Coastal Protection and
Restoration Authority of Louisiana

SUBBOTTOM PROFILER ASSESSMENT FOR BURIED OYSTER BEDS

CAMERON-CREOLE WATERSHED
GRAND BAYOU MARSH CREATION PROJECT (CS-54)
CALCASIEU LAKE
CAMERON PARISH, LOUISIANA

SUBMITTED BY

C&C Technologies
SURVEY SERVICES

AUGUST 2012

C&C Project No. 110829

Tony George
Geophysicist

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1.0 EXECUTIVE SUMMARY

- The State of Louisiana Coastal Protection and Restoration Authority contracted C & C Technologies, Inc. to provide seismic and additional bathymetry and magnetometer data as part of the Cameron-Creole Watershed Grand Bayou Marsh Creation Project (CS-54).

- The field operations were conducted between June 19-21 and July 13-14, 2012 on the M/V *C-Star*.

- The primary purpose of the survey was to determine the position and burial depths of oyster beds found in the Borrow Area. A previous Biological Oyster Assessment for the project area determined oyster beds are present in the study area.

- A marine survey crew conducted the Geophysical Survey utilizing a fathometer, magnetometer and subbottom profiler. Although not part of the work scope, a side scan sonar was deployed across the Borrow Area.

- Water depths across the Borrow Area range from -4.0 to -6.5 feet NAVD88.

- Seventeen tracklines spaced 500 feet were designed to provide subbottom profiler and fathometer data across the Borrow Area.

- Magnetometer data were collected along the centerline of the Access Corridor. Thirty nine unidentified magnetic anomalies were recorded.

- There was no conclusive evidence of buried oysters beds found on subbottom profiler data, although some higher amplitude zones are mapped with seismic signatures suggestive of potential buried oyster beds. The largest zone is found in the southwestern quarter of the Borrow Area.

- The subbottom profiler amplitudes recorded between the lake floor and five feet below the mudline were summed and contoured in an attempt to quantify the seismic recordings and delineate buried oyster beds.

- Partial coverage of the study area was obtained with side scan sonar suggesting the lake floor is composed of fine grained sediment with an area of more granular sediment occurring off the southeastern shoreline. Oyster beds or shells are interpreted on the lake floor bottom in the southeastern quarter of the Borrow Area.

2.0 SCOPE OF WORK

C & C Technologies, Inc. (C&C) was contracted by the State of Louisiana, Office of Coastal Protection and Restoration Authority (CPRA) to provide survey services for the Cameron-Creole Watershed Grand Bayou Marsh Creation Project (CS-54) located in the southeastern Lake Calcasieu in Cameron Parish. This report focuses on additional survey efforts which complement previous C&C survey work performed for the restoration project. The primary scope of this additional survey work is to determine if any buried oyster beds are found in the Borrow Area. Collection of soundings in the Borrow Area, and fathometer and magnetometer recordings in the Access Corridor are part of the work scope.

The study maps are provided in NAD83 in the Louisiana South projection and the horizontal scale is 1:6000 (1" = 500'). The bathymetric data is corrected and referenced to NAVD88.

2.1 Survey Equipment

Positioning of the survey launch was performed using C-NAV DGPS with Winfrog software used for vessel navigation and for digital water depth recording. A fathometer and subbottom profiler was operated along the east-west primary lines designed in the Borrow Area. Side scan sonar was deployed in the Borrow Area to determine potential oyster bed outcrops on the lake floor. The magnetometer was operated along the centerline of the Access Corridor. Detailed equipment descriptions and instrument settings are provided in Appendix A.

2.1 Methodology

The majority of the geophysical field operations were performed on June 19-21, 2012 aboard the M/V *C-Star*. . Weather conditions were favorable for acquisition. Fathometer data reruns due to a faulty transducer were collected on July 13-14, 2012.

Seventeen east-west transects spaced 500 feet were designed in the Borrow Area. Navigation fixes were recorded every 25 feet along the survey lines. A magnetometer line was run down the center of Access Corridor. All the geophysical systems were digitally recorded and integrated with the positioning data.

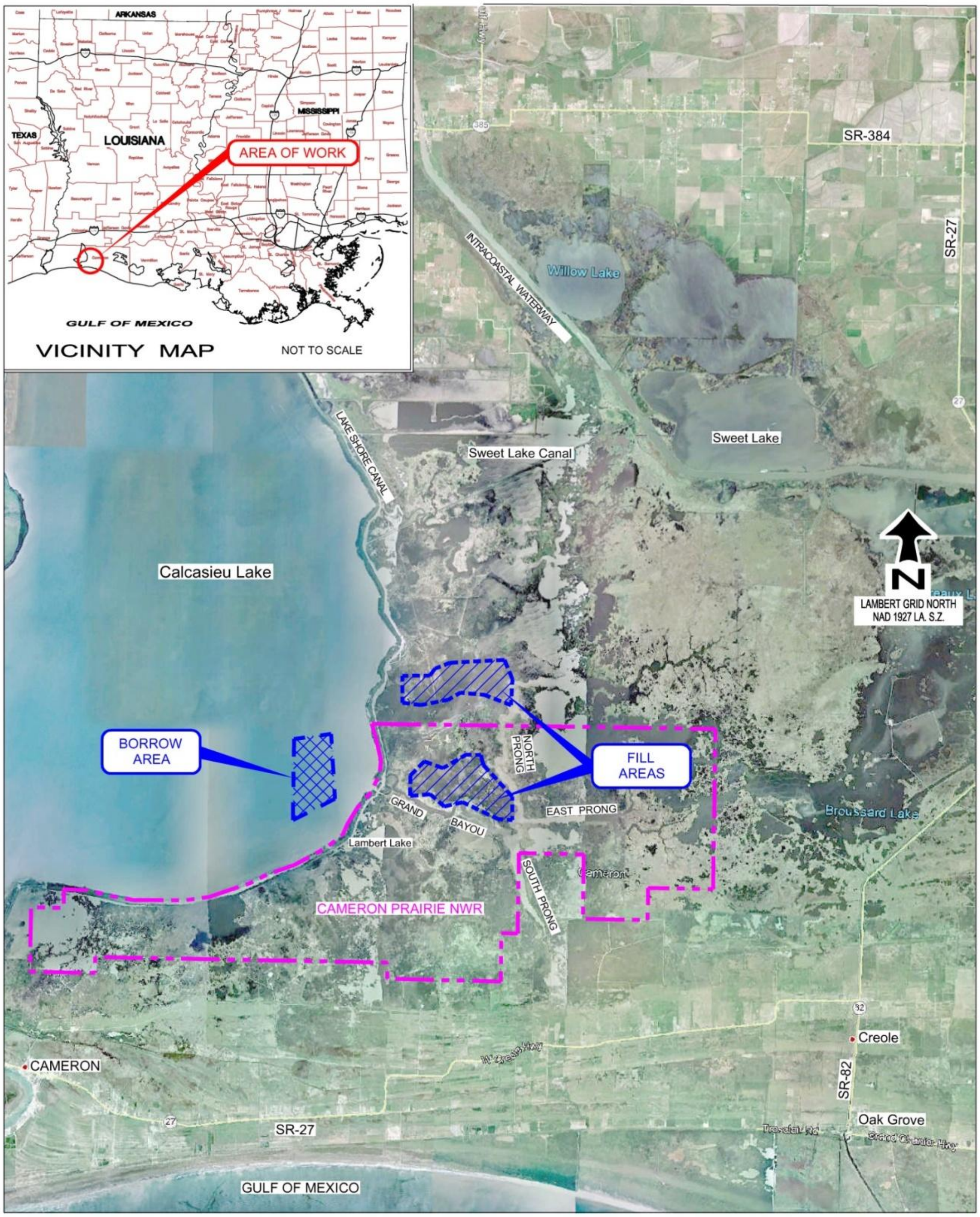
The fathometer data were processed and reduced to NAVD88 using C&C proprietary software. The bathymetric results are provided on the Bathymetry, Lake Floor and Subbottom Features Map (Sheet 1) for the Borrow Area and on the Bathymetry and Magnetic Anomaly Map for the Access Corridor.

The side scan sonar data were slant range corrected and interpreted with Chesapeake's Sonarwiz interpretation software. A geotiff sonar mosaic image and zones of probable outcropping oyster beds were output with Sonarwiz. The sonar data is presented on the Side Scan Sonar Mosaic Map (Sheet 4). The system was only operated across the Borrow Area.

Seismic Micro-Technologies, Inc. (SMT) seismic interpretation software was used to generate the seismic sections found in Appendix C. The positions of the subbottom features output from the software are shown on the Bathymetry, Lake Floor and Subbottom Features Map (Sheet 1). The Lake Floor Amplitude Map (Sheet 2) and the Seismic Amplitude Summations Between the Lake Floor and Five Feet Below the Mudline (Sheet 3) were generated using functions within the SMT.

730 EAST KALISTE SALOOM ROAD, LAFAYETTE, LA 70508

Table No. 1 - Personnel List		
Personnel	**Company**	**Responsibilities**
Client Representative/Contact:		
Anna Wojtanowicz, E.I.	CPRA	Project Engineer
Field Crew:		
Brandon Herpin	C & C Technologies, Inc.	Field Project Supervisor
S. Herpin	C & C Technologies, Inc.	Party Chief
J. Melancon	C & C Technologies, Inc.	Surveyor
C. Heizen	C & C Technologies, Inc.	Surveyor
Office Professionals:		
Frank Lipari	C & C Technologies, Inc.	Project Engineer
Gene Prather	C & C Technologies, Inc.	Project Manager, RPL
Tony George	C & C Technologies, Inc.	Geophysicist
Hallie Graves	C & C Technologies, Inc.	SMT Project Geologist
Ross Olivier	C & C Technologies, Inc.	Geo Intern
Doug Pierrottie	C & C Technologies, Inc.	Draftsperson



3.0 DISCUSSION OF DATA RESULTS

The following sections describe the results of the survey efforts for the additional project work. The narrative includes a discussion of the bathymetric, seismic and magnetometer results.

3.1 Bathymetry

Bathymetry data were acquired using an Odom 200-kHz Hydrotrac Fathometer. The soundings were recorded digitally and time tagged with the navigation software. Readings from the fathometer were reduced, reviewed for outliers and corrected to the local project datum. Water level corrections were applied. The bathymetry data is referenced to NAVD88 and presented on the study maps.

Water depths across the Borrow Area range from -4.0 feet NAVD88 in the southwest to -6.5 feet NAVD88 in the northwest. Soundings are posted on the Bathymetry and Magnetic Anomaly Map for the Access Corridor.

3.2 Magnetometer (Access Corridor)

A Geometrics Cesium Magnetometer was operated along the centerline of the Access Corridor. The magnetometer was towed 83 feet behind the vessel. These data were digitally recorded and interpreted utilizing proprietary software.

and 199 gammas, respectively. A broad 513-foot, 114-gamma anomaly is generated by the Conoco No. 2 Well.

The magnetometer interpretation results are presented on the panels for the Bathymetry and Magnetic Anomaly Map (Sheet 1 for Access Corridor). Details on the 39 unidentified magnetic anomalies are found in the Unidentified Magnetic Anomaly Table in Appendix B. The unidentified anomalies are plotted on the study map by reference number. The amplitude and duration for each anomaly are presented in a table in the map legend. Three of the magnetic anomalies are interpreted as wells and these are presented in the Identified Magnetic Anomaly Table in Appendix B.

The locations with very high intensity should be avoided or investigated should dredging operations along the Access Corridor be performed. Potential damage or debris entanglement could occur at these locations.

3.3 Side Scan Sonar

Although not part of the work scope, a Geoacoustics Side Scan Sonar was operated along the survey lines collected in the Borrow Area. A Side Scan Sonar Mosaic Map (Sheet 4) is provided on Sheet 4. Due to the shallow water depths, one hundred percent side scan sonar coverage was not obtained. The side scan sonar was operated to correlate any lake floor oyster bed deposits to the subbottom profiler interpretation.

The side scan sonar shows the lake floor is generally smooth with only a few oyster bed outcroppings occurring across the northern half of the Borrow Area. The densest zone of lake floor oyster shell accumulation is found in the southeastern quarter of the survey area. The zone measures 1,500 feet north to south and 1,000 feet east to west. The sonar records darker returns in the east south-central Borrow Area. This indicates the seafloor sediments are more granular within this zone of increased reflectivity.

3.4 Subbottom Profiler

An EdgeTech 216 "Chirped" Subbottom Profiler was utilized in an attempt to determine if any buried oyster beds are present within the Borrow Area. Figure No. 3 is a subbottom profiler record showing the seismic character of the shallow lake floor deposits.

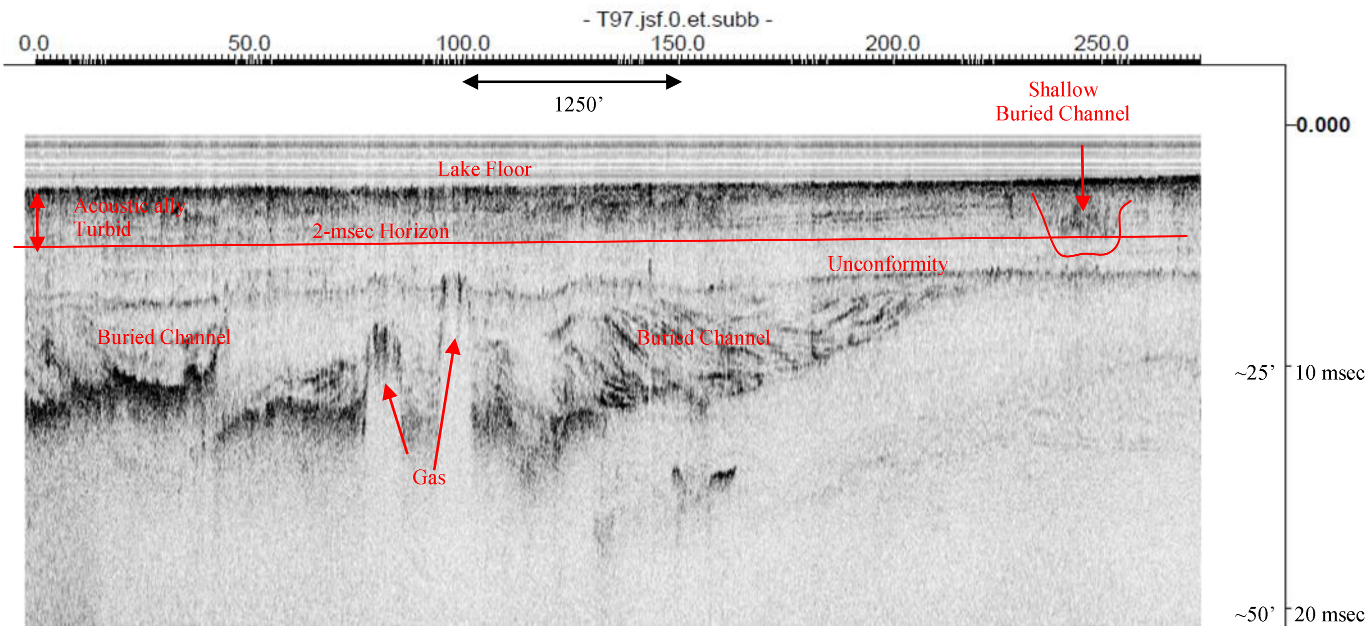


Figure No. 3 – Subbottom profiler record for Line 97 showing shallow stratigraphy and features.

The uppermost 5 feet of sediment is acoustically turbid and is generally void of horizontal reflecting horizons. Oyster shell and beds are composed of calcareous minerals and have very high acoustic impedance when compared to overlying clay or sand. Reefs are usually identified by a significant high amplitude reflector at the top of the reef with no reflectors observed below the reef top. There were no areas where the subbottom profiler was run in the Borrow Area where these acoustic voids were observed. Oyster poling, dredging and sampling in the Borrow Area, however, does confirm oysters do exist on the lake floor shell accumulations.

There are four zones interpreted where possible oysters are buried (Figure No. 4). One zone is interpreted along the center of Line 195. A zone of possible buried oyster beds is interpreted across four lines in the southwestern portion of the Borrow Area and there are two small zones in the southeast. These beds are interpreted 0.5 to 1 foot below the lake floor. The possible buried zones of oyster beds did not correlate well with where the side scan sonar delineated lake floor outcrops.

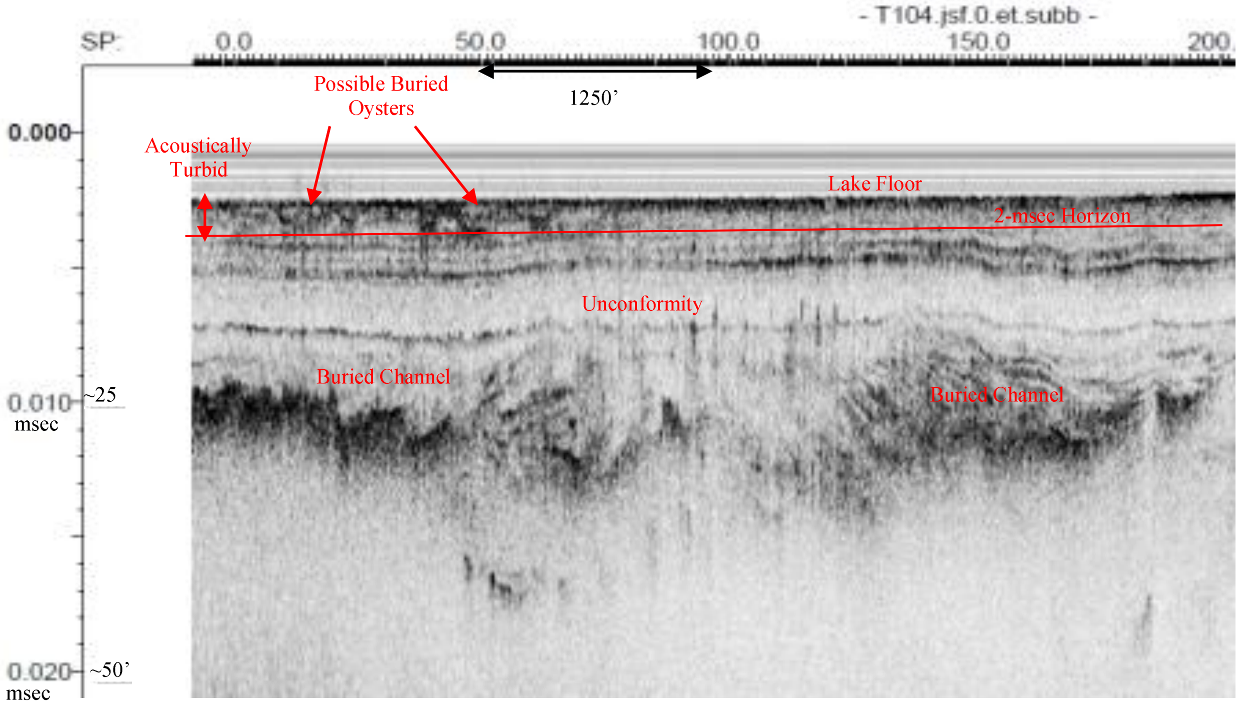


Figure No. 4 – Subbottom profiler record for Line 104 showing shallow stratigraphy and possible buried oyster beds.

Since no clear signature for oysters could be found in the interpretation review, a decision was made to quantify the seismic amplitudes in order to see if any trends could be determined in the data.

The lake floor was digitized as a seismic horizon across the Borrow Area. The seismic amplitudes of this lake floor horizon are presented on Sheet 2. These seismic amplitudes range from 0.5 to 3.5 units. Higher amplitude values are recorded in the southeastern quarter of the survey limits where the sonar returns suggest more granular sediments occur. There are small highs recorded in the southeastern quarter of the study area where the side scan sonar indicated outcropping oyster beds exist.

Another "horizon" was mapped at 2 milliseconds or 5 feet below the lake floor. A function in the seismic software was used to sum the seismic amplitude values recorded between lake floor and 5 feet below the mudline. The results are contoured on the Seismic Amplitude Summations Between Lake Floor and Five Feet Below Mudline Map (Sheet 3). Most of the values range between 30 and 40 indicating the shallow lake floor sediments are homogeneous. The contours do reflect an increase in values in the southwestern Borrow Area where the possible oyster beds are interpreted.

The subbottom profiler did record portions of a shallow channel along the eastern survey limits. This channel is buried 1 foot below the mudline and has thalweg depths up to 10 feet.

Below the uppermost acoustically turbid unit, an acoustically transparent sedimentary unit exists with some faint horizons present. The transparent unit averages 5 feet in thickness. An unconformity marks the base of the acoustically transparent unit. A large channel is observed across the western three-quarters of the Borrow Area. This buried channel is presumed to have once been the location of the Calcasieu River and may be infilled with significant sand deposits.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Water depths recorded across the Borrow Area range from -4.0 feet NAVD88 along the shoreline to -6.5 feet NAVD88 in the northwest.

The magnetometer recorded 39 unidentified magnetic anomalies along the centerline of the Access Corridor. Dredging contractors should use caution in the proximity of the ferrous debris.

The subbottom profiler recorded the uppermost 5 feet of lake floor sediment as generally an acoustically turbid unit. There were no zones of significant acoustic wipe out suggesting substantial accumulations of oyster beds or reefs. There were a few higher amplitude zones interpreted as possible buried oysters found 1 foot below the lake floor in the southwestern portion of the Borrow Area. The side scan sonar recorded oyster outcropping in the southeastern quarter of the Borrow Area.

5.0 REFERENCES

Breiner, S. 1973. Applications Manual for Portable Magnetometers, GeoMetrics, Sunnyvale, California.

Fish, John P. and H. Arnold Carr. 1990. Sound Underwater Images. A Guide to the Generation and Interpretation of Side Scan Sonar Data. Lower Cape Publishing, Orleans, MA. 189 pp.

Gaspard, Nicholas E. 2012. Biological Oyster Assessment for Cameron Creole Watershed Marsh Creation Project (CS-54) Cameron Parish, LA. Report prepared by T. Baker Smith, LLC.

Roberts, H.H., C. Wilson and J. Supan. 2000. Acoustic Surveying of Ultra-Shallow Water Bottoms (< 2.0 m) for Both Engineering and Environmental Applications. OTC Paper No. 12108.

APPENDIX A

Equipment Descriptions
Instrument Settings
Vessel Setback Diagram
Survey Logs

MARINE CESIUM MAGNETOMETER MODEL G-882 SERIES

The Geometrics cesium magnetometer provides a scalar measurement of the earth's magnetic field intensity expressed in nano-Teslas (nT) or gammas (γ). In the marine environment, geology and man-made objects create an external magnetic field, which disturbs the earth's primary magnetic field. This change affects the rate of energy transition (Larmor frequency) of cesium atoms from a higher to a lower excitation level in which case, the magnetic field is determined exclusively by the strength of the external field.

The G-882 cesium magnetometer has a very high sensitivity and sample rate due to the accuracy of the larmor frequency counter, (i.e. 0.002 nT at 10 samples per second). The frequency readings can be acquired and concatenated from up to six individual sensors to provide a sequential RS-232 data stream for transmittal through a tow cable as long as 2,500 feet. Additionally, the system is capable of providing digital readings such as depth, altitude and water temperature by providing each larmor counter with up to eight A/D converters that allow analog inputs from transducers or sensors. The data can be transmitted locally to a host CPU to interface with side scan sonar or a ROV system. Also, one of the main advantages of the cesium magnetometer design is that the "Doppler Effect" given by the rotation of the sensor in rough seas is an order of magnitude less for cesium since it has inherent low noise characteristics; therefore, the system is more tolerable to movement reducing the source of troublesome noise.

Adjustments to get the cesium sensor in the operating "active zone" include mounting the sensor in such a way that the earth's magnetic field is not less than 6 degrees from the sensor's centerlines of length and width. This is generally achieved at the beginning of a survey by tilting or rolling the sensor, or rotating the shifting keel weight.

When two or more sensors are used, magnetic gradient data is obtained, which offers enhanced detection of small anomalies, diurnal free total field profiles and improved noise rejection.

During field operation, the incoming signal amplitude is stored in files by lines with a Julian date and time, line number, voltage, and ambient magnetic field. A graphic presentation of the magnetometer data is displayed in real-time, and a hard copy output of the recording is sent to a line printer. The magnetometer is also equipped with a depth sensor, and the depth is output periodically on the hard copy record.

OPERATING PRINCIPLE:	Self-oscillating split-beam Cesium Vapor (non-radioactive)
OPERATING RANGE:	20,000 to 100,000 nT
OPERATING ZONES:	The earth's field vector should be at an angle greater than 6º from the sensor's equator and greater than 6º away from the sensor's long axis. Automatic hemisphere switching.
CM-221 COUNTER SENSITIVITY:	<0.004 nT √Hz rms. Typically 0.02 nT P-P at a 0.1 second sample rate or 0.002 nT at 1 second rate. Up to 10 samples per second
HEADING ERROR:	±1 nT (over entire 360º spin and tumble)
ABSOLUTE ACCURACY:	<3 nT throughout range
OUTPUT:	RS-232 at 9600 Baud
MECANICAL:	
Sensor Fish:	Body 2.75 in. (7cm) dia., 4.5 ft (1.37m) long with fin assembly (11 in. cross width), 40 lbs. (18 kg) Includes Sensor and Electronics and 1 main weight. Additional collar weights are 14 lbs (6.4kg) each, total of 5 capable
Tow Cable:	Keval Reinforced multiconductor tow cable. Breaking strength 3,600 lbs, 0.48 in OD, 200 ft maximum. Weights 17 lbs (7.7 kg) with terminations.
OPERATING TEMPERATURE:	-30ºF to +122ºF (-35ºC to + 50ºC)
STORAGE TEMPERATURE:	-48ºF to +158ºF (-45ºC to +70ºC)
ALTITUDE:	Up to 30,000 ft (9,000 m)
WATER TIGHT:	O-Ring sealed for up to 9000 ft (2750 m) depth operation
POWER:	24 to 32 VDC, 0.75 amp at turn-on and 0.5 amp thereafter
ACCESSORIES:	
Standard:	CM-201 View Utility Software operation manual and ship case
Optional:	Telemetry to 10Lm coax, gradiometer (longitudinal or transverse)
MagLog Lite™ Software:	Logs, displays and prints Mag and GPS data at 10 Hz sample rate. Automatic anomaly detection and single sheet Windows printer support

GEOACOUSTICS SIDE SCAN SONAR

The GeoAcoustics Side Scan Sonar System is an industry standard high-resolution search and survey instrument designed both object location and the study of sea floor geology. The GeoAcoustics Side Scan Sonar System employs a surface based Model SS981 Transceiver and Model 159 Tow Vehicle with two Model 196D Transducers and a Model SS982 Sub-surface Electronic bottle. A real time data acquisition and processing system can be used to provide high-resolution graphics, digital data storage, and imaging processing. The system offers frequency operation modes of low frequency (114 kHz) and a high frequency (410 kHz).

The GeoAcoustics dual frequency Side Scan Sonar system is a multiplexed system. All power, control signals and received sonar signals as well as optional data telemetry are multiplexed onto a standard armored single coaxial cable, which also act as the tow-cable. This simplified tow-cable configuration virtually eliminates cross talk between channels.

The Deck Unit is used to control and condition the signals from the tow-fish. With the addition of a thermal paper recorder the data can be printed out in real time.

The compact subsea electronic pressure vessel (GeoAcoustics Model No. SS982) contains side scan sonar transmitter and receiver modules. It can be fit onto the standard GeoAcoustic 159 side scan to-fish or on a standard profiler tow-fish when used as part of a combined side scan and profiler system. The port and starboard side scan transducer units are fitted on either side of the tow-fish. Each contaning two arrays, operating at 114 kHz or 410 kHz. These side scan transducers convert electronic energy to acoustic signals of high intensity. These acoustic signals travel through the water at approximately 1500 ms-1 until they reach the seabed, where some of the energy is returned back to the transducers. This acoustic return energy is converted by the same transducer to a much lower voltage electronic signal which is accepted by the receiver electronics and processed using time varied gain (TVG) and then converted to separate frequencies and transmitted back to the surface unit.

Specifications:

Transceiver – Model SS981:

General

Power requirements	110/240 VAC switchable, 40-60 Hz, 50 W, optional 24 VDC.
Size	43.2 cm W x 45.7 cm D x 18.7 cm H.
Weight	16 kg.
Temperature Storage:	-20 to 75 °C Operating: -5 to 50 °C.
Humidity	10% to 95% RH, non-condensing.
Mounting	The unit is suitable for either bench or rack mounting.

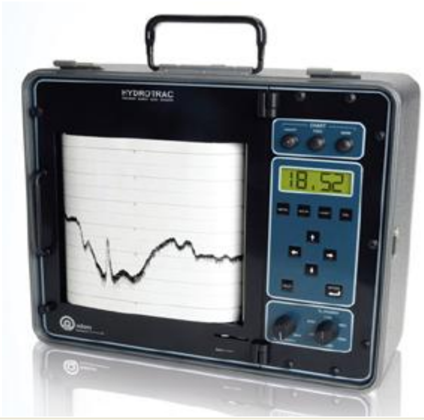
Operating Specification

Power output to tow vehicle	150 VDC ±3 VDC, 100 mA average, 320 mA peak.
Key burst out	455 kHz, pulse width selectable 16 Vpp, PRR determined by key source.
Key input	Positive CMOS or TTL, 10 kW input impedance.

Receivers

Modulation frequency	Port 135 kHz, Starboard 65 kHz.
Bandwidth	15 kHz.
Sensitivity	6 mV rms input produces 800 mV rms output with a 20 dB signal-to-noise ratio (all gain maximum).
Input impedance	5 k W .
Output impedance	600 W on all outputs.
Dynamic range Gain:	adjustable over 60 dB range. TVG: -20 to +20 dB maximum AGC: -34 dB maximum.
Output	Selectable signal envelope or amplitude modulated 12 kHz.
TVG delay	3.3 ms minimum, 330 ms maximum.
Event mark	5 Vpp, 12 kHz, front panel push button or BNC input requiring CMOS or TTL level pulse. Produces visual mark on recording media.
Key out	0.6 ms CMOS/TTL compatible.
Modes	100 kHz and 500 kHz operation. Raw signal and processed signal.

HYDROTRAC PORTABLE SURVEY ECHO SOUNDER



HYDROTRAC™ was specifically designed to work on small survey boats and inflatable watercraft in rugged conditions such as surf zones. While being compact and portable, it is fully waterproof during operation. HYDROTRAC™ incorporates the thermal printer and advanced features of Odom's established ECHOTRAC™ line of echo sounders and is competitively priced.

SPECIFICATIONS	
Frequency	200kHz (standard); 210, 40, & 33 kHz (optional)
Output Power	500 Watts
Power Requirement	11-28 VDC (standard); 110/220 VAC (optional)
Ports	2 (RS232 or RS422)

FEATURES

8.5" Thermal Printer (fax paper)
LCD display (1"high)
Sealed Keypad Controls
Manual/Remote Mark Command
Auto Scale Change (phasing)
GPS input
Heave Input from Motion Sensor
Annotation Printed on Chart
Auto Pulse Length, AGC & TVG
Output: NMEA, ECHOTRAC, etc.
Waterproof
Lightweight (32 lbs. / 14.5Kg)
Small Size (14 in. high x 16.75 in. wide x 8" deep) (356mm high x 425mm wide x 203mm deep)
Resolution 0.1 feet or 0.01 meters

CONTROLS

Sensitivity
Chart On/Off & Advance
Event Mark
Transmit Power (High/Med/Low)

TOUCH PAD SETTINGS

Draft & Velocity
Time & Date
Chart Width & Center
Blanking
Calibration Gate
Fix Interval

C-NAV® DIFFERENTIAL GPS

C-NAV® is a globally corrected differential GPS system owned and operated by C&C Technologies, Inc. The C-NAV® GPS Receiver combines a dual-frequency, geodetic grade, GPS Receiver with an integrated L-BAND communication RF detector and decoder all linked by an internal microprocessor. C-NAV® uses monitoring stations strategically located around the globe to provide worldwide accuracies on the order of 0.10m (4 inches).

Infrastructure:
The system utilizes the GPS satellite system, L-band communication satellites, and a worldwide network of referencing stations to deliver real-time high precision positioning. To provide this unique service, C-Nav has built a global network of dual-frequency reference stations, which constantly receive signals from the GPS satellites as they orbit the earth. Data from these reference stations is fed to the USA processing centers in Torrance, California, and Moline, Illinois where they are processed to generate the differential corrections. From the two processing centers, the correction data is fed via redundant and independent communication links to satellite uplink stations at Laurentides, Quebec, Canada; Perth, Australia; Burum, the Netherlands; Santa Paula, California; Auckland, New Zealand; and Southbury, Connecticut for rebroadcast via the geostationary satellites.

The key to the accuracy and convenience of the C-Nav system is the source of SBAS corrections. GPS satellites transmit navigation data on two L-band frequencies. The C-Nav reference stations are all equipped with geodetic-quality, dual-frequency receivers. These reference receivers decode GPS signals and send precise, high quality, dual-frequency pseudorange and carrier phase measurements back to the processing centers together with the data messages, which all GPS satellites broadcast. At the processing centers, C-Nav's proprietary differential processing techniques used to generate real time precise orbits and clock correction data for each satellite in the GPS constellation. This proprietary Wide Area DGPS (WADGPS) algorithm is optimized for a dual-frequency system such as the C-Nav Correction Service in which dual-frequency ionospheric measurements are available at both the reference receivers and the user receivers. It is the use of dual-frequency receivers at both the reference stations and the user equipment together with the advanced processing algorithms, which makes the exceptional accuracy of the C-Nav system possible.

Creating the corrections is just the first part. From our two processing centers, the differential corrections are then sent to the Land Earth Station (LES) for uplink to L-band communications satellites. The uplink sites for the network are equipped with C-Nav-built modulation equipment, which interfaces to the satellite system transmitter and uplinks the correction data stream to the satellite that broadcasts it over the coverage area. Each L-band satellite covers more than a third of the earth. Users equipped with a C-Nav precision GPS receiver actually have two receivers in a single package, a GPS receiver and an L-band communications receiver, both designed by the C-Nav for this system. The GPS receiver tracks all the satellites in view and makes pseudorange measurements to the GPS satellites. Simultaneously, the L-band receiver receives the correction messages broadcast via the L-band satellite. When the corrections are applied to the GPS measurements, a position measurement of unprecedented real time accuracy is produced.

INSTRUMENT SETTINGS

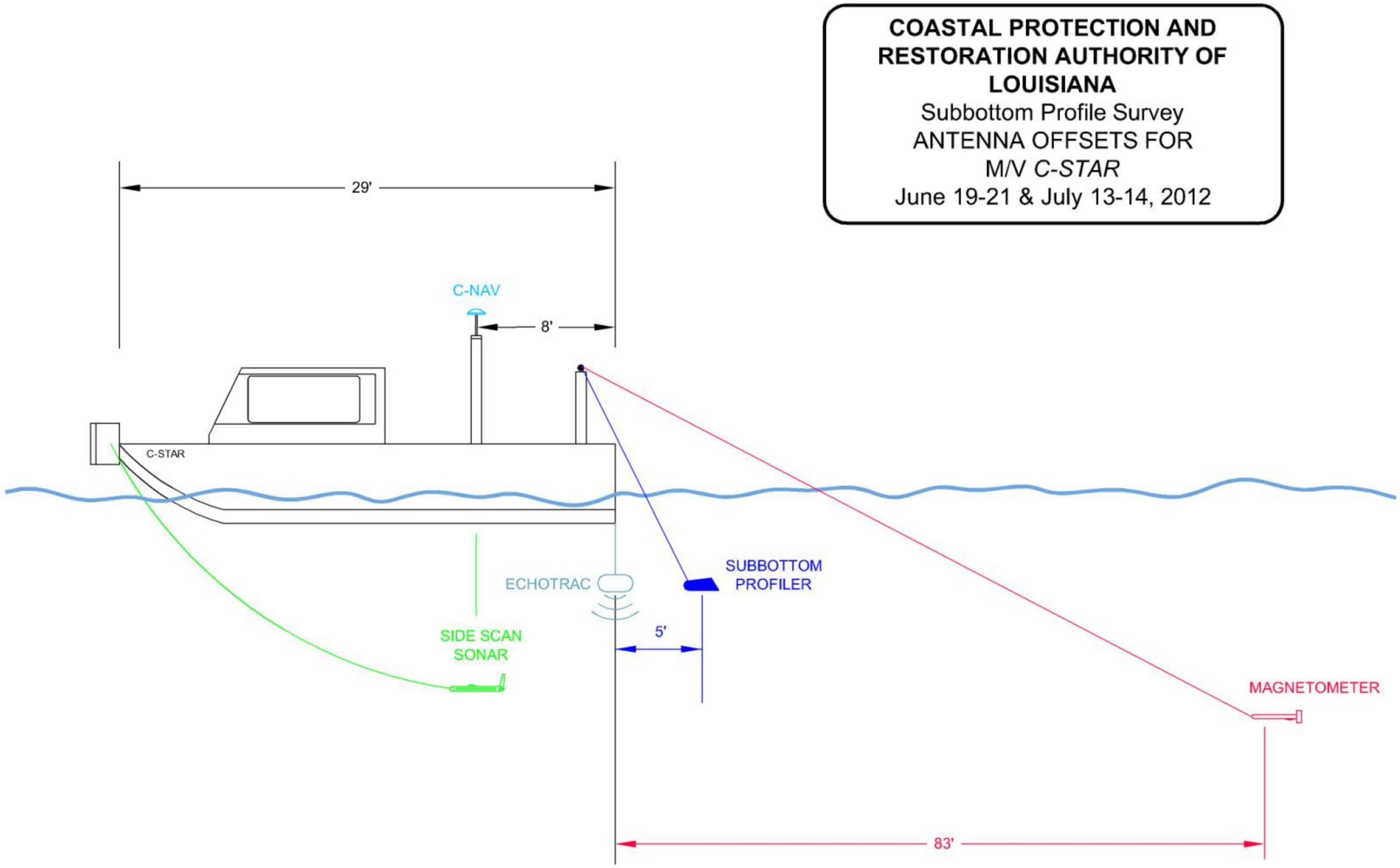
COASTAL PROTECTION AND RESTORATION AUTHORITY
SUBBOTTOM PROFILER SURVEY
CAMERON-CREOLE WATERSHED
GRAND BAYOU MARSH CREATION PROJECT (CS-54)
CALCASIEU LAKE, CAMERON PARISH

GEOACOUSTICS SIDE SCAN SONAR
Range = 50 meters per channel
Record Divisions = 25 meters
Frequency = 410 kilohertz
Setback = 0 feet (Towed from Bow)

EDGETECH MODEL 216 SUBOTTOM PROFILER
Record Length = 35 msecs
Record Division = 10 msecs
Delay = 0 msecs
Frequency = 2 to 16 kilohertz
Transducer Depth = 2 feetl
Setback = 13 feet

ODOM ECHOTRAC BATHYMETRIC SYSTEM
Record Length = 40 feet
Record Divisions = 5 feet
Setback = 0 feet
Frequency = 200 kilohertz
Velocity Input = 5,000 feet/second

SURVEY VESSEL
M/V *C-Star*
Average speed during survey = 3.5 knots


COASTAL PROTECTION AND RESTORATION AUTHORITY OF LOUISIANA
Subbottom Profile Survey
ANTENNA OFFSETS FOR
M/V C-STAR
June 19-21 & July 13-14, 2012
29'
C-NAV
8'
C-STAR
ECHOTRAC
SUBBOTTOM PROFILER
5'
SIDE SCAN SONAR
MAGNETOMETER
83'

C&C Technologies SURVEY SERVICES

GEOPHYSICAL LOG

Job Number	Client	Vessel	Geophysical Equipment (Operating)
110829	CPRA	C-Stor	subbottom, winfrog, C-Nav, Echo trac, side scan
Date	**Area**	**Remote Vessel**	**Job Description**
6/19/12	Calcasieu lake		site clearance

Page No.:

Personnel: S. Hergin, J. Mabry, C. Heinzen

Time	Heading	Fix Number	Line Number	Water Depth	Mag Depth	Mag Cable Out	Sonar Cable Out	SOL	EOL	Remarks
8:00										Arrive at dock
8:10										in route to Loc
8:45										Arrive at loc 1.4 from nail to water CHK 171-1
11:12										1.45 from nail to water chk 171-2 Echotrac 7.4
11:40	271	1315	1	8.1		83		✓		offset is off of bow (+23')
11:42		1264		7.4						Mag hit
11:47		1192		7.8						Mag hit
11:48		1168		7.7						Mag hit
11:51		1105		7.8						Mag hit
11:52		1076		8.1						Mag hit
11:56		998		7.5						Mag hit
11:59		950		8.0						Mag hit
11:59		941		8.6						Mag hit
12:04		846		8.6						Mag hit
12:19		531		7.9						Mag hit
12:25		403		7.1						Mag hit
12:42		73		8.1						Mag hit
12:49		-10		23.2					✓	
13:01	181	0	2	12.5				✓		
13:03		19		8.9					✓	
13:07	181	0	3	5.2				✓		
14:00		1027							✓	Computer went out.
14:11	180	0	20	8.1				✓		

C&C Technologies SURVEY SERVICES

GEOPHYSICAL LOG

Job Number: 110829	Client:	Vessel:	Geophysical Equipment (Operating):
Date: 6/19/12	Area:	Remote Vessel:	Job Description:
Personnel:			Page No. 2

Time	Heading	Fix Number	Line Number	Water Depth	Mag Depth	Mag Cable Out	Sonar Cable Out	SOL	EOL	Remarks
1504		1050		4.2					✓	
15:11										CHK 171-3 1.4 from water to nail

C&C Technologies SURVEY SERVICES

GEOPHYSICAL LOG

Job Number: 110829	Client: CPRA	Vessel: C-Star	Geophysical Equipment (Operating): SS, SB, Winfrog, C-Nav	
Date: 10/20/12	Area: Calcasieu lake	Remote Vessel:	Job Description: Site Clearance	Page No.
Personnel: S. Herpin, S. Melancon, C. Heinzen				

Time	Heading	Fix Number	Line Number	Water Depth	Mag Depth	Mag Cable Out	Sonar Cable Out	SOL	EOL	Remarks
7:00										Arrive at Dock
7:15										Deploy SS and SB
7:30										CHK 172 1.4 from water to nail
8:08	270	243	T-109	6				✓		Files are in JSF
8:27		-1		8					✓	
8:31	90	0	T-108	8				✓		
8:34		36		8						Objects Port + Stbd Side
8:48		245		6					✓	
8:51	270	250	T-107	4.3				✓		
9:07		-2		6.8					✓	
9:09	90	0	T-106	7.2				✓		
9:28		265		6.					✓	
9:32	270	265	T-105	6.7				✓		Changed to X+F format
9:48		-1		7.2					✓	
9:51	90	0	T-104	10				✓		
10:04		160		7.7					✓	
10:37	90	0	T-104A	8.1				✓		
10:57		266	T	6.8					✓	
10:59	270		T-103	5.9				✓		
11:17		-2		8.1					✓	

C&C Technologies SURVEY SERVICES — GEOPHYSICAL LOG

Job Number	Client	Vessel	Geophysical Equipment (Operating)	
110829				
Date	**Area**	**Remote Vessel**	**Job Description**	**Page No.**
6/21/12				2
Personnel				

Time	Heading	Fix Number	Line Number	Water Depth	Mag Depth	Mag Cable Out	Sonar Cable Out	SOL	EOL	Remarks
11:58		266		7.8					✓	
1200	270	265	T-103	6.7				✓		
1214		-1		7.9					✓	
12:15	90	0	T-104	8.5				✓		
12:31		268		6.5					✓	
12:37										Chk 173 1.45 from water to nail
12:41	270	265	T-105	6.2				✓		
12:54		-1		8					✓	
12:56	90	0	T-106	7.9				✓		
13:17		266		5.5					✓	
13:19	270	265	T-107	3.4				✓		
1326		0		7.8					✓	
13:27	90	0	T-108	7.9				✓		
1341		246		5.3					✓	
1343	270	240	T-109	4.7				✓		
1355		0		8.0					✓	
14:30										CHK 173 1.55 from water to nail

APPENDIX B

Unidentified Magnetic Anomaly Table
Identified Magnetic Anomaly Table
Nomogram for Ferrous Mass Estimation

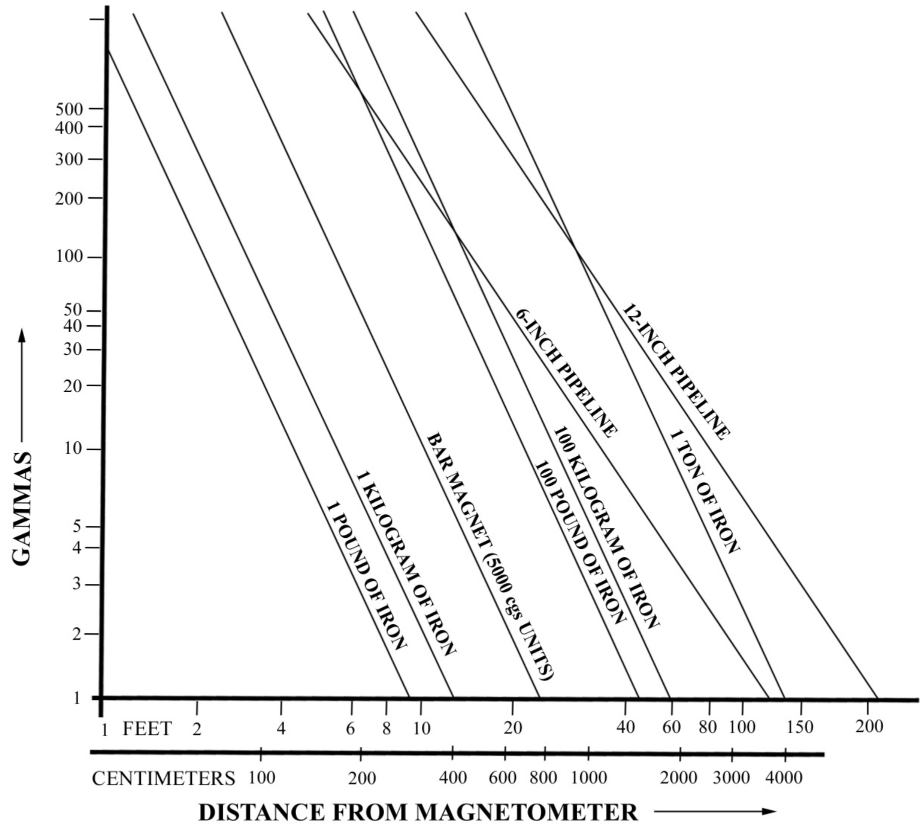
UNIDENTIFIED MAGNETIC ANOMALY TABLE

Ref. No.	Line No.	Shot Point	Signature Type	Amp. (γ)	Dura. (ft)	LOUISIANA SOUTH, ZONE: 1702			
						NAD 83		NAD 83	
						X (ft)	Y (ft)	Lat. (°)	Long. (°)
1	1	18.88	Monopole	24	33	2,644,583.07	506,120.17	29.876406	-93.341015
2	1	26.97	Monopole	8	26	2,644,785.56	506,114.63	29.876400	-93.340376
3	1	70.80	Monopole	14	113	2,645,880.89	506,074.04	29.876341	-93.336918
4	1	80.27	Monopole	47	116	2,646,117.87	506,078.46	29.876365	-93.336171
5	1	76.74	Monopole	716	125	2,646,030.00	506,082.00	29.876370	-93.336449
6	1	99.74	Monopole	2	16	2,646,604.38	506,077.83	29.876386	-93.334636
7	1	115.53	Monopole	7	30	2,646,999.02	506,058.61	29.876352	-93.333390
8	1	209.28	Monopole	24	38	2,649,343.30	506,029.62	29.876385	-93.325992
9	1	256.53	Monopole	3	36	2,650,523.65	506,014.95	29.876401	-93.322268
10	1	360.73	Monopole	2	26	2,653,128.60	505,978.81	29.876426	-93.314047
11	1	417.78	Monopole	33	28	2,654,554.93	505,943.63	29.876397	-93.309546
12	1	454.57	Monopole	4	36	2,655,474.53	505,933.17	29.876412	-93.306644
13	1	541.48	Monopole	881	416	2,657,646.17	505,889.33	29.876394	-93.299790
14	1	593.43	Monopole	23	33	2,658,944.98	505,866.35	29.876392	-93.295691
15	1	612.62	Monopole	15	25	2,659,424.61	505,858.36	29.876392	-93.294178
16	1	617.41	Monopole	4	23	2,659,544.09	505,844.68	29.876360	-93.293800
17	1	619.70	Monopole	4	48	2,659,601.49	505,842.06	29.876356	-93.293619
18	1	622.35	Monopole	4	26	2,659,667.67	505,847.66	29.876374	-93.293411
19	1	751.14	Monopole	2	22	2,662,886.97	505,806.51	29.876412	-93.283252
20	1	795.95	Monopole	2	15	2,664,007.49	505,785.72	29.876407	-93.279716
21	1	802.63	Monopole	29	37	2,664,174.65	505,789.78	29.876426	-93.279188
22	1	826.26	Monopole	30	94	2,664,764.86	505,754.72	29.876358	-93.277325
23	1	851.69	Dipole	4836	147	2,665,400.31	505,742.78	29.876354	-93.275319
24	1	896.17	Monopole	7	41	2,666,512.24	505,731.64	29.876376	-93.271811
25	1	917.05	Monopole	13	36	2,667,034.31	505,729.43	29.876394	-93.270163
26	1	946.47	Monopole	581	110	2,667,769.57	505,709.09	29.876372	-93.267843
27	1	957.04	Monopole	53	95	2,668,034.16	505,709.60	29.876386	-93.267008
28	1	1004.76	Monopole	49	52	2,669,227.00	505,690.43	29.876388	-93.263244
29	1	1082.10	Monopole	49	19	2,671,159.84	505,658.22	29.876389	-93.257144
30	1	1099.58	Monopole	40	39	2,671,596.84	505,642.15	29.876365	-93.255764
31	1	1120.42	Monopole	17	19	2,672,117.63	505,616.67	29.876319	-93.254120
32	1	1167.68	Dipole	199	57	2,673,299.16	505,616.75	29.876374	-93.250392
33	1	1173.79	Monopole	44	40	2,673,451.733	505,610.11	29.876362	-93.249911
34	1	1196.99	Monopole	34	30	2,674,031.17	505,606.45	29.876379	-93.248083
35	1	1241.94	Monopole	3	21	2,675,155.11	505,574.35	29.876342	-93.244535
36	1	1273.96	Monopole	72	31	2,675,955.45	505,553.86	29.876323	-93.242009
37	1	1276.18	Dipole	3	21	2,676,011.03	505,548.56	29.876311	-93.241833
38	1	1297.36	Monopole	2	17	2,676,540.58	505,560.06	29.876366	-93.240163
39	1	1304.62	Monopole	10	28	2,676,722.26	505,542.80	29.876327	-93.239589

IDENTIFIED MAGNETIC ANOMALY TABLE

Ref. No.	Line No.	Shot Point	Signature Type	Amp. (γ)	Dura. (ft)	X (ft)	Y (ft)	Lat. (°)	Long. (°)	Description
40	1	1080.60	Dipole	711	119	2671122	505656	29.876381	-93.257262	Texaco 11
41	1	1111.42	Monopole	127	377	2671893	505640	29.876371	-93.254829	Conoco 1
42	1	1175.70	Monopole	114	513	2673500	505611	29.876368	-93.249759	Conoco 2

BREINER NOMOGRAM (1973)



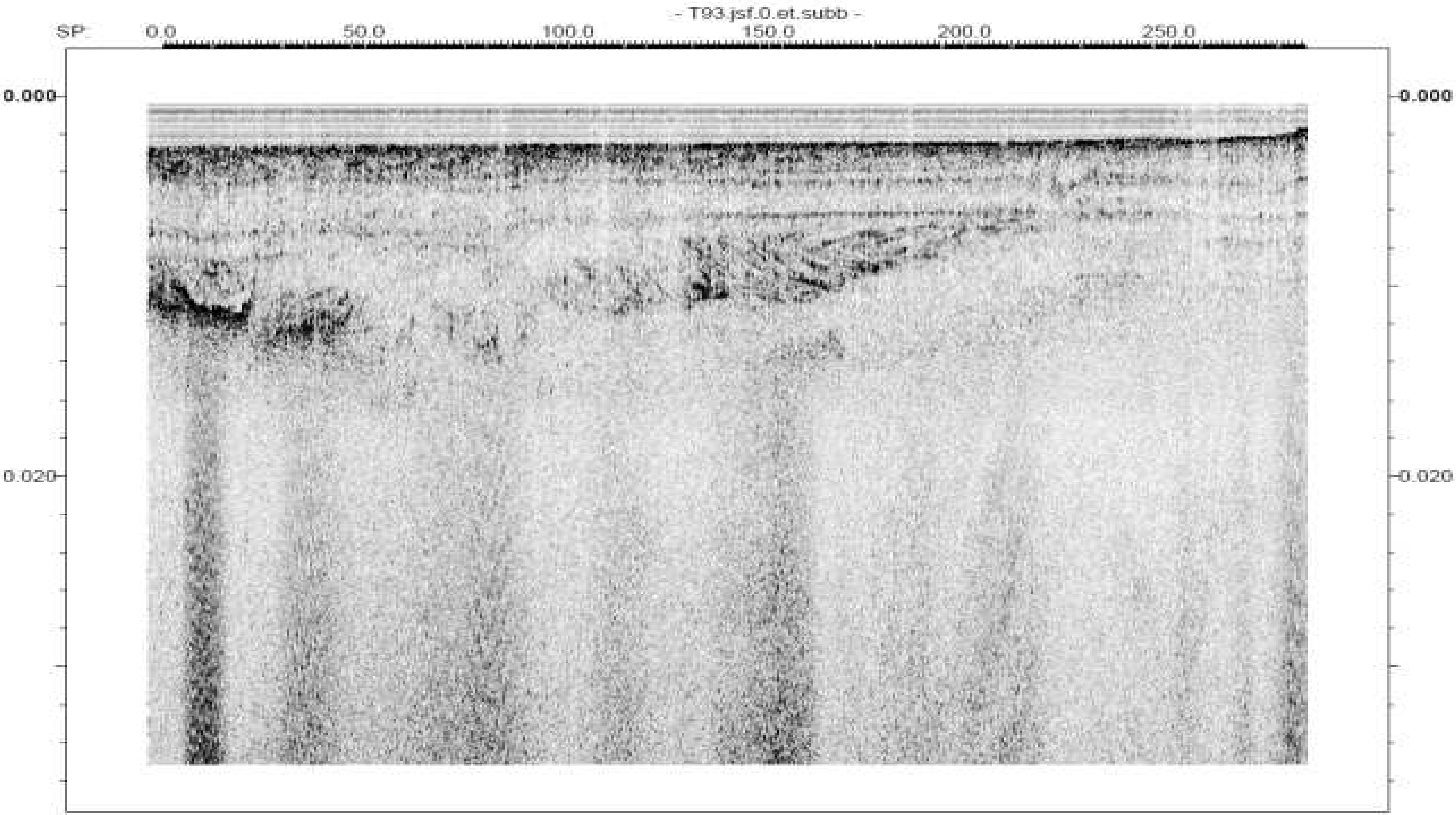
INSTRUCTIONS FOR USE:

To use the nomogram, select a given weight or type of object from among the diagonal labeled lines. Then choose a distance along the bottom line (abscissa) of the graph and follow a vertical line upwards from that distance until it intersects the diagonal line of the selected object. At that point, move horizontally to the left to a value on the vertical axis (ordinate) of the graph and read the intensity in gammas.

At a given distance, the intensity is proportional to the weight of the object. Therefore, for an object whose weight is not precisely that of the labeled lines, simply multiply the intensity in gammas by the ratio of the desired weight to the labeled weight on the graph. If the distance desired does not appear on the graph, remember that for a typical object, the intensity is inversely proportional to the cube of the distance, and for a long pipeline, the intensity is inversely proportional to the square of the distance between magnetometer sensor and object. Due to the many uncertainties described herein, the estimates derived from this nomogram may be larger or smaller by a factor of 2 to 5 or perhaps more.

APPENDIX C

Seismic Profiles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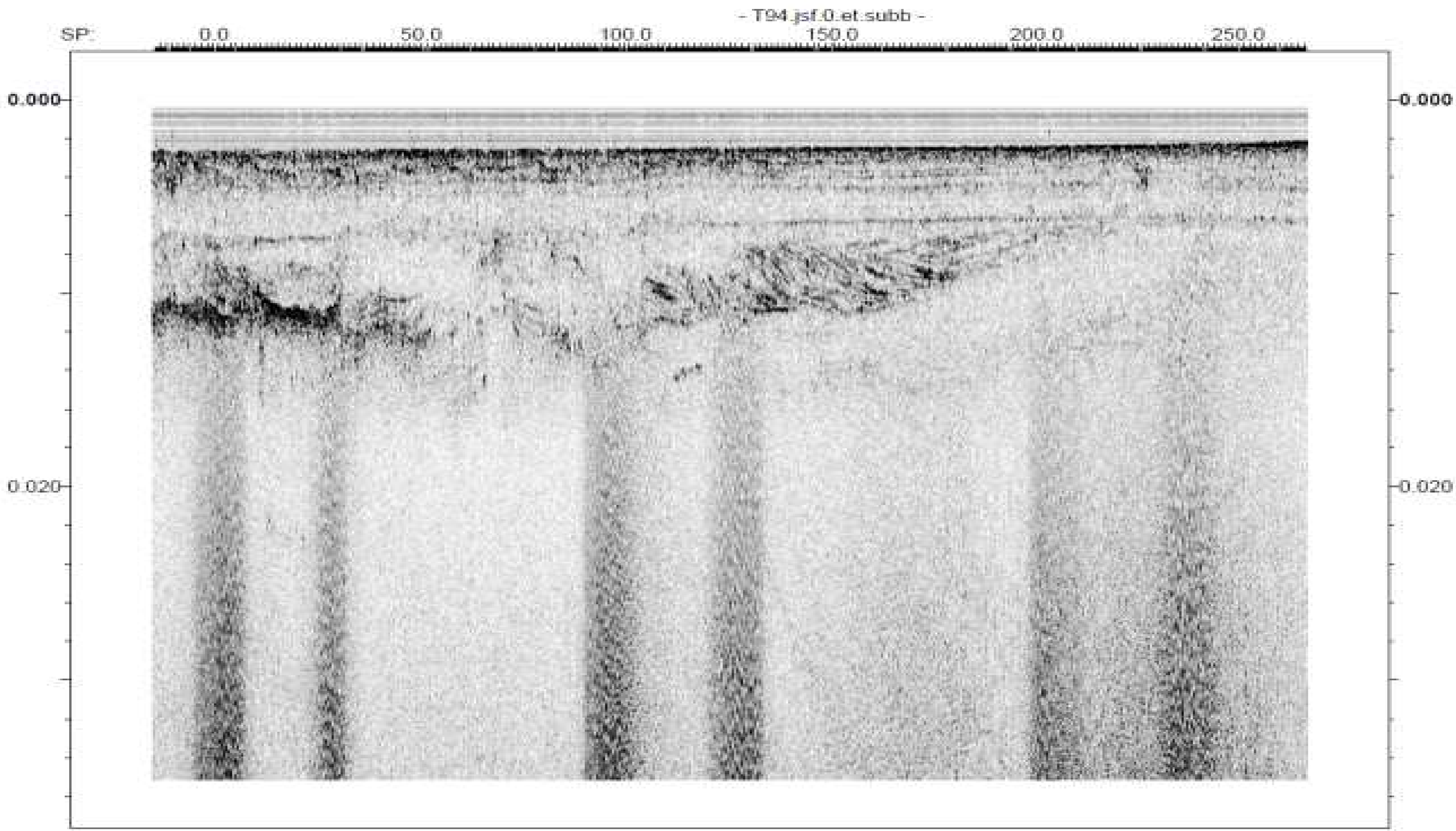
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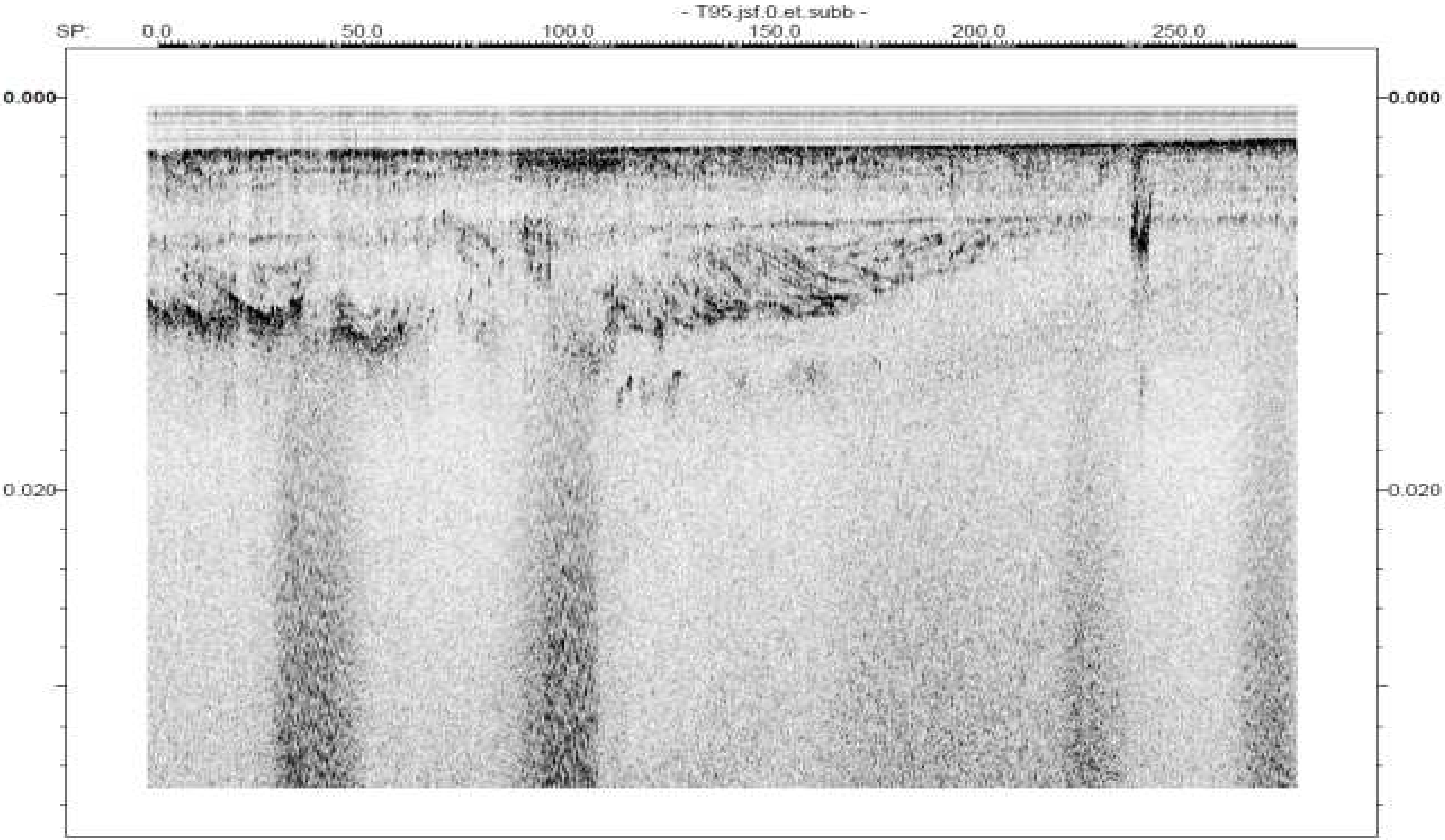
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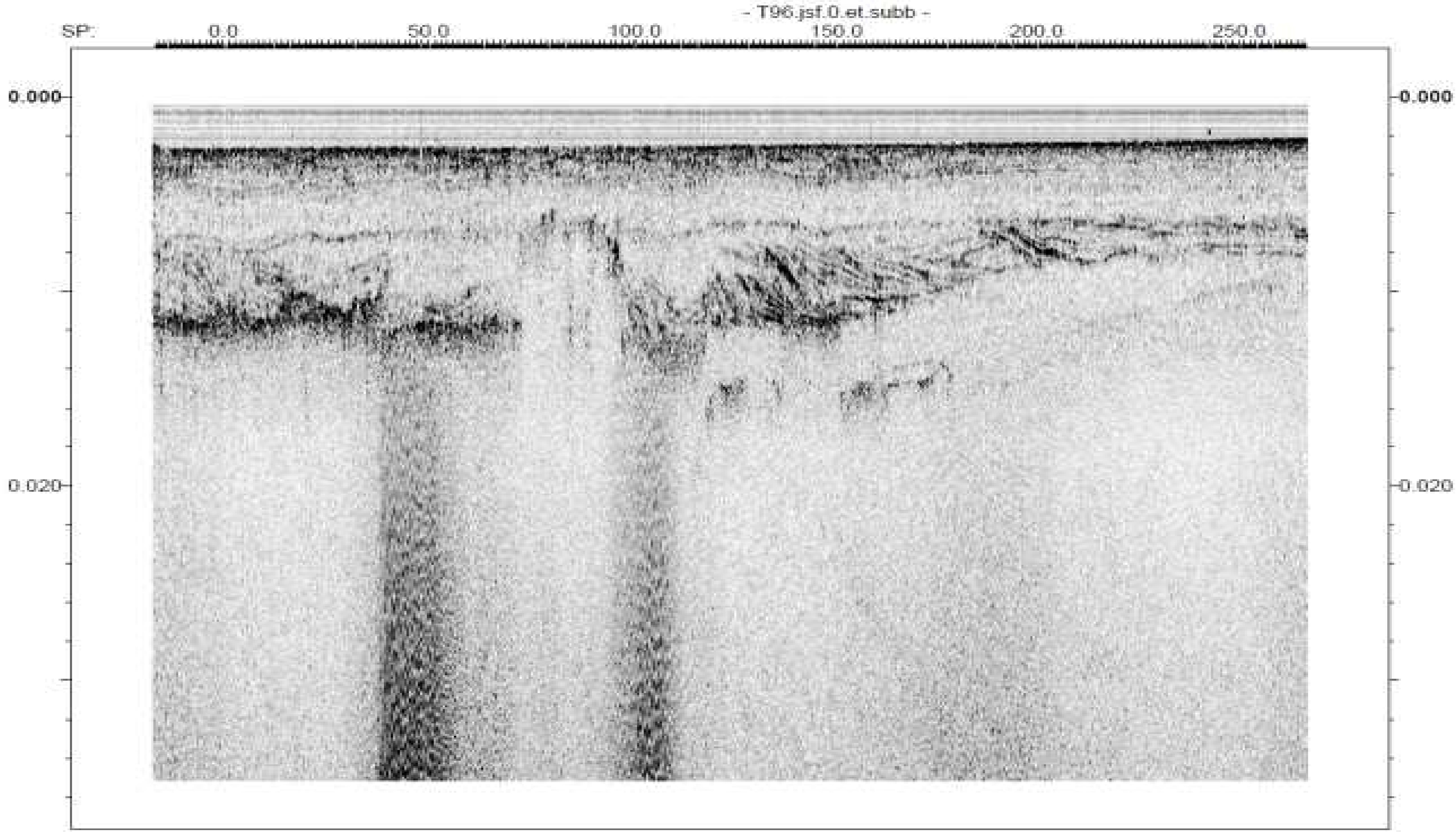

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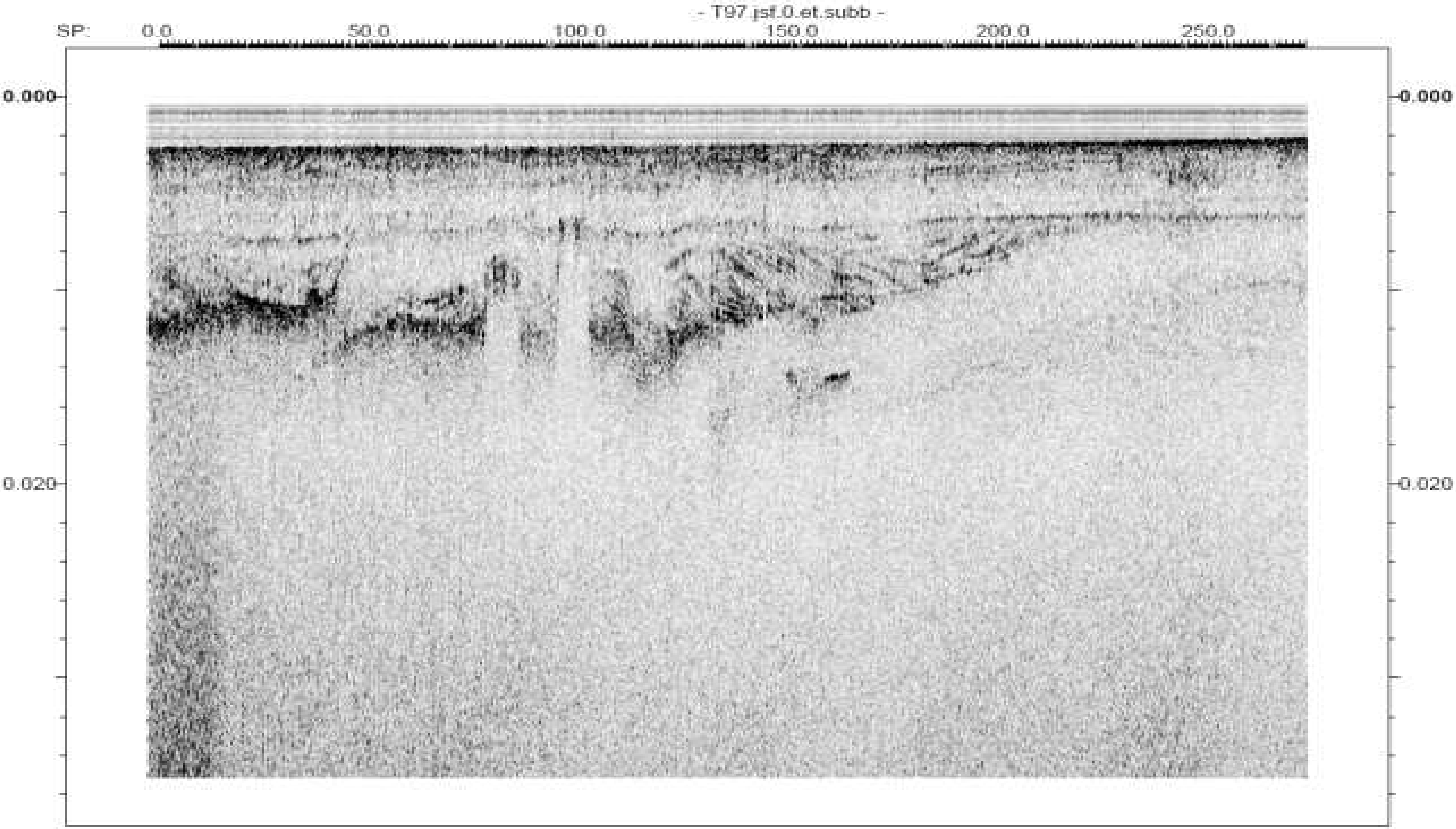

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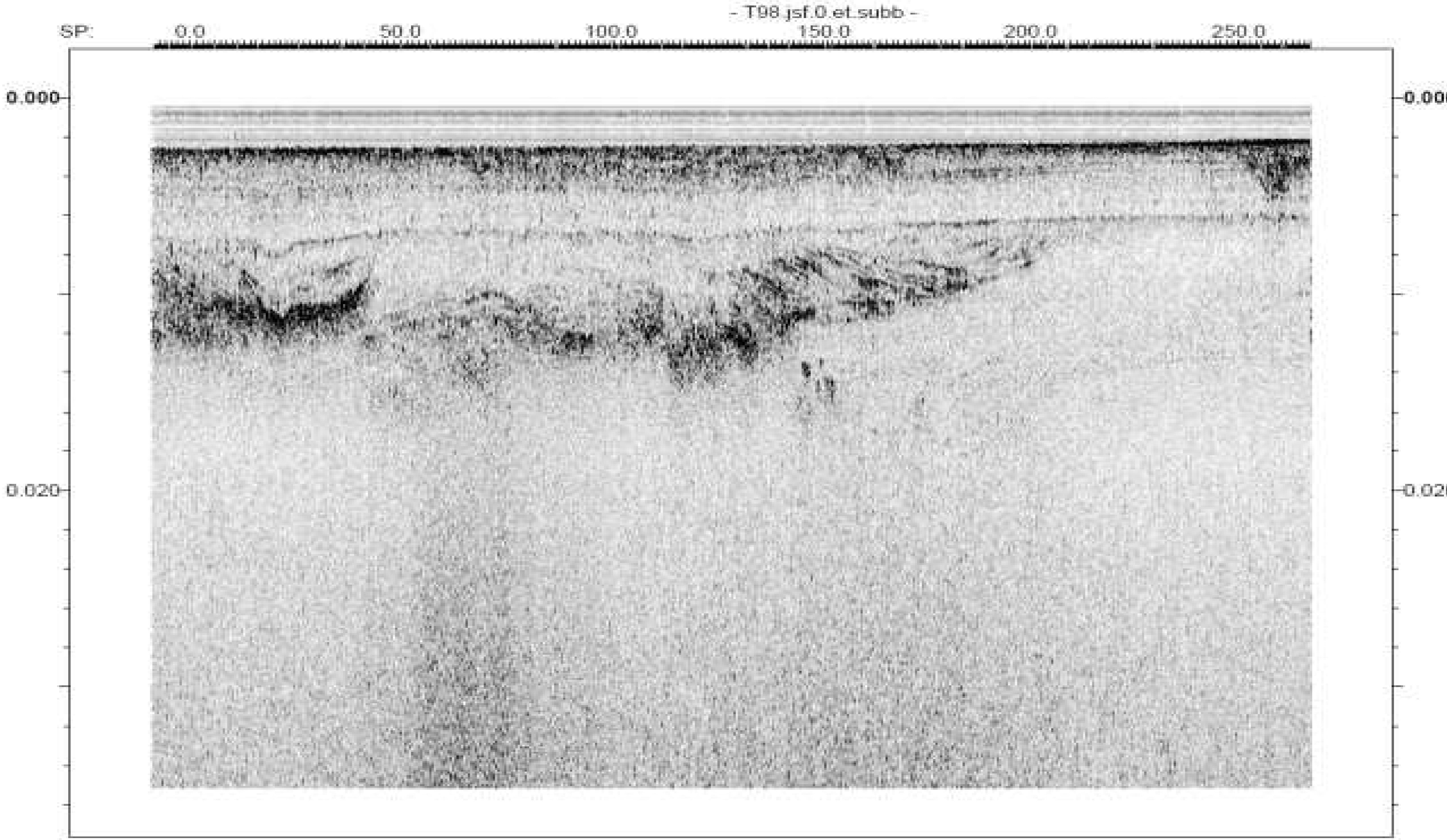
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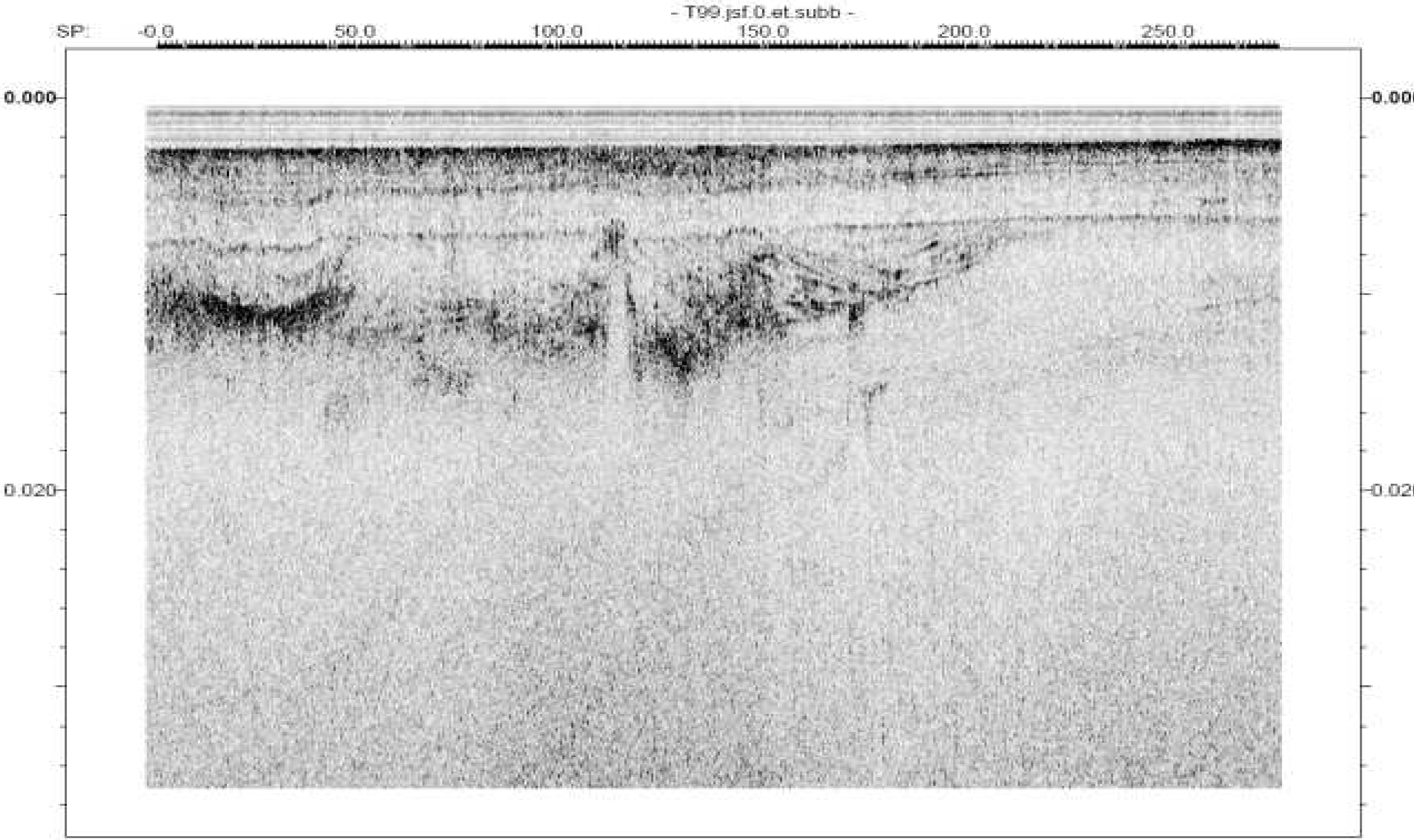
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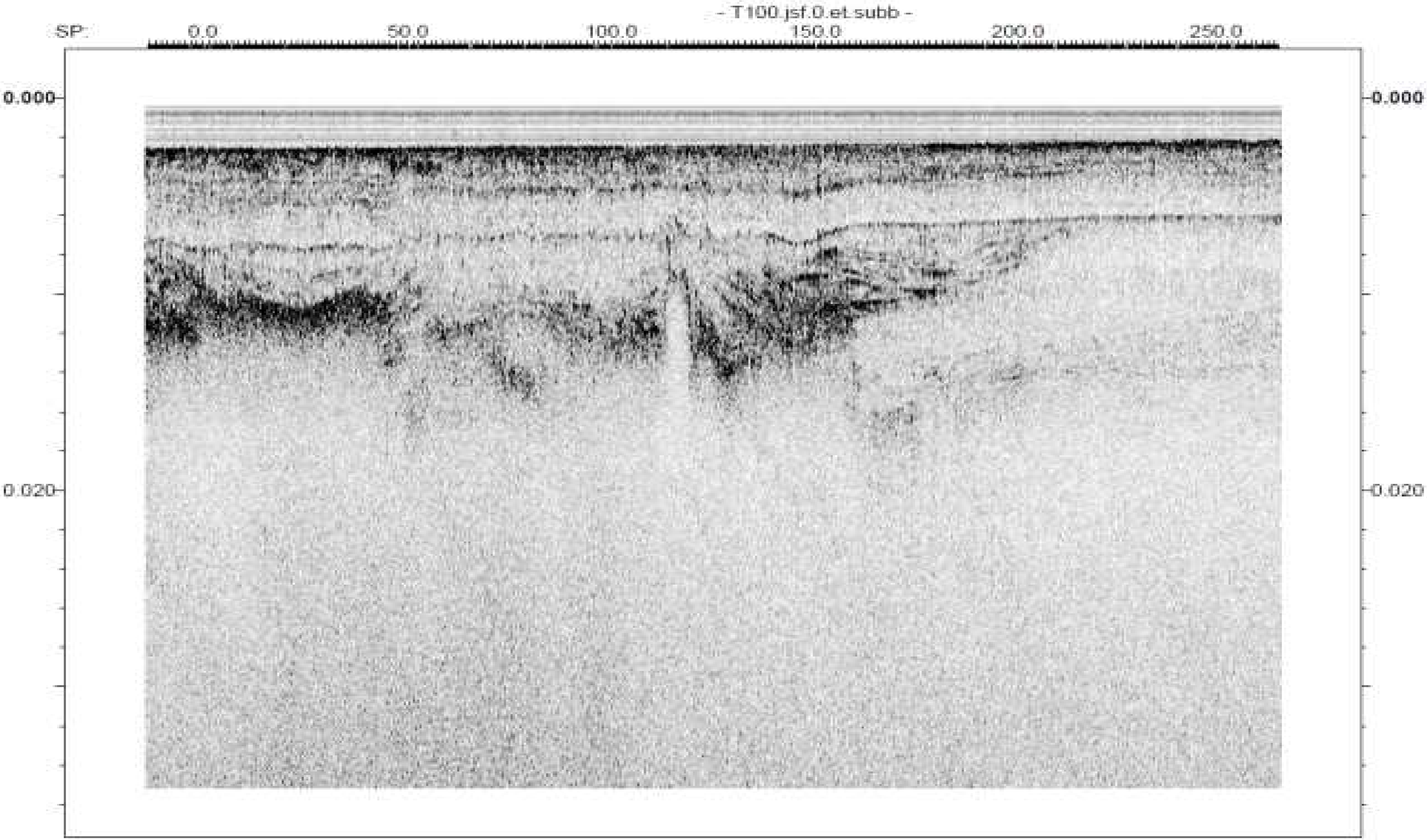

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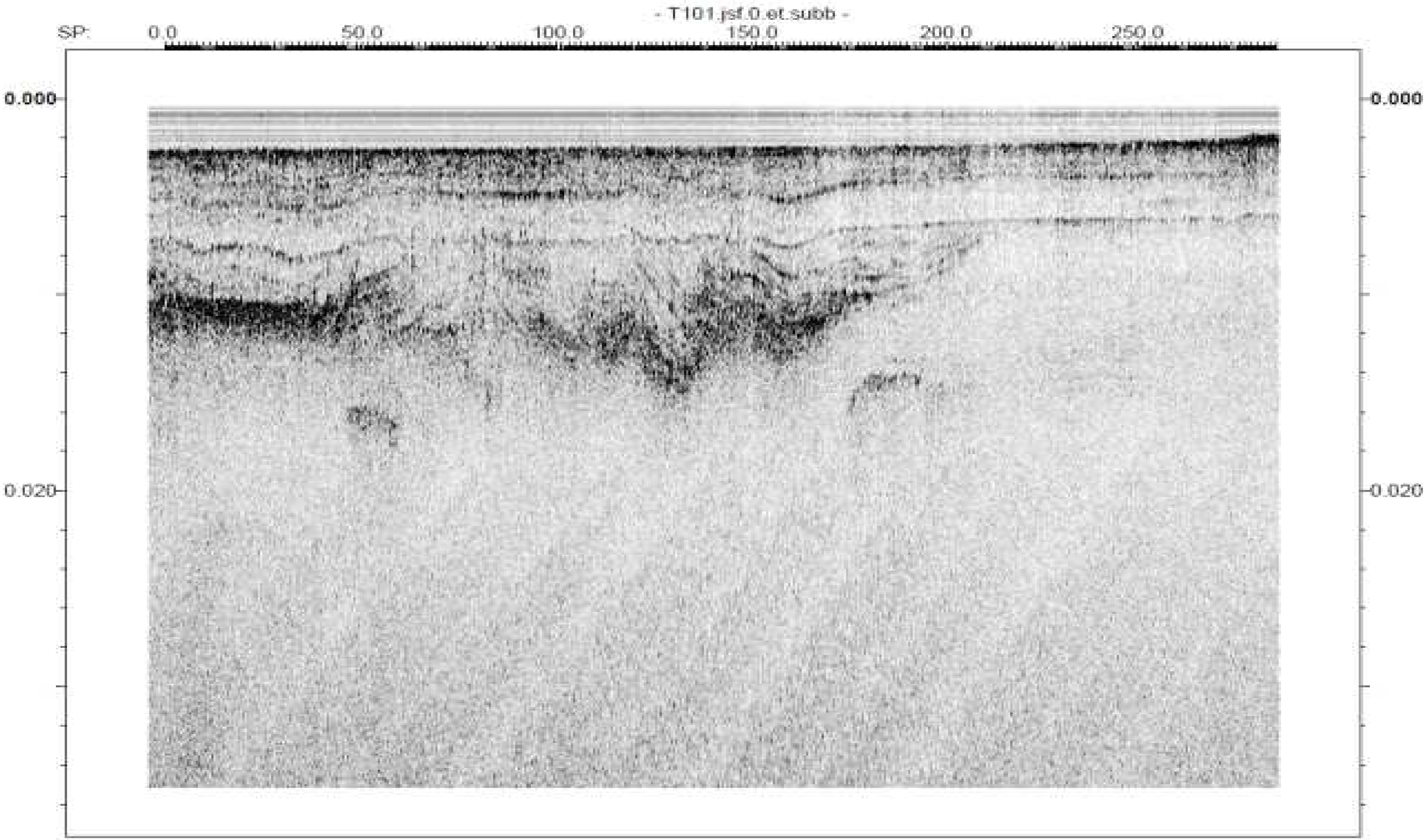

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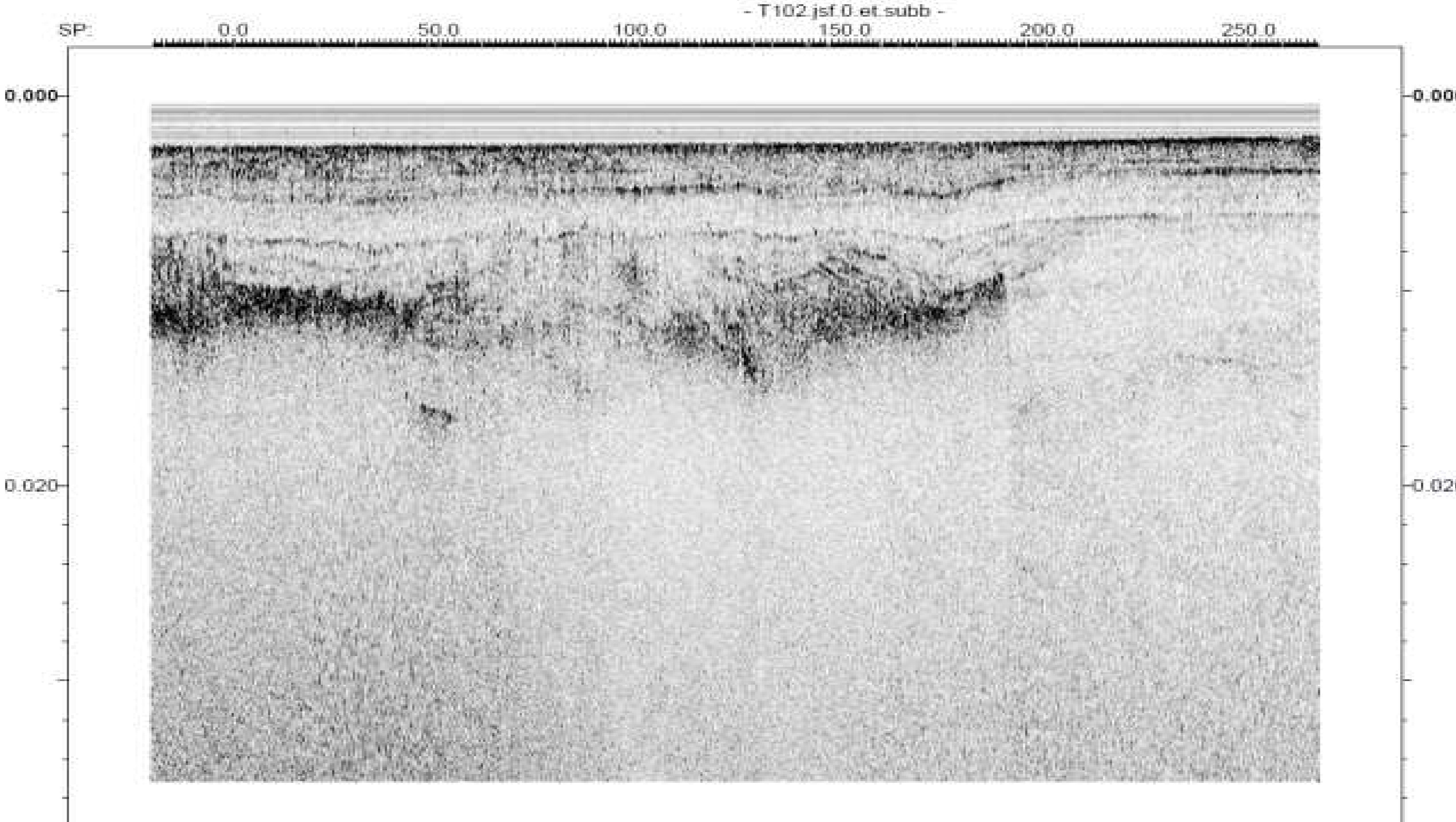

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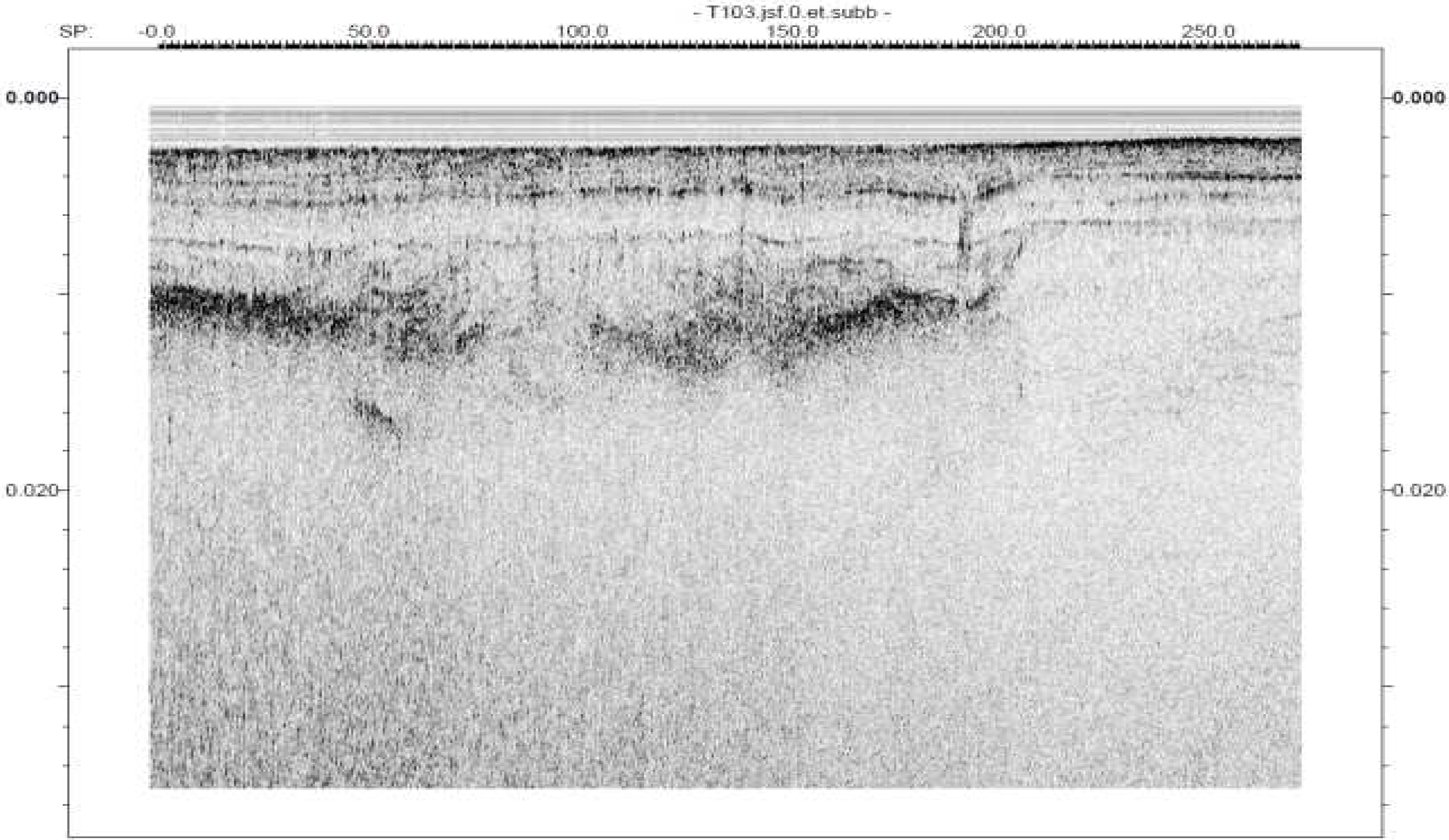

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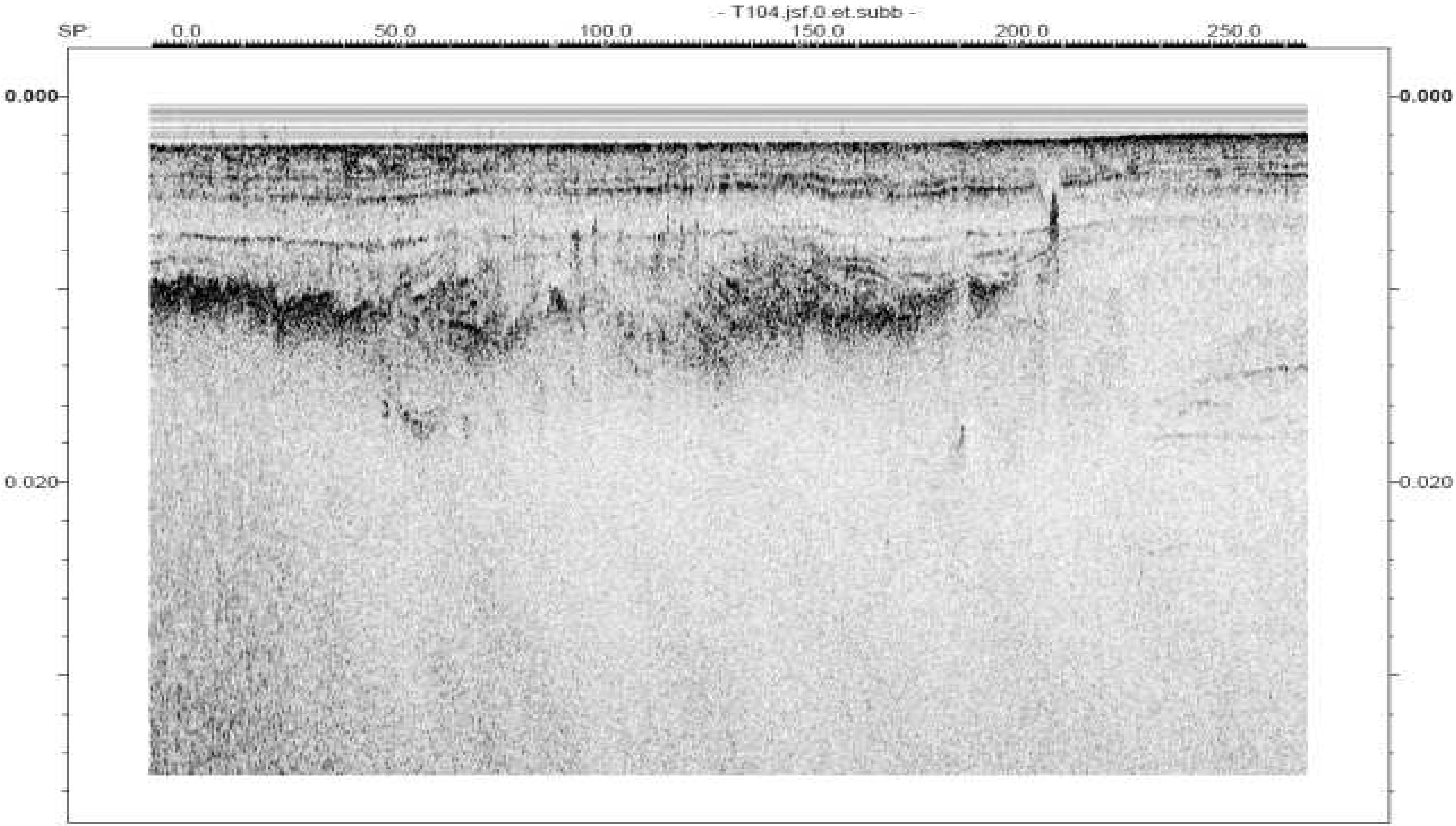

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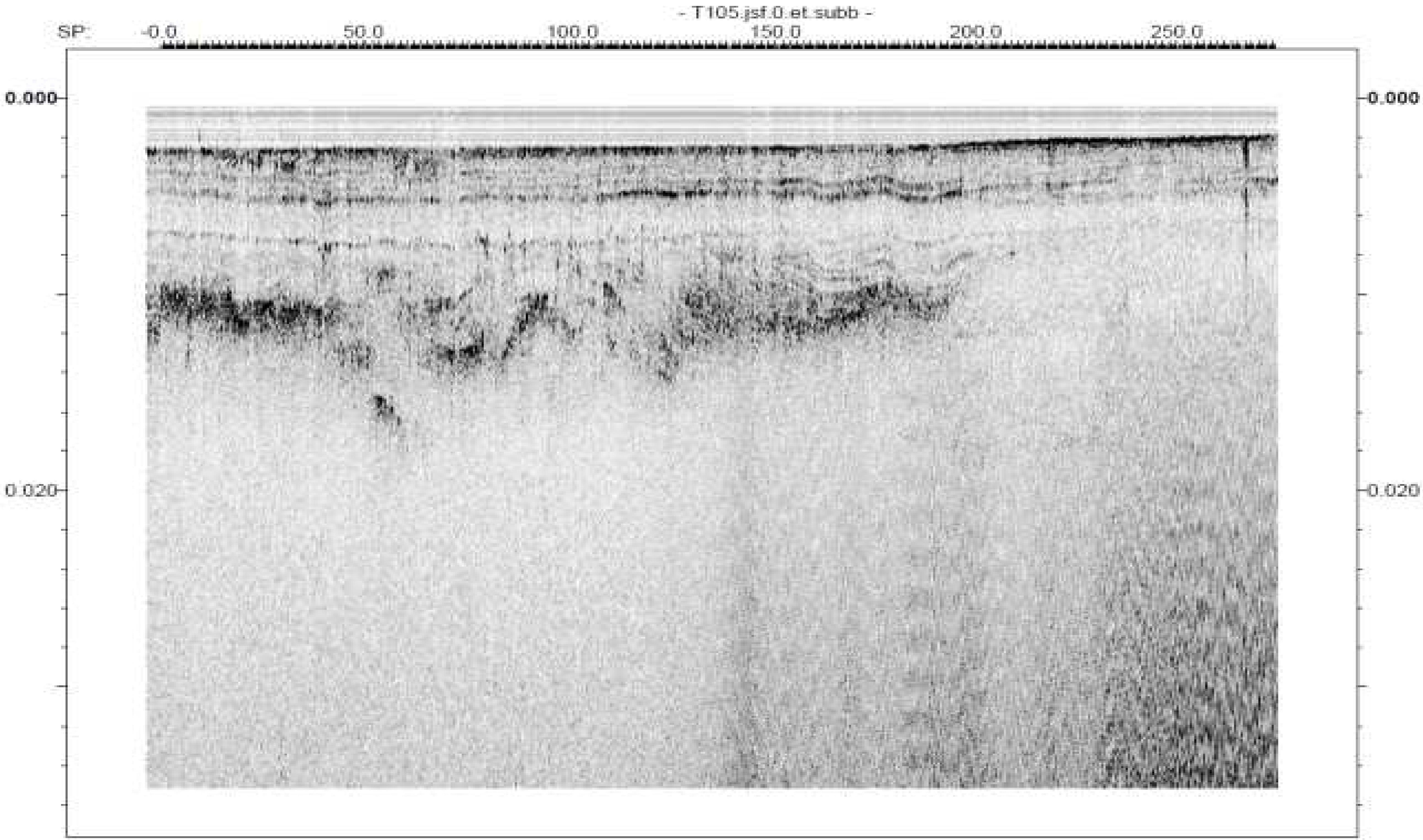

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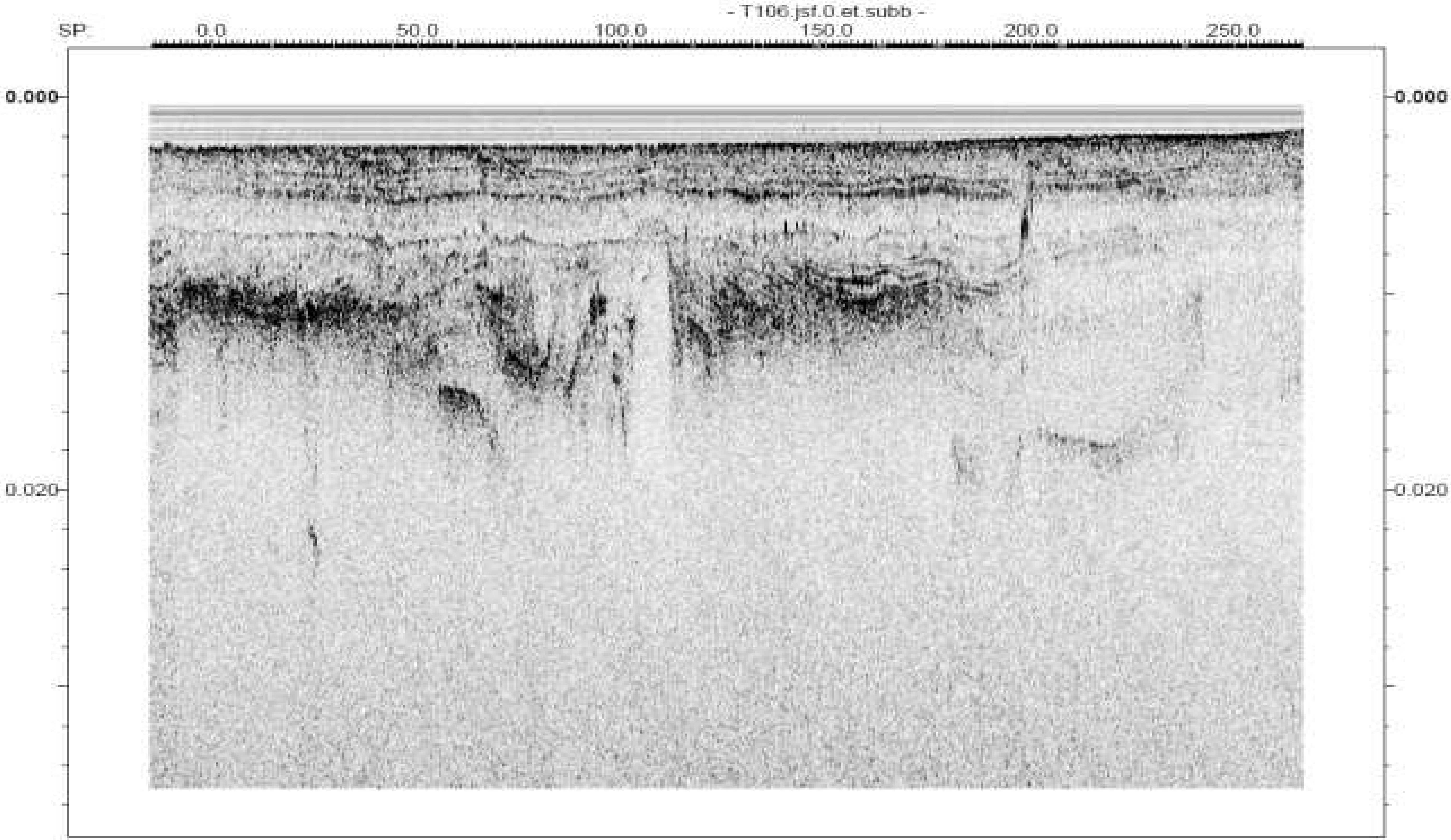
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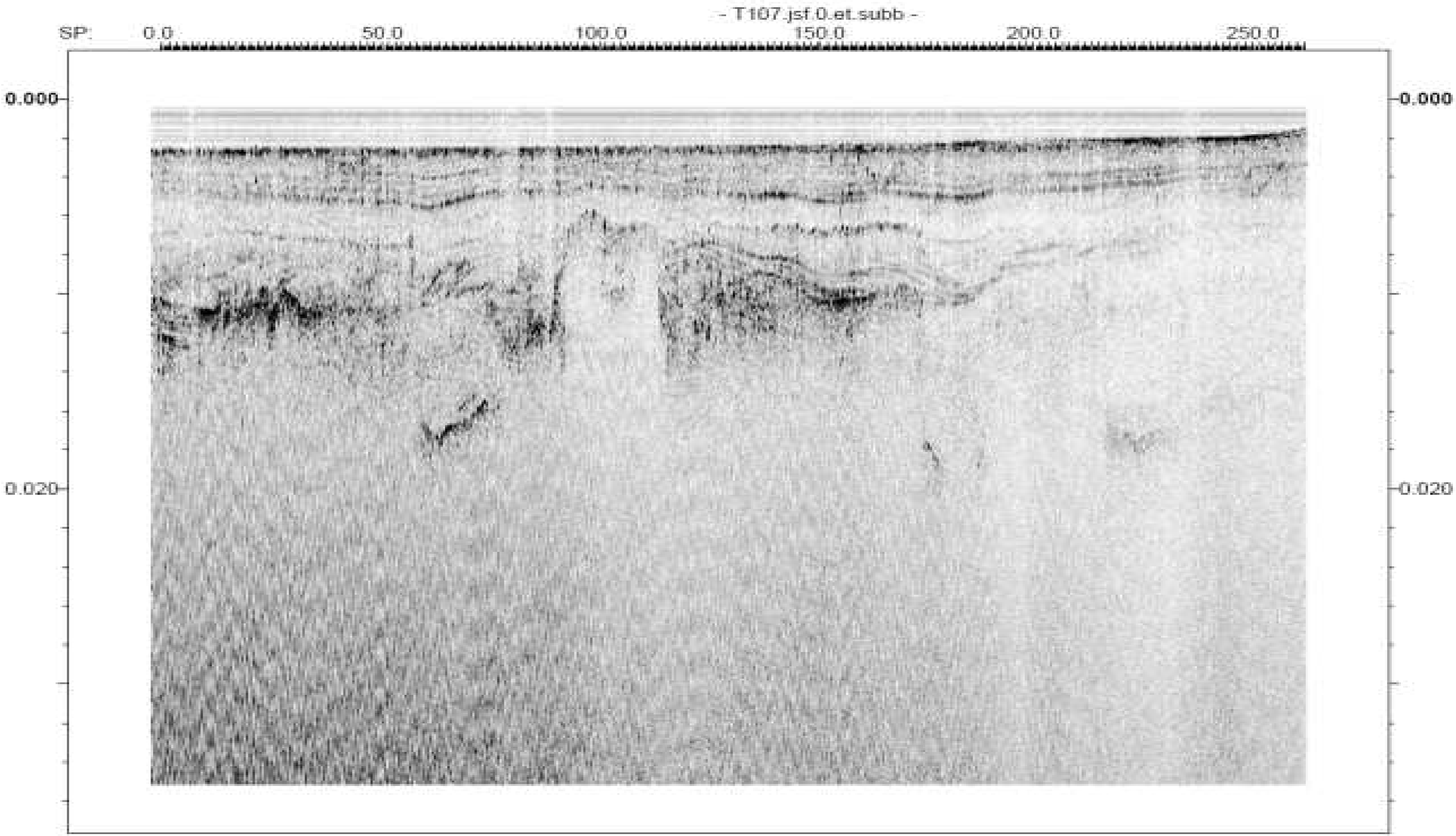
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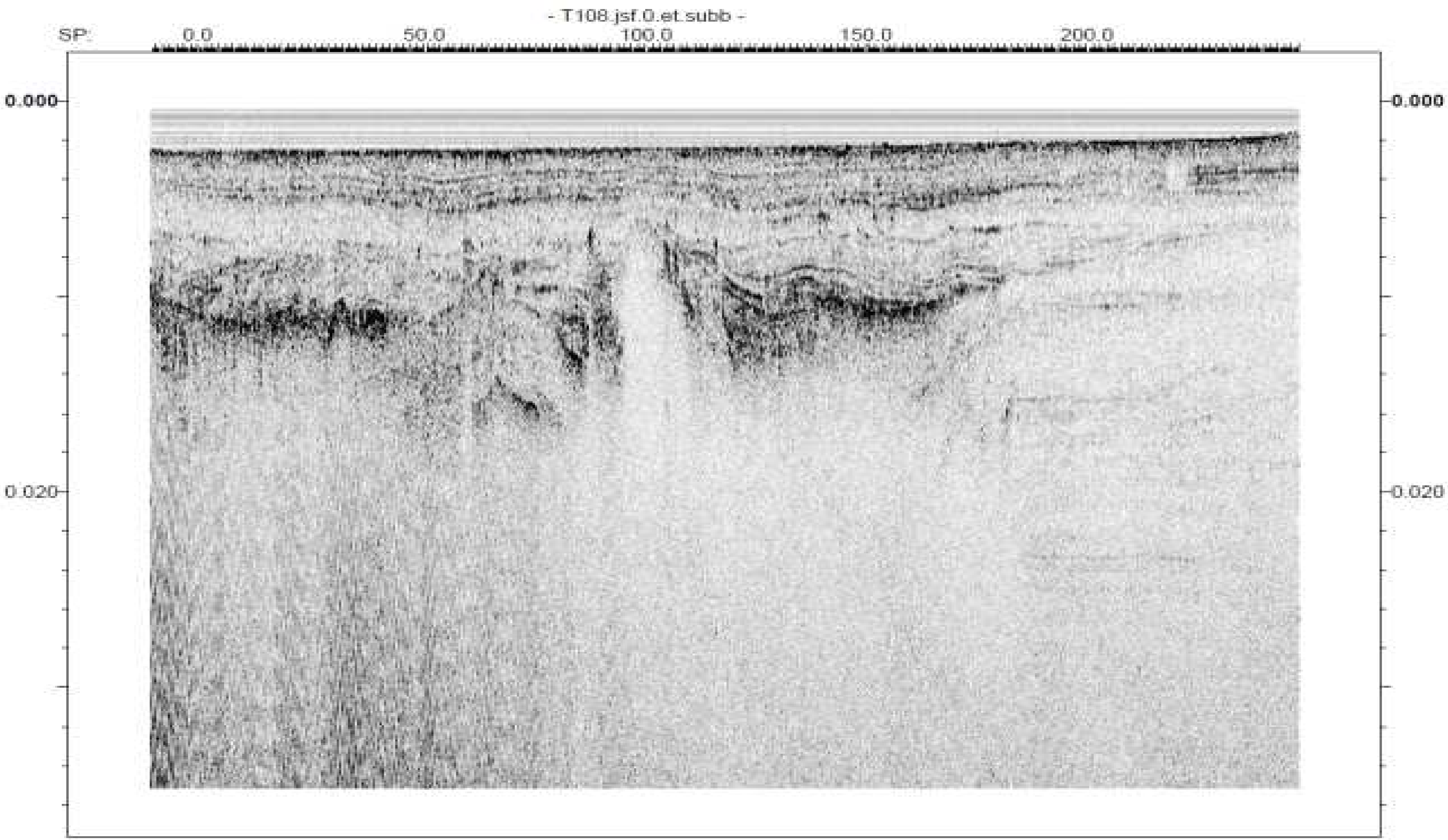

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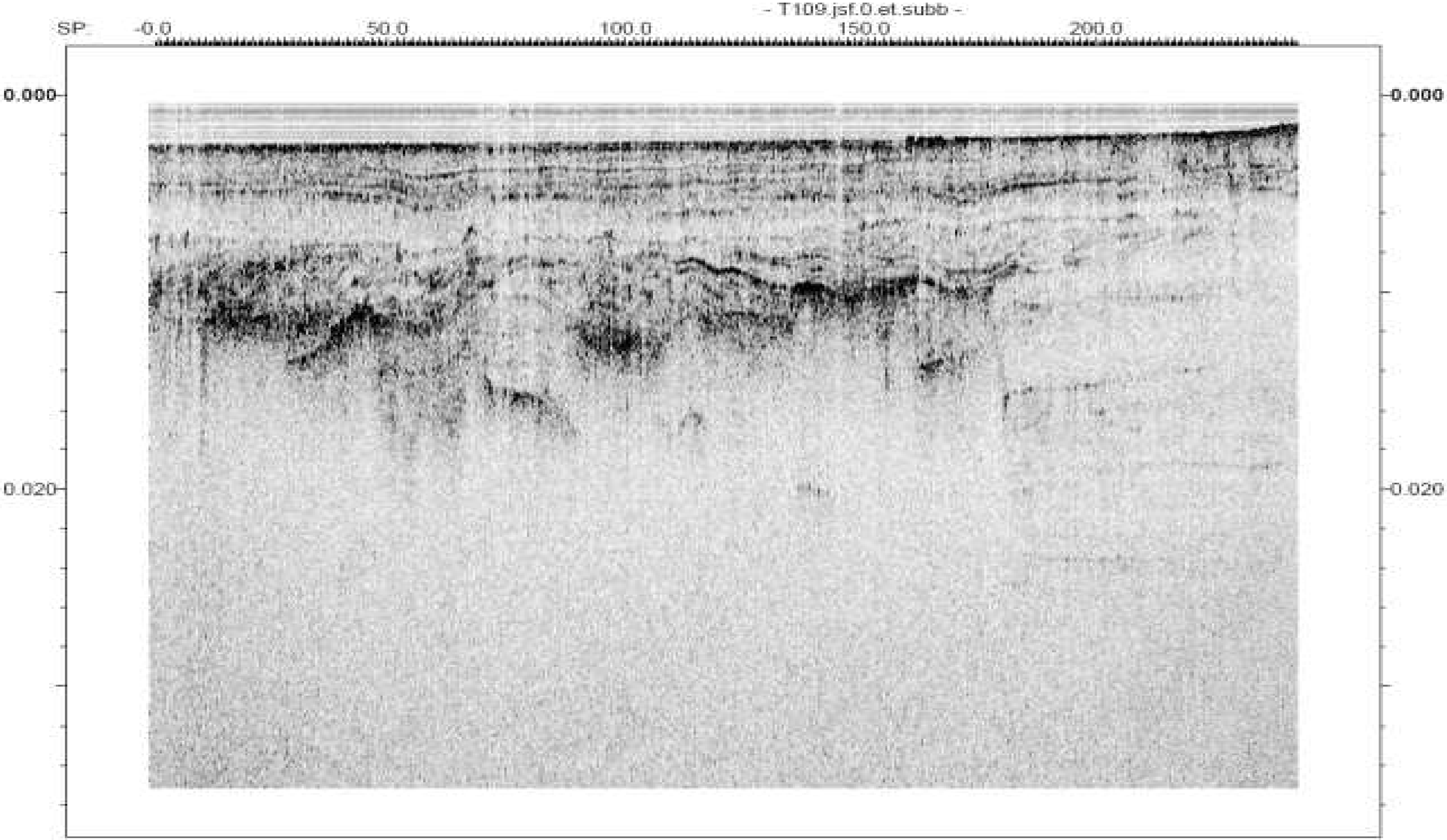

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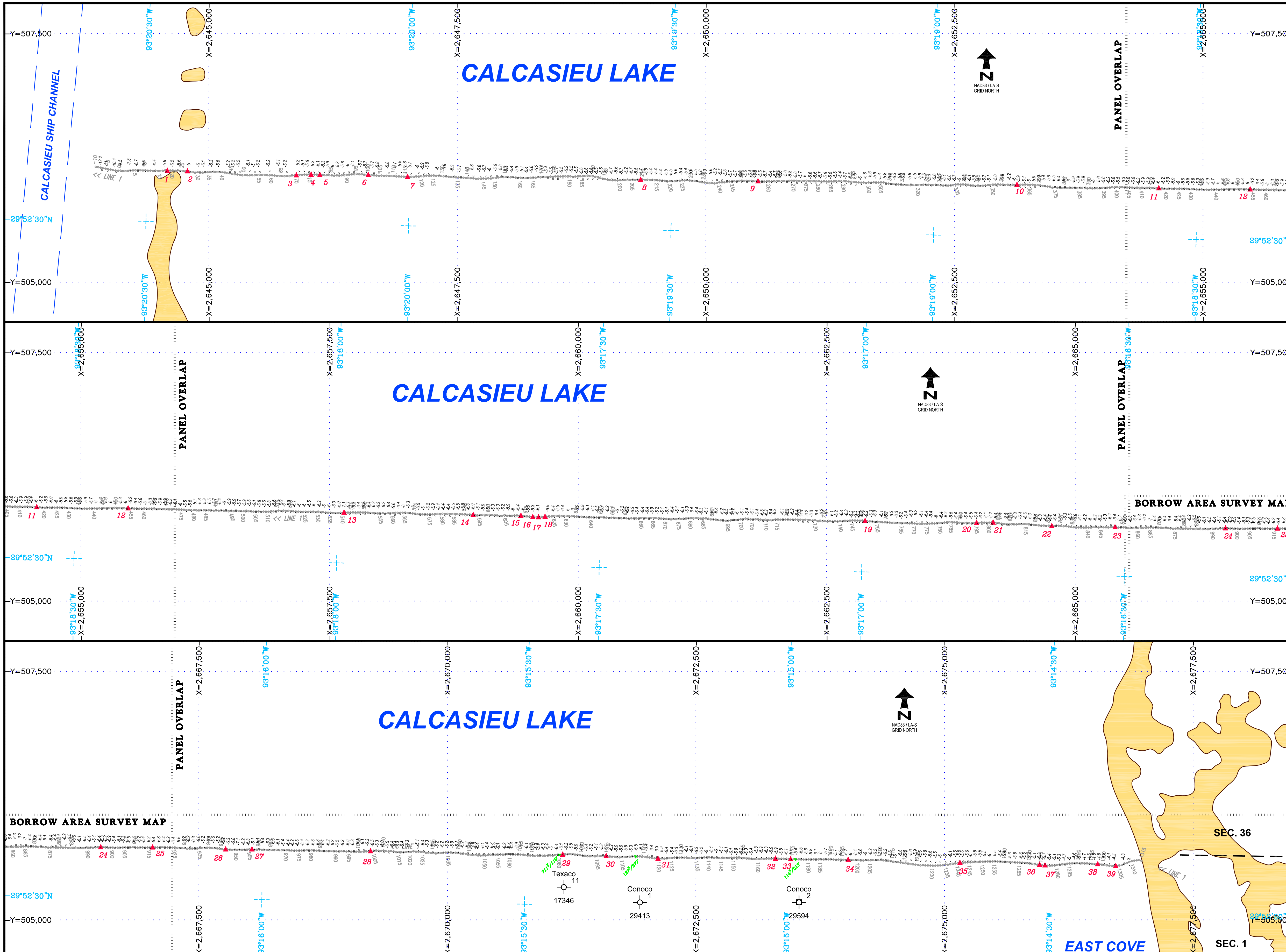
APPENDIX D

Reduced Study Maps



PLAN VIEW

LINE T95	Navigation trackline with name, direction run, fix, and fix number
	Spot water depths in feet
	Zero datum = NAVD88 Average water surface based on tide readings at "EC-1" = +1.11'
▲ 23	Unidentified magnetic anomaly with reference number
711/119	Magnetic anomaly (with amplitude in gammas and duration in feet) associated with known infrastructure

UNIDENTIFIED MAGNETIC ANOMALIES

NUMBER	AMPLITUDE	DURATION	NUMBER	AMPLITUDE	DURATION
1	24	33	21	29	37
2	8	26	22	30	94
3	14	113	23	4836	147
4	716	125	24	7	41
5	47	116	25	13	36
6	2	16	26	581	110
7	7	30	27	53	95
8	24	38	28	49	52
9	3	36	29	49	19
10	2	26	30	40	39
11	33	28	31	17	19
12	4	36	32	199	57
13	881	416	33	44	40
14	23	33	34	34	30
15	15	25	35	3	21
16	4	23	36	72	31
17	4	48	37	3	21
18	4	26	38	2	17
19	2	22	39	10	28
20	2	15			

All field data acquired June 19, & July 13-14, 2012.
Survey vessel: M/V C-Star
EQUIPMENT UTILIZED:
Subbottom - Edgetech 3100 SB-216S
Side Scan Sonar - GeoAcoustics 114-410 khz
Magnetometer - Geometrics 882 marine magnetometer
Fathometer - Hydrotrac HT97001

Coastal Protection and Restoration Authority of Louisiana

BATHYMETRY AND MAGNETIC ANOMALY MAP

ACCESS CORRIDOR SURVEY

CAMERON-CREOLE WATERSHED
GRAND BAYOU MARSH CREATION PROJECT (CS-54)
CALCASIEU LAKE, CAMERON PARISH, LOUISIANA

SCALE IN US SURVEY FEET: 500' 0 500' 1000'

GEODETIC DATUM: NAD 83
ELLIPSOID: GRS 80
GRID UNITS: US SURVEY FEET
PROJECTION: LAMBERT CONFORMAL CONIC
ZONE: LOUISIANA SOUTH SPCS
CENTRAL MERIDIAN: 91°20' W
FALSE EASTING: 3,280,833.33 ft. at C.M.
FALSE NORTHING: 0.00 ft. at 28° 30' N

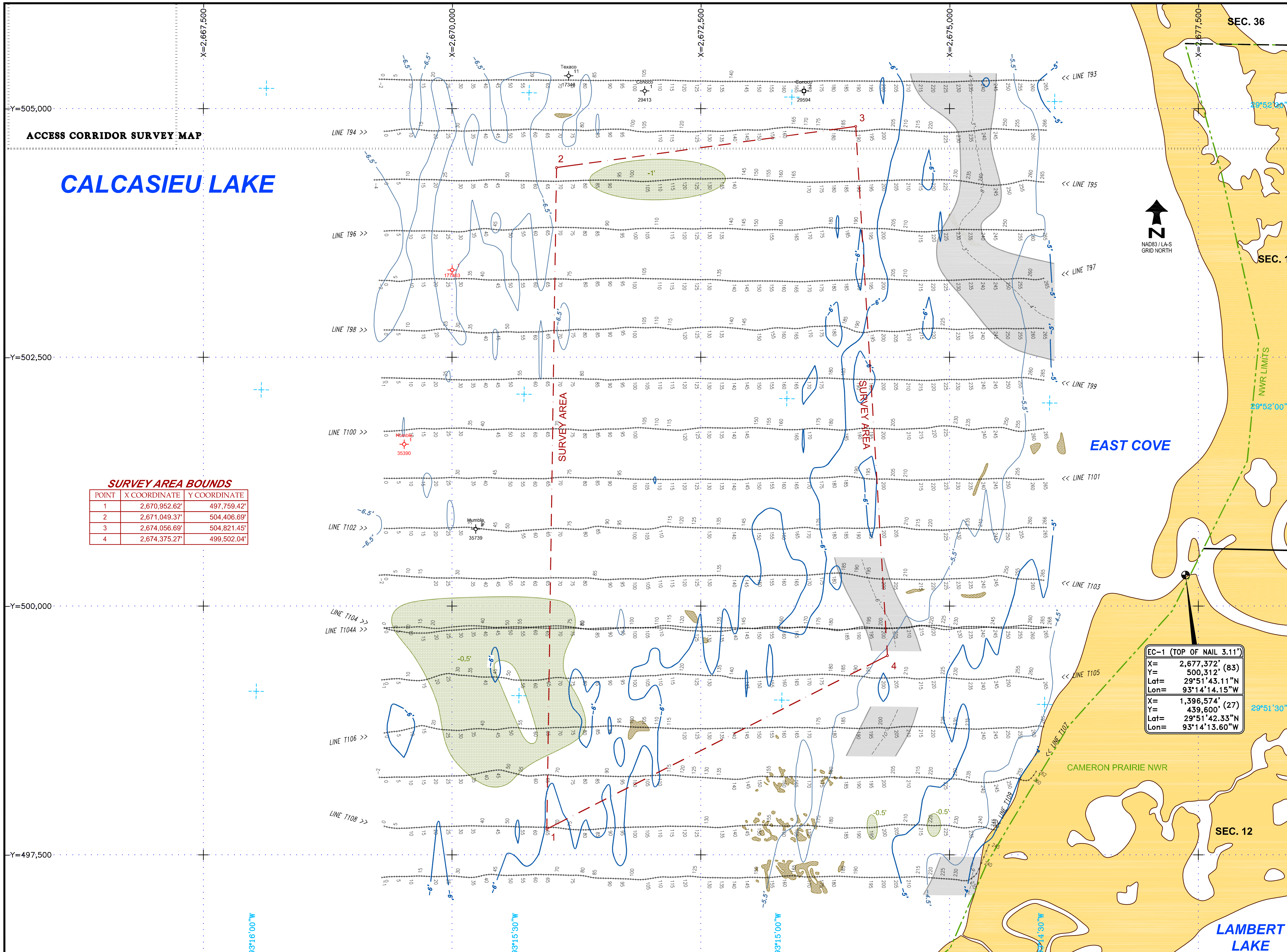
ISSUE	DATE	DESCRIPTION	DRAWN	INTERP	CHECKED
1	July 19, 2012	Preliminary issue with report	D. Pierrottie	T. George	G. Prather
2	July 30, 2012	Original issue with report	D. Pierrottie	T. George	G. Prather

PREPARED BY: C&C Technologies SURVEY SERVICES

JOB NO. 110829 DATE: July 30, 2012
FILENAME: 110829_CORRIDOR.DWG

SHEET 1 of 1

34" x 22"
DATE: 07/30/2012 TIME: 09:43 FILENAME: L:\DNR\110829\ACAD\110829_CORRIDOR.DWG



SURVEY AREA BOUNDS

POINT	X COORDINATE	Y COORDINATE
1	2,670,952.62'	497,759.42'
2	2,671,049.37'	504,406.69'
3	2,674,056.69'	504,821.45'
4	2,674,375.27'	499,502.04'

PLAN VIEW

Navigation trackline with name, direction run, fix, and fix number

Contour interval = 0.5 foot

Zero datum = NAVD88

Average water surface based on tide readings at "EC-1" = +1.11'

Areas of exposed shell interpreted from side scan sonar data

Possible oyster beds 1'-2' in thickness with burial depth

Buried channel 1 foot below lake floor and thalweg where discernible

All field data acquired June 20-21, & July 13, 2012.
Survey vessel: M/V C-Star

EQUIPMENT UTILIZED:
Subbottom - Edgetech 3100 SB-216S
Side Scan Sonar - GeoAcoustics 114-410 khz
Magnetometer - Geometrics 882 marine magnetometer
Fathometer - Hydrotrac HT97001

Coastal Protection and Restoration Authority of Louisiana

BATHYMETRY, LAKE FLOOR AND SUBBOTTOM FEATURES MAP
BORROW AREA SURVEY
CAMERON-CREOLE WATERSHED
GRAND BAYOU MARSH CREATION PROJECT (CS-54)
CALCASIEU LAKE, CAMERON PARISH, LOUISIANA

500' 0 500' 1000'
SCALE IN US SURVEY FEET

ISSUE	DATE	DESCRIPTION	DRAWN	INTERP	CHECKED
1	July 19, 2012	Preliminary issue with report	D. Pierrottie	T. George	G. Prather
2	July 30, 2012	Original issue with report	D. Pierrottie	T. George	G. Prather

GEODETIC DATUM: NAD 83
ELLIPSOID: GRS 80
GRID UNITS: US SURVEY FEET
PROJECTION: LAMBERT CONFORMAL CONIC
ZONE: LOUISIANA SOUTH SPCS
CENTRAL MERIDIAN: 91°20' W
FALSE EASTING: 3,280,833.33 ft. at C.M.
FALSE NORTHING: 0.00 ft. at 28° 30' N

PREPARED BY: C&C Technologies SURVEY SERVICES

JOB NO. 110829 | DATE: July 30, 2012
FILENAME: 110829_OBS.dwg

SHEET 1 of 4

34" x 22"
DATE: 07/30/2012 TIME: 08:51 FILENAME: L:\DNR\110829\ACAD\110829_OBS.DWG

PLAN VIEW

<<< LINE T95	Navigation trackline with name, direction run, fix, and fix number
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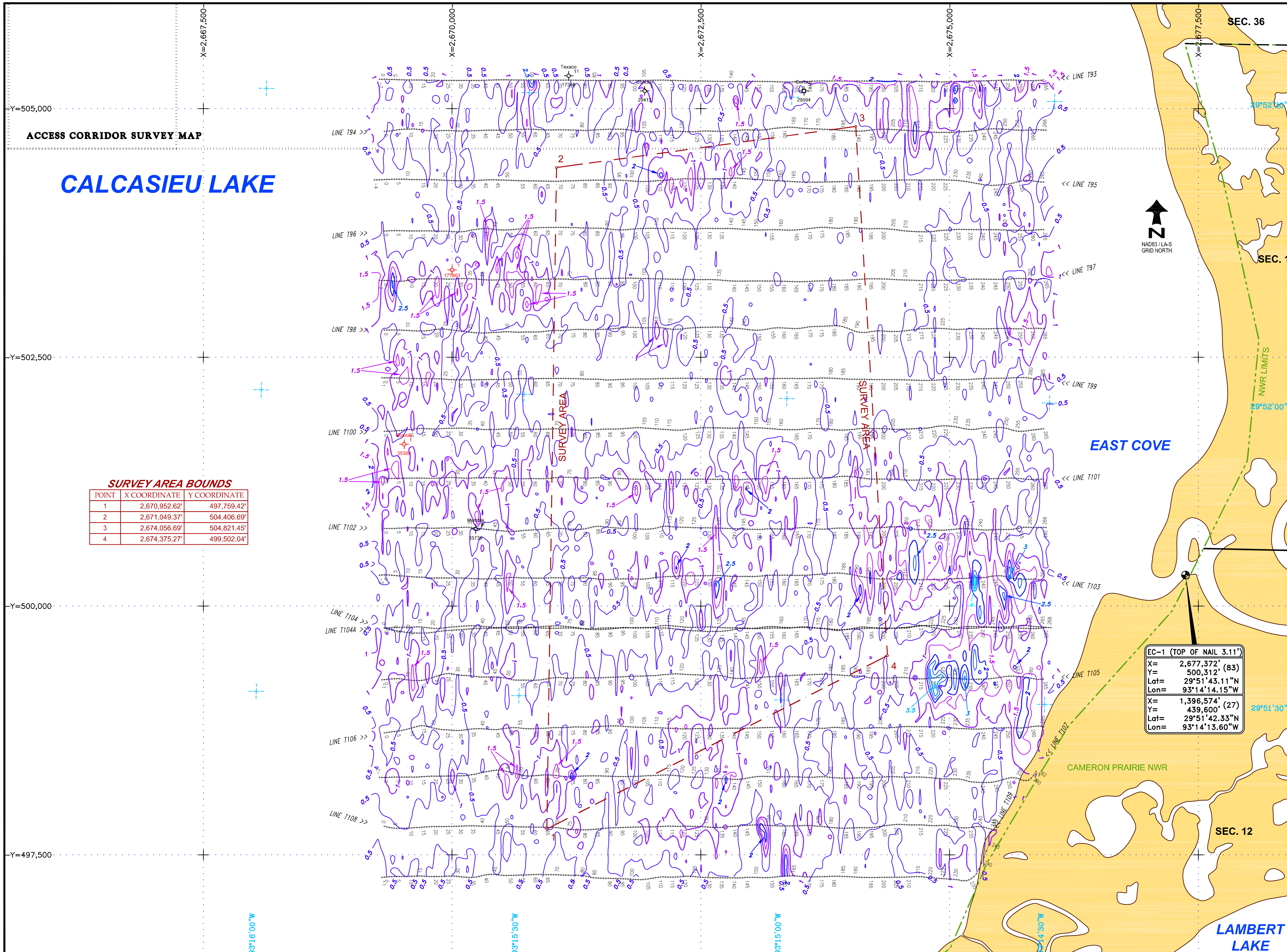

SURVEY AREA BOUNDS

POINT	X COORDINATE	Y COORDINATE
1	2,670,952.62'	497,759.42'
2	2,671,049.37'	504,406.69'
3	2,674,056.69'	504,821.45'
4	2,674,375.27'	499,502.04'

All field data acquired June 20-21, & July 13, 2012.
Survey vessel: M/V C-Star
EQUIPMENT UTILIZED:
Subbottom - Edgetech 3100 SB-216S
Side Scan Sonar - GeoAcoustics 114-410 khz
Magnetometer - Geometrics 882 marine magnetometer
Fathometer - Hydrotrac HT97001

Coastal Protection and Restoration Authority of Louisiana

LAKE FLOOR AMPLITUDE MAP

BORROW AREA SURVEY

CAMERON-CREOLE WATERSHED
GRAND BAYOU MARSH CREATION PROJECT (CS-54)
CALCASIEU LAKE, CAMERON PARISH, LOUISIANA

500' 0 500' 1000'
SCALE IN US SURVEY FEET

ISSUE	DATE	DESCRIPTION	DRAWN	INTERP	CHECKED
1	July 19, 2012	Preliminary issue with report	D. Pierrottie	T. George	G. Prather
2	July 30, 2012	Original issue with report	D. Pierrottie	T. George	G. Prather

GEODETIC DATUM: NAD 83
ELLIPSOID: GRS 80
GRID UNITS: US SURVEY FEET
PROJECTION: LAMBERT CONFORMAL CONIC
ZONE: LOUISIANA SOUTH SPCS
CENTRAL MERIDIAN: 91°20' W
FALSE EASTING: 3,280,833.33 ft. at C.M.
FALSE NORTHING: 0.00 ft. at 28° 30' N

PREPARED BY:
C&C Technologies SURVEY SERVICES
730 E. KALISTE SALOOM ROAD, LAFAYETTE, LA (337) 261-0660

JOB NO. 110829	DATE: July 30, 2012
FILENAME: 110829_OBS.dwg	

SHEET 2 of 4

34" x 22"
DATE: 07/30/2012 TIME: 08:57 FILENAME: L:\DNR\110829\ACAD\110829_OBS.DWG

PLAN VIEW

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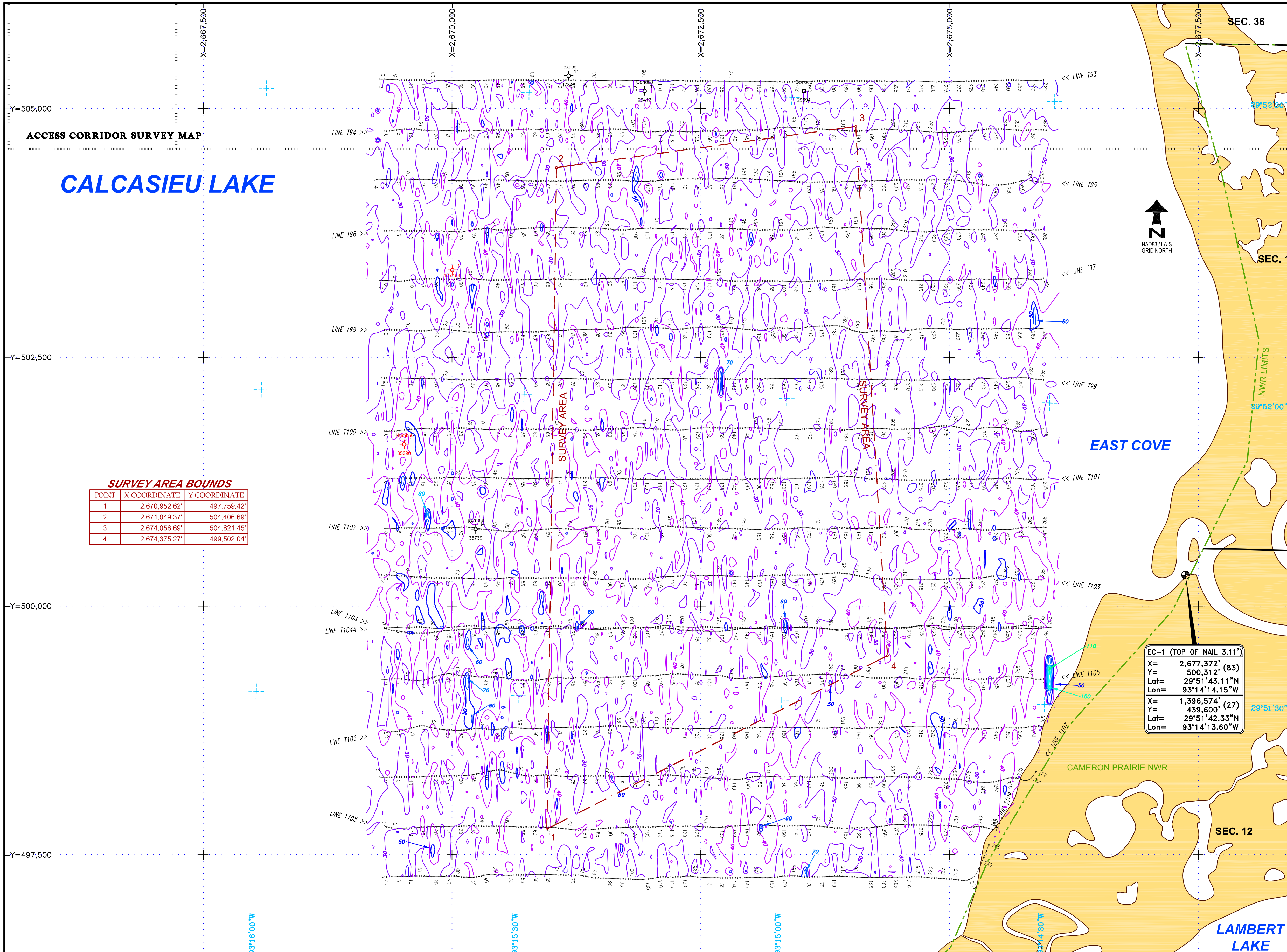
	Contour interval = 10



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Coastal Protection and Restoration Authority of Louisiana

SEISMIC AMPLITUDE SUMMATIONS BETWEEN LAKE FLOOR AND FIVE FEET BELOW MUDLINE MAP

BORROW AREA SURVEY
CAMERON-CREOLE WATERSHED
GRAND BAYOU MARSH CREATION PROJECT (CS-54)
CALCASIEU LAKE, CAMERON PARISH, LOUISIANA

SCALE IN US SURVEY FEET: 500' 0 500' 1000'

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PREPARED BY: C&C Technologies SURVEY SERVICES

JOB NO. 110829 | DATE: July 30, 2012
FILENAME: 110829_OBS.dwg

SHEET 3 of 4

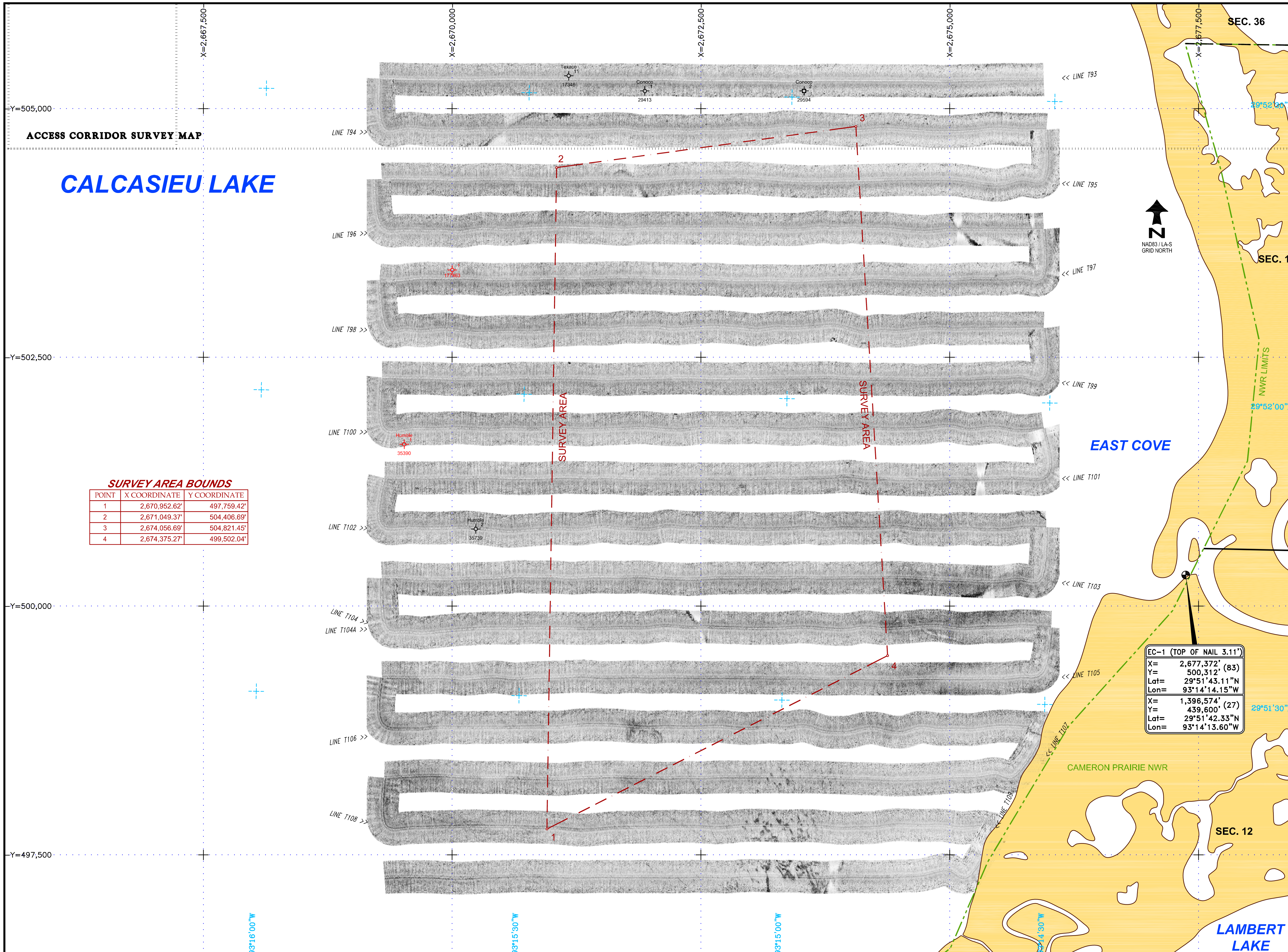
34" x 22"
DATE: 07/30/2012 TIME: 09:38 FILENAME: L:\DNR\110829\ACAD\110829_OBS.DWG

PLAN VIEW

<< LINE T95	Navigation trackline name and direction run

SONAR MOSAIC

Dark returns represent higher seafloor reflectivity.



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Coastal Protection and Restoration Authority of Louisiana

SIDE SCAN SONAR MOSAIC MAP

BORROW AREA SURVEY

CAMERON-CREOLE WATERSHED

GRAND BAYOU MARSH CREATION PROJECT (CS-54)

CALCASIEU LAKE, CAMERON PARISH, LOUISIANA

500' 0 500' 1000'
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JOB NO. 110829 | DATE: July 30, 2012

FILENAME: 110829_OBS.dwg

SHEET 4 of 4

34" x 22"
DATE: 07/30/2012 TIME: 09:40 FILENAME: L:\DNR\110829\ACAD\110829_OBS.DWG