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Geotechnical Properties of Sediments in Lancaster Sound, Nunavut

R. Bennett and J. Higgins

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Celebrating 175 yrs

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Introduction

A suite of sediment cores was collected in Lancaster Sound during the Geological Survey of Canada – Atlantic (GSCA) cruise 2008029 onboard the *CCGS Hudson* (Campbell and de Vernal, 2009). These cores have the most modern and complete set of geotechnical and sedimentological analyses for any sediment samples in the Lancaster Sound region. The purpose of this report is to make these data available and to provide a regional overview of sediment characteristics and basic geotechnical properties in Lancaster Sound. The raw data from the plots contained within this report are available by contacting robbie.bennett@canada.ca or by searching http://ed.gdr.nrcan.gc.ca/index_e.php.

Methods

The sediment cores collected during cruise 2008029 in Lancaster Sound were selected using high-resolution seismic reflection data collected during the same cruise with a Huntec Deep Tow System. Piston cores 2008029 046 PC and 049 PC also relied on multibeam echosounder data to collect samples in and around an ice scour located in ~850 m water depth (further discussion on the ice scour is available in Bennett et al., 2014).

At sea core processing

Cores were analyzed with a Geotek multi-sensor core logger (MSCL) configured for whole cores (un-split, still in liner) and measured for bulk gamma density and magnetic susceptibility onboard the *CCGS Hudson.* The MSCL consists of two tracks with a sensor stand in between them; one track has a motorized pusher that pushes whole core sections through the sensor stand and onto the passive track. The sensor stand includes a core detection laser, a gamma ray emitter and detector, and a magnetic susceptibility solenoid. Both the motor and the sensors in the stand are connected to an electronics rack that includes a computer for automating the system. Whole core sections are placed in front of the pusher on the motorized track, their lengths are automatically measured by breaking the detection laser, and are then incrementally pushed past each sensor for measurement at one centimeter intervals. Calibration of the gamma density sensors is performed at the start of every day of logging.

Whole core MSCL Gamma Ray Attenuation (GRA)

The GRA unit measures the bulk density of the sediment. It comprises a 10 millicurie ^{137}Cesium capsule housed in a 150 mm diameter primary lead shield with 2.5 and 5 mm collimators and a sodium iodide scintillation detector housed in a 100 mm diameter collimated lead shielding. The source and detector are mounted on opposite sides of the core as it moves through the central unit assembly. A narrow (pencil size) beam of gamma rays with energies principally at 0.662 MeV is emitted from the ^{137}Cesium source and passes through the diameter of the sediment core. At these energy levels Compton scattering is the primary mechanism for the attenuation of the gamma rays in most sedimentary material. The incident photons are scattered by collision with electrons encountered in the core and there is a partial energy loss. The attenuated gamma-ray beam is measured by the scintillation detector. The Compton scattering of the photons is directly related to the number of electrons in the path of the gamma-ray beam. A two-phase model representing the mineral and interstitial water of fully saturated marine sediment is assumed for the MSCL GRA calibration. Aluminum is considered to have an attenuation coefficient similar to common minerals found in marine sediments and represents the mineral phase. Distilled water represents the interstitial water phase. A calibration standard consisting of different thicknesses of aluminum and distilled water is used to calibrate the GRA. The measure of density of the sediments assumes that the marine sediment is fully saturated and completely fills the core liner. The diameter of the sediment is determined using the measured displacement between the rectilinear displacement transducers and the thickness of the liner. Sediment density is calculated using the calibration coefficients and the measured diameter of the sediment. Just like p-wave velocity, the quality of the gamma density values is dependent on: 1) an accurate measure of sediment diameter; 2) the degree of sediment saturation; and 3) the presence of air pockets or voids between the sediment and plastic core liner.

Whole core MSCL Magnetic Susceptibility

A Bartington loop sensor (MS2B) measures the magnetic susceptibility of the sediment. It is mounted to minimize the effects of magnetic or metallic components of the MSCL system. An oscillator circuit in the sensor loop produces a low intensity non-saturating, alternating magnetic field (0.565 kHz). Changes in the oscillator frequency caused by material that has a magnetic susceptibility is measured and converted into magnetic susceptibility values. The magnetic susceptibility loop sensor is calibrated absolutely, so it should not change, but a magnetic susceptibility calibration piece is logged preceding each core sample to check for consistency.

Once the whole core MSCL analyses were complete the samples were sealed on the ends with beeswax and stored upright in refrigerated storage at 4°C until they were ready to be processed in the Core Processing Laboratory at GSCA.

Laboratory core processing

Cores are processed as soon as reasonably possible upon their return from the field. Generally, processing of cores happens in the GSCA Core Processing Laboratory where a standard suite of analyses are performed. Most of these standard analyses must be performed as soon as possible because the measured properties of the samples can change over time, especially as the core dries out.

In preparation for whole core processing, beeswax is cleaned off the cores sections and, if necessary, core liners are trimmed to match the sediment surface (usually necessary if settling has occurred). Core sections are split in half longitudinally by first cutting the plastic liner using the GSCA Duits splitter and then pulling a piece of fine wire through the sediment along the cuts in the plastic core liner; care is taken to always cut core samples with multiple sections in the same orientation. The sediment is carefully pulled apart and the core halves are then designated as archive and working; the archive half of the sample is maintained as undisturbed as possible for future reference, while subsamples and measurements that will disturb the sample are reserved for the working half. The core liner for each half is then affixed with centimeter tape and labelled with down-core depths, an arrow to indicate the top of the core, the cruise number, the sample number and the section information. Once split, core halves are covered with plastic wrap in order to slow down desiccation of the sample.

Together, the working and archive halves are x-radiographed. The two halves are then separated to undergo different analyses. The archive half is photographed and described visually; the working half is measured for physical properties that disturb the sample (velocity, shear strength, spectrophotometry – described further in this section). Additional samples were taken from the working half for grain size analyses by laser diffraction in the GSCA sedimentology lab. When all analyses are completed the core halves are covered with plastic wrap, sealed in labeled plastic core sleeving, placed in labelled plastic D-tubes and stored at 4°C in the GSCA Marine Geoscience Collection Facility.

Core photography

The archive half of the core is photographed using a Nikon D300 12.3 megapixel digital camera. Overlapping digital photographs are taken at two scales. The first is a close up image covering a 30 cm interval, with a 5 cm overlap, and the second is a long shot image covering a 90 cm interval. The images are saved in raw, tiff and jpg formats.

Sample description

A written sample description of the archive half of each sediment core is recorded; this includes: i) the condition of sample (e.g. cracks, disturbance, oxidation), ii) the consistency of the sample (e.g. soft, hard, firm), iii) a rating of reaction to hydrochloric acid which indicates the presence of calcium carbonate, iv) colour based on Munsell soil colour charts, v) visual core description consisting of colour, texture, grain size, bedding, contacts, bedforms, structures, presence of organic material, bioturbation and any other visible feature, and vi) drawn representation of the split core surface and x-ray imagery.

Reflectance spectrophotometry

High accuracy measurements of spectral reflectance on split core are made over wavelengths of 400 to 700 nm using the Konica Minolta Spectrophotometer CM-2600d. The L*a*b* system (CIELAB) represents coordinates in 3 dimensional space where the L* is the vertical axis representing lightness and a* b* are horizontal radii representing chromaticity. The L* value ranges from 0 (black) to 100 (white). The a* value represents green (-) to red (+) and the b* value represents blue (-) to yellow (+). Munsell colour is calculated but there is no international standard for converting Tristimulus values to Munsell HVC notation. A zero calibration is performed to compensate for the effects of any change in the optical system and changes in ambient and internal temperature. White calibration is done using a white ceramic calibration cap and sets the maximum reflectance to 100%. Zero calibrations are performed daily and white calibrations are performed a minimum of once. Prior to spectral reflectance measurements the archive half of the core is carefully covered with Glad Saran Wrap taking care to minimize the presence of air bubbles between the sediment and the wrap.

Discrete core measurements

The working half the sediment core is subjected to velocity and shear strength analyses which are destructive to the sample. These analyses are taken only in undisturbed and undrained sediments.

Discrete velocity

The split core p-wave logger system has four transducer probes that are carefully inserted into the split core section. These probes measure compressional wave velocity in both longitudinal and transverse directions to the core axis. There is a p-wave travel time delay caused by the electronics of the system.

It is calculated for each set of transducers by measuring the distance between the transducers and measuring the travel time in distilled water at a known temperature. The measured sediment p-wave travel time is corrected for the p-wave travel time delay. The sediment p-wave velocity is calculated as the sediment diameter divided by the corrected p-wave travel time. In the standard practice, longitudinal and transverse velocity measurements are attempted every 10 cm down the core.

Discrete Shear Strength

Split-core undrained shear strength measurements are made using a motorized miniature shear vane apparatus. A four bladed vane is inserted into soft sediment to a constant depth and rotated at a constant rate of 90º per minute until the sediment fails. The difference in rotational displacement between the top and bottom of a linear spring (deflection angle) is measured and the torque required to shear the cylindrical surface around the vane is calculated. Routine calibration of the system is not necessary. Each vane has a vane blade constant dependent on the geometry of the blade, and each spring has a spring constant that relates the deflection angle to the torque. Peak and remoulded shear strength values are calculated according to ASTM Method D 4648. When possible, peak shear strength measurements are taken at a standard 10 cm interval. Two to three measurements of remoulded shear strength are taken per section.

Data compilation

All data collected during core processing were compiled into Excel workbooks. The compiled dataset was imported into Kaleidagraph and the poor quality data were masked. The edited good quality data were then saved as a tab delimited text file and plotted. The plots of graphic lithology, grain size, spectral reflectance, laboratory physical property data, and onboard MSCL data were then compiled and displayed using CorelDraw.

Regional Geology

Lancaster Sound is located in eastern Nunavut between Devon Island to the north and Baffin and Bylot Islands to the south (Figure 1). It is about 400 km long, 100 km wide and reaches water depths of ~300 m in the west to ~1000 m in the east. Lancaster Sound was occupied by glacial ice over 1600 m thick during the last glaciation (Klassen and Fisher, 1988; Dyke et al., 2003) and has been affected by previous glaciations at least as far back as the early Pleistocene (Arthur et al., 1989; Li et al., 2011). It has been a major pathway for sediment supply by fluvial and deltaic sedimentation from the Eocene to the Pliocene (Harrison et al., 2011) followed by glacially derived sedimentation through the Quaternary, leading to the formation of the Lancaster Sound Trough-Mouth Fan in Baffin Bay (Li et al., 2011).

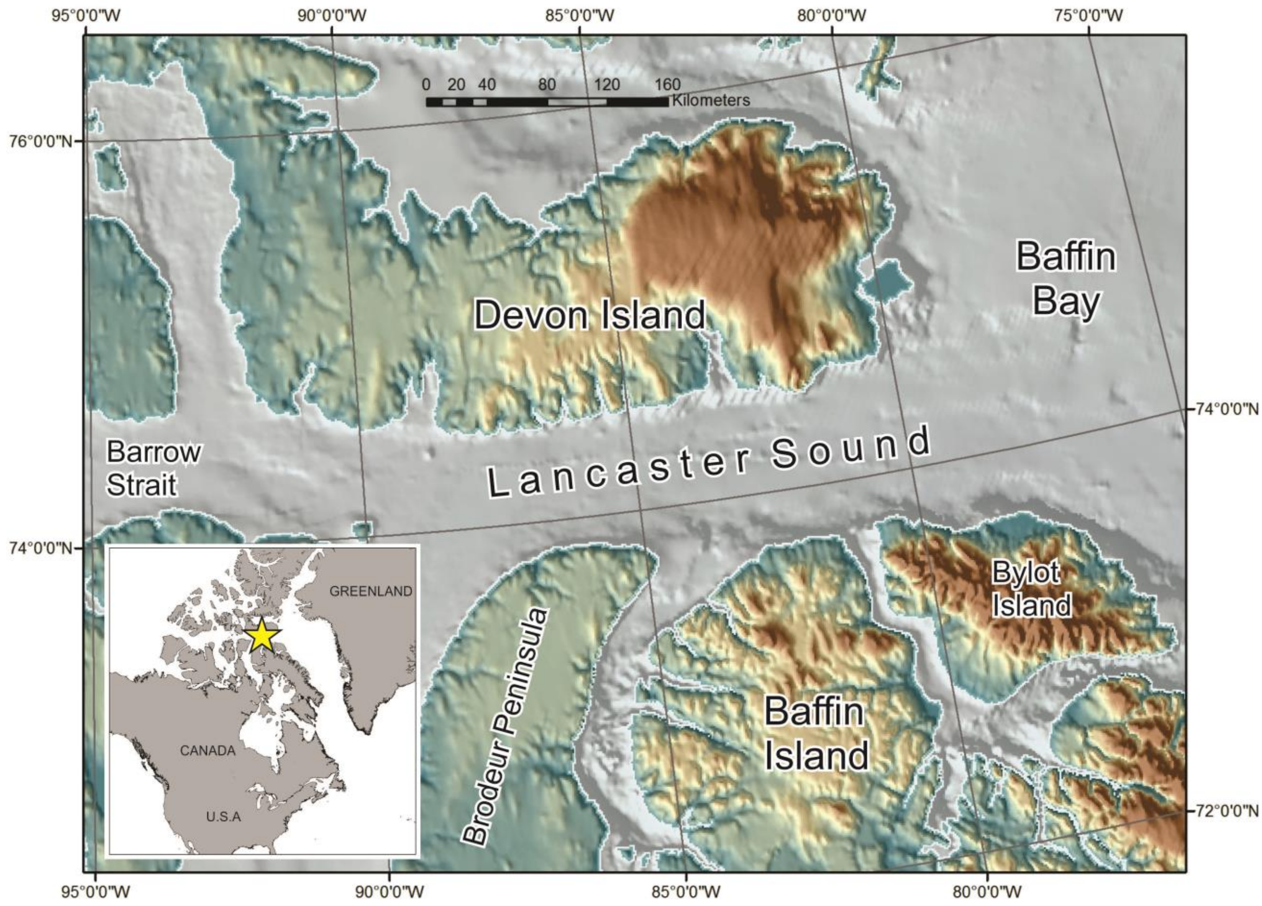

Figure 1: Location map

Bennett et al. (2014) show that the shallow stratigraphy of Lancaster Sound is similar to that of the northern Baffin Island shelf described by Praeg et al. (2007). The surficial sediments consist of soft postglacial hemipelagic muds of the Tiniktartuq Mud unit. This unit, which is up to 7 m thick, consists of grayish-brown to olive gray clay with some sand and coarser material. The Davis Strait Silt unit underlies the Tiniktartuq Mud unit; it is interpreted to be of glaciomarine origin and consists of strongly laminated carbonate-rich mud with some sand and rare gravel. This unit is usually 2–4 m thick but can reach local thicknesses of 7 m. Radiocarbon dates show that the Davis Strait Silt / Tiniktartuq Mud contact in Lancaster Sound dates from 11.6 to 15.3 ka Cal yr BP (Bennett et al., 2014). Underlying the Davis Strait Silt unit is the Baffin Shelf Drift unit which consists of glacial ice-contact sediment that may include till, ice-marginal dump material or ice-loaded sediment that has been deposited or remoulded in contact with grounded glacial ice (Syvitski and Praeg, 1989). This stratigraphy records the last cycle of glacial sedimentation (sub-ice to ice-proximal to post-glacial) during the Late Quaternary. Similar stratigraphy is observed in western Lancaster Sound, Barrow Strait, as well as Wellington, Byam Martin, and Austin channels (MacLean, 1989).

Discussion

A series of piston cores was collected during expedition 2008029 in Lancaster Sound that provides insight into the shallow stratigraphy of the area (Bennett et al., 2013; Figure 2). The lowermost sediment penetrated by these cores is glacial till of the Baffin Shelf Drift unit. This till is a very dark brown sandy clay with sandy laminations and pebbles. The till is overlain by Davis Strait Silt laminated glaciomarine sediments consisting of carbonate-rich gray mud with occasional sandy layers and pebbles. The uppermost sedimentary unit is comprised of post-glacial bioturbated olive gray mud of the Tikitartuq Mud unit. All piston cores collected during cruise 2008029 sampled this stratigraphy except for core 2008029 053 PC (Figure 2). This core was collected on a feature that is interpreted to be a mass transport deposit (see Appendix 1) based on Huntec records, and consists of 455 cm of sand with very small amounts of silt and clay (see Appendix 2).

Appendix 1 contains a summary of each core site that states the rationale behind choosing the site as well as the Huntec record that was used for the selection.

Appendix 2 contains summary plots of the ten piston cores shown in Figure 2. Analyses presented on these plots include core lithology, grain size, spectrophotometry, shear strength (maximum and remoulded), p-wave velocity (longitudinal and transverse), wet bulk density, and magnetic susceptibility.

Appendix 3 contains a detailed core plot summary (100 cm shown per page) for each piston core, trigger weight core, and box core collected in Lancaster Sound during cruise 2008029. Analyses presented on these plots include core photography, visual descriptions, grain size, spectrophotometry, shear strength (maximum and remoulded), p-wave velocity (longitudinal and transverse), wet bulk density, and magnetic susceptibility.

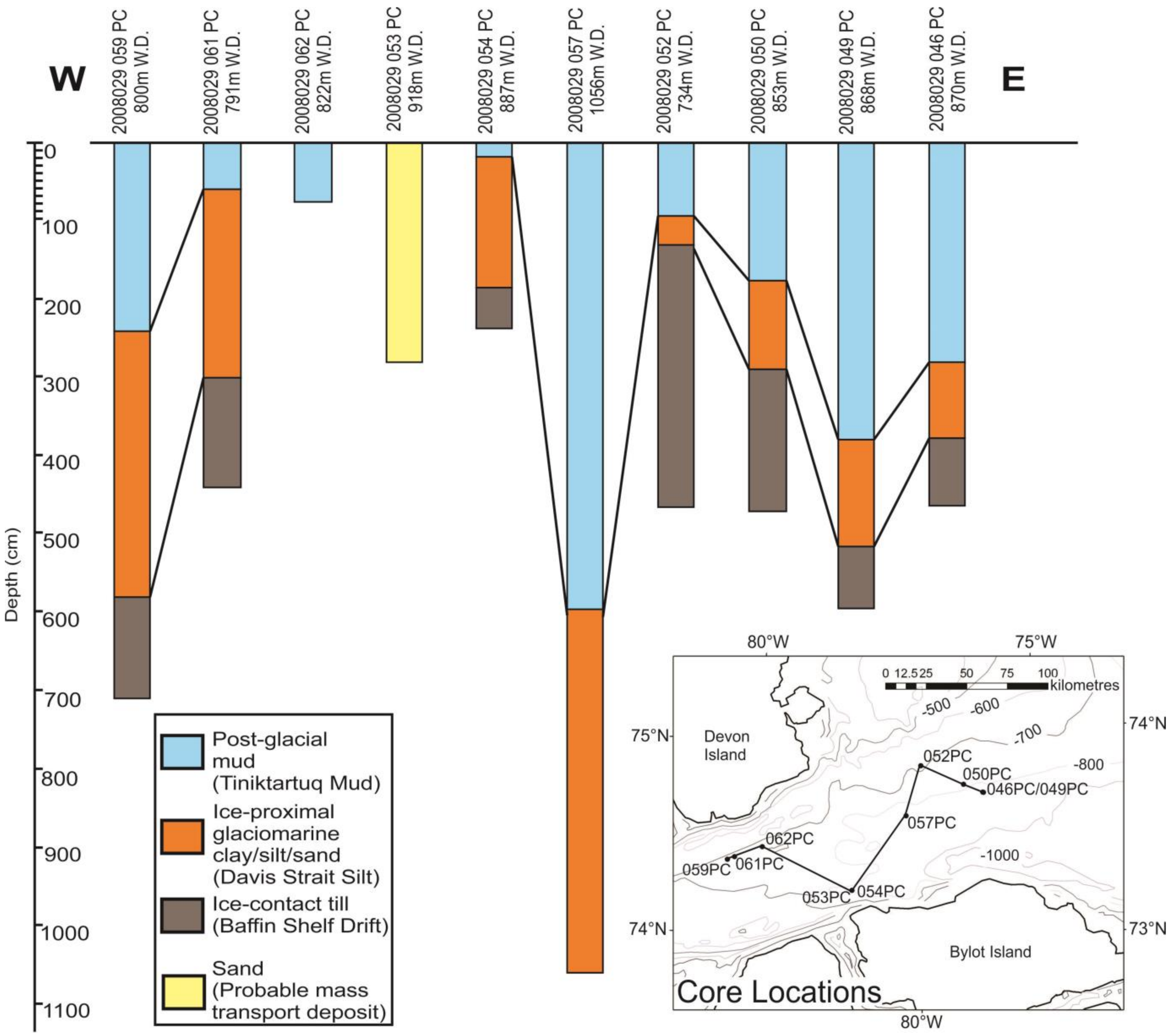

Figure 2: Diagram of piston core samples in Lancaster Sound collected during cruise 2008029.

<u>Geotechnical Properties and sediment characteristics of the Tiniktartuq Mud unit</u>

Grain size analyses show this unit is composed of silt and clay with a small sand component (typically less than 5%). Core 2008059 057 PC is an exception, however, with up to 50% sand at three depth intervals (surface to 80 cm, 350 cm, 480 to 550 cm; Appendix 2 page A2-7). X-rays of this unit (Figure 3) show occasional ice rafted detritus (IRD) that increases slightly with depth downcore. Average maximum shear strength values in the Tiniktartuq Mud are about 5,000 Pa. Some outliers from this average are observed in the sandy intervals of core 057 PC with the maximum observed value being ~16,000 Pa at 480 cm (approximately 25% sand at this depth; Appendix 2 page A2-7). P-wave velocity and wet bulk density (both measurements of sediment density) follow similar trends and are low in the Tiniktartuq Mud unit compared to the other two units. This unit is olive gray in colour and L* a* b* values are lower than the lighter-coloured, carbonate-rich sediments of the Davis Strait Silt unit but higher than the very dark sediments of the Baffin Shelf Drift unit.

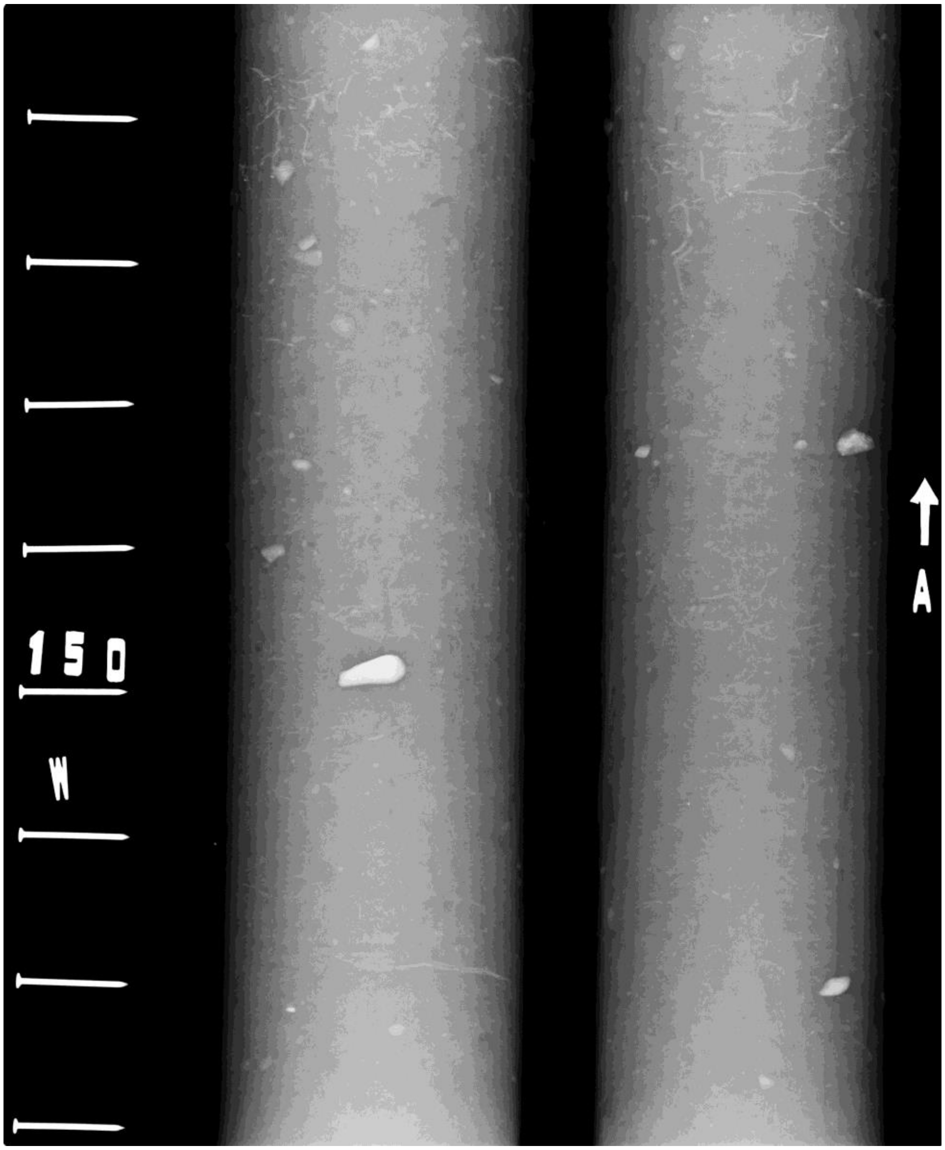

Figure 3: X-radiograph representative of the Tiniktartuq Mud unit (archive and working halves of core 2008029 059 PC at 125 to 165 cm).

<u>Geotechnical Properties and sediment characteristics of the Davis Strait Silt unit</u>

L* a* b* values of this unit are higher than the Tiniktartuq Mud and Baffin Shelf Drift units due to the high carbonate content. IRD is abundant in x-rays throughout the unit (Figure 4). Magnetic susceptibility is higher compared to the Tiniktartuq Mud and the Baffin Shelf Drift units. The average max shear strength of the David Strait Silt is greater than that of the Tiniktartuq Mud with values measured between 10,000 and 16,000 Pa. (maximum value measured was 20,000 Pa at 320 cm in core 2008029 046 PC). Grain size analyses reveal that the unit is mostly composed of silty clay or clayey silt with some sand. The laminated nature of the unit has made for variable grain size compositions with some cores having higher sand components (e.g. 2005029 052 PC and 059 PC; see Appendix 2 pages A2-4 and A2-8). Gravel was also observed in one interval of 059 PC (~25% gravel at 350 cm; Appendix 2 page A2-8).

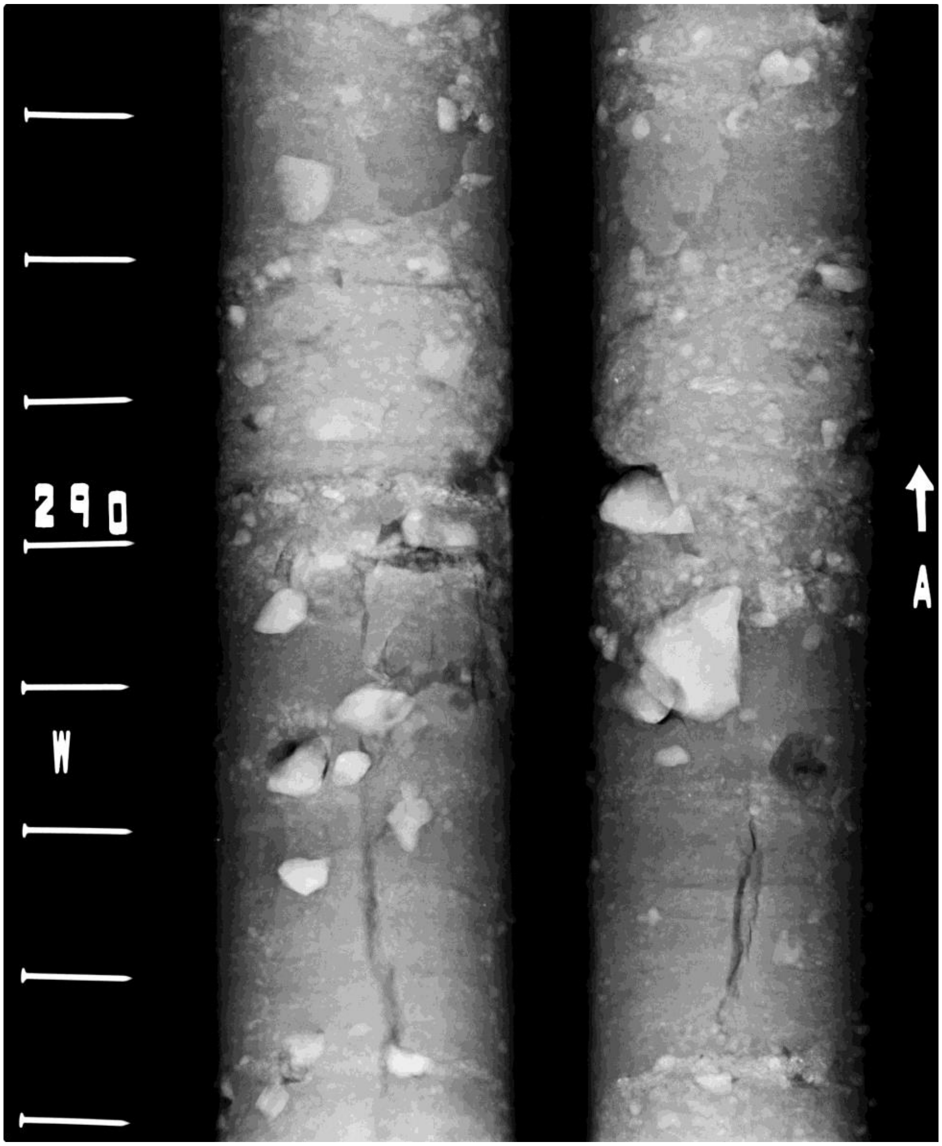

Figure 4: X-radiograph representative of the David Strait Silt unit (archive and working halves of core 2008029 059 PC at 270 to 310 cm).

<u>Geotechnical Properties and sediment characteristics of the Baffin Shelf Drift unit</u>

This unit is very dark gray to black in colour with the lowest L* a* b* values of the three units. IRD is observed in abundance in x-rays (Figure 5). The Baffin Shelf Drift has the lowest magnetic susceptibility but the highest p-wave velocity and wet bulk density measurements of any unit. The sediments of this unit are very dense and stiff has and this is reflected in high max shear strengths, as high as 40,000 Pa in core 2008029 059 PC (see Appendix 2). The Baffin Shelf Drift is coarser grained that the Davis Strait Silt but it still has a considerable silt and clay component.

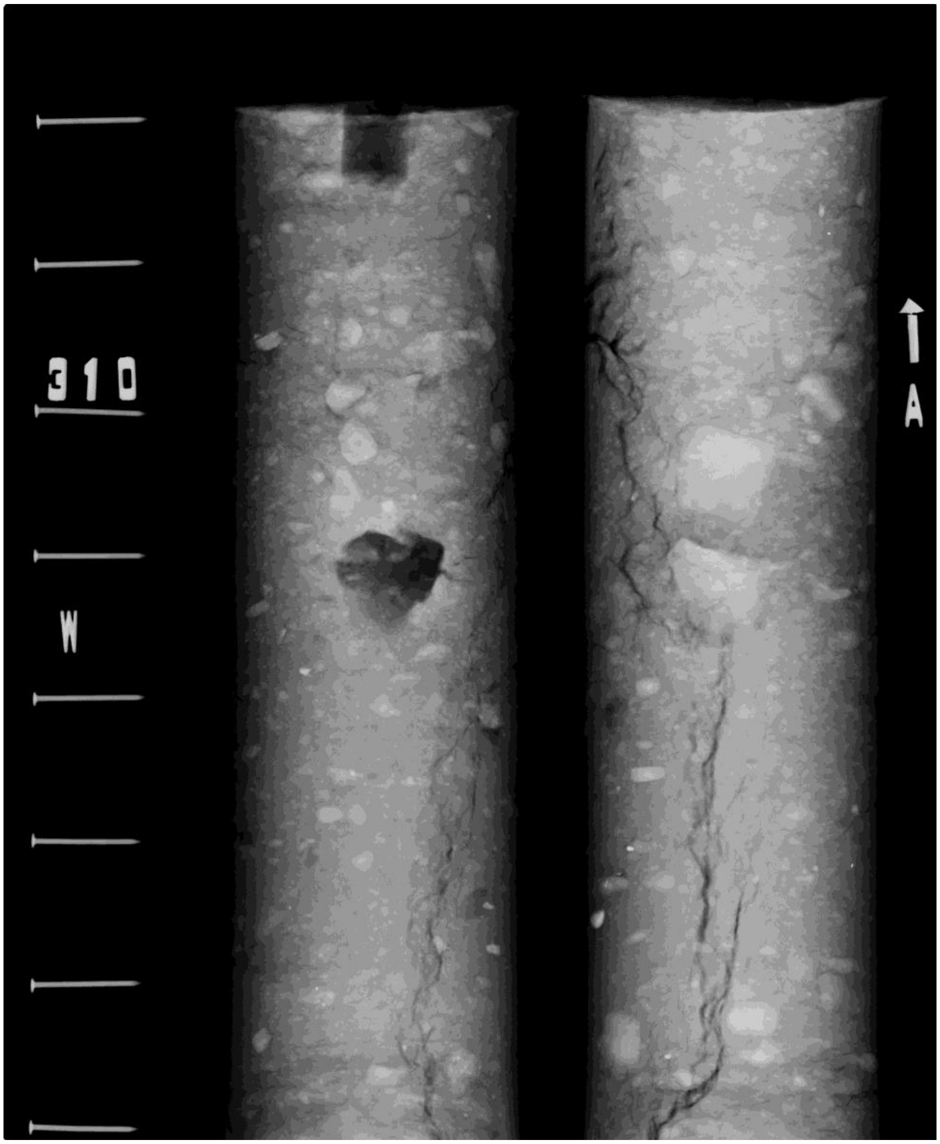

Figure 5: X-radiograph representative of the David Strait Silt unit (archive and working halves of core 2008029 050 PC at 300 to 335 cm).

Acknowledgements

Grain size analyses used in this report were performed by Owen Brown in the GSCA sedimentology laboratory. Kate Jarrett, curator at GSCA, provided access to much of the geotechnical data, core photographs, and x-rays. Courtney Fitzgerald and Jeremy Bentley assisted with figure preparation.

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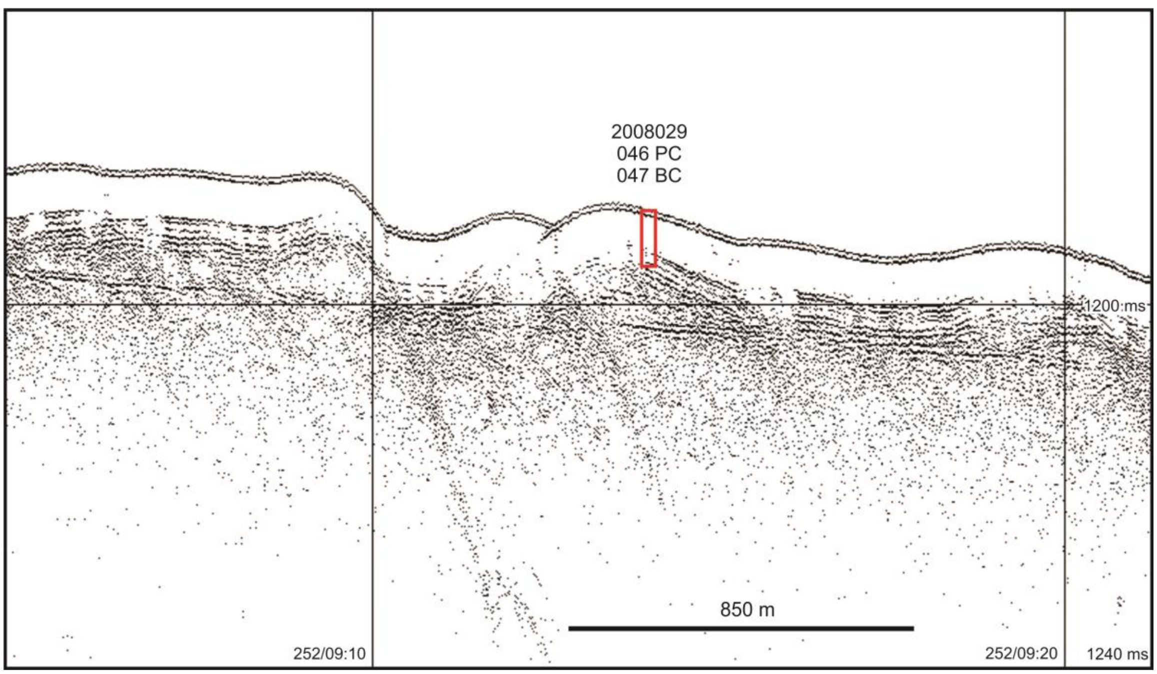
Appendix 1: Sample site summaries

046 PC: *74.023275° N / -77.116198° W; 870 m W.D.*

This site was selected using multibeam data collected by the CCGS Amundsen. It is the location of the deepest ice scour observed in the Canadian Arctic. Two cores were collected (046 PC outside of the scour, 049 PC inside the scour) in hopes to date the scour and to determine the effects (if any) of the scour process on the physical properties of the sediment. The purpose of 046 PC was to sample the unscoured seabed in this area.

Core 046 PC recovered 462 cm of sediment (see Appendices 2-1 and 3-1): 0- 280 cm, bioturbated olive gray mud with gas disturbance; 280 – 377 cm, laminated light colored olive gray mud with occasional pebbles; 377 – 462 cm, very dark brown sandy clay with sandy laminations and pebbles.

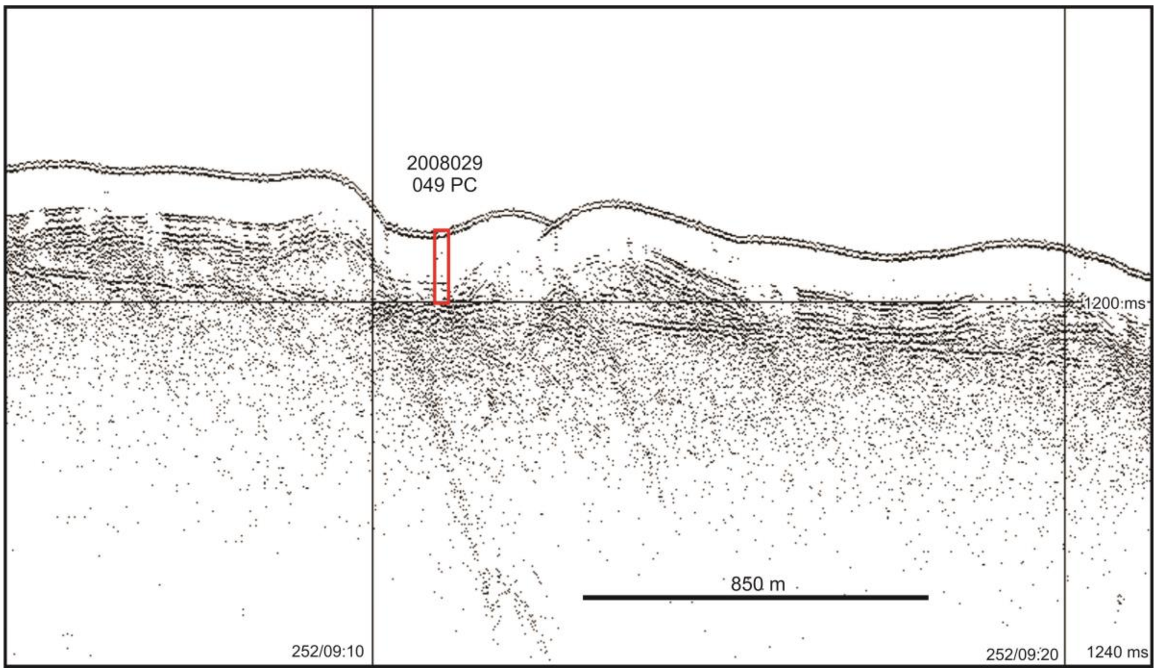
Box core 047 BC also collected at this site.



<u>049 PC:</u> *74.026178° N / -77.125268° W; 868 m W.D.*

This site was selected using multibeam data collected by the CCGS Amundsen. It is the location of the deepest ice scour observed in the Canadian Arctic. Core 049 was taken inside of the ice scour, identified in the multibeam data, to sample the bottom of the scour. Bennett et al. (2014) determined this scour was as old as 11.6 – 15.3 ka Cal yr BP.

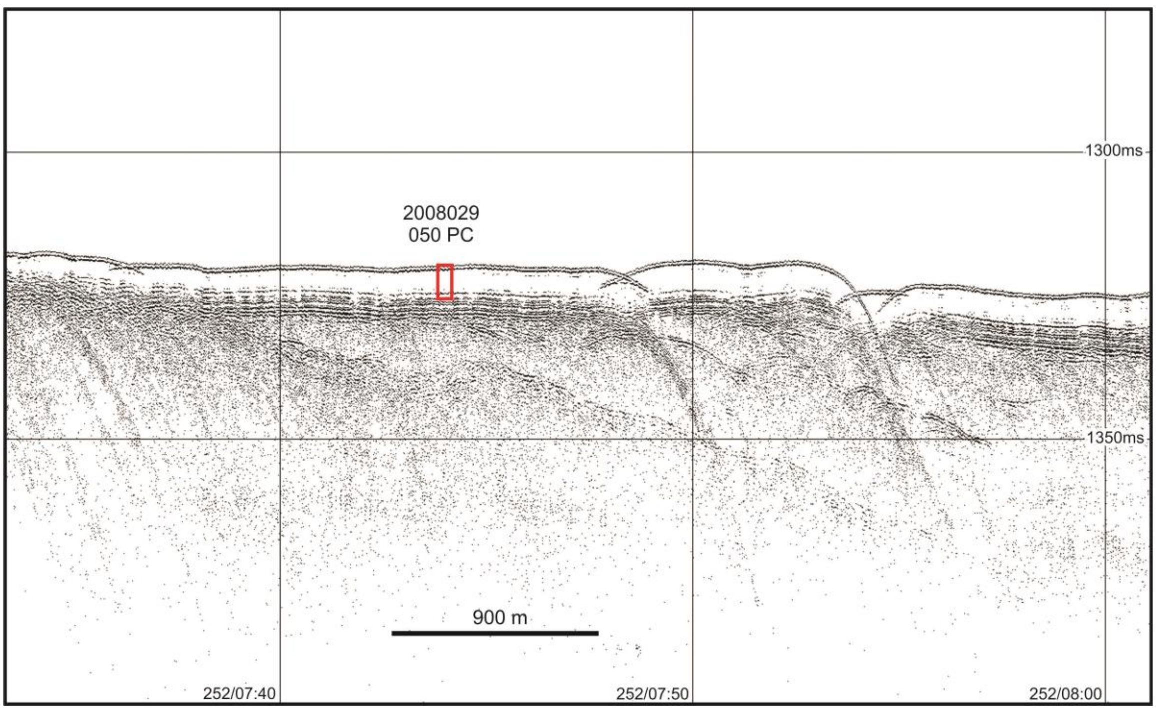
Core 049 PC recovered 594 cm of sediment (see Appendices 2-2 and 3-10): 0- 379 cm, bioturbated olive gray mud with gas disturbance; 379 – 514 cm, laminated light colored olive gray mud with occasional pebbles; 514 – 594 cm, very dark brown sandy clay with sandy laminations and pebbles.



<u>050 PC:</u> *74.112343° N / -77.400833° W; 853 m W.D.*

This site was selected using Huntec data collected during the 2008029 cruise. The site has a similar stratigraphy to the 046 and 049 sites except for a thinner post-glacial section. Core 050 PC was collected at this location in hopes of sampling the underlying glacial sediment.

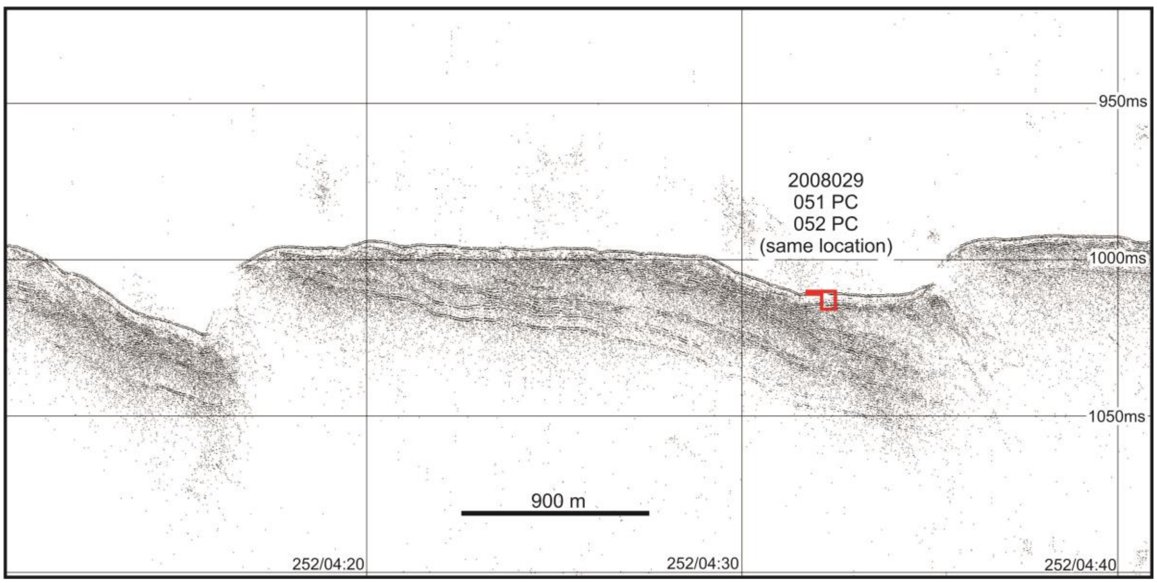
Core 050 PC recovered 469 cm of sediment (see Appendices 2-3 and 3-18): 0- 177 cm, bioturbated olive gray mud with gas disturbance; 177 – 288 cm, laminated light colored olive gray mud with occasional pebbles; 288 – 469 cm, very dark brown sandy clay with sandy laminations and pebbles.



051 PC: *74.307295° N / -78.020038° W; 735 m W.D.*

This site was selected using multibeam data collected by the CCGS Amundsen. It is at the location of a ~10 m deep pit of glacial or perhaps tectonic origin. Core 051 PC was collected in hopes of determining what type of soil is present at the bottom of the pit, if there are any gas indicators in the sediment, and to date the feature if possible. A poor core was collected (only 75 cm long) as the corer was likely stopped by sand. A summary plot of this core is not included in Appendix 2 due to its poor recovery and that it was taken at the same location as core 052 PC.

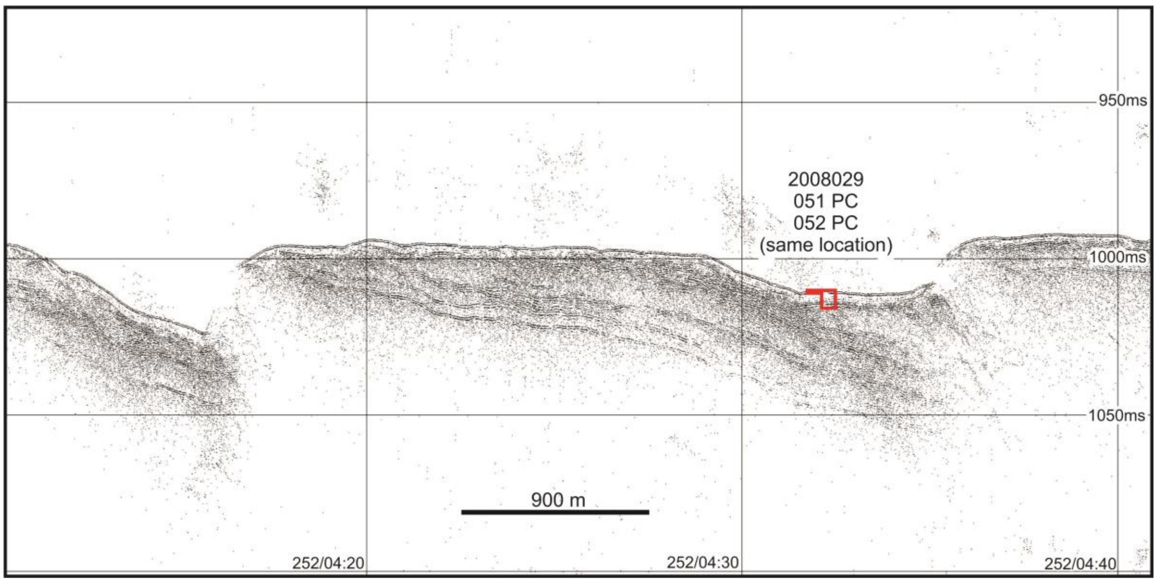
Core 051 PC recovered 75 cm of sediment (see Appendix 3-24): 0 – 20cm, olive gray mud; 20 – 75 cm, dark gray clay and sand package containing sandy blebs, sandy lenses, and deformed sandy laminations.



052 PC: *74.307075° N / -78.019601° W; 734 m W.D.*

This core was a second attempt at the same site as 051 PC. A good core (467 cm long) was obtained by this attempt.

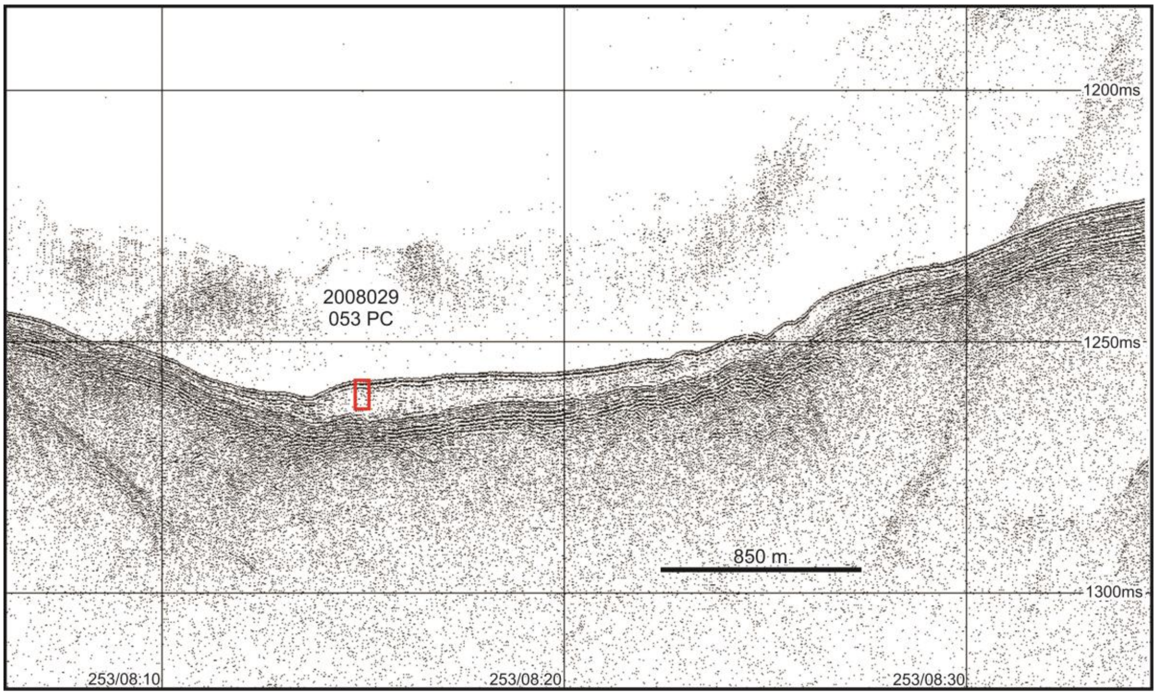
Core 052 PC recovered 467 cm of sediment(see Appendices 2-4 and 3-27): 0 – 93 cm, laminated light colored olive gray mud; 93 – 130 cm, very dark brown sandy clay; 130 – 467 cm, dark gray clay and sand package containing sandy blebs (some very large), sandy lenses, and deformed sandy laminations.



<u>053 PC:</u> *73.840550° N / -80.394580° W; 918 m W.D.*

This site was selected using Huntec data collected during the 2008029 cruise. The Huntec profile shows what appears to be a lenticular debris flow with an overlying drape of sediment.

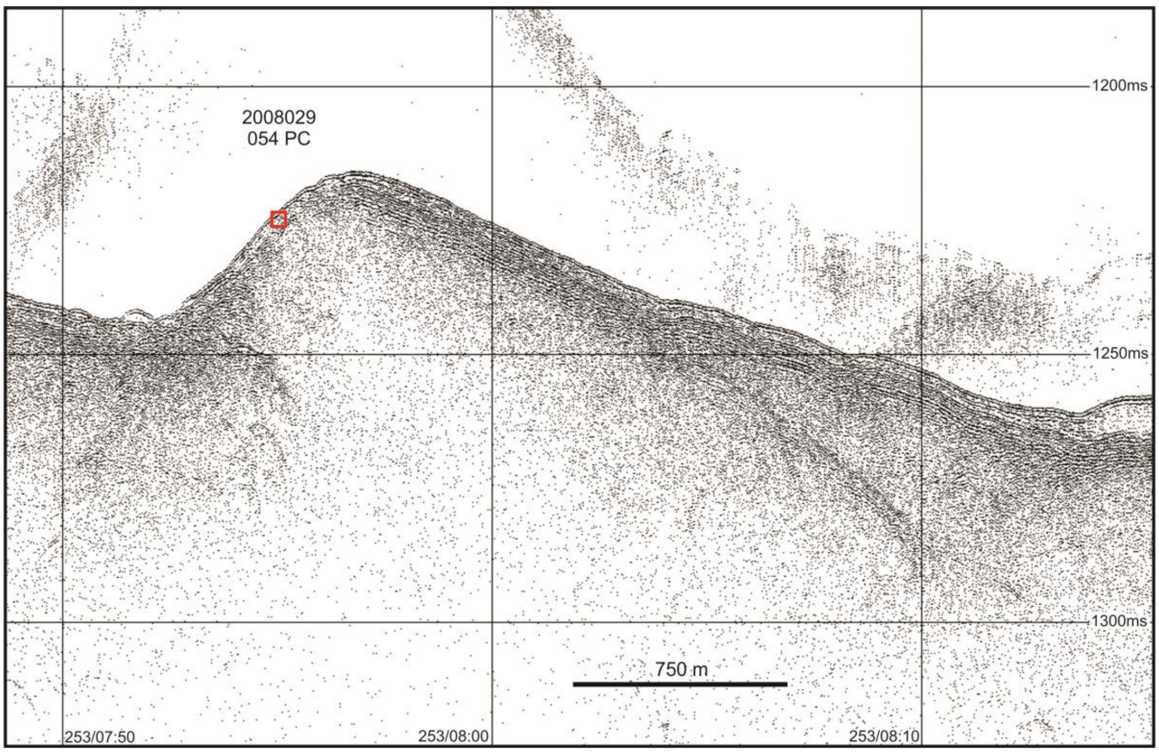
Core 053 PC recovered 455 cm of sediment (see Appendices 2-5 and 3-35): 0 – 455 cm, dark gray fine to medium grained clean sand with occasional mud blebs and some pebbles.



<u>054 PC:</u> *73.838971° N / -80.312078° W; 887 m W.D.*

The core site was selected using Huntec data collected during the 2008029 cruise. This site is close to site 053 PC but away from the debris flow on a ridge that has similar seismic characteristics to the material underlying the debris flow. The ridge observed in the Huntec data below is interpreted to be due to underlying tilted strata.

Core 054 PC recovered 237 cm of sediment (see Appendices 2-6 and 3-40): 0 – 18 cm, dark gray mud; 18 – 185 cm, laminated light colored olive gray mud with occasional pebbles and some sand; 185 – 237 cm, very dark brown laminated clay with some sandy laminations and pebbles.

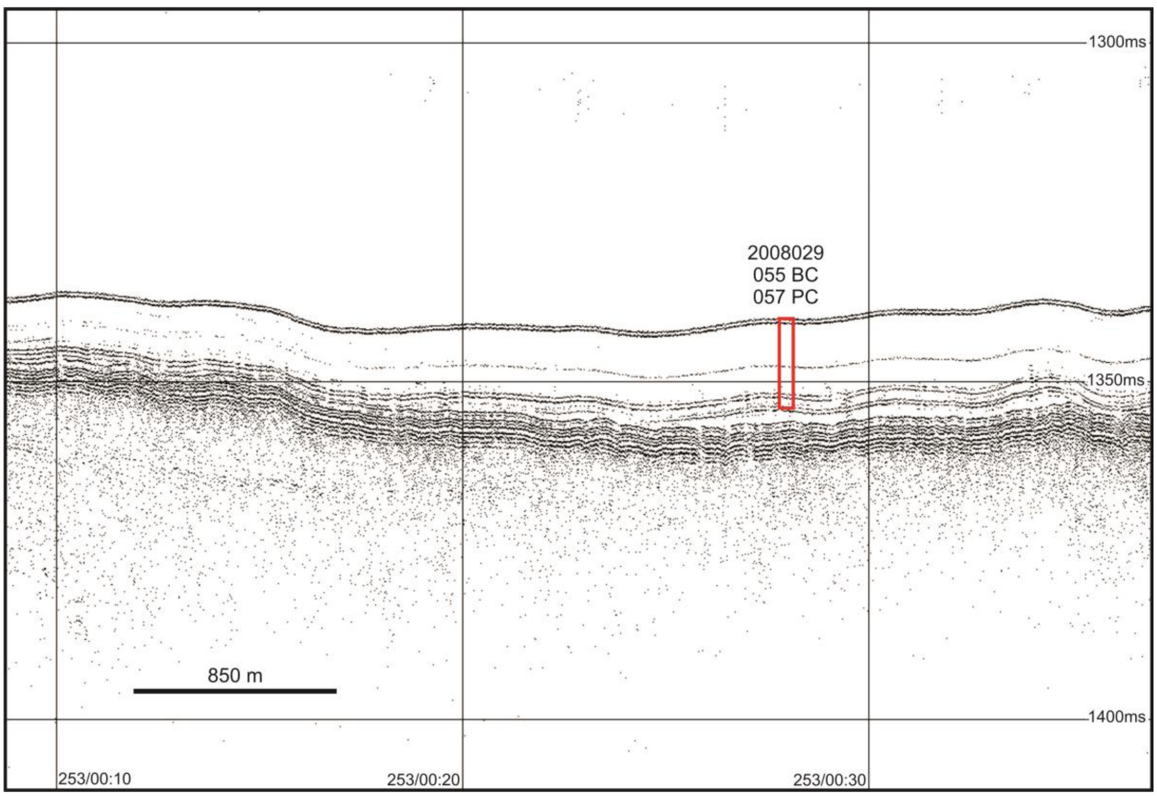


<u>057 PC:</u> *74.092035° N / -78.718158° W; 866 m W.D.*

This site was selected using Huntec data collected during the 2008029 cruise. This is the location of the thickest accumulation of post-glacial sediment that has been observed in Lancaster Sound.

Core 057 PC recovered 1056 cm of sediment (see Appendices 2-7 and 3-45): 0 – 585 cm, olive gray mud with intervals of intense black mottling and laminated intervals; 585 – 1056 cm, laminated light colored olive gray mud with some sandy laminations/intervals and occasional pebbles.

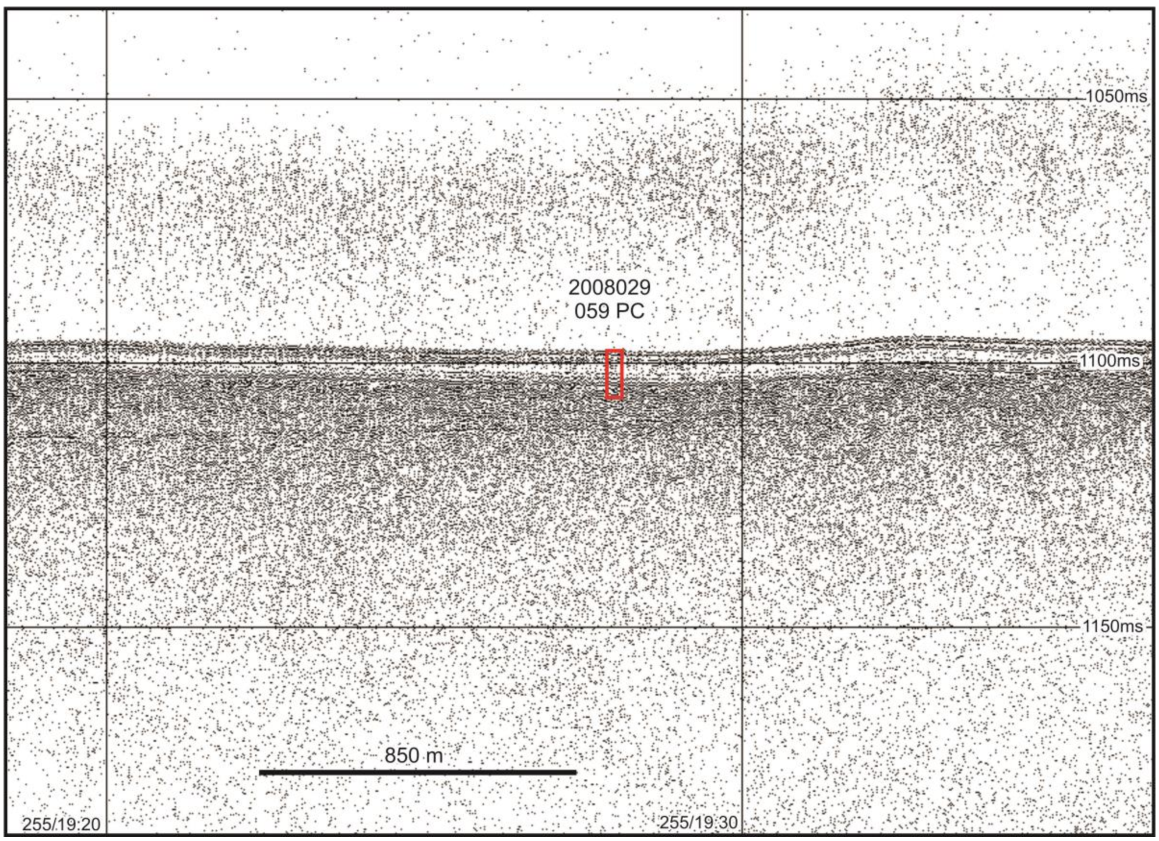
Box core 055 BC (74.092063° N / -78.718643° W) also collected at this site.



<u>059 PC:</u> *74.259623° N / -82.384150° W; 800 m W.D.*

The core site was selected using Huntec data collected during the 2008029 cruise. The Huntec profile showed acoustically stratified sediment and a core was taken at this location in hopes of penetrating the post glacial and glacial sediment near the western edge of the 2008029 Lancaster Sound study area.

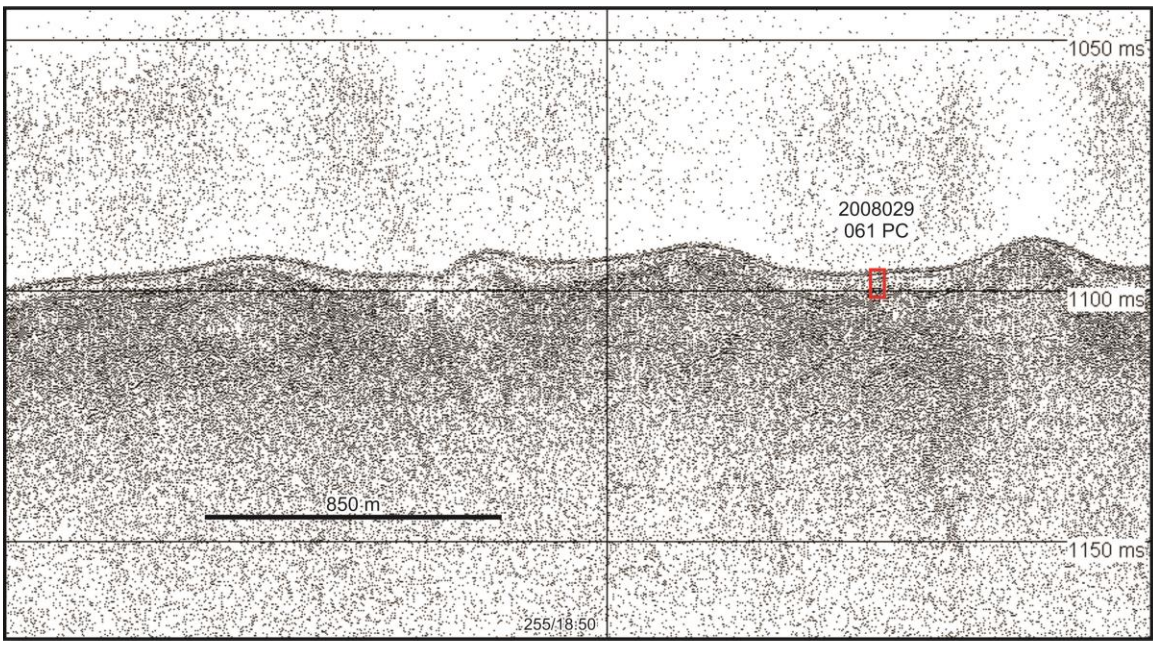
Core 059 PC recovered 709 cm of sediment (see Appendices 2-8 and 3-58): 0 – 240 cm, olive gray mud with intervals of intense black mottling and laminated intervals; 240 – 579 cm, laminated light colored olive gray mud with some sandy laminations/intervals and occasional pebbles; 579 – 709 cm, very dark brown sandy clay with pebbles.



<u>061 PC:</u> *74.258208° N / -82.230353° W; 791 m W.D.*

The core site was selected using Huntec data collected during the 2008029 cruise. The GI Gun data from this area (Line 34) showed folded beds at depth extending to the surface and being expressed as diapir-like structures on the seabed. Site selection was refined using Huntec data from line 34 and core 061 was collected in an area of these diapir-like structures in hopes of sampling the underlying folded beds.

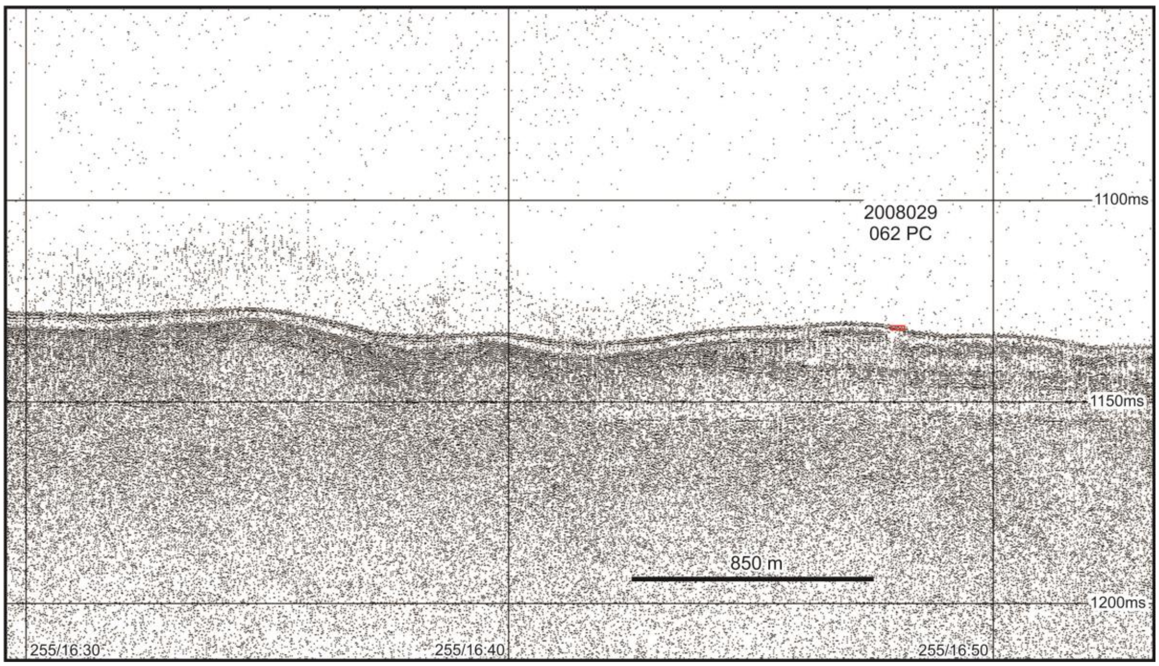
Core 061 PC recovered 441 cm of sediment (see Appendices 2-9 and 3-68): 0 – 60 cm, dark gray mud; 60 – 301 cm, laminated light colored olive gray mud with some sandy laminations/intervals and pebbles; 301 – 441 cm, very dark brown clay with abundant pebbles.



<u>062 PC:</u> *74.252531° N / -81.634845° W; 822 m W.D.*

The core site was selected using Huntec data collected during the 2008029 cruise. The Huntec profile showed ~2 m of stratified sediment over a number of stacked mass transport deposits. Less than a metre of sediment was recovered as it is likely that the corer fell over on the seabed. When recovered, it was observed that the bottom-most barrel was bent.

Core 062 PC recovered 75 cm of sediment (see Appendices 2-10 and 3-75): 0 – 75 cm: olive gray mud with some black mottling.



Appendix 2: Summary core plots for 10 piston cores collected in Lancaster Sound during GSCA cruise 2008029.

Analyses presented on these plots include:

-interpreted core lithology

-grain size

-spectrophotometry

-shear strength (maximum and remoulded)

-p-wave velocity (longitudinal and transverse)

-wet bulk density

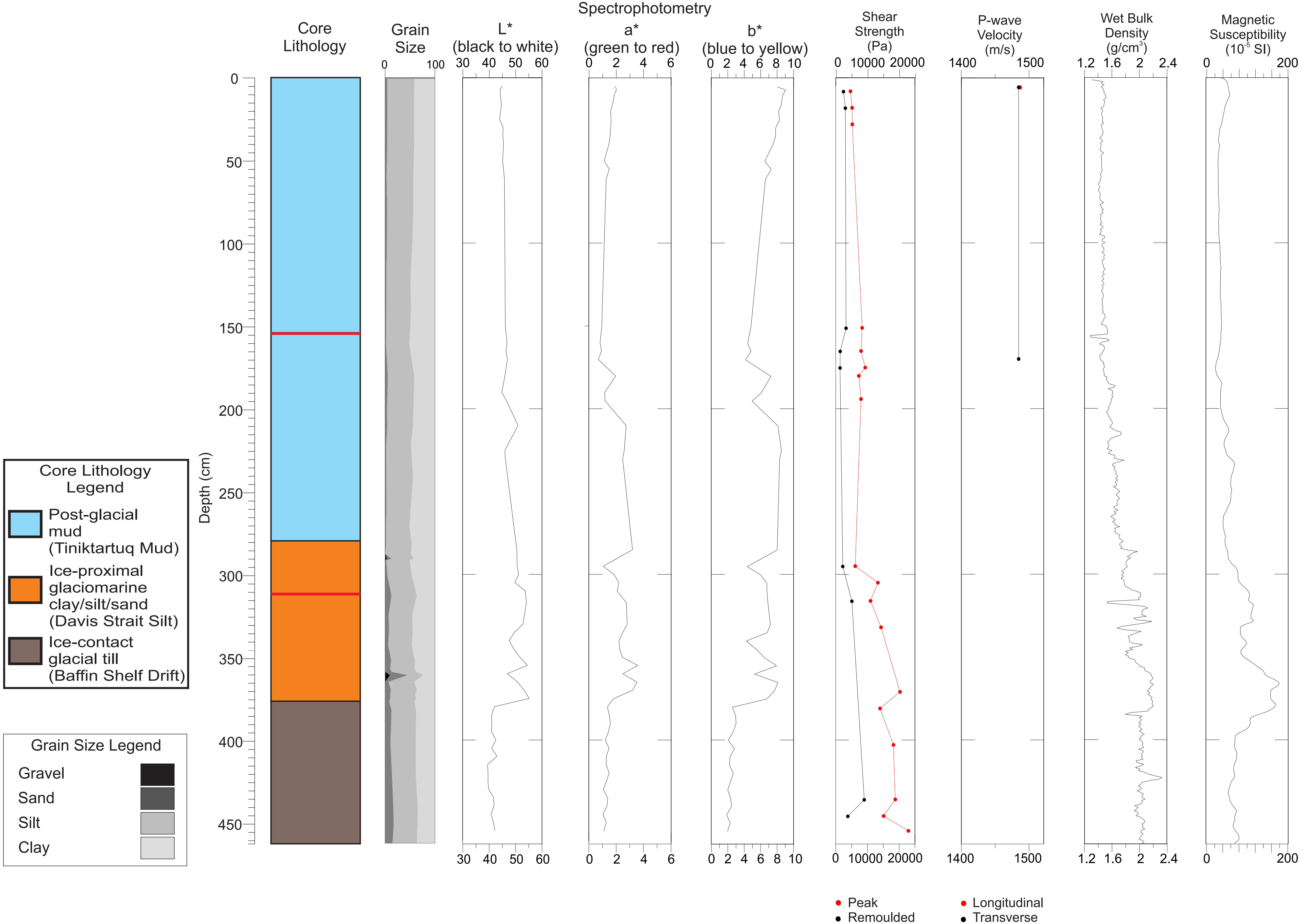
-magnetic susceptibility

Note: Red lines shown on the core lithology plot indicate core section breaks.

2008029 0046 PC

74°01.3965'N / -77°06.9719'W; Water depth = 870 m

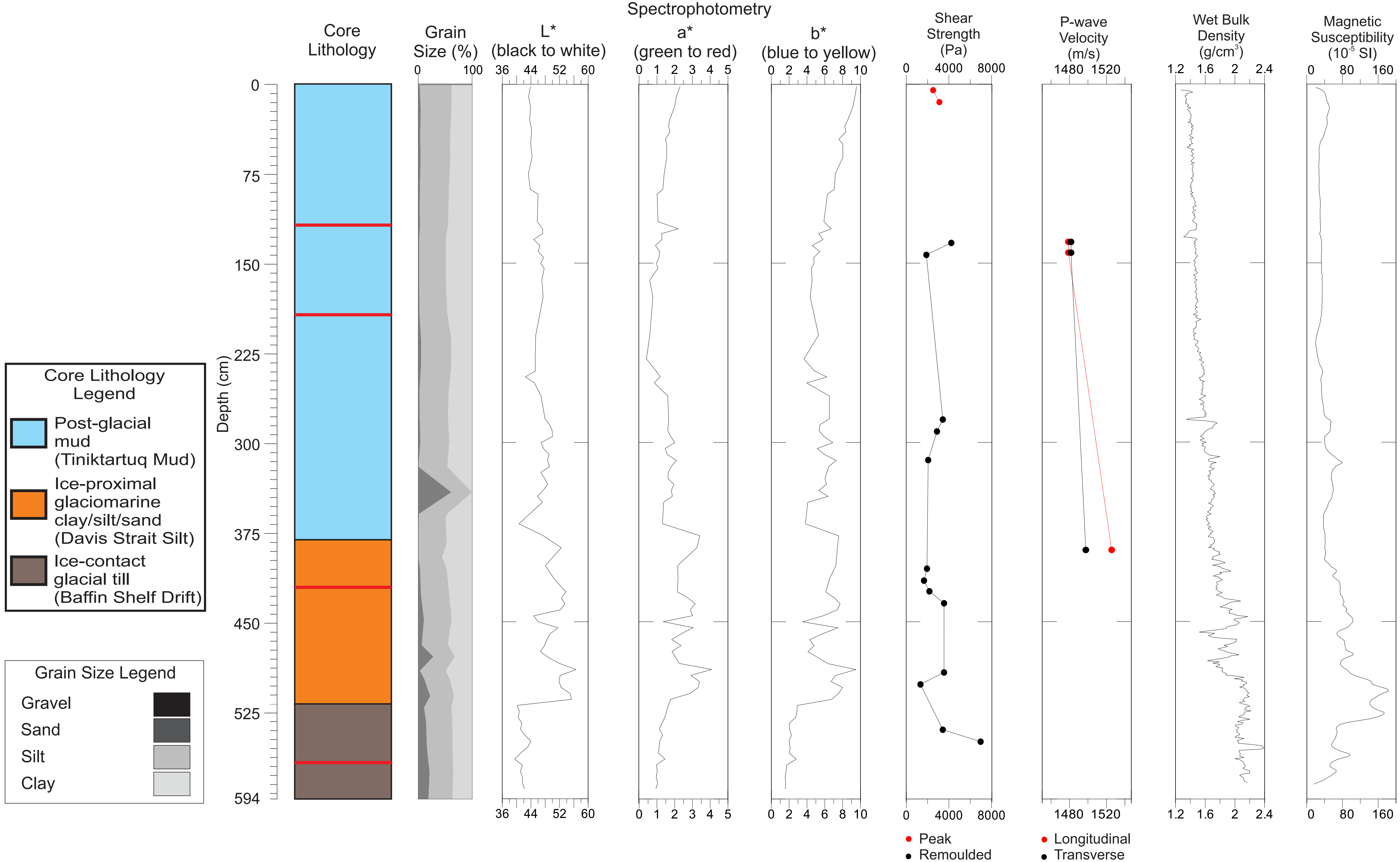
Total Length = 462 cm



2008029 0049 PC

74°01.5707'N / -77°07.5158'W; Water depth = 868 m

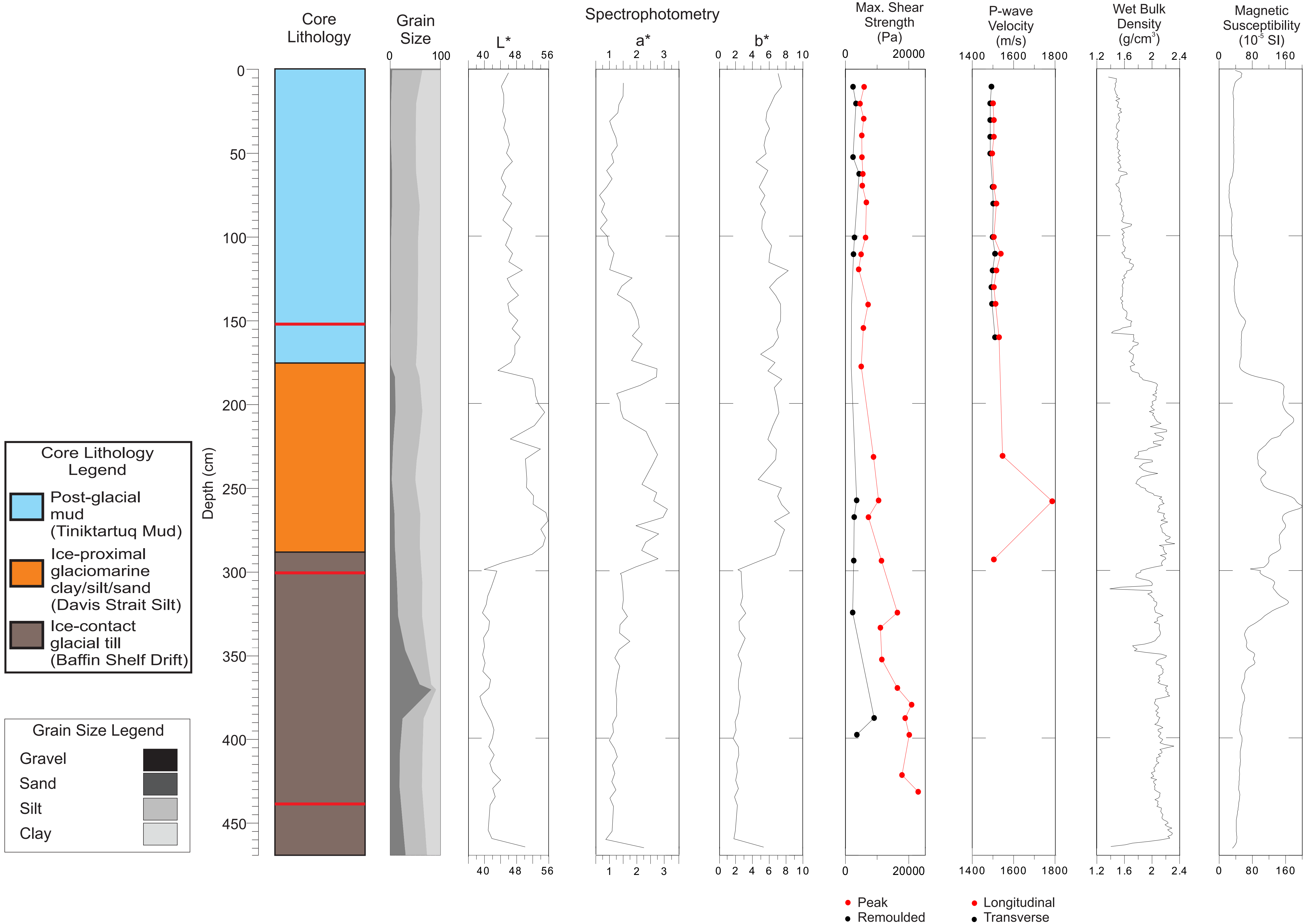
Total Length = 594 cm



2008029 0050 PC

74°06.7406'N / -77°24.0500'W; Water depth = 853 m

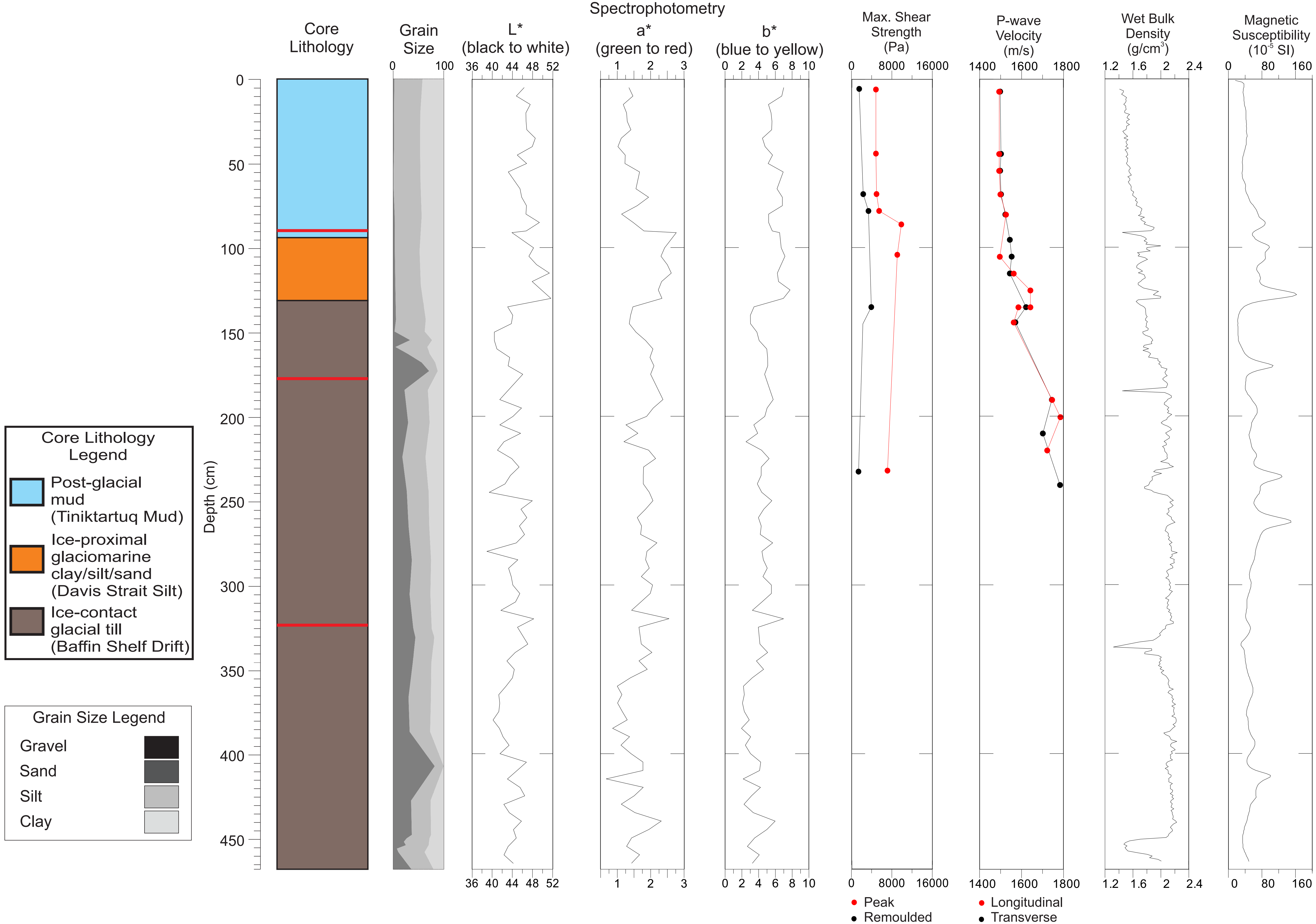
Total Length = 469 cm



2008029 0052 PC

74°18.4245'N / -78°01.1761'W; Water depth = 734 m

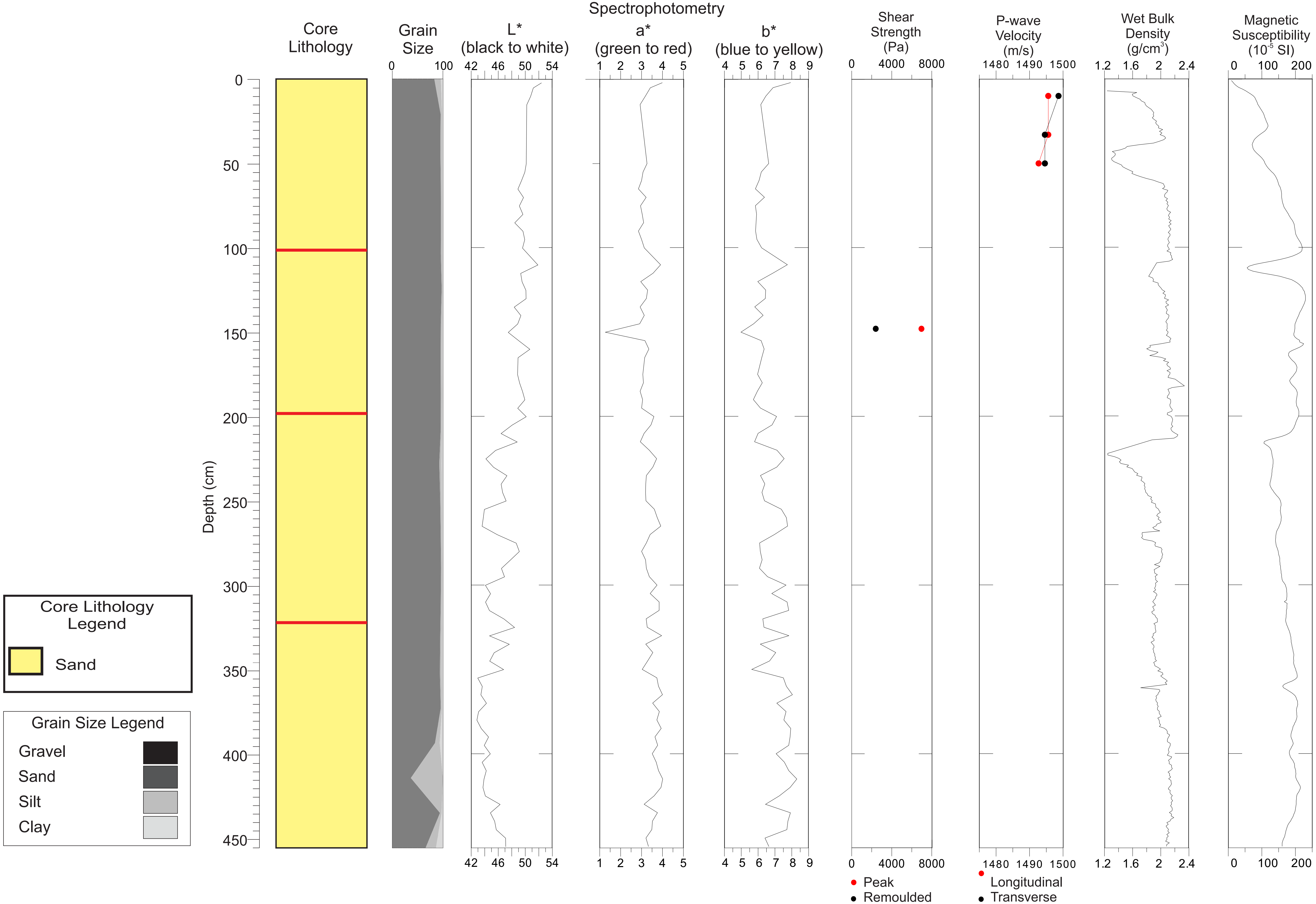
Total Length = 467 cm

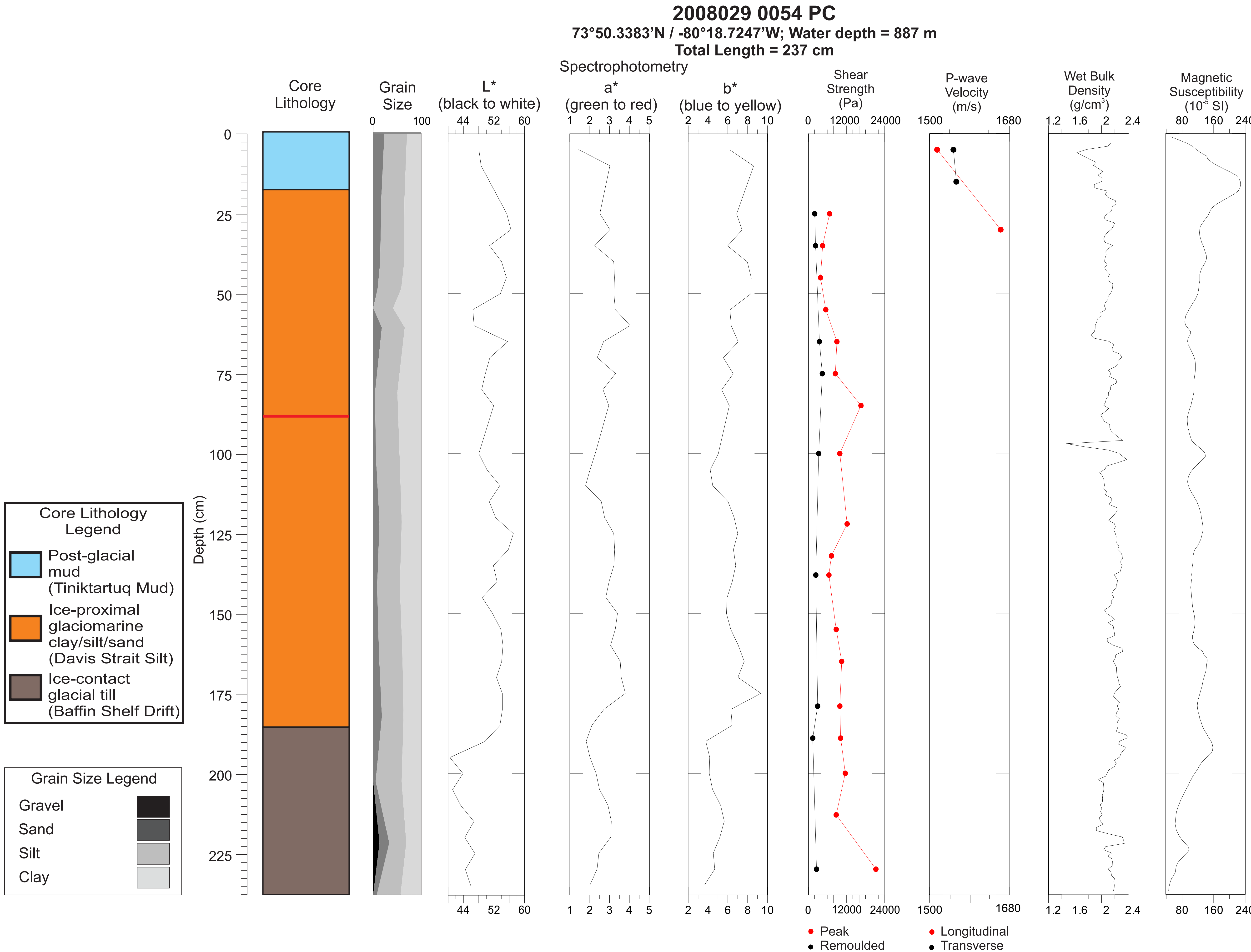


2008029 0053 PC

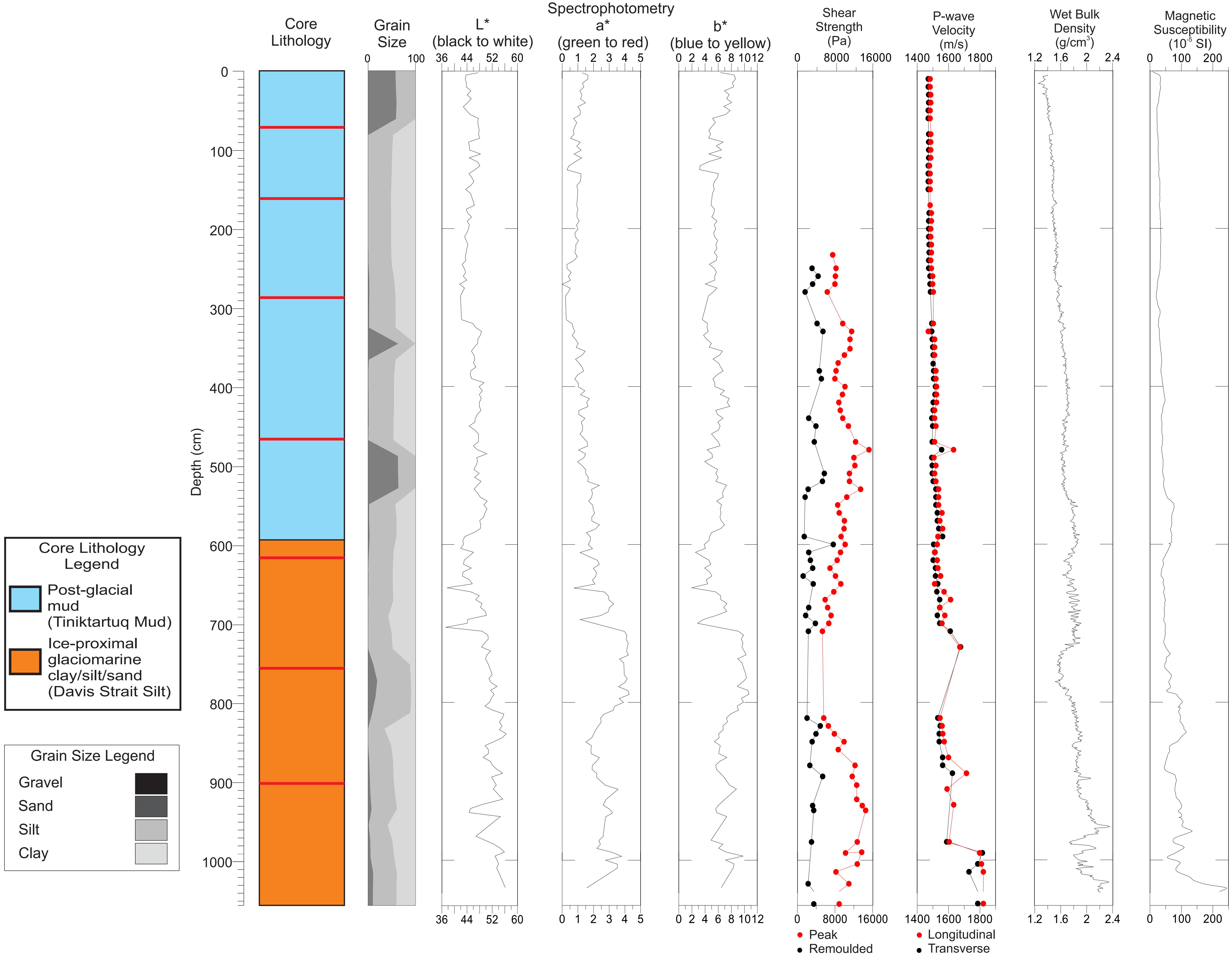
73°50.4330'N / -80°23.6748'W; Water depth = 918 m

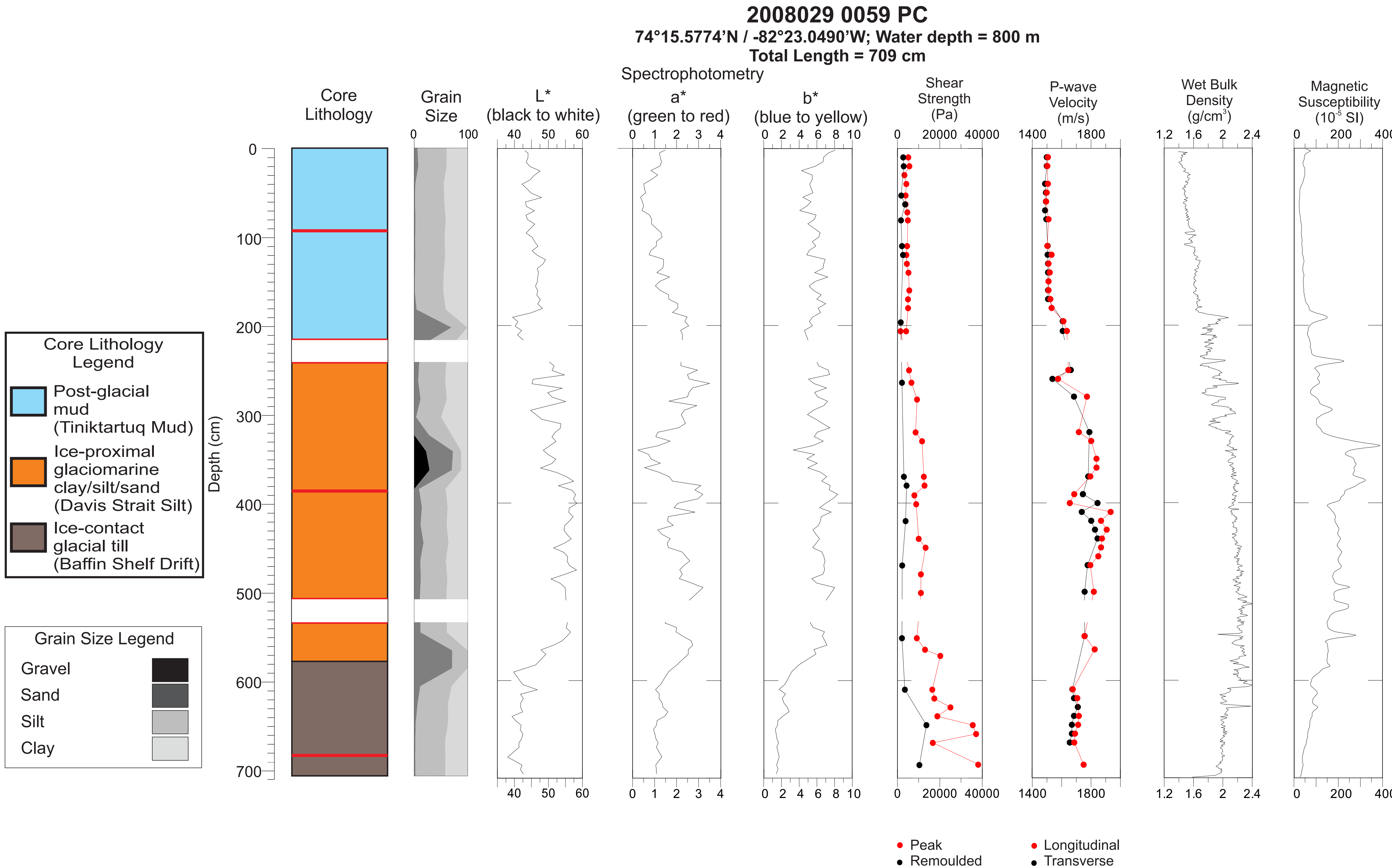
Total Length = 455 cm




2008029 0054 PC
73°50.3383'N / -80°18.7247'W; Water depth = 887 m
Total Length = 237 cm
Core Lithology
Grain Size
Spectrophotometry
L* (black to white)
a* (green to red)
b* (blue to yellow)
Shear Strength (Pa)
P-wave Velocity (m/s)
Wet Bulk Density (g/cm3)
Magnetic Susceptibility (10-5 SI)
Depth (cm)
Core Lithology Legend
Post-glacial mud (Tiniktartuq Mud)
Ice-proximal glaciomarine clay/silt/sand (Davis Strait Silt)
Ice-contact glacial till (Baffin Shelf Drift)
Grain Size Legend
Gravel
Sand
Silt
Clay
Peak
Remoulded
Longitudinal
Transverse

2008029 0057 PC, 74°05.5221'N / -78°43.0895'W; Water depth = 866 m, Total Length = 1056 cm

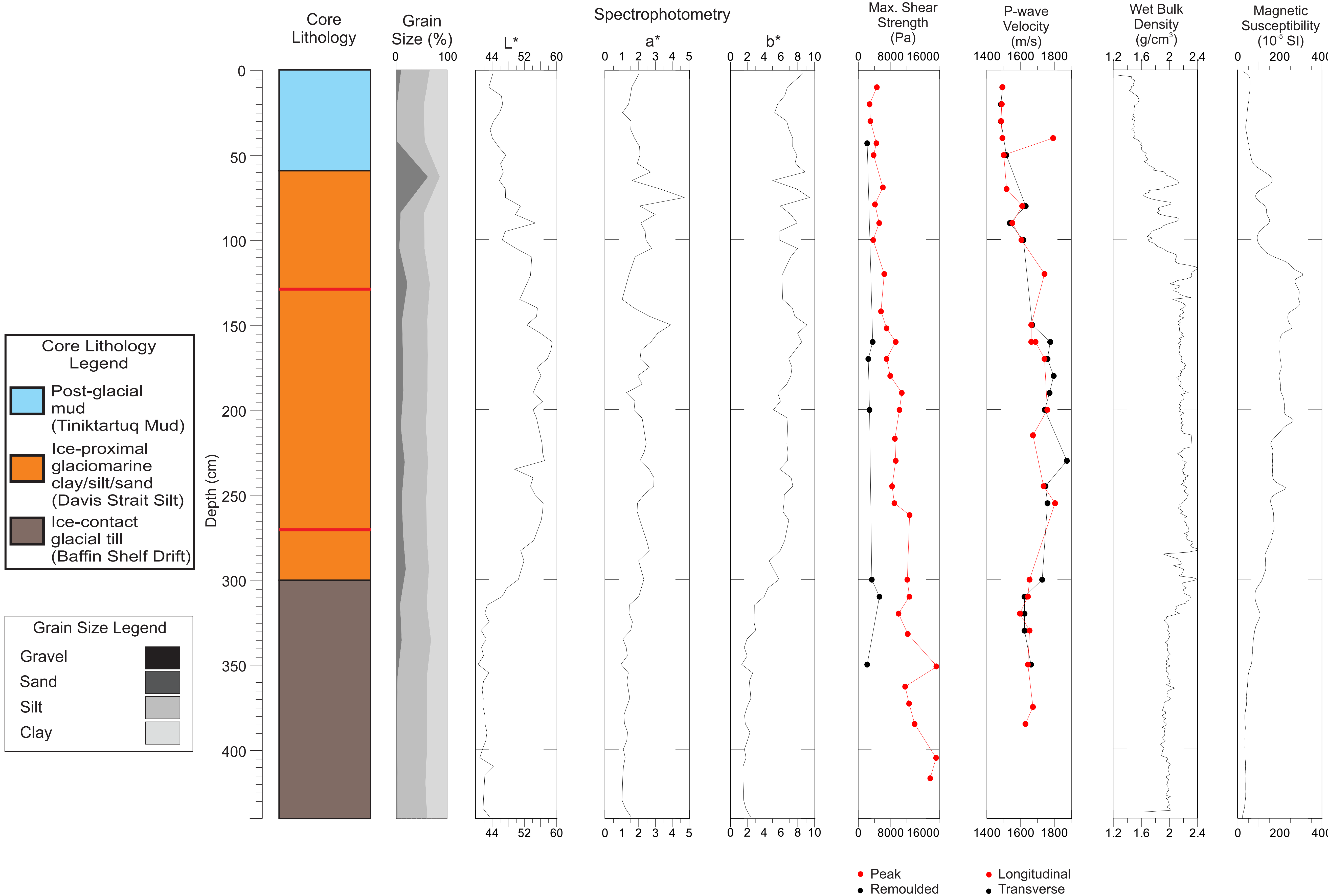



2008029 0059 PC
74°15.5774'N / -82°23.0490'W; Water depth = 800 m
Total Length = 709 cm
Core Lithology
Grain Size
Spectrophotometry
L* (black to white)
a* (green to red)
b* (blue to yellow)
Shear Strength (Pa)
P-wave Velocity (m/s)
Wet Bulk Density (g/cm3)
Magnetic Susceptibility (10-5 SI)
Depth (cm)
Core Lithology Legend
Post-glacial mud (Tiniktartuq Mud)
Ice-proximal glaciomarine clay/silt/sand (Davis Strait Silt)
Ice-contact glacial till (Baffin Shelf Drift)
Grain Size Legend
Gravel
Sand
Silt
Clay
Peak
Remoulded
Longitudinal
Transverse

2008029 0061 PC

74°15.4925'N / -82°13.8212'W; Water depth = 791 m

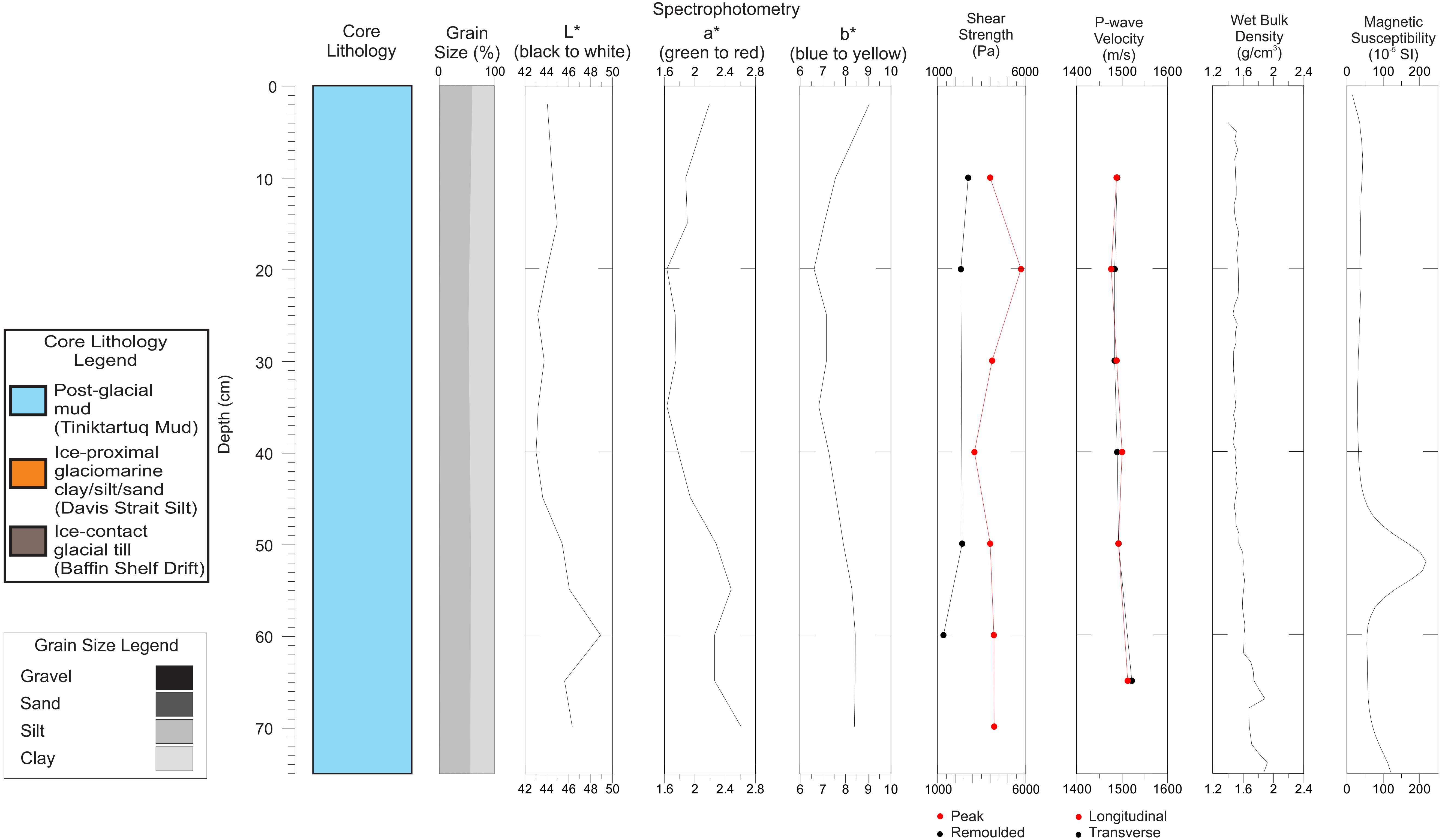
Total Length = 441 cm



2008029 0062 PC

74°15.1519'N / -81°38.0907'W; Water depth = 822 m

Total Length = 75 cm



Appendix 3: Detailed core plots for all cores collected in Lancaster Sound during GSCA cruise 2008029.

The core plots are presented at greater detail in this appendix (100 cm of core per page). Analyses included are:

-core photography

-visual descriptions (performed before grain size analyses so may differ from the plotted grain size data)

-grain size (blue arrows indicate the location of grain size analyses)

-spectrophotometry

-shear strength (maximum and remoulded)

-p-wave velocity (longitudinal and transverse)

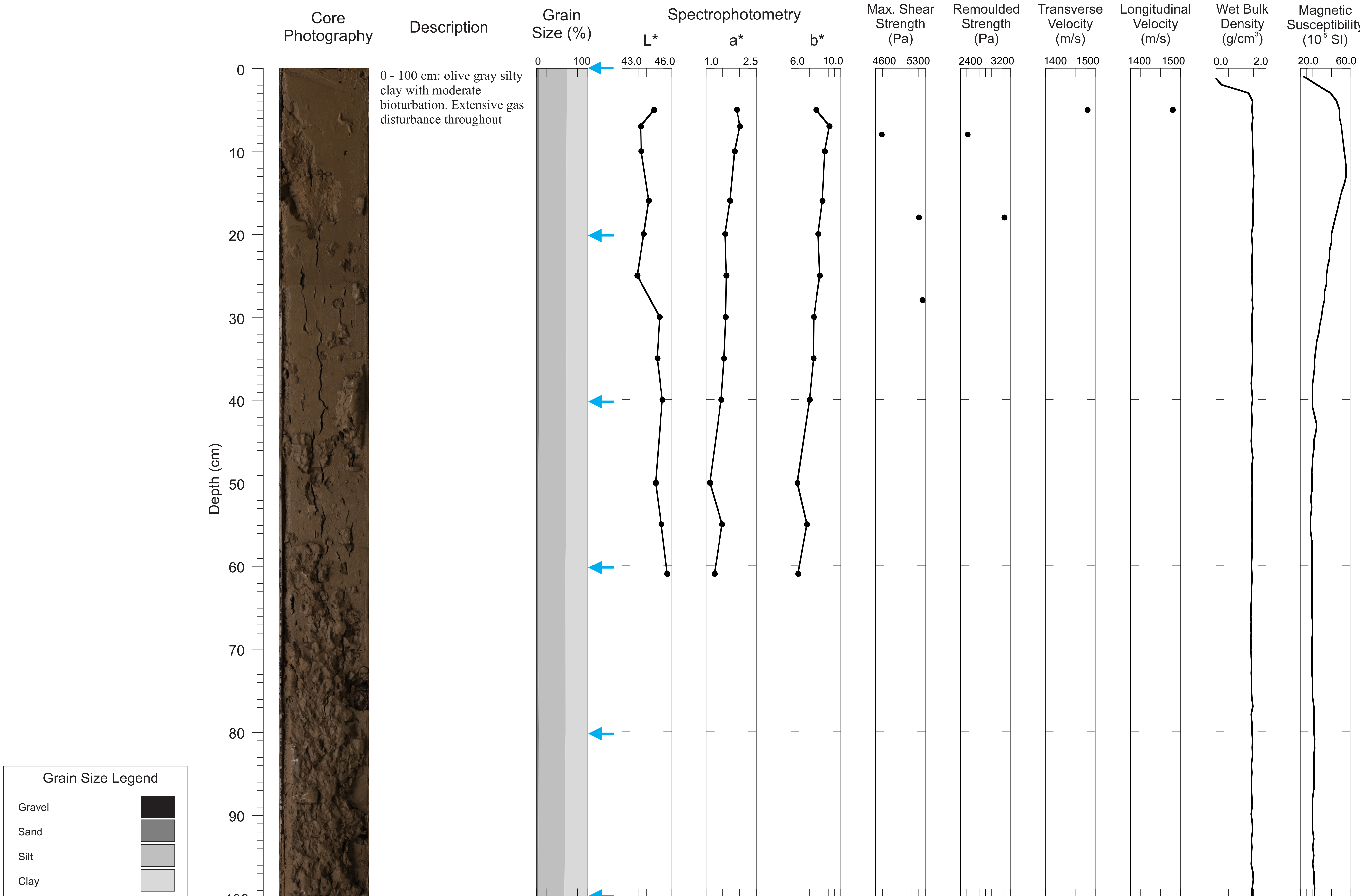
-wet bulk density

-magnetic susceptibility

2008029 0046 PC

74°01.3965'N / -77°06.9719'W; Water depth = 870 m

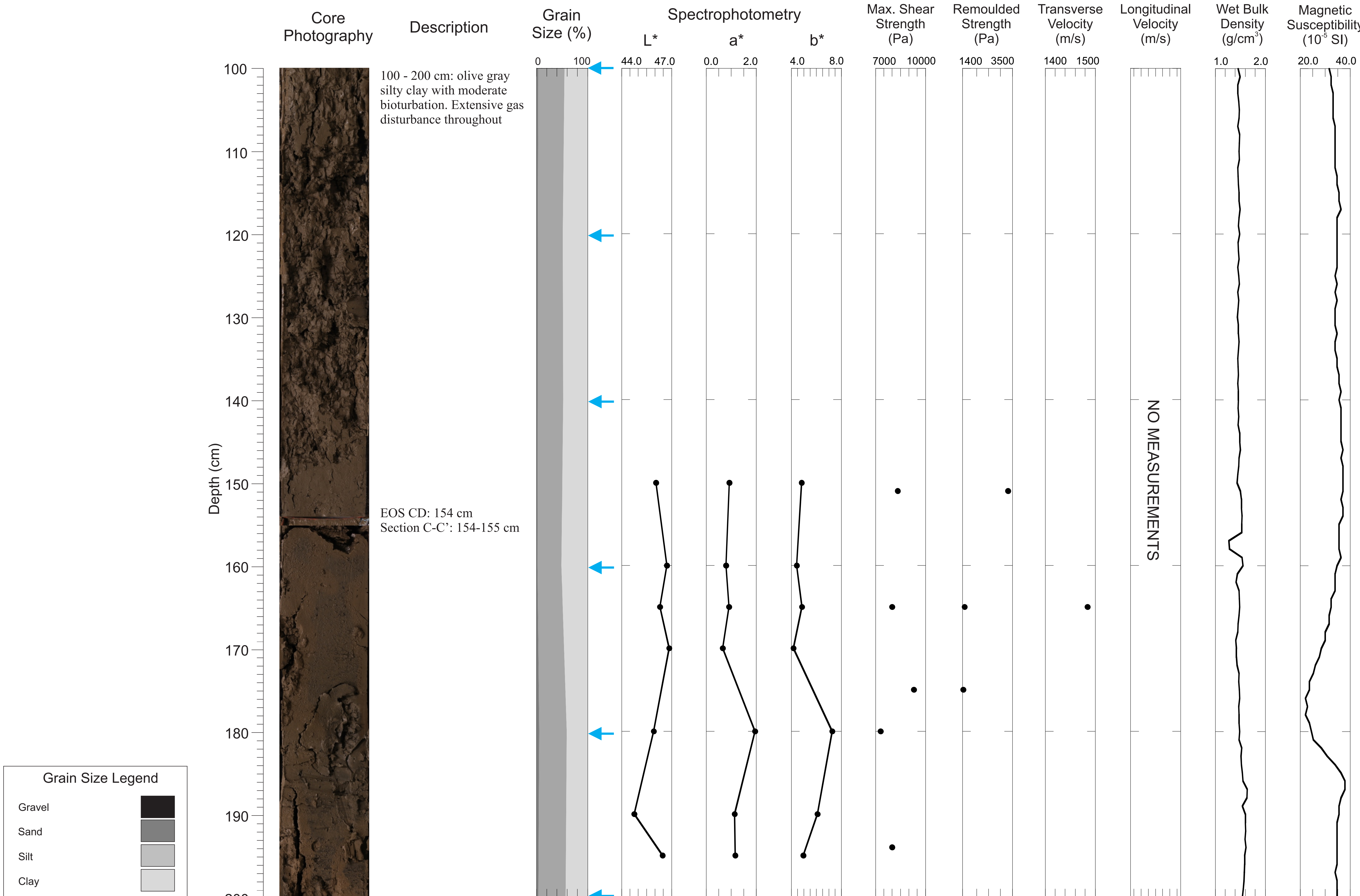
Total Length = 462 cm



2008029 0046 PC

74°01.3965'N / -77°06.9719'W; Water depth = 870 m

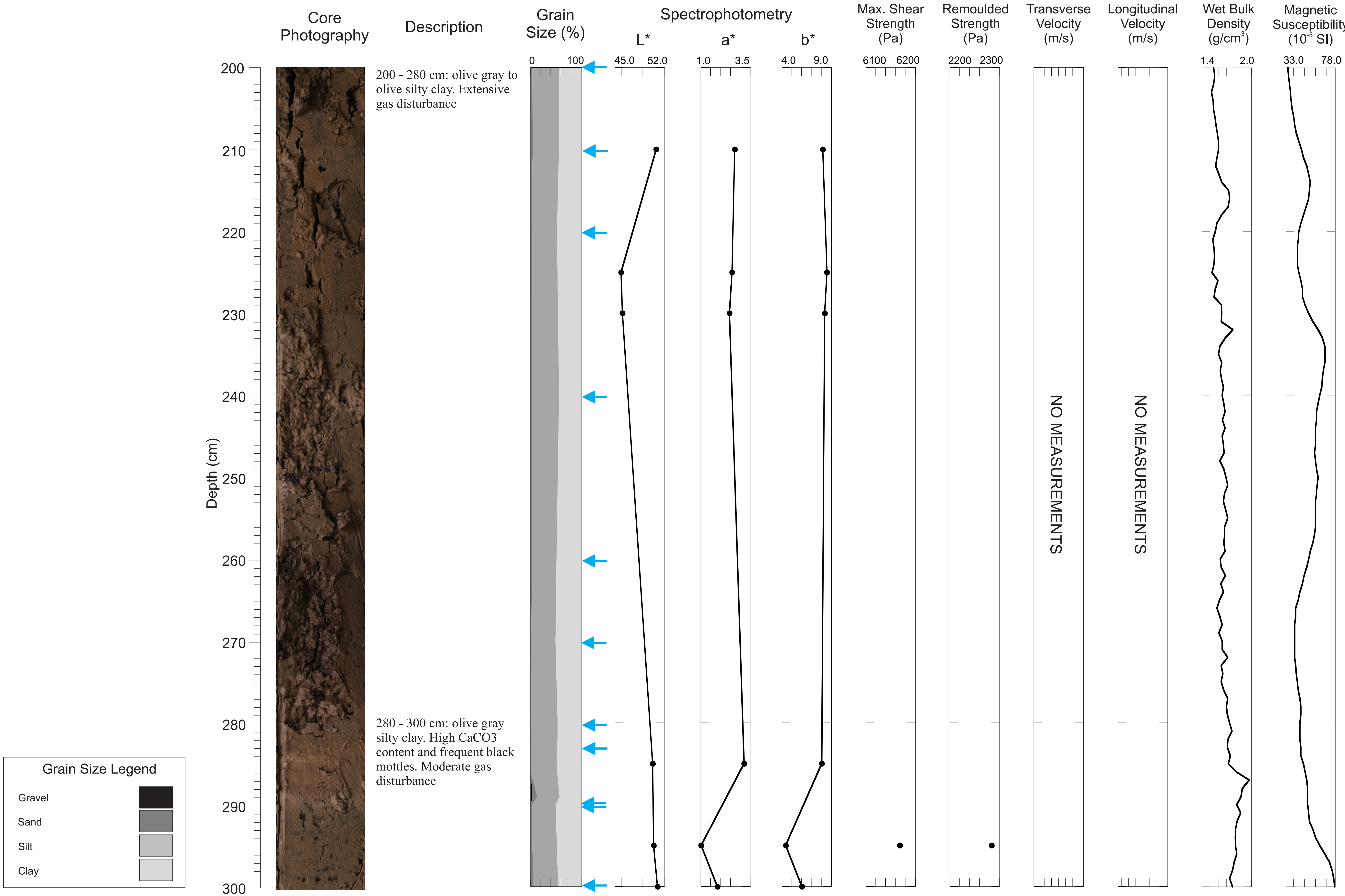
Total Length = 462 cm



2008029 0046 PC

74°01.3965'N / -77°06.9719'W; Water depth = 870 m

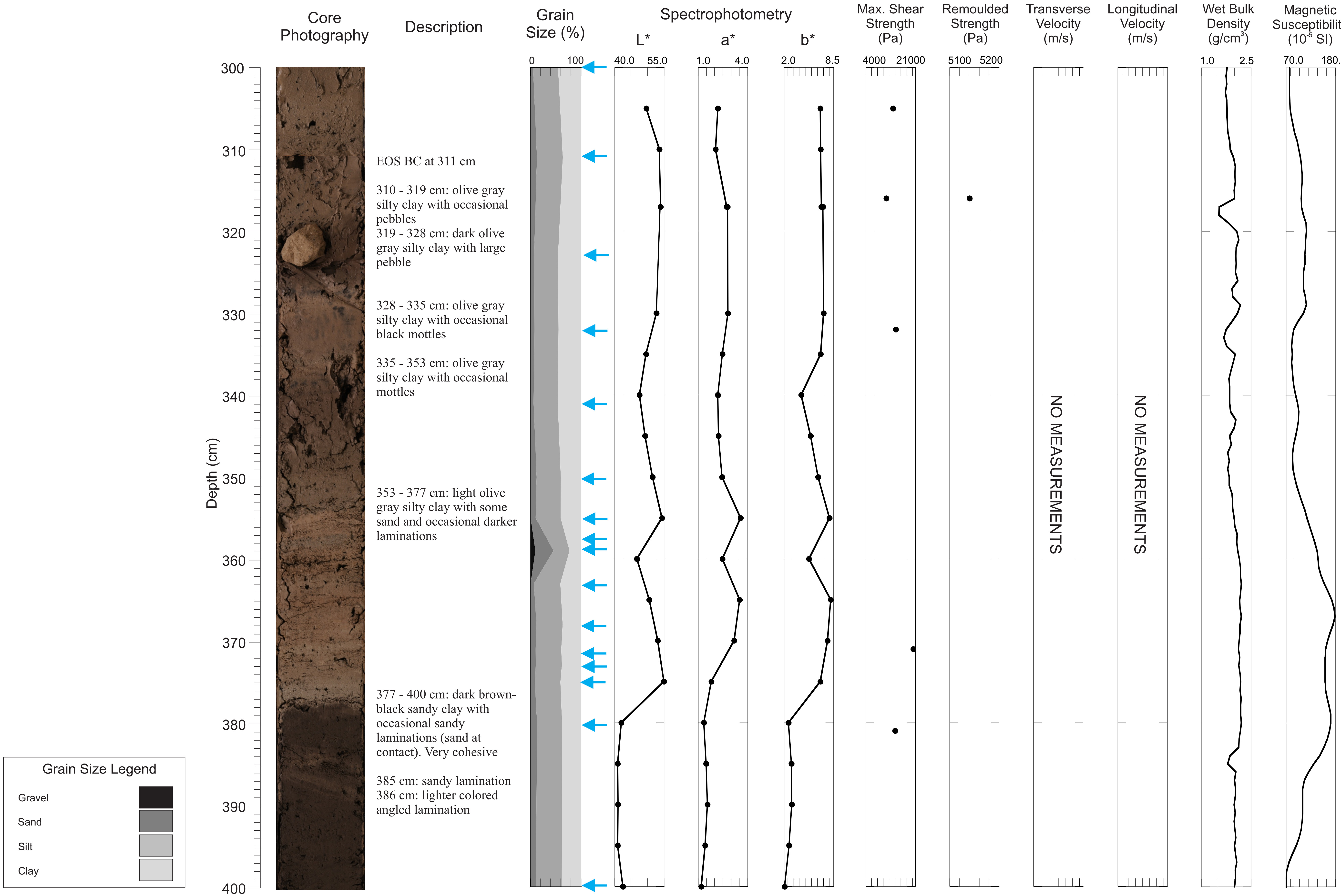
Total Length = 462 cm



2008029 0046 PC

74°01.3965'N / -77°06.9719'W; Water depth = 870 m

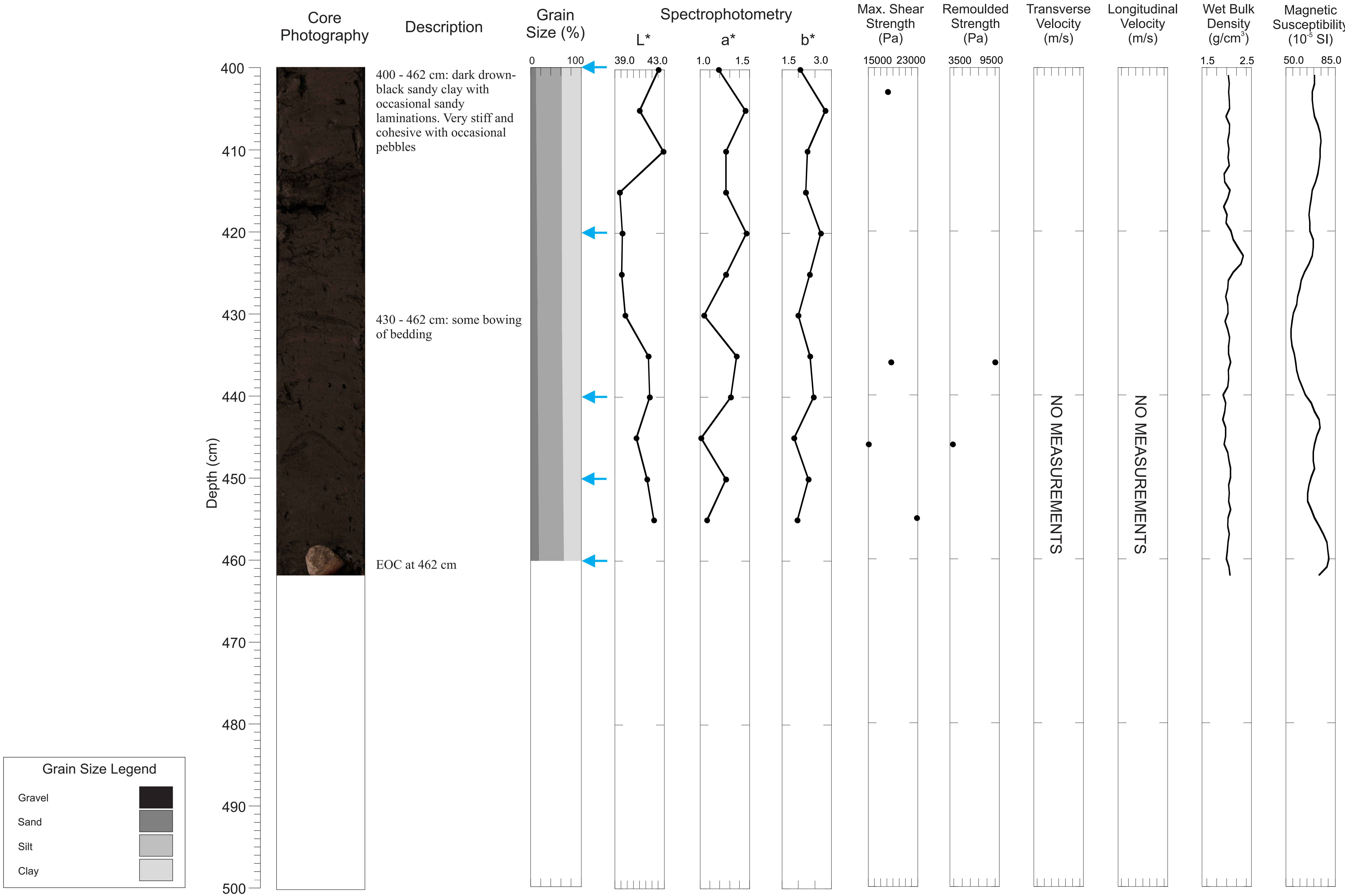
Total Length = 462 cm



2008029 0046 PC

74°01.3965'N / -77°06.9719'W; Water depth = 870 m

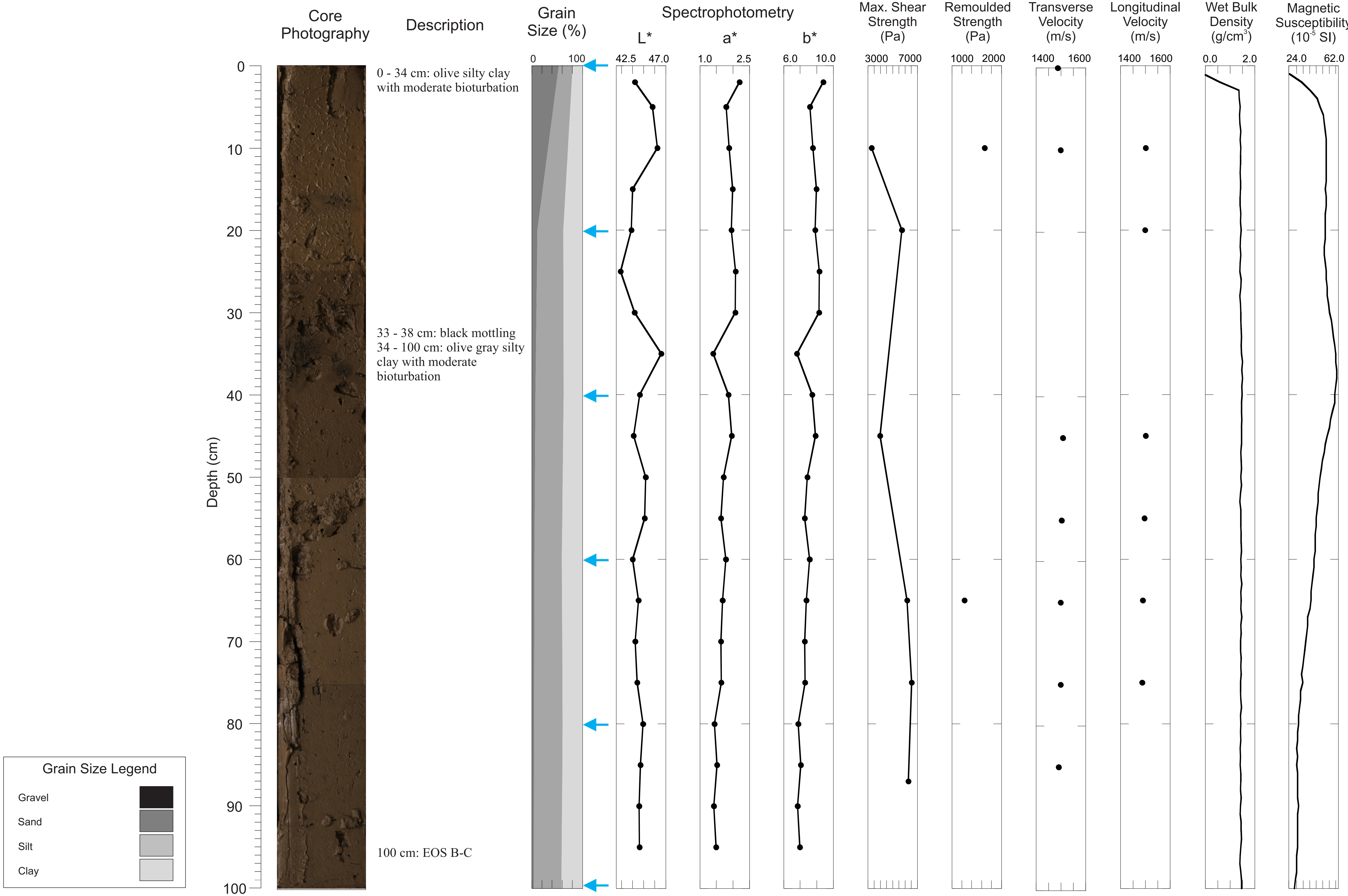
Total Length = 462 cm



2008029 0046 TWC

74°01.3965'N / -77°06.9719'W; Water depth = 870 m

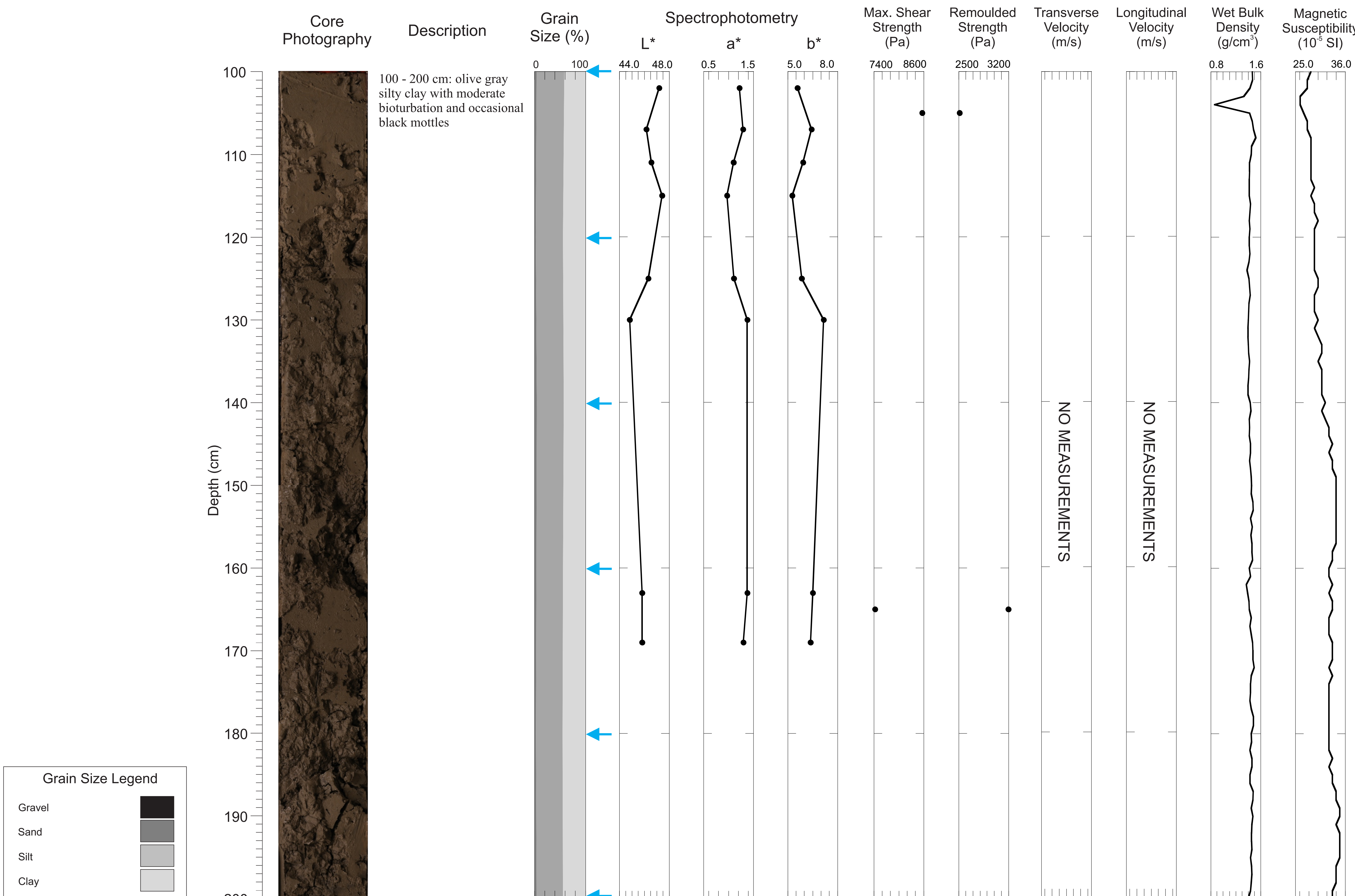
Total Length = 204 cm



2008029 0046 TWC

74°01.3965'N / -77°06.9719'W; Water depth = 870 m

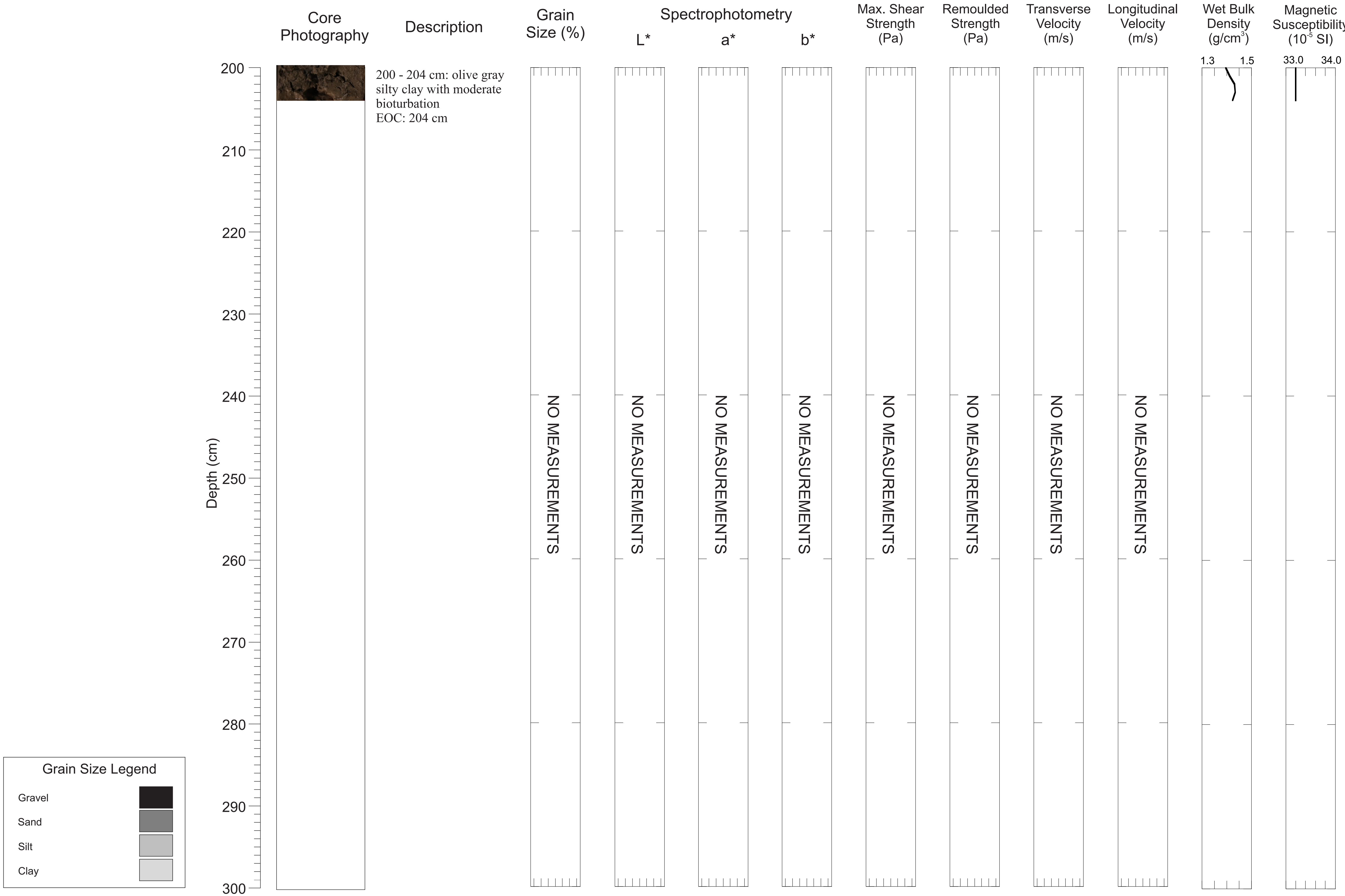
Total Length = 204 cm



2008029 0046 TWC

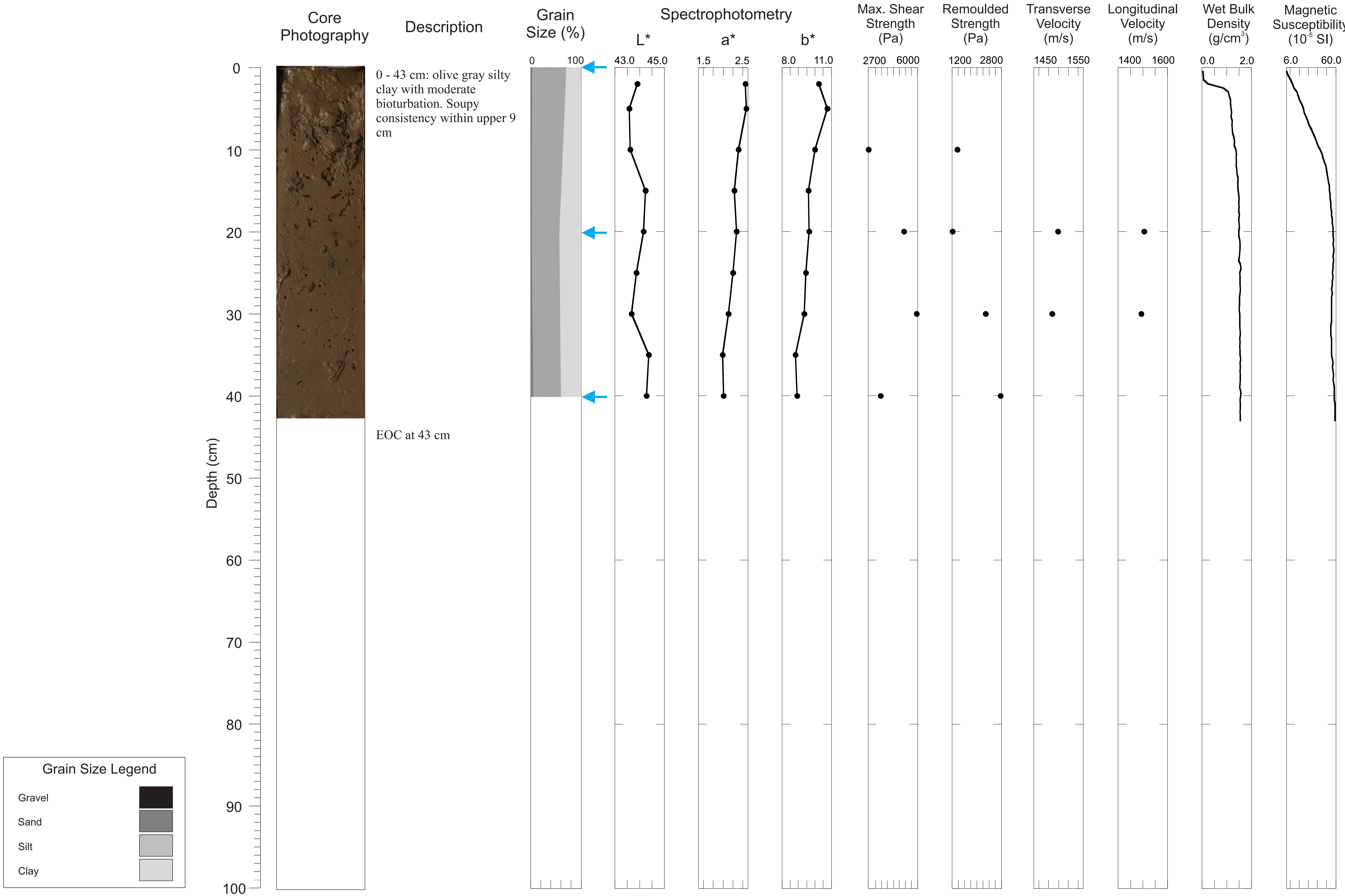
74°01.3965'N / -77°06.9719'W; Water depth = 870 m

Total Length = 204 cm



2008029 0047 BC

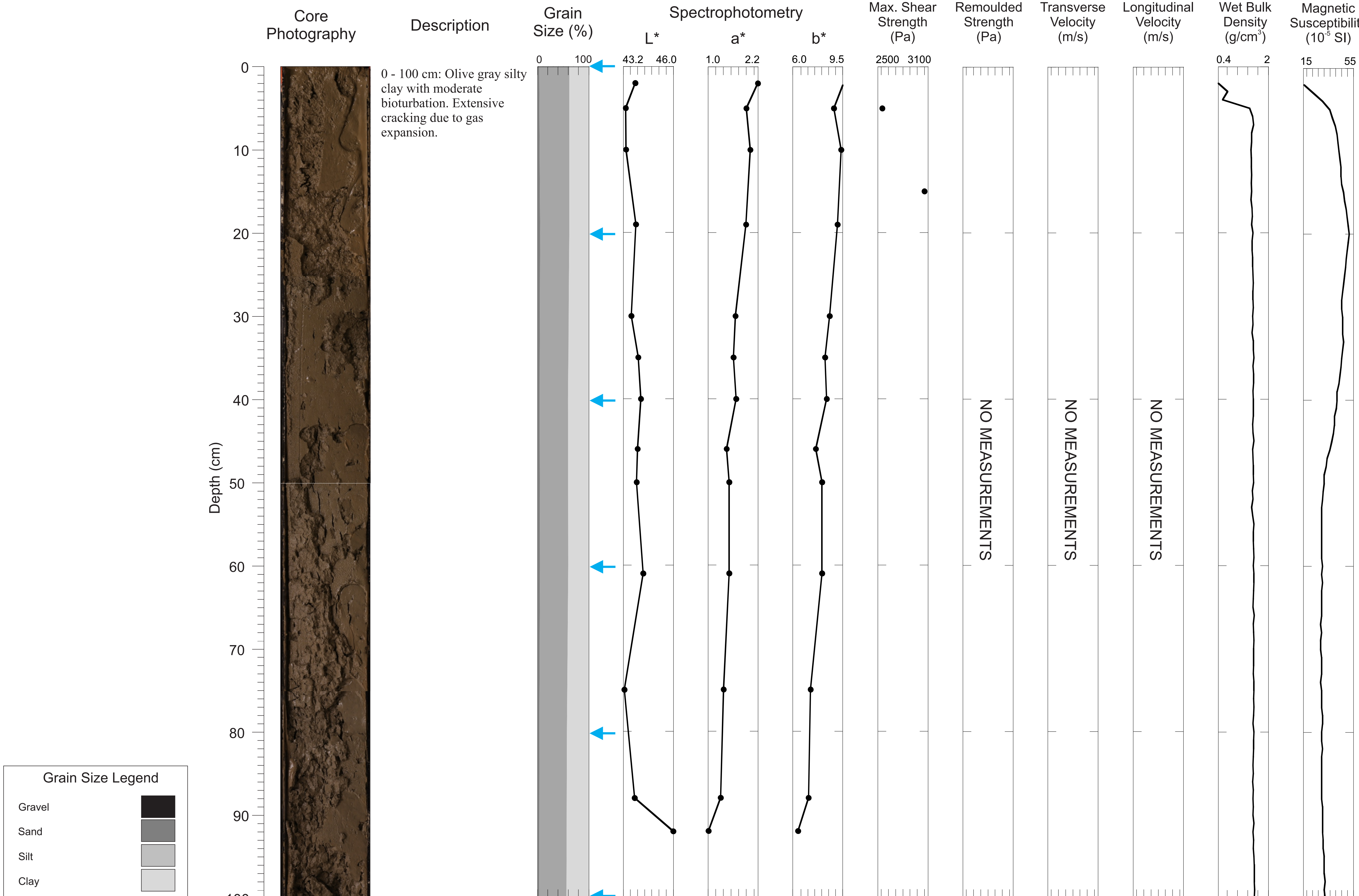
74°01.3901'N / -77°06.9801'W; Water depth = 870 m
Total Length = 243 cm



2008029 0049 PC

74°01.5707'N / -77°07.5158'W; Water depth = 868 m

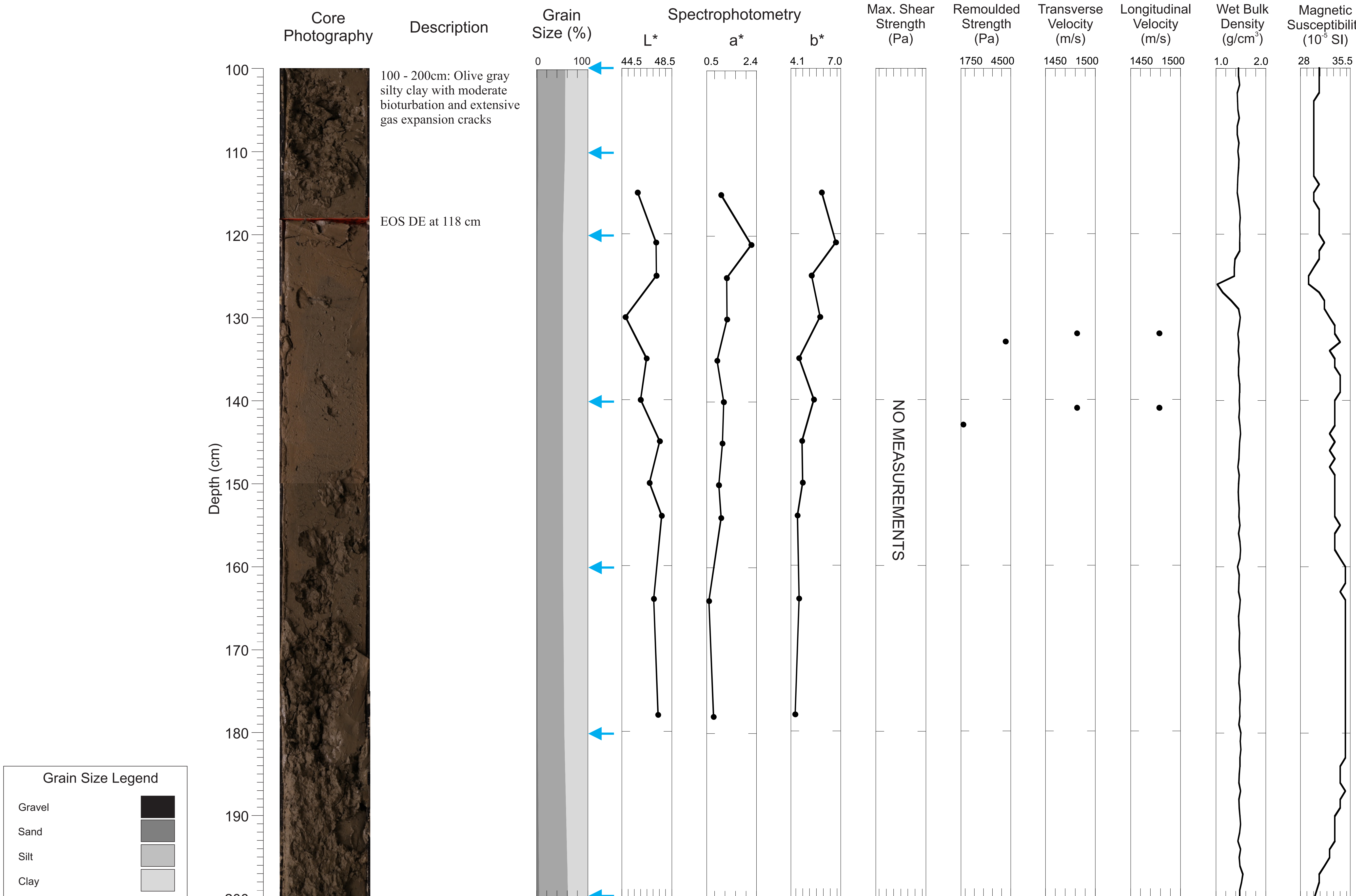
Total Length = 594 cm



2008029 0049 PC

74°01.5707'N / -77°07.5158'W; Water depth = 868 m

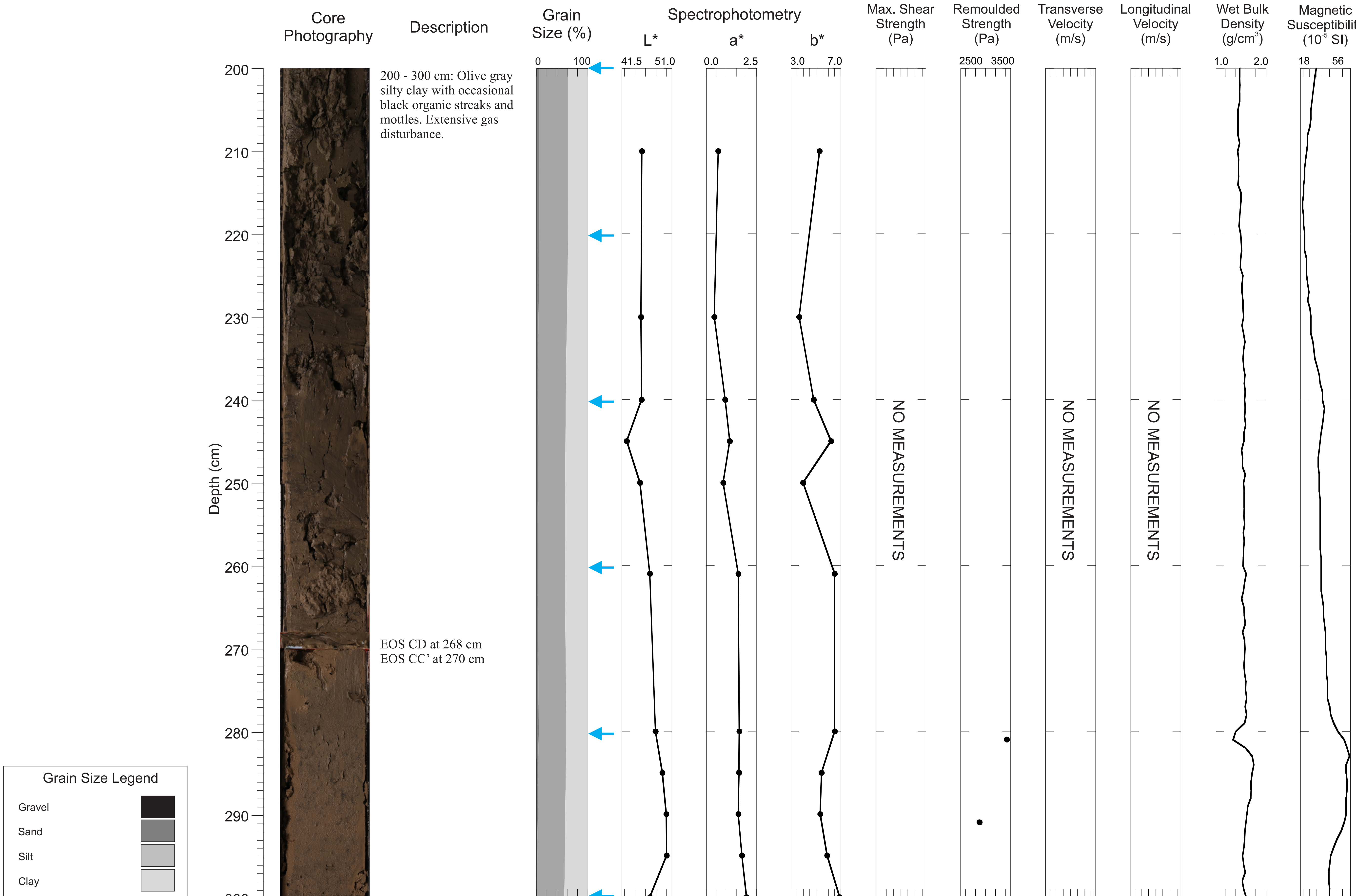
Total Length = 594 cm



2008029 0049 PC

74°01.5707'N / -77°07.5158'W; Water depth = 868 m

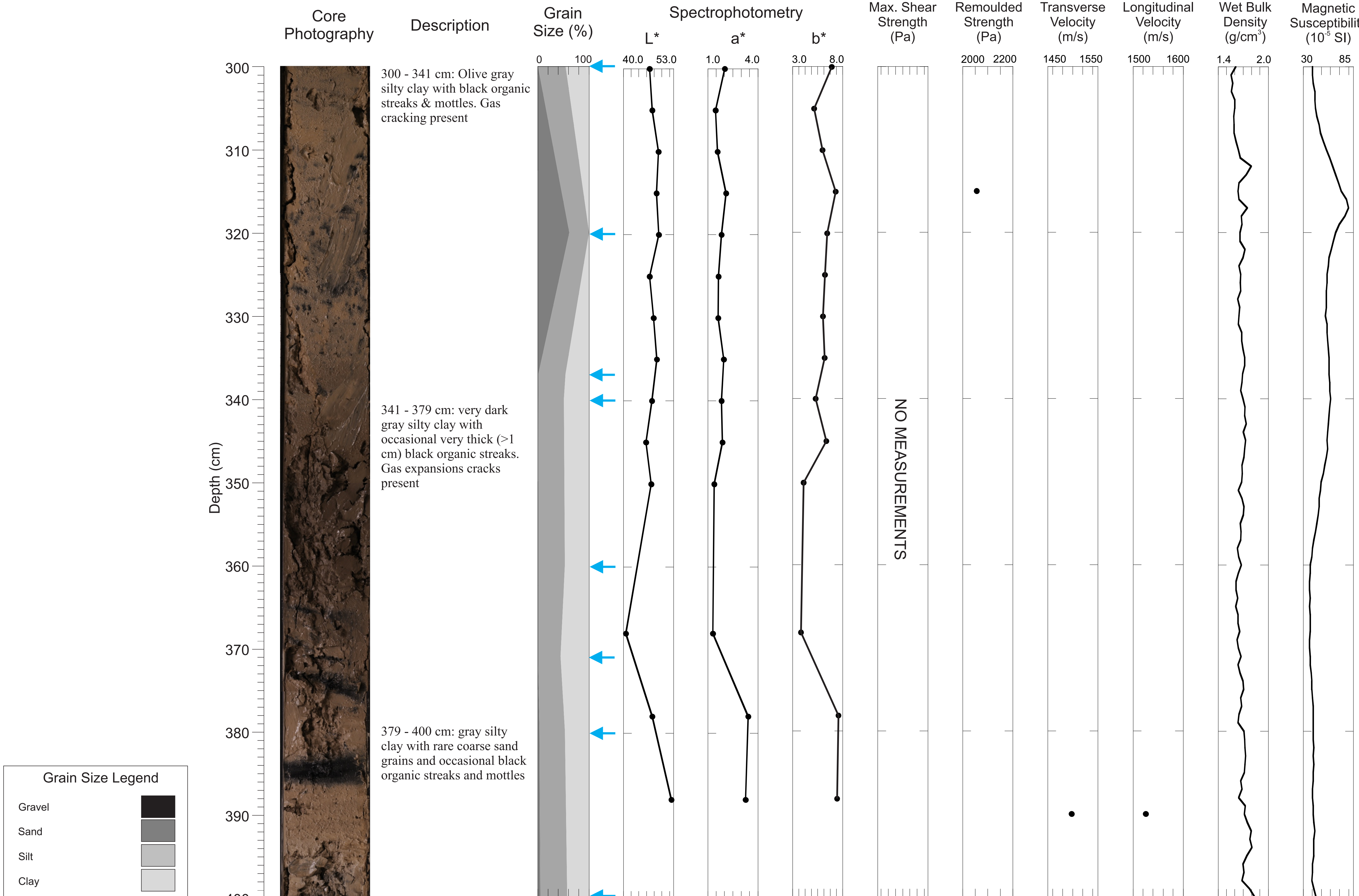
Total Length = 594 cm



2008029 0049 PC

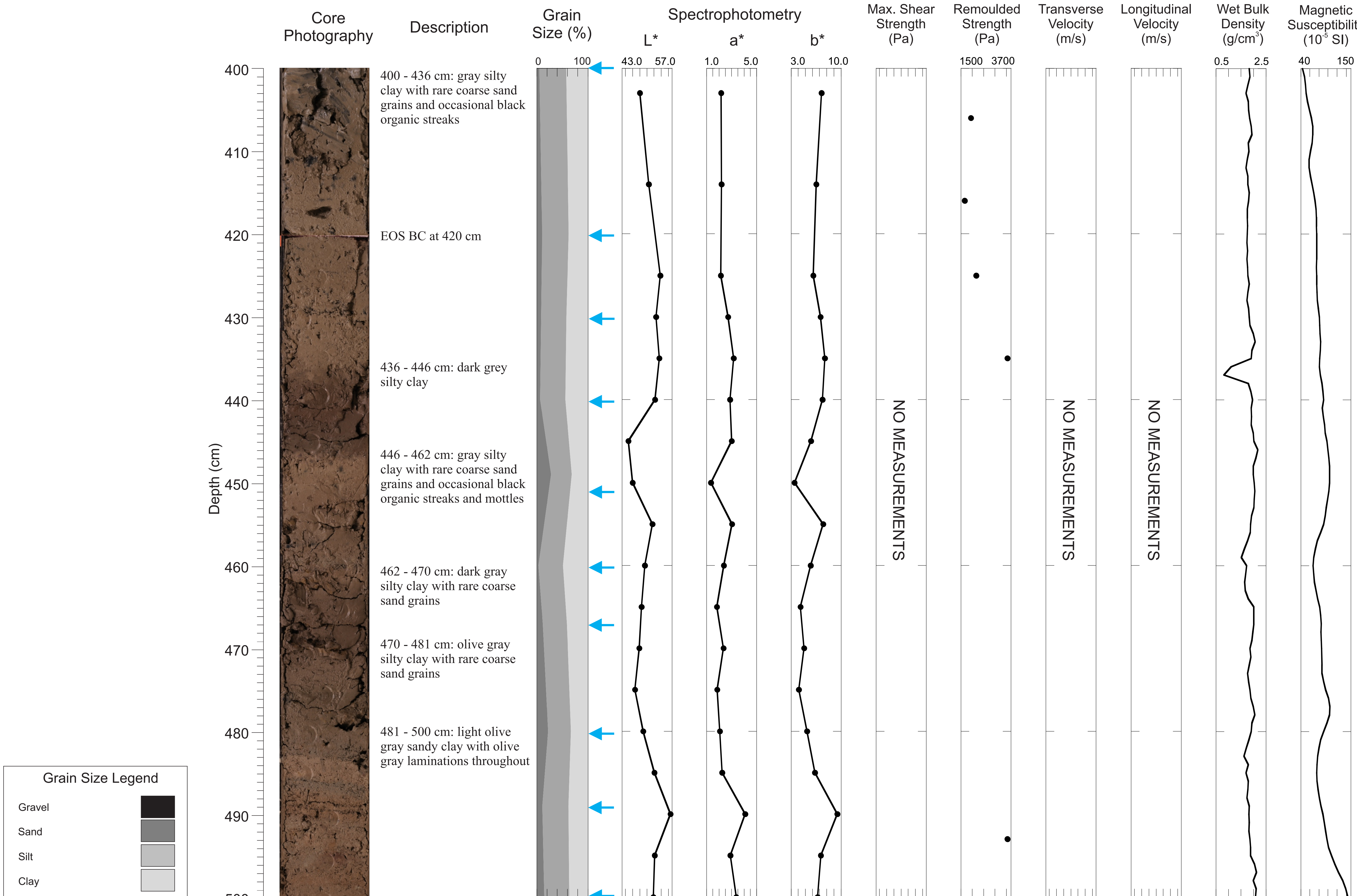
74°01.5707'N / -77°07.5158'W; Water depth = 868 m

Total Length = 594 cm



2008029 0049 PC

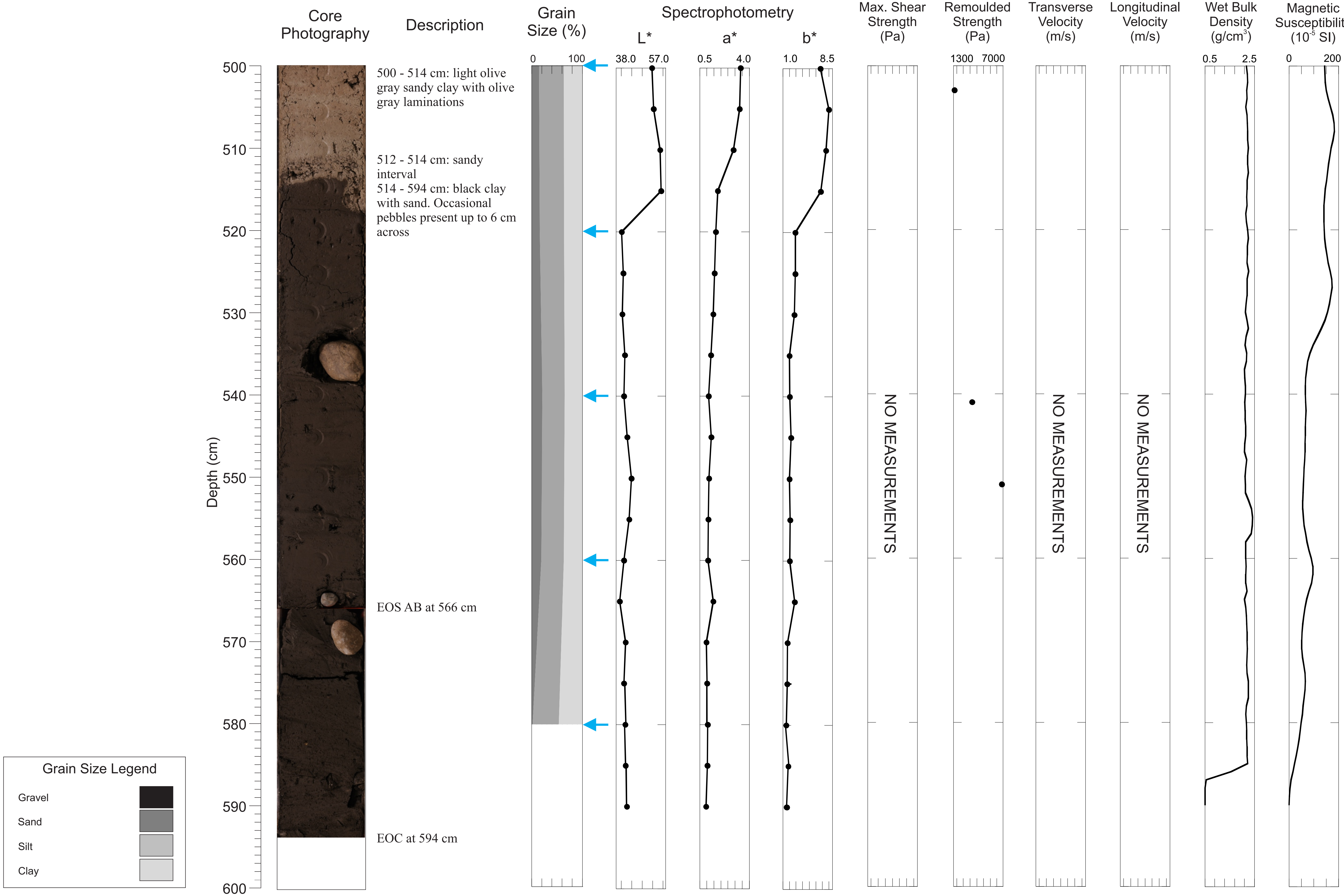
74°01.5707'N / -77°07.5158'W; Water depth = 868 m
Total Length = 594 cm



2008029 0049 PC

74°01.5707'N / -77°07.5158'W; Water depth = 868 m

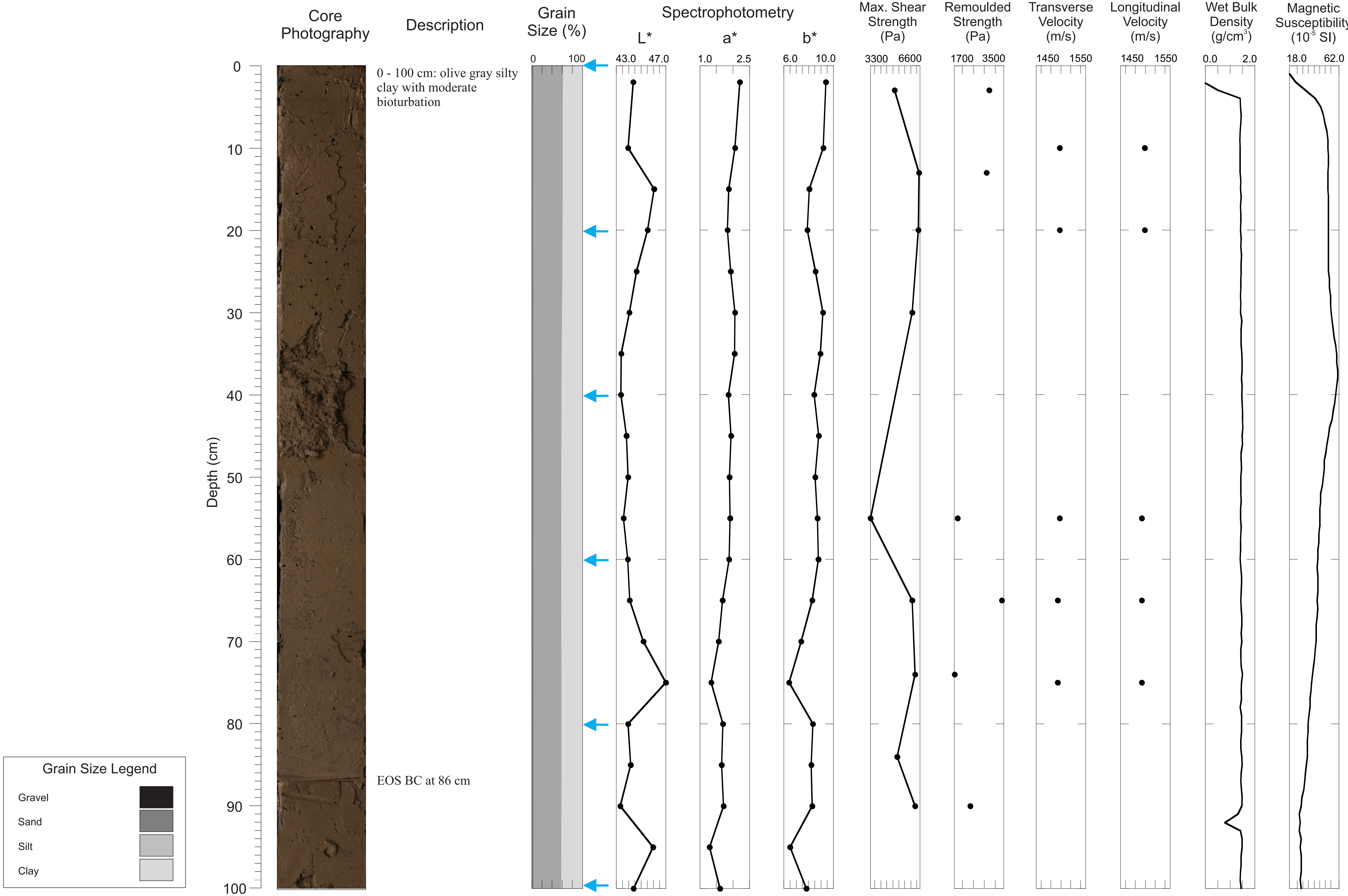
Total Length = 594 cm



2008029 0049 TWC

74°01.5707'N / -77°07.5158'W; Water depth = 868 m

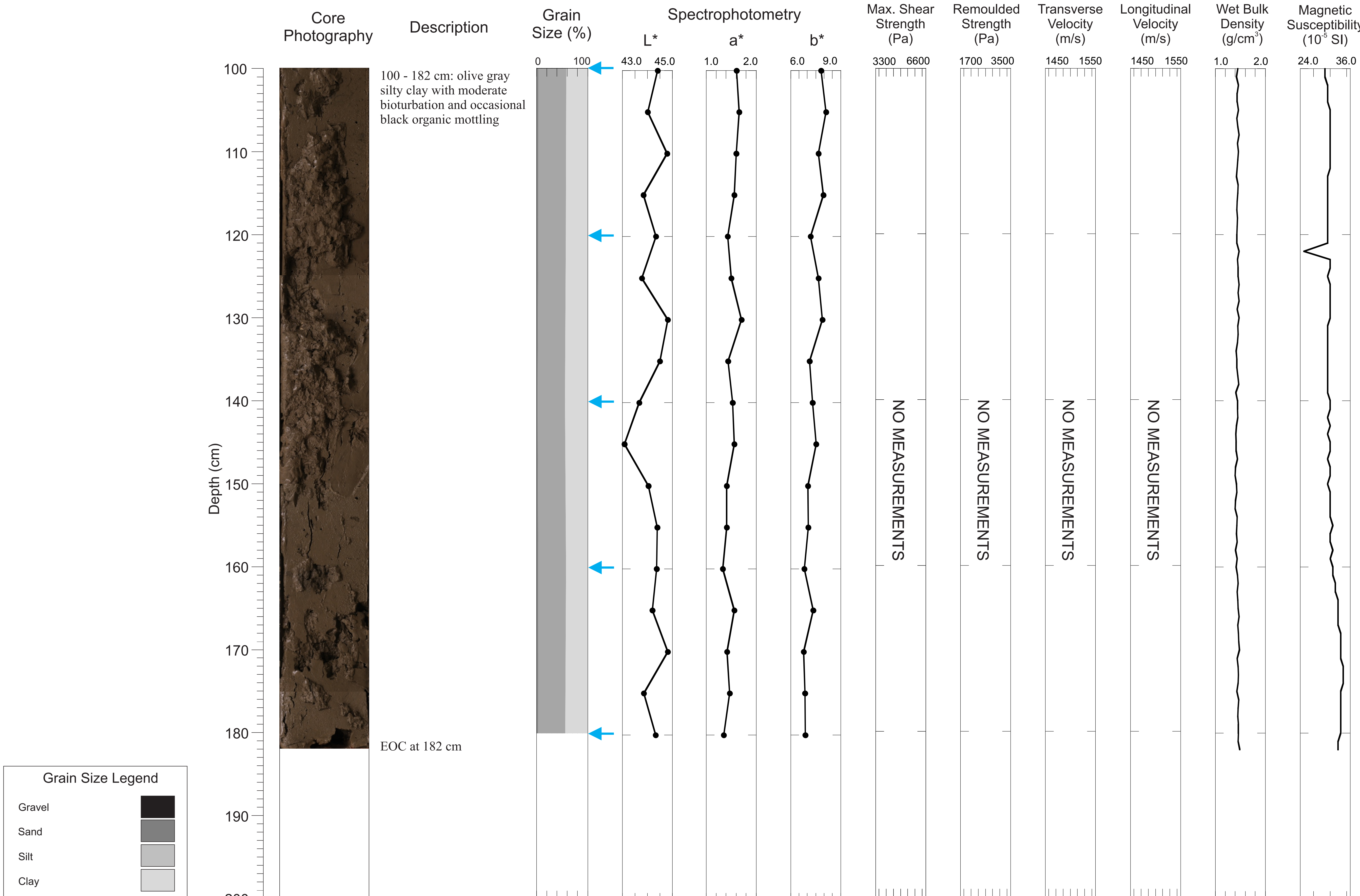
Total Length = 182 cm



2008029 0049 TWC

74°01.5707'N / -77°07.5158'W; Water depth = 868 m

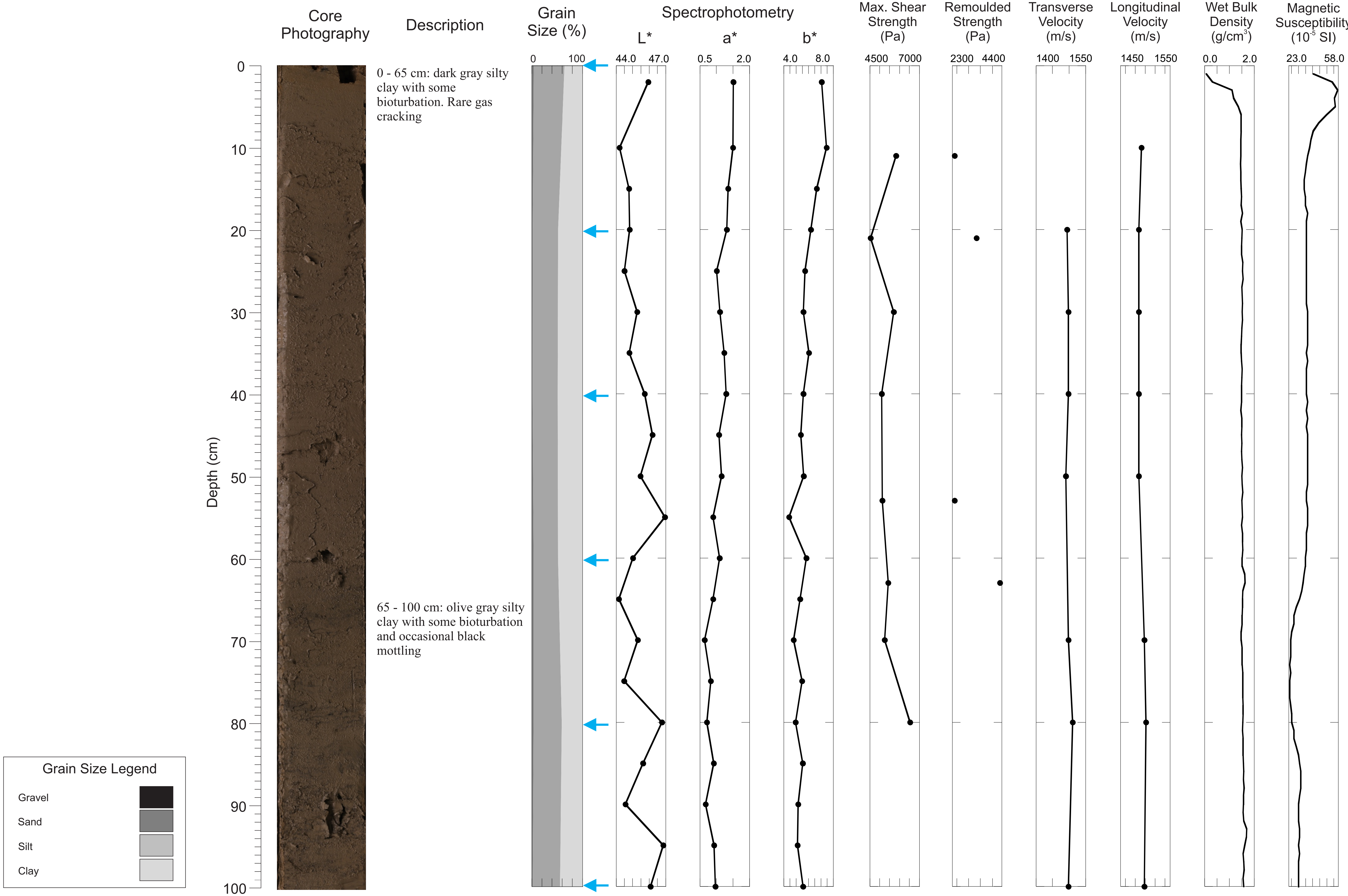
Total Length = 182 cm



2008029 0050 PC

74°06.7406'N / -77°24.0500'W; Water depth = 853 m

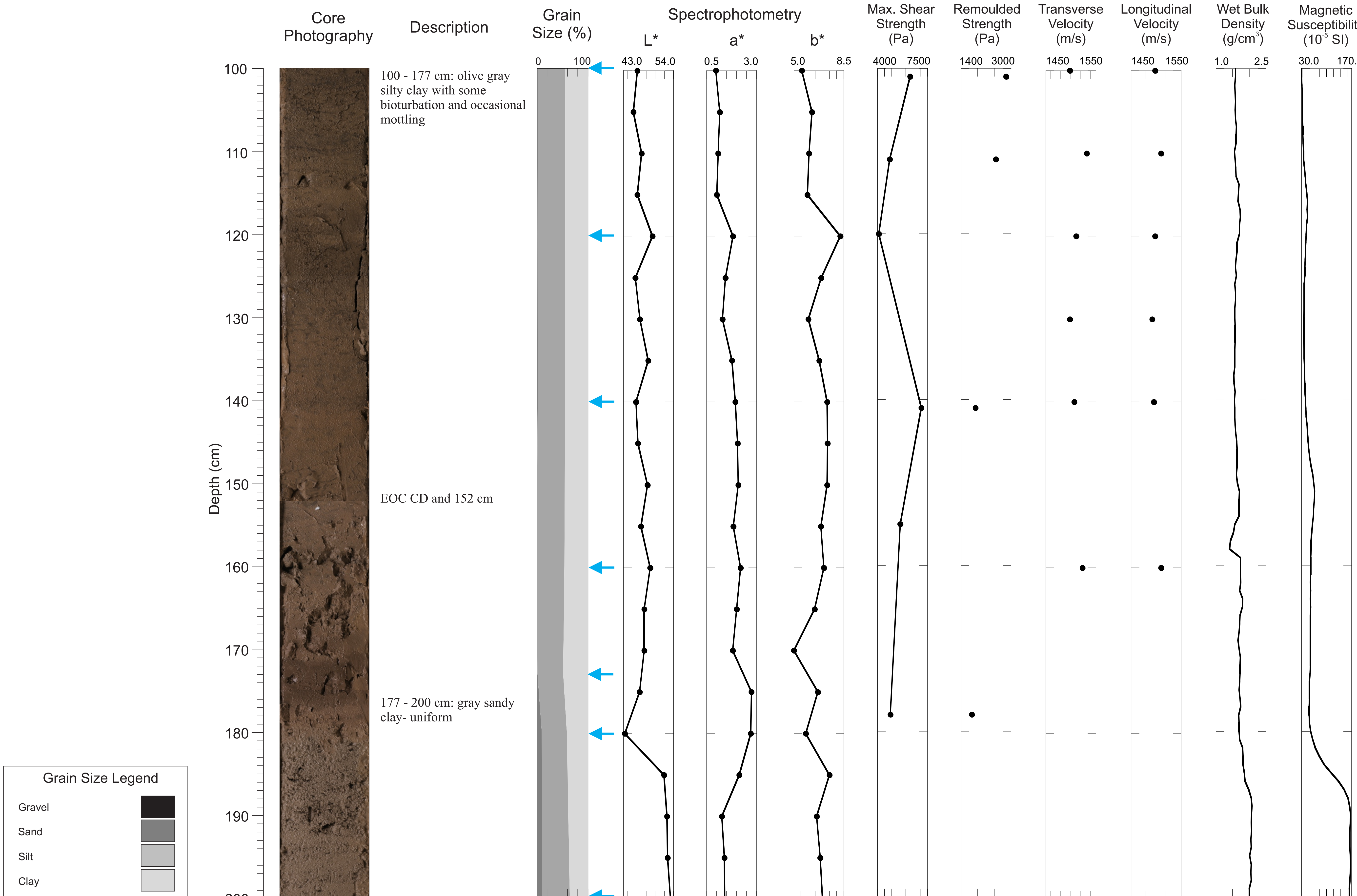
Total Length = 469 cm



2008029 0050 PC

74°06.7406'N / -77°24.0500'W; Water depth = 853 m

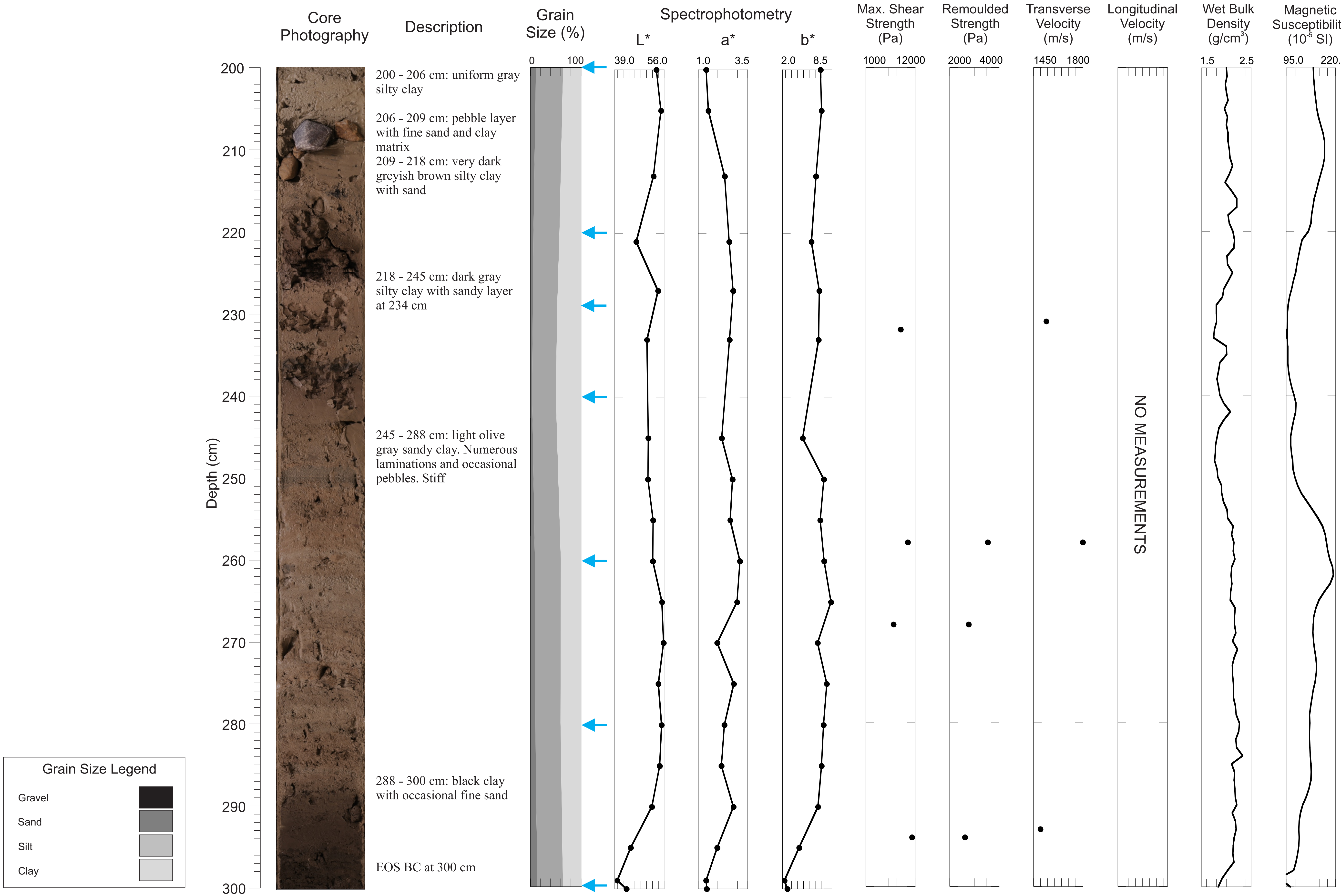
Total Length = 469 cm



2008029 0050 PC

74°06.7406'N / -77°24.0500'W; Water depth = 853 m

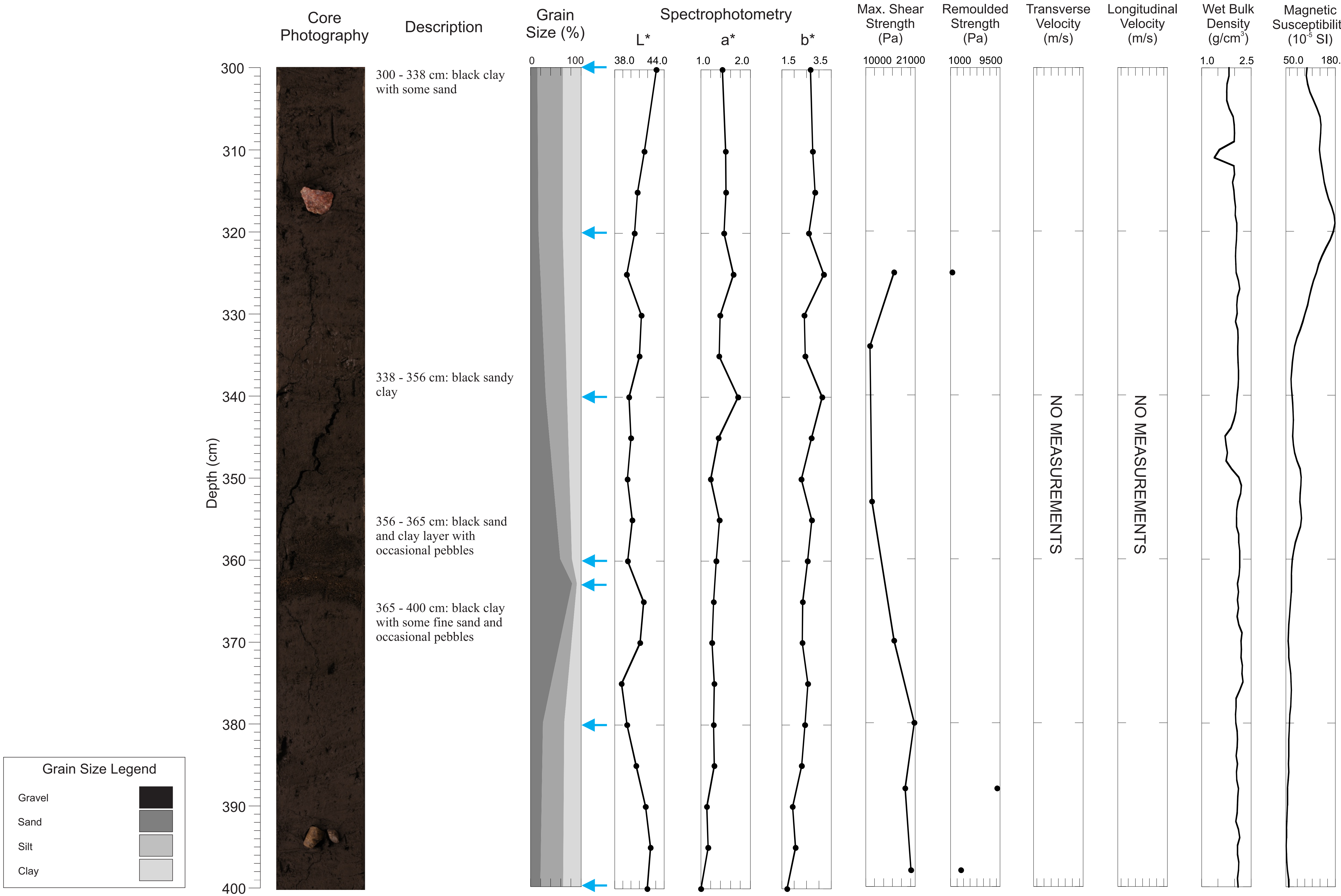
Total Length = 469 cm



2008029 0050 PC

74°06.7406'N / -77°24.0500'W; Water depth = 853 m

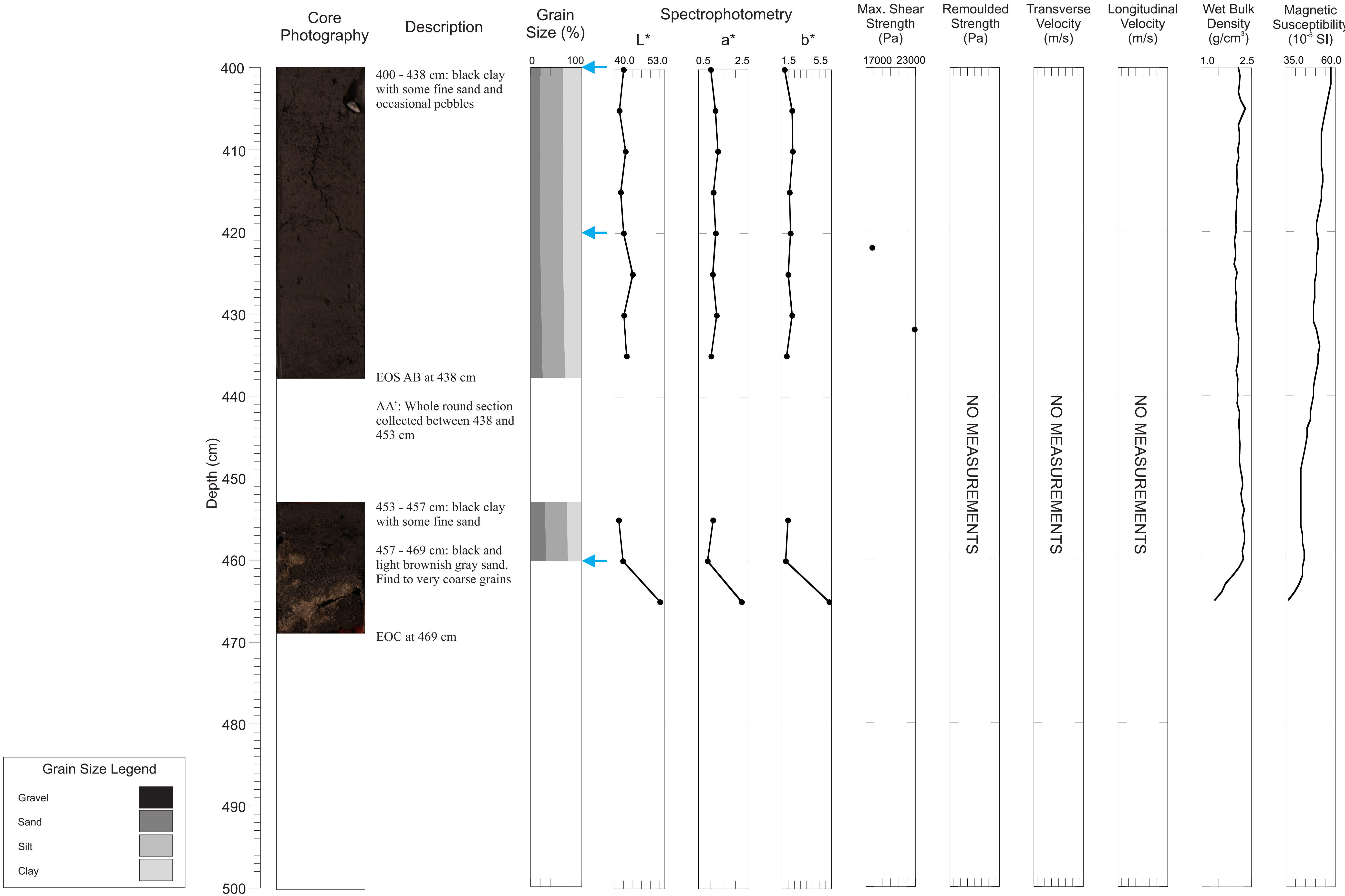
Total Length = 469 cm



2008029 0050 PC

74°06.7406'N / -77°24.0500'W; Water depth = 853 m

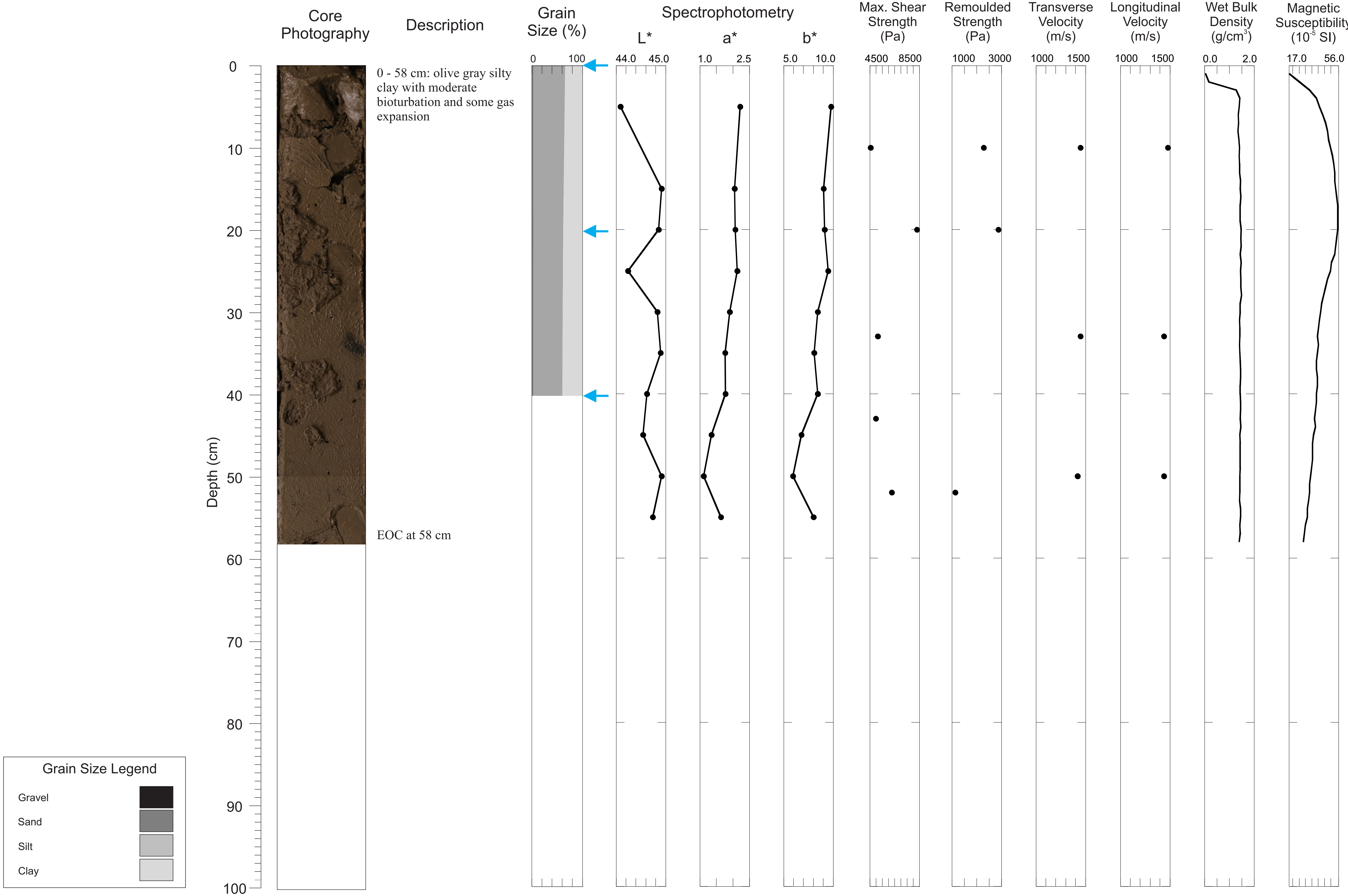
Total Length = 469 cm



2008029 0050 TWC

74°06.7406'N / -77°24.0500'W; Water depth = 853 m

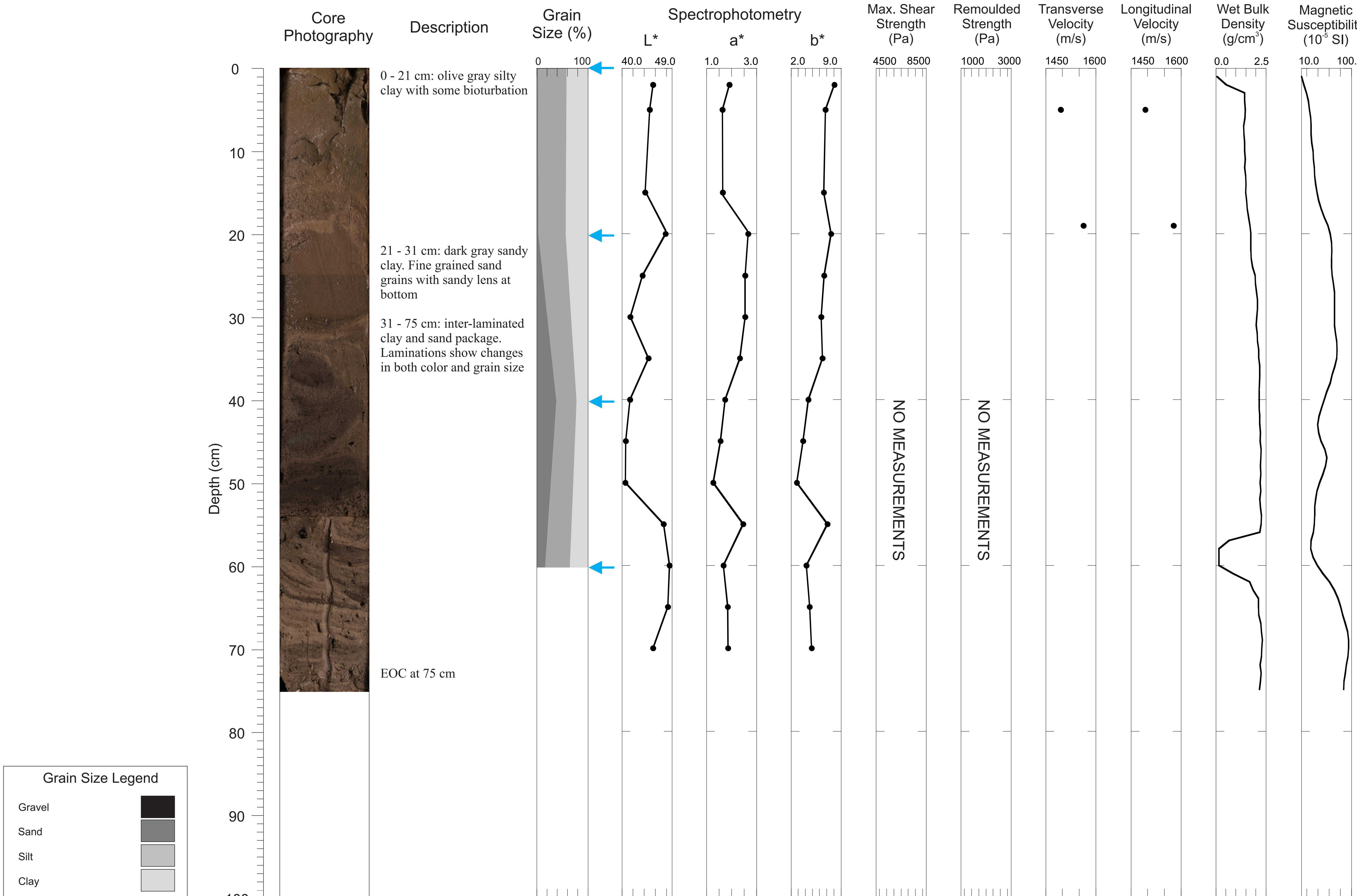
Total Length = 58 cm



2008029 0051 PC

74°18.4377'N / -77°01.2023'W; Water depth = 735 m

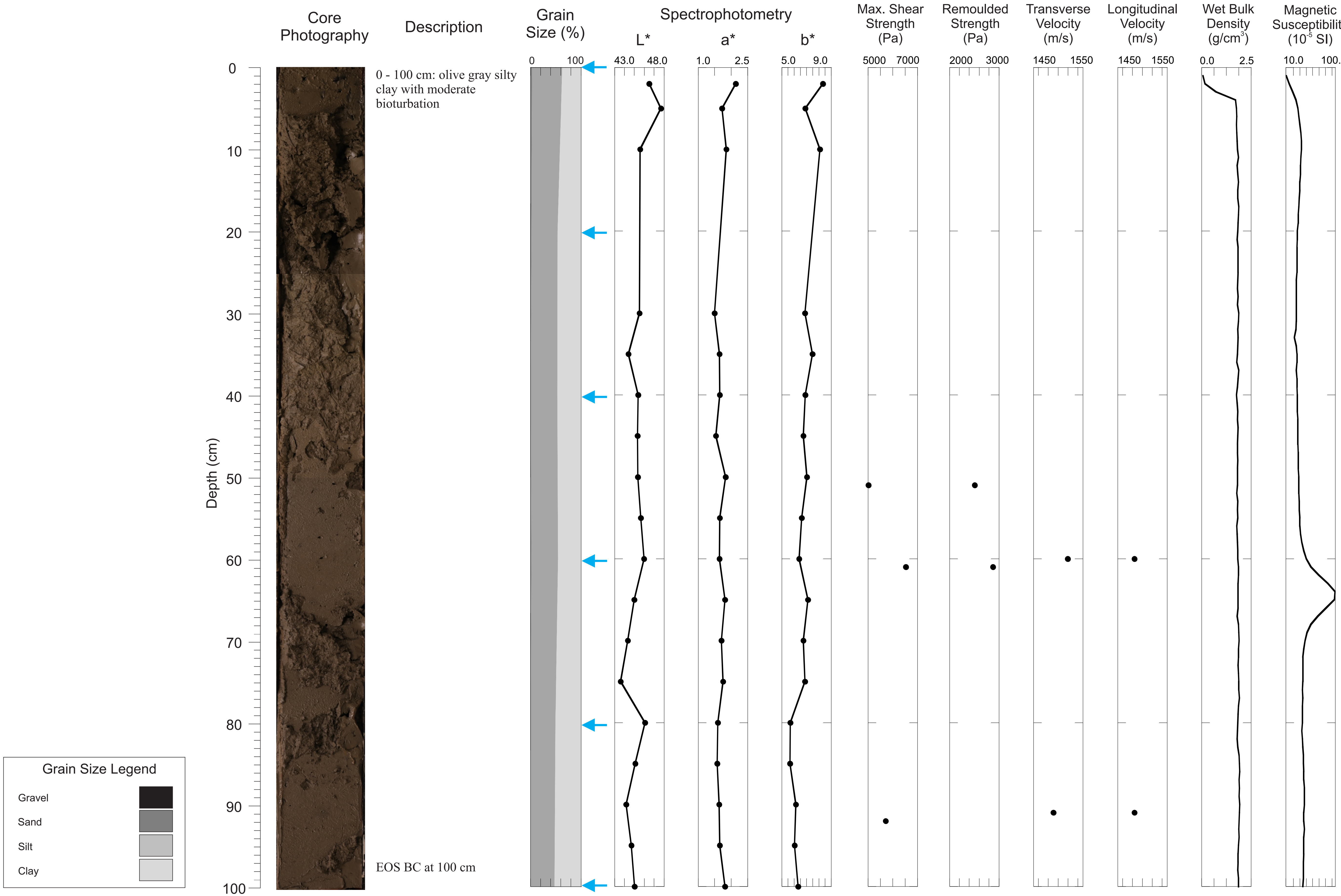
Total Length = 75 cm



2008029 0051 TWC

74°18.4377'N / -77°01.2023'W; Water depth = 735 m

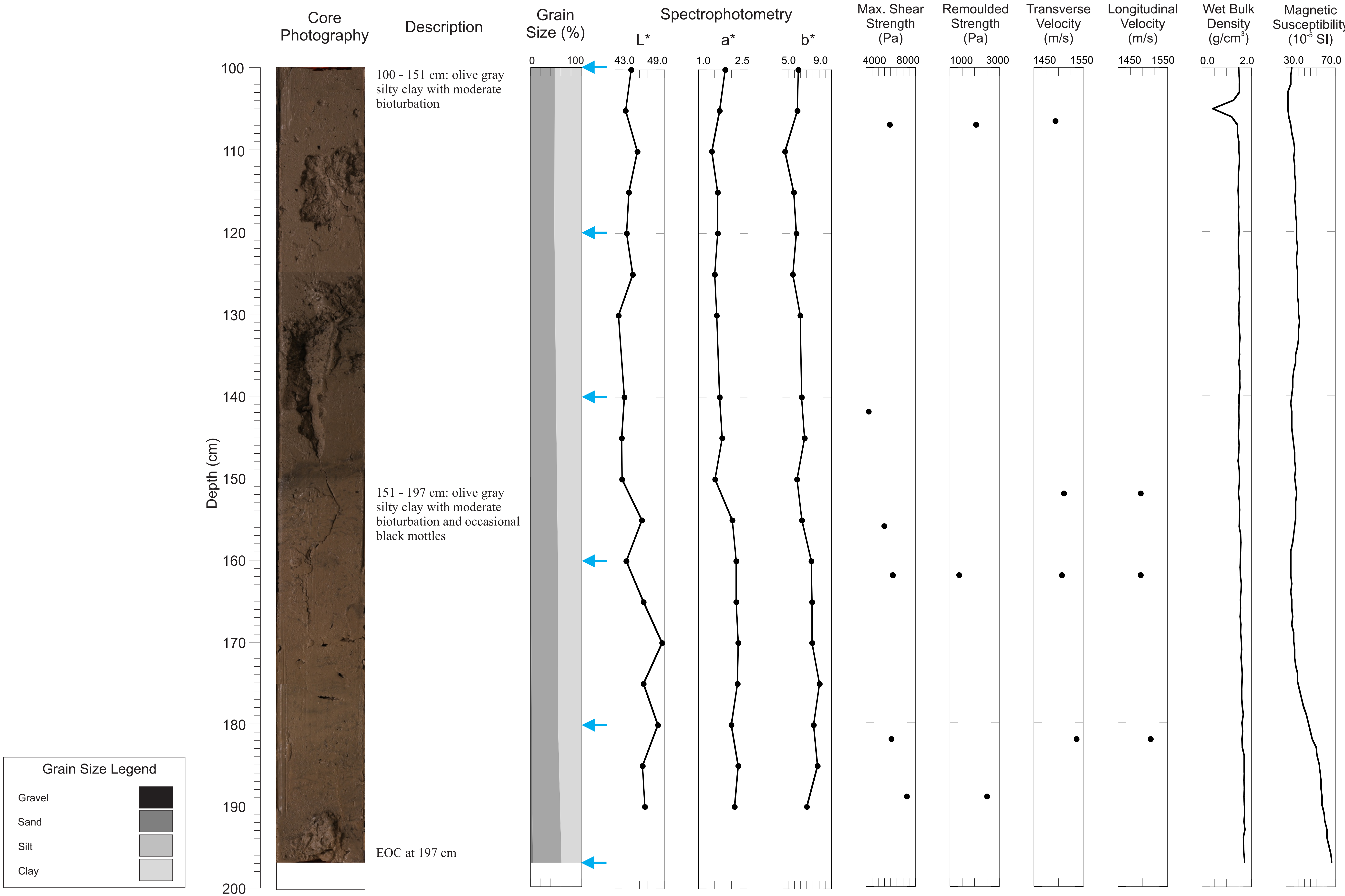
Total Length = 197 cm



2008029 0051 TWC

74°18.4377'N / -77°01.2023'W; Water depth = 735 m

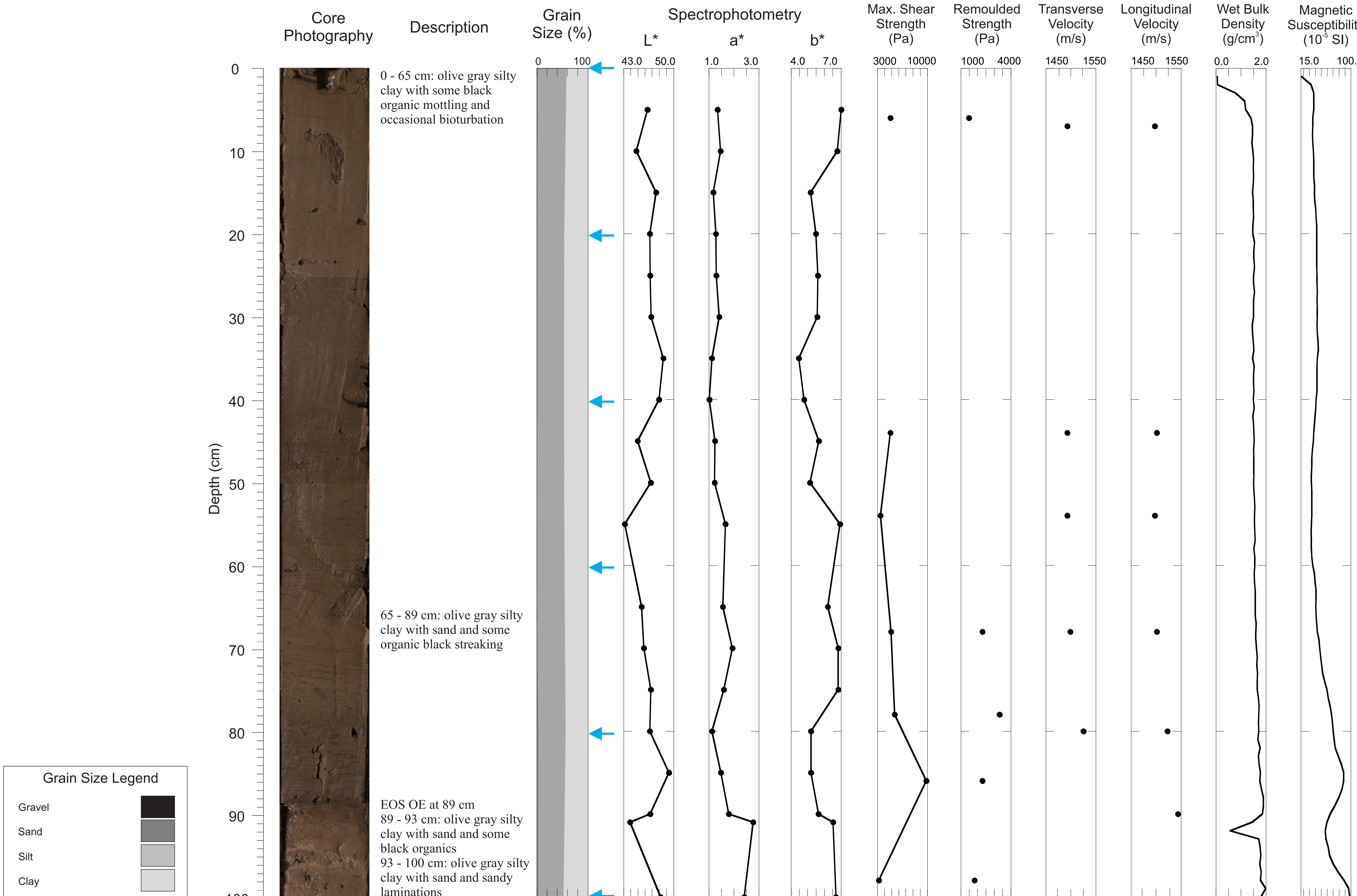
Total Length = 197 cm



2008029 0052 PC

74°18.4245'N / -77°01.1761'W; Water depth = 734 m

Total Length = 467 cm



0 - 65 cm: olive gray silty clay with some black organic mottling and occasional bioturbation

65 - 89 cm: olive gray silty clay with sand and some organic black streaking

EOS OE at 89 cm

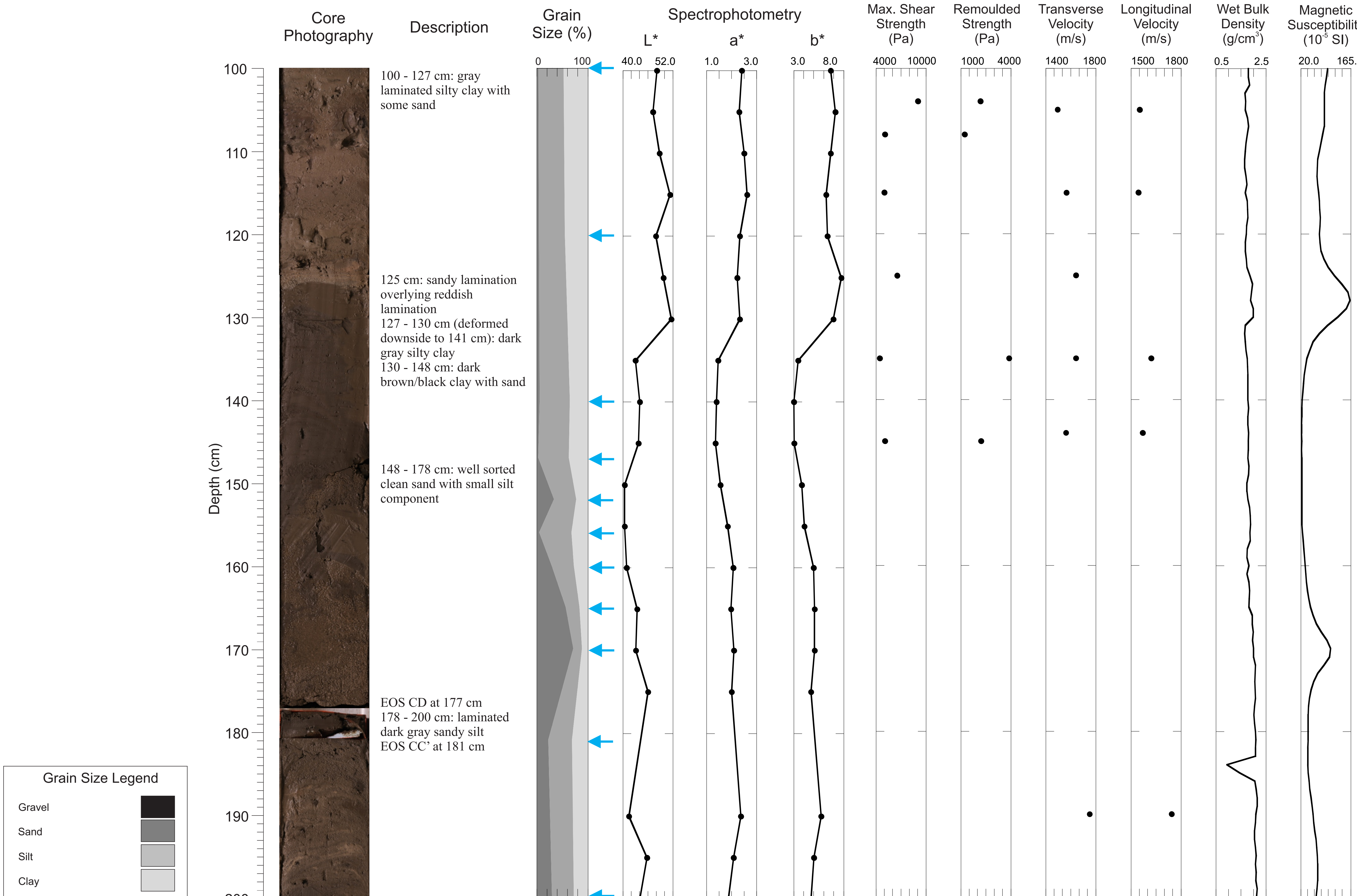
89 - 93 cm: olive gray silty clay with sand and some black organics

93 - 100 cm: olive gray silty clay with sand and sandy laminations

2008029 0052 PC

74°18.4245'N / -77°01.1761'W; Water depth = 734 m

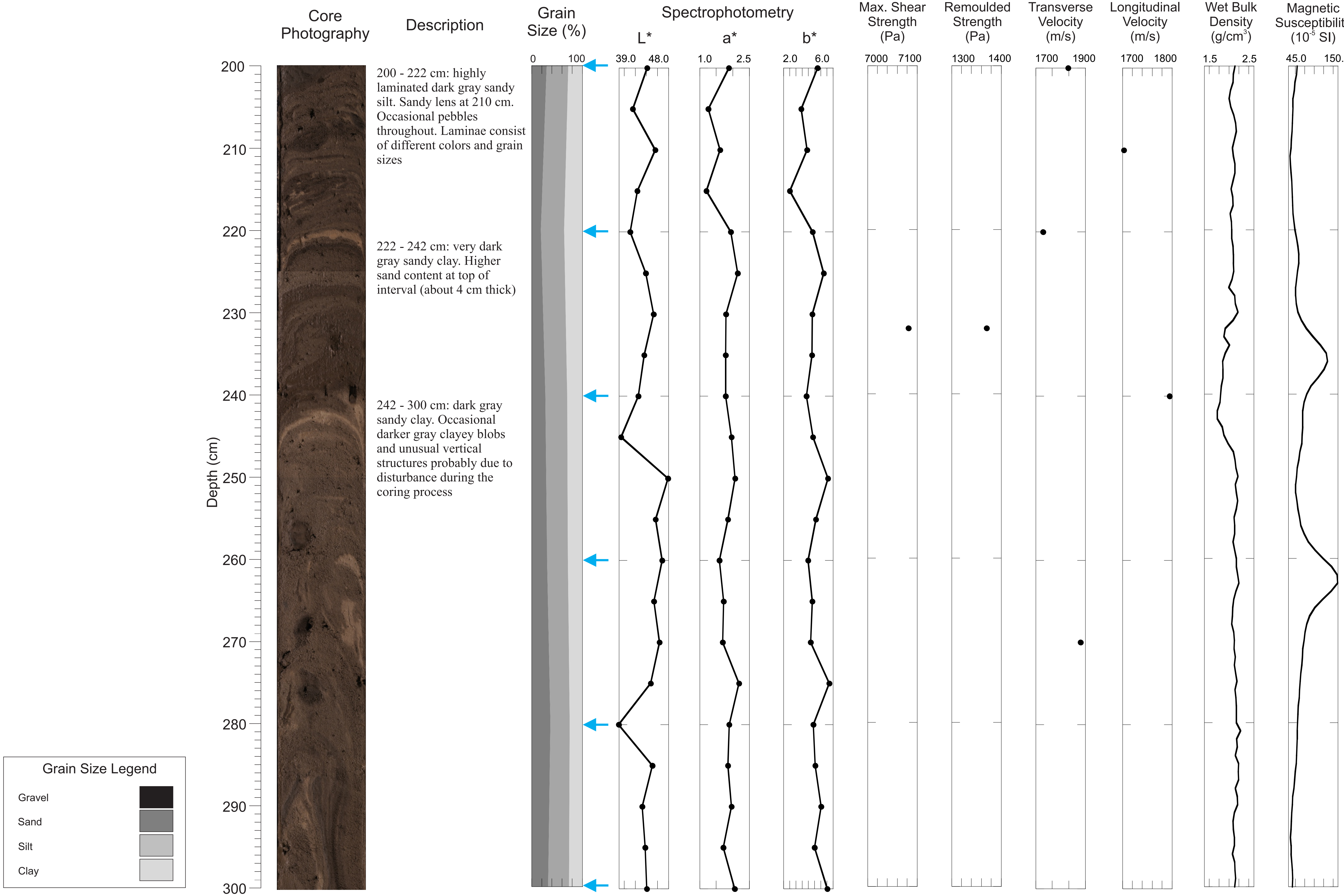
Total Length = 467 cm



2008029 0052 PC

74°18.4245'N / -77°01.1761'W; Water depth = 734 m

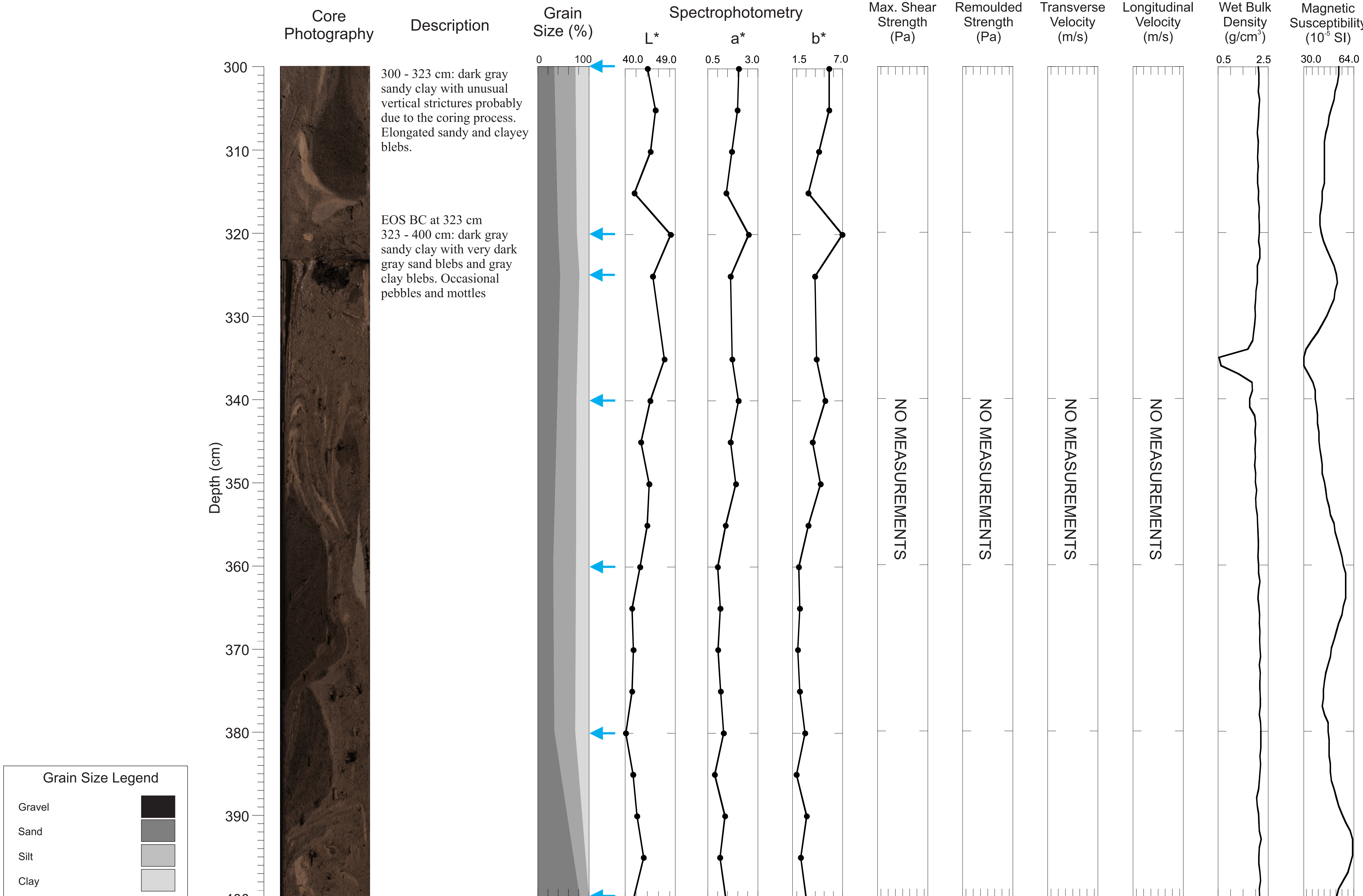
Total Length = 467 cm



2008029 0052 PC

74°18.4245'N / -77°01.1761'W; Water depth = 734 m

Total Length = 467 cm



300 - 323 cm: dark gray sandy clay with unusual vertical strictures probably due to the coring process. Elongated sandy and clayey blebs.

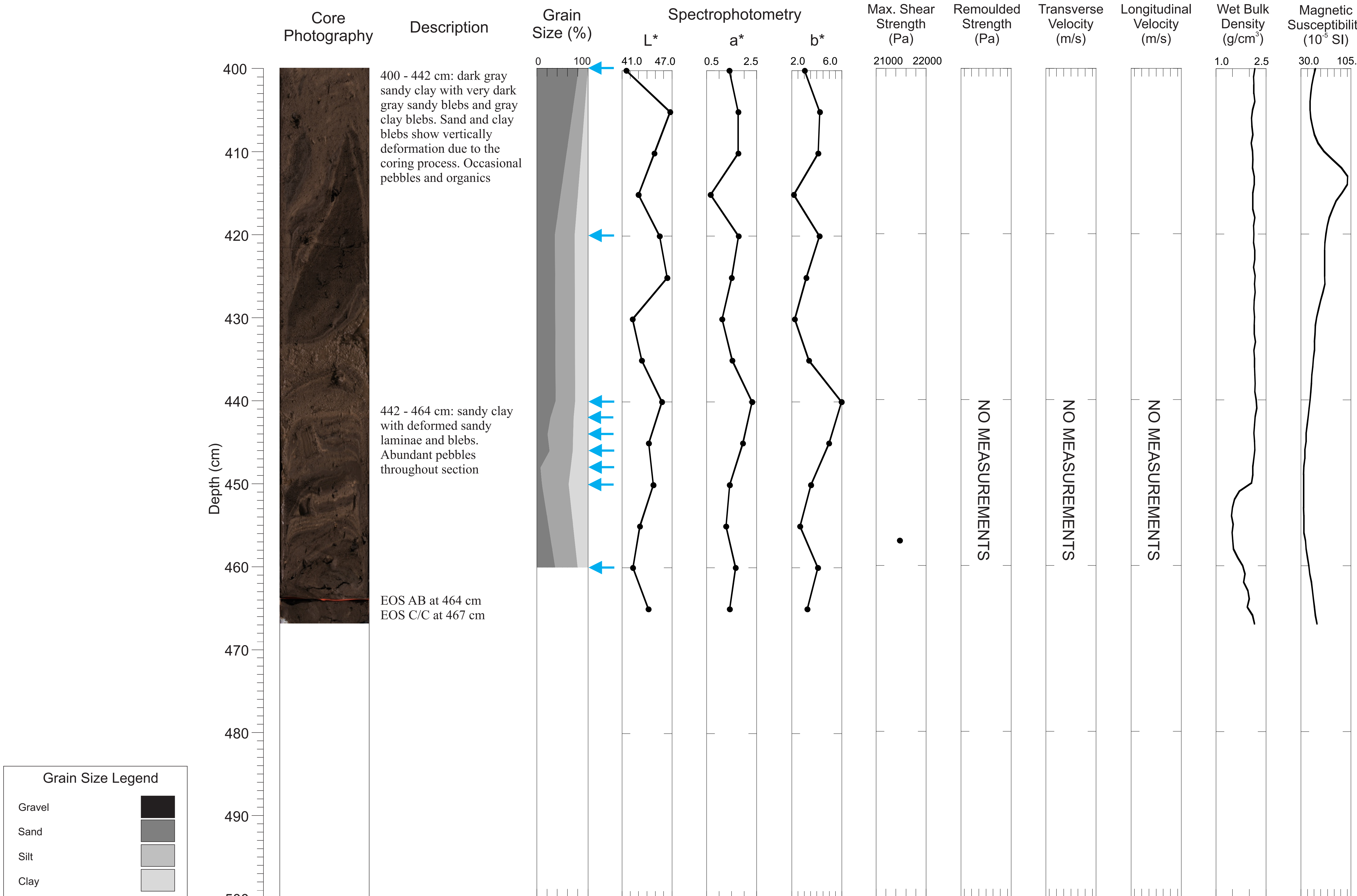
EOS BC at 323 cm

323 - 400 cm: dark gray sandy clay with very dark gray sand blebs and gray clay blebs. Occasional pebbles and mottles

2008029 0052 PC

74°18.4245'N / -77°01.1761'W; Water depth = 734 m

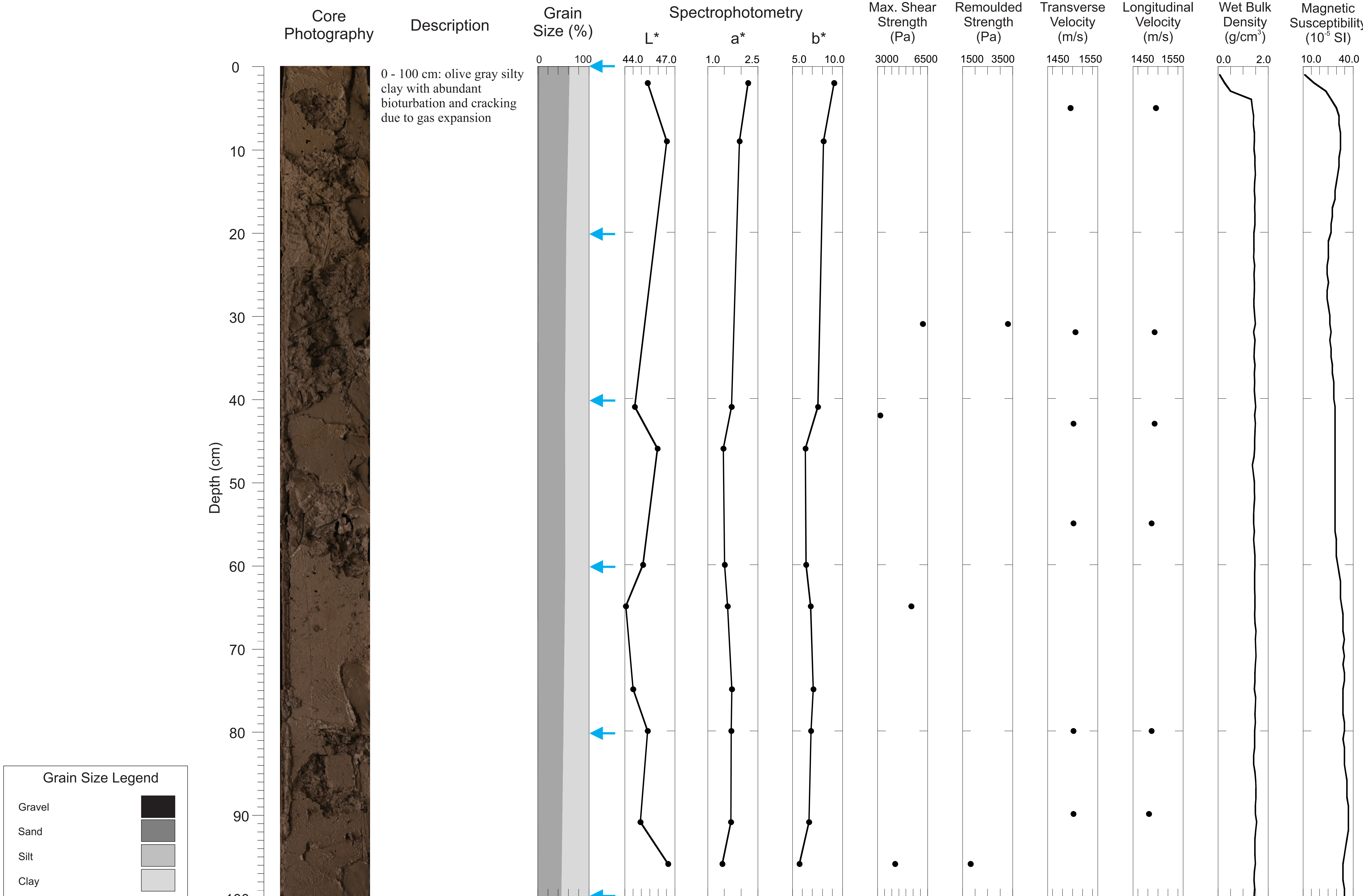
Total Length = 467 cm



2008029 0052 TWC

74°18.4245'N / -77°01.1761'W; Water depth = 734 m

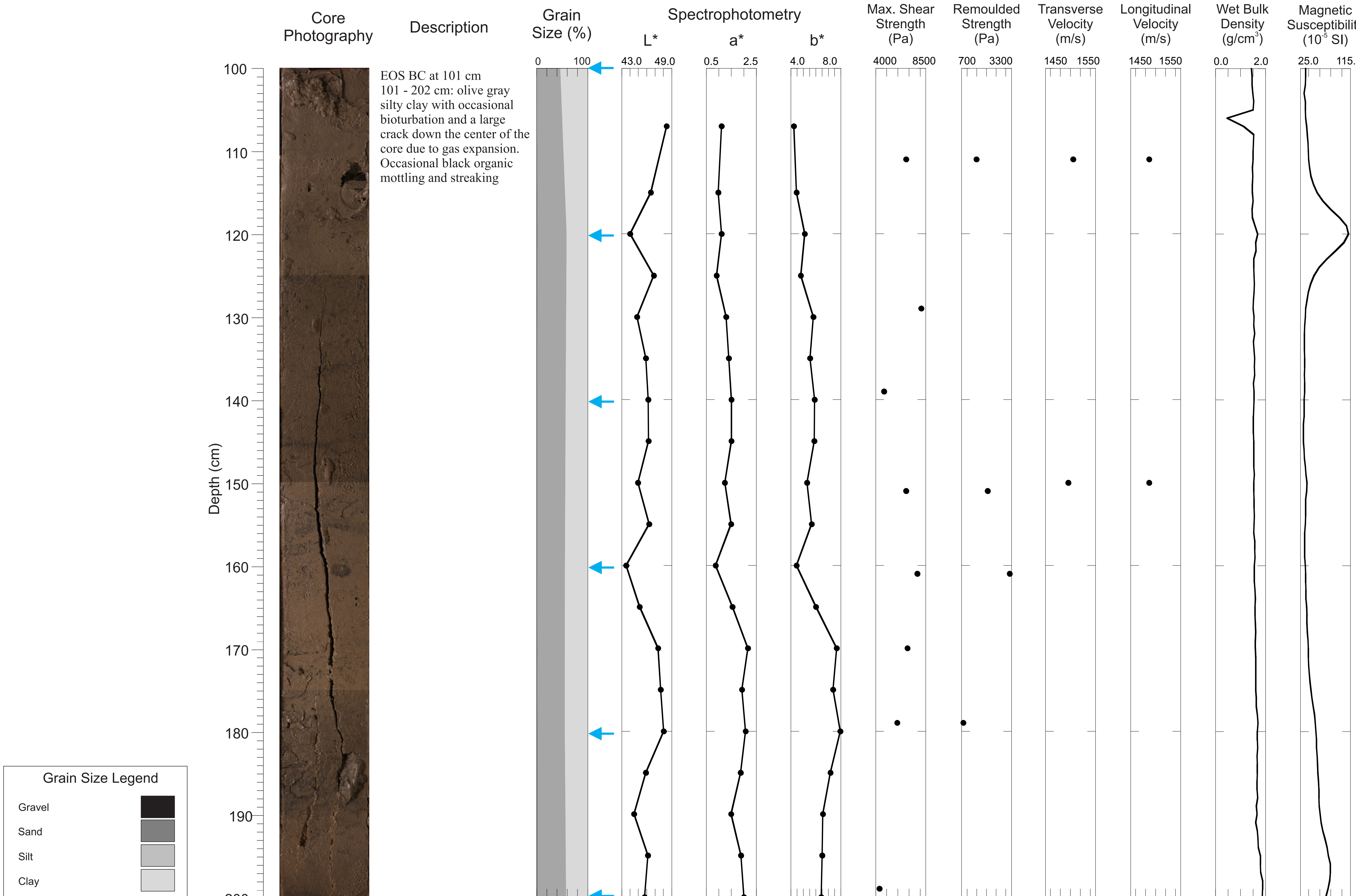
Total Length = 202 cm



2008029 0052 TWC

74°18.4245'N / -77°01.1761'W; Water depth = 734 m

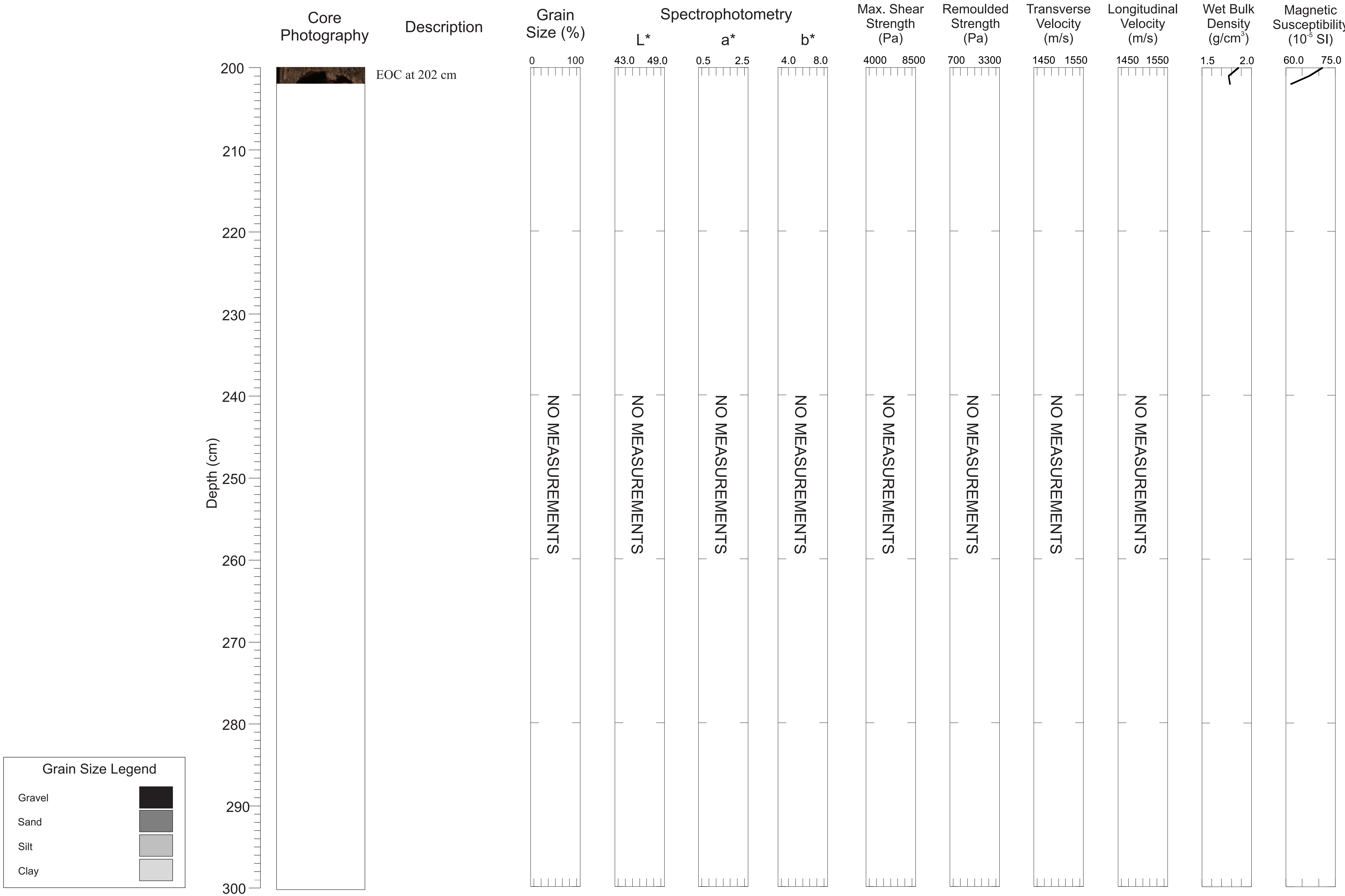
Total Length = 202 cm



2008029 0052 TWC

74°18.4245'N / -77°01.1761'W; Water depth = 734 m

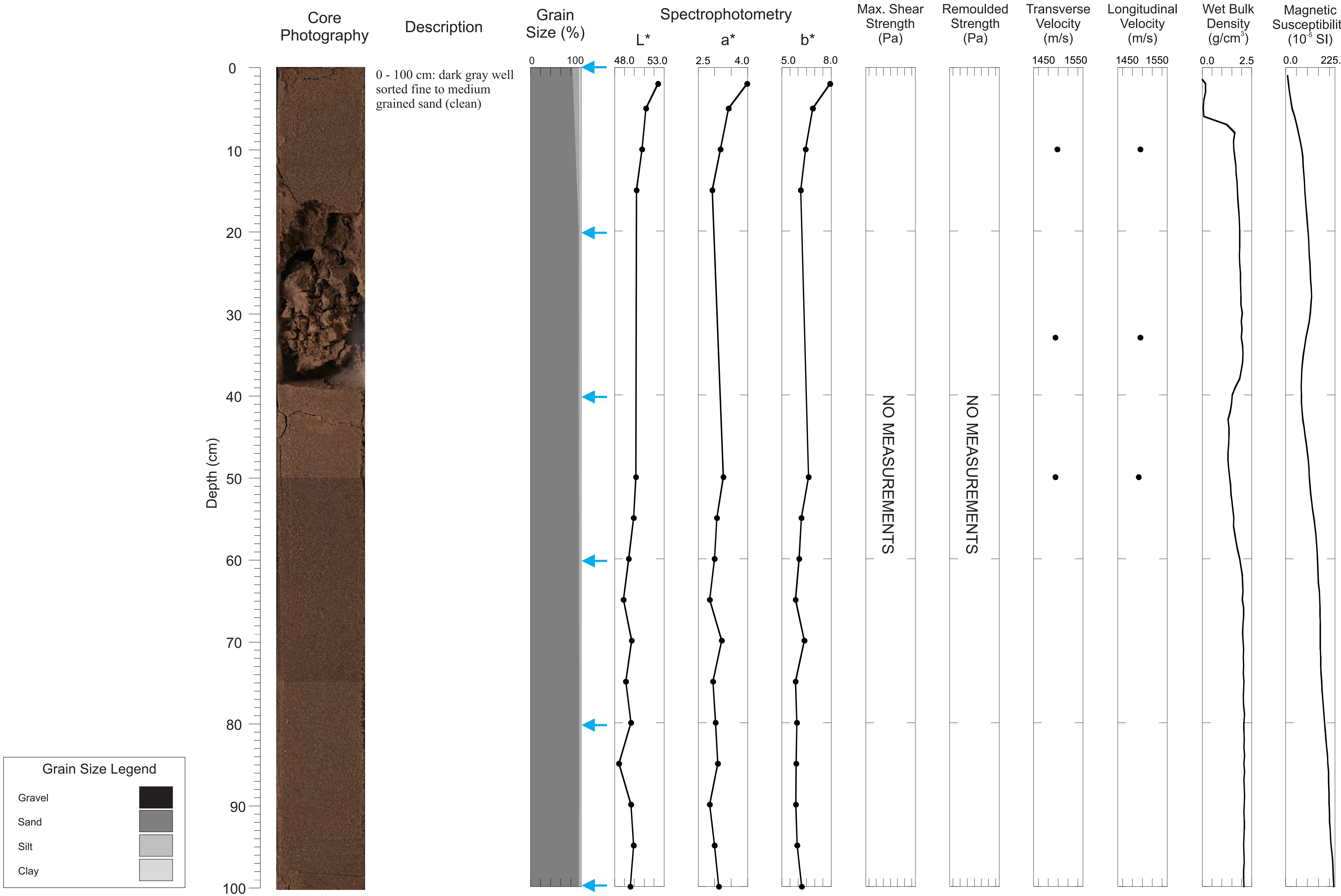
Total Length = 202 cm



2008029 0053 PC

73°50.4330'N / -80°23.6748'W; Water depth = 918 m

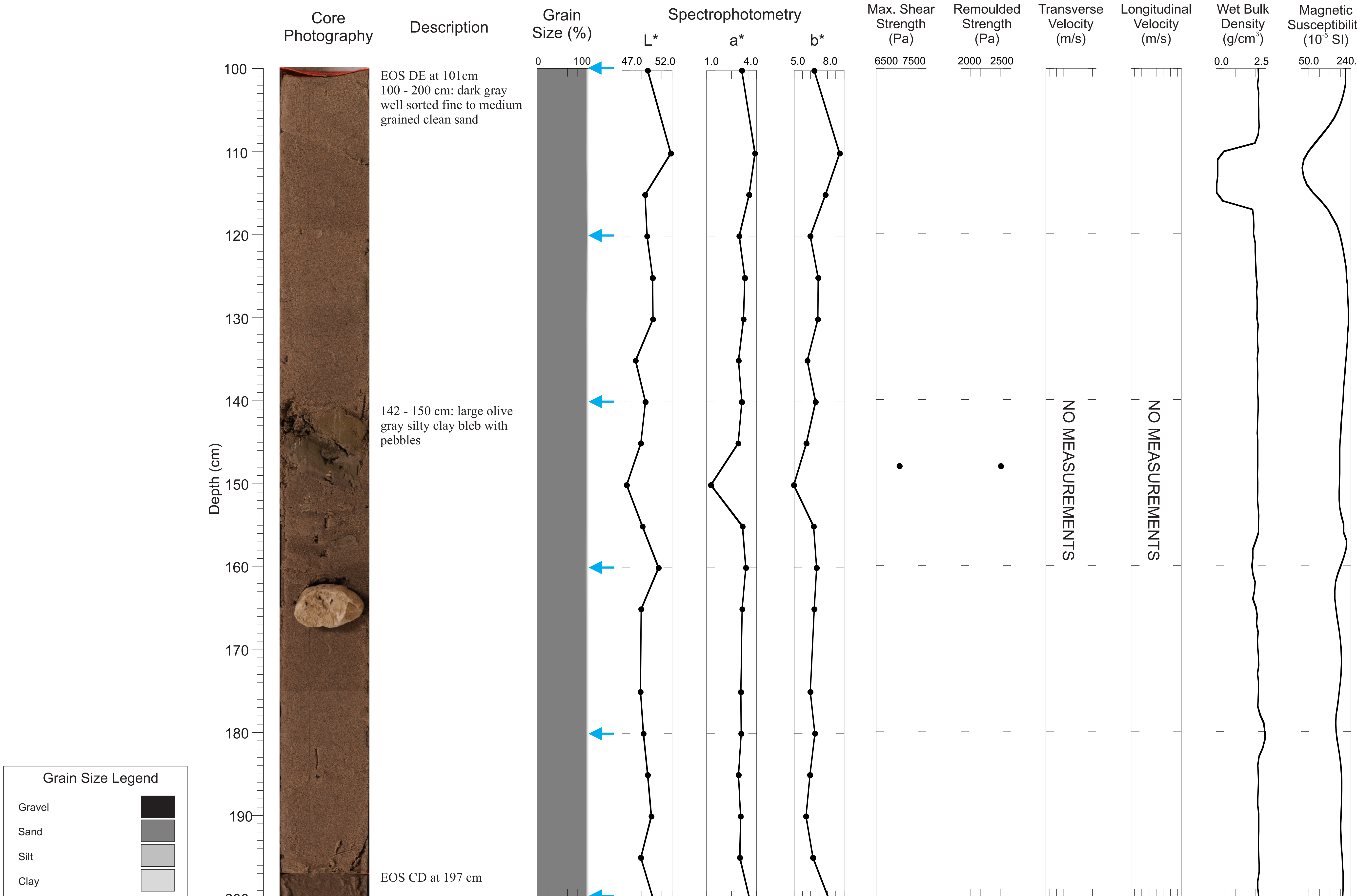
Total Length = 455 cm



2008029 0053 PC

73°50.4330'N / -80°23.6748'W; Water depth = 918 m

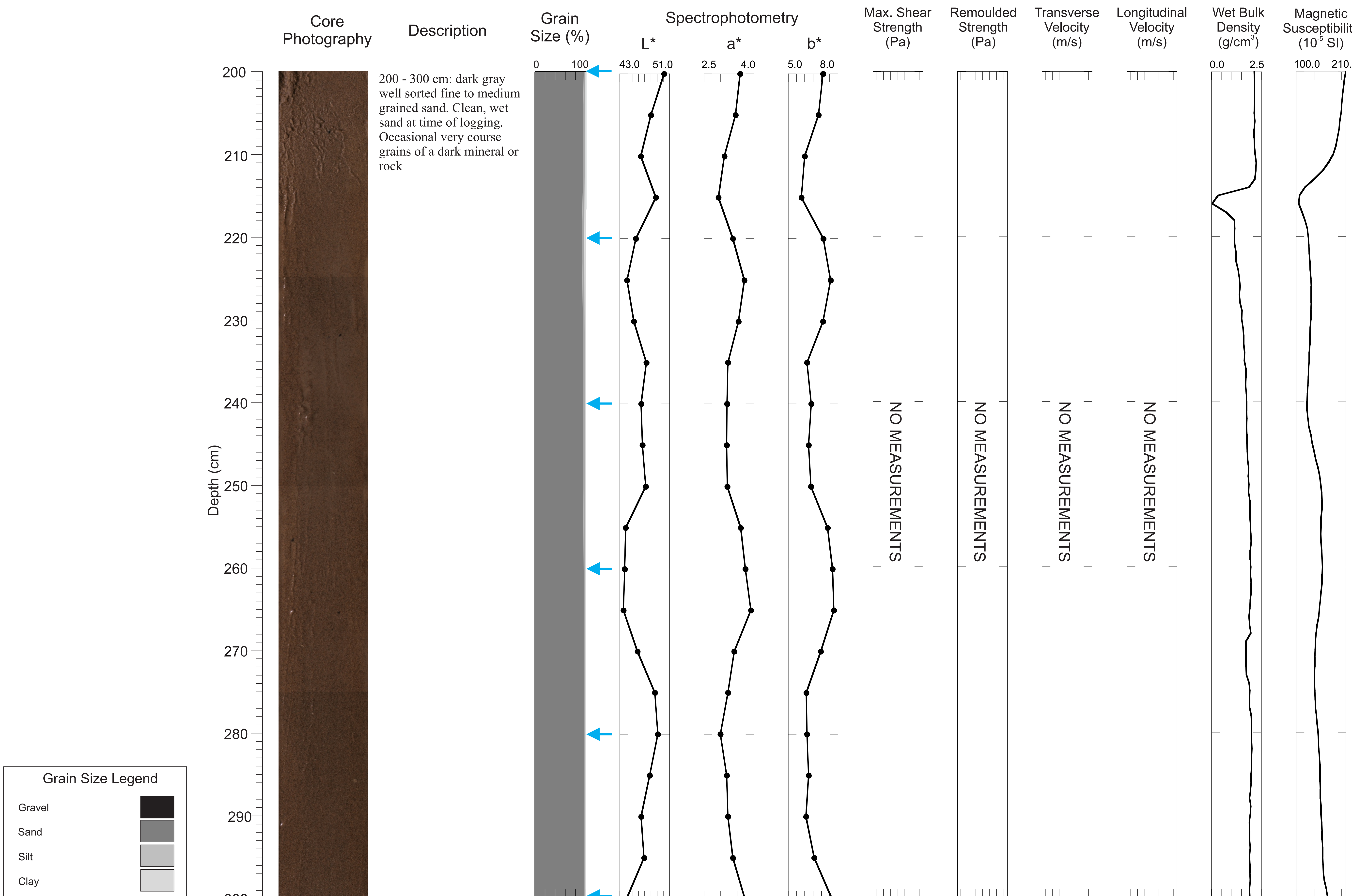
Total Length = 455 cm



2008029 0053 PC

73°50.4330'N / -80°23.6748'W; Water depth = 918 m

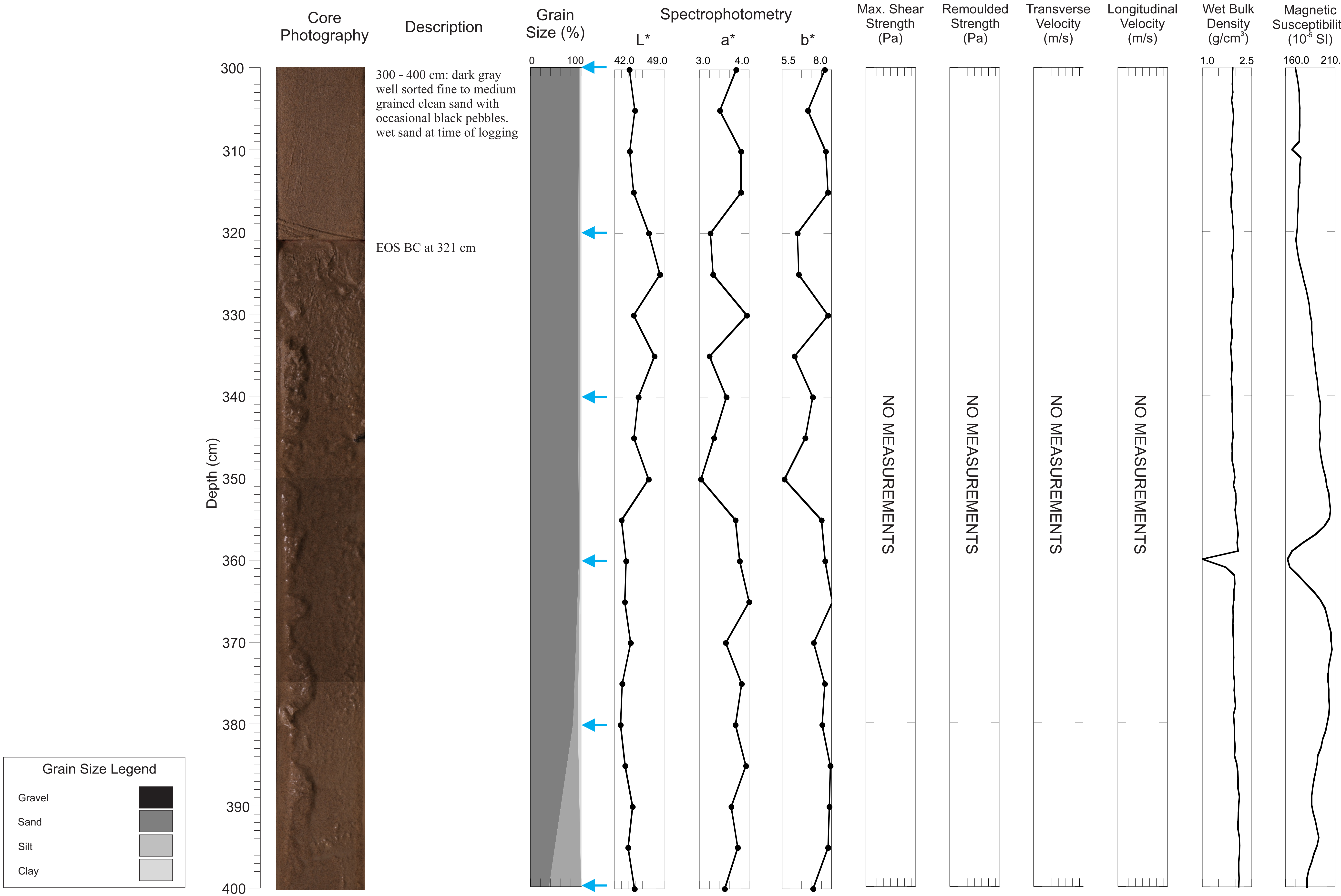
Total Length = 455 cm



2008029 0053 PC

73°50.4330'N / -80°23.6748'W; Water depth = 918 m

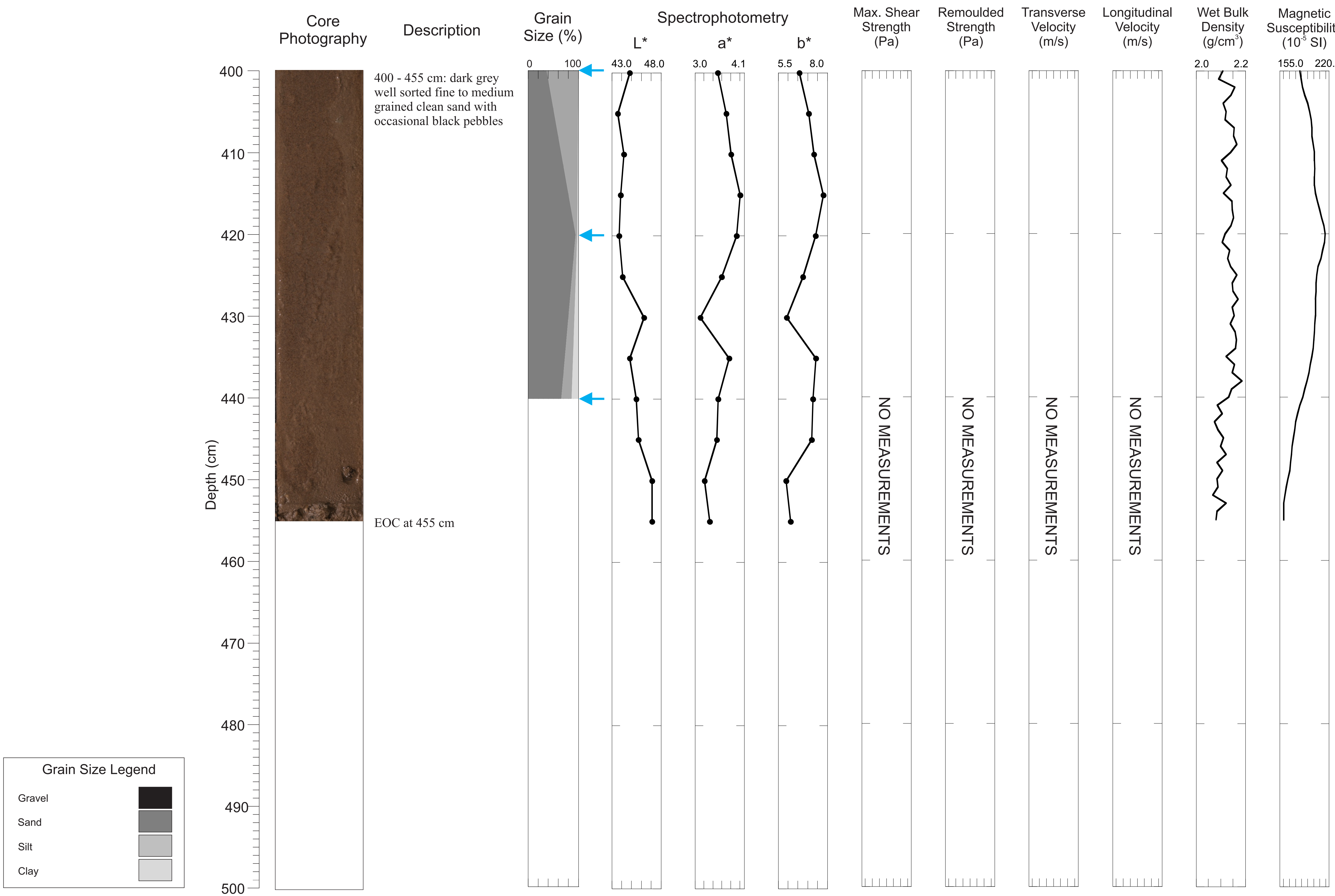
Total Length = 455 cm



2008029 0053 PC

73°50.4330'N / -80°23.6748'W; Water depth = 918 m

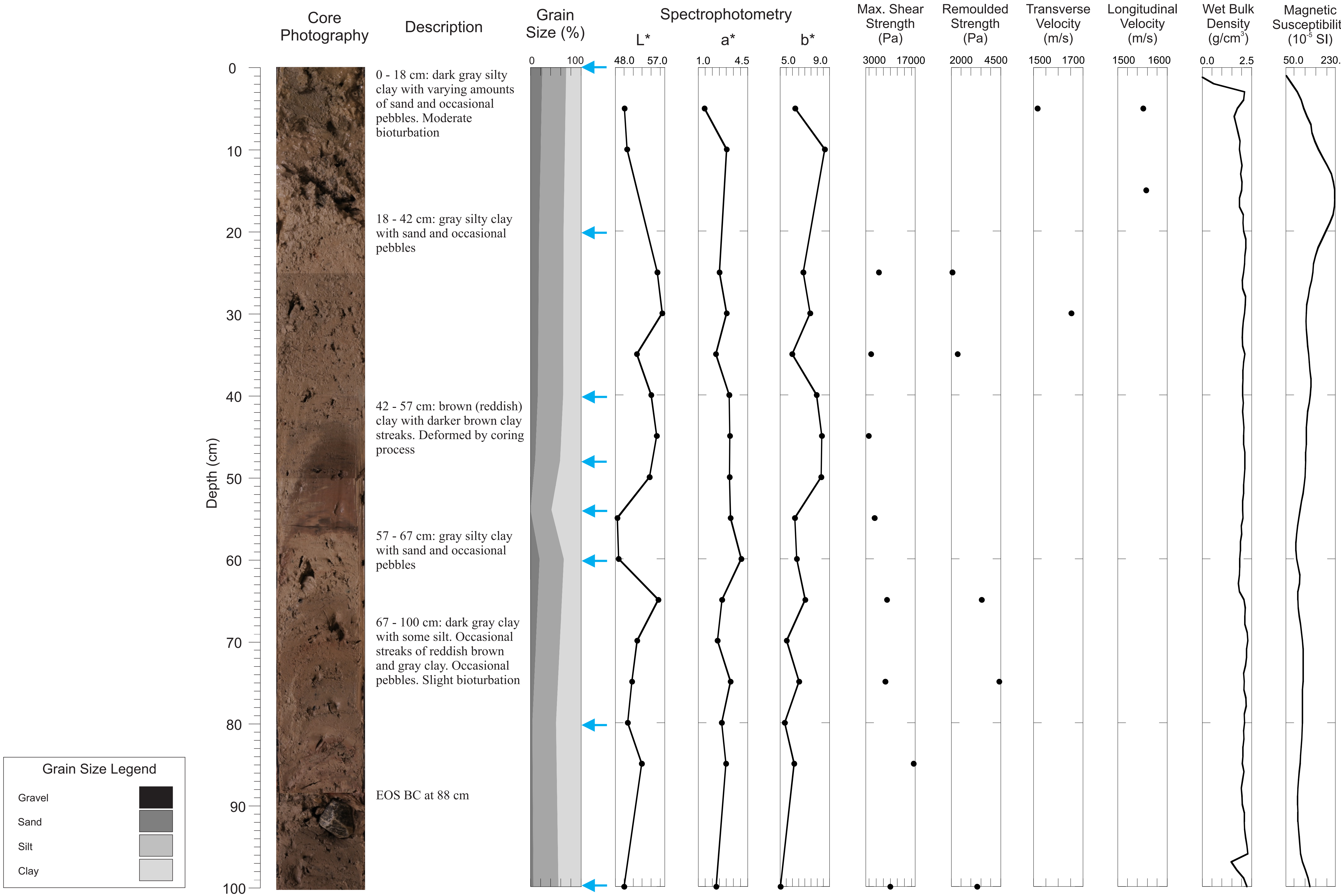
Total Length = 455 cm



2008029 0054 PC

73°50.3383'N / -80°18.7247'W; Water depth = 887 m

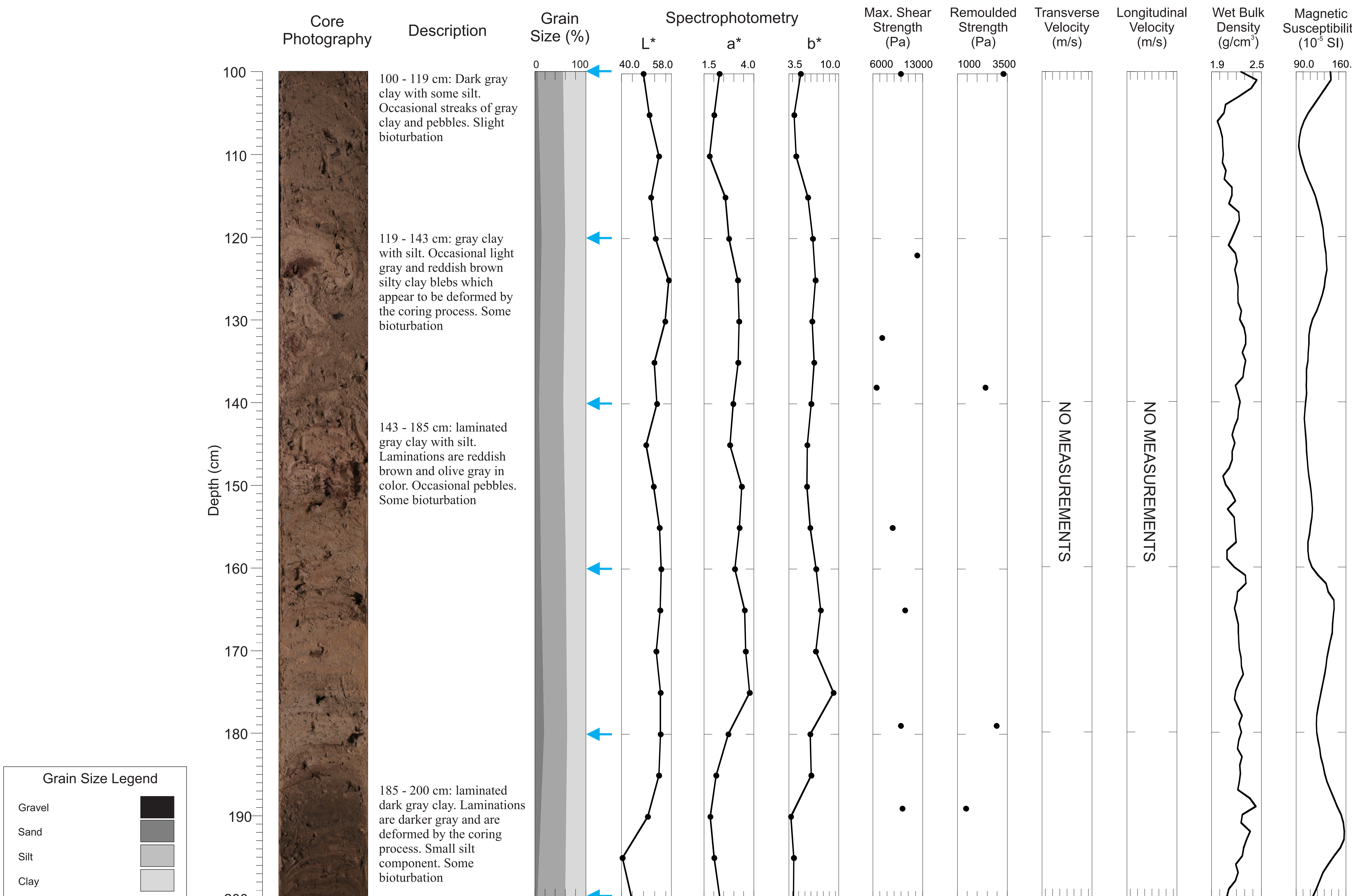
Total Length = 237 cm



2008029 0054 PC

73°50.3383'N / -80°18.7247'W; Water depth = 887 m

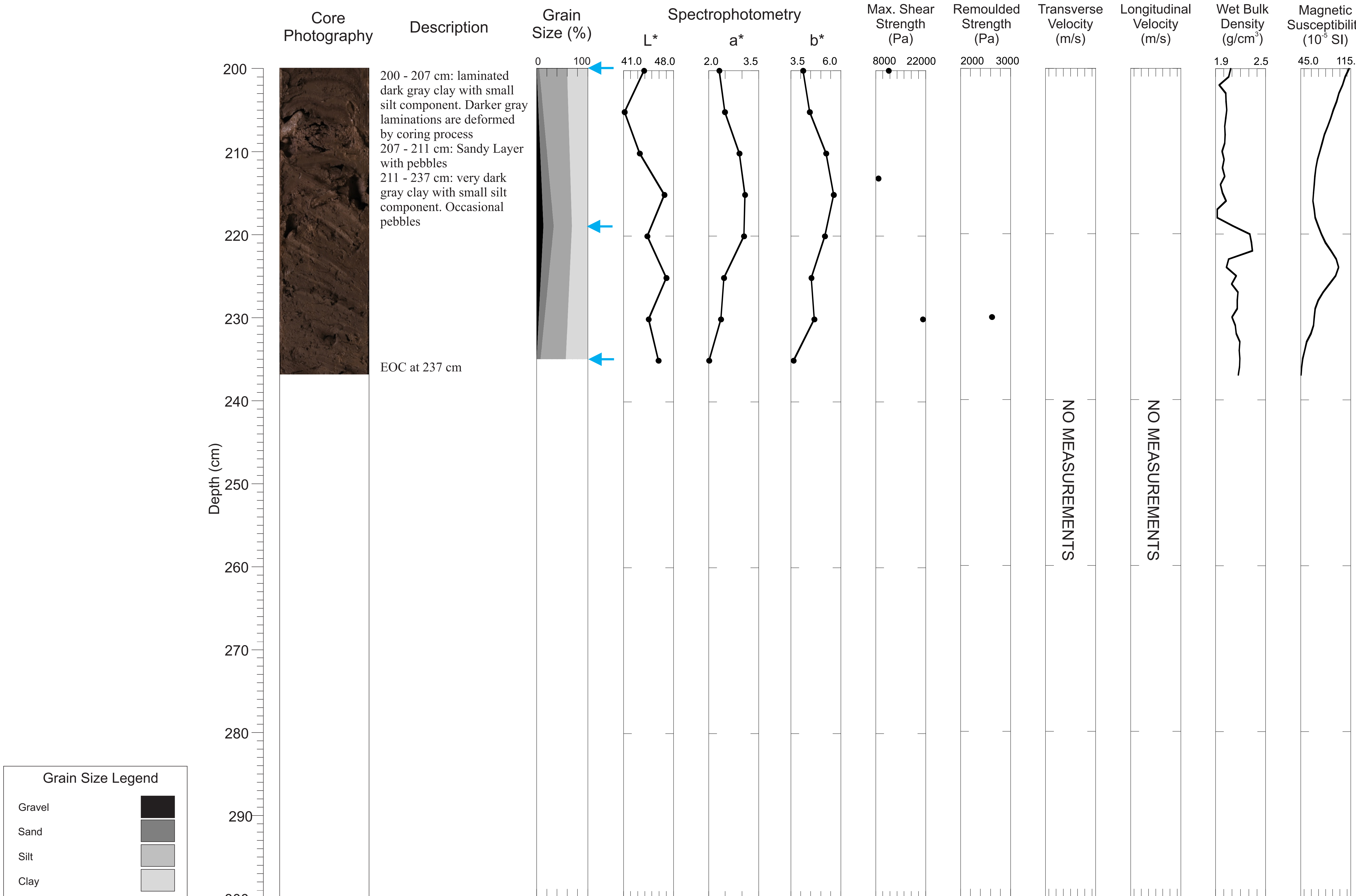
Total Length = 237 cm



2008029 0054 PC

73°50.3383'N / -80°18.7247'W; Water depth = 887 m

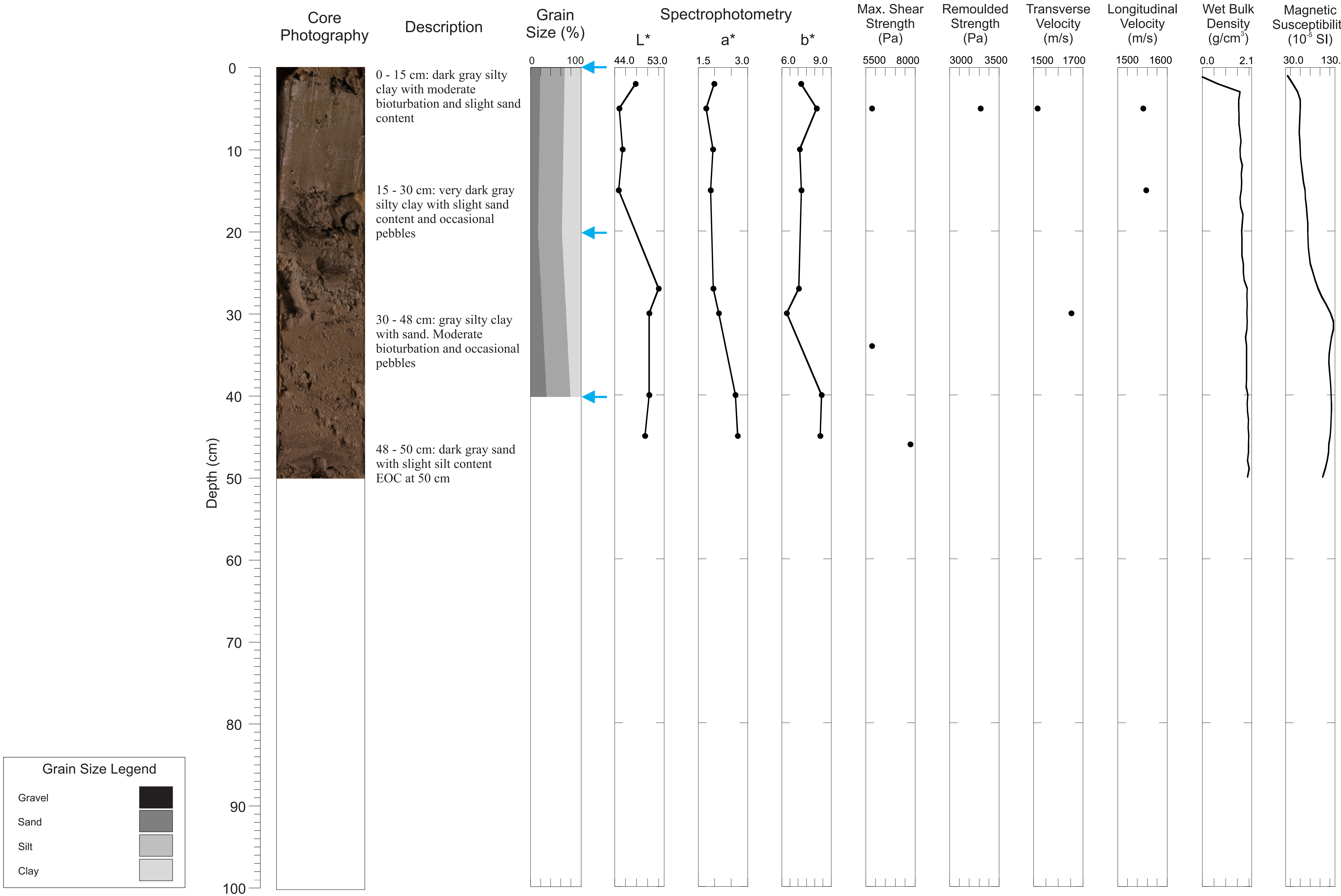
Total Length = 237 cm



2008029 0054 TWC

73°50.3383'N / -80°18.7247'W; Water depth = 887 m

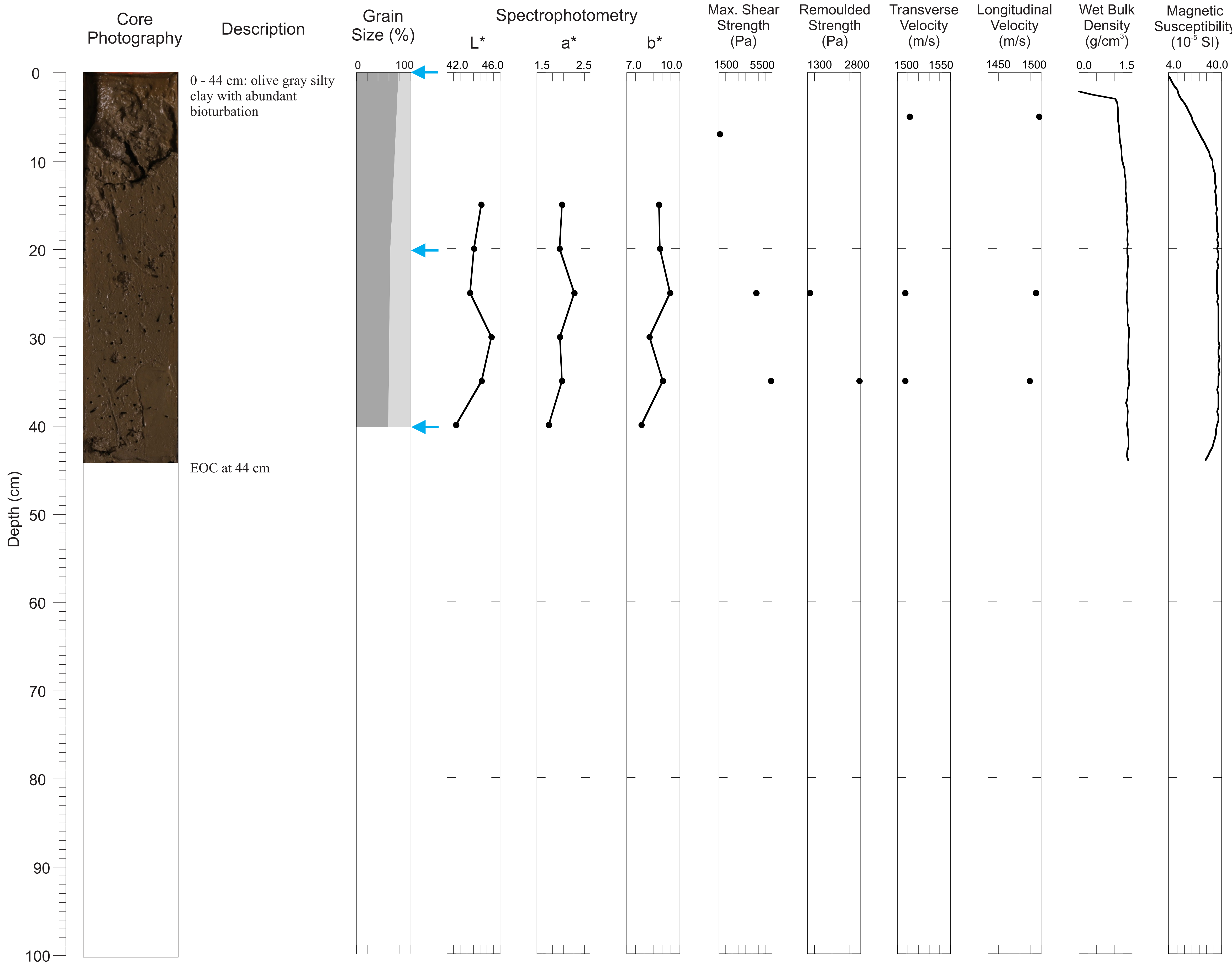
Total Length = 50 cm

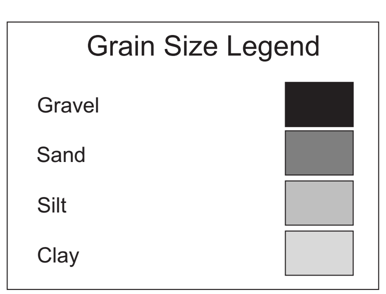


2008029 0055 BC

74°05.5238'N / -78°43.1186'W; Water depth = 866 m

Total Length = 44 cm

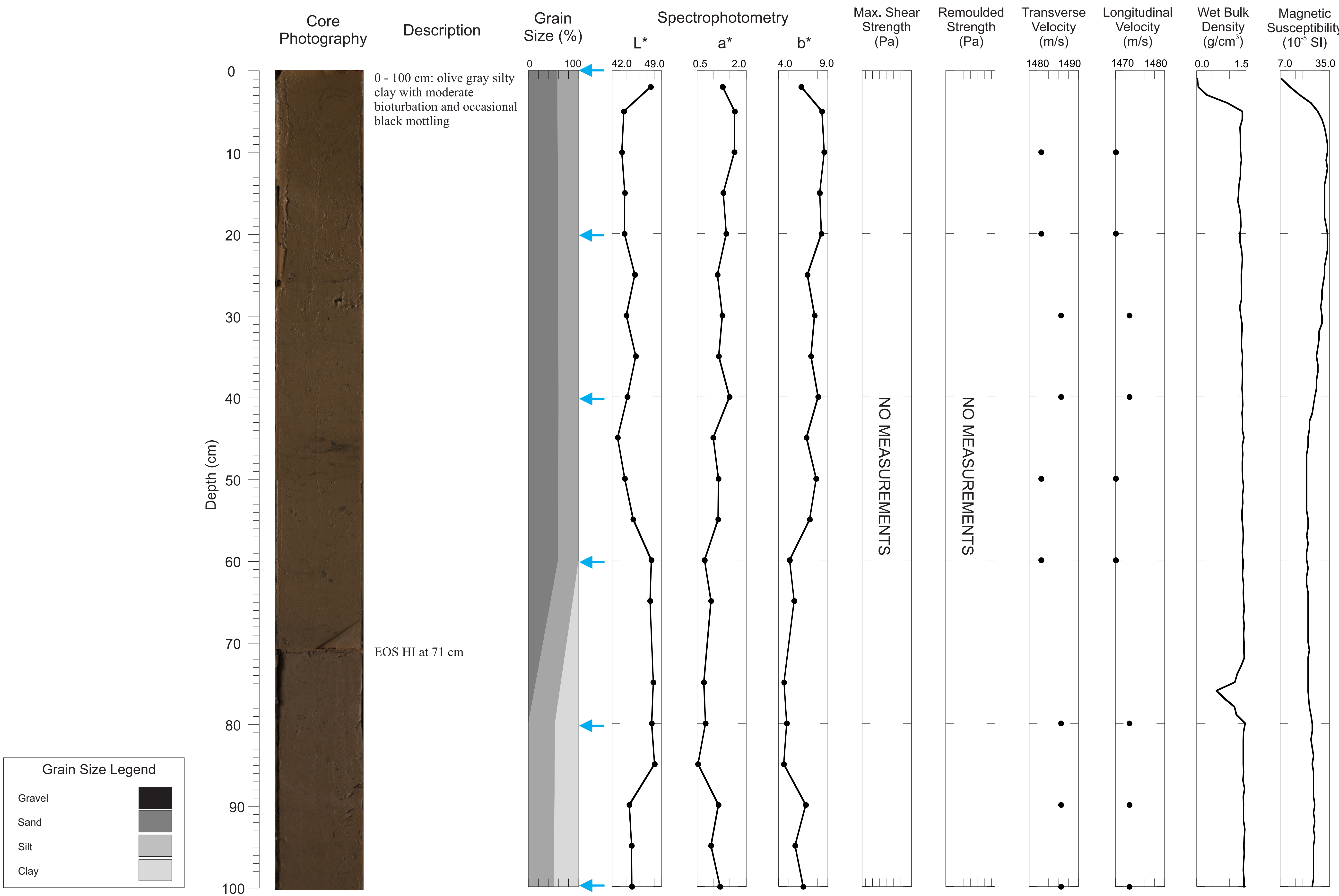




2008029 0057 PC

74°05.5221'N / -78°43.0895'W; Water depth = 866 m

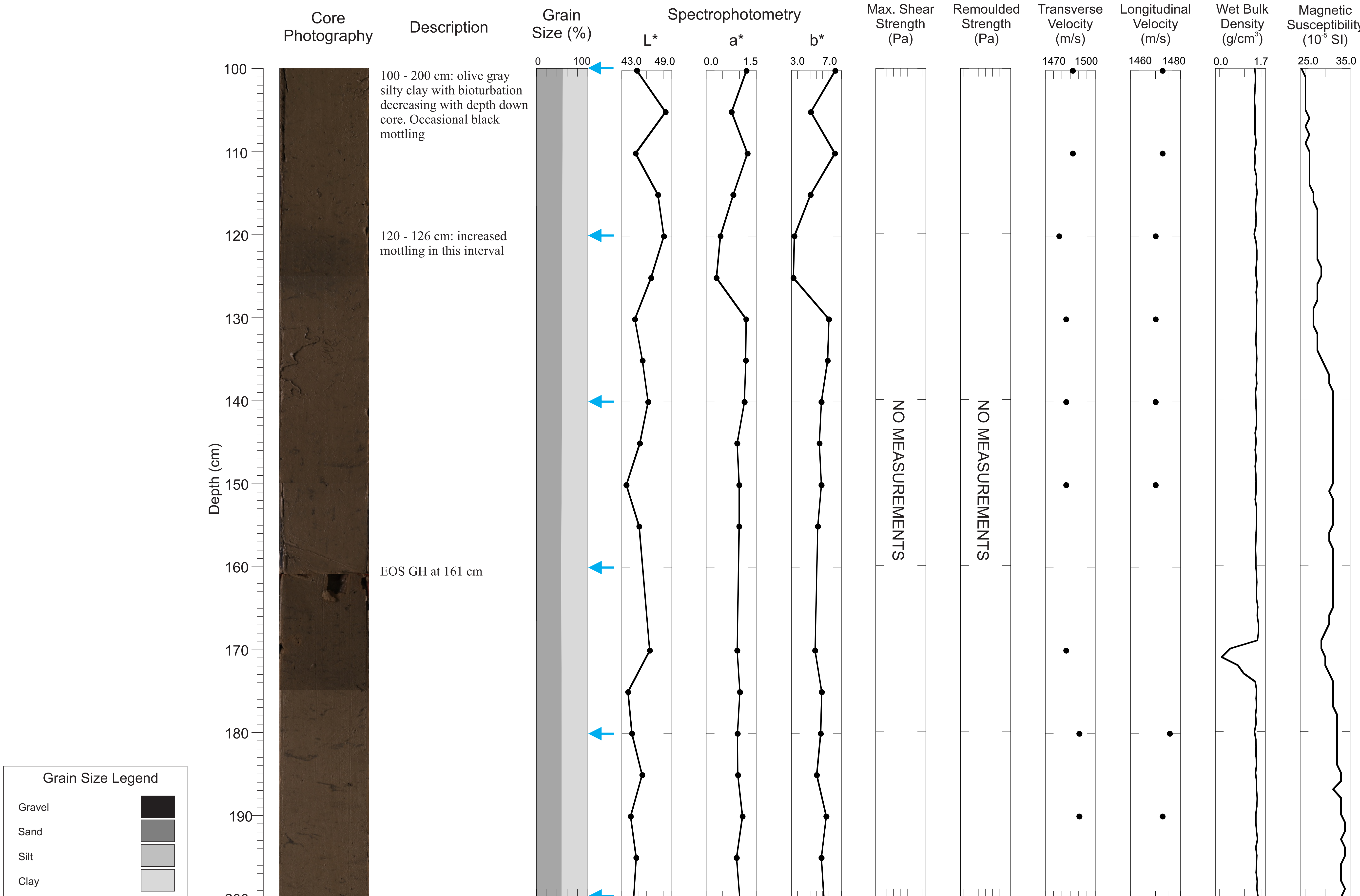
Total Length = 1056 cm



2008029 0057 PC

74°05.5221'N / -78°43.0895'W; Water depth = 866 m

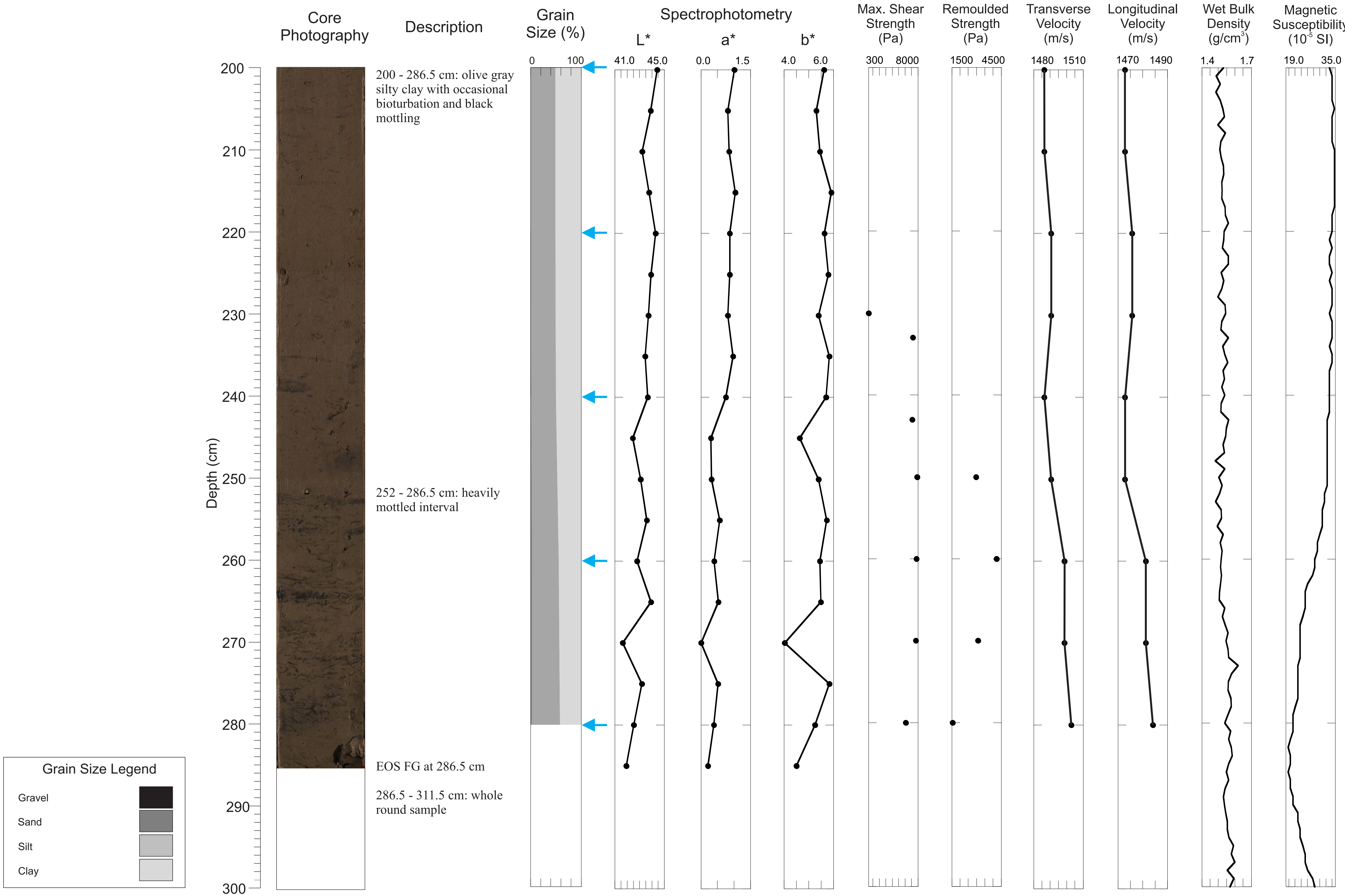
Total Length = 1056 cm



2008029 0057 PC

74°05.5221'N / -78°43.0895'W; Water depth = 866 m

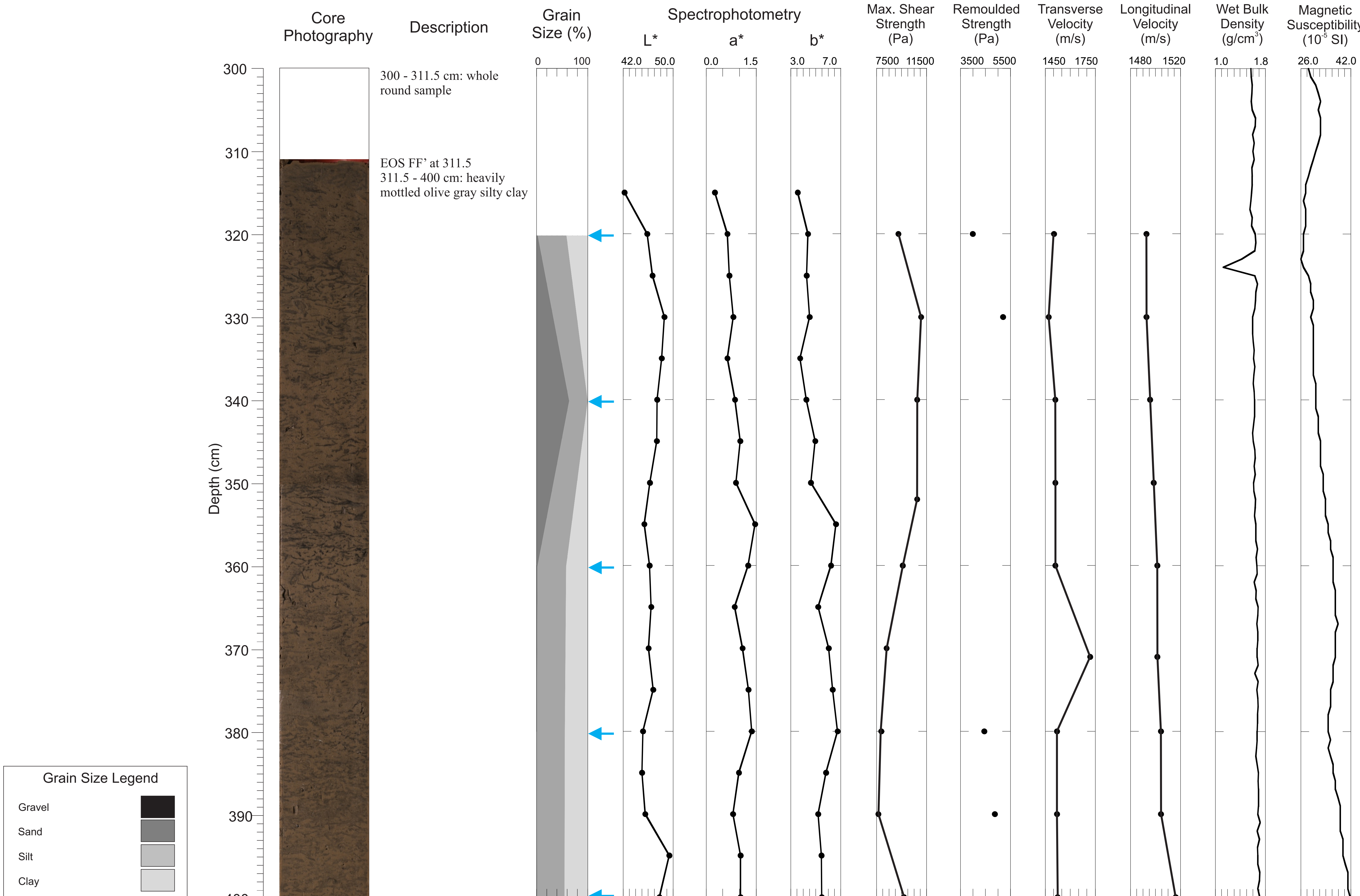
Total Length = 1056 cm



2008029 0057 PC

74°05.5221'N / -78°43.0895'W; Water depth = 866 m

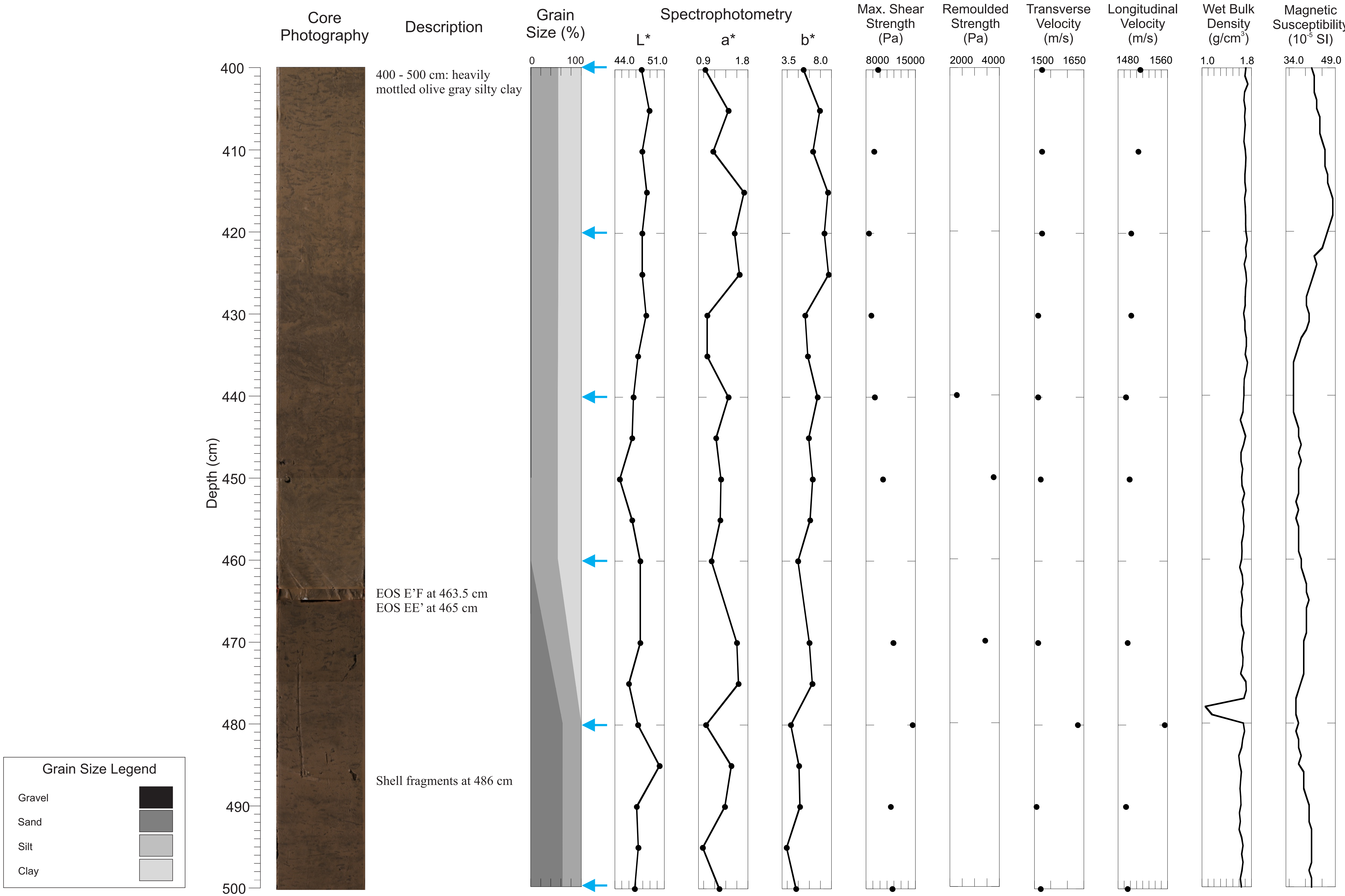
Total Length = 1056 cm



2008029 0057 PC

74°05.5221'N / -78°43.0895'W; Water depth = 866 m

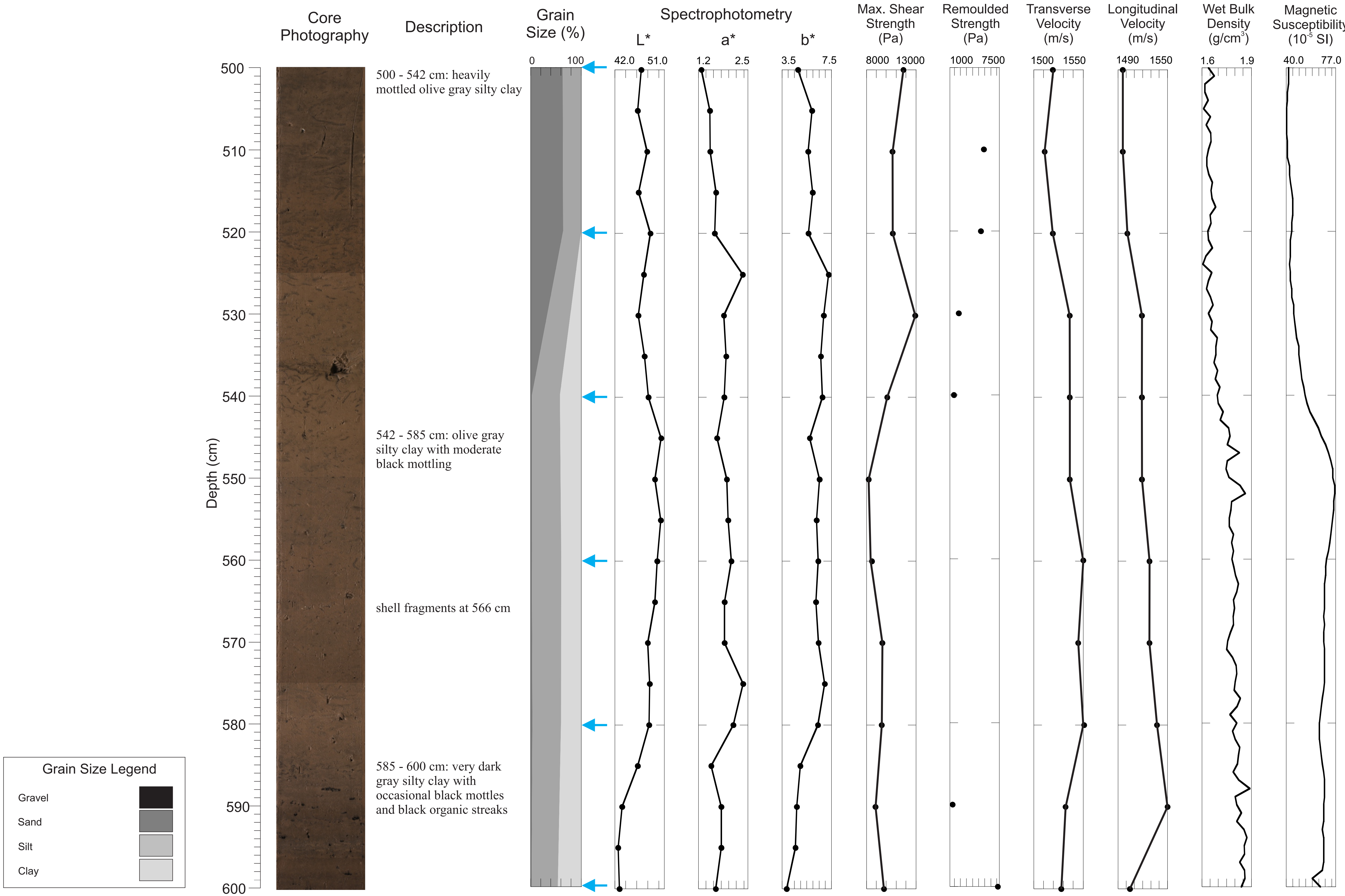
Total Length = 1056 cm



2008029 0057 PC

74°05.5221'N / -78°43.0895'W; Water depth = 866 m

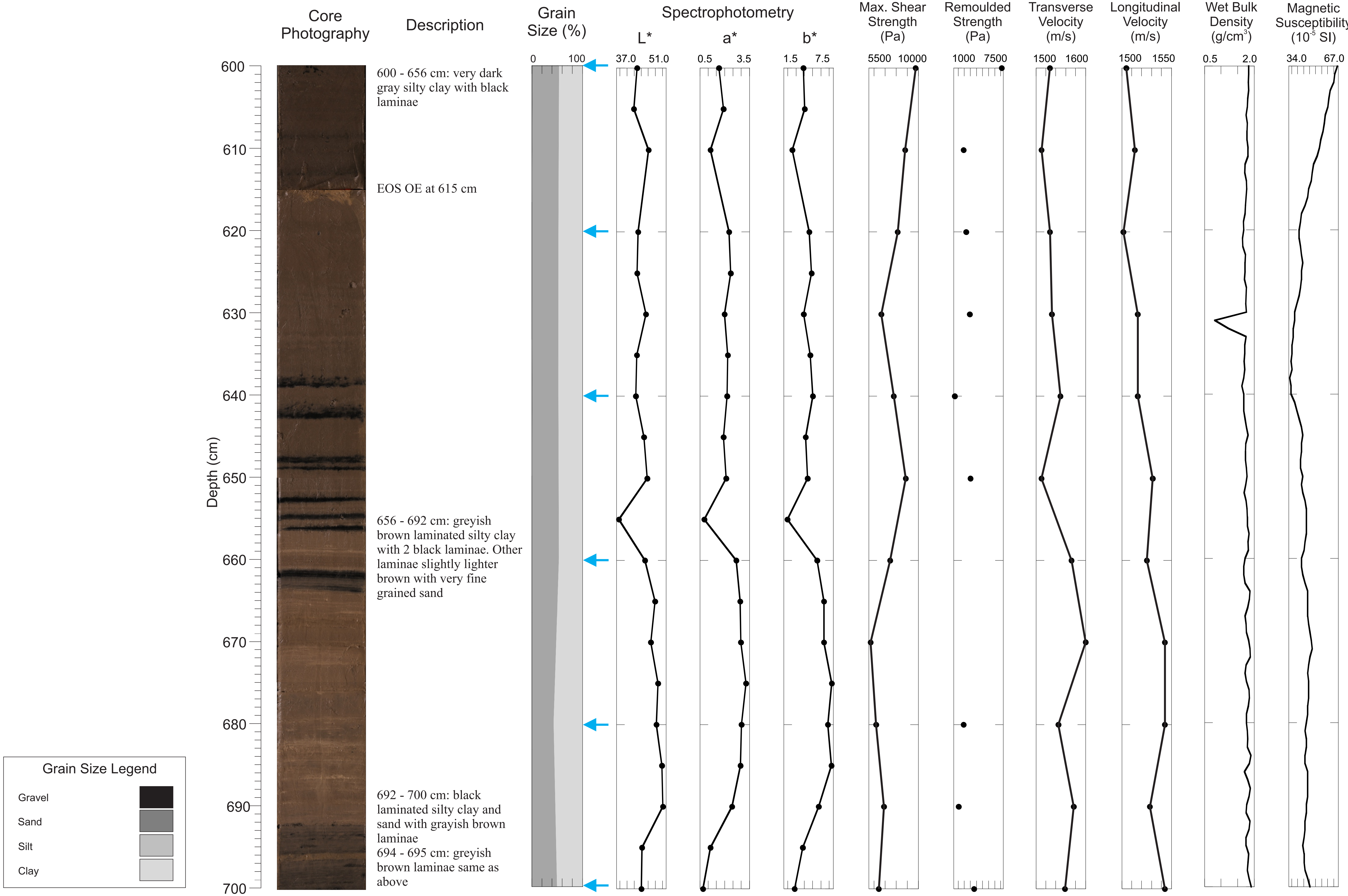
Total Length = 1056 cm



2008029 0057 PC

74°05.5221'N / -78°43.0895'W; Water depth = 866 m

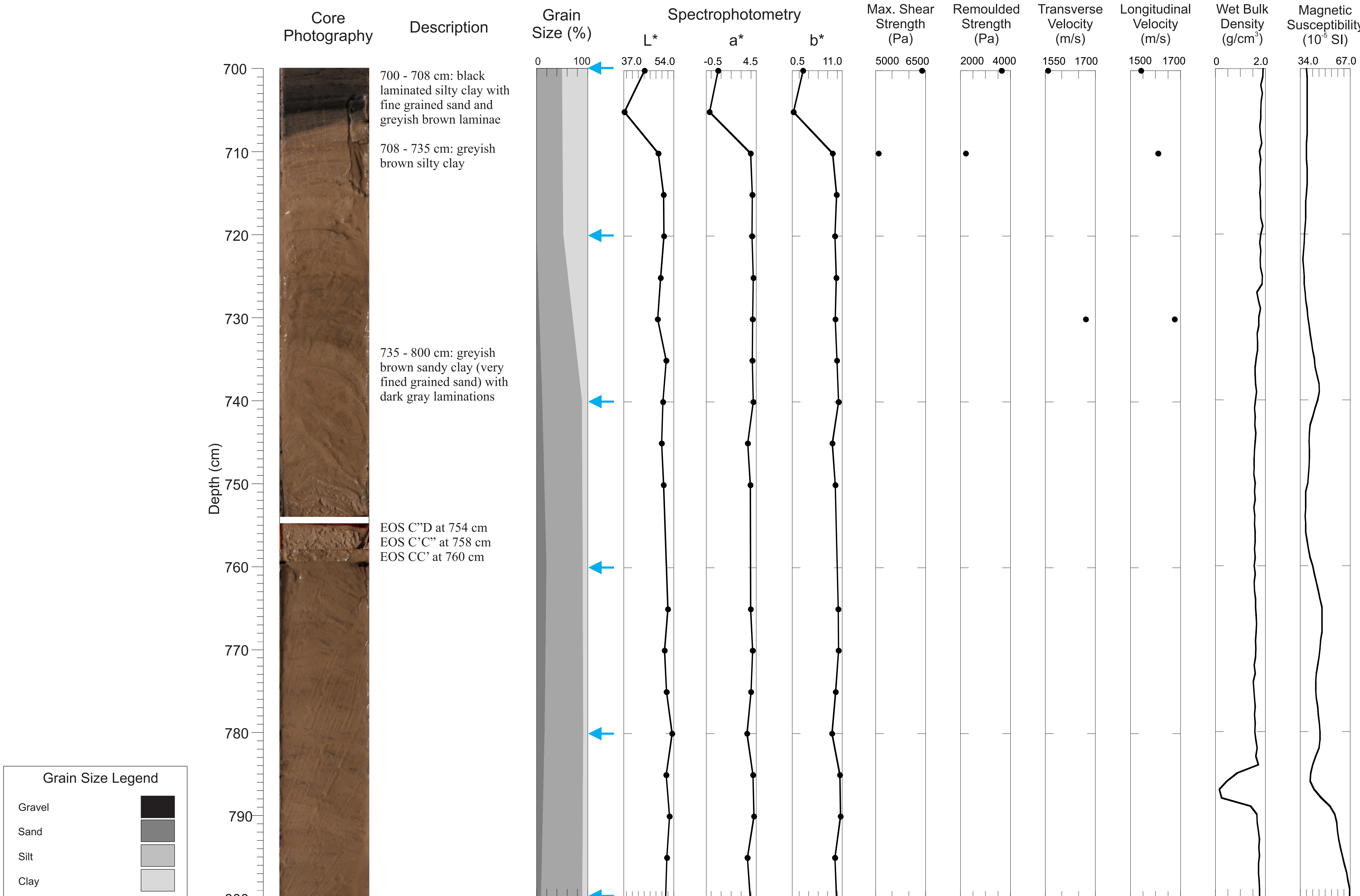
Total Length = 1056 cm



2008029 0057 PC

74°05.5221'N / -78°43.0895'W; Water depth = 866 m

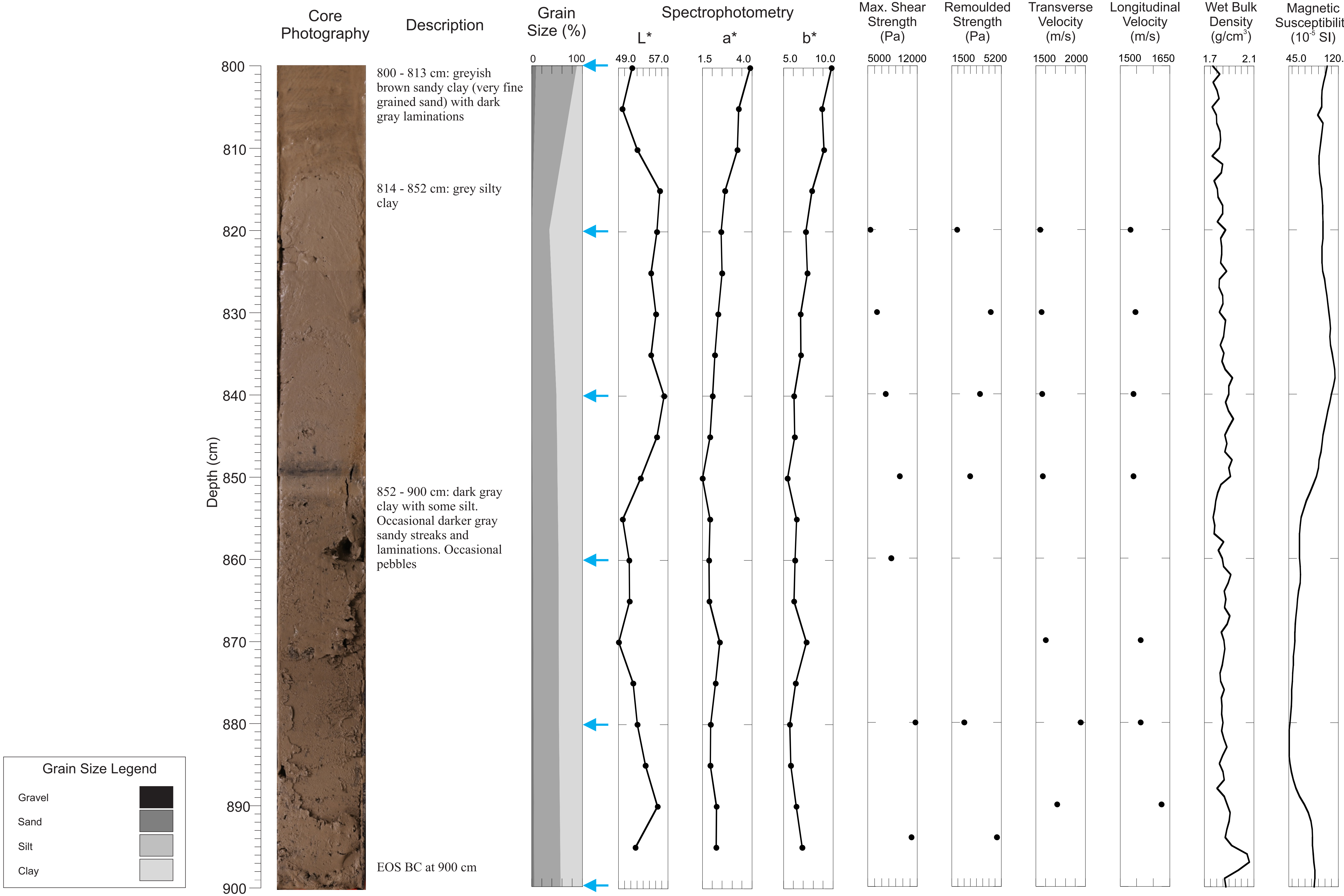
Total Length = 1056 cm



2008029 0057 PC

74°05.5221'N / -78°43.0895'W; Water depth = 866 m

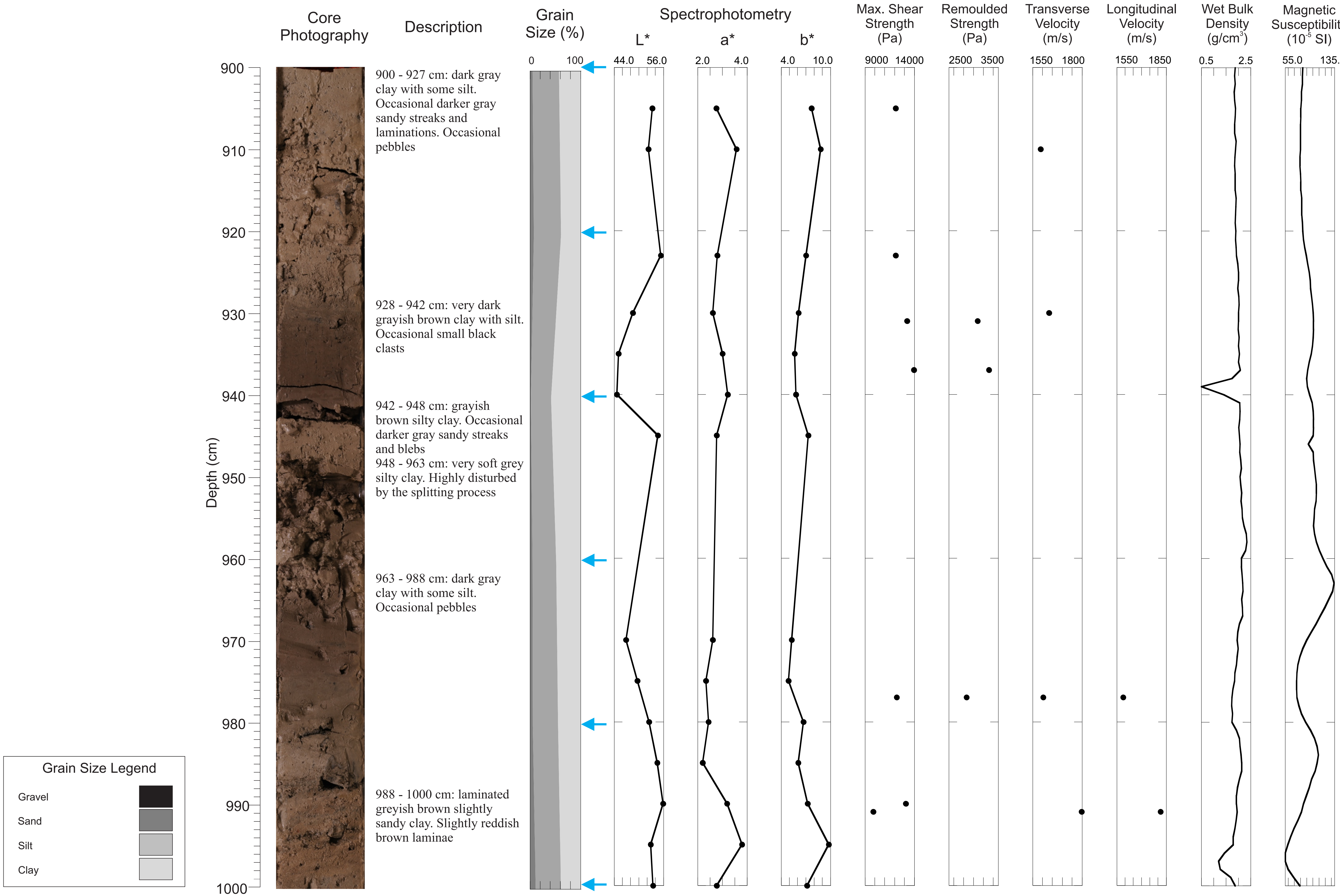
Total Length = 1056 cm



2008029 0057 PC

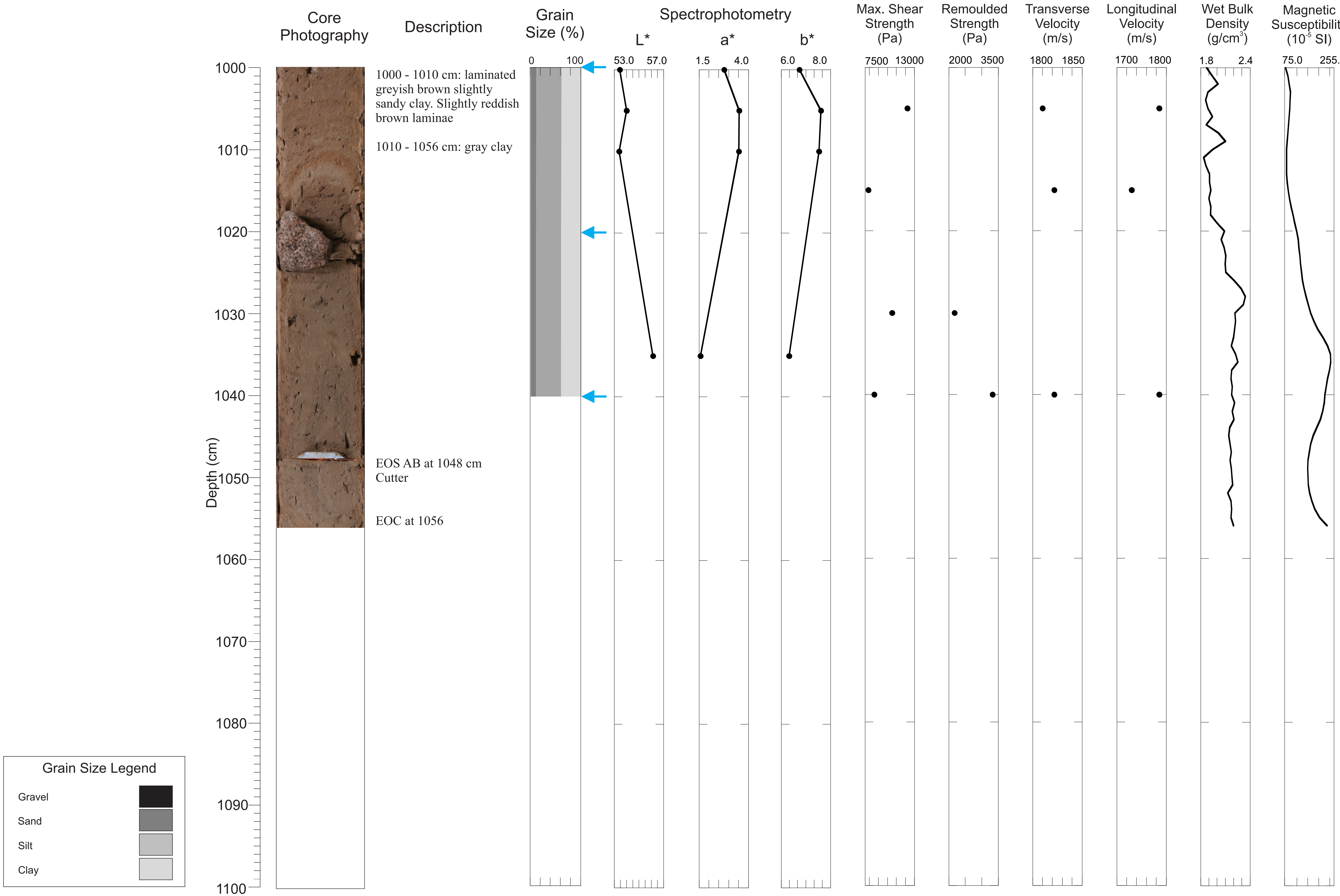
74°05.5221'N / -78°43.0895'W; Water depth = 866 m

Total Length = 1056 cm



2008029 0057 PC

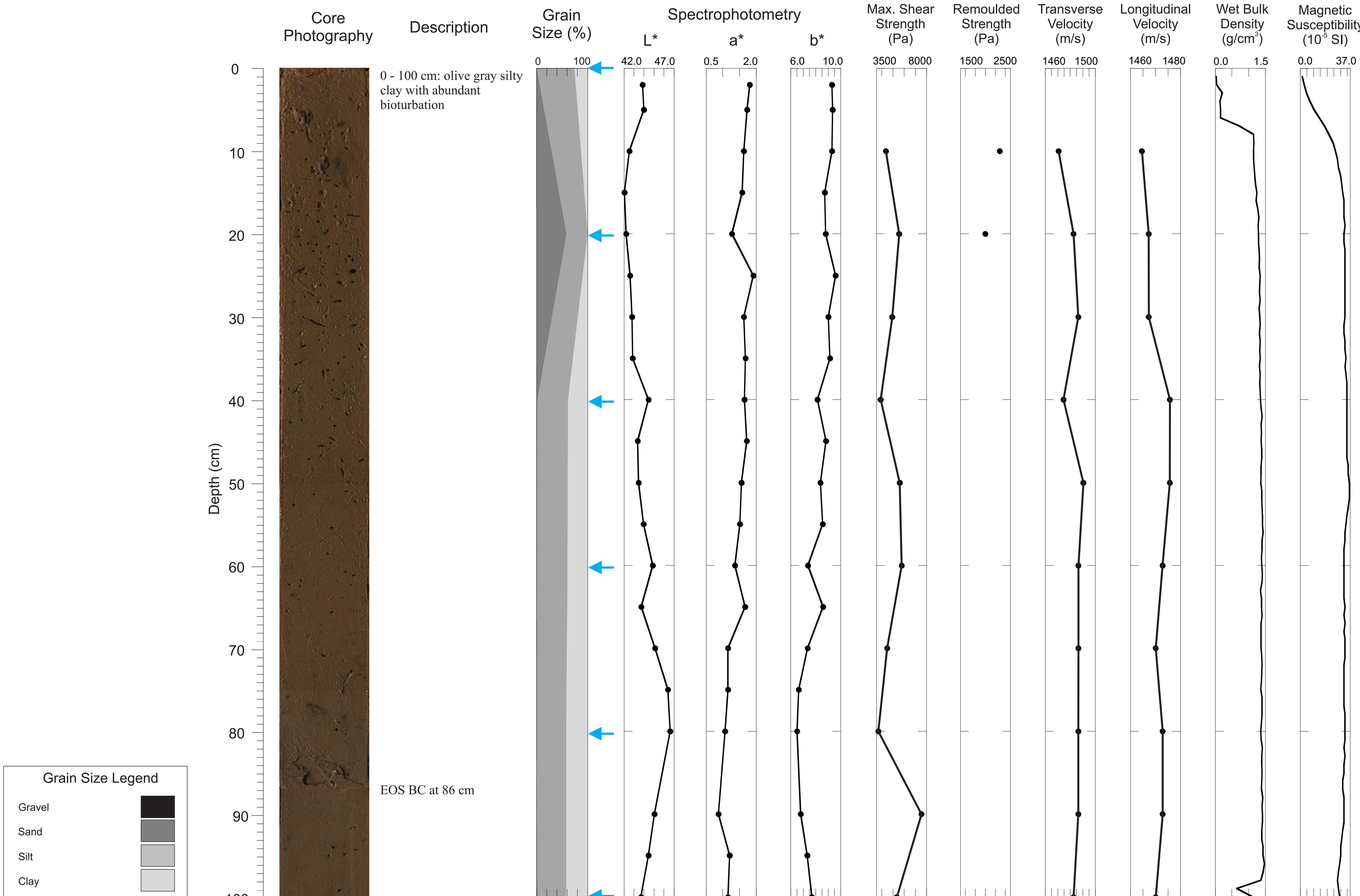
74°05.5221'N / -78°43.0895'W; Water depth = 866 m
Total Length = 1056 cm



2008029 0057 TWC

74°05.5221'N / -78°43.0895'W; Water depth = 866 m

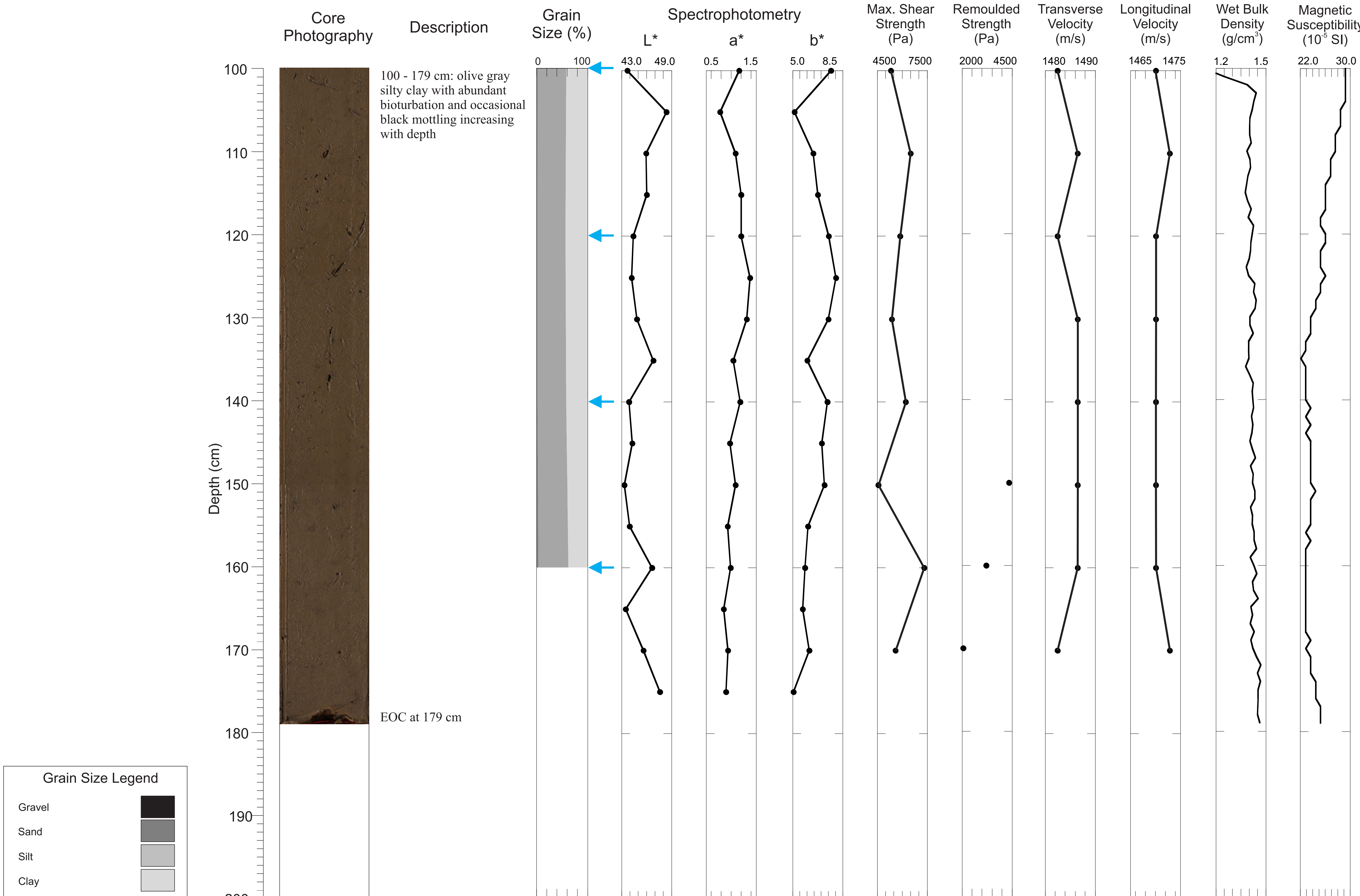
Total Length = 179 cm



2008029 0057 TWC

74°05.5221'N / -78°43.0895'W; Water depth = 866 m

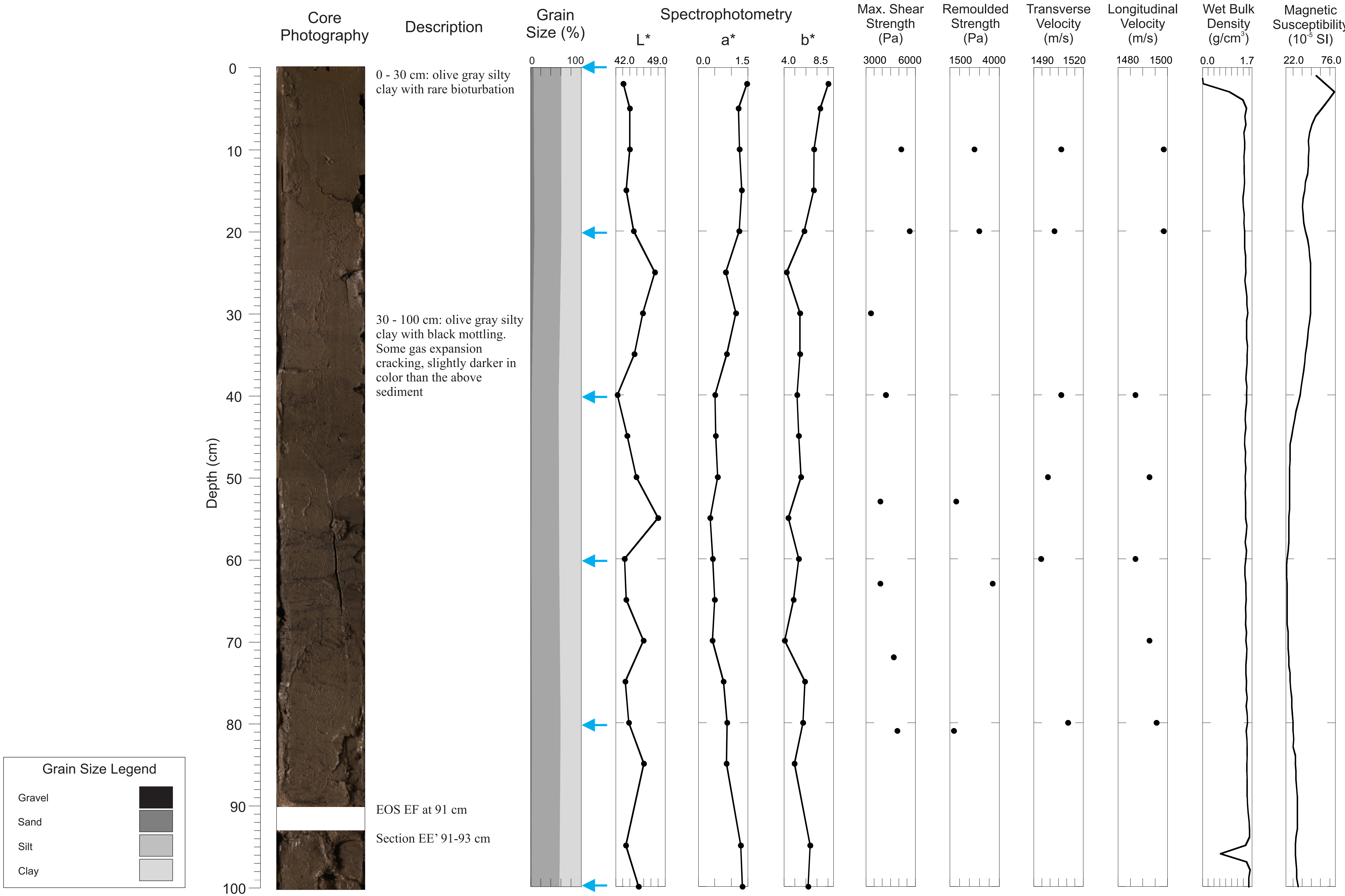
Total Length = 179 cm



2008029 0059 PC

74°15.5774'N / -82°23.0490'W; Water depth = 800 m

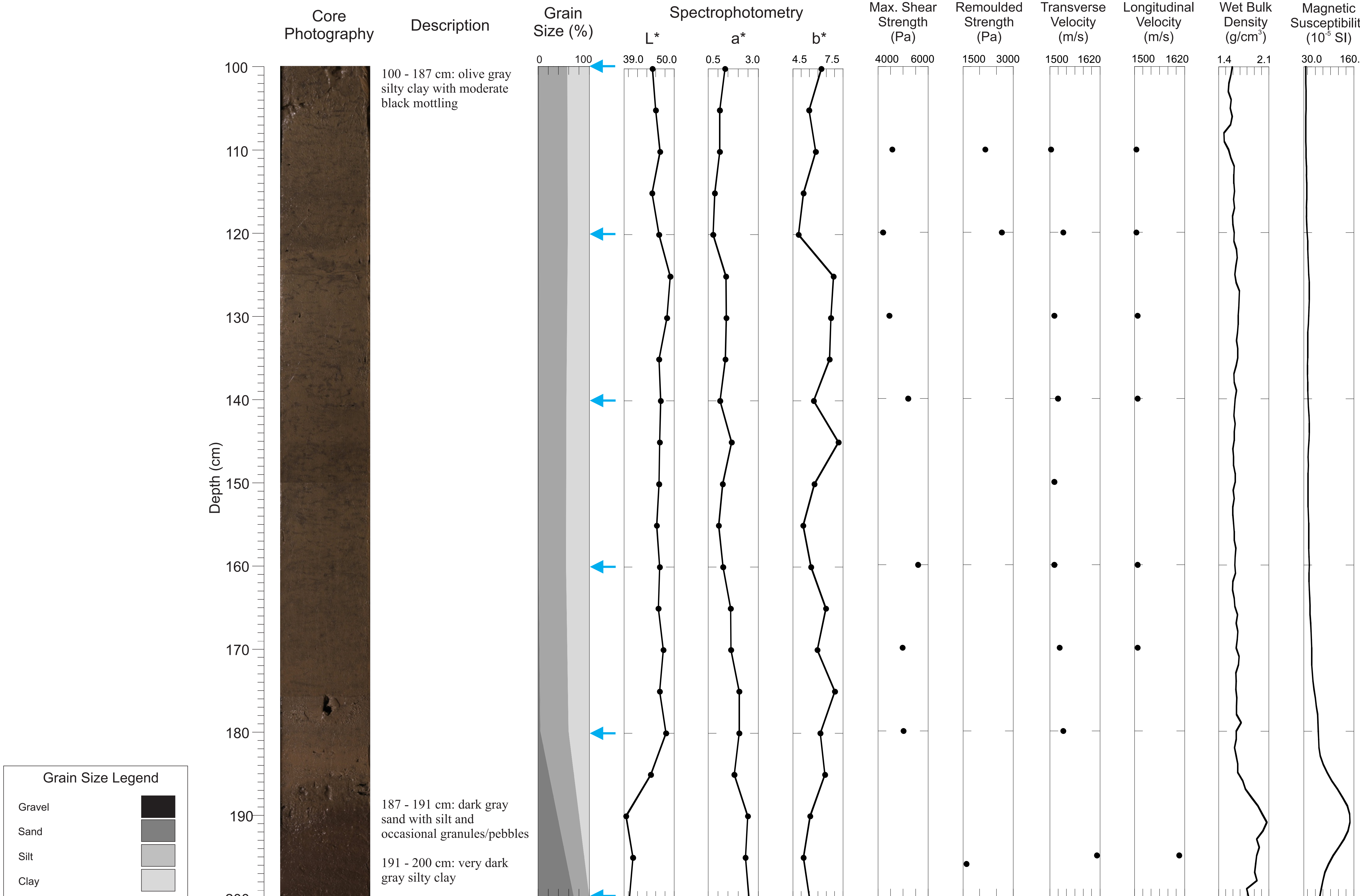
Total Length = 709 cm



2008029 0059 PC

74°15.5774'N / -82°23.0490'W; Water depth = 800 m

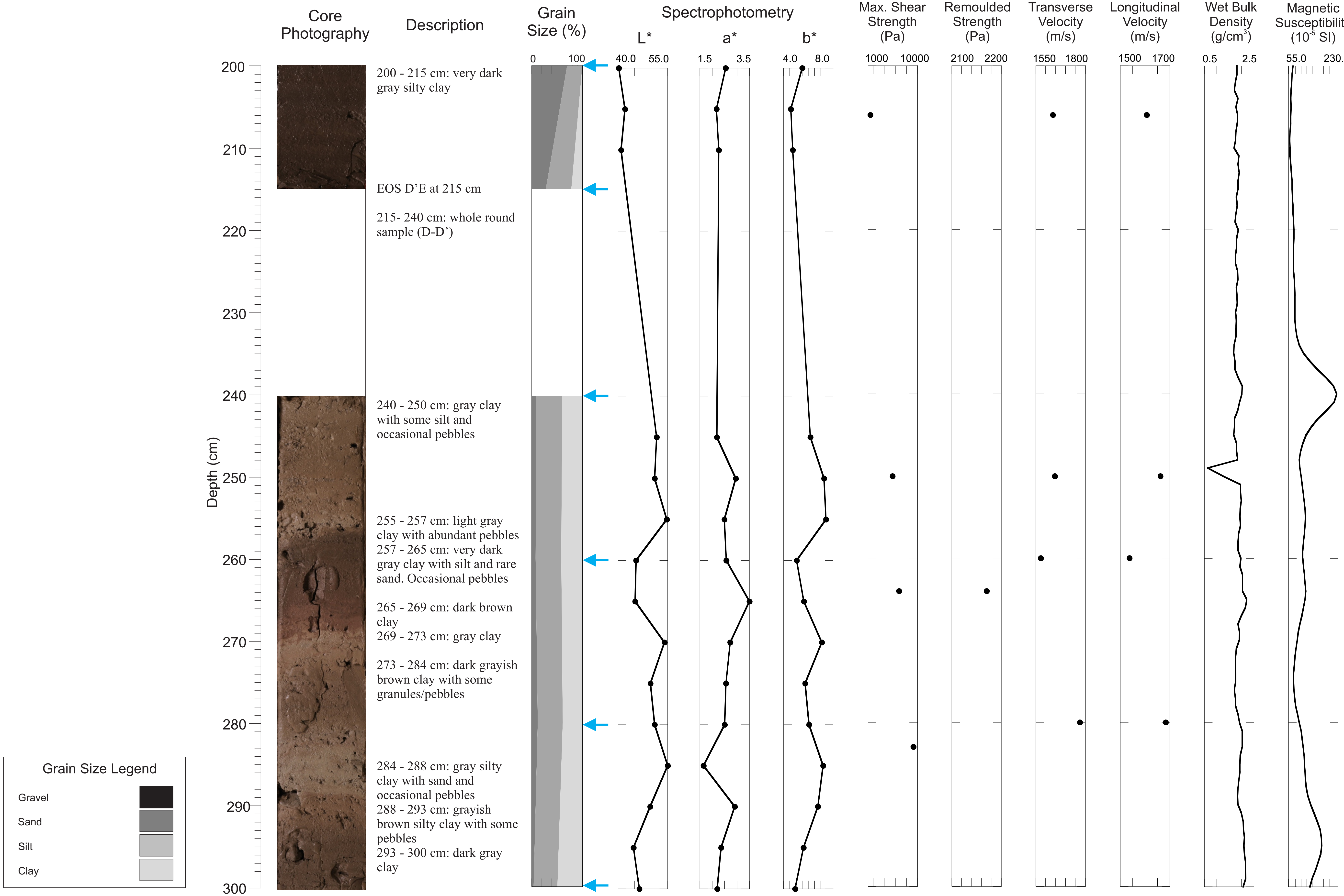
Total Length = 709 cm



2008029 0059 PC

74°15.5774'N / -82°23.0490'W; Water depth = 800 m

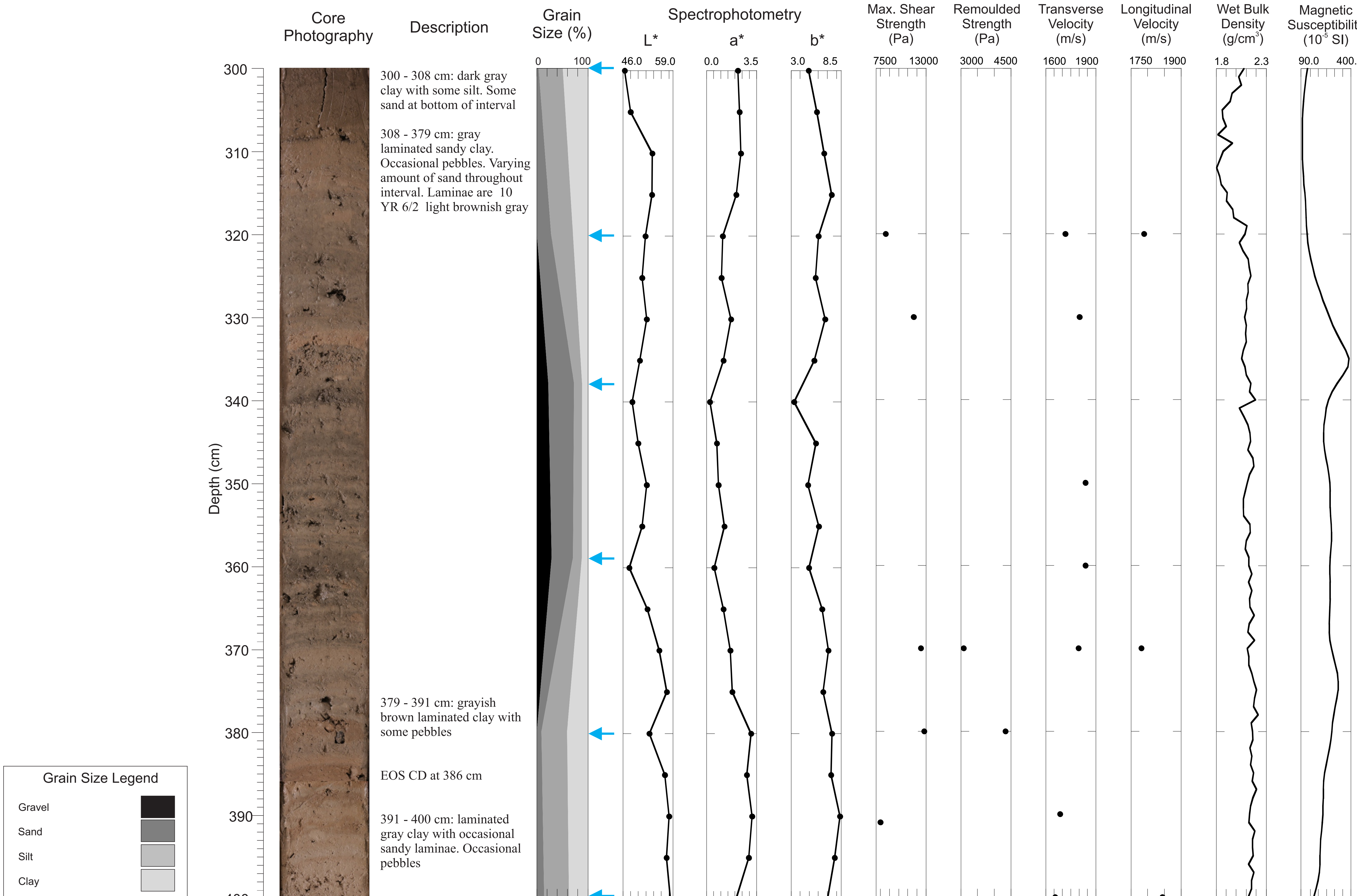
Total Length = 709 cm



2008029 0059 PC

74°15.5774'N / -82°23.0490'W; Water depth = 800 m

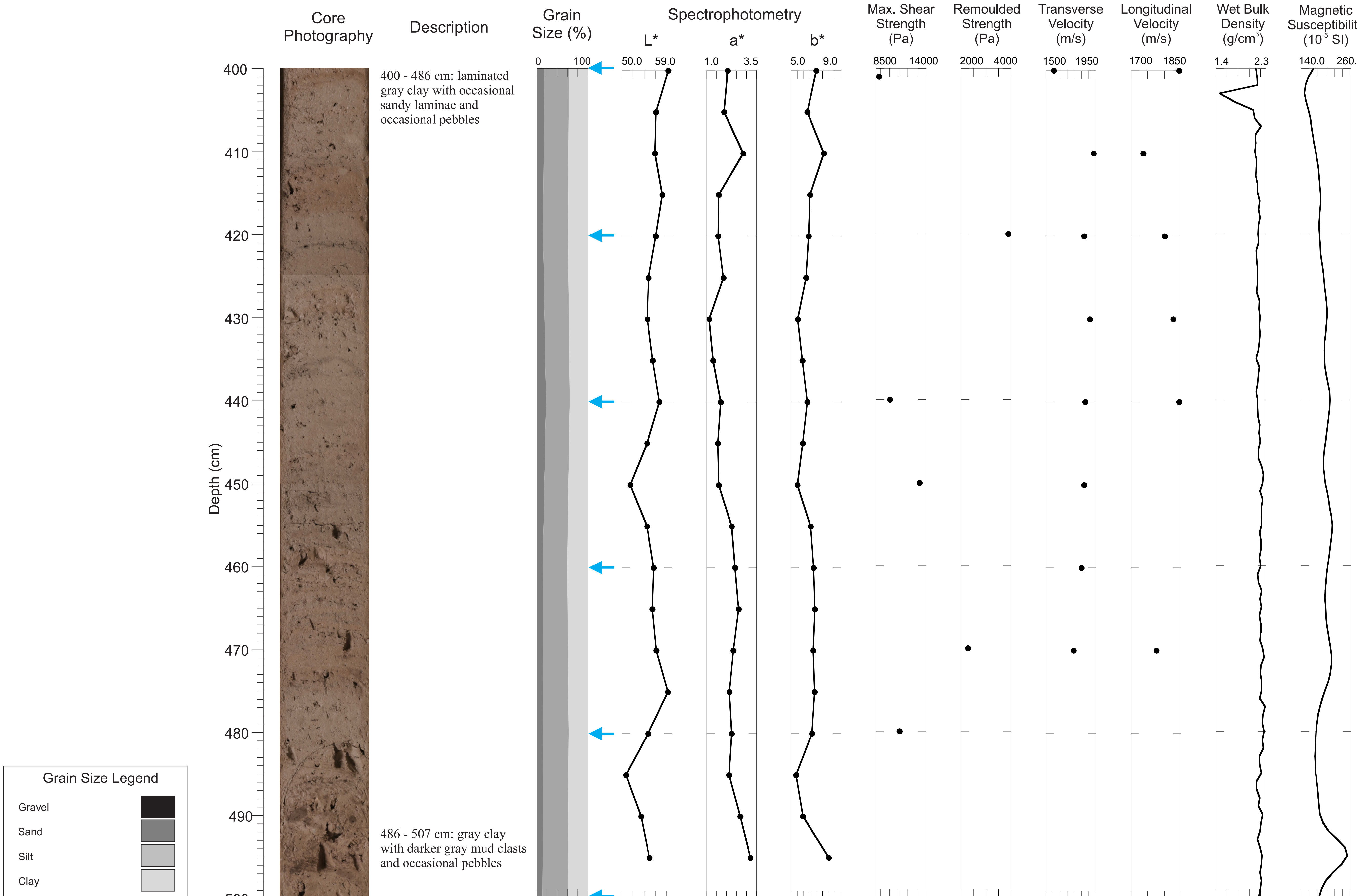
Total Length = 709 cm



2008029 0059 PC

74°15.5774'N / -82°23.0490'W; Water depth = 800 m

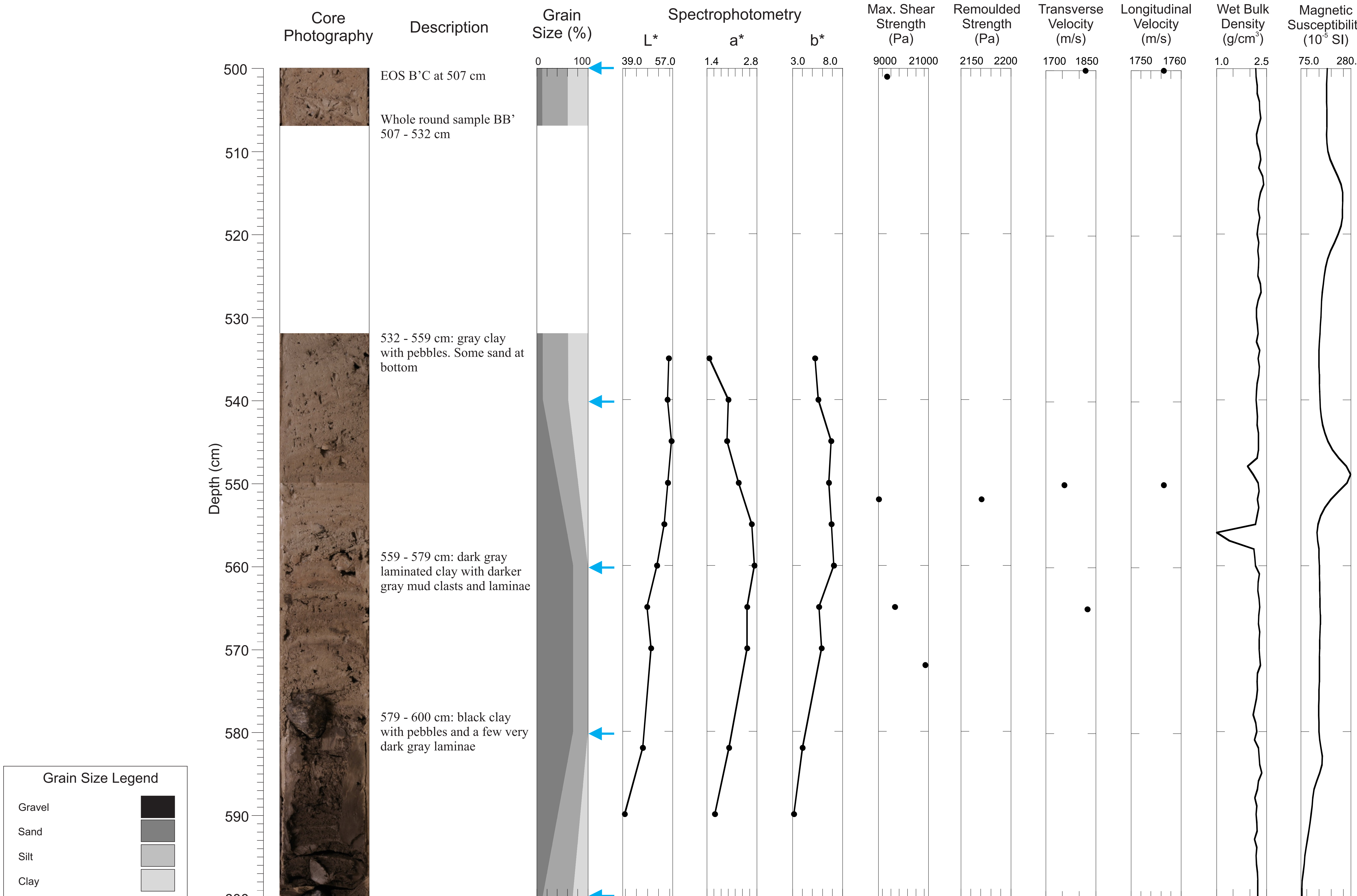
Total Length = 709 cm



2008029 0059 PC

74°15.5774’N / -82°23.0490’W; Water depth = 800 m

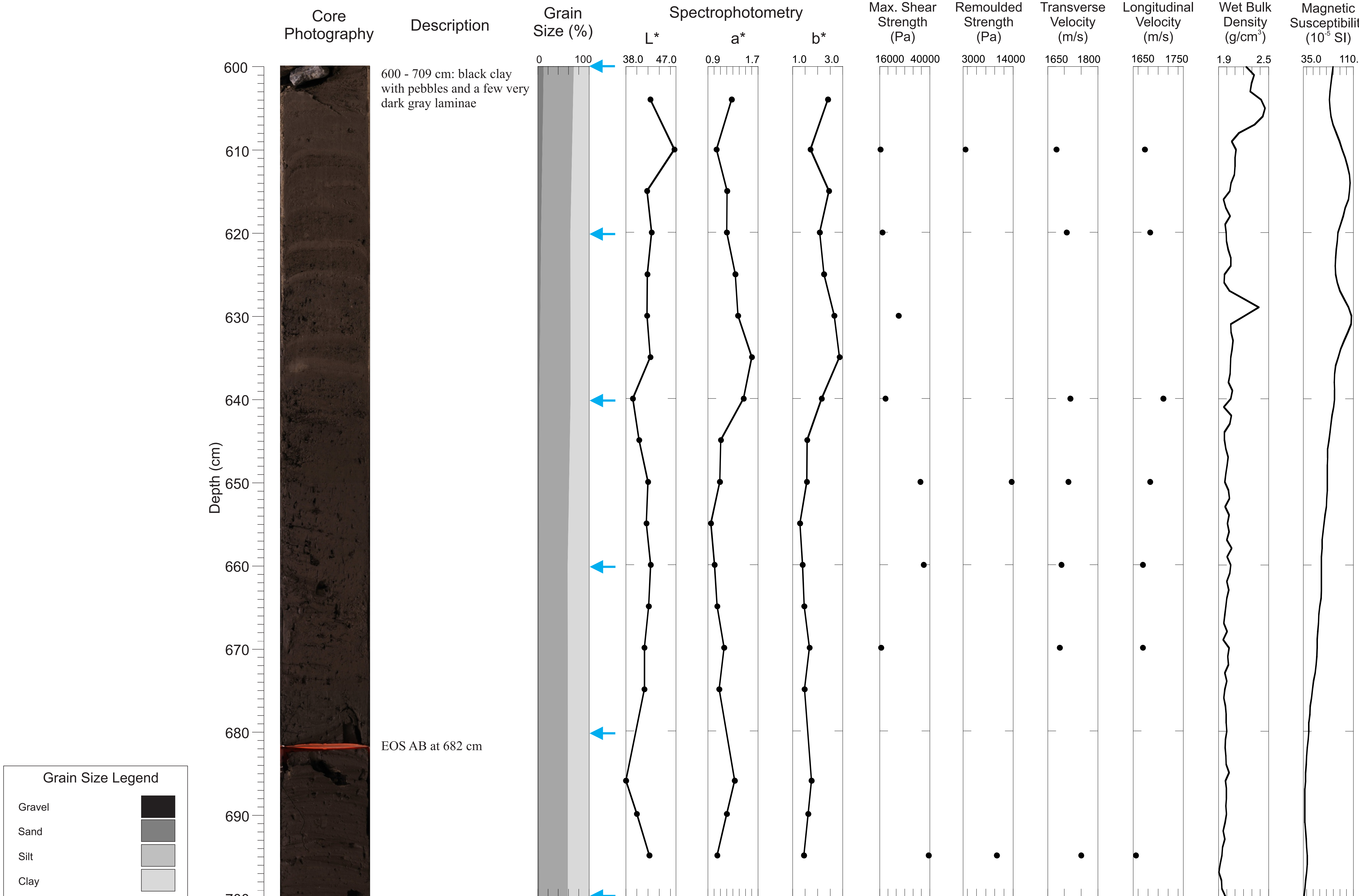
Total Length = 709 cm



2008029 0059 PC

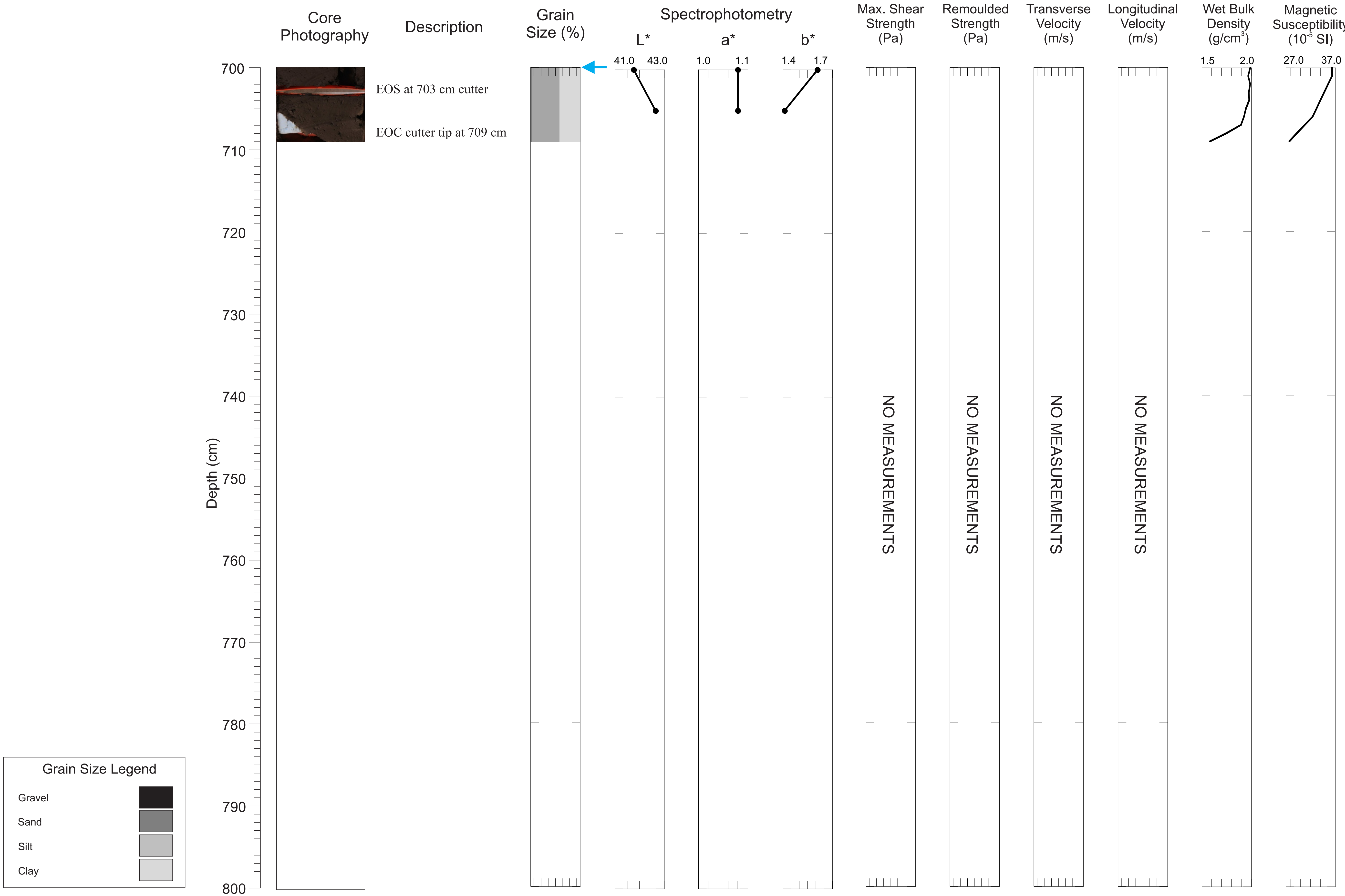
74°15.5774'N / -82°23.0490'W; Water depth = 800 m

Total Length = 709 cm



2008029 0059 PC

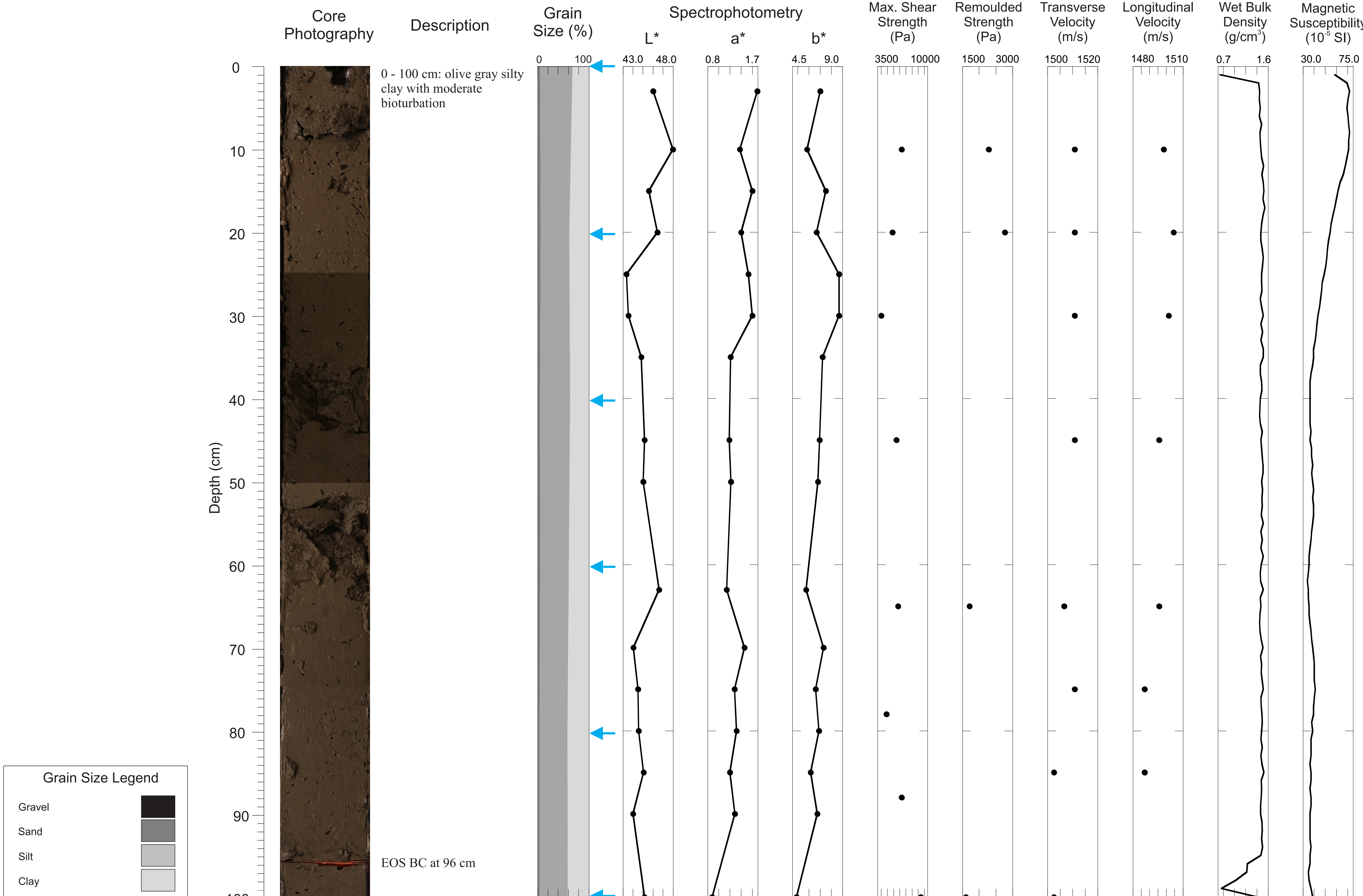
74°15.5774'N / -82°23.0490'W; Water depth = 800 m
Total Length = 709 cm



2008029 0059 TWC

74°15.5774'N / -82°23.0490'W; Water depth = 800 m

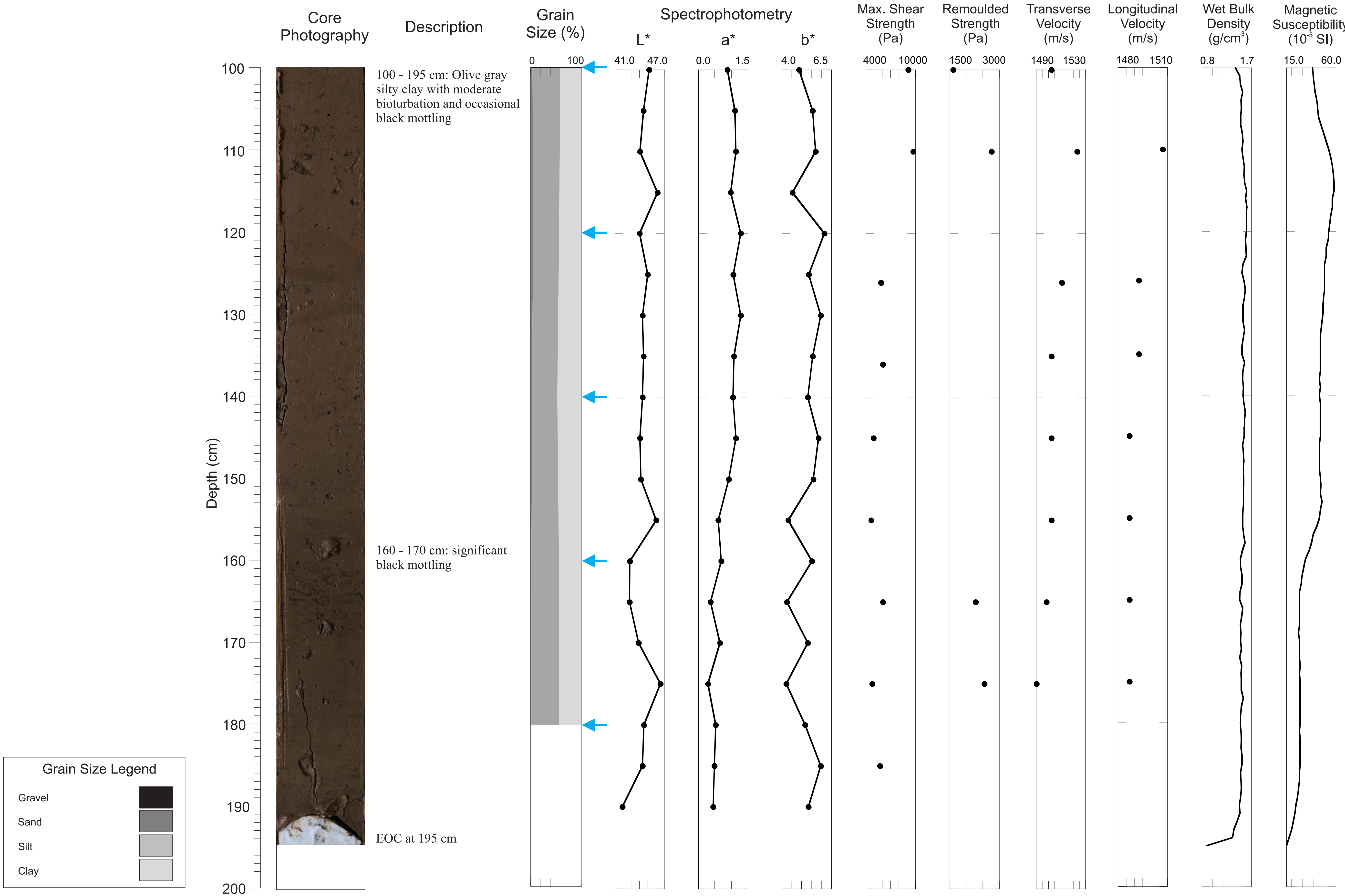
Total Length = 195 cm



2008029 0059 TWC

74°15.5774'N / -82°23.0490'W; Water depth = 800 m

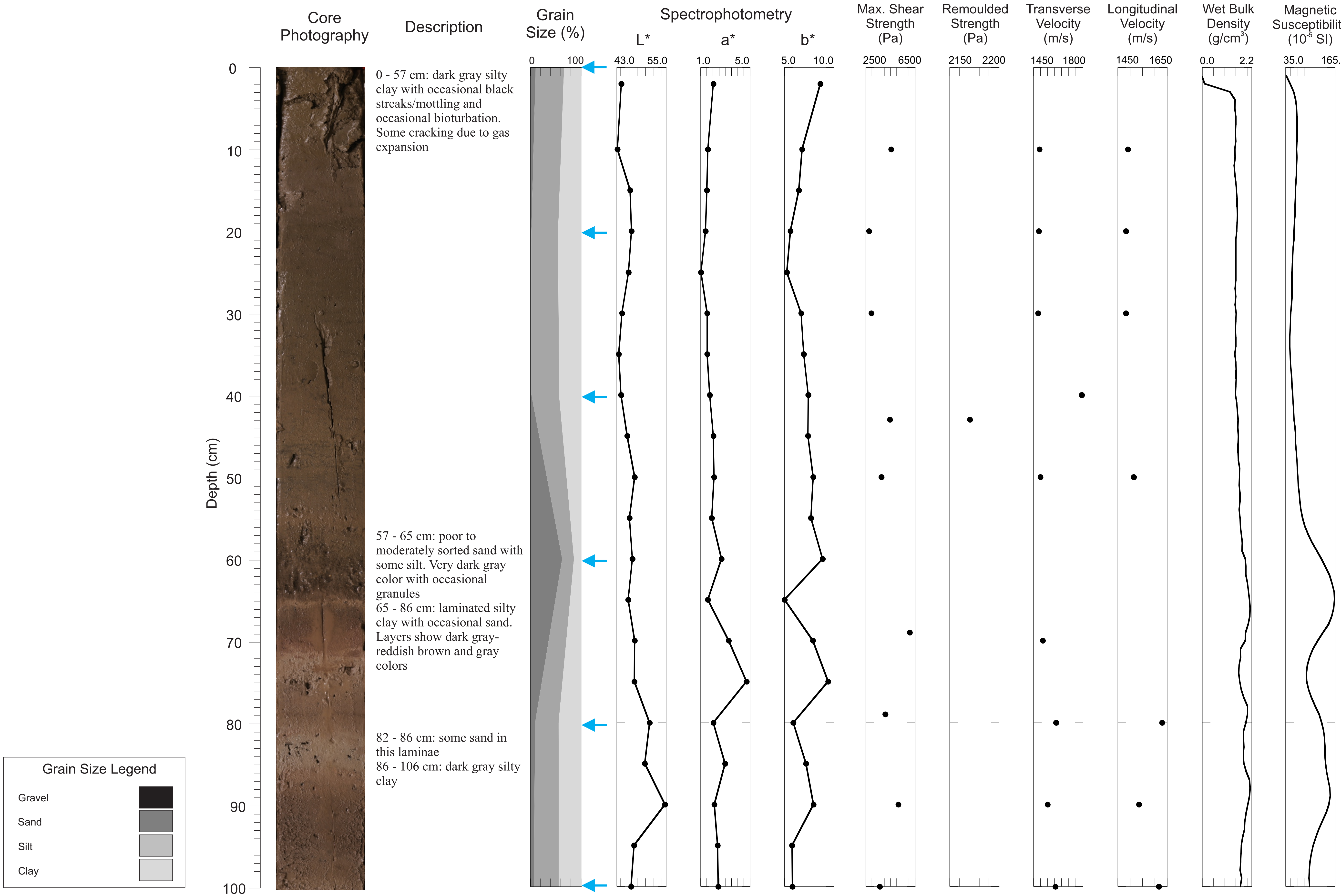
Total Length = 195 cm



2008029 0061 PC

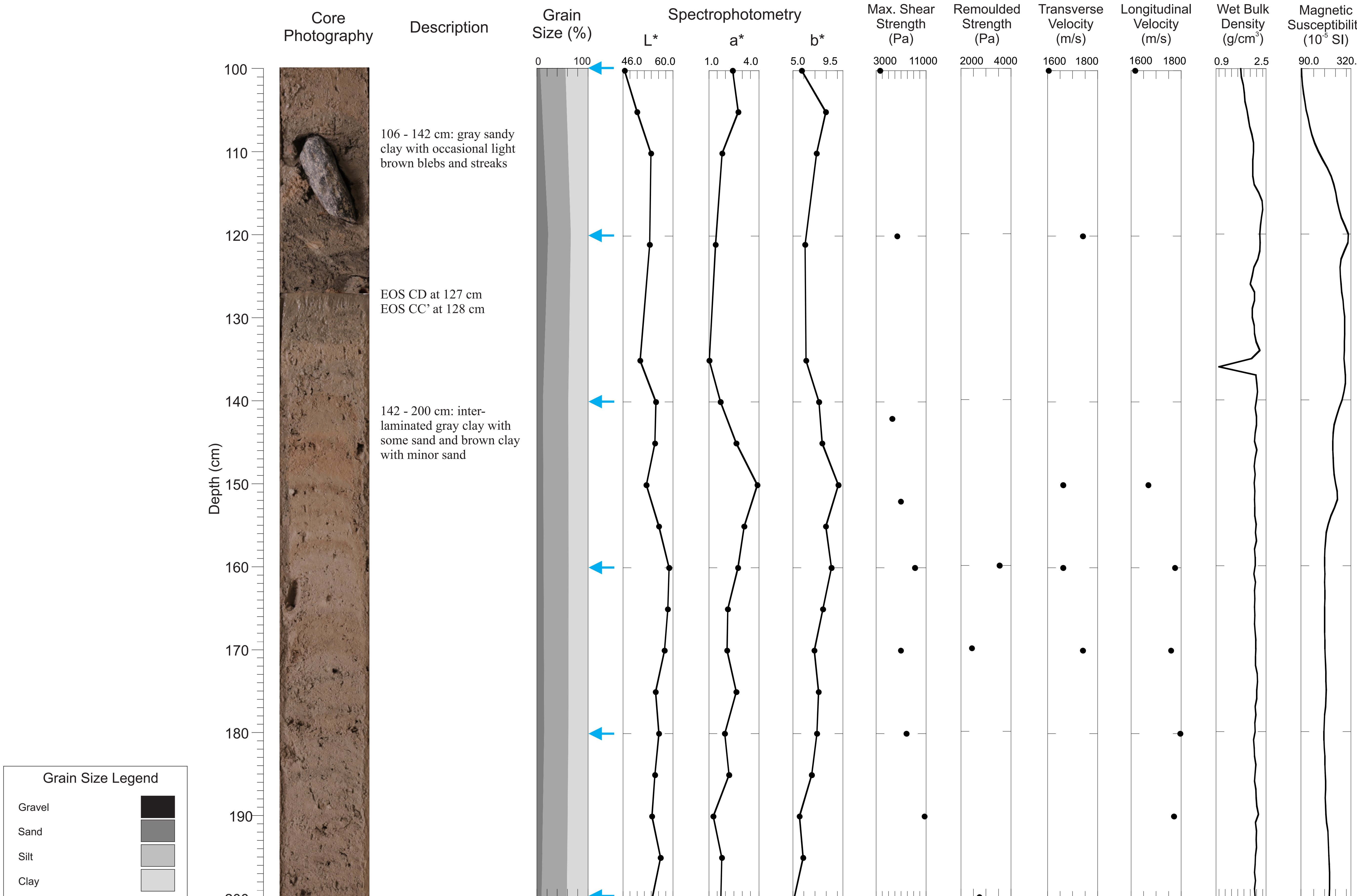
74°15.4925'N / -82°13.8212'W; Water depth = 791 m

Total Length = 441 cm



2008029 0061 PC

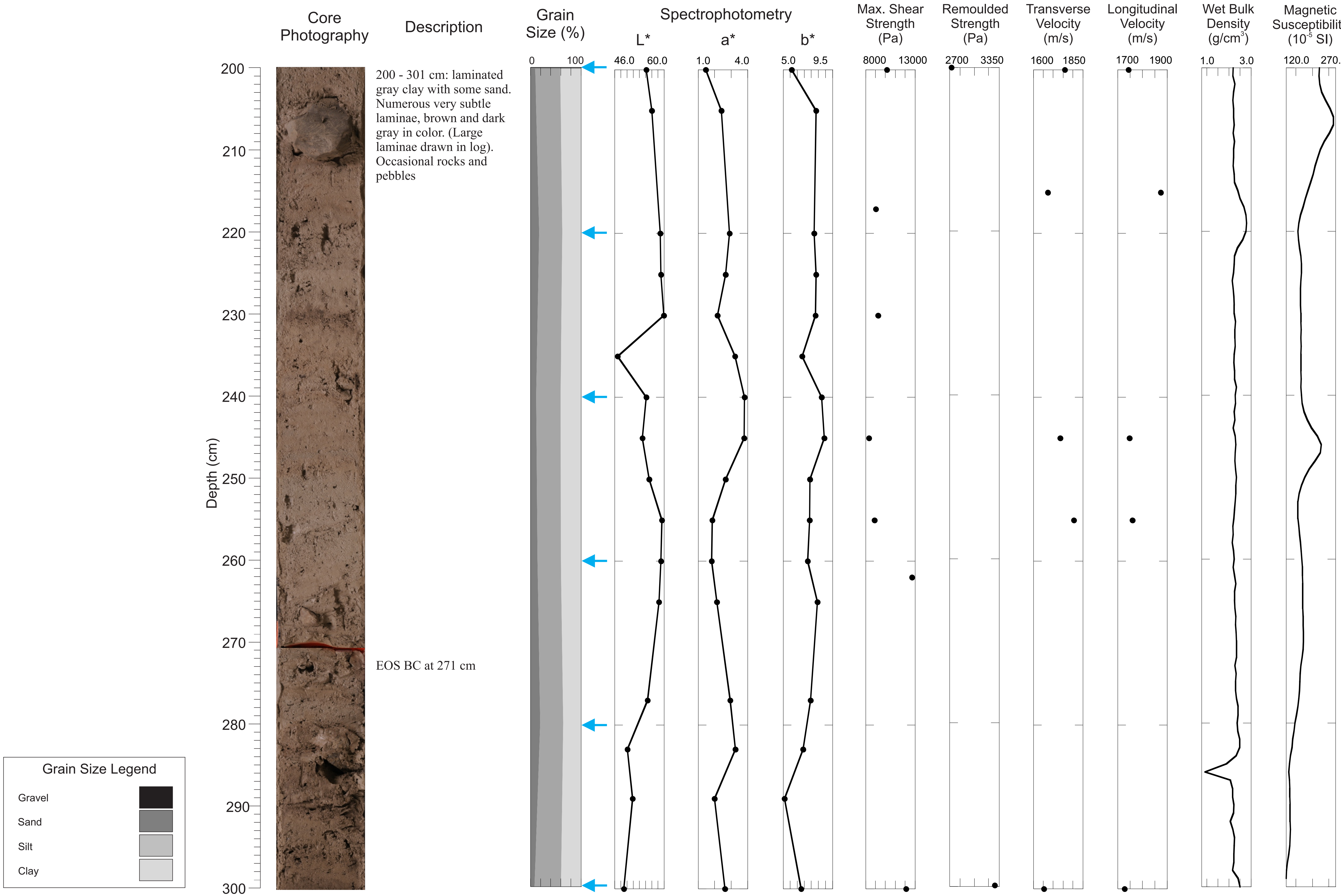
74°15.4925'N / -82°13.8212'W; Water depth = 791 m
Total Length = 441 cm



2008029 0061 PC

74°15.4925'N / -82°13.8212'W; Water depth = 791 m

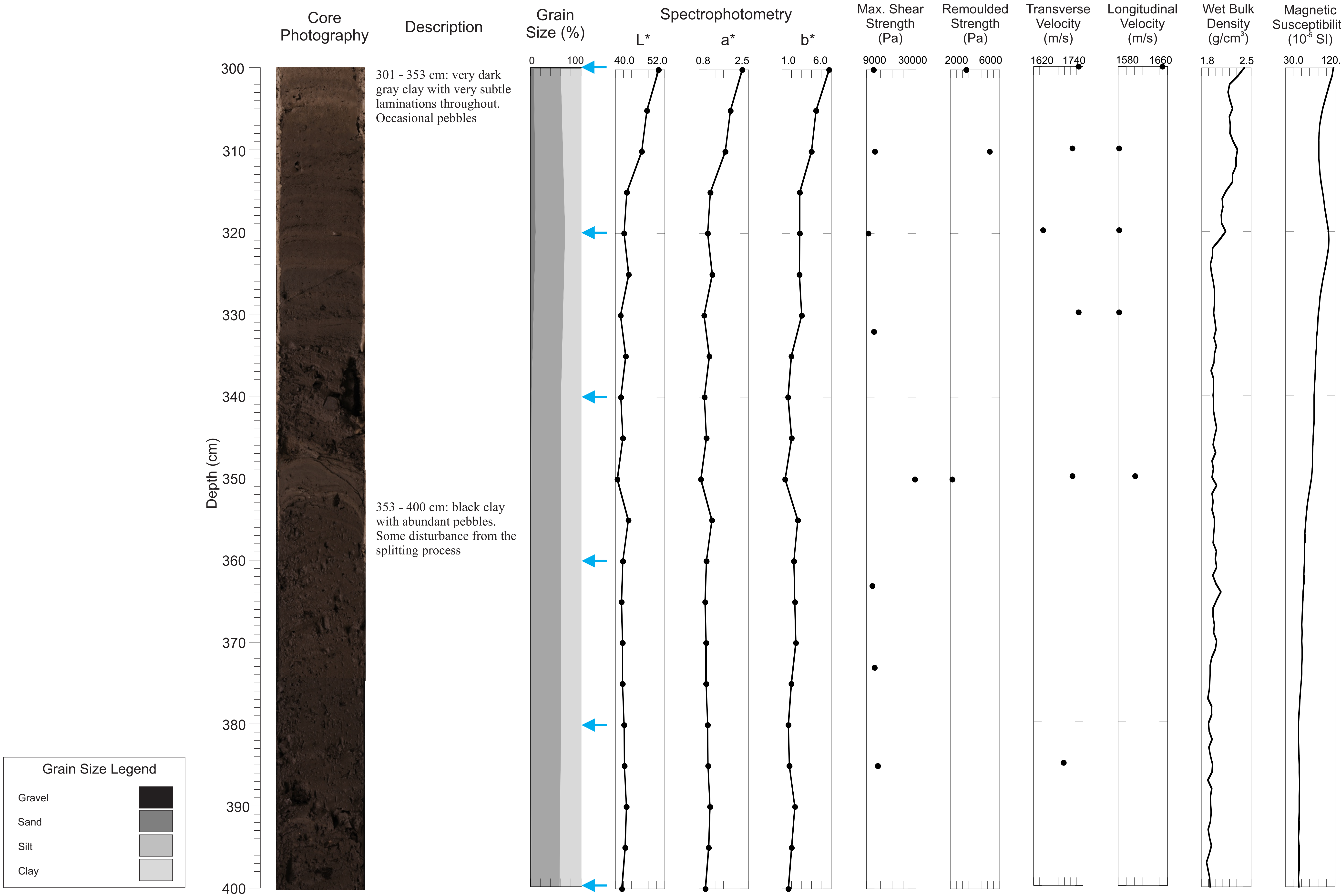
Total Length = 441 cm



2008029 0061 PC

74°15.4925'N / -82°13.8212'W; Water depth = 791 m

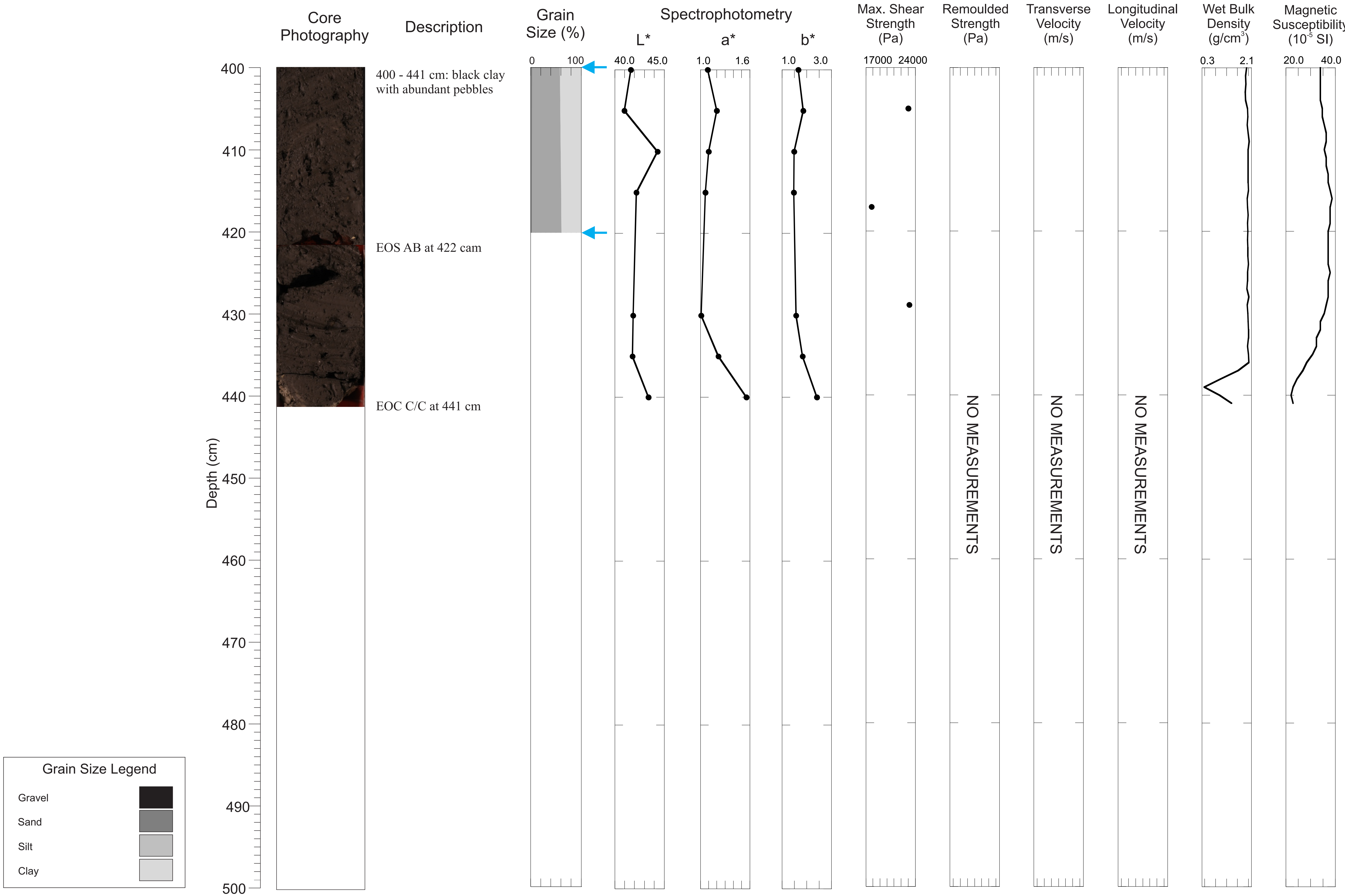
Total Length = 441 cm



2008029 0061 PC

74°15.4925'N / -82°13.8212'W; Water depth = 791 m

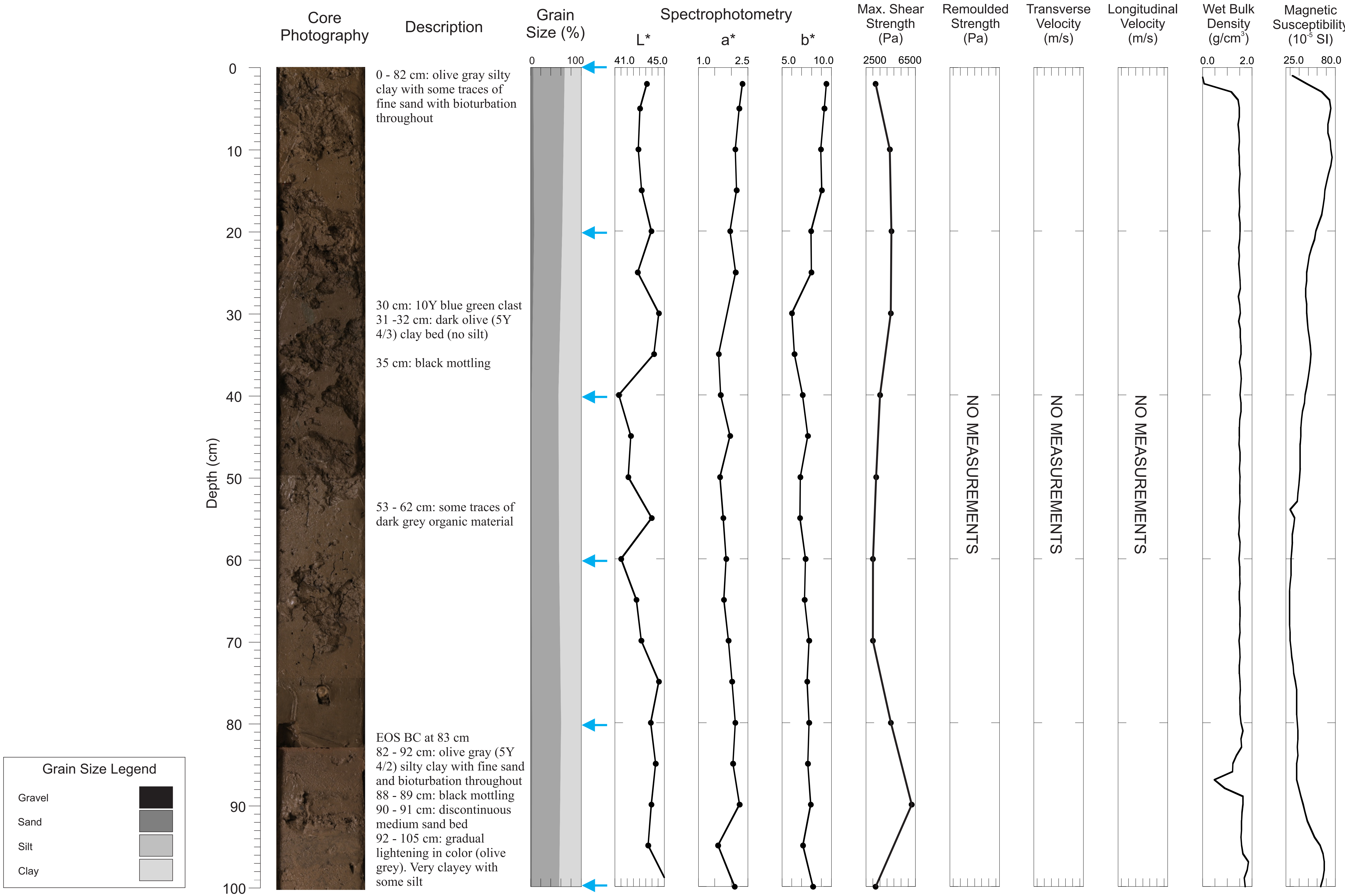
Total Length = 441 cm



2008029 0061 TWC

74°15.4925'N / -82°13.8212'W; Water depth = 791 m

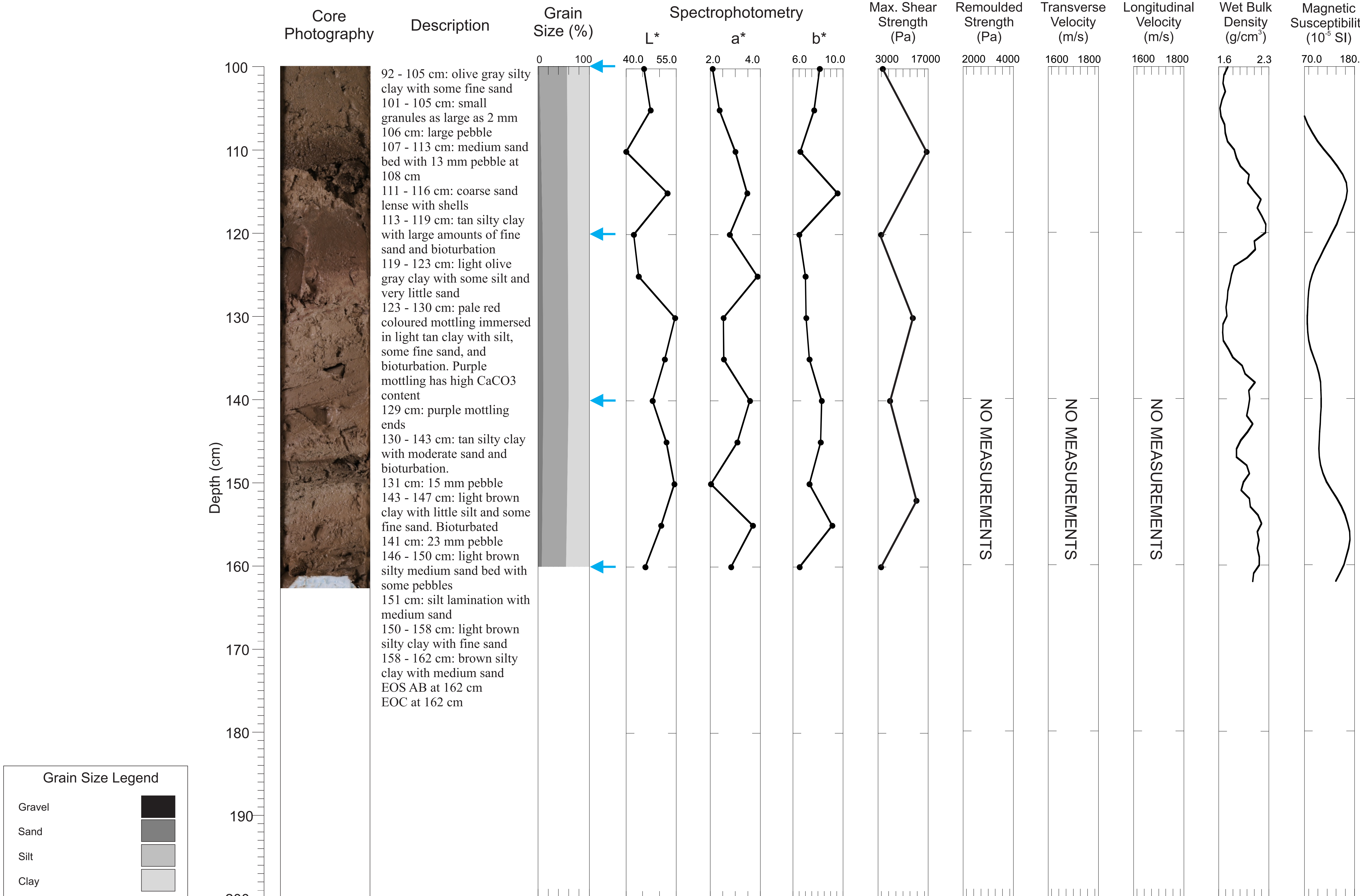
Total Length = 162 cm



2008029 0061 TWC

74°15.4925'N / -82°13.8212'W; Water depth = 791 m

Total Length = 162 cm

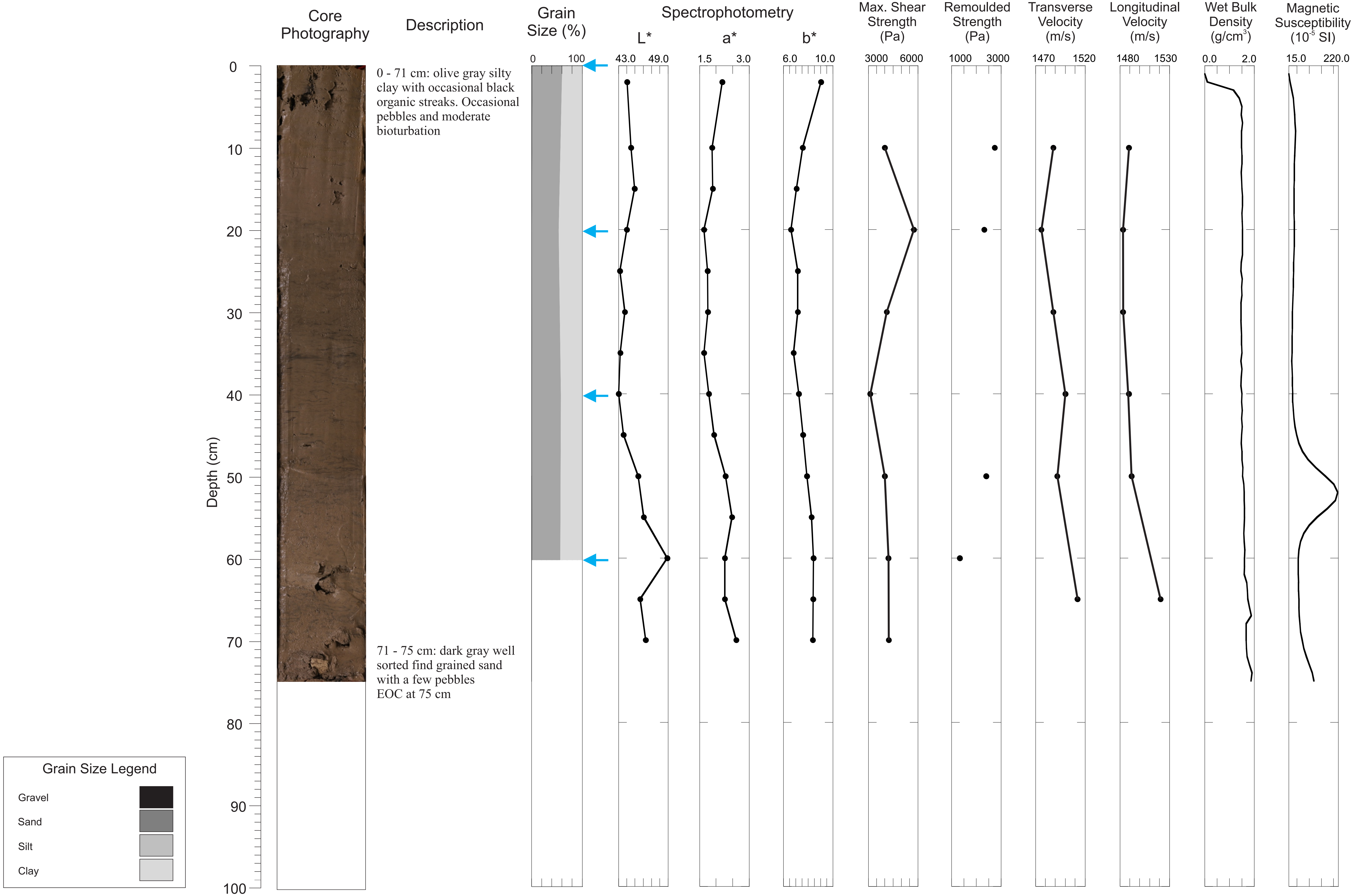


92 - 105 cm: olive gray silty clay with some fine sand
101 - 105 cm: small granules as large as 2 mm
106 cm: large pebble
107 - 113 cm: medium sand bed with 13 mm pebble at 108 cm
111 - 116 cm: coarse sand lense with shells
113 - 119 cm: tan silty clay with large amounts of fine sand and bioturbation
119 - 123 cm: light olive gray clay with some silt and very little sand
123 - 130 cm: pale red coloured mottling immersed in light tan clay with silt, some fine sand, and bioturbation. Purple mottling has high CaCO3 content
129 cm: purple mottling ends
130 - 143 cm: tan silty clay with moderate sand and bioturbation.
131 cm: 15 mm pebble
143 - 147 cm: light brown clay with little silt and some fine sand. Bioturbated
141 cm: 23 mm pebble
146 - 150 cm: light brown silty medium sand bed with some pebbles
151 cm: silt lamination with medium sand
150 - 158 cm: light brown silty clay with fine sand
158 - 162 cm: brown silty clay with medium sand
EOS AB at 162 cm
EOC at 162 cm

2008029 0062 PC

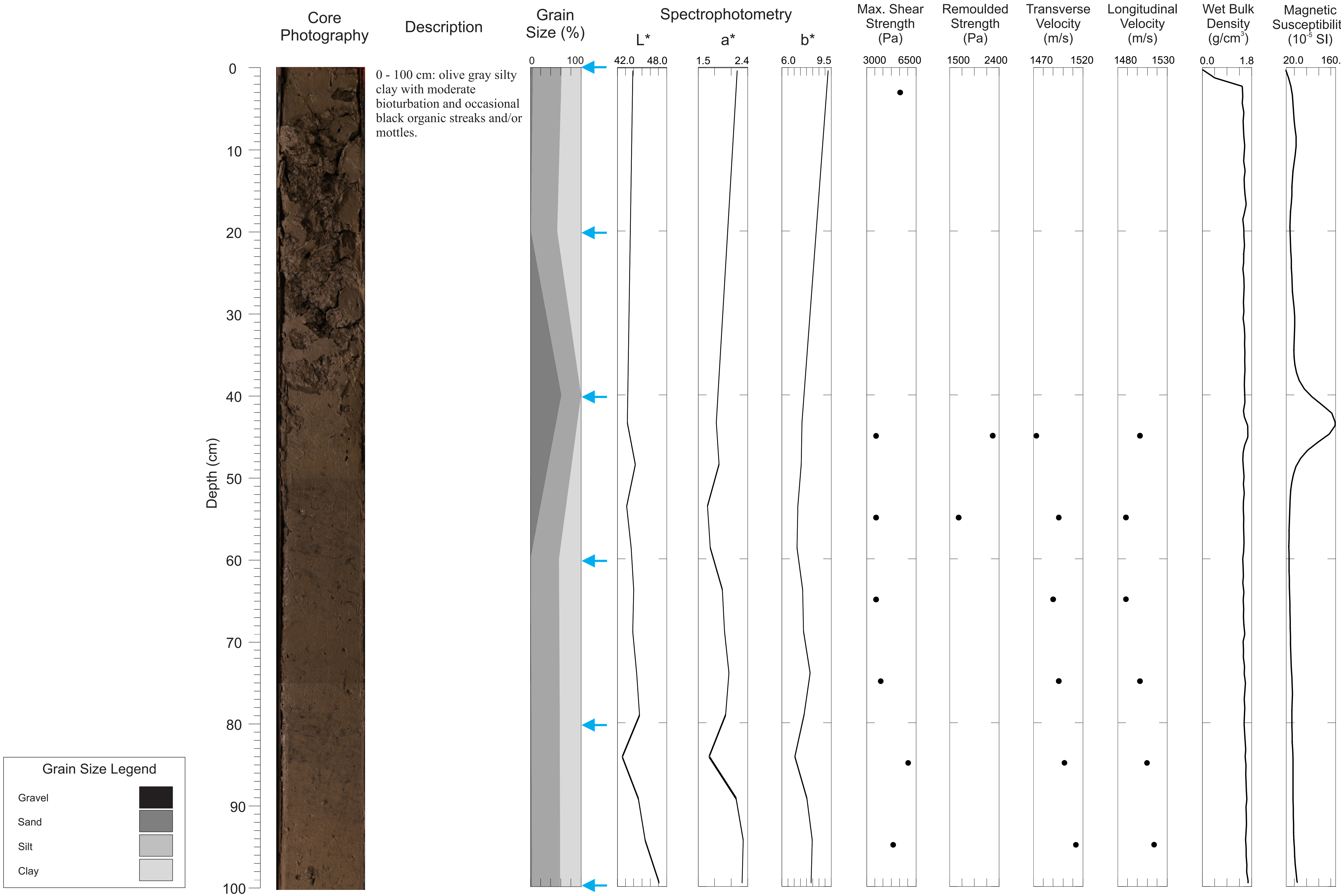
74°15.1519'N / -81°38.0907'W; Water depth = 822 m

Total Length = 75 cm



2008029 0062 TWC

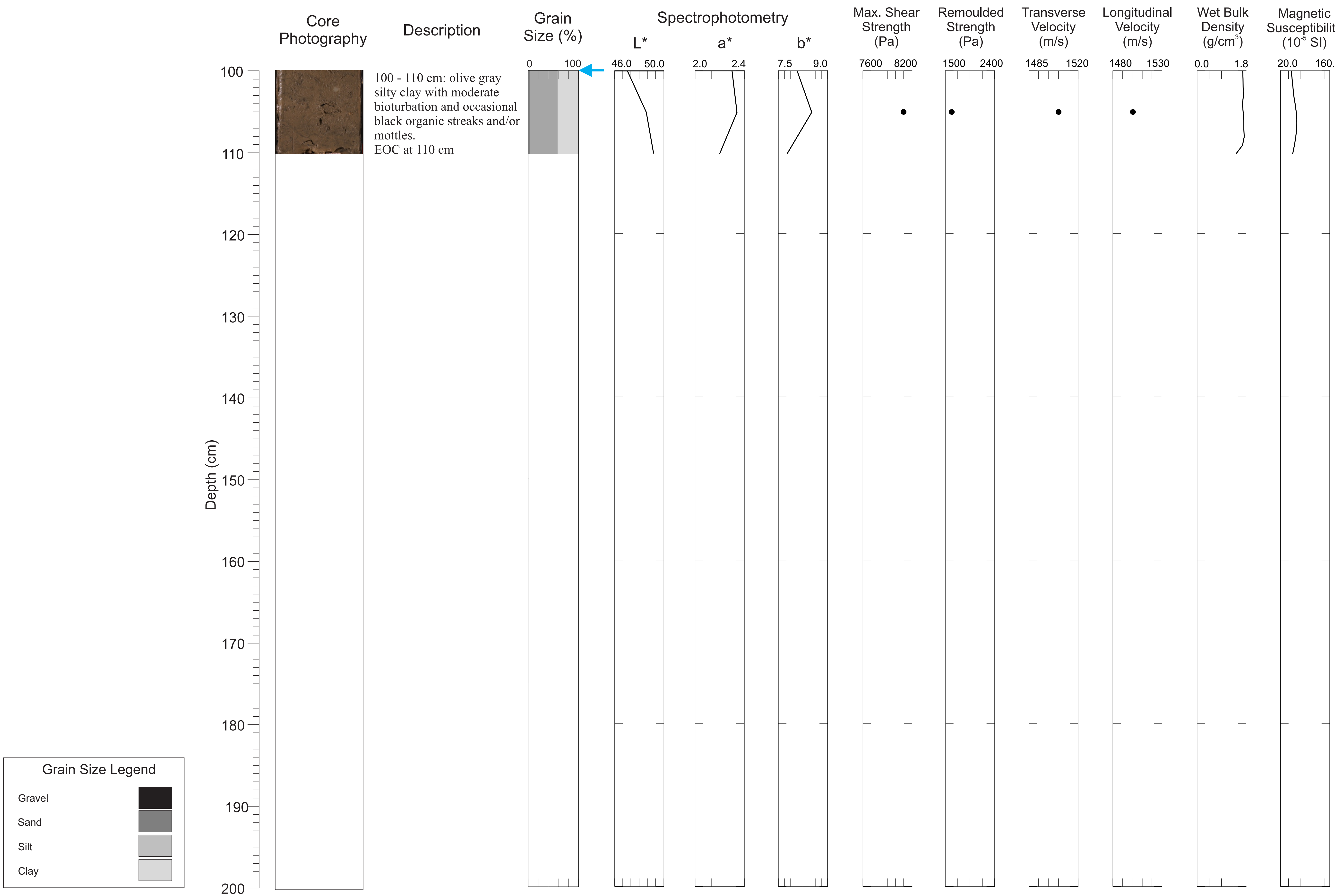
74°15.1519'N / -81°38.0907'W; Water depth = 822 m
Total Length = 110 cm



2008029 0062 TWC

74°15.1519'N / -81°38.0907'W; Water depth = 822 m

Total Length = 110 cm



100 - 110 cm: olive gray silty clay with moderate bioturbation and occasional black organic streaks and/or mottles.
EOC at 110 cm