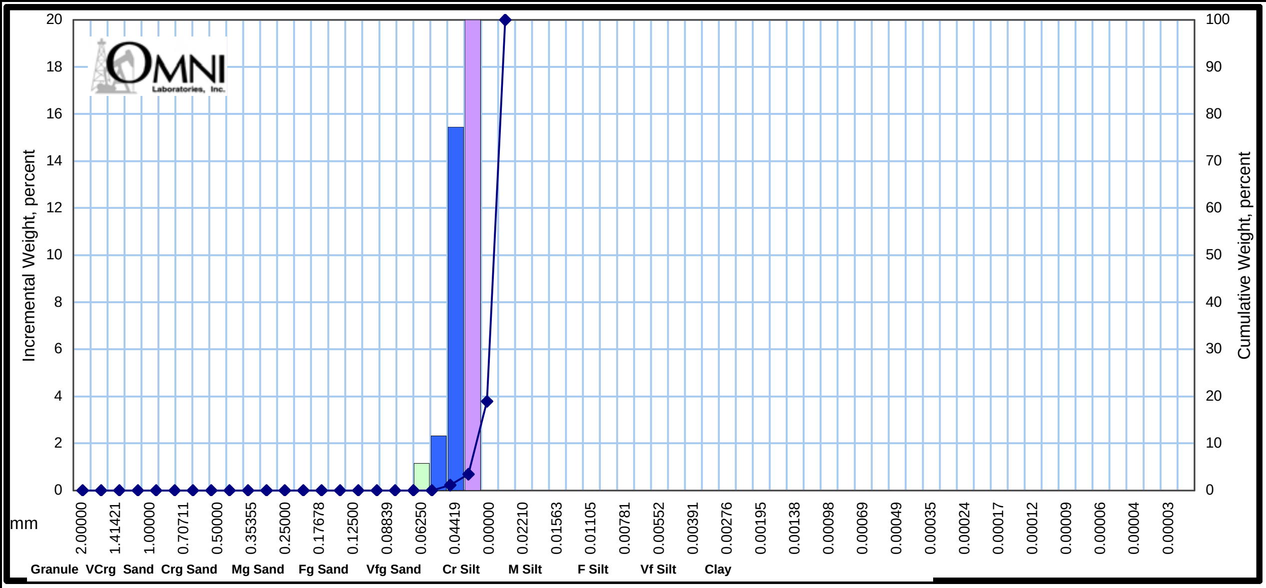
Figure 53: Grain Size Laser Analysis, Core 12, Section 3, 21 to 23 inches

SIEVE ANALYSIS

Conventional Core

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples

Core Run:	19
Core Section:	4
Sample Top-Bottom, In.:	32-34
File:	HH-36917



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Weight, percent	Cumulative Weight, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.0	0.0
	0.011705	0.29730	1.75	50	0.0	0.0
	0.009843	0.25000	2.00	60	0.0	0.0
Fg Sand	0.008277	0.21022	2.25	70	0.0	0.0
	0.006960	0.17678	2.50	80	0.0	0.0
	0.005852	0.14865	2.75	100	0.0	0.0
	0.004921	0.12500	3.00	120	0.0	0.0
Vfg Sand	0.004138	0.10511	3.25	140	0.0	0.0
	0.003480	0.08839	3.50	170	0.0	0.0
	0.002926	0.07433	3.75	200	0.0	0.0
	0.002461	0.06250	4.00	230	1.2	1.2
C Silt	0.002069	0.05256	4.25	270	2.3	3.5
	0.001740	0.04419	4.50	325	15.4	18.9
Pan				<325	81.1	100.0

Description	Sieve Size	Weight Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	0.0
Fine Sand	120	0.0
Very Fine Sand	230	1.2
Coarse Silt	0	17.8
Pan	<325	81.1

Cumulative Volume Percent greater than

Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	4.2728	0.0020	0.0517
10	4.3504	0.0019	0.0490
16	4.4493	0.0018	0.0458
25	4.5446	0.0017	0.0429
50	4.7437	0.0015	0.0373
75	4.9747	0.0013	0.0318
84	5.0679	0.0012	0.0298
90	4.5422	0.0017	0.0429
95	4.6374	0.0016	0.0402

Measure	Trask, mm	Folk, phi	Inches
Median	0.0373	4.7437	0.0015
Mean	0.0373	4.7536	0.0015
Sorting	1.1608	0.2099	
Skewness	0.9781	-0.7673	
Kurtosis	0.9052	0.3473	

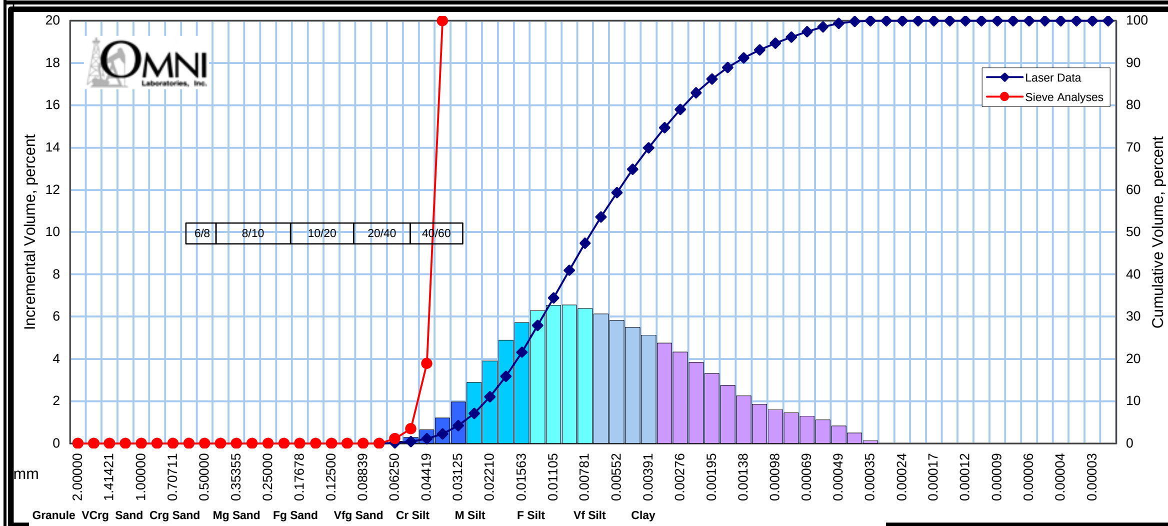
Figure 54: Grain Size Sieve Analysis, Core 19, Section 4, 32 to 34 inches

LASER GRAIN SIZE ANALYSIS

Conventional Core

U.S. Geological Survey - MA
Mt. Elbert 01 PPMA Samples

Core Run:	19
Core Section:	4
Sample Top-Bottom, In.:	32-34
File:	HH-36917



Wentworth Size Class	Mesh Size Inches	Mesh Size Millimeters	Phi of Screen	U.S. Sieve No.	Incremental Volume, percent	Cumulative Volume, percent
Granule	0.078740	2.00000	- 1.00	10	0.0	0.0
VCg Sand	0.066212	1.68179	- 0.75	12	0.0	0.0
	0.055678	1.41421	- 0.50	14	0.0	0.0
	0.046819	1.18921	- 0.25	16	0.0	0.0
	0.039370	1.00000	0.00	18	0.0	0.0
Cg Sand	0.033106	0.84090	0.25	20	0.0	0.0
	0.027839	0.70711	0.50	25	0.0	0.0
	0.023410	0.59460	0.75	30	0.0	0.0
	0.019685	0.50000	1.00	35	0.0	0.0
Mg Sand	0.016553	0.42045	1.25	40	0.0	0.0
	0.013919	0.35355	1.50	45	0.0	0.0
	0.011705	0.29730	1.75	50	0.0	0.0
	0.009843	0.25000	2.00	60	0.0	0.0
Fg Sand	0.008277	0.21022	2.25	70	0.0	0.0
	0.006960	0.17678	2.50	80	0.0	0.0
	0.005852	0.14865	2.75	100	0.0	0.0
	0.004921	0.12500	3.00	120	0.0	0.0
Vfg Sand	0.004138	0.10511	3.25	140	0.0	0.0
	0.003480	0.08839	3.50	170	0.0	0.0
	0.002926	0.07433	3.75	200	0.0	0.0
	0.002461	0.06250	4.00	230	0.1	0.1
C Silt	0.002069	0.05256	4.25	270	0.3	0.4
	0.001740	0.04419	4.50	325	0.6	1.1
	0.001463	0.03716	4.75	400	1.2	2.3
	0.001230	0.03125	5.00	450	2.0	4.2
M Silt	0.001035	0.02628	5.25	500	2.9	7.1
	0.000870	0.02210	5.50	635	3.9	11.0
	0.000732	0.01858	5.75		4.9	15.9
	0.000615	0.01563	6.00		5.7	21.6
F Silt	0.000517	0.01314	6.25		6.3	27.9
	0.000435	0.01105	6.50		6.5	34.4
	0.000366	0.00929	6.75		6.6	41.0
	0.000308	0.00781	7.00		6.4	47.4
Vf Silt	0.000259	0.00657	7.25		6.1	53.5
	0.000217	0.00552	7.50		5.8	59.4
	0.000183	0.00465	7.75		5.5	64.9
	0.000154	0.00391	8.00		5.1	70.0
Clay	0.000129	0.00329	8.25		4.8	74.7
	0.000109	0.00276	8.50		4.3	79.1
	0.000091	0.00232	8.75		3.8	82.9
	0.000077	0.00195	9.00		3.3	86.2
	0.000065	0.00164	9.25		2.8	89.0
	0.000054	0.00138	9.50		2.2	91.2
	0.000046	0.00116	9.75		1.9	93.1
	0.000038	0.00098	10.00		1.6	94.7
	0.000032	0.00082	10.25		1.4	96.1
	0.000027	0.00069	10.50		1.3	97.4
	0.000023	0.00058	10.75		1.1	98.5
	0.000019	0.00049	11.00		0.8	99.4
	0.000016	0.00041	11.25		0.5	99.9
	0.000014	0.00035	11.50		0.1	100.0
	0.000011	0.00029	11.75		0.0	100.0
	0.000010	0.00024	12.00		0.0	100.0
	0.000008	0.00021	12.25		0.0	100.0
	0.000007	0.00017	12.50		0.0	100.0
	0.000006	0.00015	12.75		0.0	100.0
	0.000005	0.00012	13.00		0.0	100.0
	0.000004	0.00010	13.25		0.0	100.0
	0.000003	0.00009	13.51		0.0	100.0
	0.000003	0.00007	13.74		0.0	100.0
	0.000002	0.00006	14.00		0.0	100.0
	0.000002	0.000051	14.26		0.0	100.0
	0.000002	0.000043	14.51		0.0	100.0
	0.000001	0.000036	14.76		0.0	100.0
	0.000001	0.000031	14.98		0.0	100.0
	0.000001	0.000026	15.23		0.0	100.0
	TOTALS				100.0	100.0

Description	Sieve Size	Volume Percent
Granule	10	0.0
Very Coarse Sand	18	0.0
Coarse Sand	35	0.0
Medium Sand	60	0.0
Fine Sand	120	0.0
Very Fine Sand	230	0.1
Coarse Silt	450	4.1
Medium Silt		17.4
Fine Silt		25.8
Very Fine Silt		22.6
Clay		30.0
	Total	100.0

Cumulative Volume Percent greater than

Percentile	Phi Value	Particle Size Inches	Particle Size Millimeters
5	5.0695	0.0012	0.0298
10	5.4338	0.0009	0.0231
16	5.7467	0.0007	0.0186
25	6.1282	0.0006	0.0143
50	7.0949	0.0003	0.0073
75	8.2534	0.0001	0.0033
84	8.8159	0.0001	0.0022
90	9.3438	0.0001	0.0015
95	10.0383	0.0000	0.0010

Measure	Trask, mm	Folk, phi	Inches
Median	0.0073	7.0949	0.0003
Mean	0.0088	7.2192	0.0003
Sorting	2.0887	1.5201	
Skewness	0.8755	0.1531	
Kurtosis	0.2551	0.9582	

Figure 55: Grain Size Laser Analysis, Core 19, Section 14, 32 to 34 inches

4.3 Project Reporting

- Accepted speaking engagement for Far North Conference, Calgary for November and arranged potential substitute speaker from Geological Survey of Canada
- Prepared for and presented project Merit review late-September meetings with DOE
    - Participated in Geoscience, reservoir model, and program review teleconferences
    - Reviewed and edited UAF presentation
    - Prepared and presented reservoir model presentation
    - Prepared and presented project management presentation
- Prepared, reviewed, approved, and presented MountElbert-01 stratigraphic test results for Arctic Energy Summit International Conference, Anchorage.
- Wrote 12 page, 24-figure presentation for Arctic Energy Summit International Conference and facilitated approval for release (Appendix A)
- Reviewed, prepared response, and mitigated concerns to gas hydrate news publications
- Reviewed, edited, and requested approvals for AGU and ICGH abstracts
- Prepared and requested approvals for AAPG 2008 abstract
    - Received notice that 2007 AAPG presentation was awarded Energy and Mineral Division Frank Kottlowski Memorial Best Paper at Long Beach national conference

4.4 Project Cost Auditing

- Maintained project activities on-hold status to ensure sufficient funds for project work
- Completed project overrun audit, provided detailed documentation of Stratigraphic Test cost overruns by cost category to DOE COR, BP management, and BP Drilling
    - Input detailed account of Stratigraphic Test budget category overruns for DOE documentation and preparation of contract Amendment 18
    - Documented cost overruns for Wireline logging, Well cementing, Drilling, Ice road and pad construction, Core acquisition, Drilling mud chilling, Logging-while-drilling and gas detection, and Drilling fluid
- Controlled project cost centers and completed cost audits with BP Drilling and subcontractors
- Monitored invoices and capital well allocations for MtElbert-01 Stratigraphic Test well
- Reviewed completed Stratigraphic Test invoices and automatic cost allocations to document budget overruns
    - Reviewed invoices and cost allocations with contractors and BP
    - Ensured invoices and costs reasonable and prudent for services

5.0 STATUS REPORT

5.1 Cost Status

Costs for the Phase 3a Stratigraphic Test Well drilling, data acquisition, and associated studies were budgeted in the September 2006 definitization based on project task and cost estimates for required contractual services associated with drilling, data acquisition, data evaluation, and initial Phase 3b planning and feasibility studies.

Comparison of budgeted versus actual cost by task was completed by end-August. Detailed costs and explanations for overrun by budget category was provided to DOE by end-August and used to justify additional $1.08MM in BP-DOE Contract Amendment 18. A summary of the explanation of planned versus actual costs is also provided below in order by amount of cost overrun. Detailed invoice records were provided separately to DOE Contract Officers Representative (COR).

5.1.1 Ice Road and Pad Cost Overrun

- Total Budgeted Costs **$272,000,** Actual Costs **$778,072,** budget overrun **$506,072.**
- Budgeted costs did not include charges for "casual services", which are trucking services charged at premium rates due to contracted equipment at contracted rates being fully utilized elsewhere. The "casual service" rates are effective when available contracted equipment is over-utilized and other equipment needs to be obtained on short-notice to complete scheduled work.
- Budgeted costs did not include **$55,111** ice road and pad surveying costs.
- Extraneous circumstances beyond the control of the primary contractor, such as third-party access delays to fresh-water sources also led to construction delays in Ice Road and Pad.
- Equipment services on the Alaska North Slope are centralized and allocated to projects through a "Central Dispatch" equipment coordinator based on priorities, needs, and availability. Some equipment was unavailable, necessitating additional equipment shipment to the North Slope to fill temporary needs.
- The "Central Dispatch" invoices were automatically charged to the cost centers and subjected to a 3-4 month processing delay before posting to cost centers. These charges were for various trucking requirements supporting the well operations.
- The project manager was informed of the invoice accounting during the 2Q07 Quarterly reporting period; financial report submitted in August 2007 included this budget overrun.
- The additional costs were necessary for performance of the work as planned with detailed invoice documentation supplied separately to COR.

5.1.2 Drilling Cost Overrun

- Total Budgeted Costs **$1,619,595,** Actual Costs **$1,895,457,** budget overrun **$275,862.**
- While over 350 invoices were processed for Drilling and Associated Services, one particular budget subcategory accounted for most of the overrun amount: Rental Trucks were budgeted for **$95,000.**
- Budgeted costs did not include charges for "casual services", which are trucking services charged at premium rates due to contracted equipment at contracted rates being fully utilized elsewhere. The "casual service" rates are effective when available contracted equipment is over-utilized and other equipment needs to be obtained on short-notice to complete scheduled work.
- Trucking and associated services accounted for **$290,235.08** as documented.
- Therefore, **$195,235** of the **$275,862** overrun was caused by the trucking services overrun.
- The remainder of the overrun was not caused by a particular budget category, but fairly evenly spread throughout the Drilling and Associated services invoices.
- The project manager was informed of the invoice accounting during the 2Q07 Quarterly reporting period; financial report submitted in August 2007 included this budget overrun.
- The additional costs were necessary for performance of the work as planned with detailed invoice documentation supplied separately to COR.

5.1.3 Cementing Cost Overrun

- Budgeted Costs **$80,000,** Actual Costs **$336,836.56,** budget overrun **$256,836.56.**
- Actual Costs included product and additional charges as in-budget, but also vendor costs including Units Allocation, Batch Mixer Allocation, and Personnel/Equipment costs.
- Actual Cementing charges occurred over 3 jobs:
    1. Surface Casing Cementing: total Cost **$97,239.07**, 8 hours,
    2. Plugging/Abandonment Cement 1: total Cost **$131,741.82**, 14 hours, and
    3. Plugging/Abandonment Cement 2: total Cost **$107,855.67**, 15 hours.
- Budget included only product and additional charges costs provided by vendor and estimated by project engineer prior to drilling operations: estimated total **$80,000** versus actual total **$79,992.47** for the 3 cementing jobs (surface casing and 2 plugging/abandon).
- Units Allocation, Batch Mixer Allocation, and Personnel/Equipment Allocation were not included on budget as these were not provided by vendor and not known by project engineer or project manager to be a significant portion of the planned costs: estimated total **$0** versus actual total **$256,844.09**.
- The detailed invoice was posted to the well charge-code by May 2007, a reasonable delay due to invoicing and accounting procedures.
- The project manager was informed of the invoice accounting during the 2Q07 Quarterly reporting period; financial report submitted in August 2007 included this budget overrun.
- The additional costs were necessary for performance of the work as planned since the costs included the February 2007 vendor allocation costs for:
    1. Units (costs shared for vendor operations as allocated to individual oil field areas),
    2. Batch Mixer (costs shared for cement-mixing equipment), and
    3. personnel/equipment (costs shared for all field areas for vendor staff and other equipment for the month of February 2007).

5.1.4 Wireline Logging Cost Overrun

- Budgeted Costs **$512,113.80,** Actual Invoiced Costs **$717,428.53,** budget overrun **$205,314.73**.
- **$679,658.14** Total onsite Wireline costs and associated February 2007 allocation costs.
- February 2006 budgeted base plan did not include **$167,544.14** additional costs necessary to run wireline logs within an oil-based drilling fluid borehole environment; the change to oil-based drilling fluid was approved by BP-DOE in early 2007 as deemed necessary by the project team for improvements in safety, borehole stability, and data acquisition. The additional costs associated with this change to oil-based drilling fluid helped enable program success.
- The detailed **$679,658.14** vendor wireline logging invoice was posted to the well charge-code by May 2007, a reasonable delay due to invoicing and accounting procedures.
- The project manager was informed of the invoice accounting during the 2Q07 Quarterly reporting period; financial report submitted in August 2007 included this budget overrun.
- The additional costs were necessary for performance of the work as planned since the costs included the changes to the logging program required by the switch to an oil-based mud system and the post-processing for specialized logs.
- Initial invoice documentation provided by vendor indicates wireline logging services costs totaled **$620,746.71,** however, final invoiced charges for the wellsite wireline logging totaled **$679,658.14**, leaving a difference of **$58,911.43** of vendor February field equipment and

personnel overhead allocations for wireline logging (these allocation charges are similar to those tracked for vendor cementing services as documented in Section 5.1.3 above).

- **$19,894.22** additional budget overrun costs were necessary for post-processing of specialized logs as authorized by project manager in post-well discussions with vendor and USGS science program manager.
- Secondary invoice costs include April 2007 (processed June 2007) charges of **$12,479.90** (totaling **$13,526.33** with overhead allocations) for OilPhase MDT chamber fluid/gas subsampling/processing and May 2007 (processed July 2007) charges of **$3,882.44** (totaling **$4,349.84** with overhead allocations) for EPT tool shipping.

5.1.5 Drilling Fluid Cost Overrun

- Budgeted Costs **$120,000,** Actual Costs **$302,773.13,** budget overrun **$182,773.13.**
- Budgeted costs did not include change to oil-based drilling fluid; this change was approved in early-2007 by BP-DOE for drilling and data acquisition optimization and for improved safety.
- The change to oil-based drilling fluid accounted for the entire overrun amount.
- The total original costs for the oil-based drilling fluids was **$359,019.69**; however, **$56,246.56** of these costs were partially refunded to this project when the subsequent Milne Point well used mud recycled from the MtElbert-01 drilling program during drilling and coring operations. Later disposal costs for this oil-based drilling fluid were borne entirely by BP.
- Secondary invoice costs of approximately **$12,000** were invoiced in 4Q07 for unbudgeted water-based surface hole mud disposal costs at Kuparuk field disposal well operated by ConocoPhillips.

5.1.6 Mudlogging and Logging-While-Drilling Cost Overrun

- Budgeted Costs **$119,659.74,** Actual Costs **$196,330.63** budget overrun **$76,670.89.**
- Budgeted costs did not include **$28,794.94** for directional drilling and bottom-hole assembly due to misunderstanding during planning that being a vertical well, these services were unnecessary, when these services were required to ensure borehole remained vertical for data acquisition.
- Budgeted costs did not include **$18,028.50** for additional directional surveying services for same reasons stated above.
- Actual Mudlogging/Gas Detection charges totaled **$50,670.98** as documented below; this was a difference of **$15,670.98** versus the original **$35,000** estimate due to various parameters including some extra onsite time, materials, and standby time, but primarily due to the **$11,480** charge for personnel (2 sample catchers) not on the original estimate.
- Budgeted costs did not include $288 drillpipe wiper ball or $346.02 miscellaneous charge.
- Logging-While-Drilling (LWD) Services total **$98,202.19**, **$13,542.45** above estimated budgeted costs of **$84,659.74** for these services.
- However, the original LWD estimate of **$84,659.74** included only charges for tools and did not account for personnel charges totaling $**49,078.03** nor workstation charges totaling **$14,290.20.**
- The original LWD estimate of **$84,659.74** included **$36,671** for sonic tools that were not run in the hole to save costs and in recognition that this data would be obtained from the wireline logging runs; taking the sonic tools out of the program would revise the original estimate to

$37,918.32 without the 13.5% contingency overrun; the actual tool cost of **$34,833.96** was very near this estimated tool cost.

- The detailed vendor invoice was posted to the well charge-code by April 2007, a reasonable delay due to invoicing and accounting procedures.
- The project manager was informed of the invoice accounting during the 2Q07 Quarterly reporting period; financial report submitted in August 2007 included this budget overrun.
- The additional costs were necessary for performance of the work as planned.

5.1.7 Mud Chilling Cost Overrun

- Budgeted Costs **$113,580,** Actual Costs **$139,942.61,** budget overrun **$26,362.61.**
- Mid-2006 budgeted plan was $0 for equipment shipping and preparations for operations; detailed invoice reveals that cost was $16,765.29.
- Mid-2006 budgeted plan was $0 for travel/training/expenses for personnel; detailed invoice reveals these costs were $7,536.
- These 2 categories account for $24,301 of the $26,362.61 budget overrun.
- The detailed vendor invoice was posted to the well charge-code by July 2007, a reasonable delay due to invoicing and accounting procedures.
- The project manager was informed of the invoice accounting during the 2Q07 Quarterly reporting period; financial report submitted in August 2007 included this budget overrun.
- The additional costs were necessary for performance of the work as planned since the costs included the travel/training expenses for personnel and the shipping costs for equipment.

5.1.8 Coring Support Operations Cost Overrun

- Budgeted Costs **$74,700,** Actual Costs **$87,473.39,** budget overrun **$12,773.39.**
- Early 2006 budgeted plan for personnel was 5 days onsite, 2 days standby for total planned cost of $23,300 ; actual costs increased due primarily to up to 8 days onsite for 2 personnel and 16 days onsite for 2 personnel for total cost of $56,350.
- Budgeted plan did not include portable gamma device at total charge $8,855.
- Some items came in under-budget, but overall budget overrun of $12,773.39
- The detailed vendor invoice was posted to the well charge-code by May 2007, a reasonable delay due to invoicing and accounting procedures.
- The project manager was informed of the invoice accounting during the 2Q07 Quarterly reporting period; financial report submitted in August 2007 included this budget overrun.
- The additional costs were necessary for performance of the work as planned since the costs included the additional onsite time for personnel during preparation for coring and for added equipment costs.

5.2 Project Task Schedules and Milestones

5.2.1 U.S. Department of Energy Milestone Log, Phase 1, 2002-2004

Note that SOPO in contract amendments 1-8 for Phase 1.
Program/Project Title: DE-FC26-01NT41332: Resource Characterization and Quantification of Natural Gas-Hydrate and Associated Free-Gas Accumulations in the Prudhoe Bay - Kuparuk River Area on the North Slope of Alaska.

Identification Number	Description	Planned Completion Date	Actual Completion Date	Comments
Task 1.0	Research Management Plan	12/02 – 12/04	12/02 and Ongoing	Subcontracts Completed
Task 2.0	Provide Technical Data and Expertise	MPU: 12/02 PBU: * KRU: *	MPU: 12/02 PBU: * KRU: *	See Technical Progress Reports
Task 3.0	Wells of Opportunity Data Acquisition	Ongoing	Ongoing	See Technical Progress Reports
Task 4.0	Research Collaboration Link	Ongoing	Ongoing	See Technical Progress Reports
Subtask 4.1	Research Continuity	Ongoing	Ongoing	
Task 5.0	Logging and Seismic Technology Advances	Ongoing		See Technical Progress Reports
Task 6.0	Reservoir and Fluids Characterization Study	12/04	Ongoing to Phases 2 and 3	Interim Results presented, 2004 Hedberg Conference
Subtask 6.1	Characterization and Visualization	12/04	Ongoing to Phases 2 and 3	Interim Results presented, 2004 Hedberg Conference
Subtask 6.2	Seismic Attributes and Calibration	12/04	Ongoing to Phases 2 and 3	Interim Results presented, 2004 Hedberg Conference
Subtask 6.3	Petrophysics and Artificial Neural Net	12/04	Ongoing to Phases 2 and 3	Interim Results presented, 2004 Hedberg Conference
Task 7.0	Laboratory Studies for Drilling, Completion, Production Support	6/04	6/04	
Subtask 7.1	Characterize Gas Hydrate Equilibrium	6/04	6/04	Results presented, 2004 Hedberg Conference
Subtask 7.2	Measure Gas-Water Relative Permeabilities	6/04	6/04	Results presented, 2004 Hedberg Conference
Task 8.0	Evaluate Drilling Fluids	12/04		
Subtask 8.1	Design Mud System	11/03		
Subtask 8.2	Assess Formation Damage	9/05	Into Phase 2	
Task 9.0	Design Cement Program	12/04		
Task 10.0	Study Coring Technology	2/04	2/04	
Task 11.0	Reservoir Modeling	12/04	Ongoing task	Interim Results presented, 2004 Hedberg Conference
Task 12.0	Select Drilling Location and Candidate	9/05		Topical Report submitted, June 2005
Task 13.0	Project Commerciality & Phase 2 Progression Assessment	9/05	Redesigned 2005 Phase 2	BPXA and DOE decision

* Date dependent upon industry partner agreement for seismic data release

5.2.2 U.S. Department of Energy Milestone Log, Phase 2, 2006

Note that SOPO in contract Amendment 9 for Phase 2.
Program/Project Title: DE-FC26-01NT41332: Resource Characterization and Quantification of Natural Gas-Hydrate and Associated Free-Gas Accumulations in the Prudhoe Bay - Kuparuk River Area on the North Slope of Alaska.

Identification Number	Description	Planned Completion Date	Actual Completion Date	Comments
Task 1.0	Research Management Plan	1/05 – 1/06	Ongoing	Subcontracts Completed
Task 2.0	Provide Technical Data and Expertise	MPU: 12/02 PBU: * KRU: *	MPU: 12/02 PBU: * KRU: *	See Technical Progress Reports
Task 3.0	Wells of Opportunity Data Acquisition	Ongoing	Ongoing	See Technical Progress Reports
Task 4.0	Research Collaboration Link	Ongoing	Ongoing	See Technical Progress Reports
Subtask 4.1	Research Continuity	Ongoing	Ongoing	
Task 5.0	Logging and Seismic Technology Development and Advances	Ongoing		See Technical Progress/Topical Reports
Task 6.0	Reservoir and Fluids Characterization Study	12/06	Ongoing into Phases 2 and 3	
Subtask 6.1	Structural Characterization	12/06	Ongoing into Phases 2 and 3	
Subtask 6.2	Resource Visualization	12/06	Ongoing into Phases 2 and 3	
Subtask 6.3	Stratigraphic Reservoir Model	12/06	Ongoing into Phases 2 and 3	
Task 7.0	Laboratory Studies for Drilling, Completion, Production Support	12/06		Some Hiatus; Phase 2-3a design, studies, & decision
Subtask 7.1	Design Mud System	12/05		
Subtask 7.2	Assess Formation Damage	1/06		
Subtask 7.3	Measure Petrophysical and Other Physical Properties	9/06	Phase 3a	No Samples Acquired; await Phase 3a acquisition
Task 8.0	Design Completion / Production Test for Gas Hydrate Well	4/06	Mt Elbert-01 strat test only	Design of Phase 3a Strat Test operation Complete
Task 9.0	Field Operations and Data Acquisition Program Planning	4/06	Mt Elbert-01 strat test only	Planning for Potential operations underway
Task 10.0	Reservoir Modeling and Project Commercial Evaluation	1/06		Regional Resource Review & Development Planning
Subtask 10.1	Task 5-6 Reservoir models	Ongoing		
Subtask 10.2	Hydrate Production Feasibility	1/06		
Subtask 10.3	Project Commerciality & Phase 3a Progression Assessment	1/06		January 2006 approval for Phase 3a Stratigraphic Test

* Date dependent upon industry partner agreement for seismic data release

5.2.3 U.S. Department of Energy Milestone Log, Phase 3a, 2006-2007

Note that SOPO in contract Amendment 11 for Phase 3a.

Program/Project Title: DE-FC26-01NT41332: Resource Characterization and Quantification of Natural Gas-Hydrate and Associated Free-Gas Accumulations in the Prudhoe Bay - Kuparuk River Area on the North Slope of Alaska

Identification Number	Description	Planned Completion Date	Actual Completion Date	Comments
Task 1.0	Research Management Plan	1/06 – 12/07	Ongoing	Subcontracts Completed
Task 2.0	Provide Technical Data and Expertise	MPU: 12/02 PBU: * KRU: *	MPU: 12/02 PBU: * KRU: *	See Technical Progress Reports
Task 3.0	Wells of Opportunity Data Acquisition	Ongoing	As-identified	See Technical Progress Reports
Task 4.0	Research Collaboration Link	Ongoing	Ongoing	See Technical Progress Reports
Subtask 4.1	Research Continuity	Ongoing	Ongoing	
Task 5.0	Logging and Seismic Technology Development and Advances	Ongoing	As-needed	See Technical Progress/Topical Reports
Task 6.0	Reservoir and Fluids Characterization Study	12/07		Under No-cost Extension
Subtask 6.1	Structural Characterization	12/07		
Subtask 6.2	Resource Visualization	12/07		
Subtask 6.3	Stratigraphic Reservoir Model	12/07		
Task 7.0	Laboratory Studies for Drilling, Completion, Production Support	12/07		Under No-cost Extension
Subtask 7.1	Design Mud System	9/07		
Subtask 7.2	Assess Formation Damage	9/07		
Subtask 7.3	Measure Petrophysical and Other Physical Properties	9/07		
Task 8.0	Implement completion/production Test for gas hydrate well	3/07	3/07	Stratigraphic Test Well Drilled February 3-19, 2007
Task 9.0	Reservoir Modeling and Project Commercial Evaluation	12/07	Ongoing	Regional Resource Review & Development Planning
Subtask 9.1	Task 5-6 Reservoir models	12/07	As-needed	
Subtask 9.2	Project Commerciality & Phase 3b Production Test Decision	12/07	Early decision possible	Phase 3a Stratigraphic Test to mitigate uncertainties

* Date dependent upon industry partner agreement for seismic data release

5.2.4 U.S. Department of Energy Milestone Plans

(DOE F4600.3)

DOE F 4600.3#

U.S. DEPARTMENT OF ENERGY FEDERAL ASSISTANCE MILESTONE PLAN: PHASE 1

1. Program/Project Identification No. DE-FC26-01NT41332	2. Program/Project Title Resource Characterization and Quantification of Natural Gas-Hydrate and Associated Free-Gas Accumulations in the Prudhoe Bay - Kuparuk River Area on the North Slope of Alaska
3. Performer (Name, Address) BP Exploration (Alaska), Inc., 900 East Benson Blvd, P.O. Box 196612, Anchorage, Alaska 99519-6612	4. Program/Project Start Date 10/22/02* 5. Program/Project Completion Date 12/31/07 (through Phase 3a)

6. Identification Number	7. Planning Category (Work Breakdown Structure Tasks)	8. Program/Project Duration (Phase 1, 2002-2004) O N D J F M A M J J A S O N D J F M A M J J A S-D	9. Comments (Primary work Performer)
Task 1.0	Research Management Plan	>>>!>	BPXA
Task 2.0	Technical Data and Expertise	>>>>>>----->>>>------>>>>>>>>------------>>>>>>>>-------->>>>>>>>-->>>>>>>>--!-	BPXA
Task 3.0	Wells of Opportunity - Data	------>>>>>-------------->>>>>--------->>>>>>>>>>>>>>>---------->>>>>>>>>>>>>>>!-	BPXA
Task 4.0	Research Collaboration Link	>>!>	BPXA, USGS, UAF, UA
Task 5.0	Logging/Seismic Technology	>>!	USGS, BPXA
Task 6.0	Characterize Reservoir/Fluid	------->>!>>	UA
Task 7.0	Lab Studies: Ph Behav, Rel k	-- ----->>!----------	UAF
Task 8.0	Evaluate Drilling Fluids	------->>>>>>>>>>>>>>>>>>>>>>>>>>>>>>-->>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>	UAF
Task 9.0	Design Cementing Program	------->>>>>>>>>>>>>>>>>>>>>>>>>>>>	UAF
Task 10.0	Study Coring Techniques	-------->>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>- --	UAF
Task 11.0	Reservoir Modeling	>>>>------------------------>>>>>>>>>----------------->>>>>>>>>>>>>>>>>>>>>>>!>>>	UAF, RyderScott
Task 12.0	Drilling Candidate Selection	>>>------ ----->>>>>>------->>>>>>>>>>>>---->>>>>>>>>>>>!	BPXA, UA, USGS, RyderScott
Task 13.0	Commerciality Assessment	>>>>>>-------------------------------->>>>>>>>-------------->>>>>>------>>>>>>>>>	BPXA, UAF, Ryder Scott

10. Remarks * Official Contract Date 10/22/02; Funded reduced-cost pre-Phase 1 from 10/01-10/02. Phase 1 project from 10/02 through 12/04.
Explanation of Symbols: (> = Major Task Work); (- = Minor Task Work); (! = Milestones).
Additional significant milestones presented in Quarterly Technical Progress Reports.

DOE F 4600.3#

U.S. DEPARTMENT OF ENERGY FEDERAL ASSISTANCE MILESTONE PLAN: PHASE 2-3a (2005-2006)

1. Program/Project Identification No. DE-FC26-01NT41332	2. Program/Project Title Resource Characterization and Quantification of Natural Gas-Hydrate and Associated Free-Gas Accumulations in the Prudhoe Bay - Kuparuk River Area on the North Slope of Alaska
3. Performer (Name, Address) BP Exploration (Alaska), Inc., 900 East Benson Blvd, P.O. Box 196612, Anchorage, Alaska 99519-6612	4. Program/Project Start Date 10/22/02* 5. Program/Project Completion Date 12/31/07 (through Phase 3a)

6. Identification Task Number	7. Planning Category (Work Breakdown Structure Tasks)	8. Program/Project Duration (Phases 2-3, 2005 - 2006) ← Planning/Analysis → ← DECISION---→ ←Planning--------→← IMPLEMENTATION deferred to 2007→ J F M A M J J A S O N D J F M A M J J A S O N D	9. Comments (Primary work Performer)
Task 1.0	Contracts and Research Management Planning	>>>>>>>!>>>--->>>>>!-->>>>>>>>>>>>>>>>>>!---------------------->>---->>-->>>>>>>	BPXA, AES
Task 2.0	Technical Data and Expertise	-->>>>>>----->>>>--!---->>>>>>>>>-------!--->>>>>>>>>-------->>>>>>>>-->>>>>>>>>--	BPXA, AES
Task 3.0	Wells of Opportunity - Data	------------->>>>>-!------------>>>>>---!---->>>>>>>>>>>>>>>----------->>>>>>>>	BPXA, AES
Task 4.0	Research Collaboration Link	---------->>>>>>>>>!---------->>>>>>>>>>!>>	BPXA, USGS, AES, UAF,UA
Task 5.0	Logging/Seismic Technology	>>>>>>>>>>>>>>>>>>>>!>>>>>>>>>>>>>>>>>>>>!>>>>>>>>>>---------------------------->>	USGS, BPXA
Task 6.0	Characterize Reservoir/Fluid	------->>>>>>>>>>>>>!---------->>>>>>>>>>!>>>>>>>>>>>>>>>>---------->>>>>>>>>>>>>>	UA, USGS
Task 7.0**	Lab Studies: Drilling, Completion, Production	------------>>>>>>>>!---------->>>>>>>>>>!>>>>>>>>------------------->----->>>>>>>>>>	UAF
Task 8.0**	Stratigraphic Test Decision, Design, and Implementation	-->>>>>>>>>>>>!>>>----->>>>>>>>>>>>>!>>>>>>>>--------------------->>>>>>>>>>>>	APA, BPXA, AES, UAF
Task 9.0**	Field Operations Planning and Implementation	---->>>>>>>>>>!>>>------->>>>>>>>>>!>>>>>>>>--------------------->>>>>>>>>>>>	APA, BPXA, AES, UAF
Task 10.0**	Reservoir Modeling and Commercial Evaluation	----->>>>>>>>>>>>>>>!>>>>>>>>>>>>>>>>>>>>>---!---------------------------------------	RS, AES, BPXA, UAF

10. Remarks * Schedule shows Phases 2-3a from 2005 through end-2006. Phase 2 project from 1/05 through 12/05. Phase 3a stratigraphic test initiated 6/05 and included 9/05 Continuation Application culminating in 1/06 decision to Drill. . Explanation of Symbols: >> Major Task Work; -- Minor Task Work; ! Milestone. Significant technical work and milestones presented in Technical Progress and Topical Reports. **Note new (Phase 2-3a) Task numbers.

DOE F 4600.3#

U.S. DEPARTMENT OF ENERGY FEDERAL ASSISTANCE MILESTONE PLAN: PHASE 3a and 3b

1. Program/Project Identification No. DE-FC26-01NT41332	2. Program/Project Title Resource Characterization and Quantification of Natural Gas-Hydrate and Associated Free-Gas Accumulations in the Prudhoe Bay - Kuparuk River Area on the North Slope of Alaska
3. Performer (Name, Address) BP Exploration (Alaska), Inc., 900 East Benson Blvd, P.O. Box 196612, Anchorage, Alaska 99519-6612	4. Program/Project Start Date 10/22/02* 5. Program/Project Completion Date 12/31/07 (through Phase 3a)

6. Identification Task Number	7. Planning Category (Work Breakdown Structure Tasks)	8. Program/Project Duration (Phases 3a-3b, 2007-2008 projection) ←Phase 3a Strat Test→ ←3a Analyses/Audit → 3bPlanning→←3b Decisioning → ← 3b Planning → J F M A M J J A S O N D J F M A M J J A S O N D	9. Comments (Primary work Performer)
Task 1.0	Contracts and Research Management Planning	!>>>>>>!>>>--->>>>>--->>>>>>>>>>>>>>>>>!------------------!--------->>!>>>>>>>>	BPXA, AES
Task 2.0	Technical Data and Expertise	!->>>>>>---->>>>------->>>>>>>>>-------!--->>>>>>>>-------!>>>>>>>>-->!>>>>>>--	BPXA, AES
Task 3.0	Wells of Opportunity - Data	!------------>>>>>---------------->>>>---!----->>>>>>>>>>>>>!>-----------!>>>>>>>>	BPXA, AES
Task 4.0	Research Collaboration Link	!>>>>>>>>>>>>>>>>>>----------->>>>>>>>>>!>>>>>>>>>>>>>>>>>>!>>>>>>>>>>>>!>>>>>>>>	BPXA, USGS, AES, UAF,UA
Task 5.0	Logging/Seismic Technology	!>>>>>>>>>>>>>>>>>->>>>>>>>>>>>>>>>>>>!>>>>>>>>>>>>>>>>>>!>>>>>>>>>>>>!>>>>>>>>	USGS, BPXA
Task 6.0	Characterize Reservoir/Fluid	!------>>>>>>>>>>>>>----------->>>>>>>>>>!>>>>>>>>>>>>>>>>---!------>>>>>!>>>>>>>>	UA, USGS
Task 7.0	Lab Studies: Drilling, Completion, Production	!----------->>>>>>>----------->>>>>>>>>>!>>>>>>>>>>>>>>>>>>!>>>>>>>>>>>>!>>>>>>>>	UAF
Task 8.0	Implement 2007 Strat Test Evaluate/Design Production Test & Phase 3b progression	! -->>>>>>>>>>>>->>>----->>>>>>>>>>>>!>>>>>>>>>>>>>>>>>>!>>>>>>>>>>>>!>>>>>>>>	APA, BPXA, AES, UAF
Task 9.0	Reservoir Modeling and Commercial Evaluation	!---->>>>>>>>>>>>>>->>>>>>>>>>>>>>>>>>>!>>>>>>>>>>>>>>>>>>!>>>>>>>>>>>>!>>>>>>>>	RS, AES, BPXA, UAF

10. Remarks * Schedule shows Phases 3a-3b (3b not approved-indicated in red) from 2007 projected through end-2008. Phase 3a stratigraphic test deferred until early 2007 by 3rd party rig delay. Explanation of Symbols: >> Major Task Work; -- Minor Task Work; ! Milestone. Significant technical work and milestones presented in Technical Progress and Topical Reports. Note that 2008 Drilling Schedule apparently fully dedicated; additional drilling rigs under construction; 2009 Implementation possible.

5.3 3Q07 Reporting Period Significant Accomplishments

Approval to proceed into Phase 3a well operations resulted in drilling and data acquisition in the MountElbert-01 Stratigraphic Test during February 2007. Documentation of Phase 3a drilling and data acquisition cost overruns (summary above in Section 5.1) enabled obligation of additional funding in contract Amendment 18 to reimburse these costs and to continue data evaluation and initial Phase 3b production test design planning. Phase 3a 2007 operations were safely accomplished and all recommended data was successfully acquired, including extensive wireline core, logging, and production testing. Phase 3a data analyses is underway in preparation for planning, site selection, budgeting, and seeking industry/government approval to proceed into Phase 3b long-term gas hydrate production test operations. Successful Phase 3a operations also proved the ability to safely, effectively, and cost-efficiently operate and acquire data within the shallow gas hydrate-bearing Alaska North Slope reservoir zones. The Phase 3a data analyses will help narrow the significant uncertainties in reservoir properties and productivity potential in preparation for Phase 3b planning activities and operations decision anticipated in 2008.

5.4 Actual or Anticipated problems, delays, and resolution

Phase 3a Stratigraphic Test definitization documents and budgets were approved in late 2006. Contract amendments were completed in December 2006 to better define operations liabilities and extend Phase 3a data analyses and Phase 3b planning activities through end-December 2007. Increases in well costs would have led to expenditure of budgeted funds before end-2007. However, additional funding in BP-DOE Contract Amendment 18 has enabled completion of 2007 Phase 3a data analyses and initiation of Phase 3b planning activities. Some of the well cost increases were known and agreed prior to drilling and data acquisition operations as discussed in-detail in Section 5.1 of this report. Extreme vendor delays in wireline log data processing continue to delay analyses of this data; these delays were not limited to the MountElbert-01 well, but included other appraisal wells during this time period. This data was released in a new industry-compatible format by October 2007, but is still being converted to standard formats at the time of this report.

5.5 Project Research Products, Collaborations, and Technology Transfer

5.5.1 Project Research Collaborations and Networks

Project objectives significantly benefit from DOE awareness, support, and/or funding of the following associated collaborations, projects, and proposals:

1. **Reservoir Model Comparison studies:** DOE NETL and University of Akron coordination of reservoir modeling significantly increased collaborative reservoir modeling efforts with Japan, Lawrence Berkeley National Lab (LBNL), Pacific Northwest National Lab (PNNL), and University of Calgary and Fekete. This important work has continued into simulation of field-scale gas hydrate bearing reservoirs. The studies to-date have facilitated a common understanding of how these different gas hydrate reservoir models handle the basic physics of gas hydrate dissociation processes within gas hydrate-bearing formations and extend into analyses of Phase 3a stratigraphic test and MDT data. Contributors to this effort include: Masanori Kurihara (Japan Oil Engineering Co., Ltd.), Yoshihiro Masuda (The University of Tokyo), Pete McGrail

(Pacific Northwest National Laboratory), George Moridis (Lawrence Berkeley National Laboratory, University of California), Hideo Narita (National Institute of Advanced Industrial Science and Technology), Mark White (Pacific Northwest National Laboratory), Joseph W. Wilder and Brian Anderson (University of Akron), Scott Wilson (Ryder Scott Company, Consultant to BP-DOE project), Mehran Pooladi-Darvish and Huifang Hong (University of Calgary and Fekete), Timothy Collett (U.S. Geological Survey), and Robert Hunter (ASRC Energy Services; BP Exploration (Alaska), Inc.).

2. **DE-FC26-01NT41248:** UAF/PNNL/BPXA studies to investigate the effectiveness of CO_2 as a potential enhanced recovery mechanism for gas dissociation from methane hydrate. DOE supported this associated project research which may help facilitate a possible future field test of this technology.
3. **UAF/Argonne National Lab project:** This associated project was approved for funding by the Arctic Energy and Technology Development Lab (AETDL), forwarded to NETL for review, and was funded in mid-2004. The project is designed to determine the efficacy of Ceramicrete cold temperature cement for possible future gas hydrate drilling and completion operations. Evaluating the stability and use of an alternative cold temperature cement may enhance the ability to maintain the low temperatures of the gas hydrate stability field during drilling and completion operations and help ensure safer and more cost-effective operations. In early 2006, the Ceramicrete material was approved for field testing at the BJ Services yard in Texas (primary contact Lee Dillenbeck). Although Ceramicrete was not yet field tested in time to be evaluated for use in 2007 Alaska operations, successful future yard testing of the material may enable limited testing in Alaska project operations. However, this project does not appear to have significantly progressed during 2006 through 2007.
4. **Precision Combustion, Inc. (PCI) – DOE collaborative research project:** Potential synergies from this DOE-supported research project with the BPXA – DOE gas hydrate research program were recognized in December 2003 by Edie Allison (DOE). Communications with Precision Combustion researchers indicate possible synergies, particularly regarding potential in-situ reservoir heating. Successful modeling and lab work could potentially proceed into field applications in future gas hydrate operations. BPXA provided a letter in April 2004 in support of progression of PCI's project into their phase 2: prototype tool design and possible surface testing. If the project proceeds into Phase 3b operations, a thermal component of production testing may be recommended and a delivery mechanism could potentially incorporate this technology.
5. **Japan gas hydrate research:** Progress toward completing the objectives of this project remain aligned with gas hydrate research by Japan Oil, Gas, and Metals National Corporation (JOGMEC), formerly Japan National Oil Corporation (JNOC). JOGMEC remains interested in research collaboration, particularly if this project proceeds into production testing operations. Communications with JOGMEC were limited during the reporting period, but were renewed in June 2006, to inform JOGMEC that the BP-DOE project is proceeding into Phase 3a stratigraphic test field operations. JOGMEC may proceed into future (2007-2008) production test operations at the Mallik field site.
6. **India gas hydrate research:** India's Institute of Oil and Gas Production Technology (IOGPT) indicates a continued interest in participating with the BPXA – DOE research program in correspondence/discussion with DOE. Dr. Tim Collett, partner in the BPXA-DOE research team, and Ray Boswell, DOE gas hydrate program, led and participated in,

respectively, certain aspects of the data acquisition at multiple offshore India field sites. India sent a technical observer to view ANS Phase 3a operations and data acquisition. The value of international research collaboration is recognized.

7. **Korea gas hydrate research:** Korea is developing a gas hydrate research program. Korea has discussed potential participation in future Alaska gas hydrate research with DOE and USGS. BPXA has not initiated direct contact with Korea, but has referred 2007 correspondence to DOE and USGS. Korea gas hydrate program representatives visited UAF in fall 2007.
8. **China gas hydrate research:** China is also developing a gas hydrate research program. BPXA has not initiated contact with China, but DOE is collaborating in certain gas hydrate research studies in China.
9. **U.S. Department of Interior, USGS, BLM, State of Alaska DGGS:** An additional collaborative research project under the Department of Interior (DOI) may provide significant benefits to this project. The BLM, USGS, and the State of Alaska recognize that gas hydrate is potentially a large untapped ANS onshore energy resource. To develop a more complete regional understanding of this potential energy resource, the BLM, USGS and State of Alaska Division of Geological and Geophysical Surveys (DGGS) have entered into an Assistance Agreement to assess regional gas hydrate energy resource potential in northern Alaska. This agreement combines the resource assessment responsibilities of the USGS and the DGGS with the surface management and permitting responsibilities of the BLM. Information generated from this agreement will help guide these agencies to promote responsible development if this potential arctic energy resource becomes proven. The DOI project has worked with the BPXA – DOE project to assess the regional recoverable resource potential of onshore natural gas hydrate and associated free-gas accumulations in northern Alaska, initially within current industry infrastructure.

5.5.2 Project Research Technologies/Techniques/Other Products

Multiple technologies are under evaluation in association with this project. With research progression into Phase 3 operations, technologies under evaluation include gas hydrate production techniques such as thermal and/or chemical stimulation to enhance gas dissociation during future Phase 3b production testing, if approved. Recent advances in electromagnetic thermal stimulation techniques may benefit potential future production test operations. Coiled-tubing unit-supported completions may offer sufficient flexibility to support various completion options during potential future production test operations.

5.5.3 Project Research Inventions/Patent Applications

DOE granted an advance patent waiver to the project in 2003. No patents are currently recorded in association with the project.

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5.5.4.9 Websites

There are currently no external project-sponsored websites. Project information is available on the DOE website: http://www.fossil.energy.gov/programs/oilgas/hydrates/index.html. A project internal website has been developed for storage, transfer, and organization of project-related files, results, and studies. This website is available to project participants only; information contained on this working website will be finalized and released at project final reporting.

6.0 CONCLUSIONS

The first dedicated gas hydrate coring and production testing well, NW Eileen State-02, was drilled in 1972 within the Eileen gas hydrate trend by Arco and Exxon. Since that time, ANS methane hydrates have been known primarily as a drilling hazard. Industry has only recently considered the resource potential of conventional ANS gas during industry and government efforts in working toward an ANS gas pipeline. Consideration of the resource potential of conventional ANS gas helped create industry - government alignment necessary to reconsider the resource potential of the potentially large (33 to 100 TCF in-place) unconventional ANS methane hydrate accumulations beneath or near existing production infrastructure. Studies show this in-place resource is compartmentalized both stratigraphically and structurally within the petroleum system.

The BPXA – DOE collaborative research project enables a better understanding of the resource potential of this ANS methane hydrate petroleum system through comprehensive regional shallow reservoir and fluid characterization utilizing well and 3D seismic data, implementation of methane hydrate experiments, and design of techniques to support potential methane hydrate drilling, completion, and production operations.

Following discovery of natural gas hydrate in the 1960-1970's, significant time and resources have been devoted over the past 40 years to study and quantify natural gas hydrate occurrence. However, only in the past decade have there been significant attempts to understand the potential production of methane from hydrate. Although significant in-place natural gas hydrate deposits have been identified and inferred, estimation of potential recoverable gas from these deposits is difficult due to the lack of empirical or even anecdotal evidence.

The potential to induce gas hydrate dissociation across a broad regional contact from adjacent free gas depressurization is demonstrated by the results of the collaborative BPXA-LBNL pre-Phase 1 scoping reservoir model (presented in the March 2003 Quarterly report and technical conferences) and corroborated by the results of continued UAF and Ryder Scott reservoir model research as presented in Section 5.9 of the December 2003 Quarterly report.

The possibility to induce in-situ gas hydrate dissociation through producing mobile connate waters from within an under-saturated gas hydrate-bearing reservoir also emphasizes the importance of saturation and permeability as key variables which, when better understood, could help mitigate productivity uncertainty. A schematic potential development screening study was undertaken to set ranges on the potential resources that might one day be recovered (if production is technically and economically feasible) given various possible production scenarios of the ANS Eileen gas hydrate trend, which may contain up to 33 TCF gas-in-place. Type-well production rates modeled at 0.4-2 MMSCF/d yield potential future peak field-wide development forecast rates of up to 350-450 MMSCF/d and cumulative production of 0-12 TCF gas. Individual wells would exhibit a long production character with flat declines, potentially analogous to Coalbed Methane production.

Results from the various scenarios show a wide range of potential development outcomes. None of these forecasts would qualify for Proved, Probable, or even Possible reserve categories using the SPE/WPC definitions since there has yet to be a fully documented case of economic production from hydrate-derived gas. Each of these categories would, by definition, require a positive economic prediction, supported by historical analogies, prudent engineering judgment, and rigorous geological characterization of the potential resource before a decision on an actual development could proceed.

Phase 3a stratigraphic test field operations enabled acquisition of critical gas hydrate-bearing reservoir data. Key data acquired included wireline cores, logs, and wireline production (MDT) testing of gas hydrate-bearing reservoir sands and associated sediments. Analyses of the core, log, and MDT results is underway and should help reduce the uncertainty regarding gas hydrate-bearing reservoir productivity and improve planning of Phase 3b gas hydrate production test studies, although Phase 3b operations are not currently approved.

7.0 LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Denotation
2D	Two Dimensional (seismic or reservoir data)
3D	Three Dimensional (seismic or reservoir data)
AAPG	American Association of Petroleum Geologists
AAT	Alaska Arctic Terrane (plate tectonics)
AETDL	Alaska Energy Technology Development Laboratory
ADEC	Alaska Department of Environmental Conservation
ANL	Argonne National Laboratory
ANN	Artificial Neural Network
ANS	Alaska North Slope
AOGCC	Alaska Oil and Gas Conservation Commission
AOI	Area of Interest
AVO	Amplitude versus Offset (seismic data analysis technique)
ASTM	American Society for Testing and Materials
BGHSZ	Base of Gas Hydrate Stability Zone
BHA	Bottom Hole Assembly; equipment at bottom hole during drilling operations
BIBPF	Base of Ice-Bearing Permafrost
BLM	U.S. Bureau of Land Management
BMSL	Base Mean Sea Level
BP	BP or BPXA
BPXA	BP Exploration (Alaska), Inc.
CMR	Combinable Magnetic Resonance log (wireline logging tool – see also NMR)
CP	ConocoPhillips
DOE	U.S. Department of Energy
DOI	U.S. Department of Interior
DGGS	Alaska Division of Geological and Geophysical Surveys

DNR	Alaska Department of Natural Resources
EM	Electromagnetic (referencing potential in-situ thermal stimulation technology)
ERD	Extended Reach Drilling (commonly horizontal and/or multilateral drilling)
FBHP	Flowing Bottom-Hole Pressure (during MDT wireline production testing)
FEL	Front-End Loading, reference to effective pre-project operations planning
FG	Free Gas (commonly referenced in association with and below gas hydrate)
GEOS	UA Department of Geology and Geophysics
GH	Gas Hydrate
GIP	Gas-in-Place
GOM	Gulf of Mexico (typically referring to Chevron Gas Hydrate project JIP)
GR	Gamma Ray (well log)
GTL	Gas to Liquid
GSA	Geophysical Society of Alaska
HP	Hewlett Packard
HSE	Health, Safety, and Environment (typically pertaining to field operations)
JBN	Johnson-Bossler-Naumann method (of gas-water relative permeabilities)
JIP	Joint Industry Participating (group/agreement), ex. Chevron GOM project
JNOC	Japan National Oil Corporation
JOGMEC	Japan Oil, Gas, and Metals National Corporation (reorganized from JNOC 1/04)
JSA/JRA	Job Safety Assessment/Job Risk Assessment; part of BP HSE operations protocol
KRU	Kuparuk River Unit
LBNL	Lawrence Berkeley National Laboratory
LDD	Generic term referencing Logging During Drilling (also LWD and MWD)
LNG	Liquefied Natural Gas
MDT	Modular Dynamics Testing wireline tool for downhole production testing data
MGE	UA Department of Mining and Geological Engineering
MOBM	Mineral Oil-Based Mud drilling fluid used to improve safety and data acquisition
MPU	Milne Point Unit
MSFL	Micro-spherically focused log (wireline log indication of formation permeability)
NETL	National Energy Technology Laboratory
NMR	Natural Magnetic Resonance (wireline or LDD tool – see also CMR)
OBM	Oil Based Mud, drilling fluid
ONGC	Oil and Natural Gas Corporation Limited (India)
PBU	Prudhoe Bay Unit
PNNL	Pacific Northwest National Laboratory
POOH	Pull out of Hole; pulling drillpipe or wireline from borehole during operations
POS	Pump-out Sub (pertaining to MDT tool)
SCAL	Special Core Analyses, references analyses beyond basic porosity/permeability
SPE	Society of Petroleum Engineers
TCF	Trillion Cubic Feet of Gas at Standard Conditions
TCM	Trillion Cubic Meters of Gas at Standard Conditions
T-D	Time-Depth (referencing time to depth conversion of seismic data)
UA	University of Arizona (or Arizona Board of Regents)
UAF	University of Alaska, Fairbanks
USGS	United States Geological Survey
USDOE	United States Department of Energy

Vp	Velocity of primary seismic wave component
Vs	Velocity of shear seismic wave component (commonly useful to identify GH)
VSP	Vertical Seismic Profile
WOO	Well-of-Opportunity

8.0 APPENDIX A: PUBLICATION FOR PROCEEDINGS OF ARCTIC ENERGY SUMMIT CONFERENCE, ANCHORAGE, ALASKA, OCTOBER 2007

Alaska Gas Hydrate Research and Stratigraphic Test Preliminary Results

Robert B. Hunter, Scott A. Digert, Ray Boswell, and Timothy S. Collett

***Abstract*— Gas hydrate may contain significant gas resources in both onshore arctic and offshore regions throughout the world. The BP-DOE collaborative research project is designed to help determine whether or not gas hydrate can become a technically and economically recoverable gas resource. Reservoir characterization, development scenario modeling, and associated studies indicated that 0-0.34 Trillion Cubic Meters (0-12 Trillion Cubic Feet – TCF) gas may be technically recoverable from 0.92 Trillion Cubic Meters (33 TCF) gas-in-place (GIP) Eileen trend gas hydrate beneath industry infrastructure within the Milne Point Unit (MPU), Prudhoe Bay Unit (PBU), and Kuparuk River Unit (KRU) areas on the Alaska North Slope (ANS). Reservoir modeling indicated sufficient potential for technical recovery to justify proceeding into field operations to acquire basic physical reservoir and fluid data to help mitigate the large range of uncertainty in recoverable resource. The BP-DOE collaborative research project was approved to proceed into a field data acquisition program including: 122-183 meters (400-600 feet) core, extensive wireline logs, and wireline production tests within the Mount Elbert gas hydrate prospect in the MPU. Successful drilling and data acquisition in the Mount Elbert-01 stratigraphic test well was completed between February 3-19, 2007. Future studies, if approved by BP and DOE, could acquire additional data and include production testing.**

***Index Terms*— Alaska, gas hydrate, resources, production.**

I. Introduction

THIS cooperative research between BP Exploration (Alaska), Inc. (BPXA) and the U.S. Department of Energy (DOE) is helping to characterize and assess Alaska North Slope (ANS) gas hydrate resources and to identify technical and commercial factors that could enable government and industry to understand the future development potential of this possible unconventional energy resource. Reservoir characterization, reservoir modeling, and associated studies culminated in approval to proceed into a 2007 stratigraphic test to acquire data designed to better characterize the physical system, reduce the uncertainty regarding resource productivity, and design potential future test programs. Collaborative research partners include U.S. Geological Survey (USGS), Arctic Slope Regional Corporation Energy Services, Ryder Scott Company, APA-RPS Engineering, University of Arizona, University of Alaska Fairbanks, Oregon State University, Pacific Northwest National Lab, Lawrence Berkeley National Lab, and others.

Gas hydrate may contain a significant portion of world gas resources within onshore arctic and offshore regions petroleum systems. In the United States, accumulations of gas hydrate occur within pressure-temperature stability regions in both onshore near-permafrost and also offshore regions. USGS probabilistic estimates indicate that gas hydrate may contain a mean of 16.7 Trillion cubic meters (590 Trillion Cubic Feet – TCF) in-place ANS gas resources (Figure 1). Up to 0.93 Trillion cubic meters (33 Trillion Cubic Feet – TCF) in-place gas hydrate resources are interpreted within shallow sand reservoirs beneath ANS production infrastructure within the Eileen trend (Figure 2). Gas hydrate accumulations require the presence of all petroleum system components including source, migration, trap, seal, charge, and reservoir. Future exploitation of gas hydrate would require developing feasible, safe, and environmentally-benign production technology, initially within areas of industry infrastructure. The information and technology being developed in this onshore ANS program will be an important component to assessing the possible productivity of the potentially much larger marine hydrate resource. The resource potential of gas hydrate remains unproven, but if proven, could increase ANS gas resources and could support greater U.S. energy independence.

In 1972, the existence of natural gas hydrate within ANS shallow sand reservoirs was confirmed by data acquired in the Northwest Eileen State-02 well. Although significant in-place gas may be trapped within the gas hydrate-bearing formations beneath existing ANS infrastructure, it has been primarily known as a shallow gas hazard during the drilling of the hundreds of well penetrations targeting deeper oil-bearing

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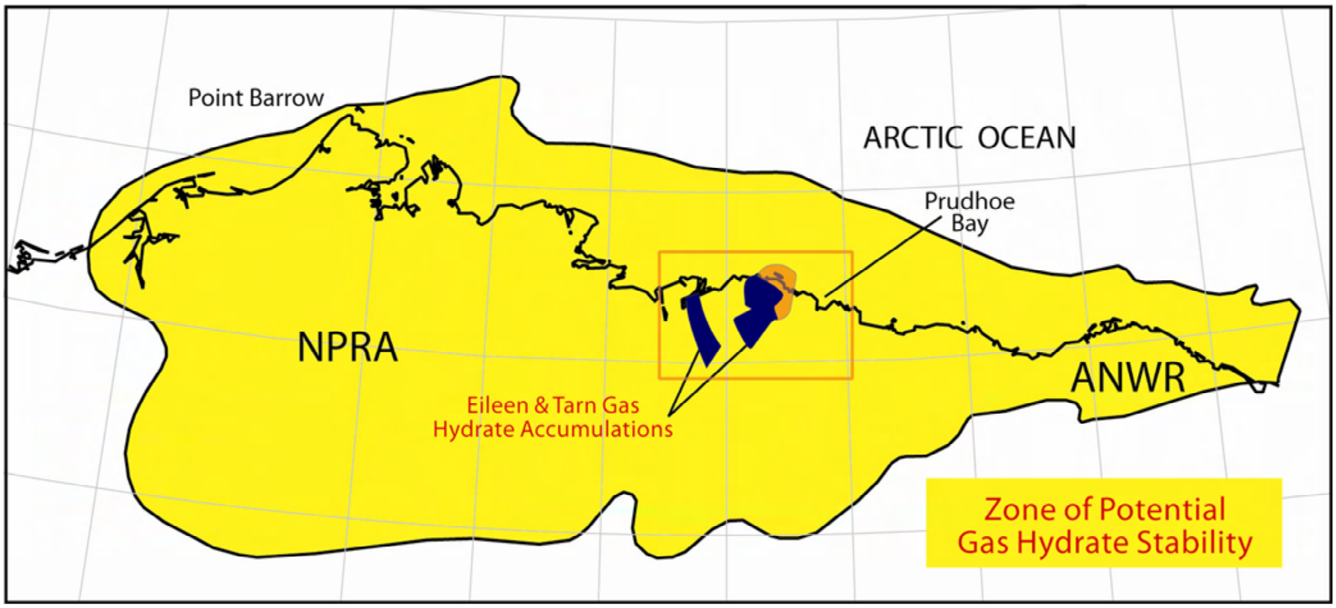

Figure 1: ANS gas hydrate stability zone extent and location of Eileen and Tarn gas hydrate trends [1].

formations and has drawn little resource attention due to no ANS gas export infrastructure and unknown potential productivity. Characterization of ANS gas hydrate-bearing reservoirs and improved modeling of potential gas hydrate dissociation processes led to increasing interest to collaboratively study gas hydrate resource and production feasibility.

If gas can be technically produced from gas hydrate and if studies help prove production capability at economically viable rates, then gas dissociated from ANS gas hydrate could help supplement fuel gas for existing operations, provide additional lean gas for reservoir energy pressure support, provide fuel gas to help establish long-term production of portions of the geographically-coincident 20-25 billion barrels viscous oil resource, and/or potentially supplement conventional export-gas in the longer term.

As part of a multi-year effort to encourage these feasibility studies, the DOE also supports significant laboratory and numerical modeling efforts focused on the small scale behaviors of gas hydrate. Concurrently, the USGS has assessed the in-place resource potential and participated in field operations with DOE and others to acquire data within many naturally occurring gas hydrate accumulations throughout the world (see related paper Arctic Gas Hydrate Energy Assessment Studies in this volume). There remain significant challenges in quantifying the fraction of these in-place resources that might eventually become a technically-feasible or possibly a commercial natural gas reserve. This study estimates this ANS resource within the Eileen trend and recommends additional research, data acquisition, and field operations.

A "chicken and egg" problem has hindered unproven resource research and development in the past; an "unconventional" resource commonly requires a few positive examples before it can generate stand-alone interest from industry. This was true for tight gas resources in the 1950-1960's, Coal-Bed-Methane plays in the 1970-1980's and the shale gas resources in the 1990-2000's. In each case, the resource was thought to be technically infeasible and uneconomic until the combination of market, technology (new or newly applied), and positive field experience helped motivate widespread adoption of unconventional recovery techniques in an effort to prove whether or not the resource could be technically and commercially produced.

In an attempt to bridge this gap, gas hydrate reservoir modeling efforts were coupled with a series of possible regional reservoir development models to quantify a suite of potential recoverable reserve outcomes. The regional reservoir

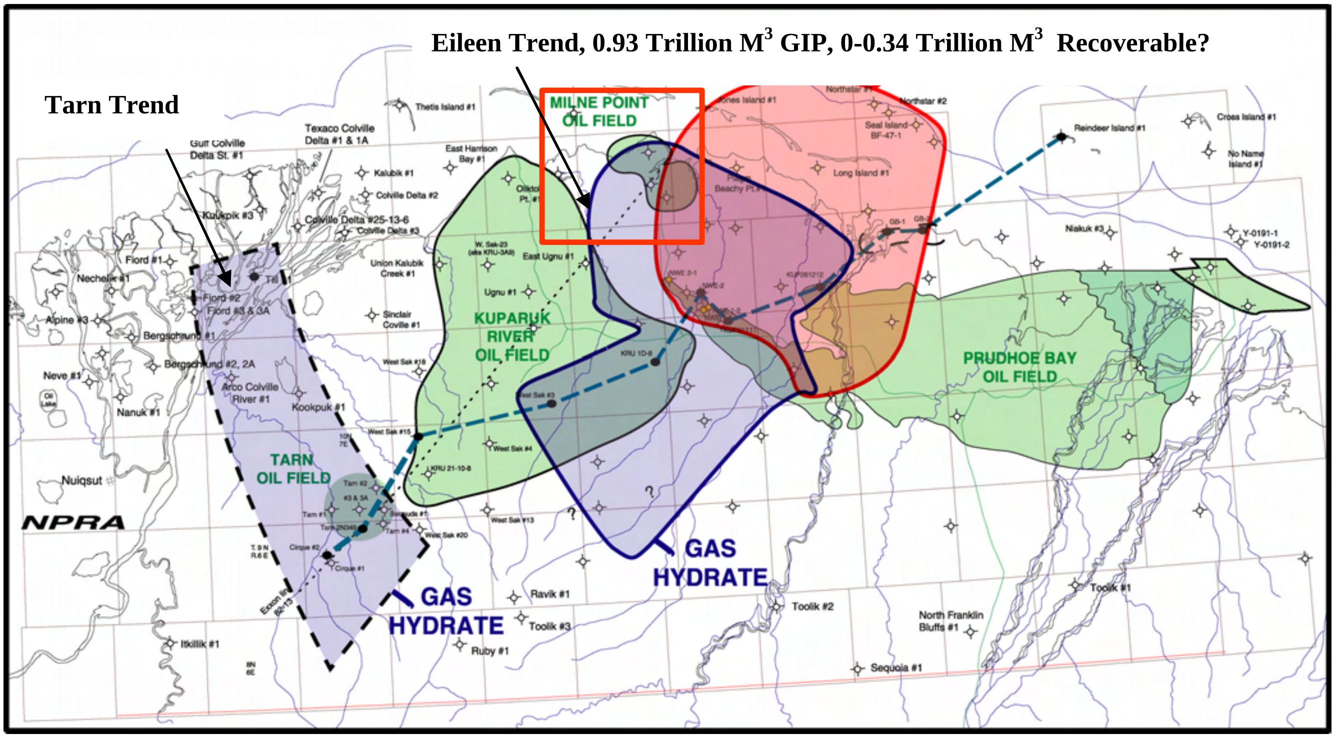

Figure 2: Eileen and Tarn gas hydrate trends and ANS field infrastructure with gas-in-place (GIP) and potential recoverable resource, modified after [2].

development model indicated that 0-0.34 Trillion Cubic Meters (0-12 Trillion Cubic Feet – TCF) gas may be technically recoverable from 0.93 Trillion Cubic Meters (33 Trillion Cubic Feet – TCF) in-place Eileen trend gas hydrate beneath ANS industry infrastructure within the Milne Point Unit (MPU), Prudhoe Bay Unit (PBU), and Kuparuk River Unit (KRU) areas. Studies of the technical viability of gas hydrate production included a range of type-well forecasts and development scenarios, using the limited available theoretical models, as there is no available analog information and little available actual physical data and no sustained flow data. Possible production scenarios included conventional depressurization and either thermal or chemical stimulation. This work indicated the range of 0-0.34 Trillion Cubic Meters of recoverable resource, with large uncertainty within this range, but with sufficient potential for technical recovery to justify field operations to acquire basic reservoir and fluid data.

The collaborative research project was approved to proceed into a field data acquisition program including: 122-183 meters (400-600 feet) core, extensive wireline log program, and wireline production tests within the Mount Elbert gas hydrate MPU prospect interpreted from the Milne 3D seismic survey (Figures 3-4). These field studies led to successful acquisition of critical data to help mitigate uncertainty in potential gas hydrate productivity. Successful Mount Elbert-01 stratigraphic test drilling and data acquisition was conducted between February 3-19, 2007. Although production test assessment is underway with data evaluation, a production test has not been designed or approved at this time. Further studies, if designed and approved, could acquire additional gas hydrate-bearing reservoir data and include production testing, likely from a gravel pad within production infrastructure.

I. STRATIGRAPHIC TEST PRELIMINARY RESULTS

A. Results Summary

This research program is designed to help assess whether the currently unproven gas hydrate resource may become a

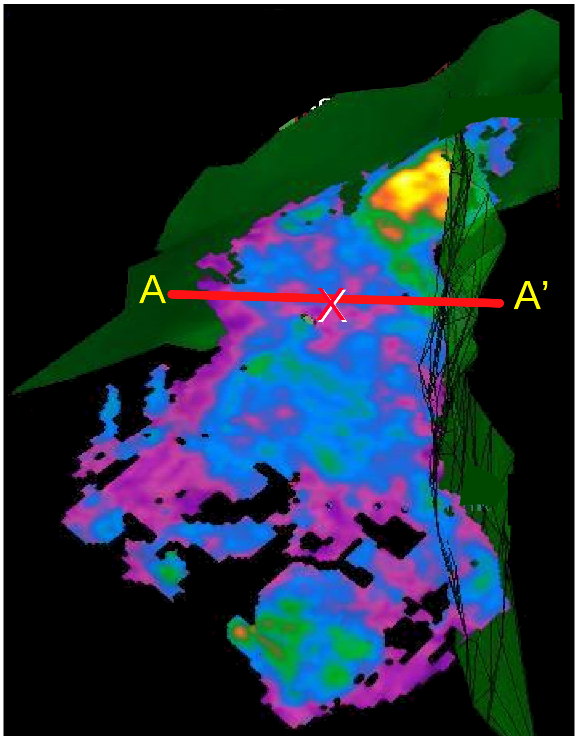

Figure 3: Seismic Amplitude map, Mount Elbert prospect within 3-way fault-bounded closure. The X marks the approximate Mount Elbert-01 location.

new unconventional gas resource. The major research objectives accomplished in early 2007 included acquisition of all recommended stratigraphic test well drilling and core, log, and wireline production test data. Acquired data included 131 meters (430 feet) of core (30.5 meters (100 feet) gas hydrate-bearing), extensive wireline logging, and wireline production testing operations using the Modular Dynamics Testing (MDT) downhole tool. Significant pre-well planning, inclusion of hydrate experts, and onsite vigilance were key elements to safely drilling and acquiring these data in February 2007 on an exploration ice pad in the Milne Point Unit on the Alaska North Slope (Figure 5). Chilled oil-based drilling fluid mitigated operational safety concerns and enhanced core and data acquisition by maintaining gas hydrate and borehole stability during openhole drilling and operations. The well test successfully demonstrated the ability to safely and effectively acquire data and wireline production test data within shallow gas hydrate-bearing reservoirs over seven to ten days (versus the standard approach to drill and case this interval within two to four days).

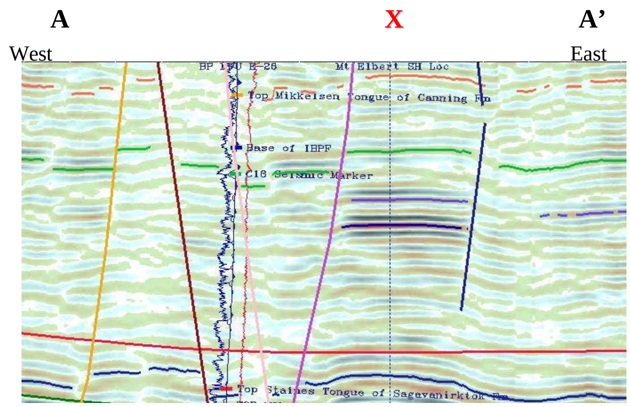

Figure 4: Seismic traverse A-A' (Figure 3) From West to East illustrates interpreted zone C and D gas hydrate-bearing intervals. The subparallel red and green lines mark range of base gas hydrate stability. Note corroborating evidence of gas hydrate within zones C and D in the prominent velocity pull-up directly beneath these zones.

The stratigraphic test validated the 3D seismic interpretation of the MPU gas hydrate-bearing Mount Elbert prospect (Figures 3-4). A total of 261 onsite core subsamples were preserved for later analyses at various labs for interstitial water geochemistry, physical properties, thermal properties, organic geochemistry, petrophysics, and mechanical properties.

Figure 5: Doyon 14 rig and pipeshed, February 2007, during early operations on Mount Elbert-01, ANS MPU

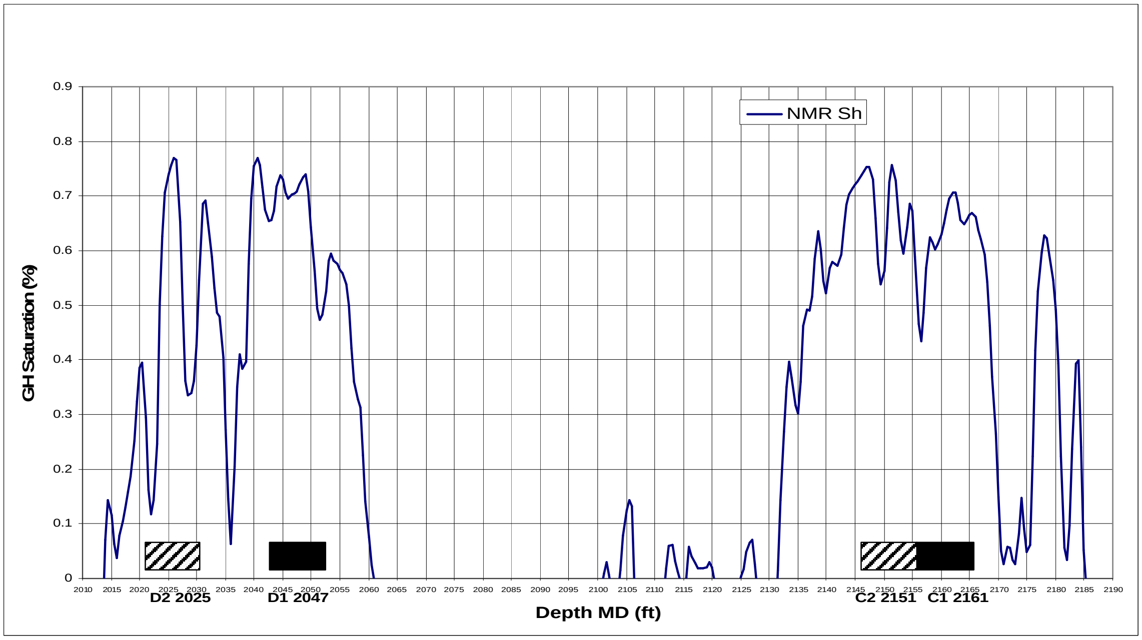

Figure 6: Gas Hydrate saturation from CMR log. Proposed sites for MDT marked by stippled and block patterns.

Acquired open-hole wireline logs included gamma-ray, resistivity, neutron-density porosity, Dipole Sonic Acoustic porosity, Nuclear Magnetic Resonance, Formation Imaging, Electromagnetic Propagation, geochemical neutron activation logging, and caliper. MDT wireline production testing was accomplished within two gas hydrate-bearing reservoir intervals and acquired four extensive, long shut-in period tests. MDT analyses are helping to improve understanding of gas hydrate dissociation, gas production, formation cooling, and long-term production potential as well as helping to calibrate reservoir simulation models. Four gas samples and one pre-gas hydrate dissociation formation water sample were obtained.

The Gas Hydrate Stratigraphic Test accomplished several ”firsts”, including: 1. First significant ANS gas hydrate bearing core (30.5 meters (100 feet) of 131 meters (430 feet) acquired), 2. First wireline retrievable coring system application on ANS with conventional drilling rig, 3. First extensive ANS open hole multi-day data acquisition program in gas hydrate section, 4. First in world open-hole dual packer MDT program in gas hydrate bearing reservoir sands, 5. First ANS MDT sampling of both gas and water in gas hydrate-bearing reservoirs, and 6. First in world reservoir temperature data tracking at the MDT inlet port during flow and shut-in periods.

B. Gas Hydrate Saturation Results

Figure 6 illustrates a gas hydrate saturation log based on the Combinable Magnetic Resonance (CMR) log acquired in the Mount Elbert-01 stratigraphic test well. Based on geophysical interpretations, the well was predicted to encounter two gas hydrate-bearing sands from 7.6 to 22.9 meters (25-75 feet) thick within an upper zone (D) and a lower zone (C). Well logging and core results show these two sands contain a combined 30.5 meters (100 feet) of gas-hydrate-bearing section (Figure 6). Gas hydrate saturation varies primarily as a function of sand content and silt/clay interbeds. In the cleanest sand zones, saturation reaches a maximum of 75% within the pore volume. The remaining 25% saturation is likely split between a mobile water phase and an irreducible water phase (bound to sand grains and clays) within the tight, hydrate-cemented sands.

C. Gas Hydrate Core Results

The use of a mud chiller operated by DrillCool, Inc. (Figure 7) was a key element to the successful acquisition of both core and log data. The chilled oil-based drilling fluid helped maintain stability of both gas hydrate and water-bearing sediments during drilling and extensive data acquisition operations. Over the 2.5 day coring program, 153 meters (504 feet) of mixed gas hydrate and water-bearing sediments were cored in 23 core runs. A total of 131 meters (430 feet) core was recovered, yielding an approximately 85% core recovery efficiency, comparable to that recovered by similar methods in the 2002 Mallik gas hydrate core as reported in GSC Bulletin 585. The wireline core recovery enabled quick drilling and recovery of each core. Maximum core recovery possible per core run was up to 7.3 meters (24 feet) plus a few centimeters in core-catcher.

Figure 7: DrillCool, Inc. Heat Exchange Mud Chilling Unit onsite at Mount Elbert-01 Ice Pad.

Approximately 30.5 meters (100 feet) of 153.5 meters (503 feet) cored was gas hydrate-bearing as shown in Figure 6. These results validated the 3D seismic interpretation of the Mount Elbert prospect (Figures 3-4). During core retrieval to the surface, the core passes through the upper limit of the gas hydrate stability zone and any gas hydrate-bearing sediment begins to dissociate into gas and water. Therefore, the core is kept as cold as possible, and rapid processing of the core from the wireline retrieval from reservoir to surface at the rig floor, to the pipe shed, and to the processing and subsampling area helps preserve remaining gas hydrate within the core (Figures 8-16). Initial core processing was accomplished onsite, primarily to ensure that time and temperature-dependent measurements and subsamples were obtained before gas hydrate completely dissociated from the core. The core is scraped to reveal sediment beneath the rind of oil-based mud (Figure 12) to allow onsite description and choosing intervals for subsampling. Various subsamples are taken (Figure 13) for both time/temperature-dependent onsite analyses and for later offsite analyses.

Core temperature provides an indicator of gas hydrate presence (Figure 14). Over the first several minutes of onsite core processing, gas and water are actively dissociating from gas hydrate. This endothermic reaction cools the core and freezes the pore water. Samples of gas hydrate were placed into water (Figure 15-16); where gas hydrate is present, the water causes the gas to more actively dissociate from the hydrate. Headspace gas evolves and can be studied qualitatively in syringes (Figure 15) or in petri-dishes or cans (Figure 16). During and following subsampling, an onsite description of the core was completed.

Certain subsamples were acquired for further onsite processing to determine the saturation and composition of pore waters (Figures 17-19). Coring with the oil-based drilling fluid also ensured that only natural pore waters were present within the core. Samples were scraped to obtain a cleaner sediment from the innermost portion of the core and placed into a press to squeeze pure pore waters from the sample for later laboratory analyses.

A total of 261 total subsamples were processed onsite, primarily to preserve time and temperature dependent data. Eleven of these samples were preserved, four in methane-charged pressure vessels and seven in liquid nitrogen. Other samples were obtained for physical property measurements, petrophysics, water chemistry, thermal properties, and microbiological and organic geochemistry studies. Subsamples of the core will be analyzed at various labs. The remaining whole core is currently stored in freezers within a refrigerated unit at the ASRC Fabrication shop in Anchorage.

D. Gas Hydrate Wireline Logging Preliminary Results

Obtaining high-quality open hole logs was a primary data acquisition priority. Evaluation of these logs is in-progress. High-quality open hole logs were obtained, due in large part to the chilled, oil-based drilling fluids maintaining gas hydrate and borehole stability (Figure 7). A full suite of wireline logs was obtained, some with initial difficulties due to the cold (-1 degree C; 30 degree F) wellbore temperatures. Open-hole wireline logs acquired included gamma-ray, resistivity, neutron-density porosity, Dipole Sonic Acoustic porosity, Nuclear Magnetic Resonance, Formation Imaging, Electromagnetic Propagation, geochemical neutron activation logging, and caliper. As shown in Figure 6, the CMR logs were a direct indicator of gas hydrate saturation and helped in planning the Modular Dynamics Testing (MDT) wireline production test data acquisition.

Figure 8: Core barrel inner liner separation in cold pipeshed processing area. Rig mats on pipe racks provided working surface.

Figure 9: Cutting inner core barrel into 3 foot core segments in pipeshed. Core end is visible lower left side of photo.

Figure 10: Transport of 3 foot core segments in lined box via forklift from pipeshed to core processing "cold" trailer.

Figure 11: Subsampling gas hydrate-bearing core in core processing "cold" trailer.

Figure 12**:** Core layout processing in "cold" trailer.

Figure 13: Foam inserts mark where core was subsampled for headspace gas, microbiology, interstitial water and physical properties.

Figure 14: Temperature probe testing used to show decreasing temperature with time during gas hydrate dissociation in hydrate-bearing core samples during onsite subsampling.

Figure 15: Gas hydrate-bearing sediment placed in syringe to monitor gas escape.

Figure 16: Gas hydrate-bearing samples in water bubble with gas escape.

Figure 17: Whole core sample is scraped to remove oil-based drilling mud contamination.

Figure 18: Cleaner innermost portion of core prior to placement into drill-press to remove formation water for later laboratory analyses.

Figure 19: Core press to obtain interstitial water samples.

E. Gas Hydrate Wireline Production Testing Results

Following the major logging runs, the second major data priority was to perform extensive wireline production testing using the Modular Dynamics Testing (MDT) tool. Even though the MDT wireline production tests are small-scale, the results of these tests within two gas hydrate-bearing zones (Figure 6) are enabling a better understanding of the nature of gas hydrate dissociation, gas production, formation cooling, and long-term production test potential.

The MDT tests were the first in the world open-hole, dual packer tests within gas hydrate-bearing sediments. The data acquired also included the first reservoir temperature measurements at the tool inlet using a small programmable capsule to measure time, temperature, and pressure (Figure 20) mounted to the tool within a screen welded to the tool (Figure 21).

Figure 20: DSTmicro capsule data logger used to record time, temperature, and pressure during coring and during MDT logging operations. Data logger on right was destroyed during operations outside capsule pressure rating.

The MDT program also obtained four gas samples and one pore water sample. Recorded observations indicated major formation cooling during gas hydrate dissociation and gas production during pressure draw-down. The response of the formation during shut-in and pressure build-up following production indicated that gas production during gas hydrate dissociation may have reduced formation permeability to flow, possibly due to the reformation of gas hydrate or formation of ice during the testing. An alternative under investigation involves potential gas storage effects within the tool or borehole due to minimal produced gas. Analyses and modeling of these test results are underway.

Primary MDT test intervals were selected after evaluation of the CMR log (Figure 6) and based on reservoir quality and fluid saturation criteria, resulting in the four primary zones-of-interest. Figures 22-23 illustrate typical MDT results from one of the four tested zones from onsite analyses by Steve Hancock, RPS-APA Engineering. MDT analyses and reservoir modeling history match studies are underway.

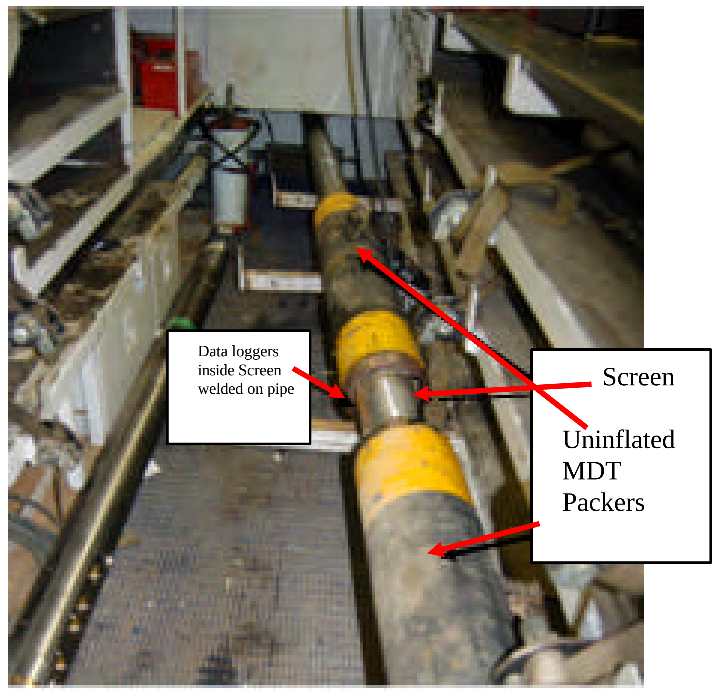

Figure 21: Photo of MDT tool with screen-mounted DSTmicro capsules welded to tool.

The preliminary results of MDT data acquisition are presented here as data analyses are still underway at the time of this writing. Reservoir modeling and history matching of MDT results are also in-progress. Figures 22-23 illustrate the 11-hour Zone C2 MDT test profiles with flow and build-up periods.

1) Zone C2 MDT test summary

- Planned longer duration test
- First flow with Flowing Bottom Hole Pressure (FBHP) above hydrate stability pressure
- Classic porous media response on first build-up
- Second flow with FBHP below hydrate stability pressure

- Second build-up distinct/different from first build-up
- Extended third flow with FBHP below hydrate stability pressure; third build-up severely dampened
- 400 psi purposefully maintained in third flow period
- Acquired gas sample
- Fourth flow ended with no inflow

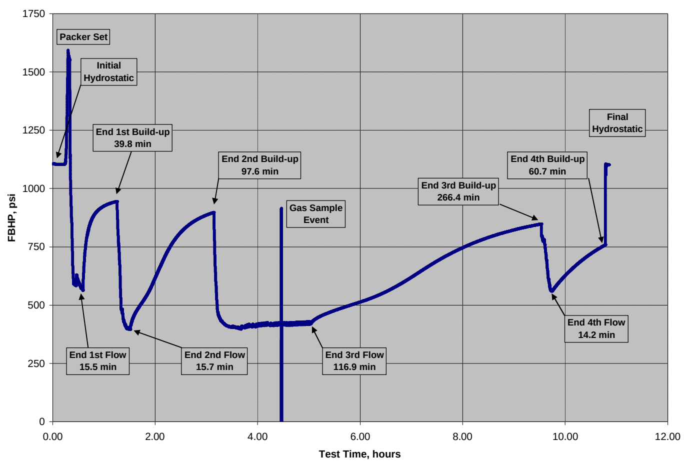

Figure 22: MDT test pressures, flow, and build-up periods in gas hydrate-bearing zone C2

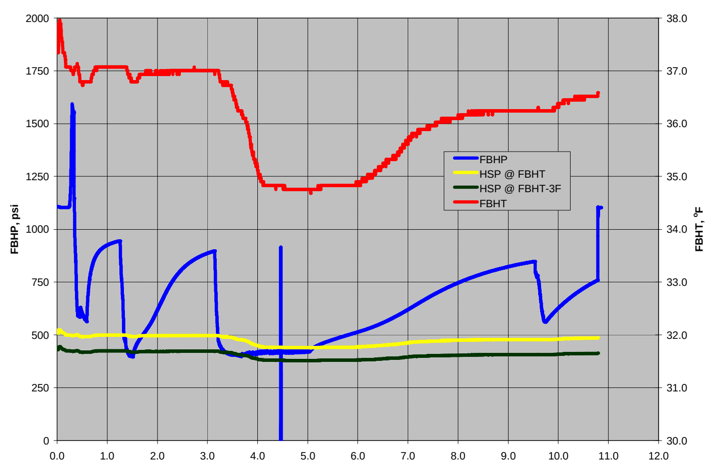

Figure 23: MDT test pressures and temperatures in gas hydrate-bearing zone C2

2) Miscellaneous MDT testing results

- Star-Oddi pressure and temperature logger data at MDT inlet to facilitate pressure/temperature match
- MDT probe tests of hydrate zones 621.5 Meters (2039 feet) and 619.4 Meters (2032 feet) failed due to lack of seal (soft water-bearing sediments)
- MDT packer test of water zone at 620.6 Meters (2036 feet) failed due to inlet plugging (fines migration); noted declining pump performance
- MDT packer test of water zone 613.3 Meters (2012 feet) failed: pump failed, sediment wear and plugging
- MDT testing terminated (note extended initial testing in gas hydrate bearing zones enabled MDT tool to remain in-hole until testing terminated by probe and pump failures due primarily to anticipated fines migration

I. CONCLUSION

The maximum gas hydrate saturation as calculated by the CMR and associated logs is approximately 75% (Figure 6). Data is still being analyzed, but preliminary results indicate that although there is some mobile water in the hydrate-bearing formation, it might not be enough to maintain dissociation of gas hydrate through depressurization alone by producing the mobile water component. The pressure build-up periods during MDT testing were extensive (up to 12 hours) and the abnormal build-ups after drawdown below gas hydrate stability pressure suggest that gas production from gas hydrate at these temperatures closer to the base permafrost may not be sustainable over a potential future long-term production test without thermal and/or chemical stimulation. However, it needs to be emphasized that this is only a single well location, and that alternate cases could be considered at higher temperatures and/or where conditions could better allow unstimulated production.

The C2 MDT test shown in the annotated graph (Figure 24) demonstrates that the formation response to initial drawdown is typical of porous media (albeit tight formation) response when pressures were maintained above the gas hydrate stability zone; this initial drawdown shows where only free connate water was flowing. However, once pressures were allowed to draw-down below the gas hydrate stability zone to induce gas (and water) dissociation, the following two shut-in periods show an abnormal pressure rebound. Causes of this abnormality remain under investigation, but may be associated with reformation of hydrate or possibly the formation of ice within the porous media.

Future field operations, including potential long-term production testing, are under consideration. Importantly, analyses of the stratigraphic test core, log, and MDT data will also help us better understand reservoir properties, permeabilities and saturations. These variables are very leveraging to understanding potential gas producibility from gas hydrate-bearing reservoirs and to design, assessment, and planning of potential future production test operations.

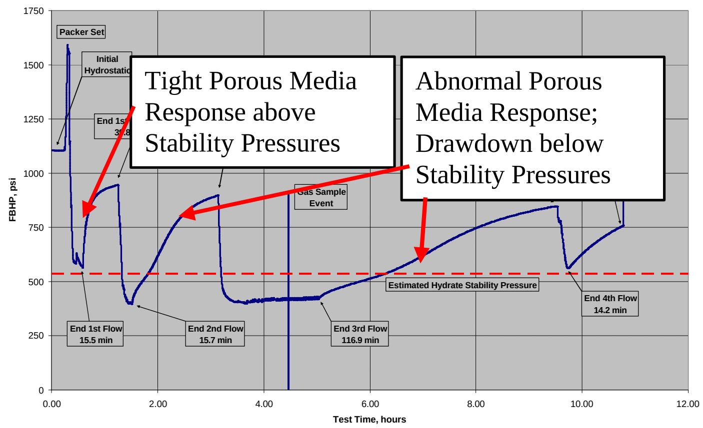

Figure 24: C2 MDT test preliminary interpretations.

ACKNOWLEDGMENT

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DISCLAIMER

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