GEOLOGICAL SURVEY OF CANADA
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CCGS Hudson expedition 2011-031
Flemish Pass and Salar Basin
August 6-22, 2011

D.C. Campbell

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0. Acknowledgments-

On behalf of the scientific staff of Hudson 2011-031 and the Atlantic division of the Geological Survey of Canada at BIO, I would like to thank the Commanding Officer David Martin, Chief Officer William Naugle, the deck crew led by Bosun Brian Randell, the engineering department under the direction of Duane Symes, as well as the entire ship's complement for continuous support in execution of the scientific objectives.

1.0 Objectives

The objectives CCGS Hudson expedition 2011-031 were to improve scientific understanding of the surficial geology, seafloor properties and processes on the continental slope and deepwater areas in Flemish Pass and Salar Basin. Specifically:

1. Assess regional surficial geology framework in the area of petroleum basins east of the Grand Banks, testing specific hypotheses developed from the NEREIDA program multibeam and TOPAS data. This includes the extent of glacial till and the character of different types of canyons.
2. Evaluate specific geohazards indicated by the NEREIDA program.
3. Carry out coring and high resolution seismic surveys in the Mizzen area to assess foundation conditions for seafloor structures.
4. Evaluate constraints to exploratory drilling on the north slope of Sackville Spur.
5. Measure sediment transport in the Labrador Current near Sackville Spur to evaluate its significance as a geohazard.
6. Geochemical sampling to characterize gas hydrates.

2.0 Participants

	First Name	Last Name	Affiliation
1	Calvin	Campbell	NRCan
2	Owen	Brown	NRCan
3	Gordon	Cameron	NRCan
4	Laura	deGelleke	Dalhousie
5	Paul	Fraser	NRCan
6	Jenna	Higgins	NRCan
7	Patricia	Jimenez	visiting Spanish scientist
8	Fred	Learning	GeoForce (contractor)
9	Desmond	Manning	NRCan
10	Katrin	Martenka	NRCan- visiting student
11	Patrick	Meslin	NRCan
12	Bob	Murphy	NRCan
13	Peter	Pledge	NRCan
14	Angus	Robertson	NRCan
15	Colin	Rothwell	GeoForce (contractor)
16	Natalie	Shea	NRCan (Newfoundland)
17	Francky	St-Ange	NRCan
18	Mathieu	Tougas	GeoTop-volunteer student
19	Dustin	Whalen	NRCan

3.0 Summary of Activities

Hudson 2011-031 Summary of Activities				*Sampling*			*Geophysical Surveys*		
Date	*JD*	*Location*	*Purpose*	*Core*	*Camera*	*Lander*	*GI Gun*	*Huntec*	*3.5 kHz*
06-Aug	218	BIO	Depart BIO at 0900						
07-Aug	219	BIO to Flemish Pass	24 hour transit						
08-Aug	220	BIO to Flemish Pass	Began general watchkeeping at 0800 running 3.5 kHz while steaming.						transit
09-Aug	221	Sackville Spur	Deploy lander and collect samples for gas hydrates	3	1	2	1-7	1-7	
10-Aug	222	Sackville Spur	Investigate mounds	5-7	4		8-11	8-11	
11-Aug	223	Northern Flemish Pass	Ground truth and seismic surveys of recent failure	8-12			11-21	11-21	
12-Aug	224	Northern Flemish Pass	Ground truth and seismic surveys of recent failure	13-16			22-26	22-26	
13-Aug	225	Central Flemish Pass	Ground truth and seismic surveys of sediment waves and small fan	17-20			27-31	27-31	
14-Aug	226	Central Flemish Pass	Ground truth and seismic surveys of drift north of Beothuk Knoll	21-24			32-37	32-37	
15-Aug	227	South of Flemish Cap	Ground truth and seismic surveys of hummocky seabed	24-29			38-42	38-42	
16-Aug	228	South of Flemish Pass	Ground truth and seismic surveys of failures	30-32	33		43-45	43-45	
17-Aug	229	Salar Basin	Ground truth and seismic surveys of slope area	34-38			46-48	46-48	
18-Aug	230	Salar Basin	Ground truth and seismic surveys of slope area	39-43	44		49-52	49-52	
19-Aug	231	Salar Basin	Ground truth and seismic surveys of slope area	44-49			53-55	53-55	
20-Aug	232	South of Flemish Pass	Ground truth and seismic surveys of canyon/ridge system	50-53					
21-Aug	233	Sackville Spur	Lander recovery and gas hydrates sampling	55-58		54			
22-Aug	234	Northern Flemish Pass	Stratigraphy of Sackville Spur and Flemish Pass	59-63					
23-Aug			Steam to St. John's						

4.0 Preliminary Results

4.1 Cruise statistics

During the expedition, the following scientific data were collected:

- 1330 line-km of high quality 1x210 in^3 GI Gun single channel seismic reflection data and Huntec DTS ultra-high resolution seismic reflection data (sparker mode).
- 3 .5 kHz chirp data were collected during transits.
- 57 piston cores were collected using the AGC Long Coring Facility, recovering 442 m of sediment.
- 3 deployments of the newly developed Deep Imager live video system.
- 1 successful deployment and recovery of an instrumented seabed lander.
- 1 drop camera station using the 4K Camera system with VladCam bullet was collected.

4.2 Key Preliminary Results

1. Mounds in northern Flemish Pass remain an enigma. New seismic data does not support an interpretation of failure features. The Deep Imager transect shows abundant gravel and boulders on the top of a mound. Piston cores recovered grey sandy mud, except for one core which penetrated red sediment at its base.

2. The instability zone in northern Flemish Pass is complex with multiple phases and styles of seabed failure. Strategic coring will hopefully sort out the timing of failure events. Zones that appear draped and old on multibeam data reveal MTDs at the surface in Huntec data and cores recover very fine sand and silt (winnowed facies?), possibly representing liquefaction. This area is less than 30 km from the current Mizzen drill site and shares a similar setting.

3. Sediment waves in central Flemish Pass are sandy on their up-dip side and muddy on their down-dip side suggesting preferential trapping of sand in wave troughs. A small submarine fan only discernible from the NERIEDA backscatter and Huntec data consists of well-sorted fine sand that did not allow any significant penetration by the piston corer.

4. The surficial geology of southern Flemish Pass, Salar Basin and the slope south of Flemish Cap are complex. The large canyon and sedimentary ridge immediately south of Flemish Pass appear to be at least partially fed by the contourite system to the north. Prominent unconformities and large bedforms in the subsurface suggest strong bottom currents in the area in the Pliocene and Pleistocene.

5. Geological data collected during the NEREIDA program enabled targeted coring in the floor of Flemish Pass and it appears clear that the backscatter data delineates the main pathways for the Labrador Current. A swath of seabed characterized by high backscatter oriented North - South on the floor of the Pass corresponds to a subtle depression. Piston cores in the swath recovered ~3 m of very clean fine sand.

6. A piston core in southern Flemish Pass near Beothuk Knoll recovered an interval of clean basalt fragments which presumably is eroded from somewhere nearby or dropped during ice rafting. The layer possibly coincides with a prominent reflection in Huntec data from the area.

7. The Deep Imager, developed in-house, is a very useful tool and something that has been lacking for deepwater work until this point. The live video allows an ROV-like experience and the quality of the HD video is superb.

5.0 Daily Narrative

(all times in Atlantic Daylight Time except where noted, all positions are the planned positions, not necessarily the actual ship position)

JD 212 Sunday July 31, 2011- BIO
Original sailing date delayed due to ship issues. Awaiting repairs.

JD 215 Wednesday August 3, 2011- BIO
Ship staff conduct ship familiarization for science staff.

JD 217 Friday August 5, 2011- BIO
Fire and boat drill for all staff. Planned departure time following repairs is 0900 on Saturday.

JD 218 Saturday August 6, 2011- Steaming to study area
Sailed from BIO at 0900.

JD 219 Sunday August 7, 2011- Steaming to study area
Sailing to Flemish Pass.

JD 220 Monday August 8, 2011- Steaming to study area
Sailing to Flemish Pass. Staff began general watchkeeping at 0800. Turned on 3.5 kHz and continued transit towards northern Flemish Pass.

JD 221 Tuesday August 9, 2011- Northern Flemish Pass
Arrived in Northern Flemish Pass at 0700.

Camera STN 001 48 25.9023 -46 14.2816

The purpose is to conduct a bottom photograph transect and deploy a seabed lander in the area to capture the effects of the Labrador Current. Camera transect was an unsuccessful attempt with only photos of water column. Plunger jammed on camera, but onboard video should provide useful information about the seabed in the area.

Seabed Lander STN 002 48 25.9023 -46 14.2816

Deployed seabed lander at same location. Difficulty deploying lander as the acoustic release was unresponsive. Upon recovery, it was discovered that the release strap failed and the landed likely free fell to the seabed from some unknown depth.

Piston Core STN 003 48 24.1817 -46 14.7781

Core target was an area where gas hydrate may be outcropping at seabed. Good recovery on the piston and trigger weight core. Core sampled for headspace gas and pore water chemistry.

Steamed 7 nmi to SOL 01. Began deploying seismic gear at 1700. Air leak discovered at fitting in air hose during deployment. Recovered airgun and fixed leak. Redeployed airgun and streamer. Issues with LongShot gun controller computer. Huntec online by 1800. GIGun on line by 2000. The purpose of the seismic survey was to collect data over the lander and sample locations, to tie into older seismic profiles, and to further image the mounds on Sackville Spur.

JD 222, Wednesday August 9, 2011- Northern Flemish Pass

Recovered seismic gear at 0610 at EOL 7. Sailed to prominent mound in area of mounds on Sackville Spur.

Deep Imager STN 004 48 10.4633 -46 48.4446

Location in ~850 m water depth. Deployed Deep Imager at 0800 (STN 004) and did transect across mound. Video imagery shows generally muddy seafloor with occasional broad areas with gravel and small boulders. Recovered Deep Imager at1040.

Piston Core STN 005 48 08.9624 -46 49.2664

Piston core site on top of large mound. Recovered ~3 m of sediment in piston core. Good recovery in TWC. Grey green sandy to gravelly mud.

Piston Core STN 006 48 13.4086 -46 44.2871

Piston core site at base of regional escarpment where Huntec data suggests some recent failure along the scarp wall. Target was a shallow MTD at base of scarp. No recovery on TWC (possibly fell over). ~2.5 m of recovery in the PC. Top of piston core was sandy, base was stiff grey silty clay with granules and sponge spicules.

Piston Core STN 007 48 13.4467 -46 42.5881

Target was top of a prominent mound. No recovery in the TWC. Top of piston core was sandy-gravelly grey mud. Base of piston core penetrated red sediments.

Steamed 14 nmi to the east and deployed seismic gear at 1800. Everything online by 1830. Ran lines 8-11. The purpose of the seismic transect was to extend the seismic continuity along the spine of Sackville Spur and to cross a shallow instability zone first imaged during Hudson 2001-043.

JD 223 Thursday August 11, 2011- Northern Flemish Pass
Recovered seismic gear at 0600. Steamed to first piston core station. Purpose of coring was to characterize the instability zone (age, physical properties, lithology)

Piston Core STN 008 48 32.2746 -45 49.5189

Target was the pinch out of large slide, selected target was where the slide is barely resolved by Huntec. Good recovery on both the TWC and PC. Possible contact observed through liner near 4.5 m. Upper 1 m of core sandy and gravelly.

Piston Core STN 009 48 21.4035 -45 43.2949

Target was the top of the shallowest slide observed in the instability zone in order to determine age of youngest slide. Good recovery in TWC and PC. Reddish brown clast in greyish green matrix apparent at base of core.

Piston Core STN 010 48 22.6729 -45 38.0504

The targets for cores 010-012 are a series of stepped terraces that will hopefully provide an extended composite stratigraphy for the floor of Flemish Pass. Core 010 is the shallowest core in the series. Good recovery in both TWC and PC. Approximately 8.5 m recovery in the PC.

Piston Core STN 011 48 22.8945 -45 38.3009

Piston Core 011 is located on the terrace below PC 010. Good recovery in both PC and TWC. Recovered ~6.5 m of greyish green sediment.

Piston Core 012 48 23.3201 -45 38.8366

Piston Core 012 is located on the terrace below PC 011. Good recovery in both PC and TWC. Recovered ~6.5 m of greyish green sediment.

Steamed to SOL 12. Deployed seismic gear at 1700. Problems with ship's auxiliary generator resulted in a ½ hr delay in start-up of the airgun. The purpose of the seismic transect was to increase the seismic coverage of the shallow instability zone first imaged during Hudson 2001-043.

JD 224 Friday August 12, 2011- Northern Flemish Pass
Recovered seismic gear at EOL 21. Steamed towards first core site.

Piston Core STN 13 48 34.8517 -45 33.8589

Target was a shallow MTD in order to date failure. Good recovery in both piston and TWC. Colour change at base of TWC may indicate contact with shallow MTD.

Piston Core STN 14 48 23.5764 -45 39.1109

Target was the deepest stratigraphic level in the composite stratigraphic series of cores. No recovery in TWC (few granules).

Piston Core STN 15 48 23.5189 -45 41.6222

Target was a small slump near the edge of a prominent escarpment that appears to post-date a widespread failure on seismic data. Short TWC recovery. Piston core recovered 3.5 m of sediment. Sandy in the upper 1.5 m.

Piston Core STN 16 48 17.6195 -45 46.1834

Target was a shallow MTD that covers a large area and has smooth topgraphic expression and different acoustic facies compared to the other failures in the area. Piston core recovered 7.5 m.

Steamed 45 nmi to the south. Arrived at deployment site at 1845. Deployed seismic gear. Online by 1915. Ran lines 22-26. The purpose of the seismic transect is to cross the western margin of Flemish Cap into Flemish Pass and across a submarine fan system with large, upslope migrating sediment waves.

JD 225 Saturday August 13, 2011- Central Flemish Pass
Recovered seismic gear at 0630. Steamed to first piston core location. The purpose of the day's sampling plan was to investigate two small fans on the floor of Flemish Pass. One fan is associated with the development on a field of sediment waves. The second fan has no topographic expression and is only apparent from backscatter data and Huntec data.

Piston Core STN 17 47 37.3224 -46 20.5738

Target was the downslope side of a sediment wave in central Flemish Pass. Previous coring during 96018 and 2006046 target the upslope side of sediment waves in the region. Core recovered ~8 m of sediment with full TWC.

Piston Core STN 18 47 38.9831 -46 27.0008

Target was the distal part of the northern (wavy fan). TWC and PC each recovered less than 1 m of fine muddy sand.

Piston Core STN 19 47 33.6550 -46 27.7168

Target was the middle of the southern fan. Like the previous core, TWC and PC each recovered less than 1 m of fine muddy sand.

Piston Core STN 20 47 35.6648 -46 32.3498

Target was the distal part of the southern fan. TWC recovered ~1m of muddy fine sand. PC damaged, lost first barrel as corer likely fell over.

Steamed 45 nmi to the south. Ran lines 27-31. The purpose of the survey was to collect regional seismic profiles across Flemish Pass, to tie some piston cores that were collected by TDI Brook is 2002, and to image a large sediment drift north of Beothuk Knoll.

JD 226 Sunday August 14, 2011- North of Beothuk Knoll
Recovered seismic gear at 0630. Steamed to piston core location.

Piston Core STN 21 46 45.0583 -46 41.0378

Target was the top of a large sediment drift north of Beothuk Knoll. Good recovery in both TWC and PC. PC had varied lithology ranging from v.fine sand to sandy mud with granules.

Piston Core STN 22 46 42.0118 -46 48.9062

Target was a seabed high interpreted to represent a contourite levee on the eastern side of the floor of Flemish Pass. Core recovered v.fine sand and sandy/silty mud. A very clean interval of angular basalt fragments was encountered approximately 3 m downcore.

Piston Core STN 23 46 41.7302 -46 53.3920

Target was the middle of a broad depression in the floor of Flemish Pass that corresponds to a broad N-S zone of high backscatter on the floor of the pass. The zone is interpreted to mark the main pathway for the south-flowing Labrador Current. Core recovered ~3 m of v.fine sand.

Piston Core STN 24 46 42.2509 -47 02.1317

Target was a sequence of stacked mass transport deposits on the western slope of Flemish Pass. Core recovered sandy mud with granules.

Steamed to SOL 32. Deployed seismic gear at 1530. Ran lines 32-37. Purpose of the survey lines was to collect data over a variety of morphological regions on the slope south of Flemish Cap, from canyons to hummocky seabed.

JD 227 Monday August 15, 2011- South of Flemish Cap
Recovered seismic gear at EOL 37 at 0600. Some issues overnight with Long Shot gun controller and a compressor. Steamed to first core site.

Piston Core STN 25 46 08.0930 -45 33.9444

Target was an area of smooth seabed up-slope from an area of pervasive depressions that possibly represent large pockmarks. Recovered approximately 4.3 m of stiff sandy mud.

Piston Core STN 26 46 05.5084 -45 37.1519

Target was a large depression in an area of hummocky and depression-filled seabed. Recovered ~6.5 m of stiff silty and sandy mud.

Piston Core STN 27 46 06.0542 -45 52.6628

Target was an area of smooth seabed. Recovered very silty mud.

Piston Core STN 28 46 19.6331 -46 13.0059

Target was the lower levee of a low relief channel. No recovery in TWC (stopped in sand?). Piston core recovered ~6.5 m of silty mud with sand in the upper section in the core.

Piston Core STN 29 46 23.5144 -46 10.4646

Target was the upper levee of the same low relief channel targeted by STN 28. Core stopped in diamict, but otherwise consisted of silty and sandy mud.

Steamed to SOL 38. Ran lines 38-42. Purpose of the survey lines was to tie data from south of Flemish Pass to Flemish Pass, and tie data from cruise 2001-043 and 96-018, therefore tying Salar Basin stratigraphy to Flemish Pass.

JD 228 Tuesday August 16, 2011- South of Flemish Pass
Recovered seismic gear at EOL 42. Steamed to first piston core location.

Piston Core STN 30 46 08.4155 -46 51.4038

Target was a shallowly buried mass transport deposit with the purpose of dating the deposit. Good trigger weight core and approximately 6 m of recovery in the Piston Core.

Piston Core STN 31 46 08.0204 -46 51.8146

Target was a well stratified interval on the flank of the MTD targeted by core 030. Good TWC and approximately 7 m of recovery in piston core.

Piston Core STN 32 46 03.1461 -46 56.6385

Target was shallow MTD at the base of an arcuate escarpment. Full penetration TWC and PC (to core head). Good recovery of gassy sediments. Observable expansion cracks in the core.

Steamed to Deep Imager drift.

Deep Imager STN 33 45 53.3579 -47 01.4355

Deep Imager drift was across an area of hummocky seabed associated with a large MTD in the area. Instrument was flown near the seabed for ~45 minutes collecting high quality video across varied seabed ranging from muddy sediment to gravel and boulders. Active sediment transport and a mobile nepheloid layer was observed in several places. Recovered Deep Imager at 1610.

Steamed to SOL 43. Ran lines 43-45. Purpose of survey lines were to image contourite and failure features in Salar Basin and to make ties between data collected during 2001-043.

JD 229 Wednesday August 17, 2011- Salar Basin

Recovered seismic gear at 0610. Issues overnight with compressor and bird modem. Sensor malfunctions in compressor caused automatic shut-down, losing~50 min of data. Streamer bird modem failed, resulting in a loss of streamer depth control.

Steamed to first core site.

Piston Core STN 34 45 48.6843 -47 31.5216

Target was the eastern levee of a broad channel. Short TWC. Evidence of sandy clasts in core end (MTD?).

Piston Core STN 35 45 56.7148 -47 28.7758

Target was ponded stratigraphy immediately seaward of a large contourite moat in Salar Basin. Full penetration on TWC and PC (rigged to 12 m). PC recovered >9m sediment.

Piston Core STN 36 46 01.6157 -47 19.7861

Target was a thick acoustically stratified interval that appears to correspond with a broad, along slope contourite levee. PC recovered 6 m, stopping in fine sand.

Piston Core STN 37 46 06.3351 -47 21.8385

Target was part of a series of stepped, retrogressive escarpments. High amplitude and chaotic reflection in Huntec. Core recovered 3 m of sediment. Colour contact near base of section A-B apparent through core liner.

Piston Core STN 38 46 09.0502 -47 22.9984

Target was a chaotic interval interpreted to be till overlain by ~3 m of stratified sediment. Only a vial of gravel and biota from the TWC. PC base consisted of moderately stiff diamict.

Steamed to SOL 46. Deployed seismic gear at 1730. Ran lines 46-48. Purpose of survey lines was to image the thick succession of Quaternary sediments that lie seaward of a major marine onlap surface and unconformity in the area, tying in regional dip lines collected during 99031 and 2001043.

JD 230 Thursday August 18, 2011- Salar Basin

Recovered seismic gear at 0600 near Salar Basin. Steamed to first core site.

Piston Core STN 39 45 10.9397 -48 37.1820

Core target was an acoustically stratified interval on top of a broad ridge west of Carson Canyon. Only 0.5 m recovery in TWC and ~1.5 m in PC. Very fine muddy sand.

Piston Core STN 40 45 15.5350 -48 30.5210

Target was the western levee of Carson Canyon. Core appeared to penetrate similar fine-sandy sediments that STN 39 sampled. ~2 m recovered in PC with damaged cutter.

Piston Core STN 41 45 19.9106 -48 21.1797

Target was a shallow MTD on an area of flat seabed. Core recovered 6 m.

Piston Core STN 42 45 20.9096 -48 19.0004

Target was a broad shallow channel which headed in the middle slope. Full penetration on PC, recovering > 10 m of sediment.

Piston Core STN 43 45 22.8386 -48 14.8924

Target was a wide area of MTD. Full penetration on TWC and PC.

Deep Imager STN 44 45 27.1008 -48 16.8198

Target for camera transect was a regional contourie moat that coincides with the contact between onlap and slope erosion in the area. Camera deployment aborted prematurely when camera cable slipped from block and became snagged. No video.

Steamed to SOL 49. Ran lines 49-52. Purpose of seismic transect was to tie a number of older regional seismic lines, across the outer shelf, the erosional upper-middle slope and the depositonal lower slope in Salar Basin.

JD 231 Friday August 19, 2011- Salar Basin
Recovered seismic gear at 0610. Steamed to first core site.

Piston Core STN 45 45 35.8836 -48 04.5293

Target was an acoustically stratified interval overyling an MTD in what appears to be a sediment wave.

Piston Core STN 46 45 35.1201 -48 04.6081

Target was an area where erosion of the seabed has exposed the deeper stratigraphy. Core recovered stiff clayey silt at the base. Damage to liner.

Piston Core STN 47 45 31.0329 -48 04.9974

Target was a shallow diapir in acoustically stratified interval. Core recovered ~3m of soft sandy mud. Core sampled for headspace gas and pore water chemistry.

Piston Core STN 48 48 45 26.6742 -48 10.2076

Target was an acoustically stratified interval with continuous high amplitude reflections near the seabed.

Piston Core STN 49 45 26.9147 -48 05.4355

Target was an acoustically stratified interval.

Steamed 20 nmi to the east and deployed seismic gear. Ran lines 53-55. The purpose of the survey transect was to investigate a large canyon and ridge complex immediately south of Flemish Pass.

JD 232 Saturday August 20, 2011- South of Flemish Pass
Piston Core STN 50 45 25.1271 -47 12.5884

Target was a stratigraphic core on a small ridge on the south side of a large sedimentary ridge south of Flemish Pass. Soupy and sandy mud (possible foram rich). Long TWC and 5 m recovery in the PC. Deformation of soupy sediments in upper section of core.

Piston Core STN 51 45 33.7313 -47 02.8726

Target was perched sediments on the top of a levee above the levee of a large canyon south of Flemish Pass. Colour change in TWC with light grey upper interval over a dark brown lower interval. Piston core stopped in stiff and brittle silt interval. Foram ooze in section CD.

Piston Core STN 52 45 32.4975 -47 09.7515

Target was top of crest of large ridge south of Flemish Pass. ~7.5 m recovery in PC. Stiff silt with gravel at base. Foram ooze in middle of core.

Piston Core STN 53 45 37.0412 -47 13.0722

Target was a small levee in the floor of a large channel south of Flemish Pass. Core recovered ~ 5 m of stiff clayey silt and sand.

Steamed overnight to Sackville Spur for seabed lander recovery.

JD 233 Sunday August 21, 2011- Sackville Spur
Arrived at seabed lander location at 0700.

Seabed Lander STN 54

Lander successfully recovered and on deck by 0910. Steamed to first core location

Piston Core STN 55 48 28.9873 -46 11.8775

Target was a piston core within the NAFO sponge protection area north of Sackville Spur. Core recovered ~ 9m of sediment with no obvious sponge spicules in core ends.

Piston Core STN 56 48 25.2586 -46 15.5780

Target was to sample seabed to test for gas hydrates. Location was based on Statoil 3D survey site 10. PC recovered ~ 6 m intersecting gravel.

Piston Core STN 57 48 25.5733 -46 16.5451

Target was to sample seabed to test for gas hydrates. Location was based on Statoil 3D survey site 11. PC recovered ~5.5 m.

Piston Core STN 58 48 20.8572 -46 21.2968

Target was to sample seabed to test for gas hydrates. Location was based on Statoil 3D survey site 5.

Steamed to SOL 59. Deployed seismic gear at 1810. The purpose of the transect was to survey the eastern portion of Sackville Spur, tying in data collected earlier in the survey and during 2001-043.

JD 234 Monday August 22, 2011- Sackville Spur
Recovered seismic gear at 0630. Steamed to first piston core site.

Piston Core STN 59- 48 26.1922 -45 18.7075

Target was acoustically stratified interval seaward of potential till on northern Flemish Cap. Core recovered 9 m of sediment.

Piston Core STN 60 48 36.5327 -45 17.2675

Target was an acoustically stratified interval on the northern slope of Flemish Cap. PC recovered ~9 m.

Piston Core STN 61 48 41.4390 -45 20.5514

Target was a shallowly buried MTD on the northern slope of Flemish Cap. PC recovered ~9 m.

Piston Core STN 62 48 46.3684 -45 27.9825

Target was a stratigraphic core in the NE Flemish Pass. Good recovery with 9 m of sediment in PC.

Piston Core STN 63 48 34.7177 -45 48.9200

Target was a stratigraphic core along the eastern Sackville Spur. Steamed to SOL. Ran line across floor of Flemish Pass and up western slope.

JD235 Tuesday August 23, 2011- Flemish Pass to St. John's, NL
Recovered seismic gear at 0600. Steamed to St. John's. End of program.

6.0 Equipment and Procedures

6.1 Piston Coring

Owen Brown, Jenna Higgins, Angus Robertson

The piston coring system used was the AGC Long Corer. This device obtains a core sample with an inner diameter of 99.2 mm and an outer diameter of 106 mm. Barrel lengths for this system are 10 ft (305cm) and the system is typically rigged to a maximum of 5 barrels. During this cruise the system was rigged with three or four barrels depending upon the seismic interpretation of the sediment. The core head is 3m long, 0.6m in diameter and weighs approximately 3000 lb (1350Kg). Each barrel has an internal diameter of 4.25" (10.8cm), a 3/8" (9.5mm) wall thickness, and exterior couplings secured by set screws. The liner was a CAB plastic in 10 ft (305cm) lengths. A split piston with O-rings and a variable orifice size (split piston orifice used was either 1/16" to 1/8" in size) was used and a standard core catcher was used at all coring sites. The trip arm for the core system also supported a 4.25" (10.8cm) diameter gravity corer with a single 7ft 10" (2.14m) barrel and 300 lb (135 kg) head composed of circular lead weights. In addition, an acoustic pinger was used to track the core in water depths over 2500 m as it becomes difficult to see the core hit bottom at greater depths.

The corer used the ship's Pengo winch with a ¾" wire cable, the starboard foredeck crane and GSCA trawl block to deploy and retrieve the corer. The corer was handled on deck using a system that includes a rotating core-head cradle, outboard support brackets, a monorail transport system with two 1 ton chain hoists, a lifting winch and a processing half-height container. Each recovered core was broken down at the barrel joints and moved to the processing half-height container via the monorail, where each 10ft (305cm) section of liner was extruded from the barrel and cut in half and labelled.

Core extrusion operations in the half height container were made more efficient with several tools developed pre-field season. An aluminum core pushing tool was designed and fabricated to slide over the standard diameter core barrel and make contact with the CAB liner circumference within the barrel not disturbing the delicate sediment face. This tool proved to be very effective in the majority of sample extrusions bypassing the need to use the slower hydraulic ram and was far safer for the operator and sample (Figure 6.1).


Figure 6.1 Core Extrusion Pusher

On the opposite end of the core barrel during the extrusion process, another tool was developed that allowed the liner to be held and pulled once an initial push was accomplished as described above. This tool had a secondary feature to allow the core liner to be held firmly while the stainless steel radial cutting tool was used to cut the liner. This tool sped up the extraction process and provided a safer ergonomic method of holding the sample and liner (Figure 6.2).


Figure 6.2 Core Extrusion Puller

A stationary clamp tool was also available for this mission and at the prototype stage allowing the extruded core liner to be clamped while cutting. It had very minor use as there were almost always two core technicians in the container so one could cut while the other used the handheld clamp tool. This was the second year for the core table clamp and vertical cutting ring guide. These proved very useful in the core processing section of the GP lab effectively allowing one person rather than two to safely and accurately cut a core to length.
(Figure 6.3).

Figure 6.3 Core Holder and Cutting alignment ring.

Of the 57 attempted coring sites the piston corer was successful 56 times while the trigger weight corer (TWC) returned 51 samples. Liner implosions occurred at stations 56 and 57 while liner at station 46 was shattered. At station 20, the first barrel broke in the second coupling and, in effect, the first barrel and coupling, the cutter, the catcher and half of the piston were lost at sea. Also during this cruise, nine cutters and seven catchers were destroyed.

6.2 Onboard core processing and subsampling

Owen Brown and Jenna Higgins

In total, 442 m of sediment core was obtained. All cores were processed according to standard GSC Atlantic core procedures (refer to GSC Open File #1044). All cores were identified alphabetically by section at the time of dismantling individual 10 ft core barrels from the bottom to the top, commencing with the bottom-most core barrel and proceeding to the uppermost barrel containing sediment. Each 10 ft length of liner was extruded from the barrel and cut in half, using a modified pipe cutter, in the half height container (Figure 6.4). The sediment in the liner was cut using a wire saw and the section ends were carefully capped to minimize disturbance to the sediment surface. The top end cap was labelled with the cruise number, station number, section label and top. The base of the core is designated with the letter A and the top of the base section is designated as B. The base section is AB. Each section was brought into the GP Lab and stored horizontally on the benches. Each core, starting with the base section AB, was processed using the following procedure. The core liner was labelled with an up arrow, cruise number, station number, section label and the top and base of the section were labelled with the appropriate letter.

Figure 6.4 Processing core samples in the half height container.

When possible, a vial of sediment was taken from the top of each TWC for dinoflagellate analysis by GEOTOP (UQAM). For stations 3, 47, 56, 57, and 58, whole round samples were removed from the base of each section of the piston core for subsequent gas sampling. When conditions allowed, undrained shear strength measurements and constant volume samples were taken at the top and base of each section for both the TWC and piston core. Inert packing was placed in the voids created by the constant volume sampling, and the ends of each core section were re-capped, taped then sealed with wax at both ends to prevent water loss, and then the lengths of each section were measured. For stations 3, 47, 56, 57, and 58, the pore-water from the piston cores was sampled at multiple depths.

The sealed core sections were stored upright in the refrigerated reefer container and maintained at 4°C. All core cutters and catchers were measured, labelled, placed in sections of liner, waxed and stored upright in buckets in the refrigerated container. All extruded core sections due to sediment expansion or core processing methods were likewise labeled and stored. All samples and subsamples were catalogued and their location information within the container was recorded in an excel spreadsheet.

All station location information, core section lengths, extruded pieces and cutter/catcher lengths, sediment description and core performance information have been documented on deck sheets and then input into the expedition database (ED). The ED has been backed up and will be verified before downloading into the main ORACLE sample database.

6.3 Physical properties measurements

Jenna Higgins

Undrained shear strength measurements and constant volume samples were taken at the ends of each section if the condition of the sediment allowed (Table 6.1). The constant volume sampler was inserted into the end of the section, the undrained shear strength measurement was taken and then the constant volume sampler was removed.

The undrained shear strength was measured using a hand-held Hoskin Scientific Torvane according to ASTM Test Method D2573-94 Standard Test Method for Field Vane Shear Test in Cohesive Soil. The dial on the Torvane was zeroed, the fins on the vane were gently pushed into the sediment until they were completely inserted (Figure 6.5). The dial was rotated at a constant rate until the sediment failed.

Figure 6.5 Taking a Torvane measurement.

The Torvane dial reading ranges from 0 to 1 and reports values in kg-force/cm^2 units (1 kg/cm^2 = 98.07 kPa). The Torvane has three adapter vanes as described below:

<u>L - Sensitive vane</u> has a range of 0 to 0.2 Kg-force/cm^2
Su = dial reading * 0.2 Kg-force/cm^2

M - Regular vane has a range of 0 to 1.0 Kg-force/cm^2
Su = dial reading * 1 Kg-force/cm^2

S - High capacity vane has a range of 0 to 2.5 Kg-force/cm^2
Su = dial reading * 2.5 Kg-force/cm^2

All three vanes were used (although mainly the sensitive vane) for a total of 252 undrained shear strength measurements taken during the cruise.

Constant volume samples for bulk density and water content determinations were taken by inserting stainless steel samplers of a known volume. Prior to insertion, the sampler was lightly sprayed with Pam cooking oil and gently wiped with a small Kimwipe tissue. The bevelled edge of the sampler was placed on the flat sediment surface and the carefully inserted into the sediment at a constant rate using two flat headed spatulas (Figure 6.6). The sampler is inserted at a constant rate to minimize compression of the sediment within the sampler. The sampler was then carefully removed and the sediment was trimmed using a wire saw and extruded into a pre-weighed 1 oz screw-top glass bottle. The bottle cap was then labelled and sealed using electrical tape to prevent the lid from loosening. A total of 338 constant volume samples were taken during the cruise. The samples will be weighed, dried at 105°C for 24 hours and re-weighed to determine bulk density, dry density and water content according to ASTM Test Method D 2216-90 (revision of 2216-63, 2216-80) Standard method for laboratory determination of water (moisture) content of soil and rock. All relevant information for the Torvane measurements and constant volumes was recorded on data sheets and input into Excel spreadsheets and will be incorporated into the physical property database.

Figure 6.6 Taking a constant volume sample.

Table 6.1 – Summary of 2011031 physical property sampling

Station #	Sample type	# of Torvane measurements	# of constant volume samples
0003	TWC	-	-
0003	PC	6	8
0005	TWC	-	-
0005	PC	1	-
0006	TWC	-	-
0006	PC	-	-
0007	TWC	-	-
0007	PC	-	1
0008	TWC	-	1
0008	PC	4	8
0009	TWC	-	-
0009	PC	6	5
0010	TWC	-	-
0010	PC	4	7
0011	TWC	-	-
0011	PC	5	8
0012	TWC	-	-
0012	PC	5	5
0013	TWC	-	-
0013	PC	6	6
0014	TWC	-	-
0014	PC	5	6
0015	TWC	-	-
0015	PC	2	3
0016	TWC	2	2
0016	PC	5	6
0017	TWC	2	1
0017	PC	5	5
0018	TWC	-	-
0018	PC	-	-
0019	TWC	-	-
0019	PC	-	-
0020	TWC	-	-
0020	PC	-	-
0021	TWC	2	2
0021	PC	9	9
0022	TWC	1	1
0022	PC	3	5
0023	TWC	-	-
0023	PC	2	2
0024	TWC	-	-
0024	PC	4	4
0025	TWC	-	-
0025	PC	2	3
0026	TWC	-	-
0026	PC	7	7

0027	TWC	2	3
0027	PC	4	6
0028	TWC	-	-
0028	PC	3	6
0029	TWC	-	-
0029	PC	4	5
0030	TWC	2	1
0030	PC	4	4
0031	TWC	1	2
0031	PC	3	5
0032	TWC	1	2
0032	PC	3	7
0034	TWC	-	-
0034	PC	5	6
0035	TWC	2	2
0035	PC	5	8
0036	TWC	2	1
0036	PC	2	2
0037	TWC	-	-
0037	PC	2	2
0038	TWC	-	-
0038	PC	2	1
0039	TWC	-	-
0039	PC	-	-
0040	TWC	-	-
0040	PC	-	-
0041	TWC	-	-
0041	PC	4	7
0042	TWC	2	-
0042	PC	6	6
0043	TWC	2	3
0043	PC	8	10
0045	TWC	-	-
0045	PC	4	8
0046	TWC	-	-
0046	PC	2	5
0047	TWC	2	1
0047	PC	2	2
0048	TWC	2	2
0048	PC	5	9
0049	TWC	-	-
0049	PC	8	11
0050	TWC	2	2
0050	PC	2	3
0051	TWC	2	3
0051	PC	2	3
0052	TWC	2	1
0052	PC	6	9
0053	TWC	2	2
0053	PC	2	4
0055	TWC	2	2

0055	PC	4	6
0056	TWC	2	2
0056	PC	5	6
0057	TWC	-	-
0057	PC	4	3
0058	TWC	-	2
0058	PC	4	4
0059	TWC	-	2
0059	PC	5	9
0060	TWC	-	2
0060	PC	4	8
0061	TWC	2	2
0061	PC	4	9
0062	TWC	2	2
0062	PC	5	8
0063	TWC	1	2
0063	PC	6	10

6.4 Gas sampling

Owen Brown and Jenna Higgins

The 6-cm long whole round was cut from the base of each section was trimmed down to a 6-cm cube using a wire cutter. The sediment cube was then sliced up with a spatula (Figure 6.7) and placed in a 1-pint paint can. In the geochemistry lab, the sediment was covered with 170mL of 0.5% sodium azide aqueous solution and then the air in the can was replaced with pure nitrogen gas (Figure 6.8). The lid was immediately sealed using a rubber mallet, the container was inverted and then stored in a deep freezer. The trimmings from the whole round were stored in plastic bags and were also stored in a deep freezer.

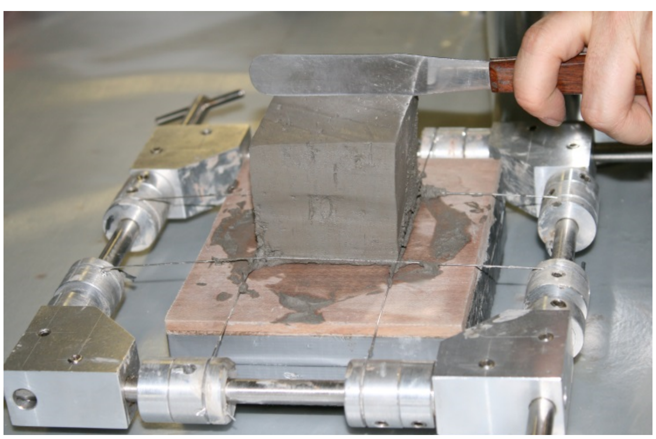


Figure 6.7 Taking a sediment sample for gas analysis.

Figure 6.8 Adding nitrogen to canned sediment sample.

6.5 Pore-water sampling

Owen Brown and Jenna Higgins

Pore-water samples were taken, on average, every 60 cm. The samplers consisted of rhizon ceramic heads connected to a syringe. To collect the pore-water, holes were punched into the liner, the rhizon ceramic heads were inserted into the sediment, and the syringes were drawn back and locked with a wooden dowel (Figure 6.9). After roughly 45 minutes, the heads were removed from the sediment and the holes were closed with tape. 2mL of pore-water (or less, depending on recovery) was transferred to $HgCl_2$-prepared vials (Figure 6.10) with any remaining pore-water being transferred to other vials. All pore-water samples were stored at 4ºC

Figure 6.9 Extracting pore water samples from sediment cores.

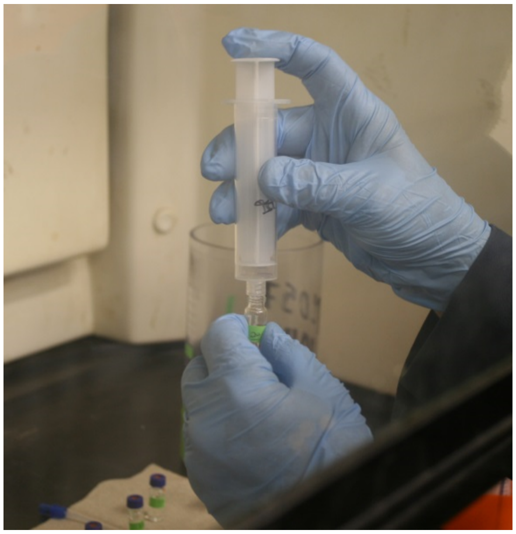


Figure 6.10 Transferring pore water to vials.

6.6 Navigation

Paul Fraser and Peter Pledge

Subsea positioning for the two seabed camera systems (4K-VladCam Bullet and Deep Imager) was achieved via USBL (Ultra Short BaseLine). Each of the camera sleds were equipped with a self-powered Applied Acoustics beacon which was turned on manually prior to individual dives. A new Trackpoint III USBL system was used to interrogate and track the subsea beacons. The deck unit for the USBL system was located in the GP lab at the stern of the vessel. A ram containing the transducer was lowered and raised manually before and after dives through the hull by the navigator. Once the camera sleds were in the water column heading down to the seabed the GSCA Master logger and GSCA USBL processing application were activated remotely to track and acquire the subsea beacon. Filters were set to try and eliminate as much erroneous positioning as possible.

The USBL positioning worked well for these drift stations as there were very little surface currents and therefore little need for vessel thrusting which results in acoustic blanking. As the two key camera drift stations were at 820 and 1730 metres, both fell well within the 45° detection cone of the ram transducer. Even at a depth of 1730 m the USBL data was quite good with the new Trackpoint III system.

6.7 Seafloor Photography

Peter Pledge and Angus Robertson

Two camera systems were used during the trip with mixed results.

The 4K camera sled (Peter Pledge and Bill MacKinnon, GSCA 2008) deployed from the winch room consisted of a small compact frame lowered on the hydrocast winch line. The key camera on the sled was a 10 Megapixel Canon Rebel SLR camera with wide angle lens firing from a bottom weight closure when reaching a distance of 1.5 m above the seabed. Two professional Canon flashes were set to sync with each touchdown. Bottom drops were timed so that stills could be taken every 30 – 60 seconds. The VladCam Bullet HD video camera (Robertson, GSCA 2009) was attached to the 4K sled wasself-powered and set to run autonomously for the entire length of a dive recording the seabed under continual lighting provided from a Deepsea Power and Light Matrix LED. The SLR, flashes and LED light were all powered from a 12 volt Deepsea Power and light battery. A 12 kHz pinger was attached and provided the audio closure once the camera sled reached the target height above the bed. A Raytheon 12 kHz sounder was used at the surface with a line scanner to monitor and record each touchdown. An applied acoustics beacon was attached to the sled on a small acetal bracket and activated to provide USBL positioning. Directions were given to the winch operators from two GSCA staff during the transect drift. (Figure 6.11).

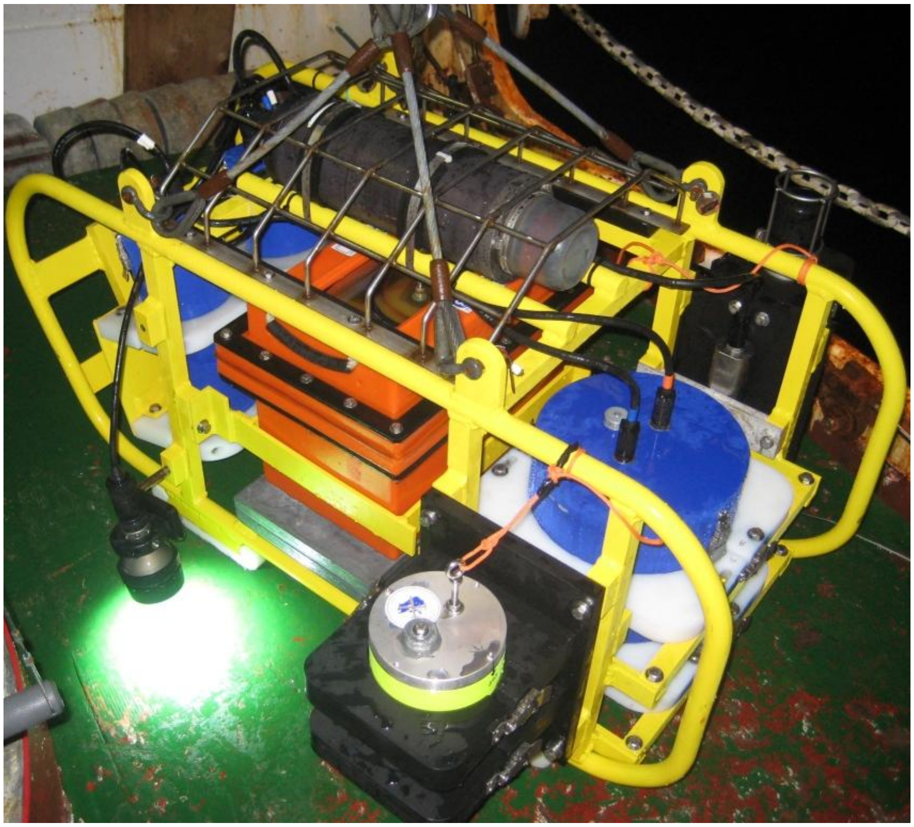


Figure 6.11 VladCam Bullet Combo

The DeepImager camera system (Peter Pledge and Bill MacKinnon, GSCA 2010) was deployed from the foredeck of the vessel using a dedicated DT Marine winch and the main coring crane. Two key GSCA technicians controlled the operations from the deck and the fore lab. The camera sled was lowered manually from the winch position on deck to near the seabed and then the lab operator would take over the operation using a remote joystick. During the recovery operations winch control would be passed back to the deck with all key steps being broadcast with deck radio boxes.

The system consisted of a Sony 520CX HD video camcorder residing in a robust underwater pressure case. Four Deepsea Power and Light Matrix LED lights were employed to provide seabed illumination. A high resolution Valeport pressure transducer was mounted low on the sled to give very accurate sled depth along with an Imagenix multibeam allowing seabed mapping. Another Imagenix (881 sector scanning) was mounted at the front of the sled to provide a forward scan of the seabed and often showed in fine detail the bedforms ahead. An Applied Acoustics beacon was strapped to the inner part of the sled and provided subsea positioning. A new tail fin was attached to the sled to reduce heading spin and improve attitude parameters that were logged with a motion reference unit. Data from all these components was sent by modem up the twisted pair cable to be displayed at the surface on the operations laptop. The subsea instruments and lights were powered by a Deepsea Power and Light 24 volt battery (Figure 6.12).

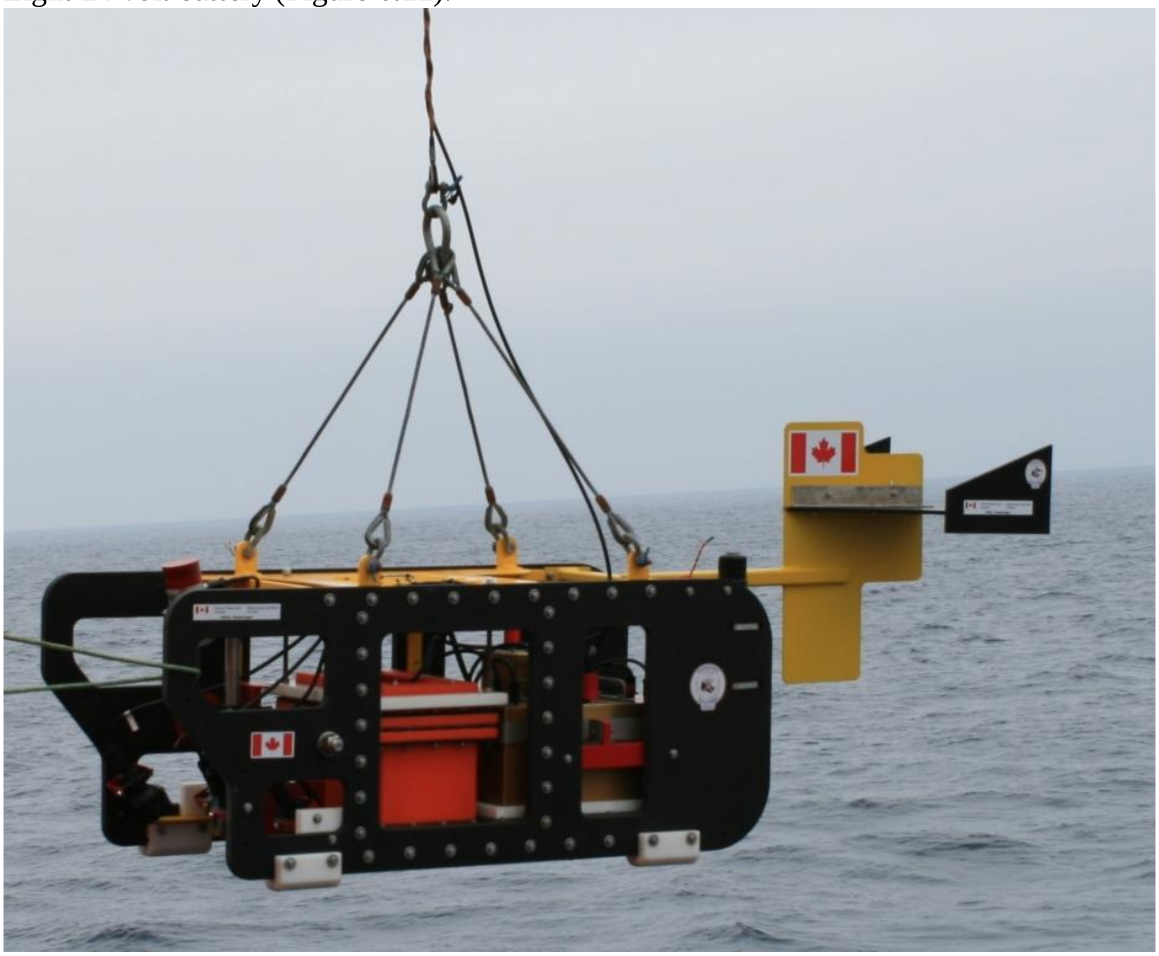


Figure 6.12 DeepImager

Unfortunately, the 4K camera and VladCam Bullet combination sled did not perform well at the one station (#001). Upon recovery it became evident that the bottom triggering system for the main still camera was jammed behind the acetal mounting bracket for the Applied Acoustics USBL beacon. A shackle connecting the bottom trip wire was locked from rotating which caused the actual trip wire to tangle and effectively jam. So, when the sled was near the seabed and within the still photo trigger distance no audible closure could be detected at the surface resulting in no seabed images being exposed. This was quickly rectified after the dive by removing the bracket from the sled and remounting on the opposite end of the camera frame away from the trip wire mechanism. The VladCam Bullet pressure case contained an older camcorder that had never been used in conjunction with this system before and it stopped recording just before the sled reached the seabed for an unknown reason (all the regular camcorders were in use on other projects or landers). In future this camcorder will not be used with this system as the more modern camcorders in the GSCA collection have never failed.

The DeepImager sled worked well on the two stations where it was deployed. Station #004 reached a depth of 822 m starting at lat: 48.174512ºN, lon: 46.807366ºW drifting SW with 119 bottom stills and 97 minutes of HD video. Station #033 reached a depth of 1730 m starting at lat: 45.890102ºN, lon: 47.022291ºW drifting NW with 124 bottom stills and 40 minutes of HD video. A third station (#044) was abandoned as the deck cable covering was damaged in the deployment block below the crane so the dive was scrubbed.

Several modifications were discussed throughout the mission for the DeepImager system that would facilitate easier and safer operations. The addition of an SLR and flashes would give higher resolution still photos through faster exposure times effectively freezing the bottom. Downloading the HD video was somewhat clumsy as the entire pressure case had to be removed each time along with 8 radial bolts and argon gas replenishment. This task could be simplified with a small memory card jumper pressure case that could be plugged externally into the main housing. The deck winch forward rollers should be modified as the cable jacket was torn during one recovery and the level wind could possibly be adjusted further so less manual input would be necessary. The deployment sheave should also be modified so that the side cheek gap tolerance is lessened to prevent cable jam and damage that occurred on this mission. A more powerful operations laptop would be useful in the control lab while flying the camera sled to allow quicker application boots and faster post dive transfer of data.

Curation and Data Processing:

All of the seabed imagery (both stills and HD video) as well as the applicable navigation were stored on two Fantom 1 Tb external Green drives. At the conclusion of the mission one of the drives was presented to the archive section of the GSCA while the other was given to the chief scientist. The data was transferred from the processing laptop via eSATA cables due to the large file sizes. Each station folder for the camera sled included raw imagery, processed imagery and navigation subfolders.

There were numerous steps involved in processing the imagery involving GSCA applications and licensed software products. First, the cameras would be downloaded and the raw stills, HD video and navigation data would be saved to disk. A processed folder would be created for the stills and all non-seabed images would be removed, i.e. deck shots or water column. These stills would then have position and in some cases depth metadata injected.

The raw HD video was viewed in DVMP Pro software allowing the actual seabed touchdown/liftoff running times to be viewed and the elapsed times to be noted. The same raw video was then edited in Sony PMB software and the noted elapsed times were used as the lead in/lead out points for trimming. This then became the processed video M2ts file. DVMP Pro was used to extract the timestamp information from this file as a subtitle file which was set aside for further manipulation in a subsequent step.
The trimmed video file saved from the PMB software was then imported into EMICSoft conversion software so a compressed video file (AVI) could be created from the much larger M2ts files. This was quite taxing on the laptop computer and usually took approximately one to two hours per station.

The initial subtitle folder which only included date and time was modified using a navigation injector application by merging the DeepImager logfile in order to extract heading, positioning and sled depth.

This final subtitle file was then combined in the processed folder with the AVI so that this vital information could be portrayed while reviewing the video.

Both seafloor imagery curation and processing were carried out during any slow periods during the day or during the evenings. These tasks could be made more efficient in future with a dedicated powerful multi-core processor laptop with USB-3 or Thunderbolt ports and a dedicated watch schedule timeslot for processing.

6.8 Freefall Deep Lander

Angus Robertson

A free fall instrumented lander was designed and constructed at BIO by Angus Robertson, Todd Peters and Peter Pledge during late July, 2011. The lander was deployed over the Sackville Spur location in order to record in situ current and sediment transport measurements.

The lander was designed to freefall to the seabed but it was decided to lower it close to the bed and activate an acoustic release mechanism to drop it the last 15 m in order to improve site positioning accuracy. Unfortunately, this operation failed because the release unit had not been properly armed at the surface. So, the end result was that the lander broke free from the lowering wire at about 880 m water depth during spooling in of the main Pingo winch and freefell at 1.45m/s to the seabed resting at a depth of 1199m at 1430 UTC on August 9th (Lat: 48.431792° N, Lon: 046°.238048 W).

The lander frame was constructed out of both square and round section aluminum tubing with high density polyethylene instrument mounts. Four Benthos Glass floatation spheres encased in protective plastic hardhats were securely mounted at the top of the frame to provide the recovery buoyancy once the deployment was completed. A 560 lb steel train wheel provided the ballast to pull the frame to the seabed and keep the proper orientation (Figure 6.13).

Figure 6.13 Freefall deep lander.

Recovery was attempted early in the morning on August 21st with some difficulty activating the acoustic release. Several attempts were made without positive feedback from the Benthos 866 release. Finally, a faint confirmation was heard at 1034 UTC and about 20 minutes later just before 1100 UTC the Iridium locator beacon sent a positive email with positioning that the lander was at the surface. The position was given to the bridge and the Hudson maneuvered nearby to begin grappling for recovery. This proved to be futile so the FRC was launched in order to attach a lift strap by hand. The frame was then safely recovered to the foredeck.

The main instrument on the lander was a 2 MHz Nortek AquaDopp acoustic Doppler current profiler that was mounted 162 cm above the bed facing downward. The instrument was programmed with a 10 cm blanking zone and measured 3-dimensional flow in 17 10 cm cells continuously at 1 Hz. Temperature, attitude and pressure were also recorded over this period. An external optical backscatter sensor was logged by the AquaDopp and it was mounted at a height of 123 cm above the bed to measure turbidity.

The other key instrument on the lander was a high definition camcorder illuminated by a DeepSea Power and Light LED light. The camera was mounted 145 cm above the seabed pointed at 70° downward. The camera was programmed to take a still photo followed by 10 secs of video every 30 minutes.

The AquaDopp ran for the entire deployment period as programmed and could possibly have carried on for a couple of more days before depleting the battery. After a brief look at the data there appears to be no high energy events but there is current direction change in the order of 90°.

Unfortunately, the camera system did not work entirely as programmed. The seabed was captured on video including the actual freefall touchdown on August 9th at 1430 UTC. The bed appeared to be grey mud and a turbid cloud was raised when the iron ballast train wheel impacted the bed. The camera logged bursts until the 13th intermittently and then did not record anymore bursts until back on deck on the 21st. The main battery pack was tested upon recovery and proved to be depleted but as it was expected to be able to run for 40 – 60 days was not suspected as being the fault. Testing will be done back in the GSCA laboratories in a cold reefer environment at 4°C in order to replicate the deployment to discover what drained the battery prematurely. Ocean pressure will not be applied during this lab test so hopefully the temperature alone will bring clarity to the fault.

The seabed lander station sheets were done by the senior lander technician and included instrument heights and detailed sampling strategies. The deployment and recovery sheets were modified post recovery to reflect more accurate bottom touchdown times, depths and positions as well as updated liftoff parameters extracted from the various lander sensors.

6.9 Acoustic Systems

Des Manning

The seismic portion of the cruise was conducted through the evening and night from 1800 through 0600 except where project requirements demanded data collection outside that window.

Three systems were employed for the collection of all seismic data.

1. Single channel seismic system consisting of a pneumatic sound source and hydrophone streamer.
2. Huntec DTS (sparker)
3. Two channel Knudsen 3260 (12 KHz ram-mounted transducer and 3.5 KHz hull-mounted transducer array).

6.9.1 Single Channel Seismic System

Seismic Sources:

One Sercel 210 cubic inch GI gun (Generator – Injector) suspended from an I-beam. A large (A6) Norwegian buoy was used for primary floatation with a small secondary buoy used to keep deployment and recovery line away from the gun during the survey. The GI gun was towed approximately 30 meters behind the stern at a depth of 1.5 to 2 meters. The tow umbilical was attached to a portside outrigger (Ironing board) to insure separation of all equipment being towed during turns.

Figure 6.14 below illustrates the floatation and towing arrangement.

The MITS was used to supply the master trigger to the Long Shot Seismic Source Controller and the Four Shot Seismic Source Power Supply unit. Initial parameters used in the setup of the GI Gun were entered into the control software of the Long Shot/Four Shot system. A blast phone mounted to the GI Gun was the primary sensor used in monitoring performance. The Long Shot firing control tunes the Generator and Injector over several shots. The MITS also supplied the trigger for the HUNTEC DTS ensuring shot and signal separation between the two seismic sources.

The towing arrangement for the GI Gun, single channel streamer, the Huntec Deep Tow, and the sidescan sonar can be seen in Figure 6.15.

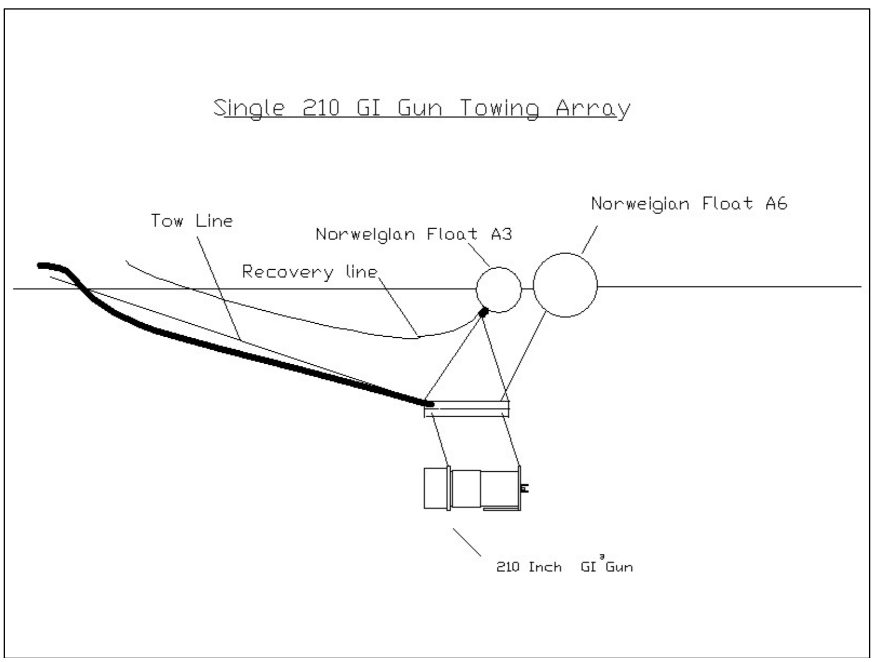


Figure 6.14 Flotation and towing arrangement for airguns

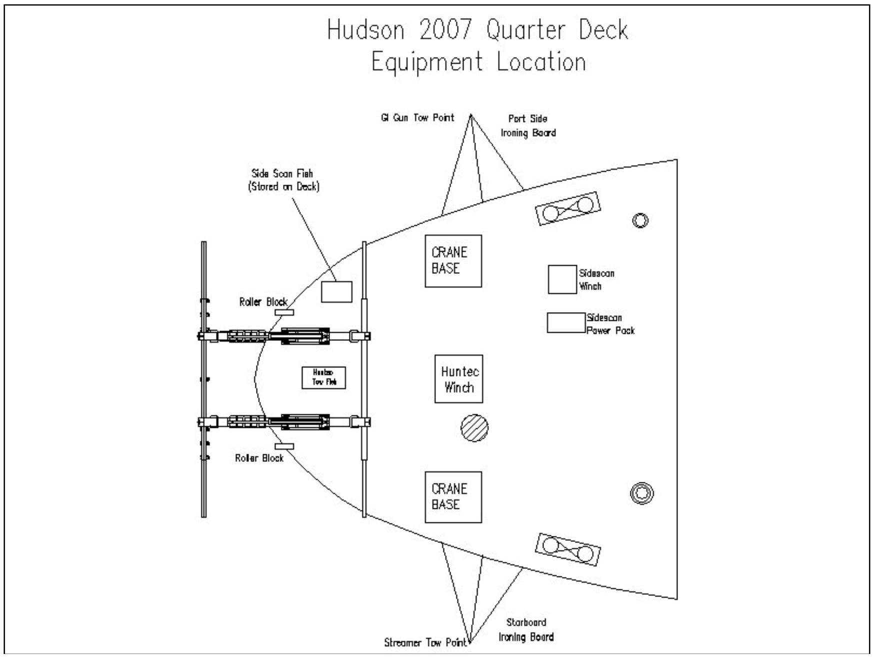


Figure 6.15 Quarter deck configuration for geophysical systems.

A Price W2 Air Gun Master capable of supplying air at 200 SCFM and 2000 psi was employed to fire the GI gun at 1700-1750 psi every six seconds. The compressor was driven by a 200 HP AC motor which was, in turn, controlled by a Cutler Hammer SV9000 Variable Frequency Controller located in the workshop container.

The air umbilical to the gun was contained and deployed using a winch located on the port side of the ship. A small M7 Pullmaster tugger winch was used to take up the strain during deployment and recovery of the GI gun and umbilical. The electrical and air lines were taped to the tow cable as it went over the side to its' final towing position.

The steamer was deployed from a winch located on the starboard flight deck and towed from the outrigger located on the starboard rail of the quarterdeck. The 25 HP pumping unit could supply hydraulic power to only one winch at a time. Hydraulic ball valves were employed to direct flow to one system or the other.

The flight deck arrangement is illustrated in Figure 6.16.

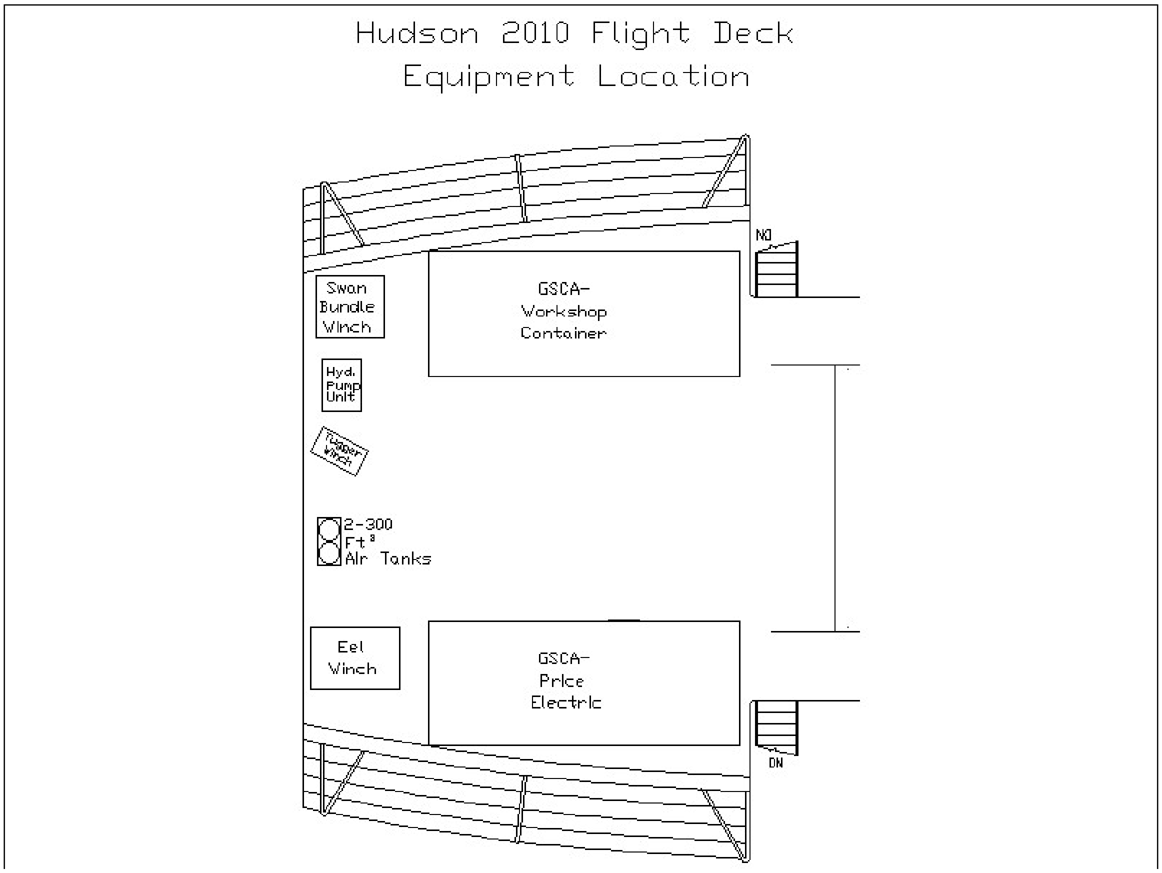


Figure 6.16 Flight deck configuration for geophysical systems.

Hydrophone Streamer:

The streamer was deployed from a winch on the flight deck and towed from an outrigger (Ironing board) mounted to the starboard side of the ship. The streamer was refitted in 2007 by Swain Geophysical in Texas. During the refit the streamer was outfitted with two coils allowing for the use of DigiBirds. The Streamer has a 27ft dead section at the head and a 16ft dead section at the tail. The active section is approximately 150ft long containing 48 Teledyne B-1 acceleration canceling hydrophone cartridges. As in previous years the streamer was towed approximately 100 metres behind the ship at a depth of 1 to 3 meters. A small drogue provided some drag for stability but its use was discontinued due to excessive drag and strain on the streamer.

The 48 hydrophones make up 6 groups of 8 elements each. These 6 groups are summed together, amplified and the sent to the GSCDIGS for digitizing and storage. The signal is also sent to a Krohn-Hite filter and then to an EPC 9801 Thermal Recorder for a hardcopy. The filtered of processed was also logged on the digitizer.

Streamer tow depth was controlled using a combination of drag, ship log speed, and primarily, two DigiBirds programmed through a modem using the DigiCourse software. The streamer worked well with two DigiBirds. Depth settings and fin angles were changed according to tow and sea conditions.
.

Data Acquisition, Display, Storage and Processing:

Filters- Krohn-Hite Model 3323 Filter
Settings- High Pass 20db 80Hz
Low Pass 0db 1.5KHz

Applies filtered Acoustic signal to the EPC Model 9801 Thermal Hardcopy

EPC- Model 9801 Thermal Hardcopy
Settings 1 to 2 Second Sweep

GSC Digs- <u>GDAIMS Ver 1.4 18</u>

<u>GI Guns</u>

Firing rate: 6.0 sec
Sample rate: 250uS for a 2 second window.

The schematic shown in Figure 6.17 illustrates equipment setup data acquisition using the GI Gun.

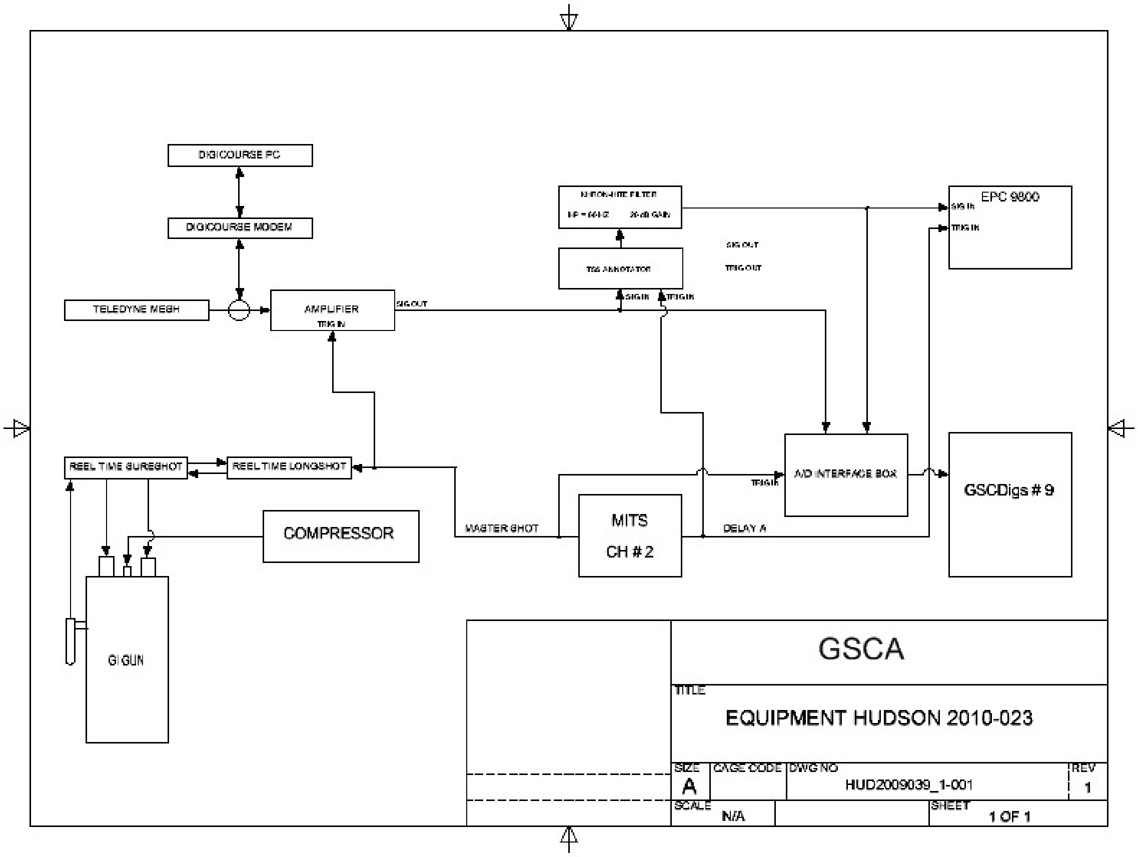


Figure 6.17 Equipment setup for geophysical data acquisition.

GSC Portable Digitizer

While the GSC Digs was the primary data logging system on the trip this new system was logging data concurrently. The trigger and analogue signal are input to a small A/D interface and logged on a laptop computer.

The new system has the advantage of being able to interface directly with the EPC through the parallel port. Annotation of the record is achieved without the aging and increasingly unreliable TSS annotators. Gain and filters can be made digitally and only affect the printed record. The raw data is left intact. The system has the further advantage of taking the space required only for a laptop and the A/D converter.

Suggestions on improvement to address our specific preferences have been made and it is expected the old GSC Digs will be phased out over the next couple of years.

Performance Issues - Single Channel Seismic

On the evening of the ninth the Longshot firing controller froze up. When the unit was opened it was found that the hard drive was overheating. The hard drive was replaced with a flash drive. The following evening the unit would not boot from the flash drive and the old hard drive was put back in place. The cover was removed and the system rebooted. The added cooling allowed by leaving the unit open to the ambient air improved the performance. It was later discovered that the higher internal temperature aggravated marginal cable connections. These connectors were replaced with gold connectors following the project.

It should be noted that no spare firing controller was available at the time of this cruise. Since that time two more LongShot/FourShot systems have come to GSCA.

The Hammond speed controller will automatically shut down the 200 HP electric motor which drives the Price compressor if certain conditions arise. A flow sensor detects the movement of cooling water. If the supply of cooling water is interrupted a shutdown condition occurs. The temperature between stages is also monitored and in the event of overheating a shutdown condition will be generated.

An intermittently faulty temperature sensor resulted in a shutdown but this cause was not, at first, apparent. It was not until two subsequent shutdowns on August 14th that the faulty sensor was discovered. The sensor was taken out of the system and the interstage temperature was monitored manually using an infrared temperature sensor.

A second temperature sensor for the cooling water and problems with the Doppler flow monitor resulted in a shutdown and fifty minutes of downtime on the 16th of August. The temperature sensor was removed from the system and replaced the following day. The Doppler sensor was reprogrammed and no further issue occurred with it.

On August 13th the blast phone that monitors the firing of the GI Gun failed. This signal is used by the LongShot system to tune the array and monitor the performance of the gun. The system was already tuned at the time of the failure and it was decided that the data would be checked through the evening. If problems became apparent the gun would be brought in and the phone replaced.

The Chief Scientist found the data to be fine and the blast phone was replaced before deployment the following evening.

The Digicourse Bird Modem used in controlling and monitoring the 5010 Digibirds failed on the evening of August 16th. It was found that a board mounted battery had leaked resulting in a small fire. No spare was available and attempts to repair the board were unsuccessful.

The last commands the birds had been sent would have the birds maintain two meters depth. In the absence of new commands the last command state will be maintained as long as battery power lasts. The Lithium chemical batteries in the birds lasted for the remainder of the cruise.

A new Positioning Control System has since been purchased from ION who had acquired Digicourse since we had last purchased a system. The board from the old modem has successfully been repaired.

6.9.2 Huntec Deep Tow System

The Huntec DTS S was used in sparker mode for the duration of this cruise. Internal and external raw data was logged to a GSC Digitizer and the filtered signals were printed to the EPC on channels A and B respectively. Filter settings of 1.2 KHz and 10 KHz were used. On the last night of the project the firing became intermittent. It was assumed that the sparker tips needed trimming and with only a few hours remaining in the program the system was brought aboard. The problem was later discovered to be an intermittent break in the firing line of the tow cable.

6.9.3 Knudsen 3260 Echo-Sounder

During much of the program a ram mounted 12 kHz transducer, transceiver and recorder were used to track bottom and gather some sub-bottom data when sampling. During transit, or when the Huntec DTS was unavailable during survey, the 3.5 kHz hull mounted transducer was employed. No problems were encountered with this system for the duration of the cruise.

6.9.4Timing

The triggers for the Huntec DTS, the GI gun, and the data recorders were handled by the GSCA-MITS trigger unit which is accurate to 1 millisecond. Timing changes and applied delays kept the individual systems from interfering with each other. Delays applied to the EPC recorders allow for shifting the print window to minimize the water column. The master timing for the 4 Channel TSS 312B record annotator originates from the ships clock system and gets its delay timing for the EPC recorders from the appropriate GSCA-MITS channel.

The GSCA-MITS supplied the timing for the Huntec EPC recorder (Chan 1B) through a TSS 312B record annotator channel, and the air gun EPC (Chan 2A) recorder through a TSS 312B record annotator channel.

The GSCA-MITS (Chan 2) supplied the trigger for the LongShot seismic source controller andthe Four Shot seismic source power supply units which generate the generator and injector fire pulses for the GI Gun and the GSC Digs.

<u>Sercel 210 GI Gun</u>

The GSCA-MITS (Chan 2) time interval for the GI Guns was approximately 6 seconds except where a longer interval was required to minimize interference with the Huntec DTS. The air volume was set to 105 cu. in. The injector timing for the gun was 55 ms with an 80 ms bubble. The LongShot Seismic source controller was used to set the above parameters. The Long Shot and the Four Shot seismic source power supply units worked well during the survey period except in a couple of instances where the system was freezing or rebooting. A power supply was swapped out to correct the problem.

Huntec DTS

The GSCA-MITS (Chan 1A) timing for the Huntec DTS was supplied by the GSCA-MITS. To keep the Huntec from interfering with the air gun data, the time interval and corresponding EPC delay (Chan 1B), was adjusted as needed. The GSCA-MITS (Chan 1A) also provides the trigger for the GSC DIGS data handling system.

7.0 Appendices

7.1 Lines

2011031 LINES									
Line	Start	End	Seismic GI Gun			Seismic Huntec			Kndsen 3.5 kHz & 12 KHz
			Rec.#	GSC DIGS DVD #	Portable DIGS DVD#	Rec.#	GSC DIGS DVD #	Portable DIGS DVD#	DVD #
1	221/2052	221/2245	1	1	1	1	1	1	1
2	221/2245	221/2313	1	1	1	1,2	1	1	1
3	221/2313	222/0314	1	1	1	2	1	1	1
4	222/0316	222/0543	1	1	1	2	1	2	1
5	222/0557	222/0726	1	1	1	2	1	2	1
6	222/0726	222/0806	1	1	1	2	1	2	1
7	222/0806	222/0911	1	1	1	2	1	2	1
8	222/2130	223/0119	1	1	1	3	2	2	1
9	223/0119	223/0444	1	1	1	3	2	3	1
10	223/0447	223/0512	1	1	1	3	2	3	1
11	223/0512	223/0900	1	1	1	3	2	3	1
12	223/2130	223/2245	2	1	1	4	3	3	1
13	223/2245	223/2324	2	1	1	4	3	3	1
14	223/2324	223/2331	2	1	1	4	3	3	1
15	223/2336	224/0059	2	1	1	4	3	3	1
16	224/0105	224/0142	2	1	1	4	3	4	1
17	224/0150	224/0256	2	1	1	4	3	4	1
18	224/0301	224/0452	2	1	1	4	3	4	1
19	224/0457	224/0502	2	1	1	4	3	4	1
20	224/0507	224/0750	2	1	1	4	3	4	1
21	224/0751	224/0930	2	1	1	4	3	4	1
22	224/2207	225/0432	3	1	1	5	3	4	1
23	225/0440	225/0526	3	1	1	5	3	5	1
24	225/0530	225/0712	3	1	1	5	3	5	1
25	225/0720	225/0740	3	1	1	5	3	5	1
26	225/0747	225/0930	3	1	1	5	3	5	1
27	225/2130	225/2305	4	1	1	6	4	5	1
28	225/2310	226/0049	4	1	1	6	4	5	1
29	226/0049	226/0401	4	1	1	6	4	6	1
30	226/0411	226/0602	4	1	1	6	4	6	1
31	226/0611	226/0928	4	1	1	6	4	6	1
32	226/2039	226/2212	5	1	1	7	4	6	2
33	226/2218	226/2306	5	1	1	7	4	6	2
34	226/2313	227/0201	5	1	1	7	4	6	2
35	227/0205	227/0505	5	1	1	7	4	7	2
36	227/0511	227/0745	5	1	1	7	4	7	2
37	227/0749	227/0900	5	1	1	7	4	7	2
38	227/2016	227/2333	6	1	1	8	5	7	2
39	227/2336	228/0514	6	1	1	8	5	7	2
40	228/0750	228/0833	6	1	1	8	5	8	2

41	228/0839	228/0906	6	1	1	8	5	8	2
42	228/0906	228/0930	6	1	1	8	5	8	2
43	228/2151	229/0225	7	1	1	9	6	8	2
44	229/0225	229/0450	7	1	1	9	6	9	2
45	229/0459	229/0911	7	1	1	9	6	9	2
46	229/2043	229/2247	8	1	1	10	7	9	2
47	229/2248	230/0803	8	1	1	10,11	7	10	2
48	230/0807	230/0900	8	1	1	11	7	10	2
49	230/2115	230/2329	9	1	1	12	8	10	2
50	230/2334	231/0408	9	1	1	12	8	10	2
51	231/0414	231/0748	9	1	1	12	8	11	2
52	231/0757	231/0911	9	1	1	12	8	11	2
53	231/2206	232/0008	10	2	1	13	9	11	2
54	232/0008	232/0136	10	2	1	13	9	11	3
55	232/0138	232/0320	10	2	1	13	9	11	3
56	232/0325	232/0532	10	2	1	13	9	11	3
57	232/0545	232/0619	10	2	1	13	9	11	3
58	232/0622	232/0930	10	2	1	13	9	11	3
59	233/2140	234/0243	11	2	1	14	9	12	3
60	234/0248	234/0451	11	2	1	14	9	12	3
61	234/0453	234/0728	11	2	1	14	9	12	3
62	234/0737	234/0931	11	2	1	14	9	12	3
63	234/2019	235/0055	12	2	1	15	10	12	3
64	235/0056	235/0900	12	2	1	15	10	12	3

7.2 Records and DVDs

SEISMIC GI GUN				
Record #	**Start Time**	**End Time**	**Line #**	**Notes**
	221/2355	222/0910		
1	222/2146	223/0850	1 - 11	
2	223/2100	224/0845	12 - 21	
3	224/2215	225/0920	22 - 26	
4	225/2127	226/0922	27 - 31	
	226/2056	227/0030		
5	227/0040	227/0850	32 - 37	
6	227/2018	228/0920	38 - 42	
	228/2205	228/2350		
7	229/0040	229/0910	43 - 45	
8	229/2040	230/0900	46 - 48	
9	230/2110	231/0910	49 - 52	
10	231/2200	232/0930	53 - 58	
11	233/2130	234/0930	59 - 62	
12	234/2015	235/0900	63 - 64	

SEISMIC HUNTEC RECORDS				
Record #	**Start Time**	**End Time**	**Line #**	**Notes**
1	221/2050	221/2300	1,2	
2	221/2300	222/0910	2 - 7	
3	222/2122	223/0901	8 - 11	
4	223/2015	224/0900	12 - 21	
5	224/2150	225/0927	22 - 26	
6	225/2113	226/0927	27 - 31	
7	226/2020	227/0900	32 - 37	
8	227/2019	228/0930	38 - 42	
9	228/2128	229/0915	43 - 45	
10	229/2035	230/0052	46 - 47	
11	230/0053	230/0900	47 - 48	
12	230/2100	231/0900	49 - 52	
13	231/2205	232/0930	53 - 58	
14	233/2120	234/0930	59 - 62	
15	234/2010	235/0430	63 - 64	

SEISMIC HUNTEC DVD's - GSCDigs				
DVD #	**Start Time**	**End Time**	**Line #**	**Notes**
1	221/2035	222/0910	1 - 7	
2	222/2117	223/0900	8 - 11	
3	223/2014	225/0929	12 - 26	
4	225/2111	227/0900	27 - 37	
5	227/2014	228/0930	38 - 42	
6	228/2130	229/0912	43 - 45	
7	229/2024	230/0900	46 - 48	
8	230/2057	231/0910	49 - 52	
9	231/2145	234/0930	53 - 62	
10	234/2002	235/0434	63 - 64	

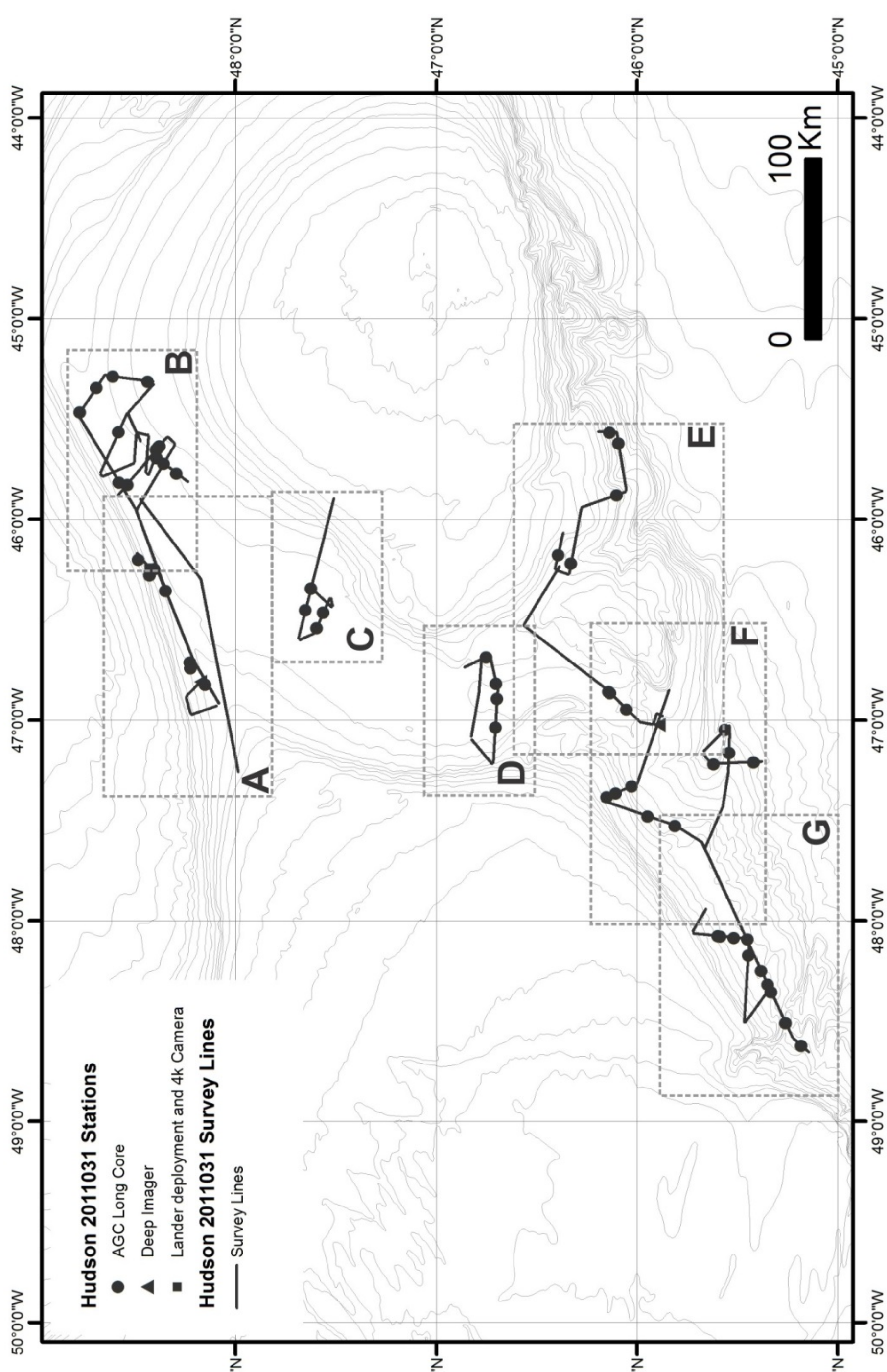
SEISMIC GI AIRGUN DVD's - GSCDigs				
DVD #	**Start Time**	**End Time**	**Line #**	**Notes**
1	221/2349	231/0910	1 - 52	
2	231/2201	235/0900	53 -64	

SEISMIC GI AIRGUN DVD's - GSC Portable DIGS				
DVD #	Start Time	End Time	Line #	Notes
1	221/2000	235/0900	1 - 64	

SEISMIC HUNTEC DVD's - GSC Portable DIGS				
DVD #	Start Time	End Time	Line #	Notes
1	221/2036	222/0316	1 - 3	
2	222/0316	223/0118	4 - 8	
3	223/0118	224/0059	9 - 15	
4	224/0059	225/0435	16 - 22	
5	225/0435	226/0051	23 - 28	
6	226/0051	227/0202	29 - 34	
7	227/0202	228/0514	35 - 39	
8	228/0514	229/0225	40 - 43	
9	229/0225	229/2247	44 - 46	
10	229/2247	231/0408	47 - 50	
11	231/0408	232/0930	51 - 58	
12	233/2000	235/0057	59 - 64	

Knudsen 3.5 kHz and 12 kHz DVD's				
DVD #	Start Time	End Time	Line #	Notes
1	220/1128	226/1204	1 - 31	
2	226/1204	232/0008	32 - 53	
3	232/0800	235/0900	54 - 64	

7.3 Maps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AGC Long Core
Deep Imager
Lander deployment and 4k Camera
Hudson 2011031 Survey Lines
Survey Lines
A
B
C
D
E
F
G
0
100
Km
44°0'0"W
45°0'0"W
46°0'0"W
47°0'0"W
48°0'0"W
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50°0'0"W
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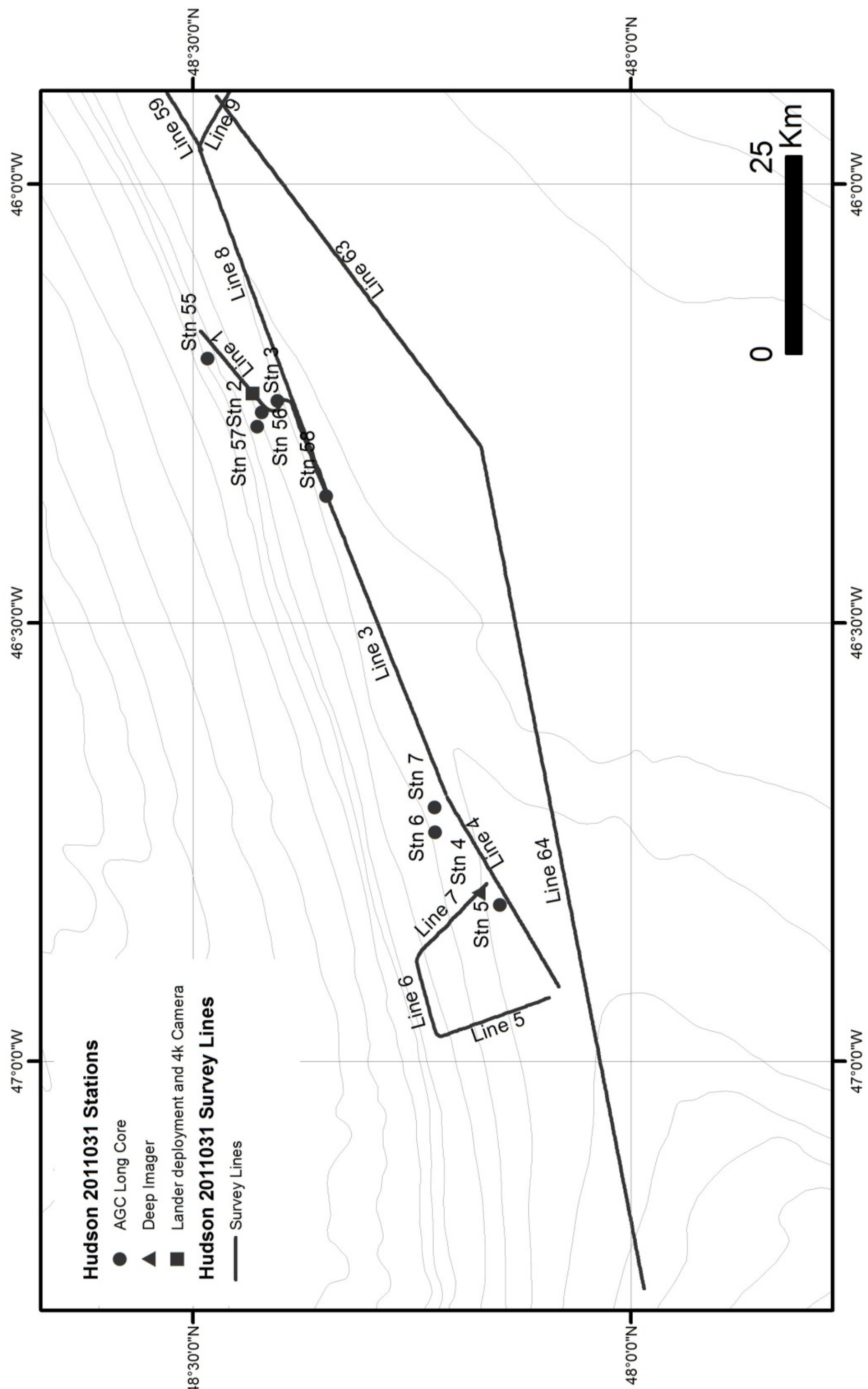
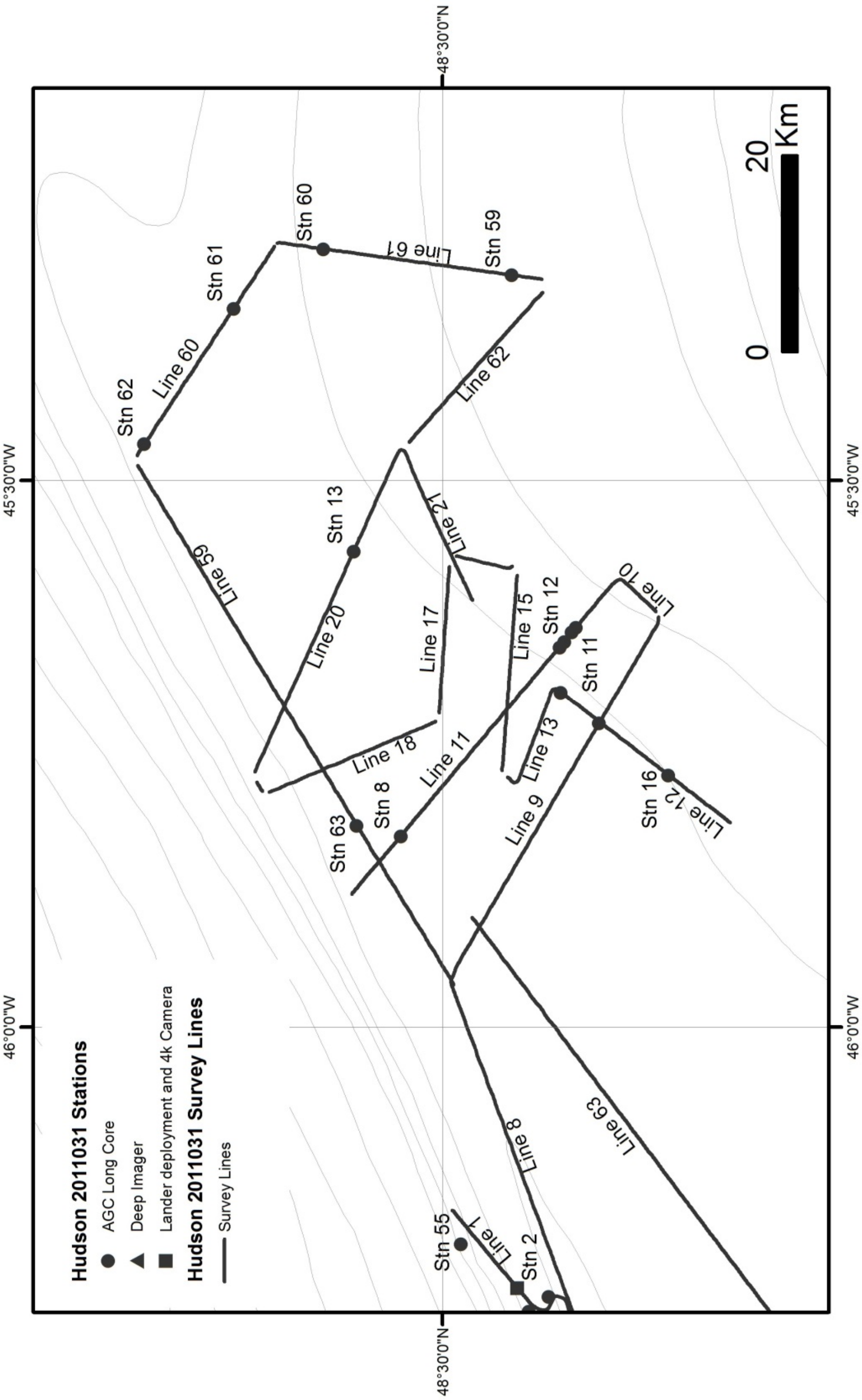
45°0'0"N



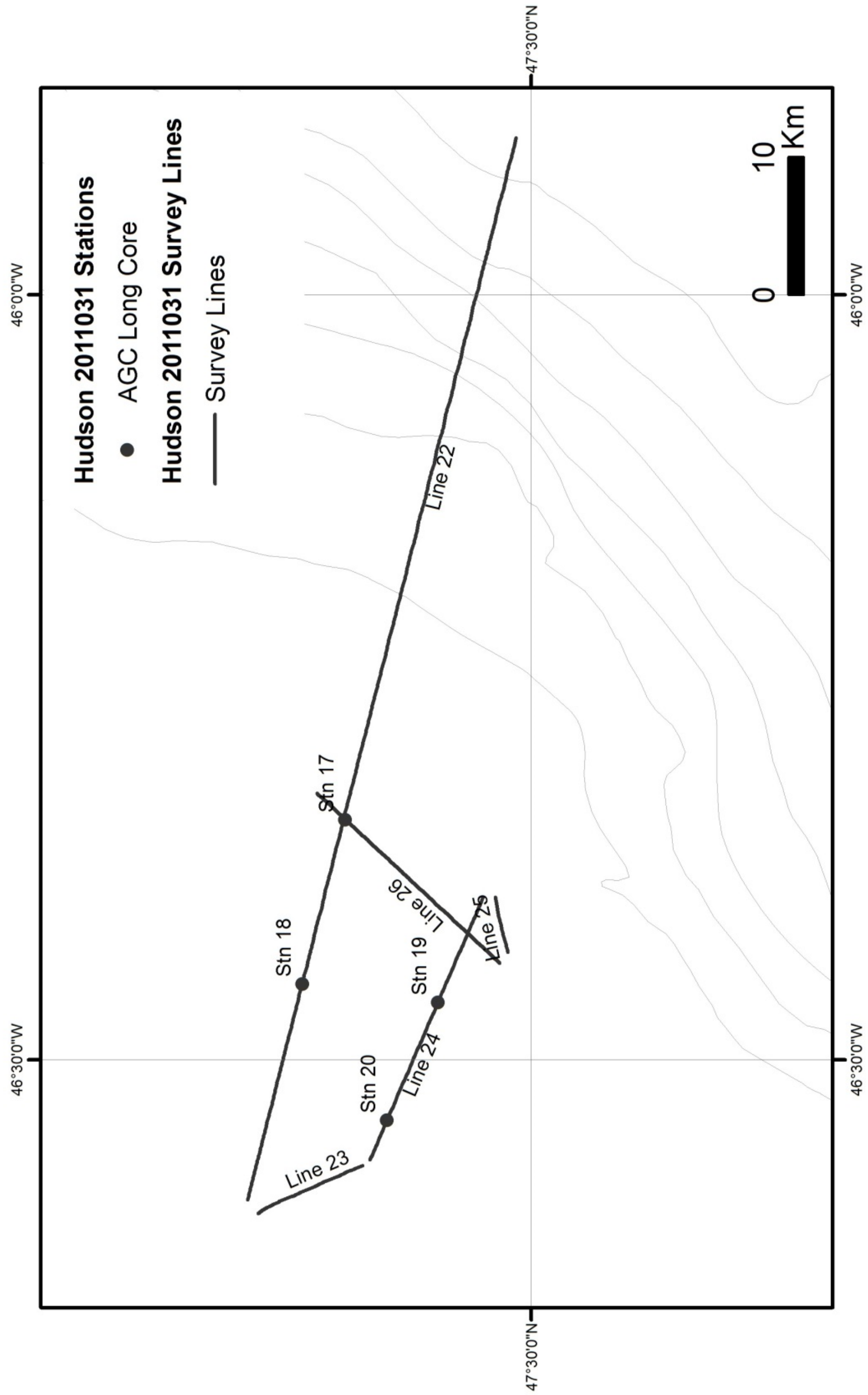
Hudson 2011031 Stations
AGC Long Core
Deep Imager
Lander deployment and 4k Camera
Hudson 2011031 Survey Lines
Survey Lines
48°30'0"N
48°0'0"N
46°0'0"W
46°30'0"W
47°0'0"W
0
25
Km
Line 59
Line 9
Line 8
Line 63
Line 1
Line 3
Line 4
Line 5
Line 6
Line 7
Line 64
Stn 55
Stn 2
Stn 3
Stn 56
Stn 57
Stn 58
Stn 4
Stn 5
Stn 6
Stn 7

Inset A

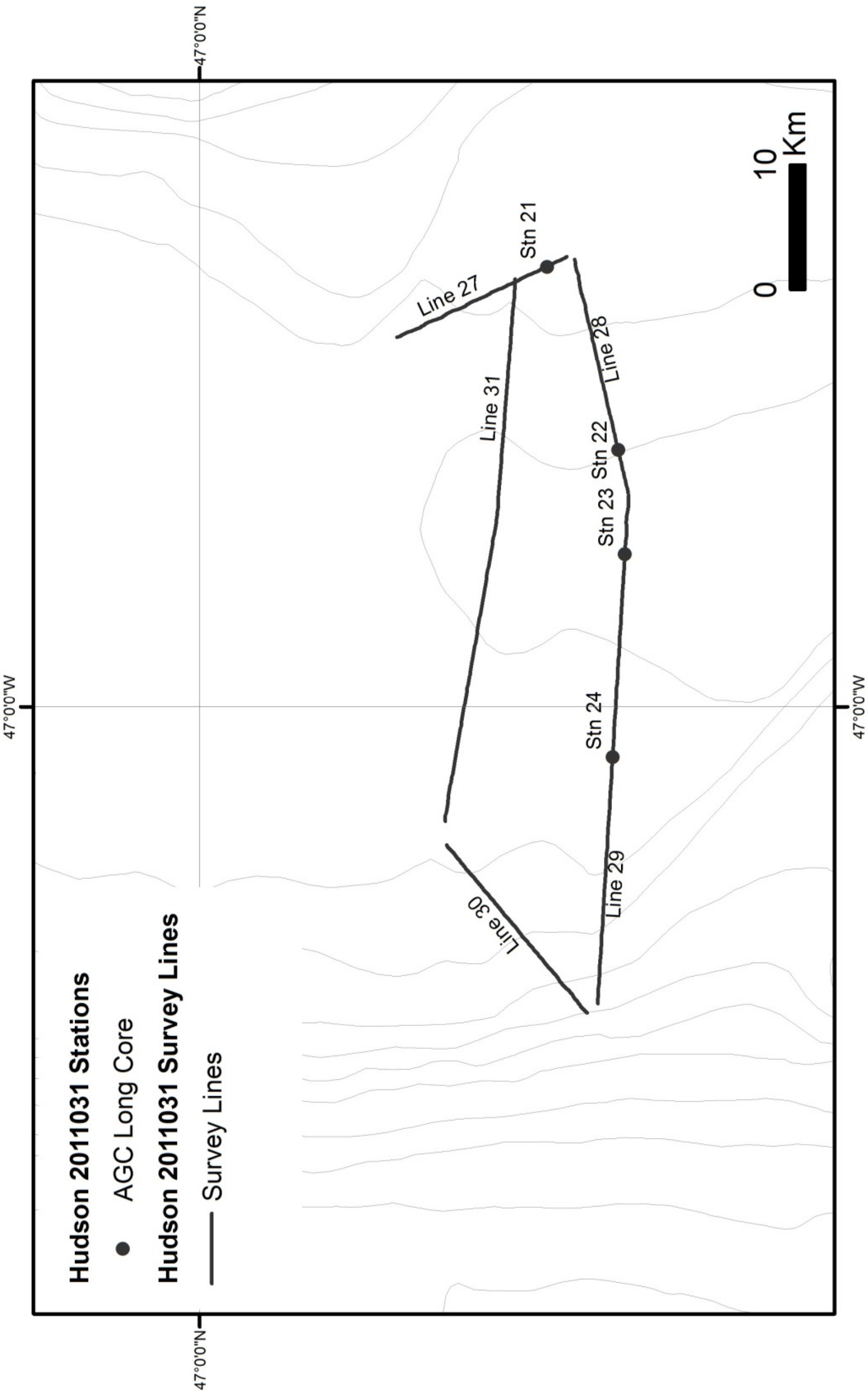


Hudson 2011031 Stations
AGC Long Core
Deep Imager
Lander deployment and 4k Camera
Hudson 2011031 Survey Lines
Survey Lines
48°30'0"N
45°30'0"W
46°0'0"W
0
20
Km
Stn 59
Stn 60
Stn 61
Stn 62
Stn 13
Stn 12
Stn 11
Stn 16
Stn 8
Stn 63
Stn 55
Stn 2
Line 61
Line 60
Line 62
Line 59
Line 21
Line 20
Line 17
Line 15
Line 10
Line 18
Line 11
Line 13
Line 12
Line 9
Line 8
Line 63
Line 1

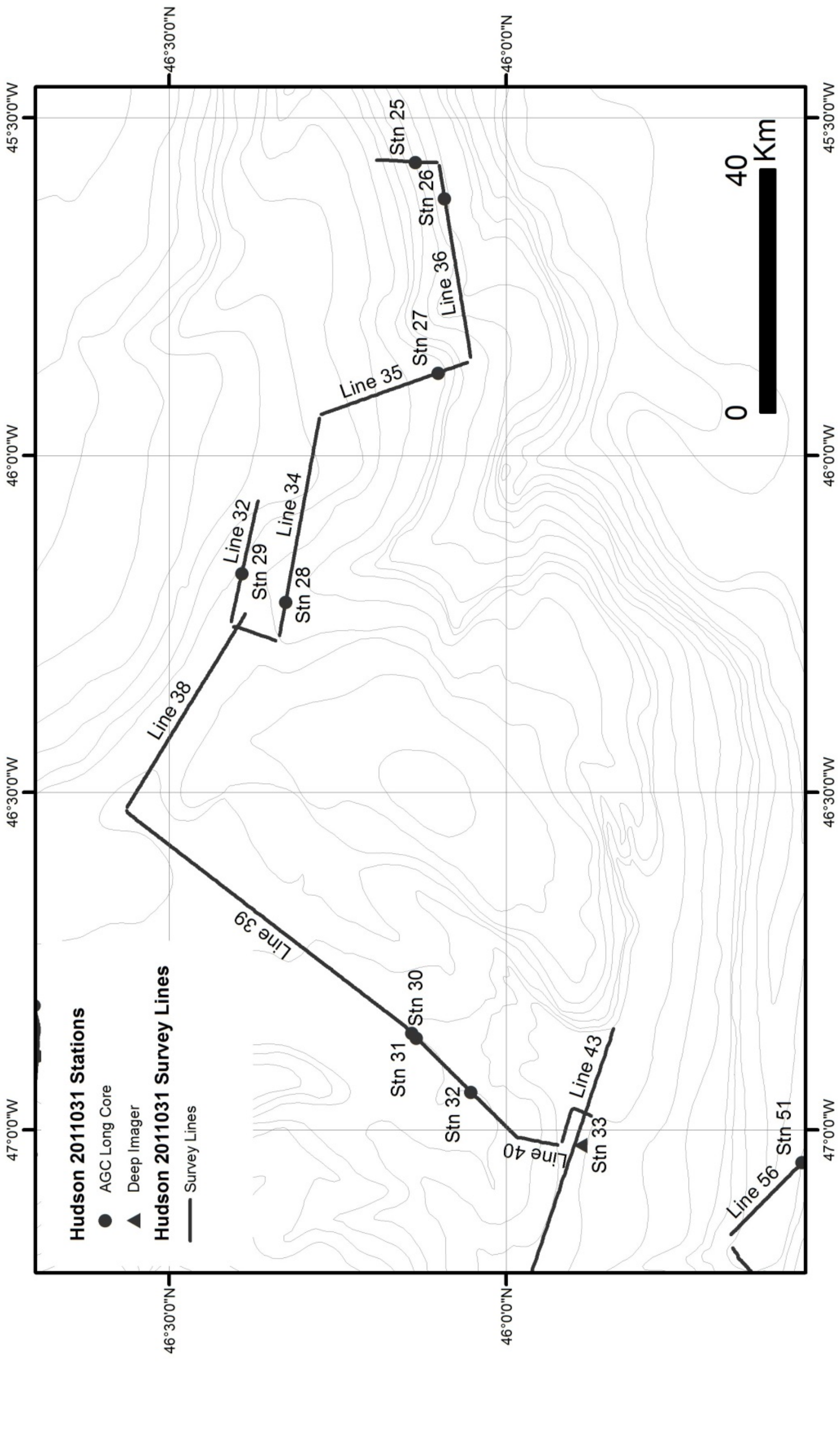
Inset B


Hudson 2011031 Stations
AGC Long Core
Hudson 2011031 Survey Lines
Survey Lines
0
10
Km
47°30'0"N
46°0'0"W
46°30'0"W
Line 22
Line 23
Line 24
Line 25
Line 26
Stn 17
Stn 18
Stn 19
Stn 20

Inset C


Hudson 2011031 Stations
AGC Long Core
Hudson 2011031 Survey Lines
Survey Lines
Line 27
Line 28
Line 29
Line 30
Line 31
Stn 21
Stn 22
Stn 23
Stn 24
0
10
Km
47°0'0"W
47°0'0"W
47°0'0"N
47°0'0"N

Inset D


Hudson 2011031 Stations
AGC Long Core
Deep Imager
Hudson 2011031 Survey Lines
Survey Lines
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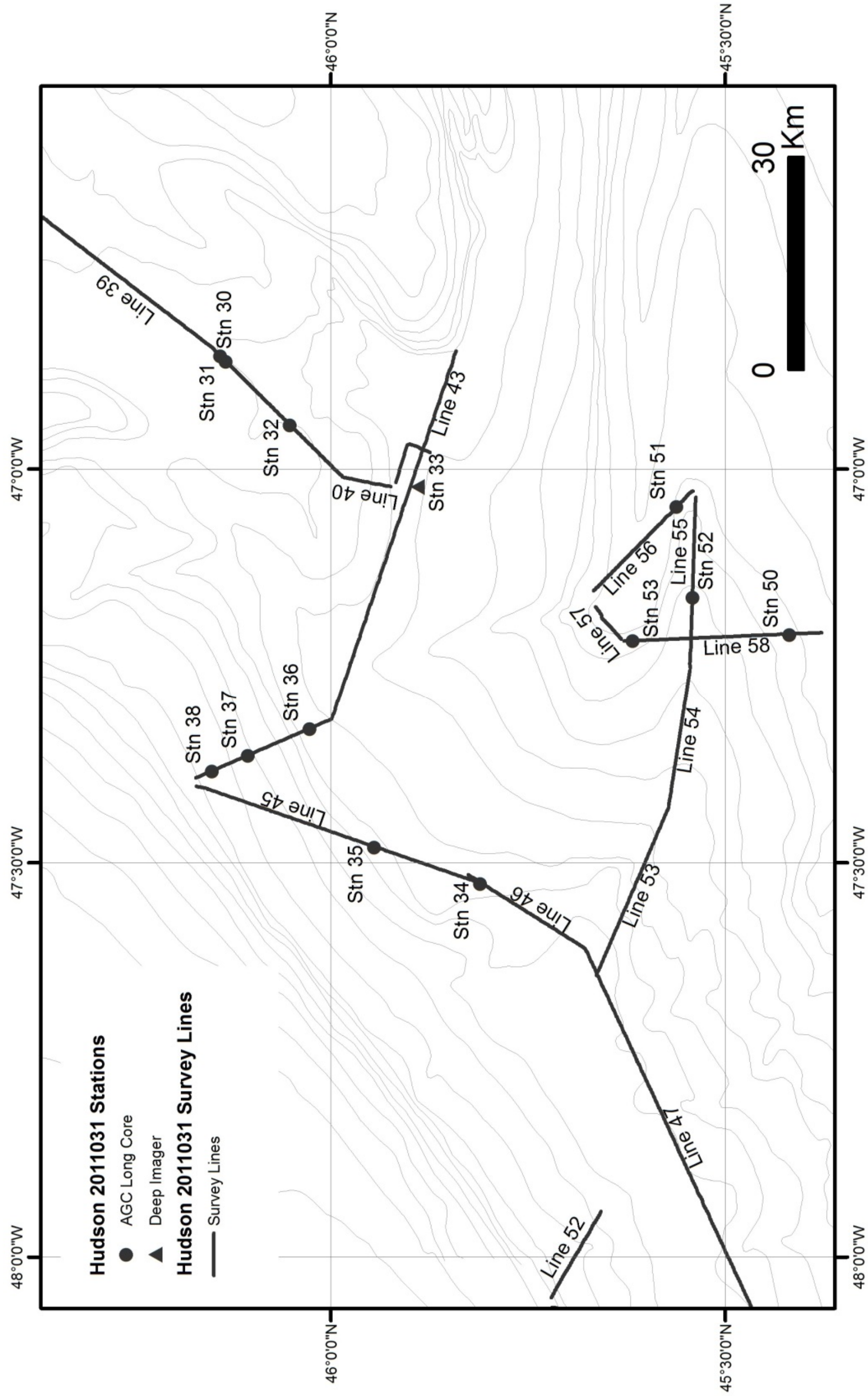
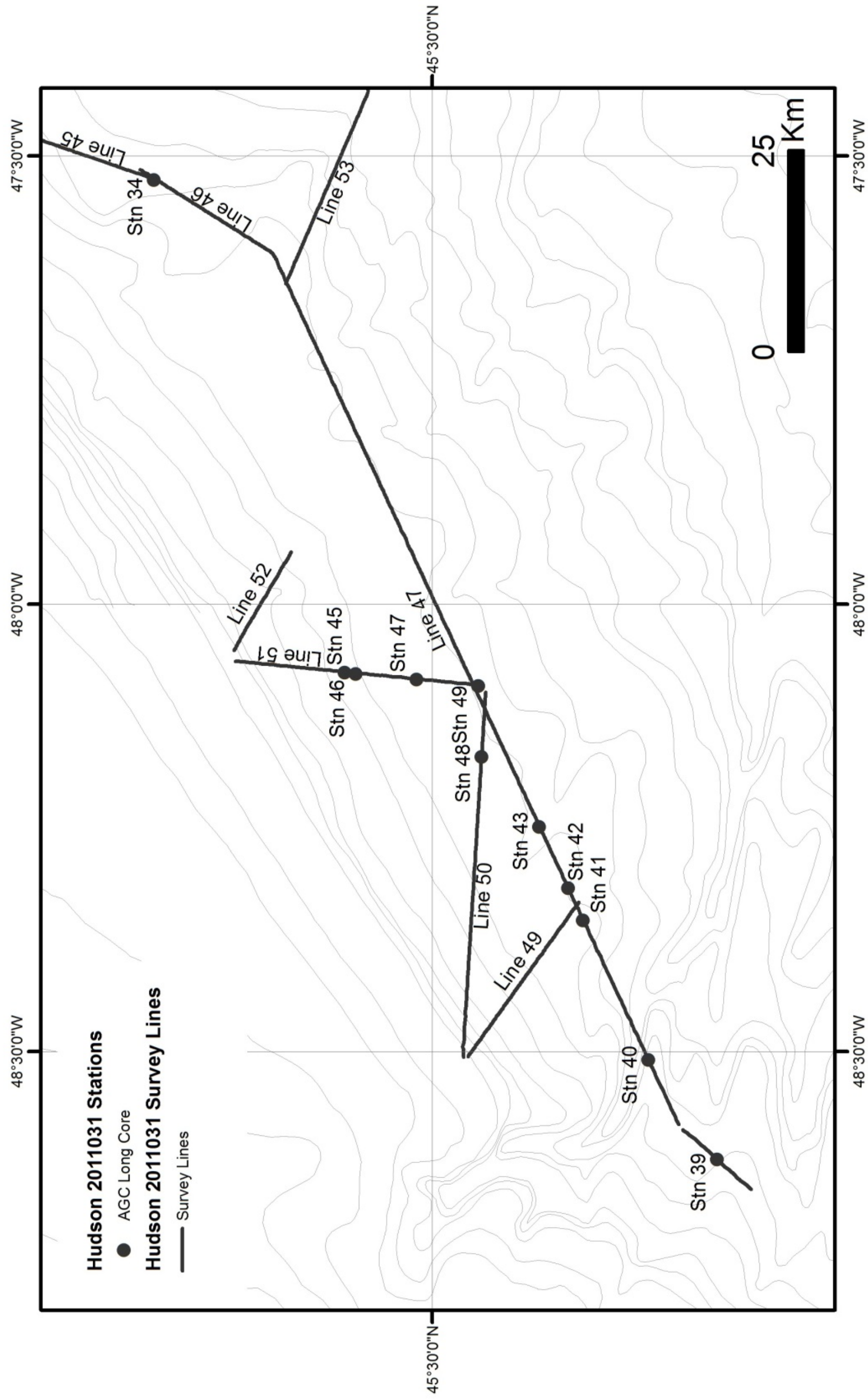
46°0'0"N
45°30'0"W
46°0'0"W
46°30'0"W
47°0'0"W
Stn 25
Stn 26
Stn 27
Stn 28
Stn 29
Stn 30
Stn 31
Stn 32
Stn 33
Stn 51
Line 32
Line 34
Line 35
Line 36
Line 38
Line 39
Line 40
Line 43
Line 56
0
40
Km

Inset E

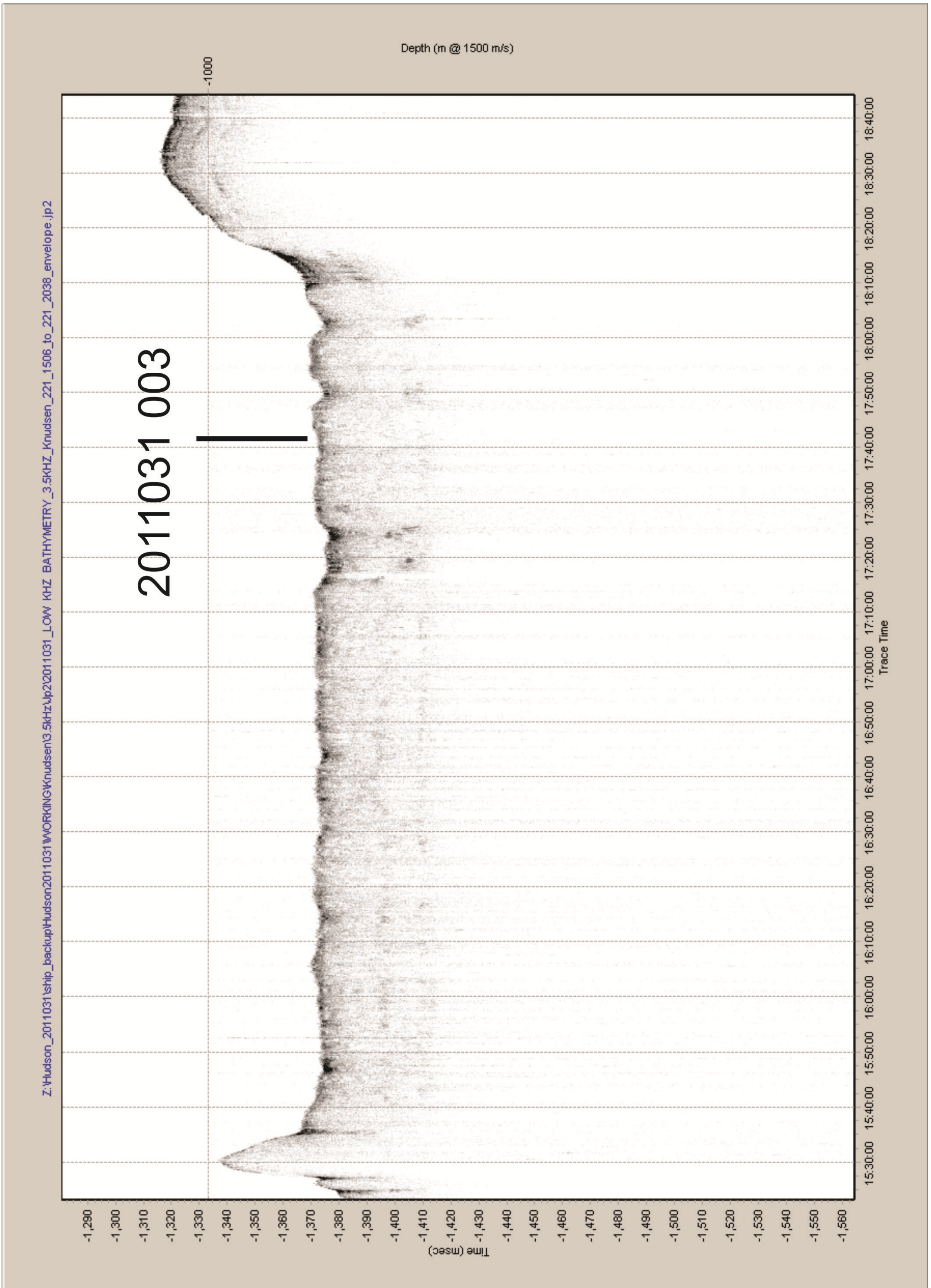

Hudson 2011031 Stations
AGC Long Core
Deep Imager
Hudson 2011031 Survey Lines
Survey Lines
Stn 30
Stn 31
Stn 32
Stn 33
Stn 34
Stn 35
Stn 36
Stn 37
Stn 38
Stn 50
Stn 51
Stn 52
Stn 53
Line 39
Line 40
Line 43
Line 45
Line 46
Line 47
Line 52
Line 53
Line 54
Line 55
Line 56
Line 57
Line 58
0
30
Km
46°0'0"N
45°30'0"N
47°0'0"W
47°30'0"W
48°0'0"W

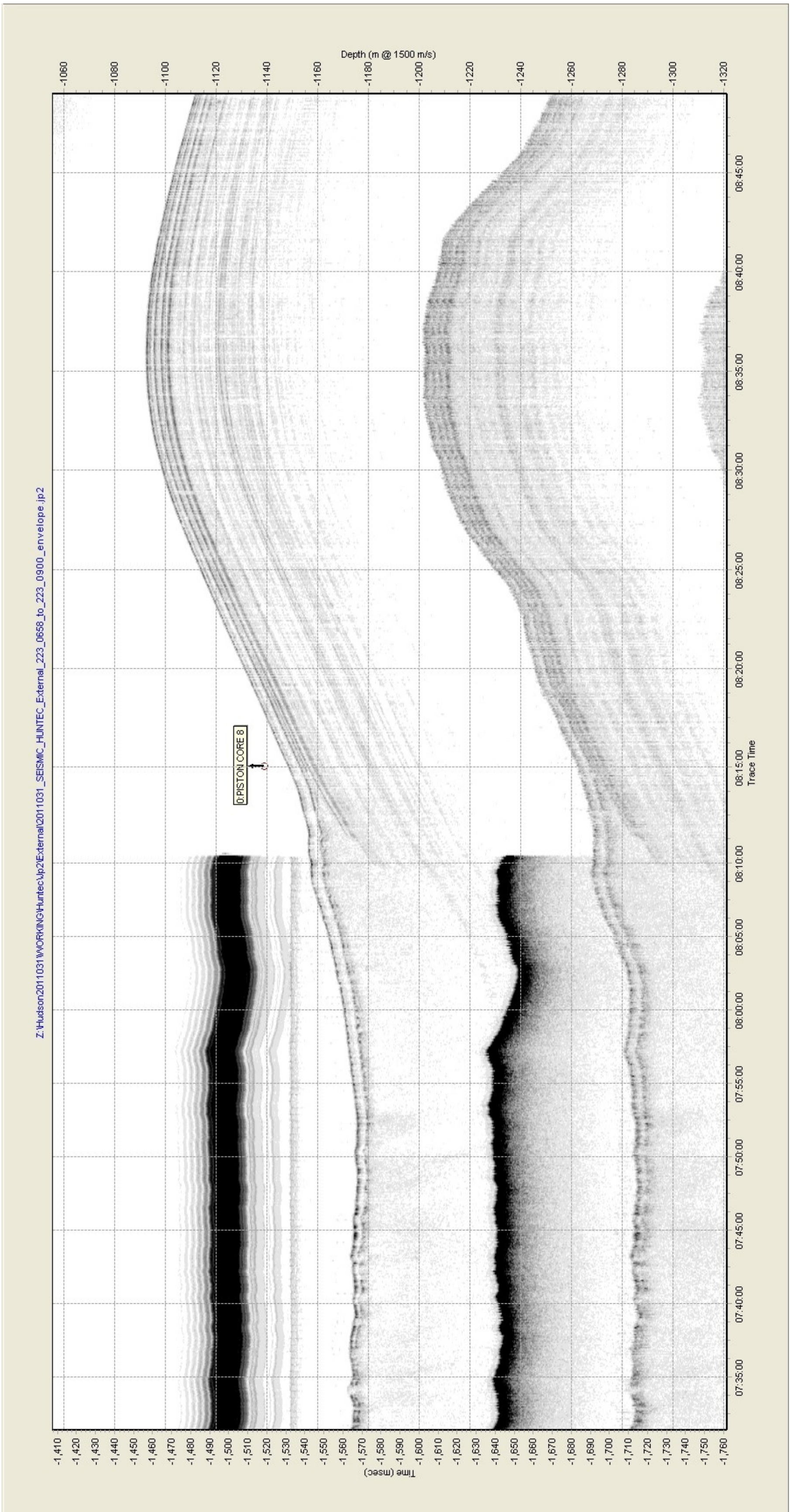
Inset F

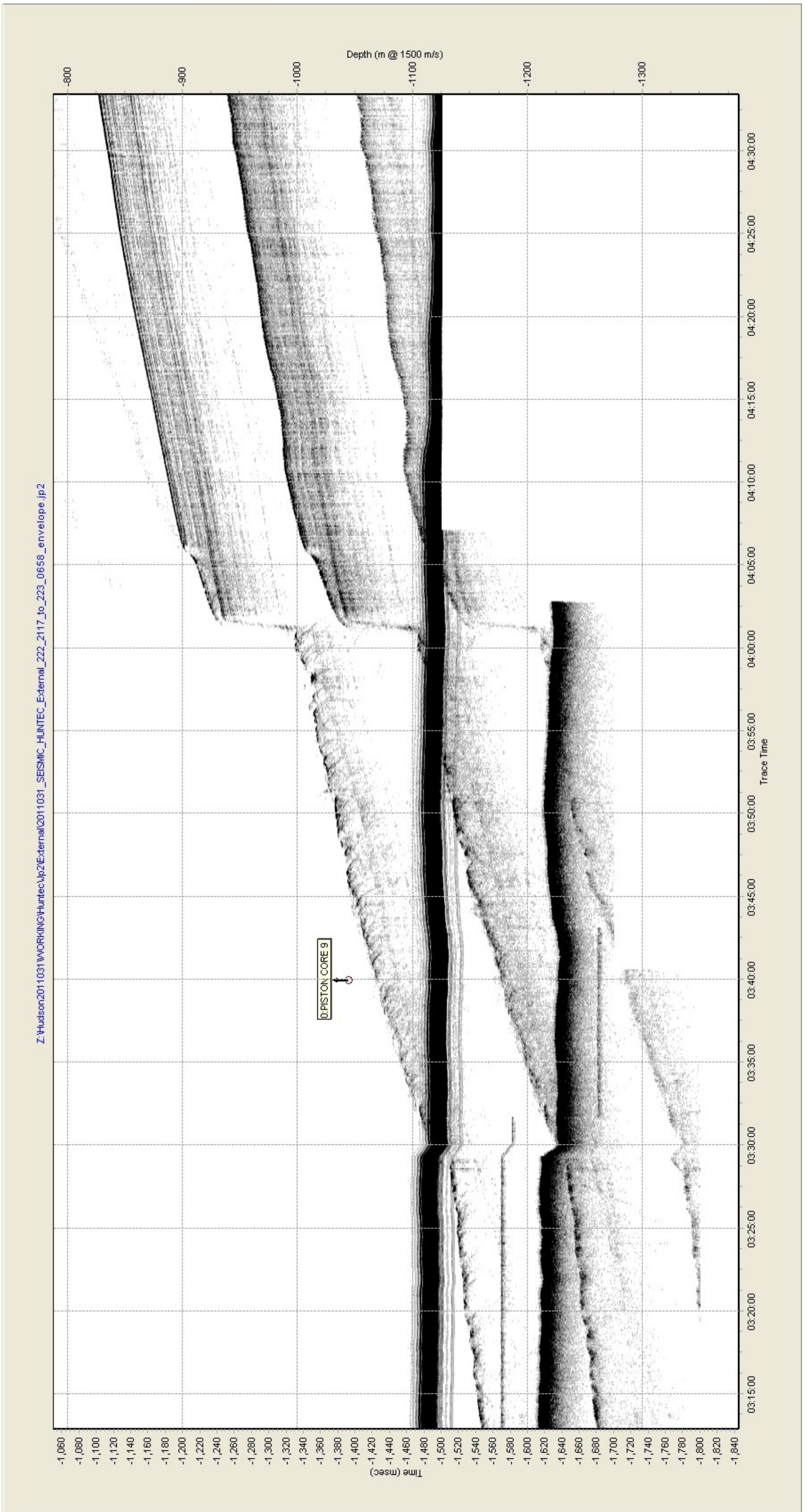

Hudson 2011031 Stations
AGC Long Core
Hudson 2011031 Survey Lines
Survey Lines
Line 45
Line 46
Stn 34
Line 53
Line 52
Line 51
Stn 45
Stn 46
Stn 47
Line 47
Stn 49
Stn 48
Stn 43
Stn 42
Stn 41
Line 50
Line 49
Stn 40
Stn 39
0
25 Km
45°30'0"N
47°30'0"W
48°0'0"W
48°30'0"W

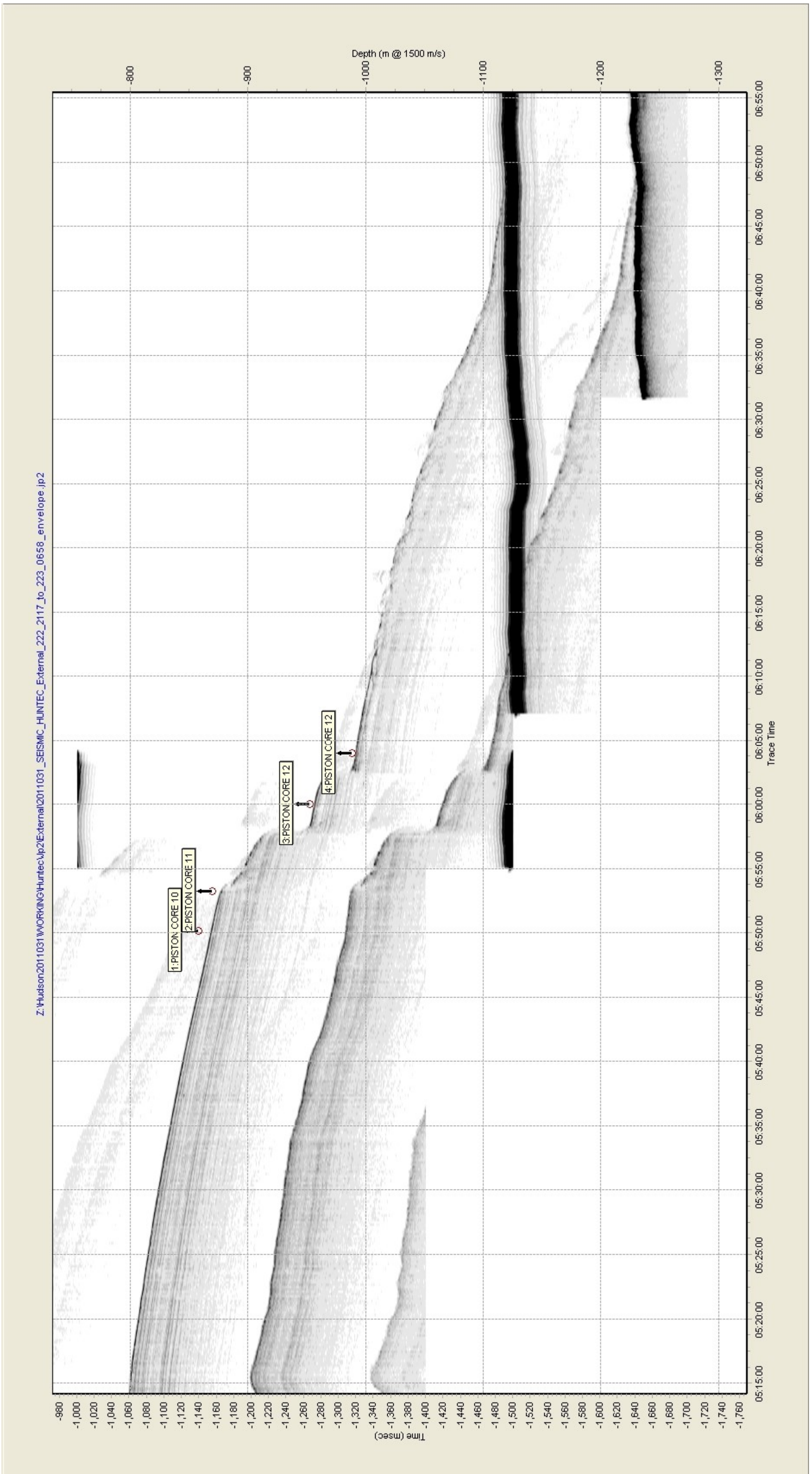
Inset G

7.4 Piston core site seismic profiles

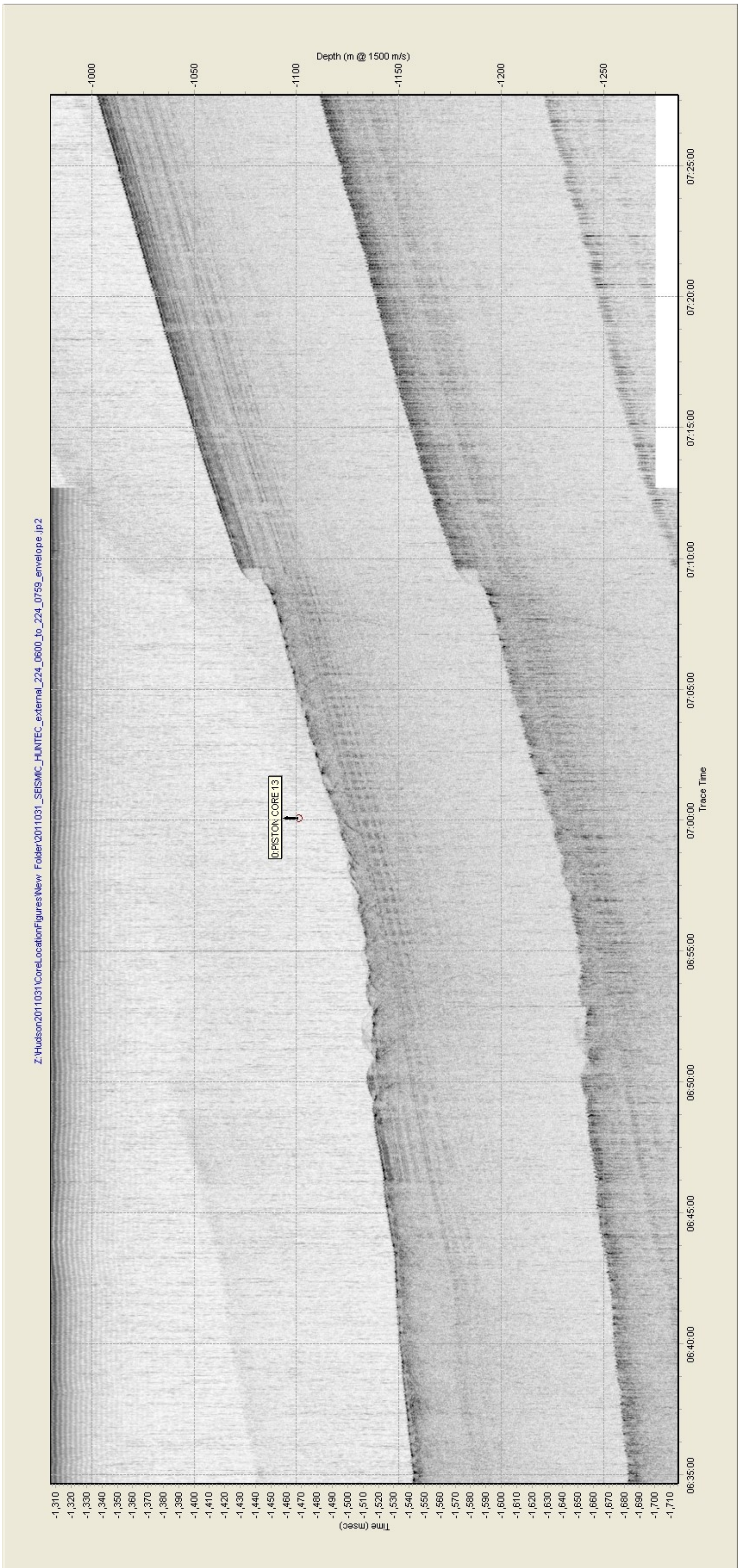


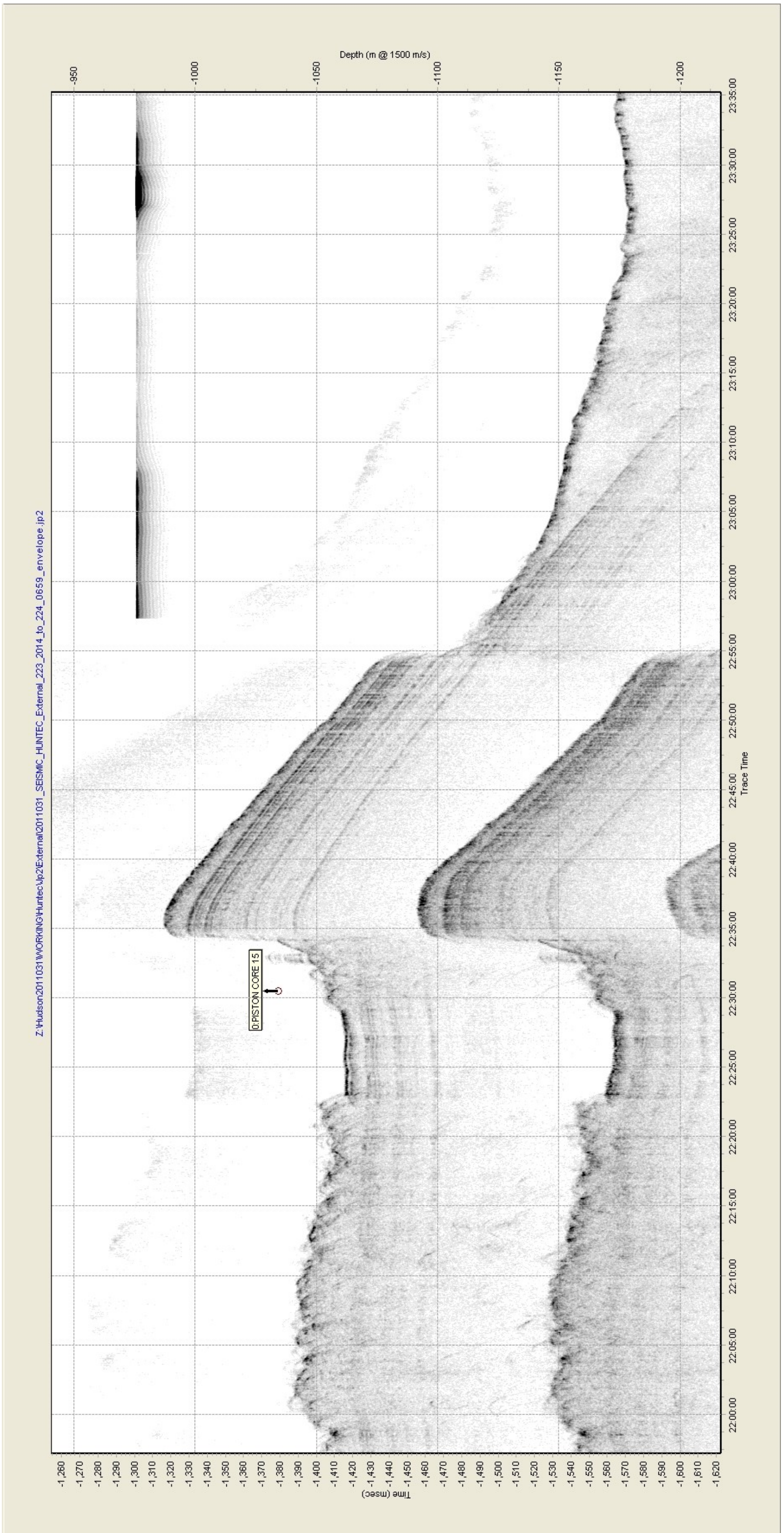

Depth (m @ 1500 m/s)
Trace Time
Time (msec)
0:PISTON CORE 8

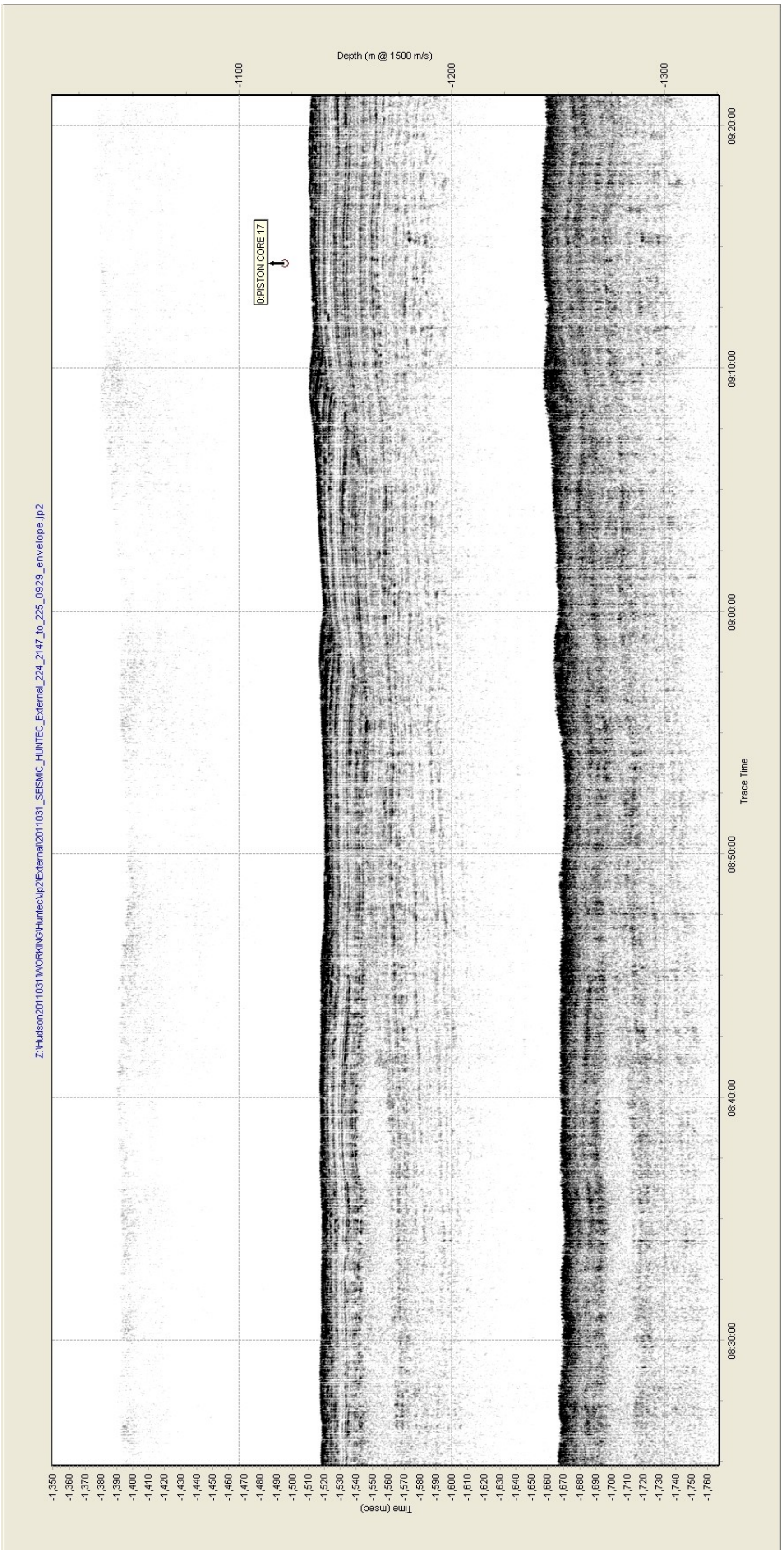

Z:\Hudson2011031\WORKING\Huntec\Jp2\External\2011031_SEISMIC_HUNTEC_External_222_2117_to_223_0658_envelope.jp2
Depth (m @ 1500 m/s)
Trace Time
Time (msec)
0:PISTON CORE 9

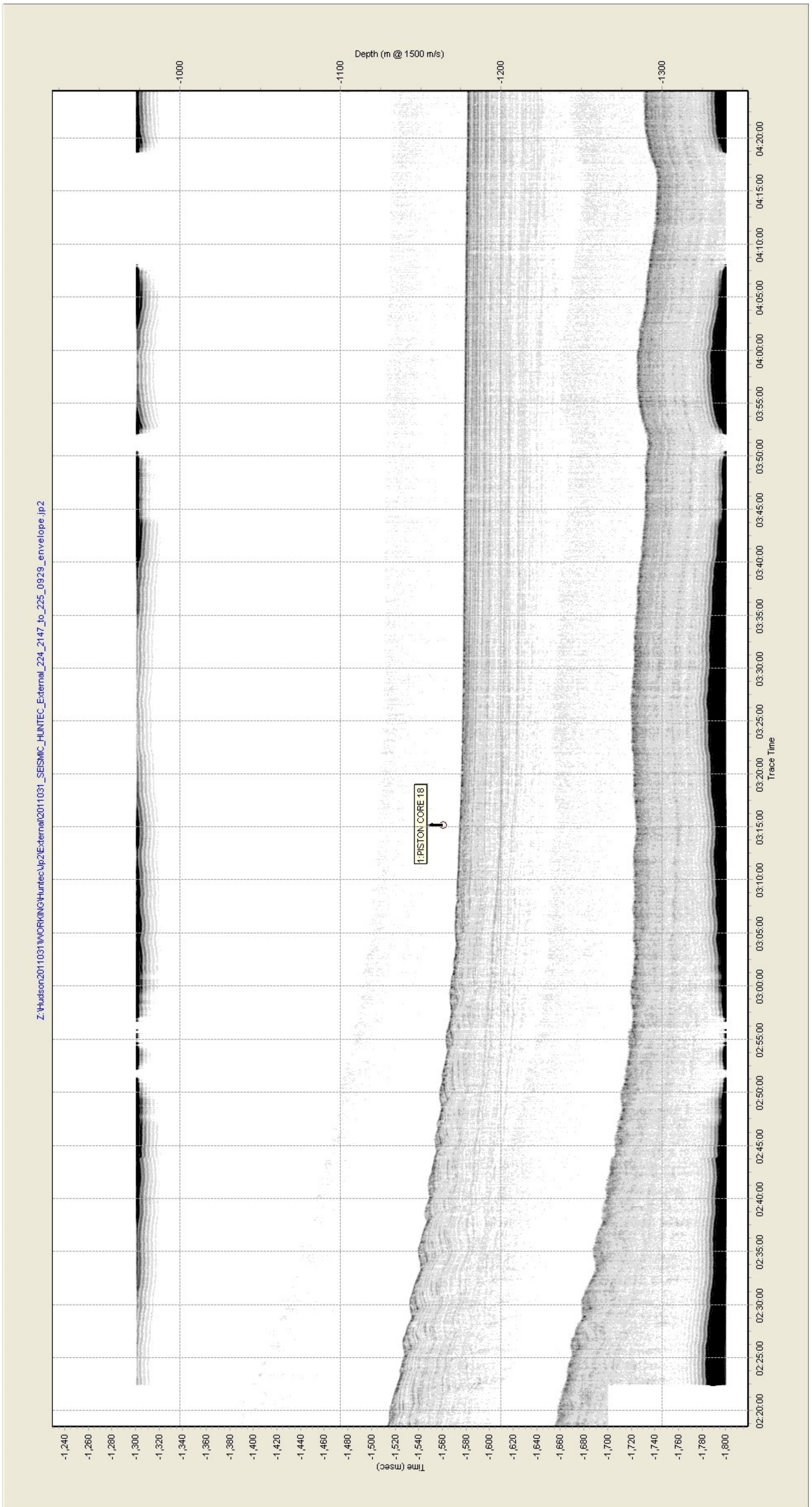


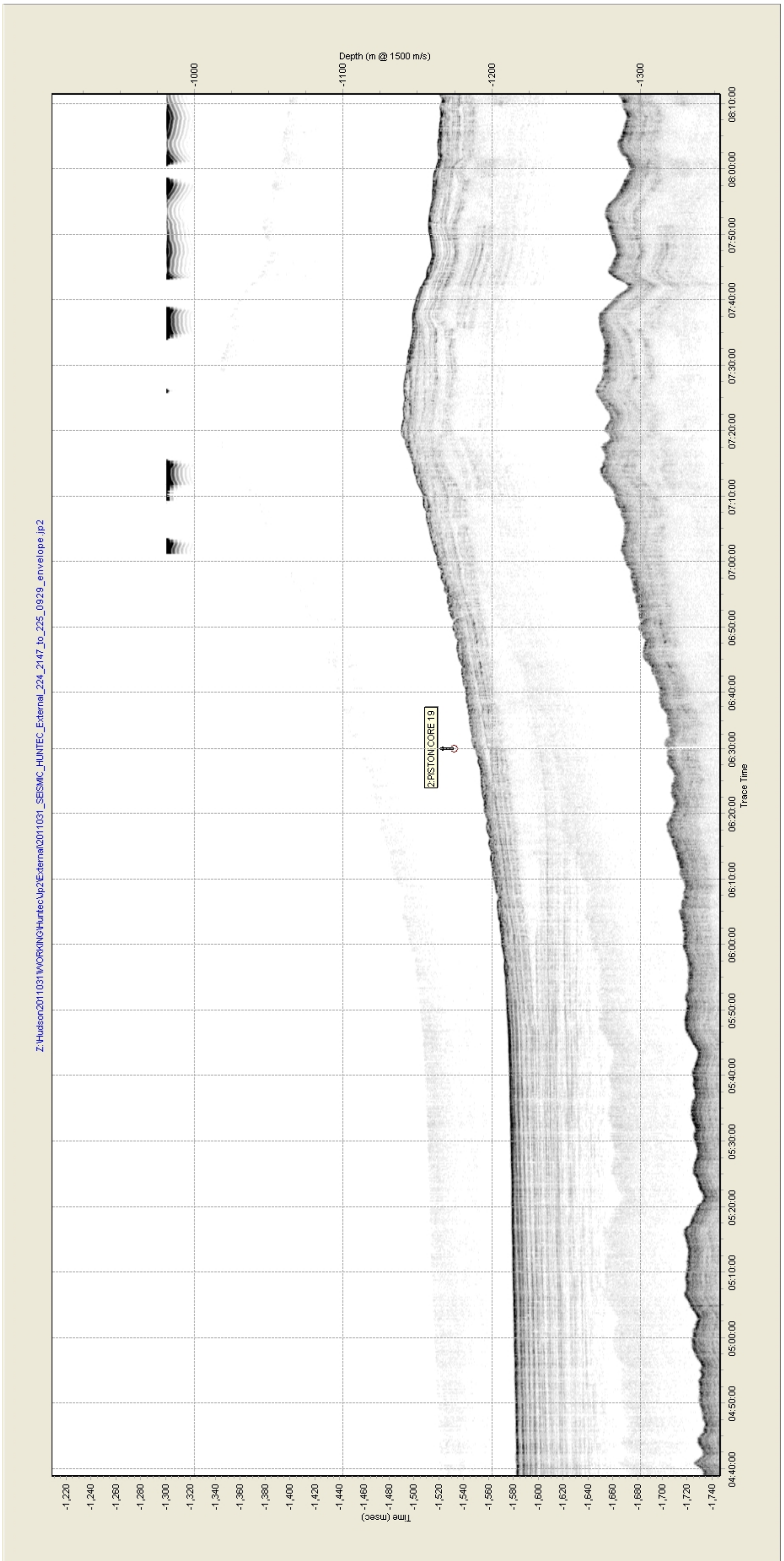
Z:\Hudson2011031\WORKING\Huntec\Jp2\External\2011031_SEISMIC_HUNTEC_External_222_2117_to_223_0658_envelope.jp2
Depth (m @ 1500 m/s)
Time (msec)
Trace Time
1:PISTON CORE 10
2:PISTON CORE 11
3:PISTON CORE 12
4:PISTON CORE 12

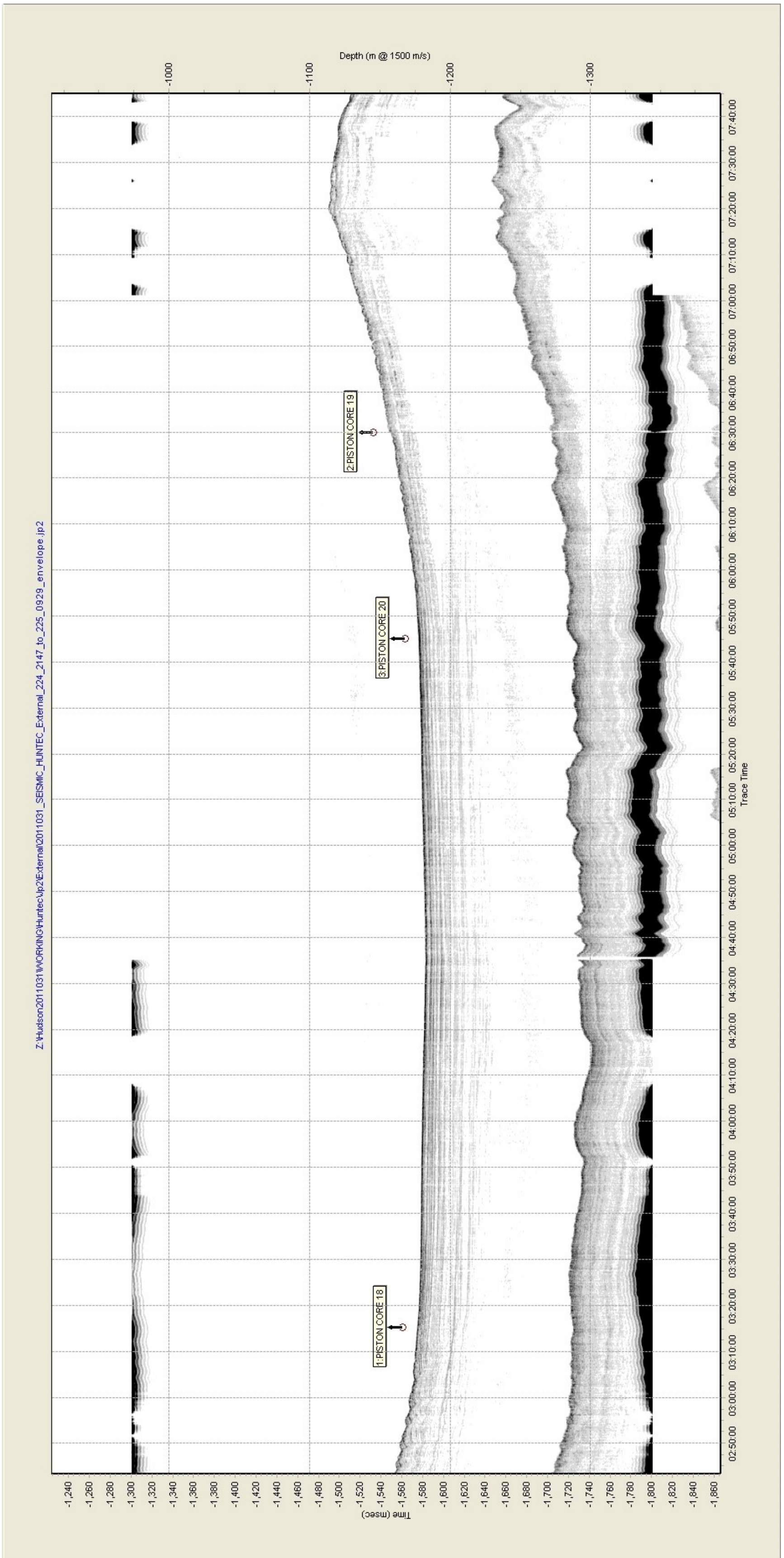

Depth (m @ 1500 m/s)
Trace Time
Time (msec)
0 PISTON CORE 13


Depth (m @ 1500 m/s)
Trace Time
Time (msec)
0.PISTON CORE 15

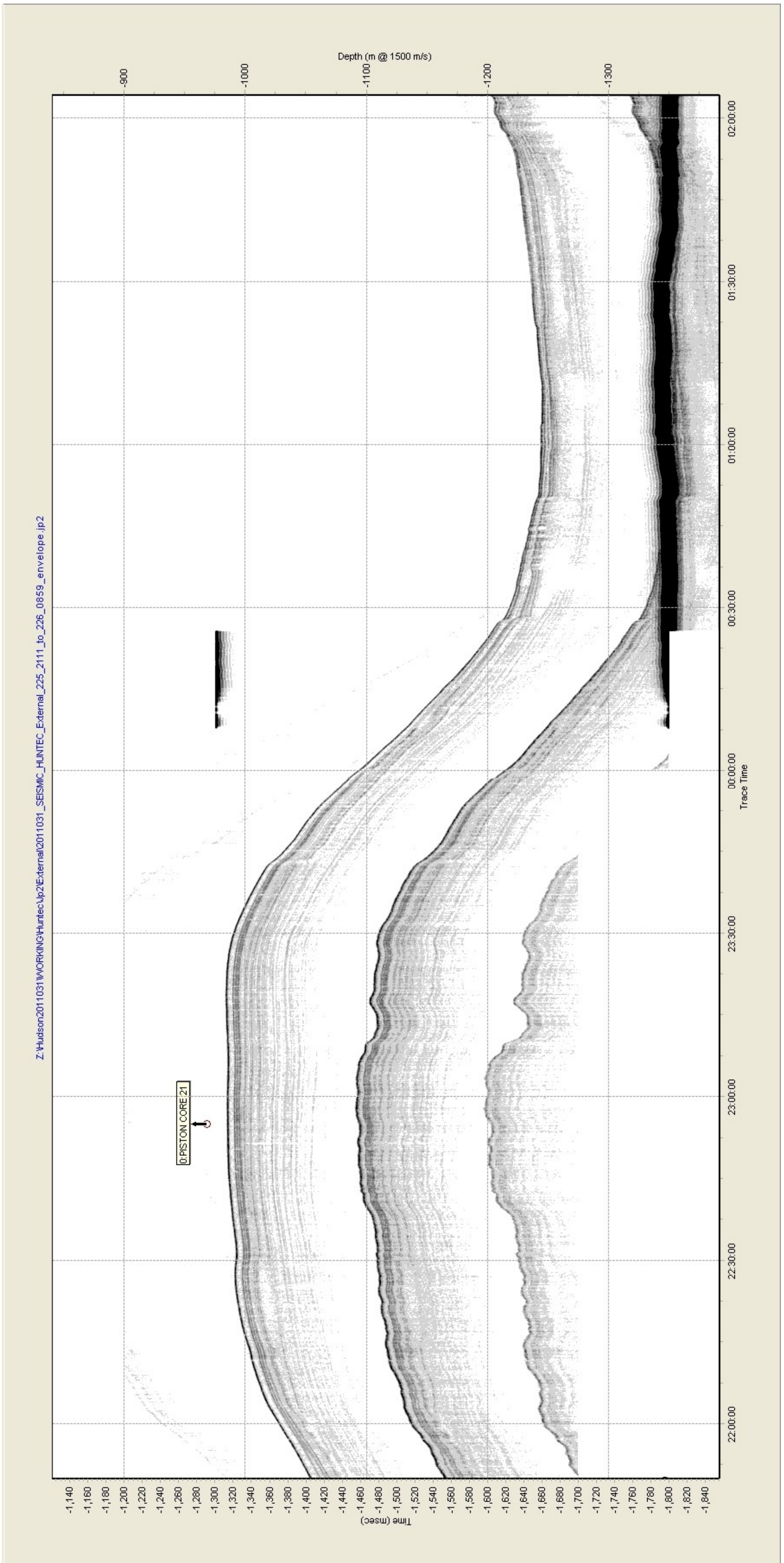

Z:\Hudson2011031\WORKING\Huntec\jp2\External\2011031_SEISMIC_HUNTEC_External_224_2147_to_225_0929_envelope.jp2
Depth (m @ 1500 m/s)
-1100
-1200
-1300
0:PISTON CORE 17
09:20:00
09:10:00
09:00:00
08:50:00
08:40:00
08:30:00
Trace Time
Time (msec)

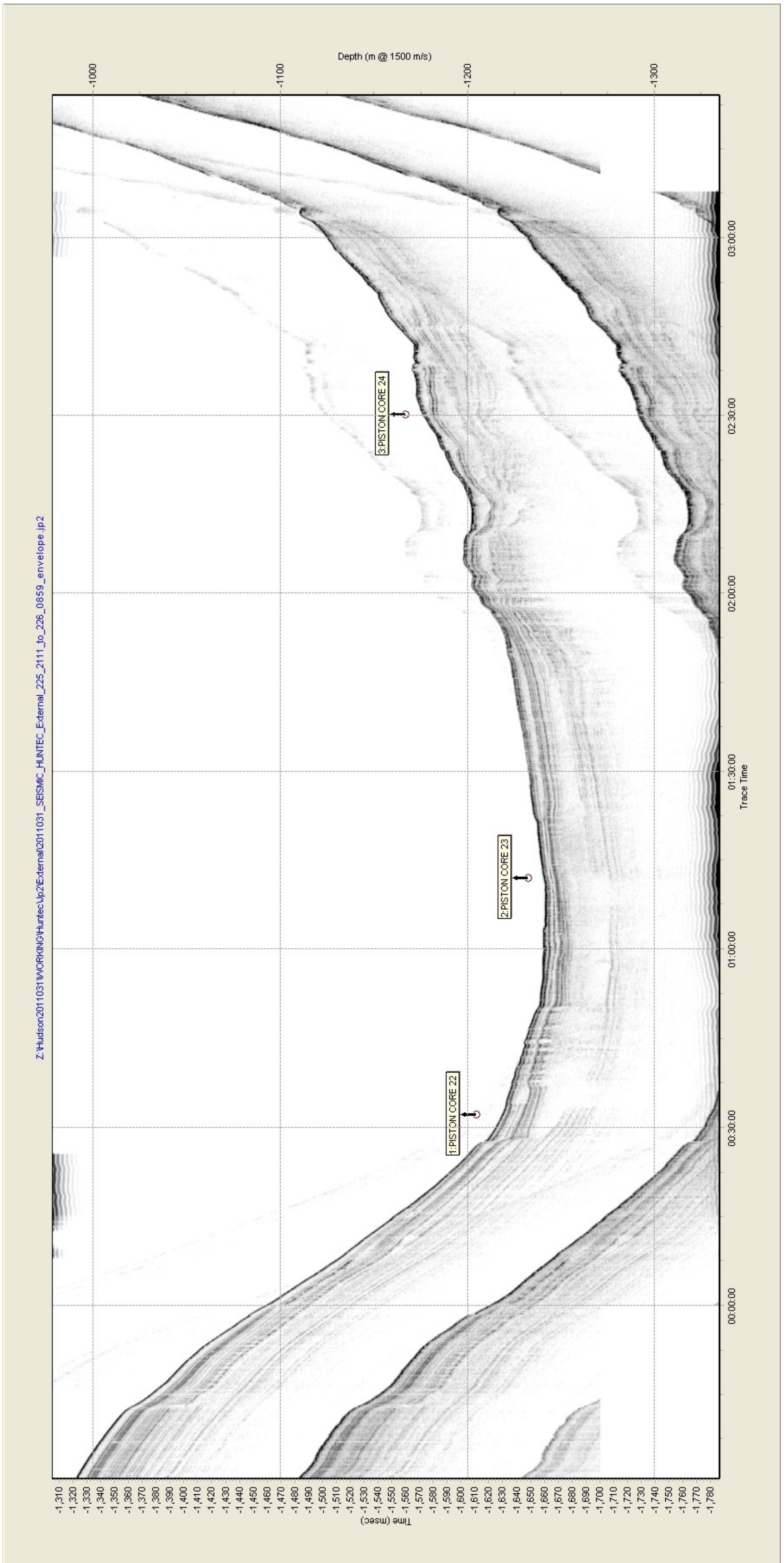

Z:\Hudson2011031\WORKING\HuntecUp2\External\2011031_SEISMIC_HUNTEC_External_224_2147_to_225_0929_envelope.jp2
Depth (m @ 1500 m/s)
1:PISTON CORE 18
Trace Time
Time (msec)

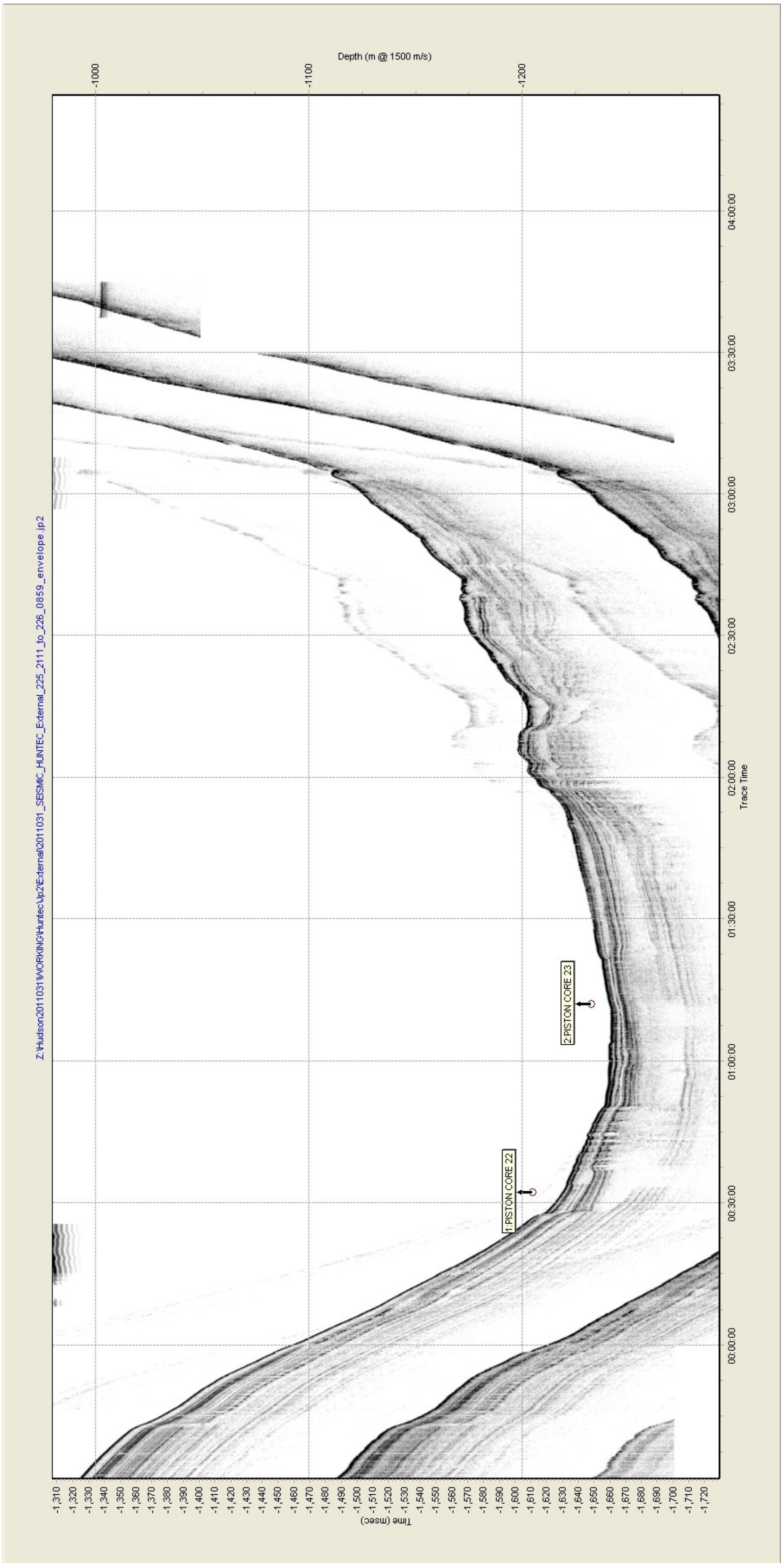

Depth (m @ 1500 m/s)
Trace Time
Time (msec)
2.PISTON CORE 19

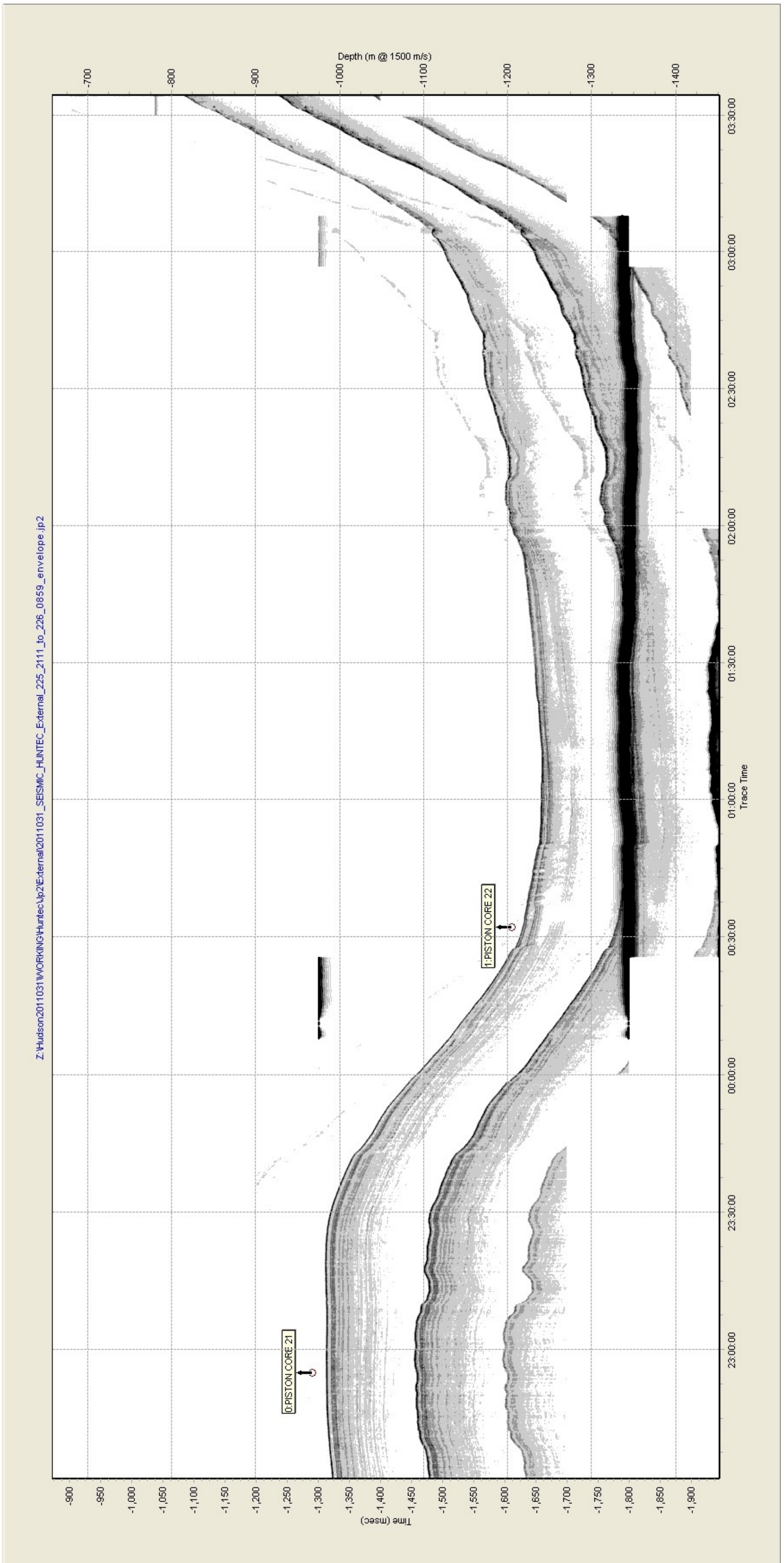


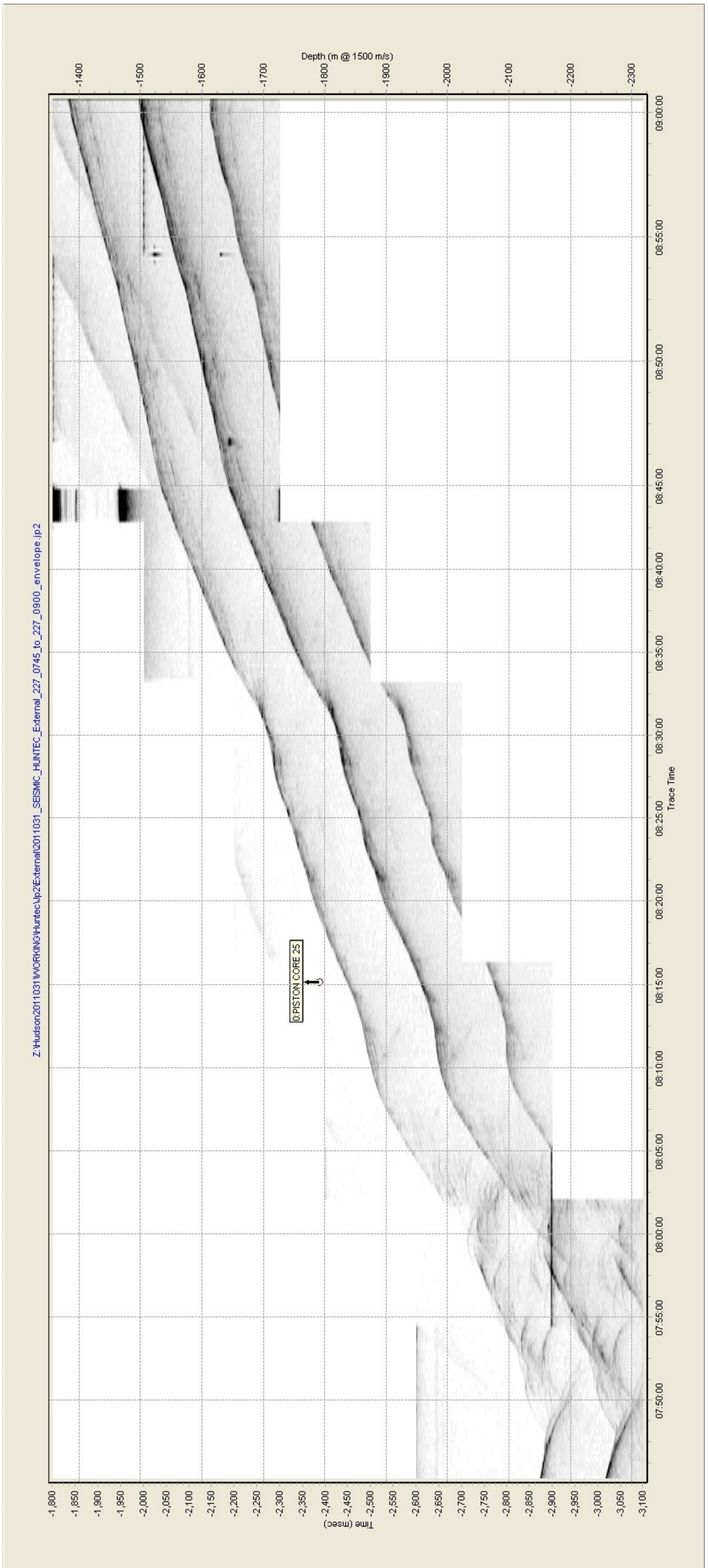
Z:\Hudson2011031\WORKING\Huntec\jp2\External\2011031_SEISMIC_HUNTEC_External_224_2147_to_225_0929_envelope.jp2
Depth (m @ 1500 m/s)
Trace Time
Time (msec)
1:PISTON CORE 18
2:PISTON CORE 19
3:PISTON CORE 20

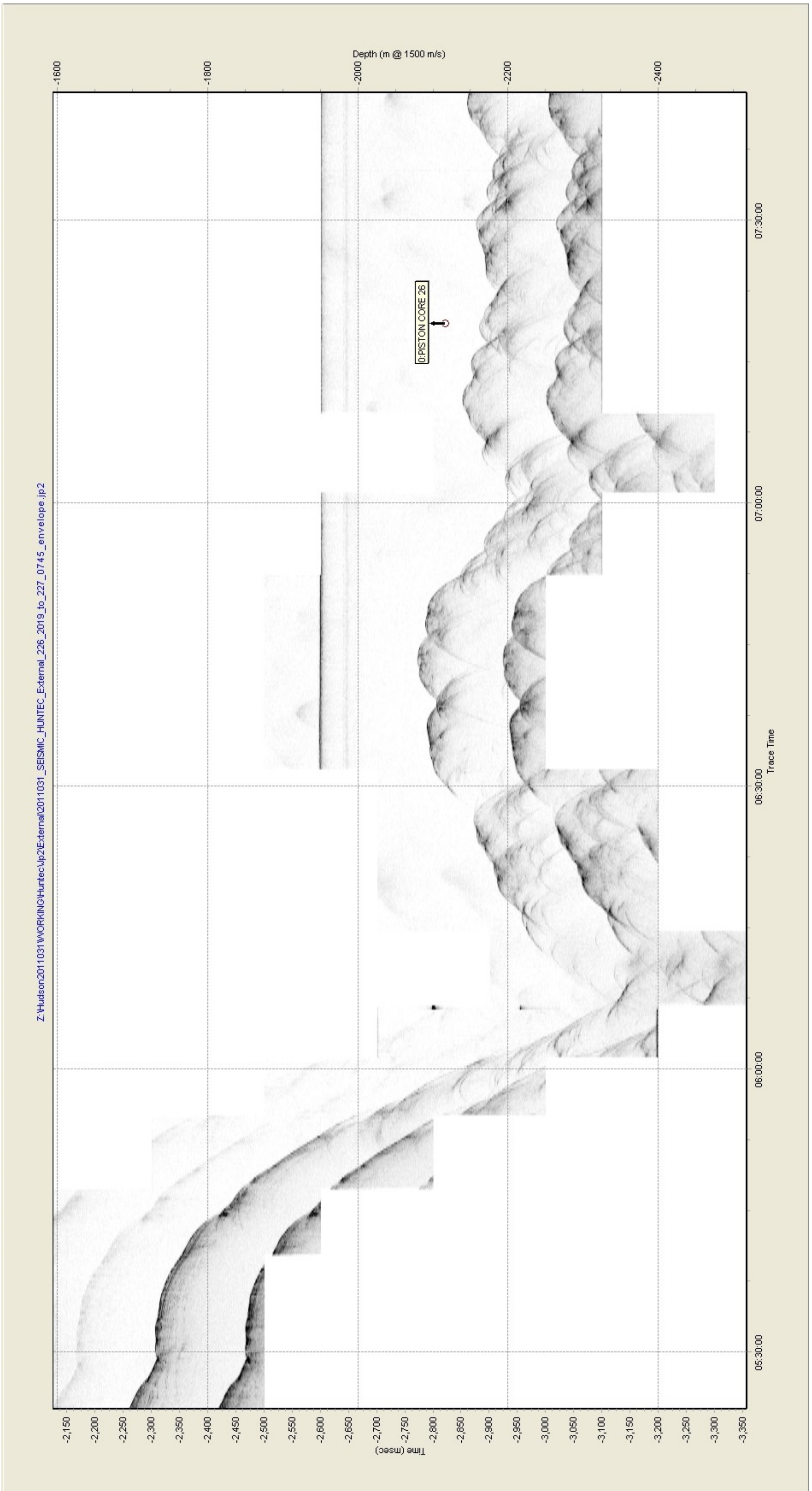

Depth (m @ 1500 m/s)
Trace Time
Time (msec)
0 PISTON CORE 21

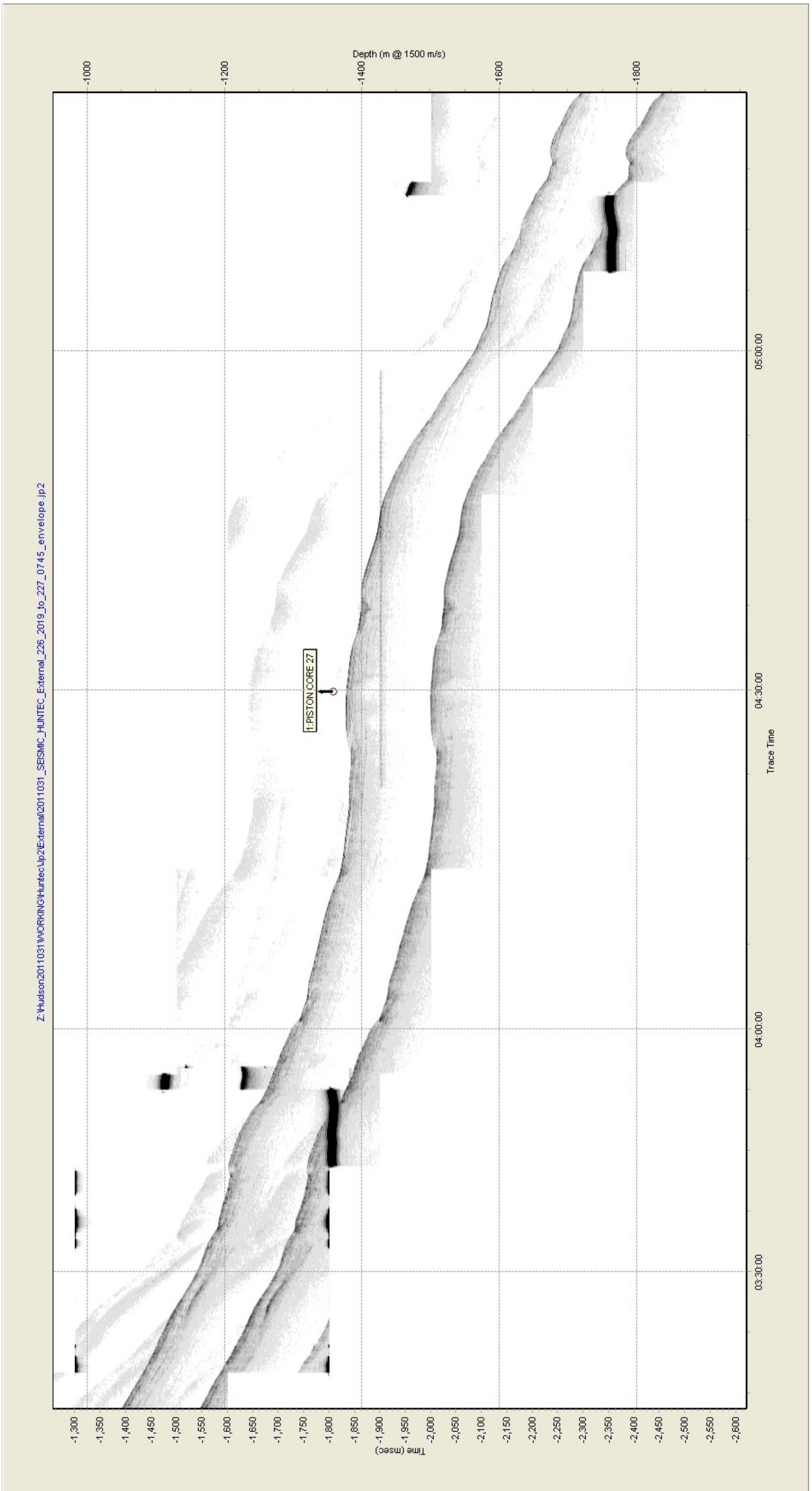

Depth (m @ 1500 m/s)
Trace Time
Time (msec)
1:PISTON CORE 22
2:PISTON CORE 23
3:PISTON CORE 24

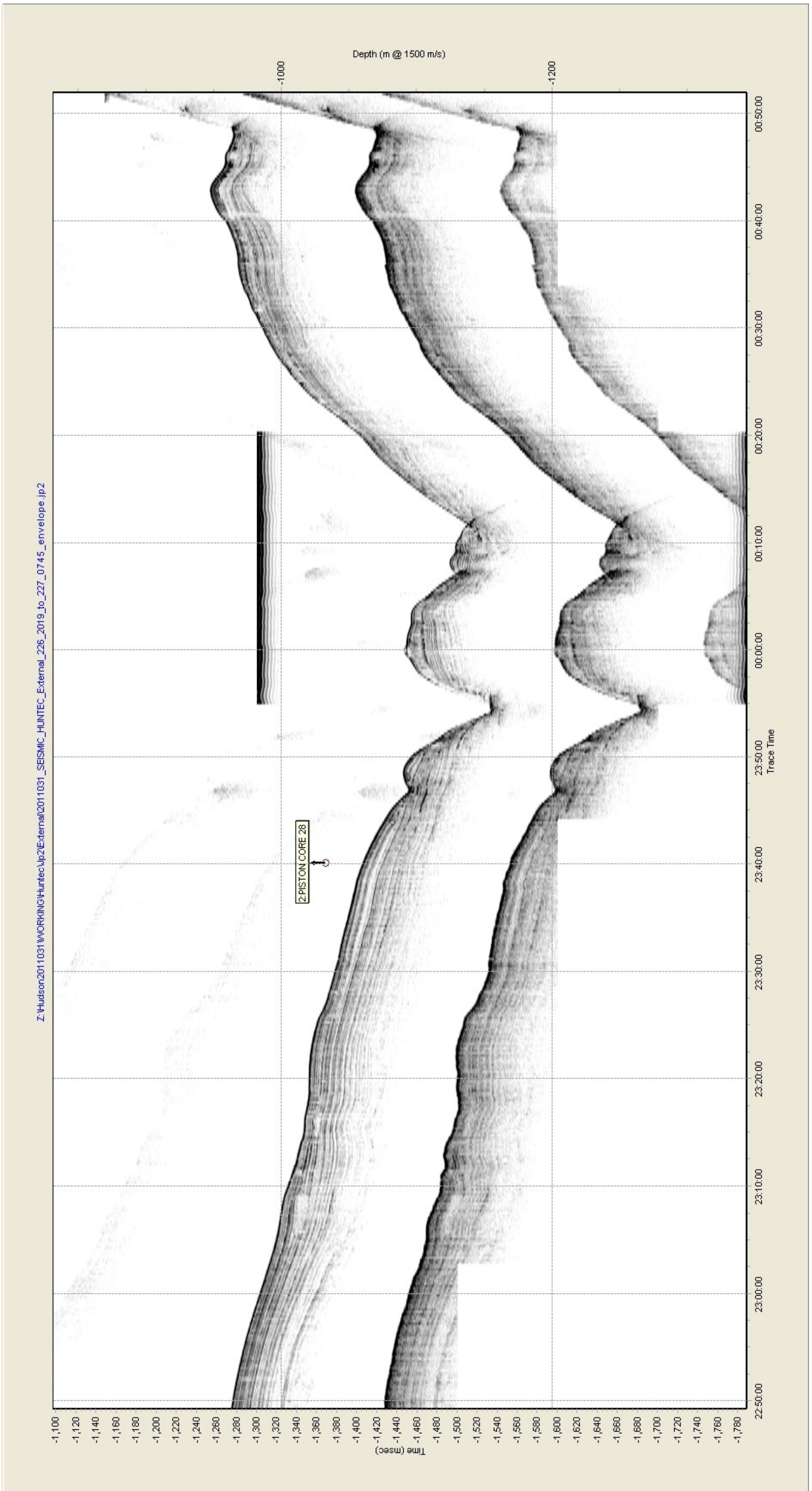

Depth (m @ 1500 m/s)
Trace Time
Time (msec)
1:PISTON CORE 22
2:PISTON CORE 23

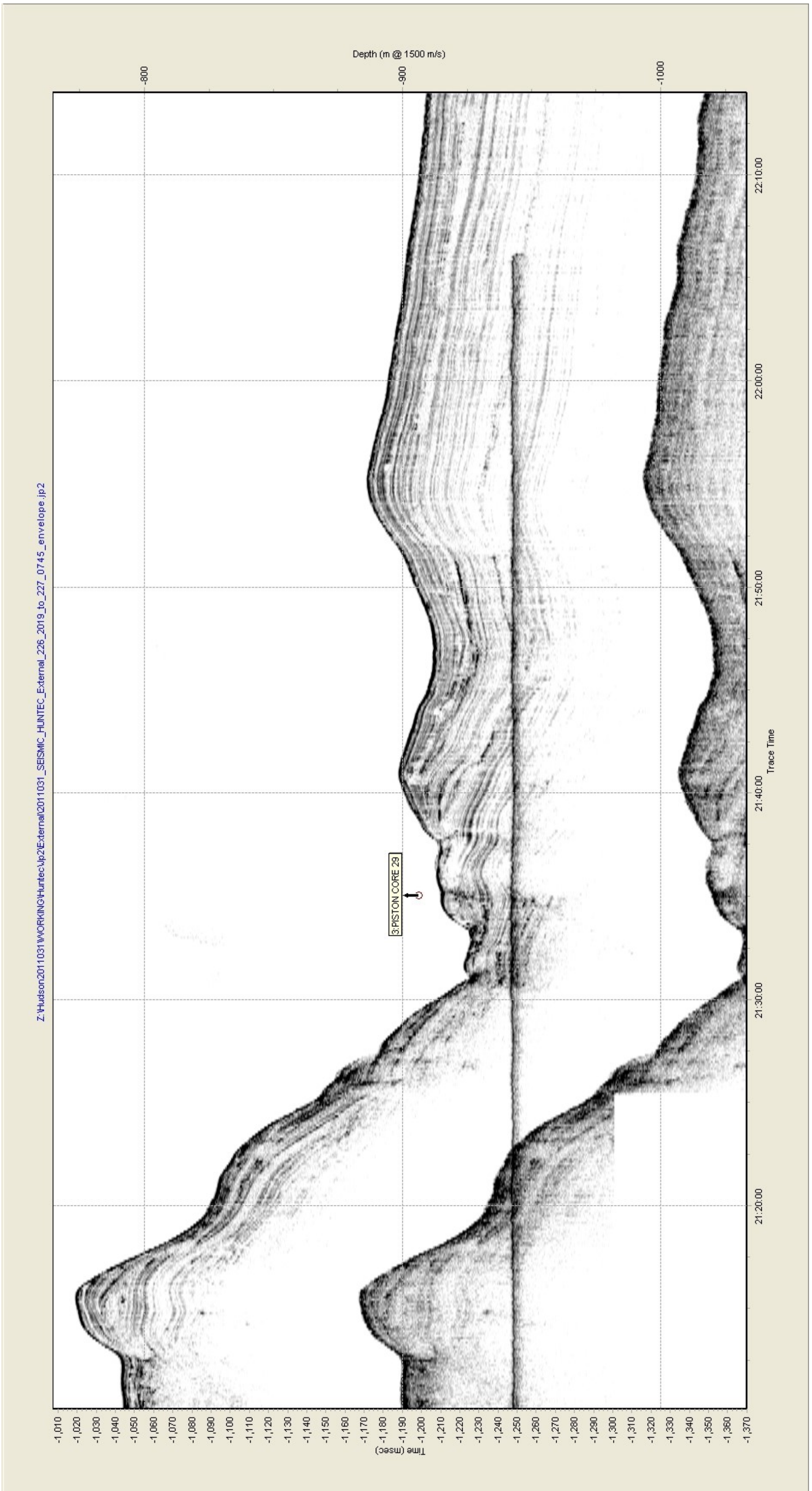

Z:\Hudson2011031\WORKING\Huntec\jp2\External\2011031_SEISMIC_HUNTEC_External_225_2111_to_226_0859_envelope.jp2
Depth (m @ 1500 m/s)
Time (msec)
Trace Time
0:PISTON CORE 21
1:PISTON CORE 22

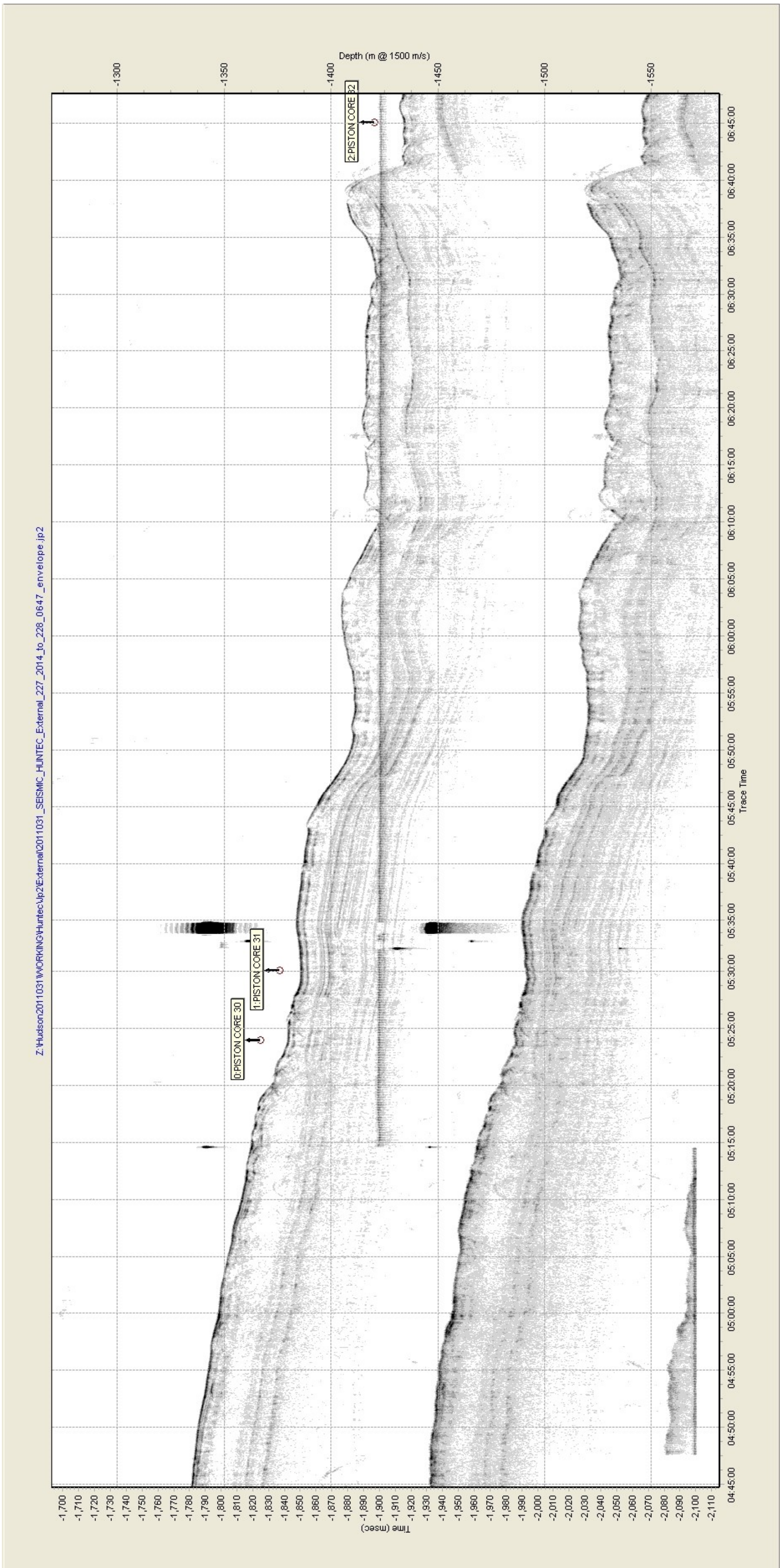

Z:\Hudson2011031\WORKING\Huntec\Jp2\External\2011031_SEISMIC_HUNTEC_External_227_0745_to_227_0900_envelope.jp2
Depth (m @ 1500 m/s)
0:PISTON CORE 25
Trace Time
Time (msec)

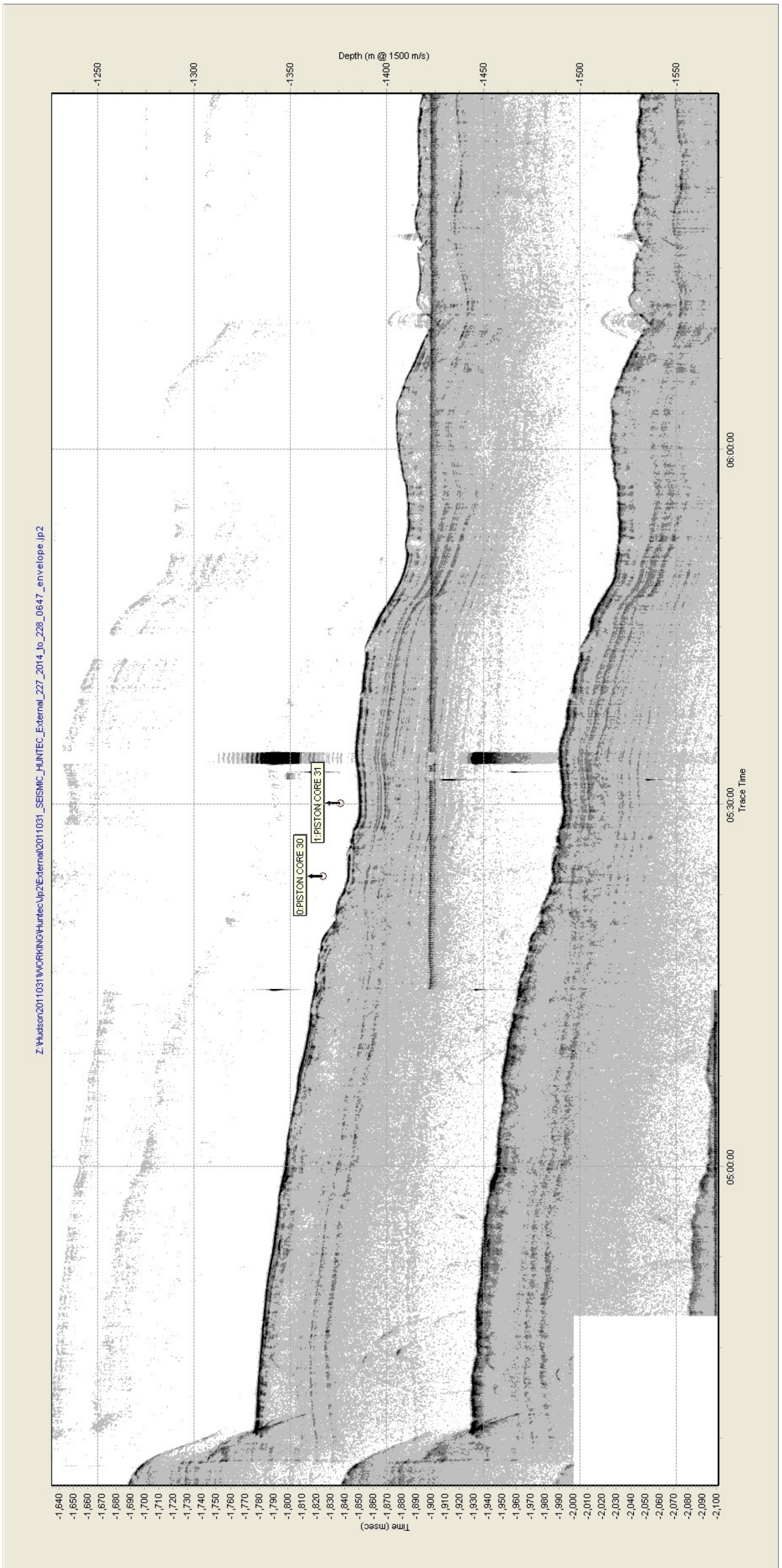

Z:\Hudson2011031\WORKING\HuntecUp2\External\2011031_SEISMIC_HUNTEC_External_226_2019_to_227_0745_envelope.jp2
Depth (m @ 1500 m/s)
-1600
-1800
-2000
-2200
-2400
0:PISTON CORE 26
05:30:00
06:00:00
06:30:00
07:00:00
07:30:00
Trace Time
Time (msec)
-2,150
-2,200
-2,250
-2,300
-2,350
-2,400
-2,450
-2,500
-2,550
-2,600
-2,650
-2,700
-2,750
-2,800
-2,850
-2,900
-2,950
-3,000
-3,050
-3,100
-3,150
-3,200
-3,250
-3,300
-3,350


Depth (m @ 1500 m/s)
1:PISTON CORE 27
Trace Time
Time (msec)

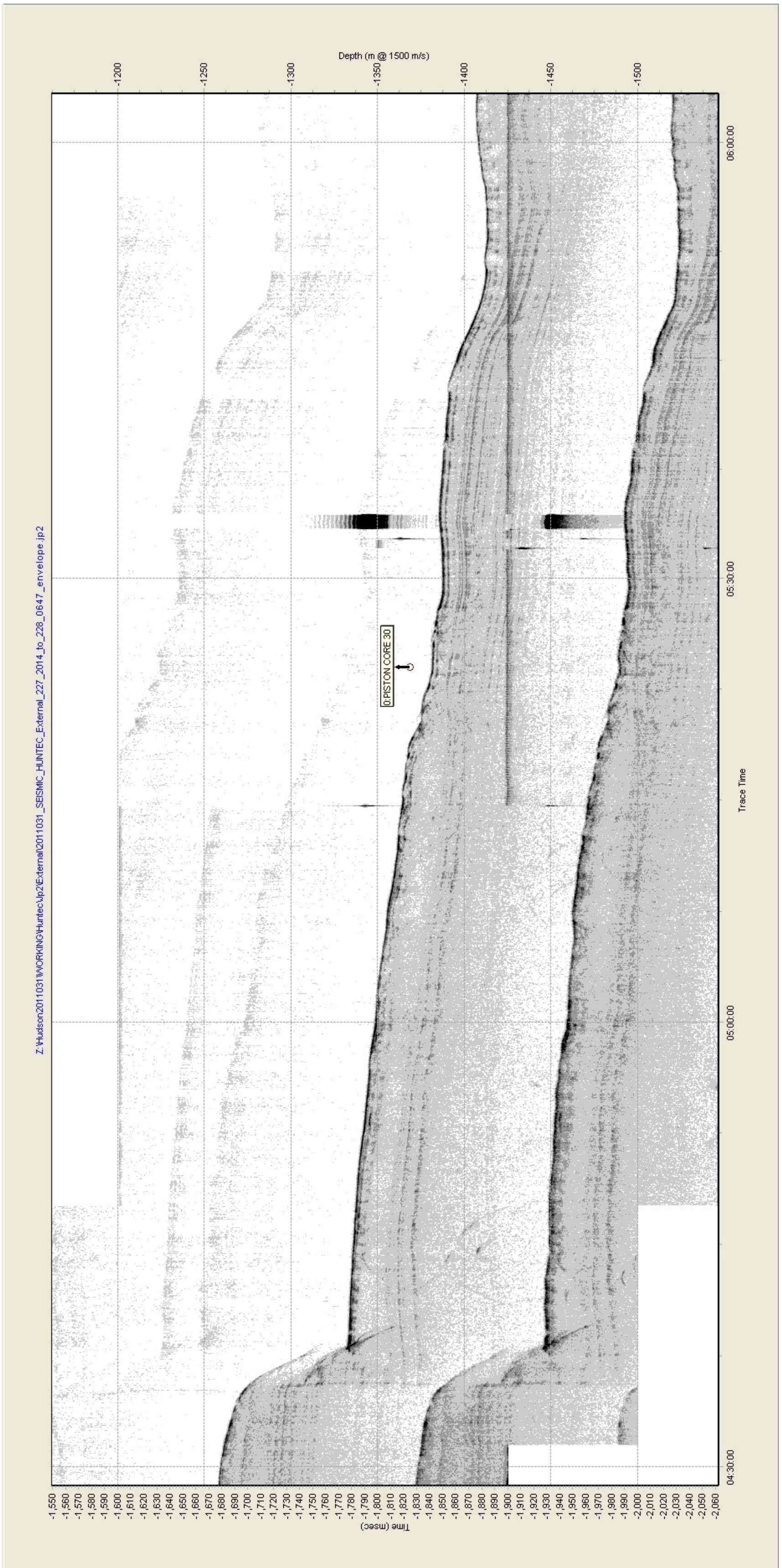

Depth (m @ 1500 m/s)
Trace Time
Time (msec)
2:PISTON CORE 28


Depth (m @ 1500 m/s)
Trace Time
Time (msec)
3:PISTON CORE 29

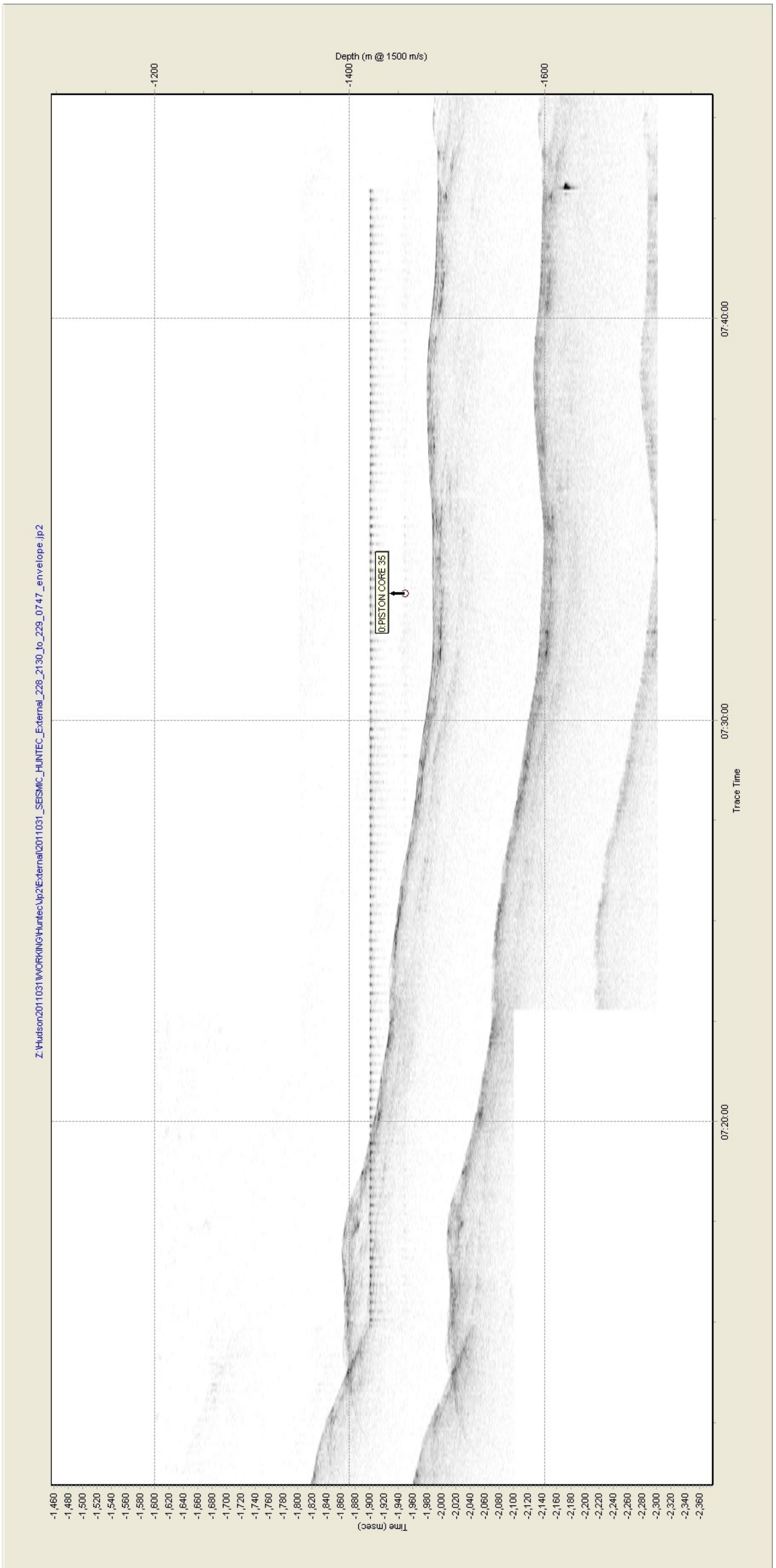

Z:\Hudson2011031\WORKING\Huntec\Jp2\External\2011031_SEISMIC_HUNTEC_External_227_2014_to_228_0647_envelope.jp2
Depth (m @ 1500 m/s)
0:PISTON CORE 30
1:PISTON CORE 31
2:PISTON CORE 32
Trace Time
Time (msec)



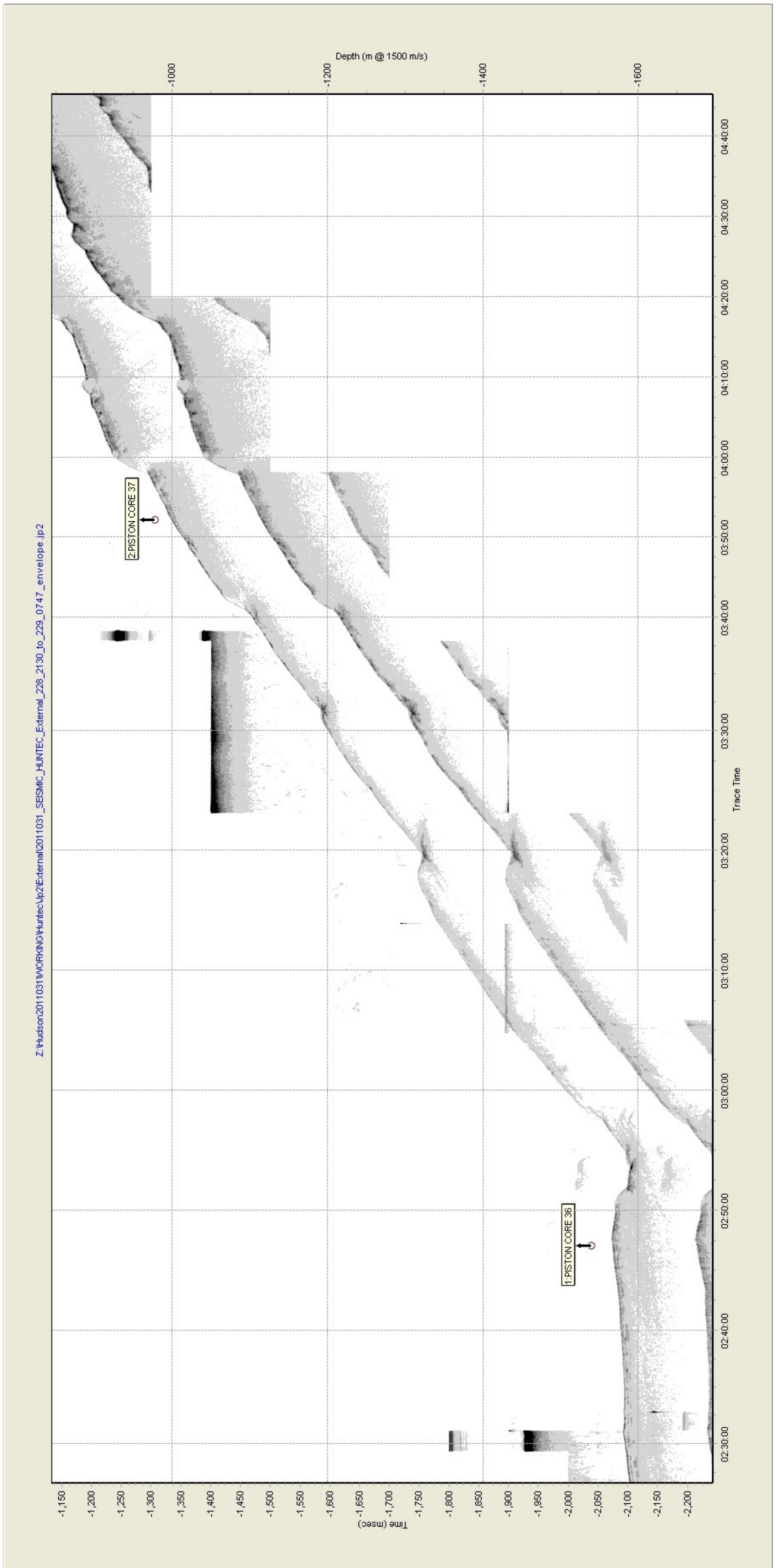
Z:\Hudson2011031\WORKING\Huntec\Jp2\External\2011031_SEISMIC_HUNTEC_External_227_2014_to_228_0647_envelope.jp2
Depth (m @ 1500 m/s)
-1250
-1300
-1350
-1400
-1450
-1500
-1550
0:PISTON CORE 30
1:PISTON CORE 31
05:00:00
05:30:00
06:00:00
Trace Time
Time (msec)

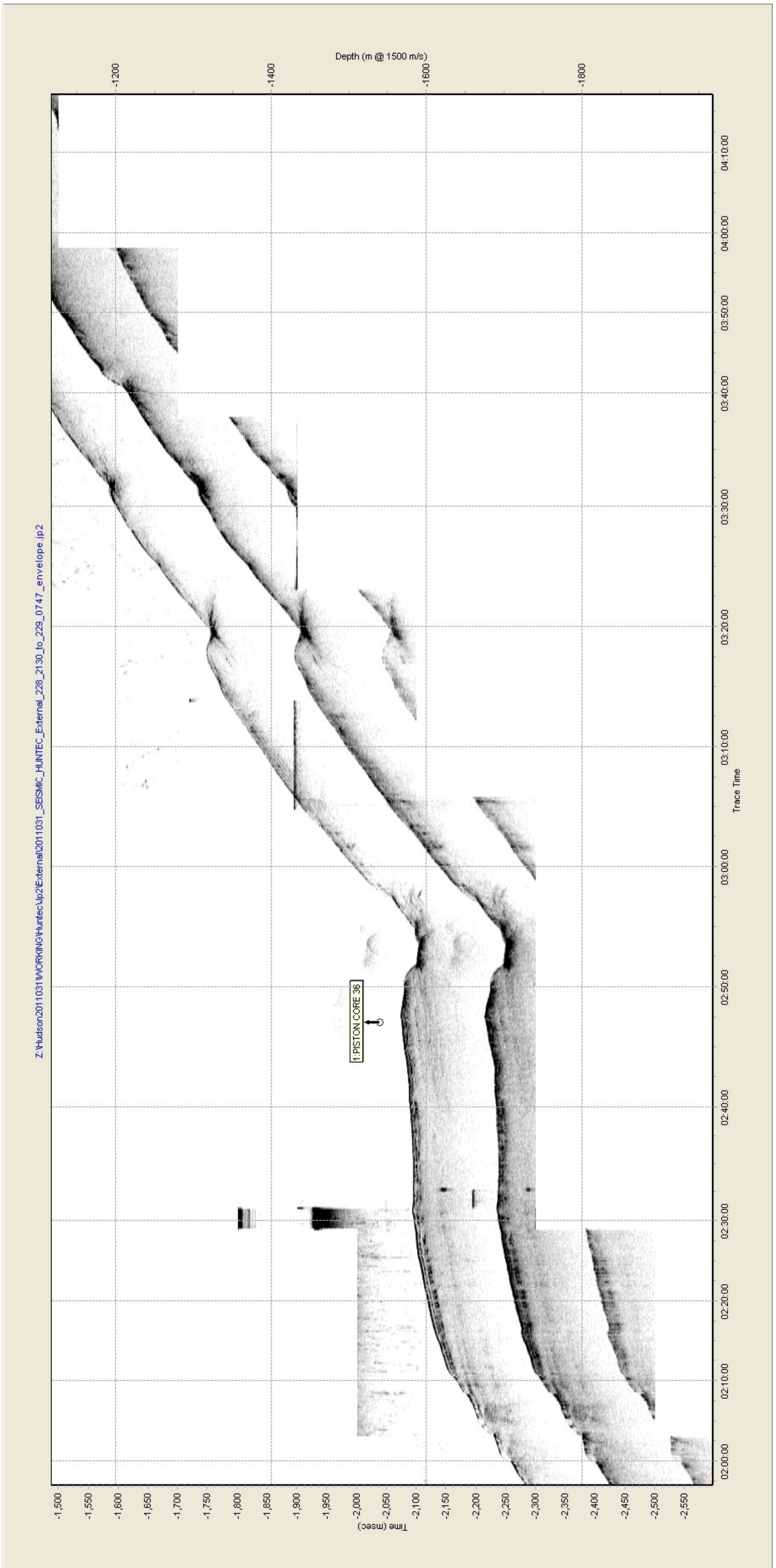

Z:\Hudson2011031\WORKING\Huntec\Jp2\External\2011031_SEISMIC_HUNTEC_External_227_2014_to_228_0647_envelope.jp2
Depth (m @ 1500 m/s)
-1200
-1250
-1300
-1350
-1400
-1450
-1500
0:PISTON CORE 30
06:00:00
05:30:00
05:00:00
04:30:00
Trace Time
Time (msec)

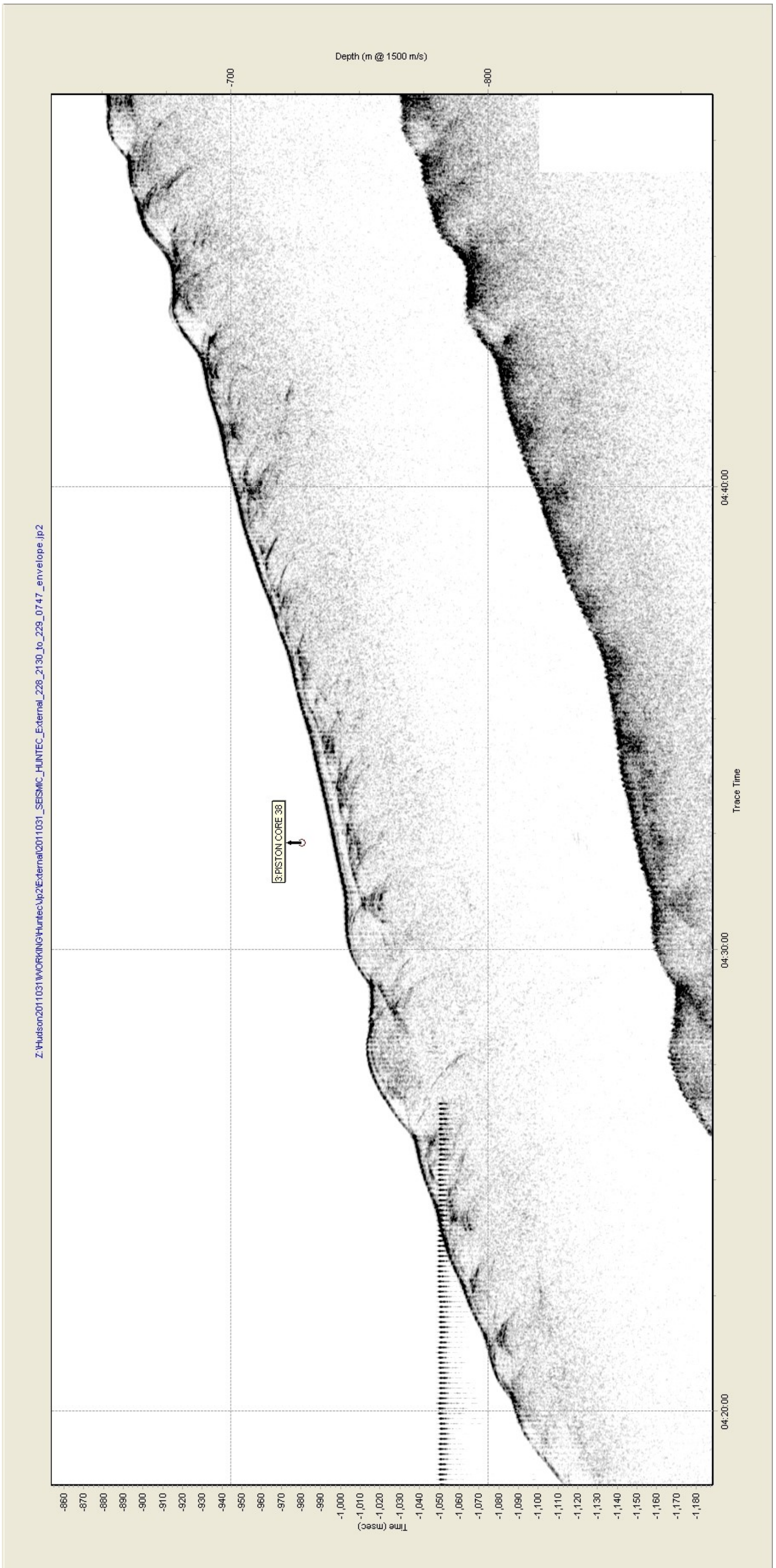

Depth (m @ 1500 m/s)
0:PISTON CORE 34
Trace Time
Time (msec)

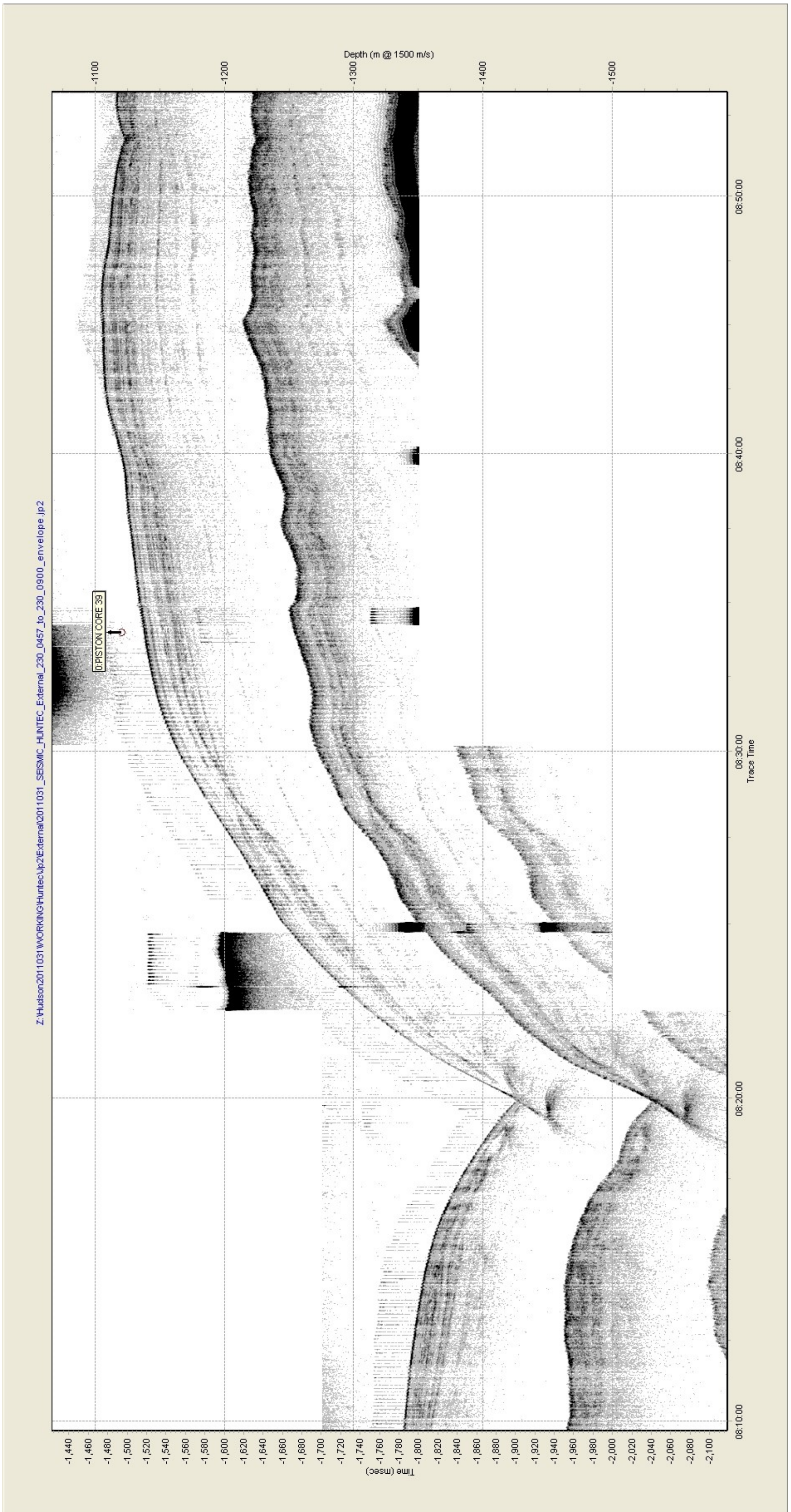


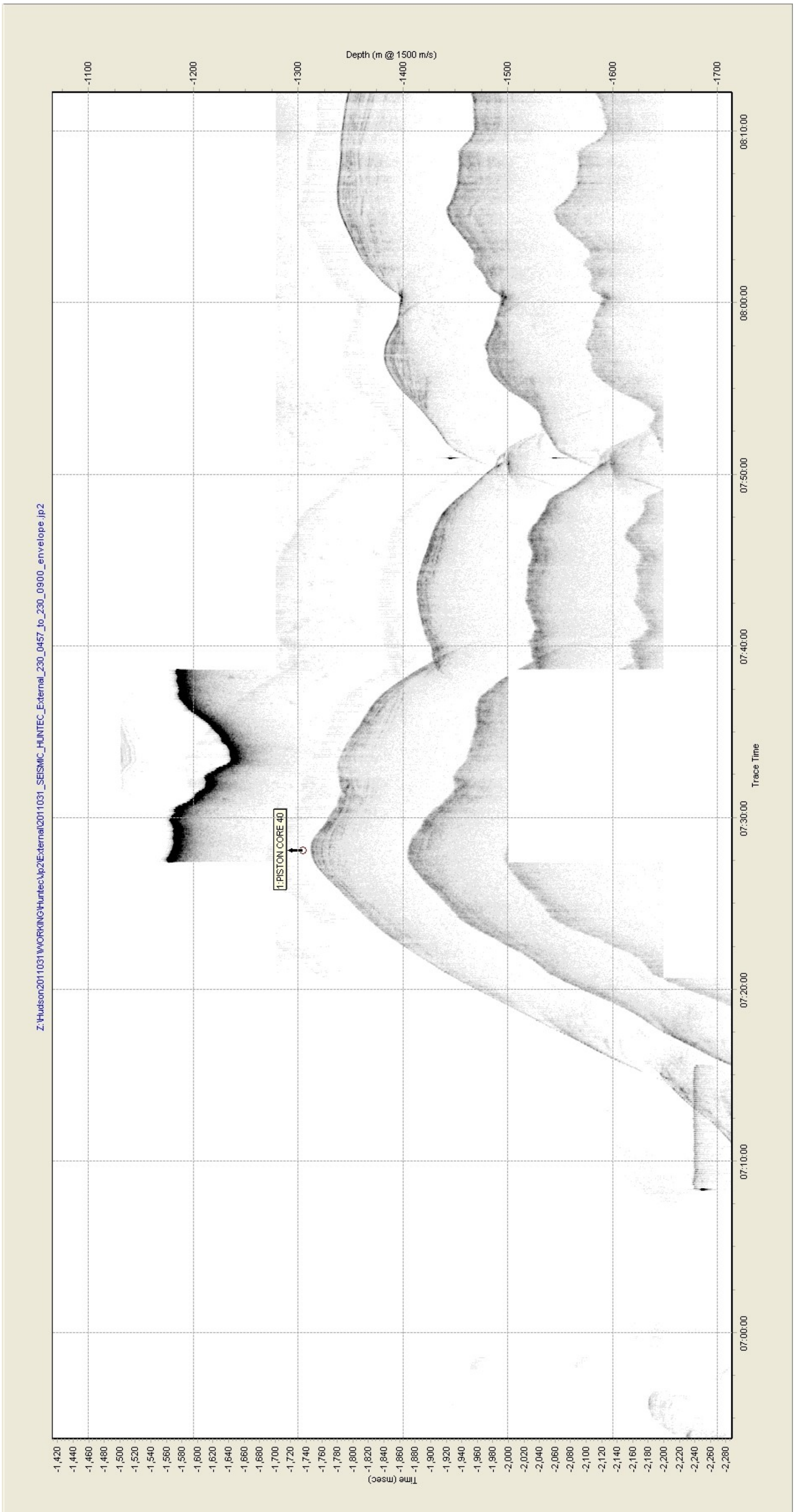
Depth (m @ 1500 m/s)
-1200
-1400
-1600
0 PISTON CORE 35
07:40:00
07:30:00
07:20:00
Trace Time
Time (msec)

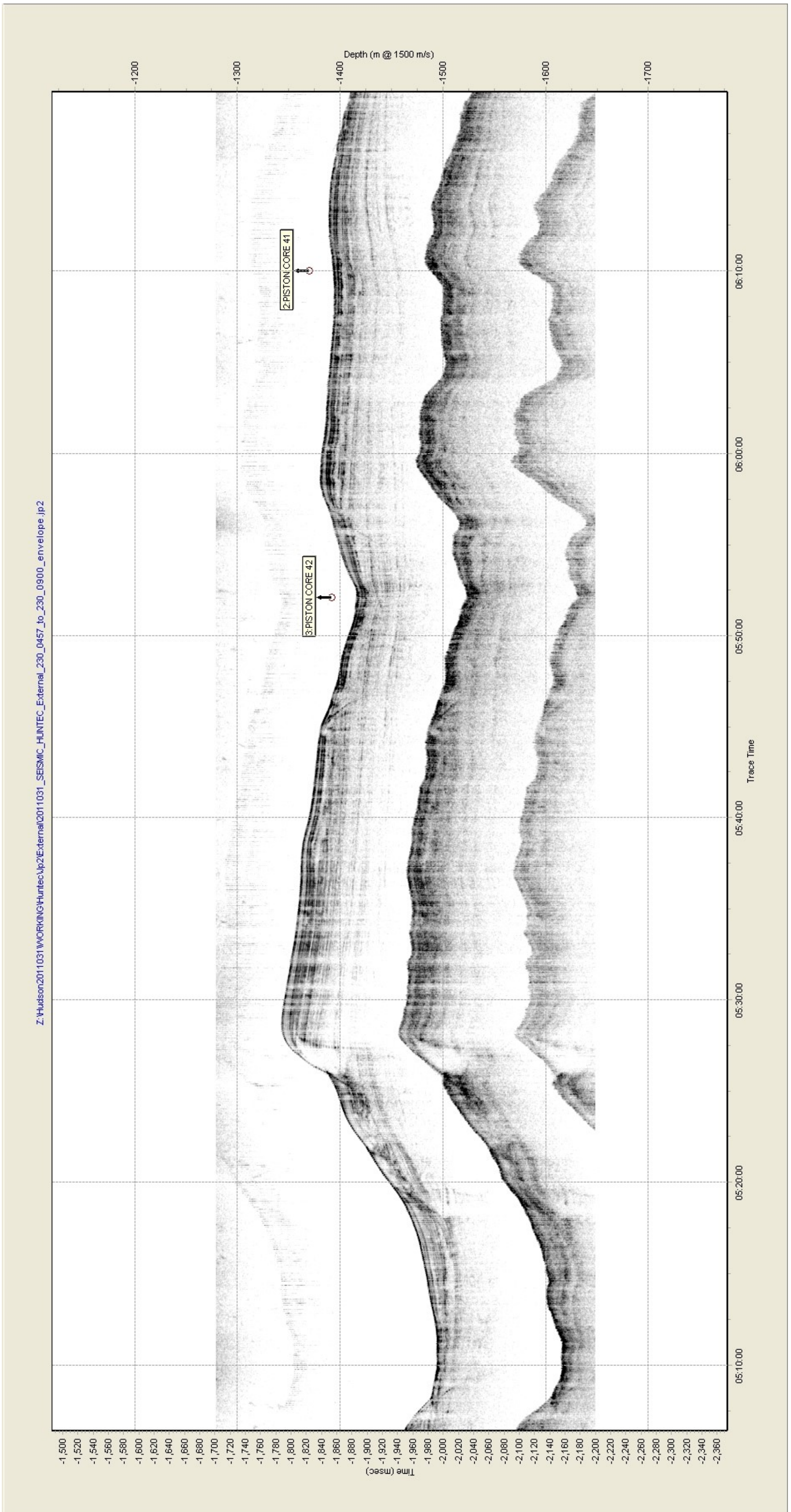

Z:\Hudson2011031\WORKING\Huntec\jp2\External\2011031_SEISMIC_HUNTEC_External_228_2130_to_229_0747_envelope.jp2
Depth (m @ 1500 m/s)
Time (msec)
Trace Time
2:PISTON CORE 37
1:PISTON CORE 36


Z:\Hudson2011031\WORKING\Huntec\Jp2\External\2011031_SEISMIC_HUNTEC_External_228_2130_to_229_0747_envelope.jp2
Depth (m @ 1500 m/s)
-1200
-1400
-1600
-1800
1-PISTON CORE 36
Trace Time
02:00:00
02:10:00
02:20:00
02:30:00
02:40:00
02:50:00
03:00:00
03:10:00
03:20:00
03:30:00
03:40:00
03:50:00
04:00:00
04:10:00
Time (msec)
-1,500
-1,550
-1,600
-1,650
-1,700
-1,750
-1,800
-1,850
-1,900
-1,950
-2,000
-2,050
-2,100
-2,150
-2,200
-2,250
-2,300
-2,350
-2,400
-2,450
-2,500
-2,550

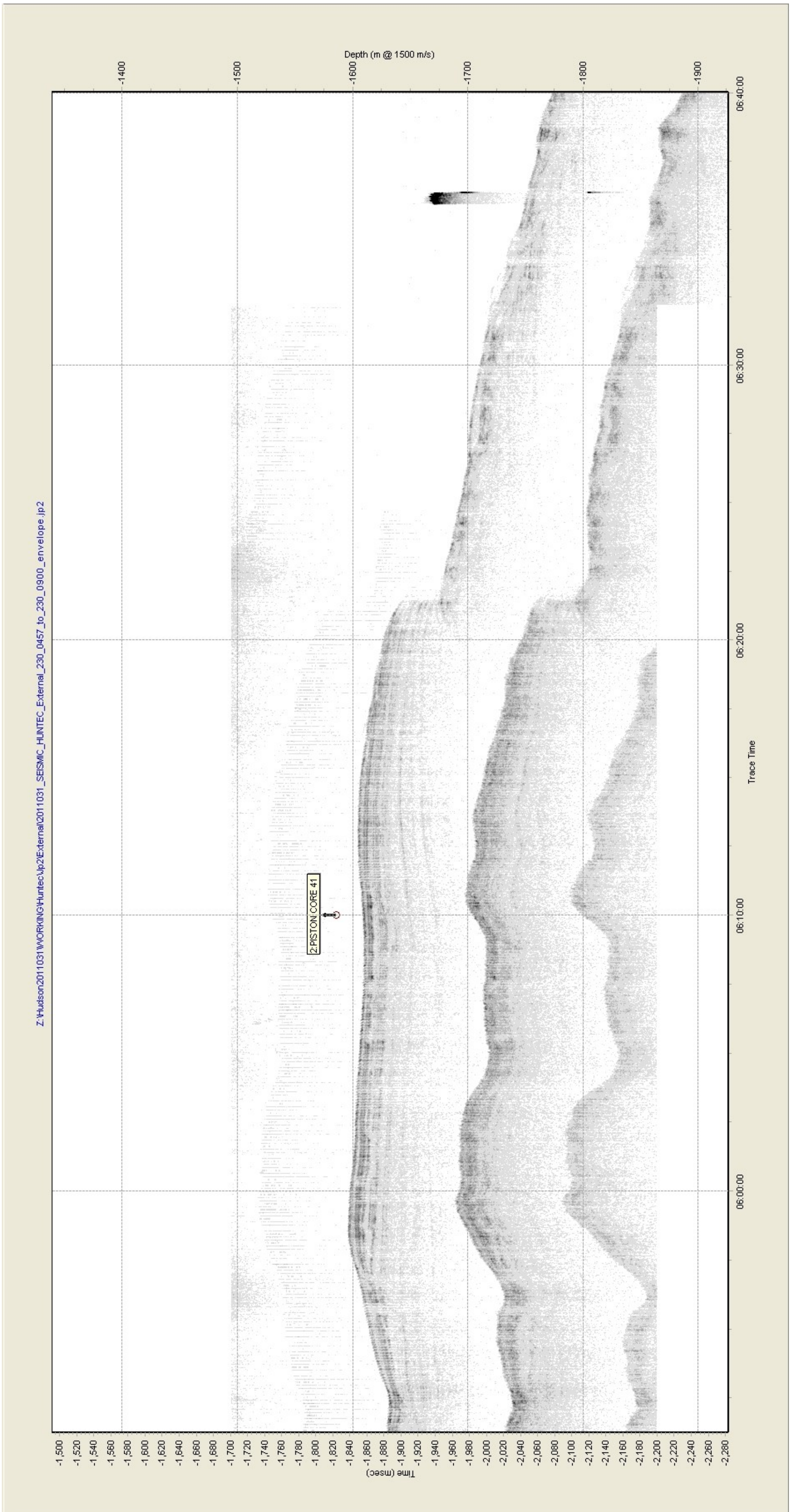

Depth (m @ 1500 m/s)
-700
-800
3:PISTON CORE 38
Trace Time
04:20:00
04:30:00
04:40:00
Time (msec)

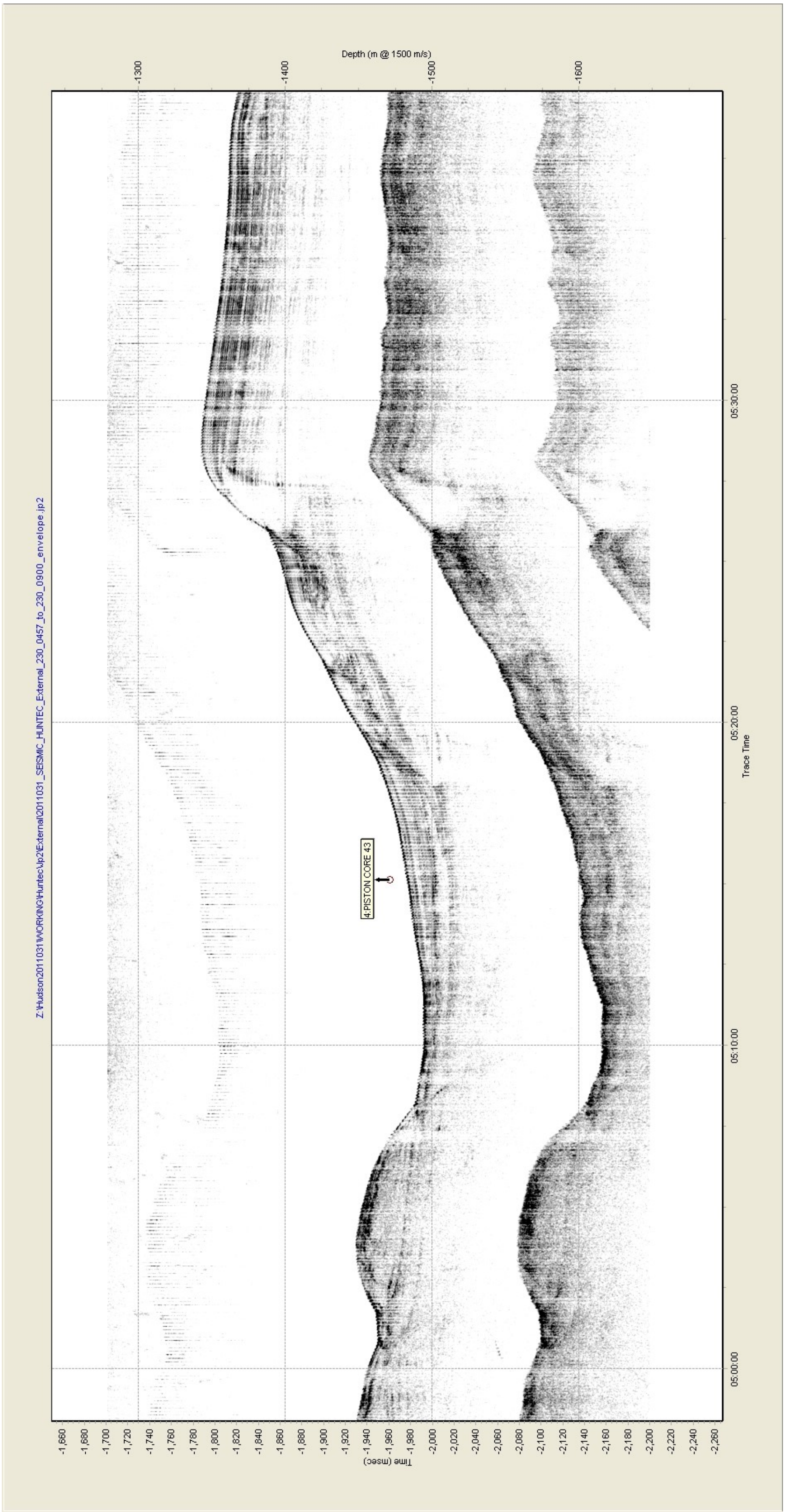

Z:\Hudson2011031\WORKING\Huntec\Jp2\External\2011031_SEISMIC_HUNTEC_External_230_0457_to_230_0900_envelope.jp2
Depth (m @ 1500 m/s)
0 PISTON CORE 39
Trace Time
Time (msec)

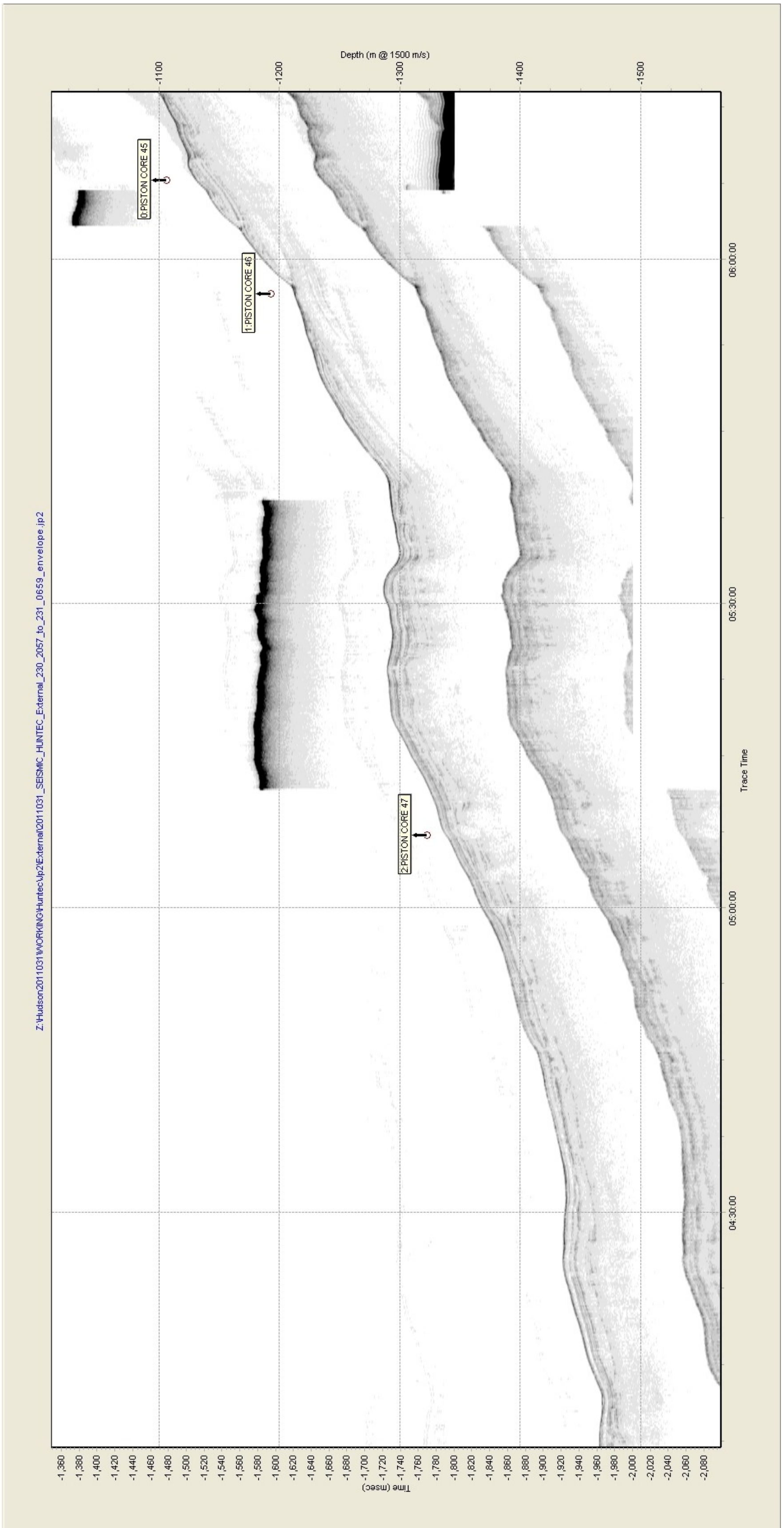

Z:\Hudson2011031\WORKING\Huntec\Up2\External\2011031_SEISMIC_HUNTEC_External_230_0457_to_230_0900_envelope.jp2
Depth (m @ 1500 m/s)
Trace Time
Time (msec)
1:PISTON CORE 40



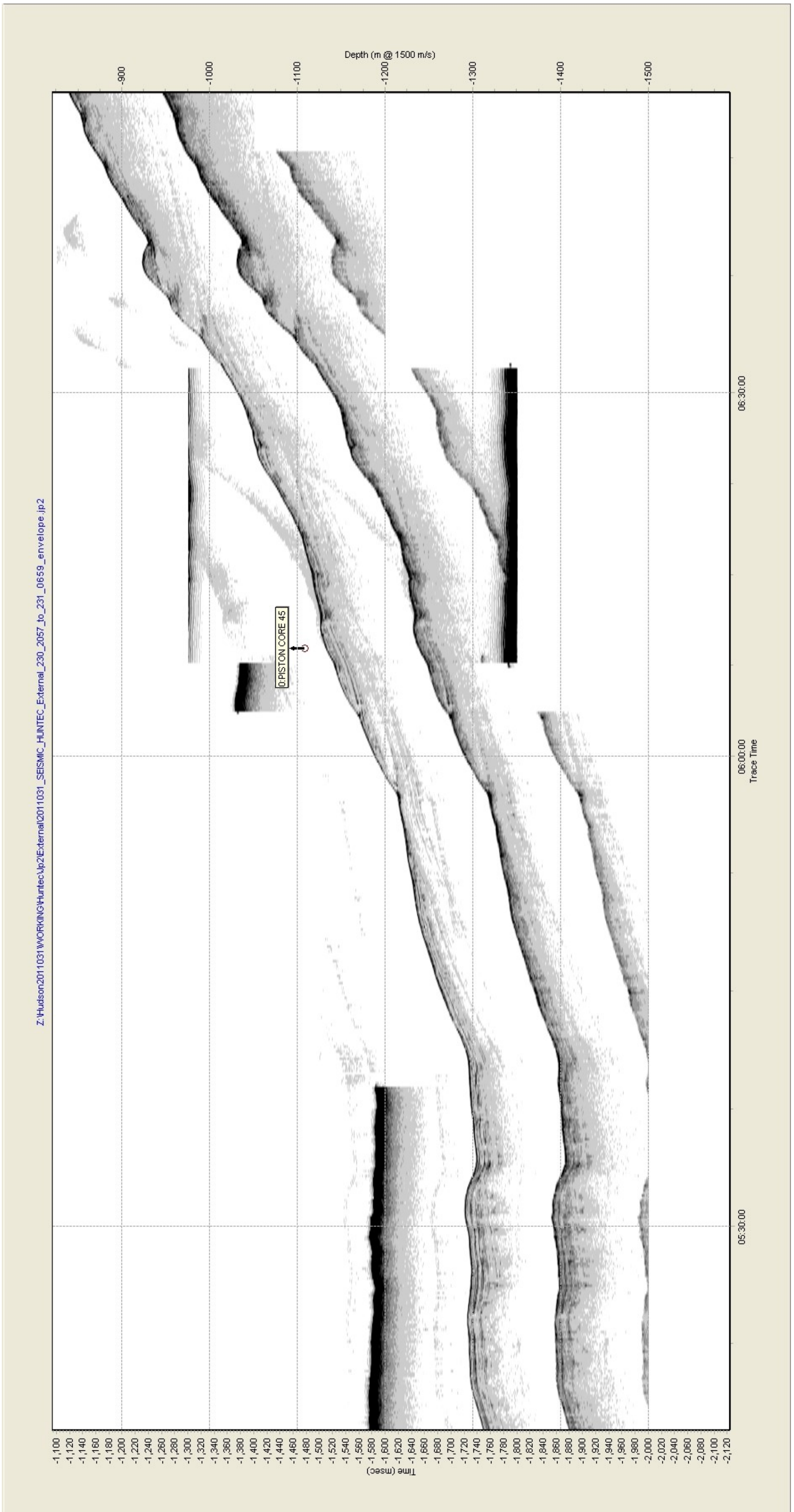
Z:\Hudson2011031\WORKING\Huntec\Jp2\External\2011031_SEISMIC_HUNTEC_External_230_0457_to_230_0900_envelope.jp2
Depth (m @ 1500 m/s)
2-PISTON CORE 41
3-PISTON CORE 42
Trace Time
Time (msec)

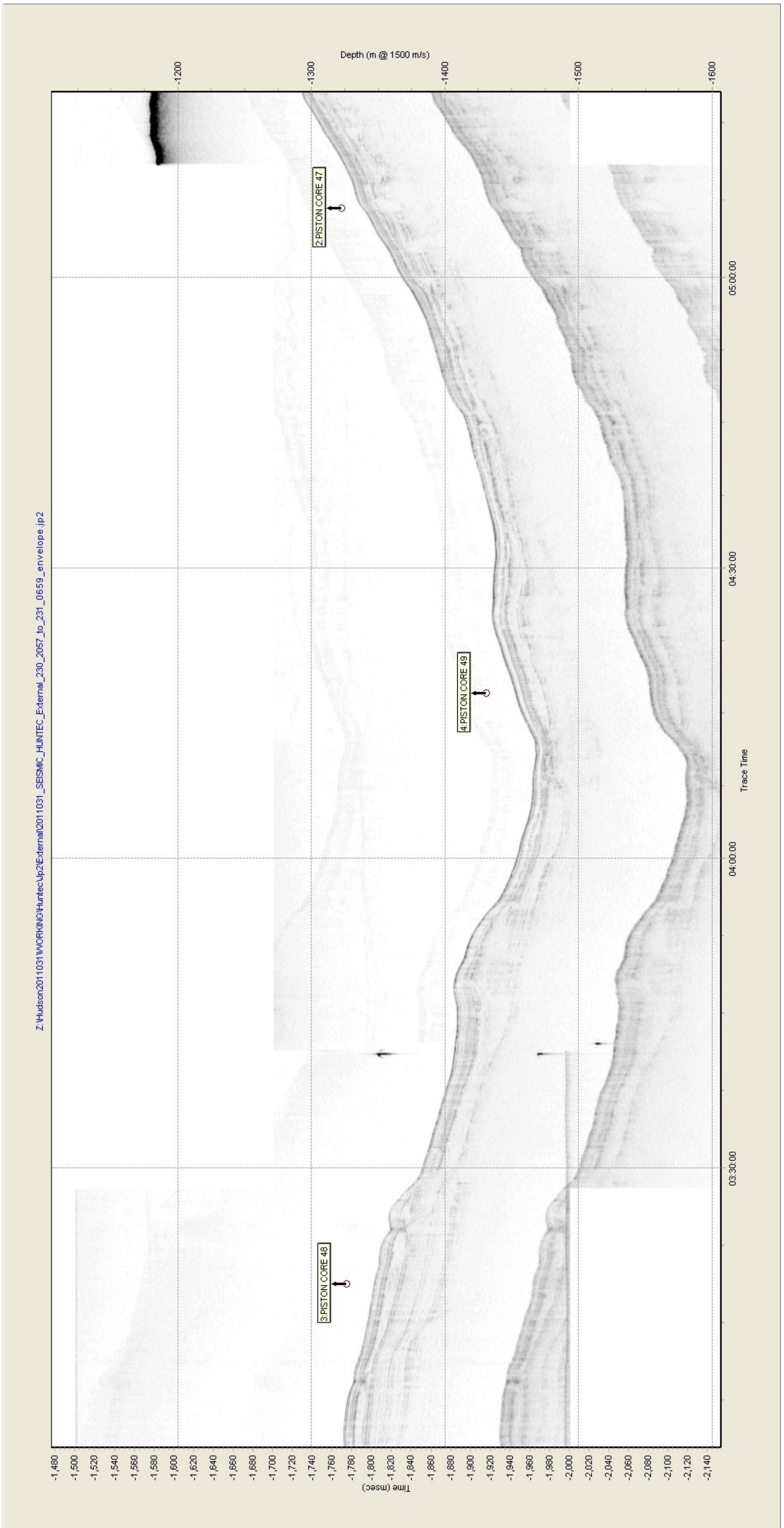

Depth (m @ 1500 m/s)
2:PISTON CORE 41
Trace Time
Time (msec)

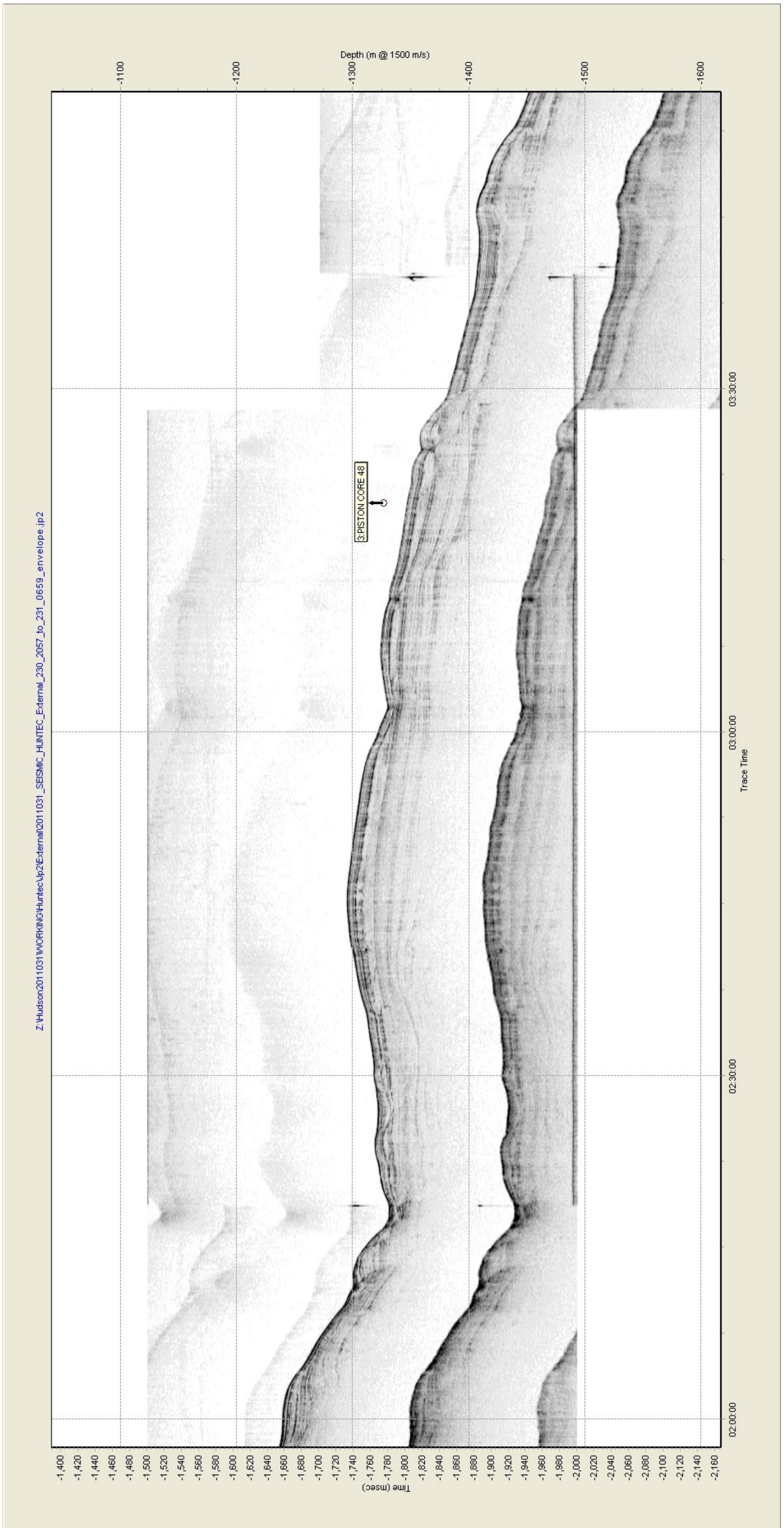

Z:\Hudson2011031\WORKING\Huntec\Jp2\External\2011031_SEISMIC_HUNTEC_External_230_0457_to_230_0900_envelope.jp2
Depth (m @ 1500 m/s)
1300
1400
1500
1600
4-PISTON CORE 43
05:00:00
05:10:00
05:20:00
05:30:00
Trace Time
Time (msec)

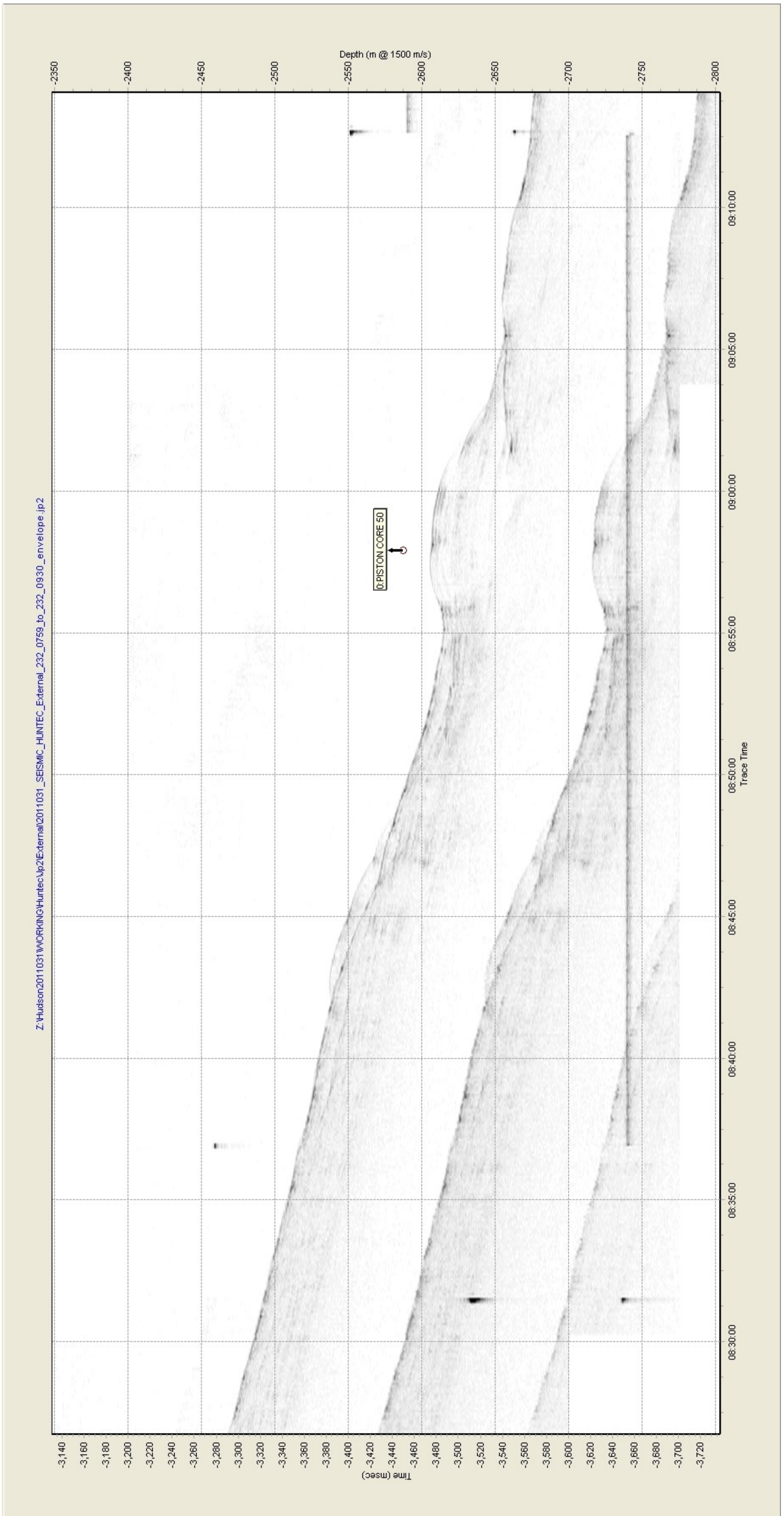

Z:\Hudson2011031\WORKING\Huntec\jp2\External\2011031_SEISMIC_HUNTEC_External_230_2057_to_231_0659_envelope.jp2
0:PISTON CORE 45
1:PISTON CORE 46
2:PISTON CORE 47
Depth (m @ 1500 m/s)
Trace Time
Time (msec)

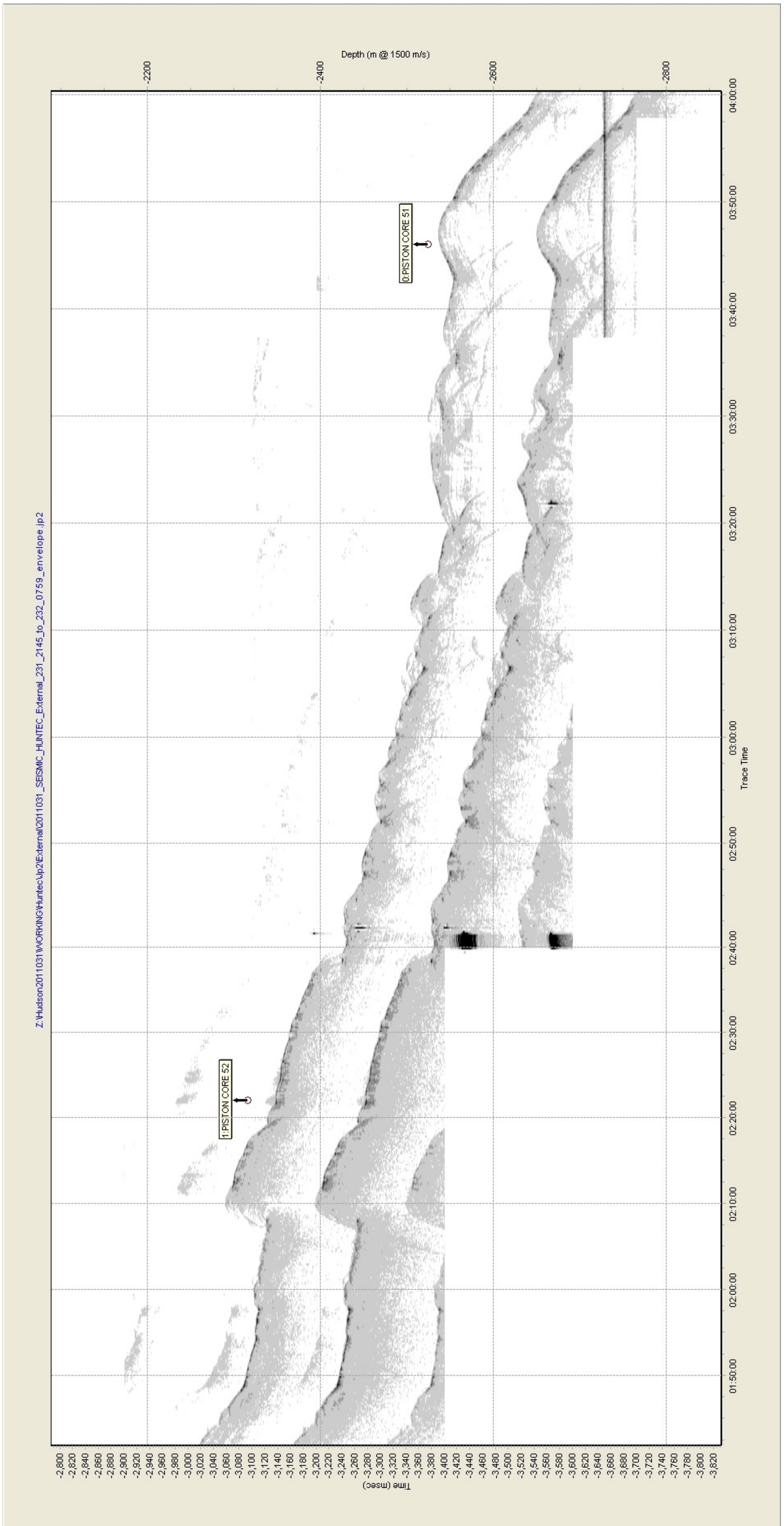

Z:\Hudson2011031\WORKING\Huntec\jp2\External\2011031_SEISMIC_HUNTEC_External_230_2057_to_231_0659_envelope.jp2
Depth (m @ 1500 m/s)
Time (msec)
Trace Time
0:PISTON CORE 45
1:PISTON CORE 46
05:00:00
05:30:00
06:00:00
06:30:00

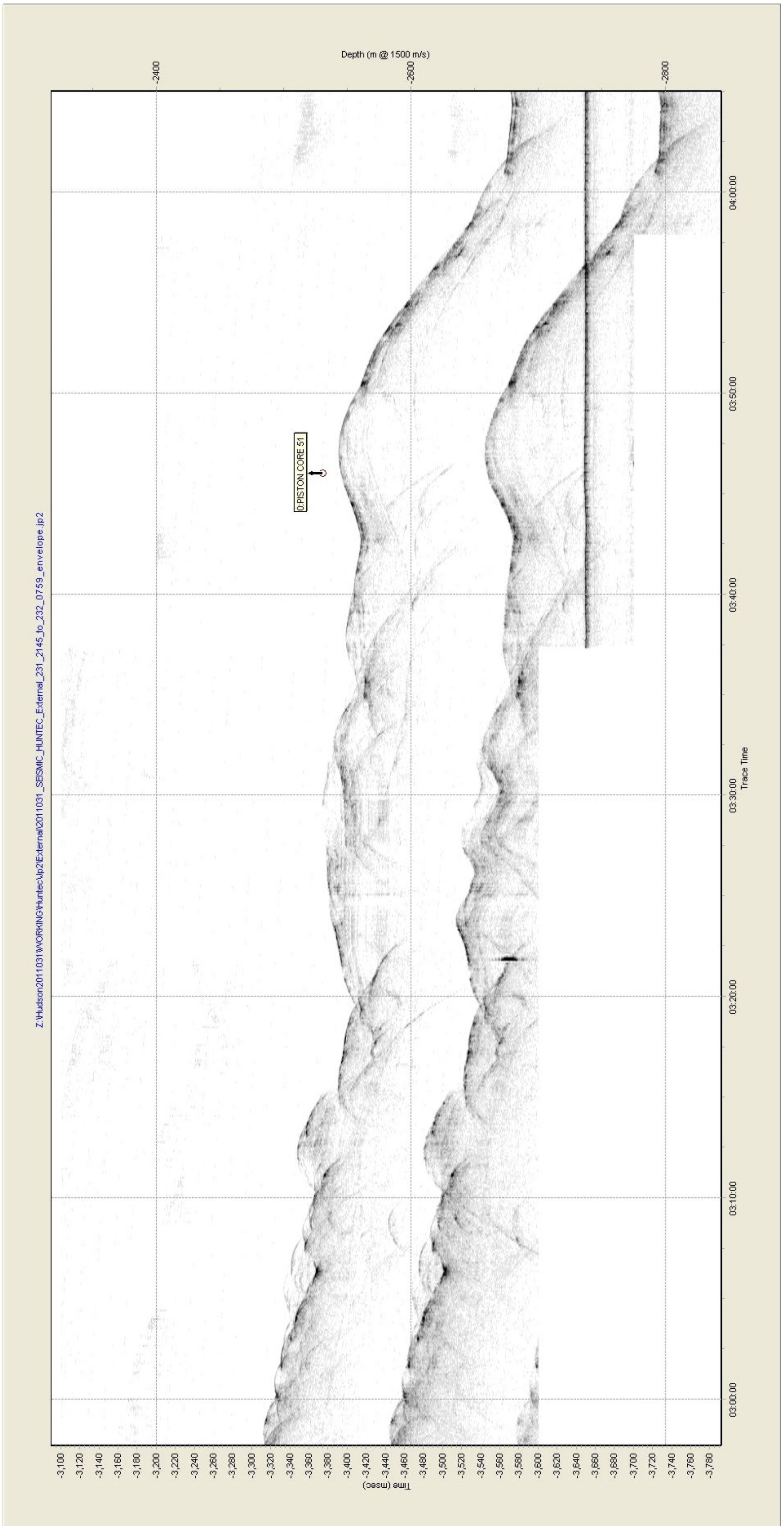

Z:\Hudson2011031\WORKING\Huntec\Jp2\External\2011031_SEISMIC_HUNTEC_External_230_2057_to_231_0659_envelope.jp2
Depth (m @ 1500 m/s)
Time (msec)
Trace Time
0:PISTON CORE 45

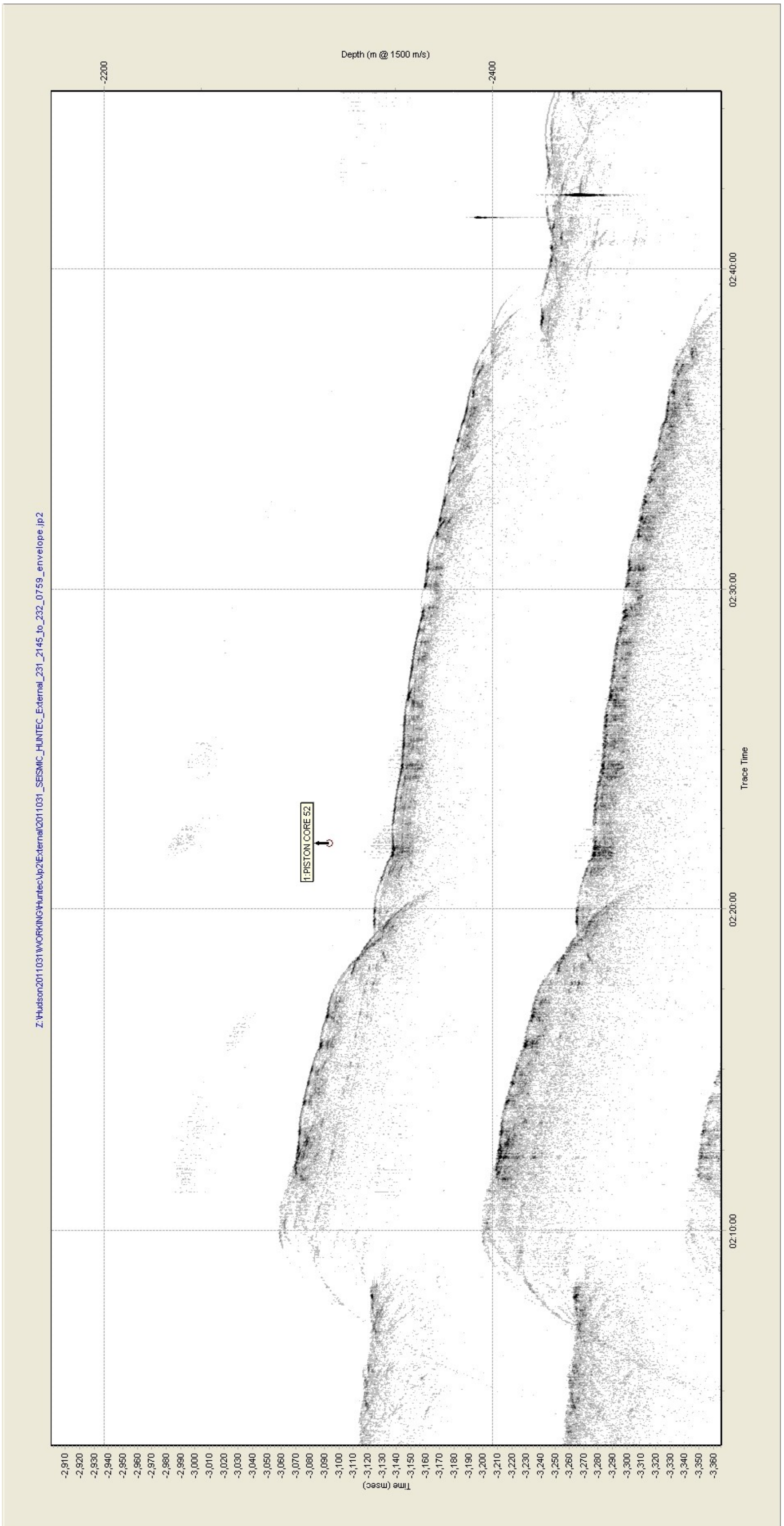

Depth (m @ 1500 m/s)
2:PISTON CORE 47
4:PISTON CORE 49
3:PISTON CORE 48
Trace Time
Time (msec)
05:00:00
04:30:00
04:00:00
03:30:00

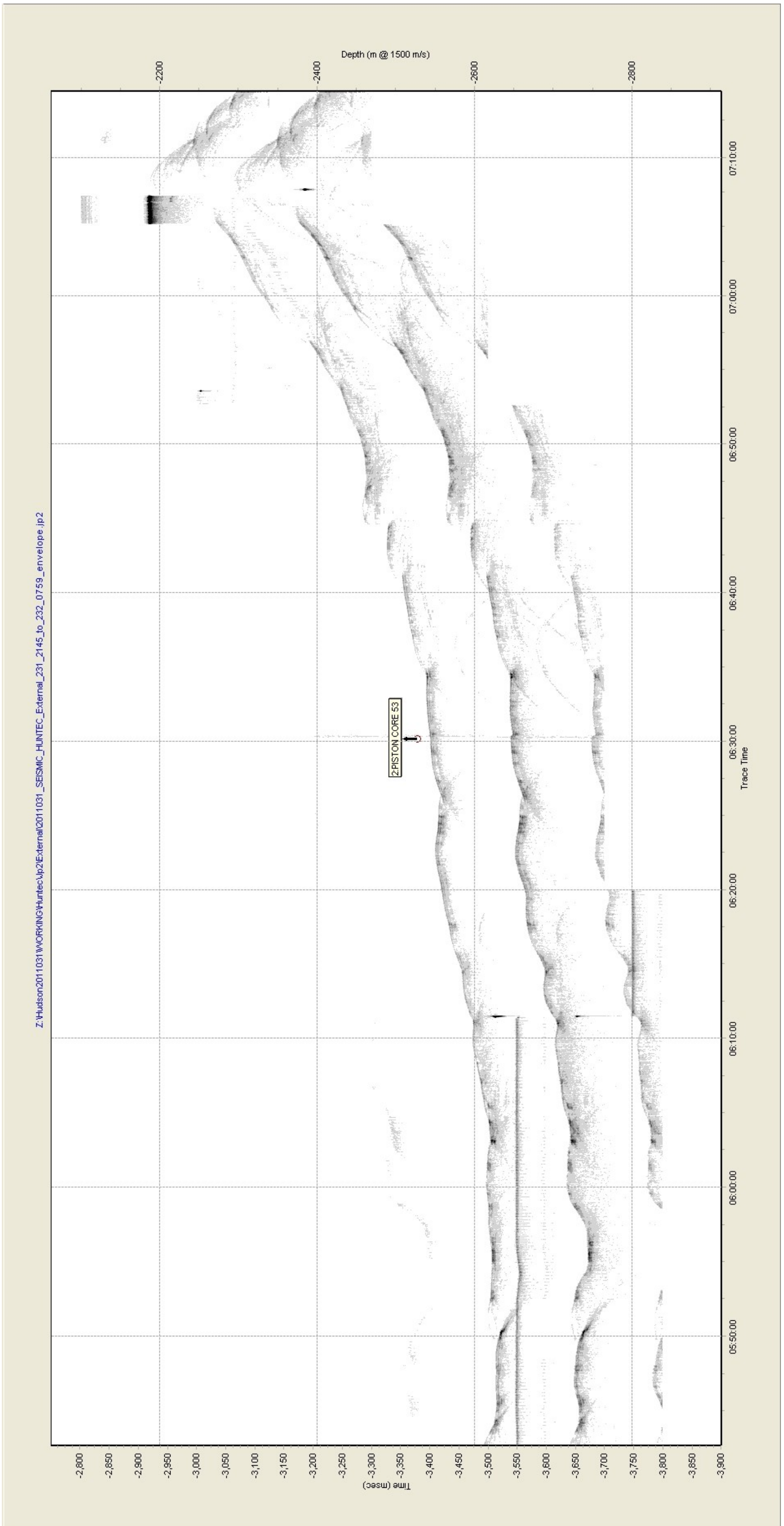

Depth (m @ 1500 m/s)
Trace Time
Time (msec)
3:PISTON CORE 48

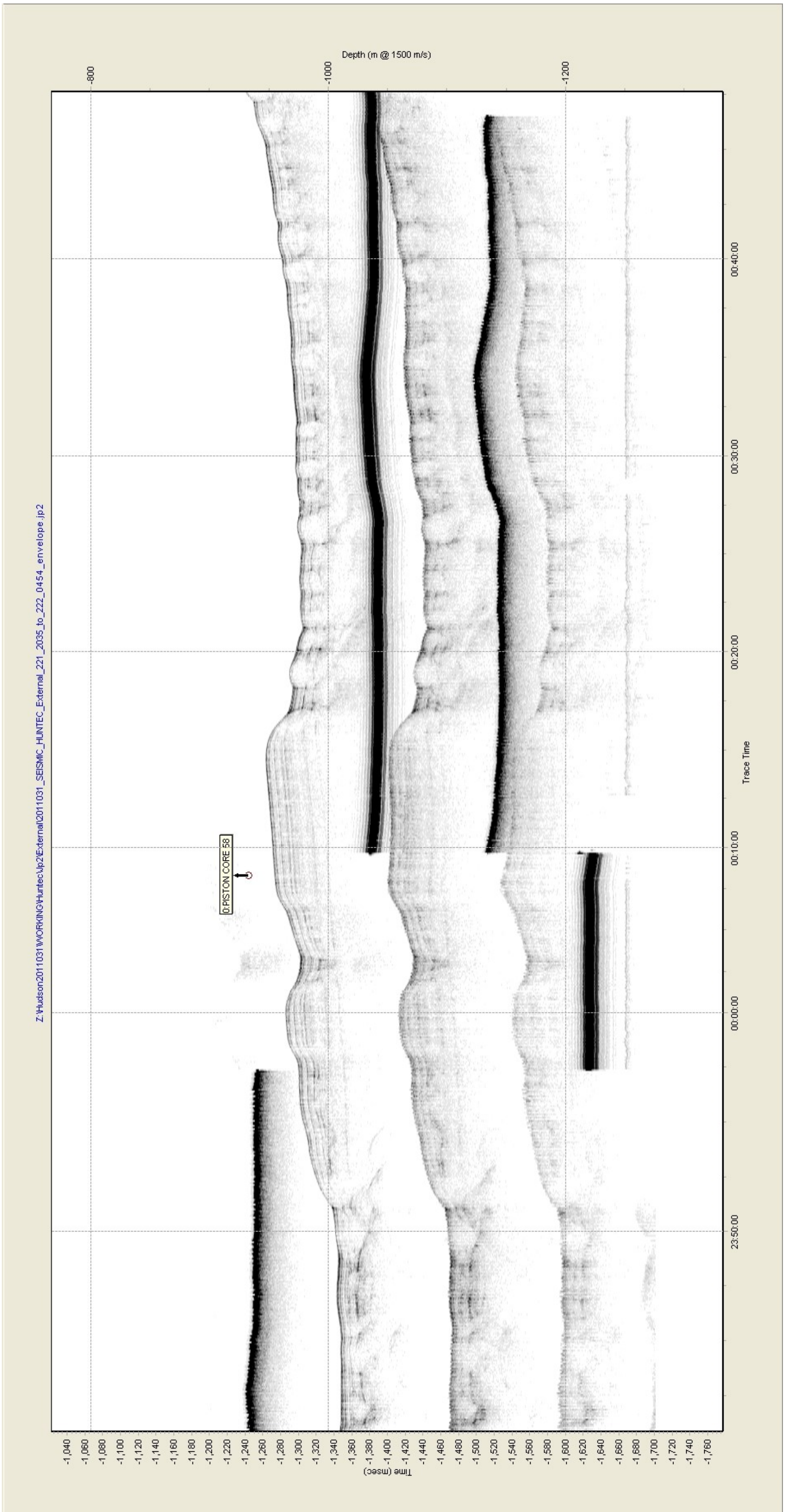

Z:\Hudson2011031\WORKING\Huntec\jp2\External\2011031_SEISMIC_HUNTEC_External_232_0759_to_232_0930_envelope.jp2
Depth (m @ 1500 m/s)
0:PISTON CORE 50
Trace Time
Time (msec)
08:30:00
08:35:00
08:40:00
08:45:00
08:50:00
08:55:00
09:00:00
09:05:00
09:10:00

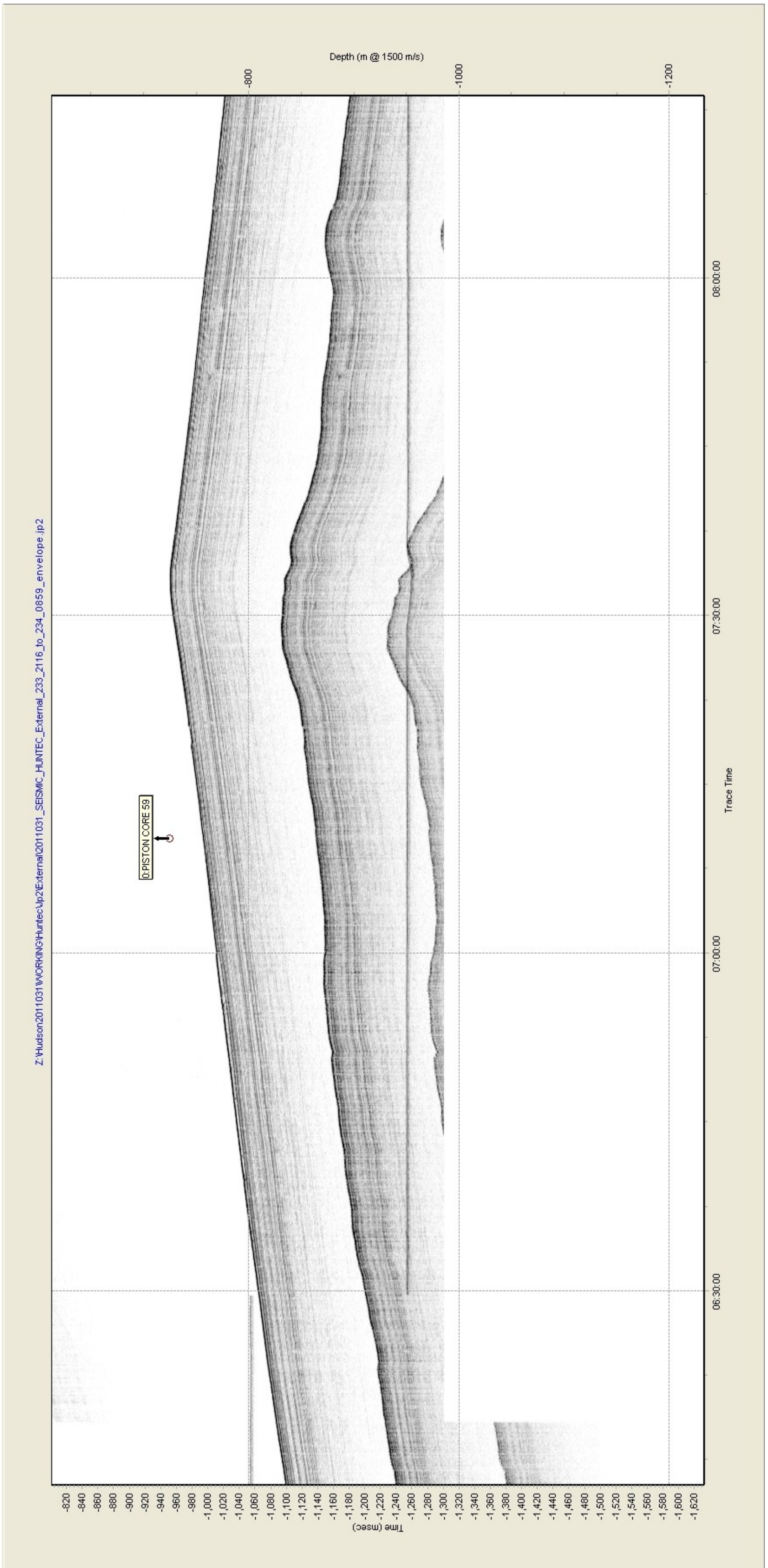

Depth (m @ 1500 m/s)
Trace Time
Time (msec)
0:PISTON CORE 51
1:PISTON CORE 52

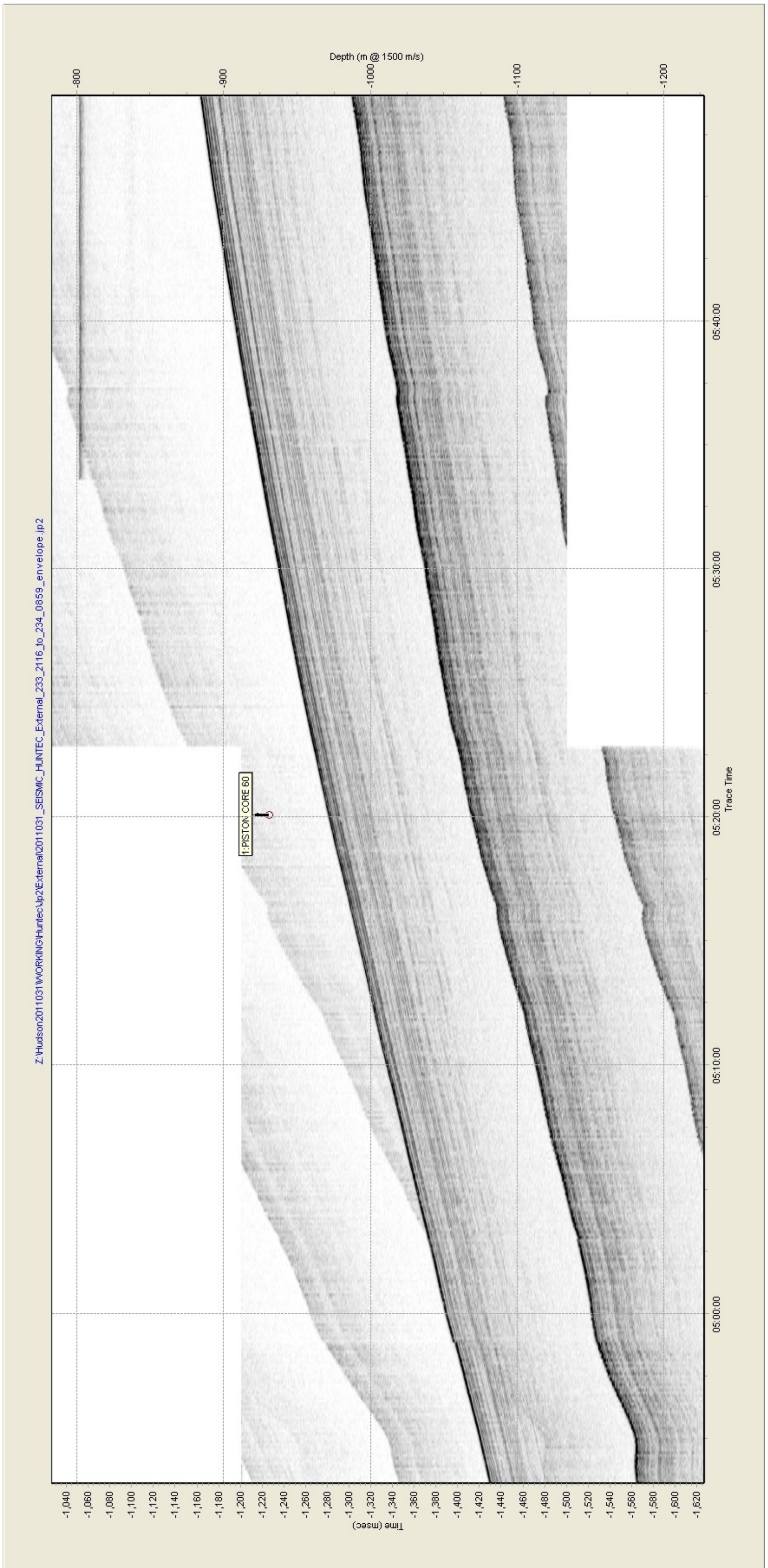

Depth (m @ 1500 m/s)
Trace Time
Time (msec)
0:PISTON CORE 51

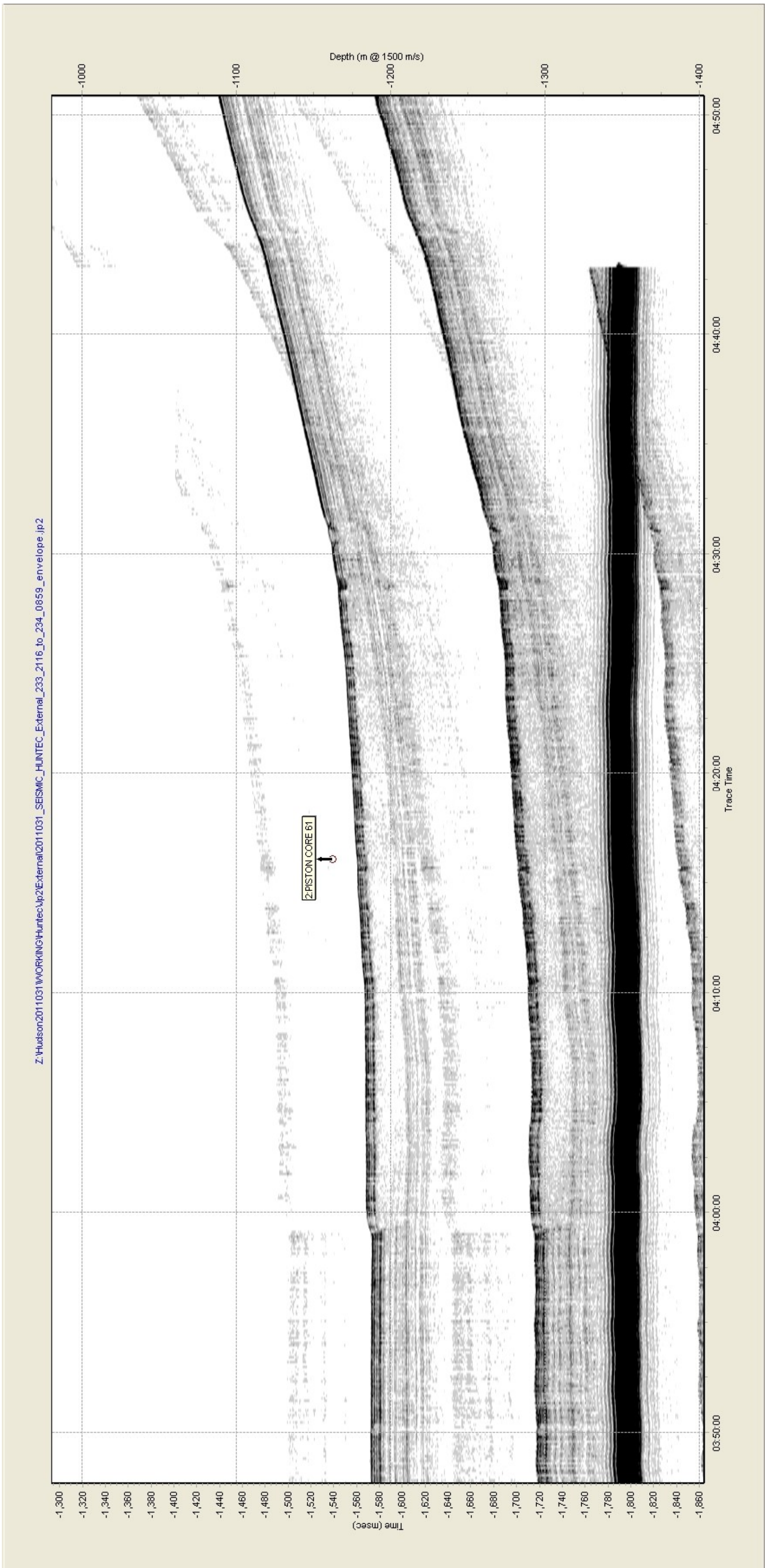

Z:\Hudson2011031\WORKING\Huntec\Jp2\External\2011031_SEISMIC_HUNTEC_External_231_2145_to_232_0759_envelope.jp2
Depth (m @ 1500 m/s)
-2200
-2400
1:PISTON CORE 52
Trace Time
02:10:00
02:20:00
02:30:00
02:40:00
Time (msec)


Z:\Hudson2011031\WORKING\Huntec\jp2\External\2011031_SEISMIC_HUNTEC_External_231_2145_to_232_0759_envelope.jp2
Depth (m @ 1500 m/s)
Trace Time
Time (msec)
2:PISTON CORE 53

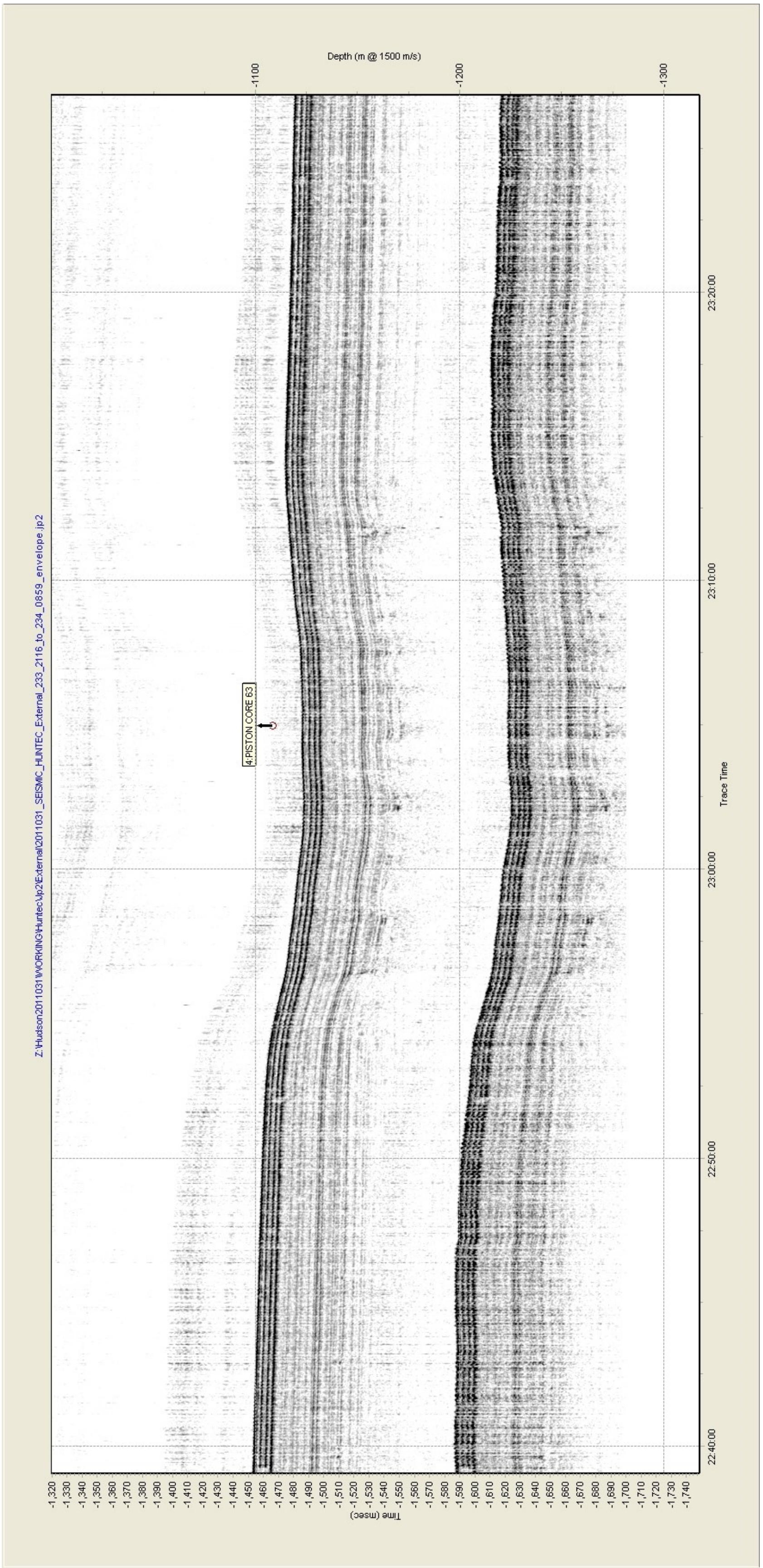

Z:\Hudson2011031\WORKING\Huntec\Jp2\External\2011031_SEISMIC_HUNTEC_External_221_2035_to_222_0454_envelope.jp2
Depth (m @ 1500 m/s)
-800
-1000
-1200
0:PISTON CORE 58
Trace Time
23:50:00
00:00:00
00:10:00
00:20:00
00:30:00
00:40:00
Time (msec)


Z:\Hudson2011031\WORKING\Huntec\jp2\External\2011031_SEISMIC_HUNTEC_External_233_2116_to_234_0859_envelope.jp2
Depth (m @ 1500 m/s)
-800
-1000
-1200
0:PISTON CORE 59
06:30:00
07:00:00
07:30:00
08:00:00
Trace Time
Time (msec)


Depth (m @ 1500 m/s)
Trace Time
Time (msec)
1-PISTON: CORE 60
05:00:00
05:10:00
05:20:00
05:30:00
05:40:00


Z:\Hudson\2011031\WORKING\Huntec\p2\External\2011031_SEISMIC_HUNTEC_External_233_2116_to_234_0859_envelope.jp2
Depth (m @ 1500 m/s)
Trace Time
Time (msec)
2:PISTON CORE 61


Z:\Hudson2011031\WORKING\Huntec\jp2\External\2011031_SEISMIC_HUNTEC_External_233_2116_to_234_0859_envelope.jp2
Depth (m @ 1500 m/s)
3:PISTON CORE 62
Trace Time
Time (msec)


Z:\Hudson\2011031\WORKING\Huntec\jp2\External\2011031_SEISMIC_HUNTEC_External_233_2116_to_234_0859_envelope.jp2
Depth (m @ 1500 m/s)
-1100
-1200
-1300
4:PISTON CORE 63
22:40:00
22:50:00
23:00:00
23:10:00
23:20:00
Trace Time
Time (msec)