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GEOLOGICAL SURVEY OF CANADA
OPEN FILE 8398

The Queen Charlotte–Fairweather fault zone – a submarine transform fault, offshore British Columbia and southeastern Alaska; cruise report of 2017003PGC *CCGS Vector* and 2017004PGC *CCGS John P. Tully*

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2018

Canada

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Publications in this series have not been edited; they are released as submitted by the author.

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INTRODUCTION

Under a Geological Survey of Canada (Natural Resources Canada), US Geological Survey (USGS), and Sitka Sound Science Center collaborative program, two scientific cruises were planned along the Queen Charlotte-Fairweather transform fault (QC-FW) system to determine fault geometry and associated risk to the communities of northern BC and SE Alaska (Fig. 1). The first objective was to continue the multibeam swath bathymetry and high-resolution CHIRP sub-bottom mapping to complete full coverage of the fault in Canadian waters using the *CCGS Vector*, including the mapping of the mud volcano with a 700 m plume discovered in 2015 that straddles the international boundary. The second objectives was to conduct a 20 day marine survey aboard the *CCGS John P. Tully* to understand earthquake hazards, fault system mechanics, hydrogeology, and submarine mass wasting processes along the entire QC-FW system, the 1200-km-long transform boundary that separates the Pacific and North American tectonic plates. In particular, the growing cities of Prince Rupert, BC and Sitka, Alaska are both very vulnerable to tsunamis generated along the QC-FW system.

Data collection involved piston cores, seafloor photography, large grab samples, CTD casts, 3.5 kHz CHIRP sub-bottom profiles, and multi-channel seismic-reflection profiles along the continental margin of western British Columbia and southeastern Alaska. Other key objectives of the cruise were to better understand sedimentation history along the margin and to examine a series of fluid seeps that were identified during the 2015 *John P. Tully* expedition and the USGS geophysical surveys of 2016 and 2017 (Brothers et al., 2017). Fluid seeps can provide a window into geological processes happening at depth and can be used in conjunction with heat flow modeling, to better understand the hydrogeology of the margin.

The *CCGS John P. Tully* and *Vector* cruises expanded on results from the 2015 *Tully* survey and coring expedition (Greene and Barrie, 2017) and the 2017 *R/V Ocean Starr* cruise in Alaska. On the *Ocean Starr* MCS survey, several unmapped faults along the margin were mapped, including evidence for dip-slip deformation along the seaward edge of the Queen Charlotte Terrace (and its northern morphological equivalent), parallel and subparallel faults on the shelf edge (e.g., "Sitka Sound Fault"), and post-glacial stratigraphy in five of the major glacially scoured sea valleys of southern Alaska (Dixon Entrance, Sumner, Chatham, Sitka Sound, and Yakobi). In total, 3,000 km of high-resolution multichannel sparker profiles, 300 km of sub-bottom Chirp profiles and one 80-km sonobuoy profile were collected during this 20-day cruise.

In addition, a short multichannel seismic and sub-bottom profiling survey was planned for the area where the Devils Mountain and Leech River Faults are believed to join just offshore the city of Victoria in the central Strait of Juan de Fuca. During the transit north, along western Vancouver Island, a short stop to collect a core for Cascadia paleo-seismicity studies was planned.

BACKGROUND

The QC-FW fault system is a major structural feature that extends from the Explorer Triple Junction of British Columbia, Canada to well into the bight of the Gulf of Alaska (Fig. 1). This system represents a major transform boundary that separates the Pacific Plate from the

North American Plate, similar to the San Andreas Fault system (SAF) of California (Atwater, 1970; Plafker et al., 1978). The length of the QC-FW fault system is 1,330 km, slightly longer than the SAF, with a reported width of 1 to 5 km and approximately 75% of the length located offshore (Carlson et al., 1985). The QC-FW is widely recognized as one of the world's most seismically active continent ocean transform faults (Plafker et al., 1978; Nichenko and Jacob, 1990). At least seven earthquakes of magnitude 7 or greater have occurred along the QC-FW in the past century (Brothers et al., 2017).

In the south, the QC-FW fault system extends for over 350 km along the western margin of British Columbia and offshore of the Haida Gwaii Islands (formerly Queen Charlotte Islands) archipelago. It is a near-vertical fault zone and seismically active down to approximately 21 km (Hyndman and Ellis, 1981) with a mainly right-lateral transform motion of approximately 50 to 60 mm/year (Prims et al., 1997; Rohr et al., 2000). Previous studies have documented the fault morphology, identified features associated with localized deformation along the fault (step-overs), submarine canyons, gullies and a submarine slide adjacent to the fault (Barrie et al., 2013; Harris et al., 2014).

In contrast to the predominately strike-slip motion along the central and northern portions of the QC-FW fault zone, plate motion along the southern portion is more oblique with up to 20^o of convergence up to central Haida Gwaii where the motion becomes primarily strike-slip (Hyndman and Hamilton, 1993). For example, the 2012 Haida Gwaii (M_W 7.8) earthquake involved slightly oblique thrust faulting on a shallow dipping fault plain whose strike is parallel to the QC fault zone (Lay et al., 2013).

The 1949 M_S 8.1 (M_W 7.9) Queen Charlotte Island earthquake is the largest historical earthquake in Canada and the largest recoded along the entire QC-FW system. This strike-slip event has an estimated rupture length between 265 and 490 km (300 km north and 190 km south of the epicenter) and an average co-seismic displacement of 4.0-7.5 m (Bostwick, 1984; Lay et al., 2013). The 2013 M_W 7.5 Craig strike-slip earthquake occurred near the northern end of the 1949 rupture zone. In addition, several large earthquakes have been reported along the fault zone (Page, 1969; Carlson et al., 1985; Lisowski et al., 1987) including the powerful (M_L 6.7) earthquake that occurred close to the QC-FW fault zone south of the Chatham Strait fault zone on June 28, 2004 (USGS, 2004).

The most recent seismicity includes a shallow (>1 km deep) moderate magnitude earthquake (M_L 5.7, January 6, 2000) along the QC-FW fault zone offshore of Yakutat and northwest of the entrance to Cross Sound (http://www.aeic.alaska.edu/html_docs/information_releases.html) and a deeper (10 km) moderate magnitude (M_L 5.9) earthquake that occurred in the south February 17, 2001 (http://www.aeic.alaska.edu/maps/southeast_panhandlemap.html), and the 2004 Chatham Strait (M_L 6.8) fault zone on June 28, 2004 (USGS, 2004). The latest earthquake occurred on 16 January 2017, a magnitude 4.3 event located on the QC-FW fault offshore of Elfin Cove (offshore of Cross Sound), approximately 145 km north of Sitka. Based on stress distribution, a continued rise in earthquake hazard is anticipated for the Haida Gwaii, or central segment of the QC-FW fault zone is anticipated (Bufe, 2005).

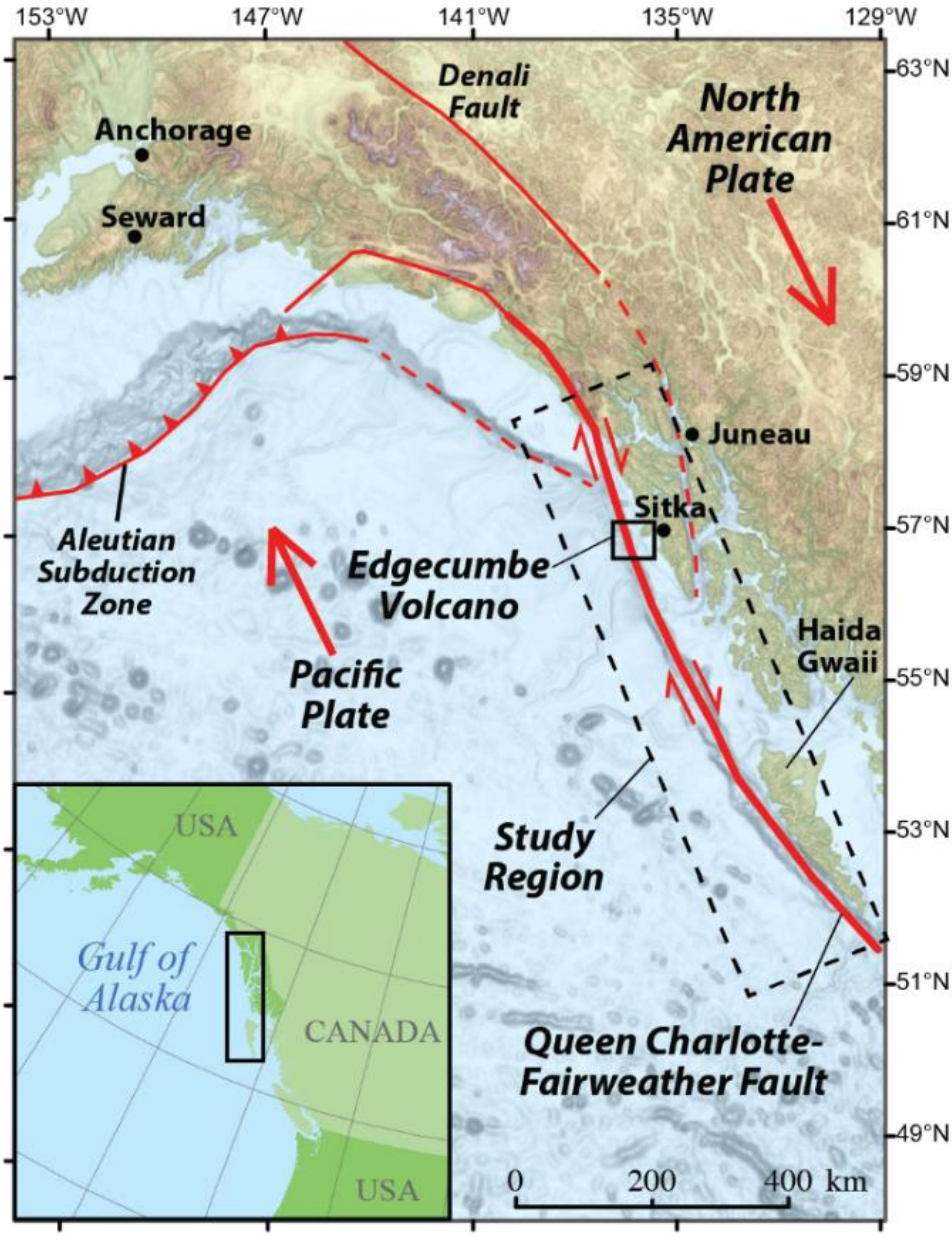


Figure1. Tectonic setting of the Pacific Northwest of North America including the Queen Charlotte-Fariweather fault system that extends from NW British Columbia, Canada off Haida Gwaii into SE Alaska.

2017003PGC *CCGS Vector* – July 20 - 28

Survey Equipment

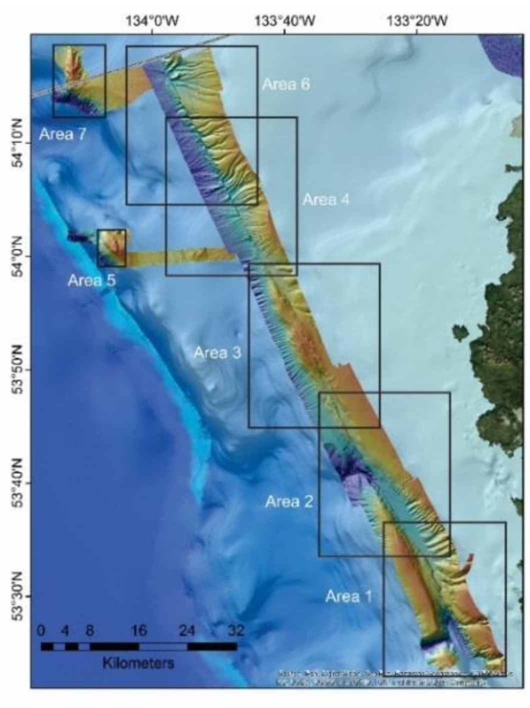
Multibeam: Kongsberg Maritime EM710MkII Multibeam Echosounder
Sub-bottom profiler: Knudsen Chirp 3260 3.5 kHz
IMU: Applanix POSMV 320 V5
SV: Rolls Royce Moving Vessel Profiler – MVP 200; 2x AML MINOs exchange 1000 db
Preliminary Processing PC: VTR-PROC-01 i74790 CPU 3.60 GHz 16 G RAM

Field Party

Canadian Hydrographic Service – Pacific
Jacques Gagne (Chief Hydrographer)
M. Breton
M. Carre
L. Quon Turtle
R. Rombs
Natural Resources Canada (Geological Survey of Canada)
Peter Neelands (Chief Scientist)

Data Collection

Total Coverage (Fig. 2)
Queen Charlotte-Fairweather Fault – 326 km^2
Queen Charlotte-Fairweather Volcano - 128 km^2
3.5 kHz CHIRP data – 52 Lines (Fig. 3)



Multibeam Swath Bathymetry – Areas 1 to 7
(including positions of cores collected in 2015)

Figure 2a. Location of multibeam map Areas 1 to 7 (Figures 2b, c, d, e, f, g, and h)

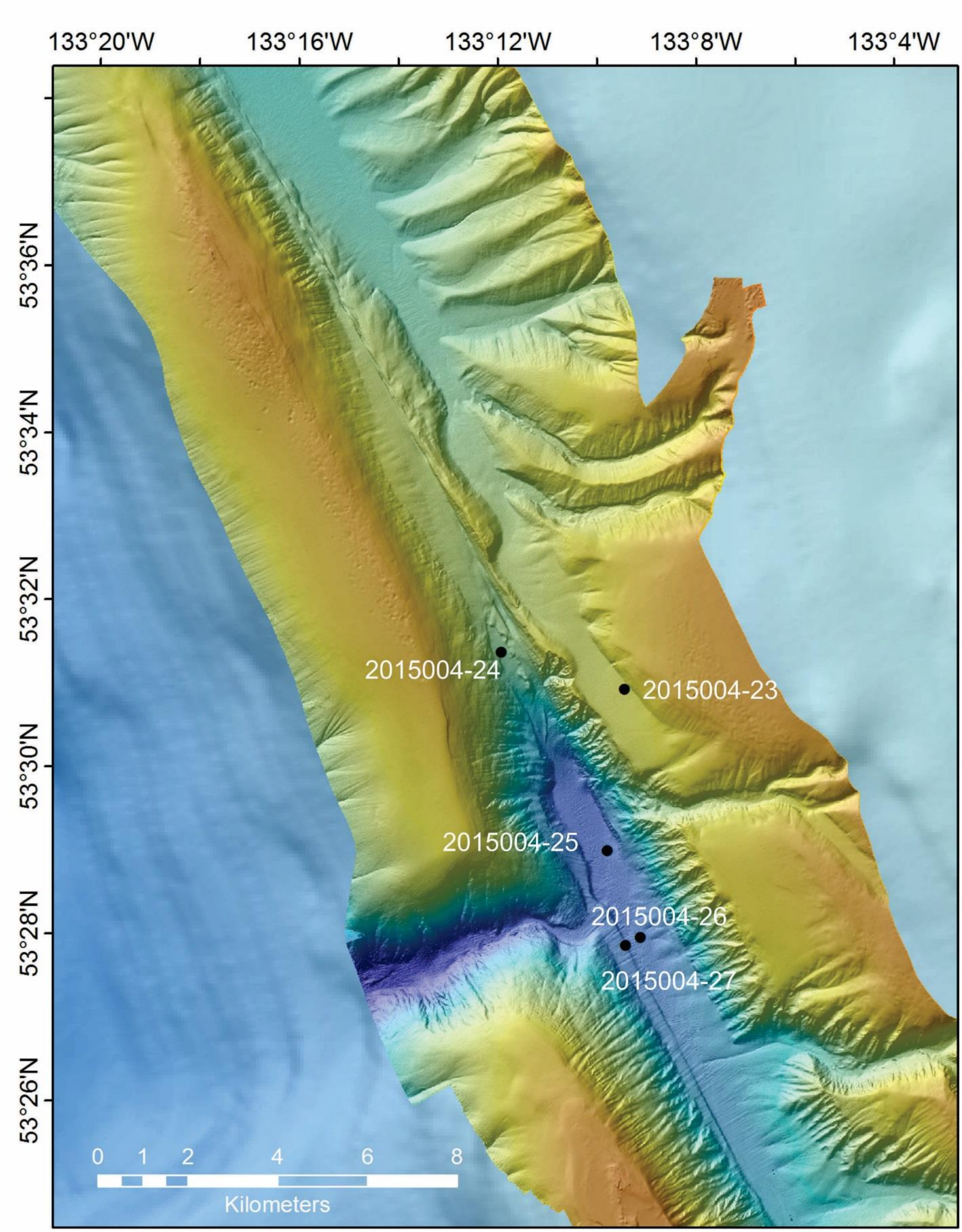


Figure 2b. Area 1 and positions of cores 2015004-23, 24, 25, 26, and 27

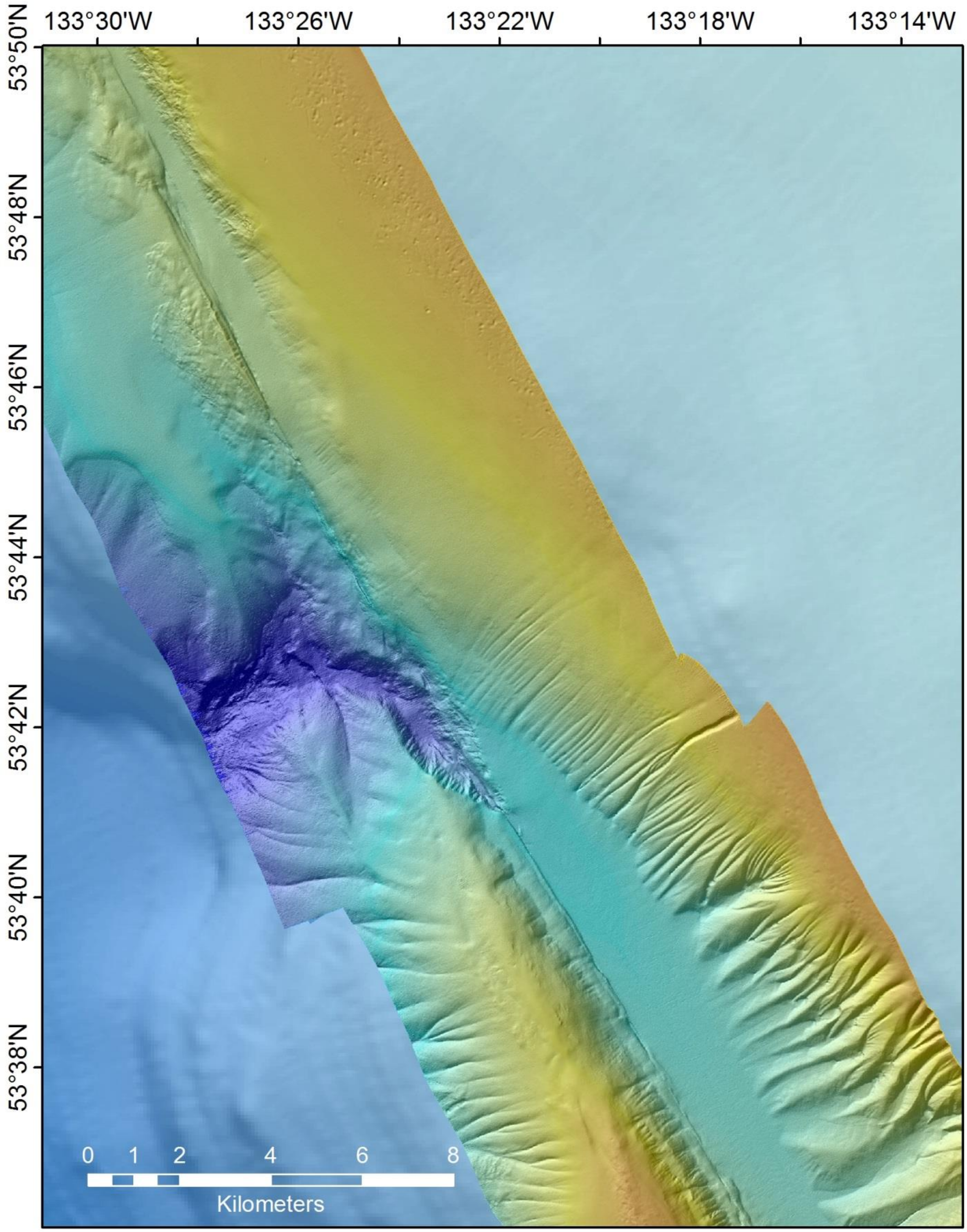


Figure 2c. Area 2

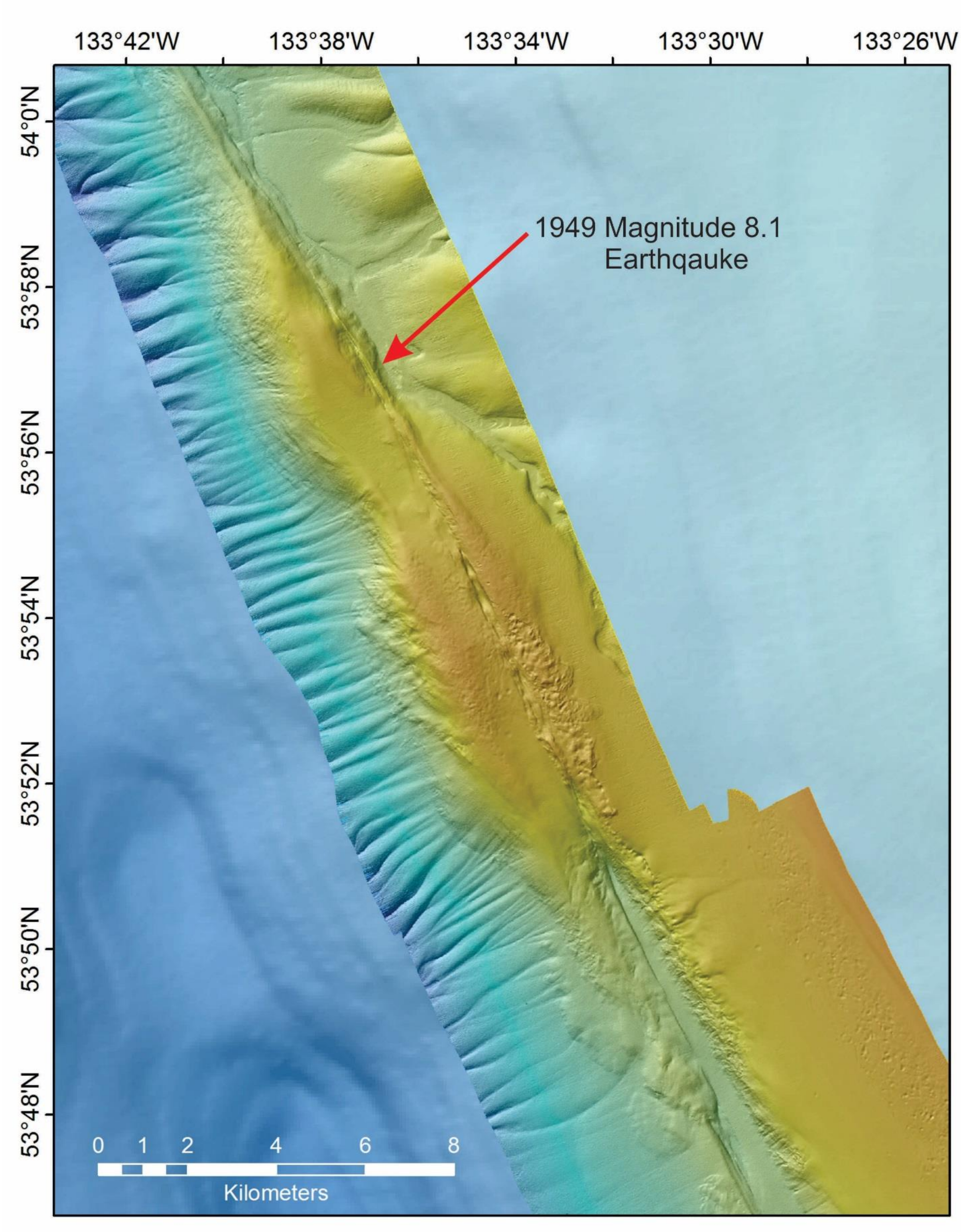


Figure 2d. Area 3

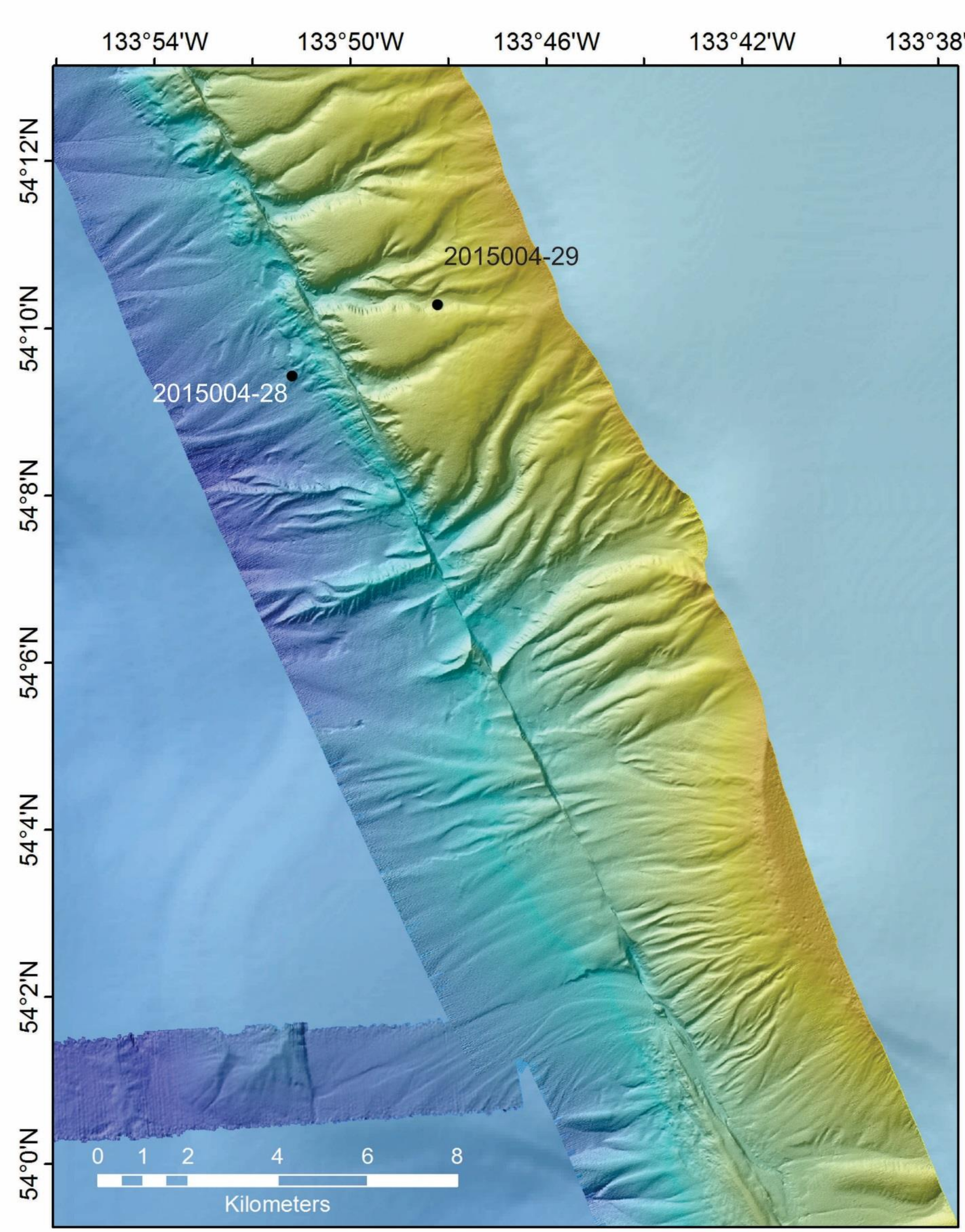


Figure 2e. Area 4 and positions of cores 2015004-28 and 29

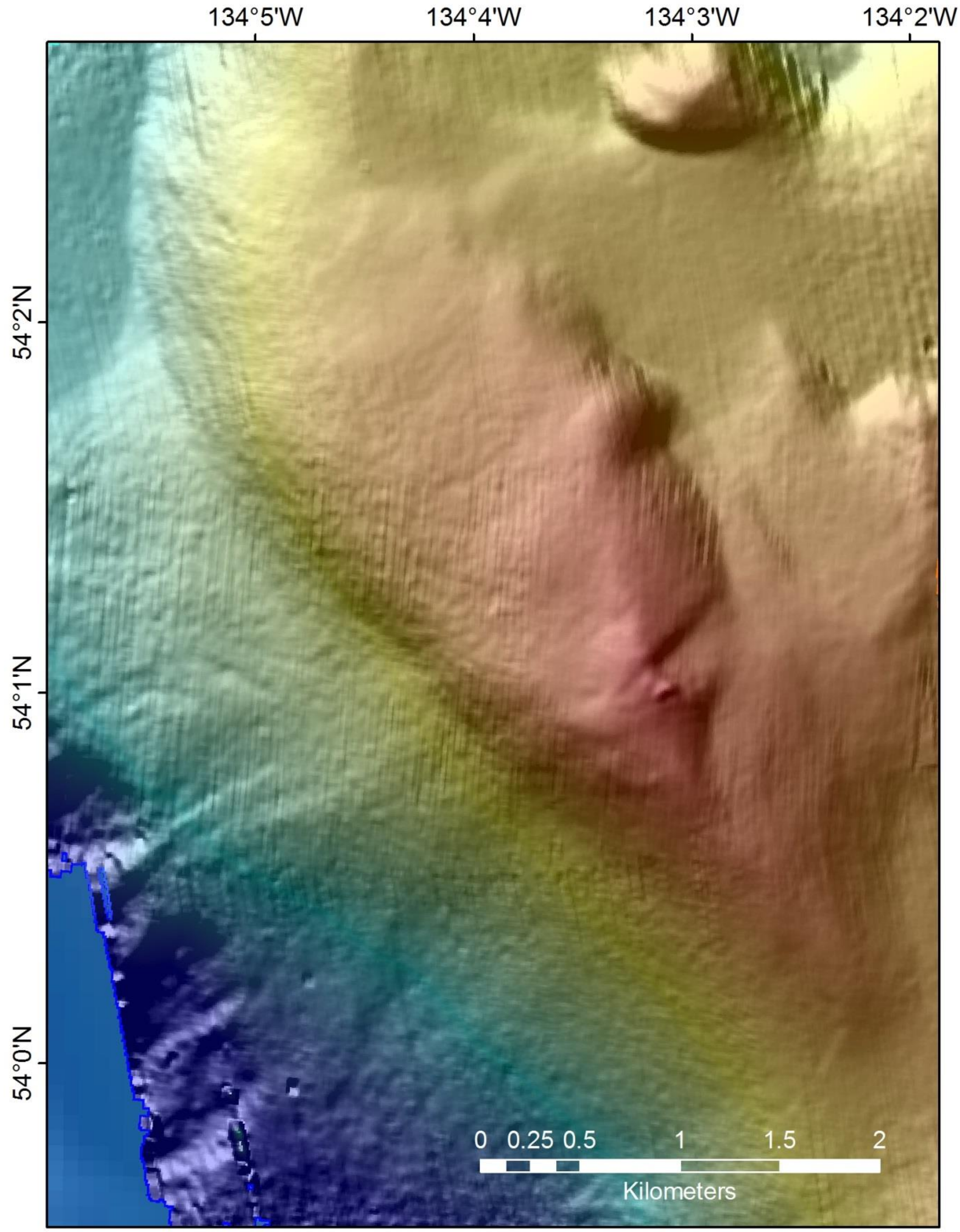


Figure 2f. Area 5 – Mud Volcano

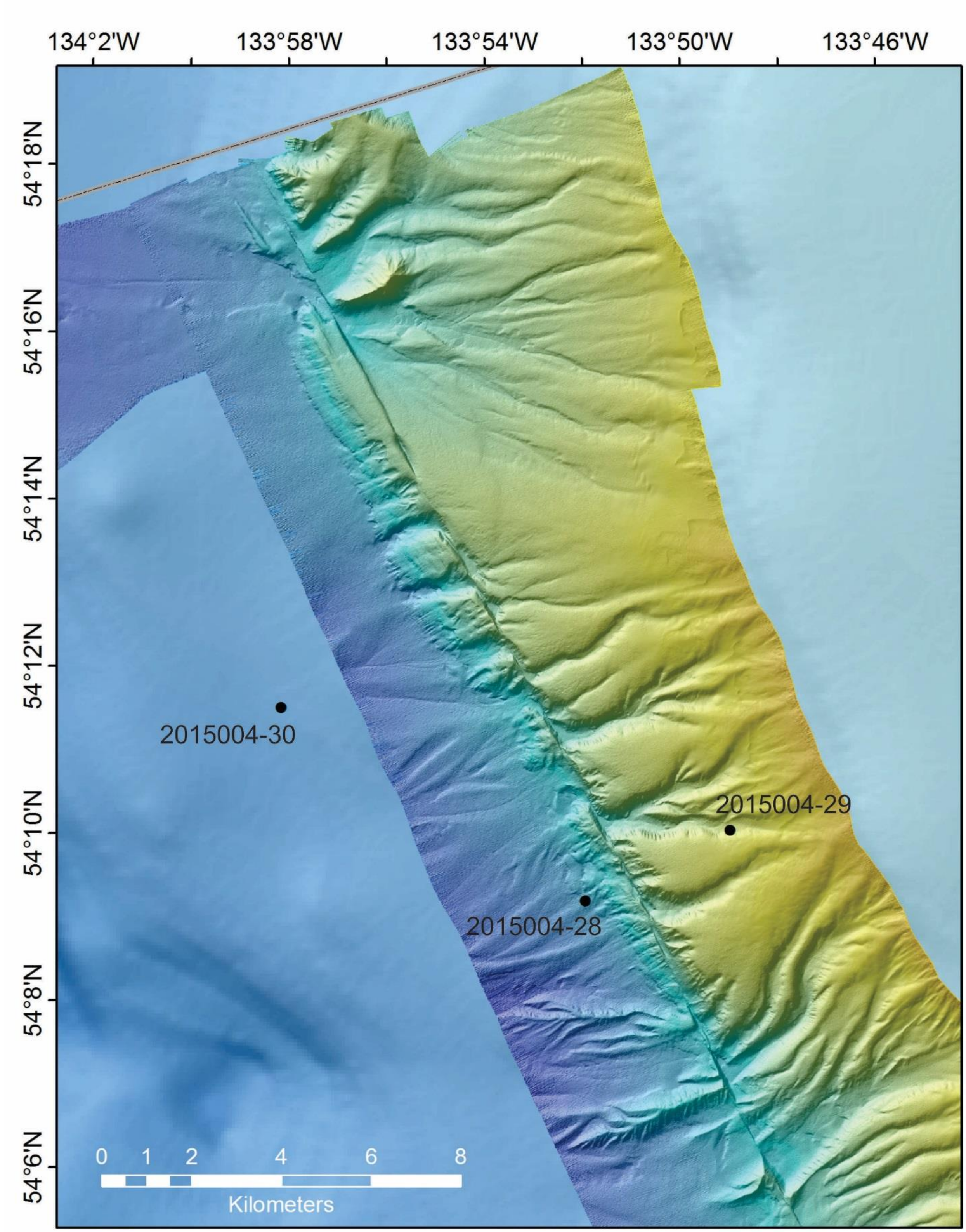


Figure 2g. Area 6 and positions of cores 2015004-28, 29 and 30

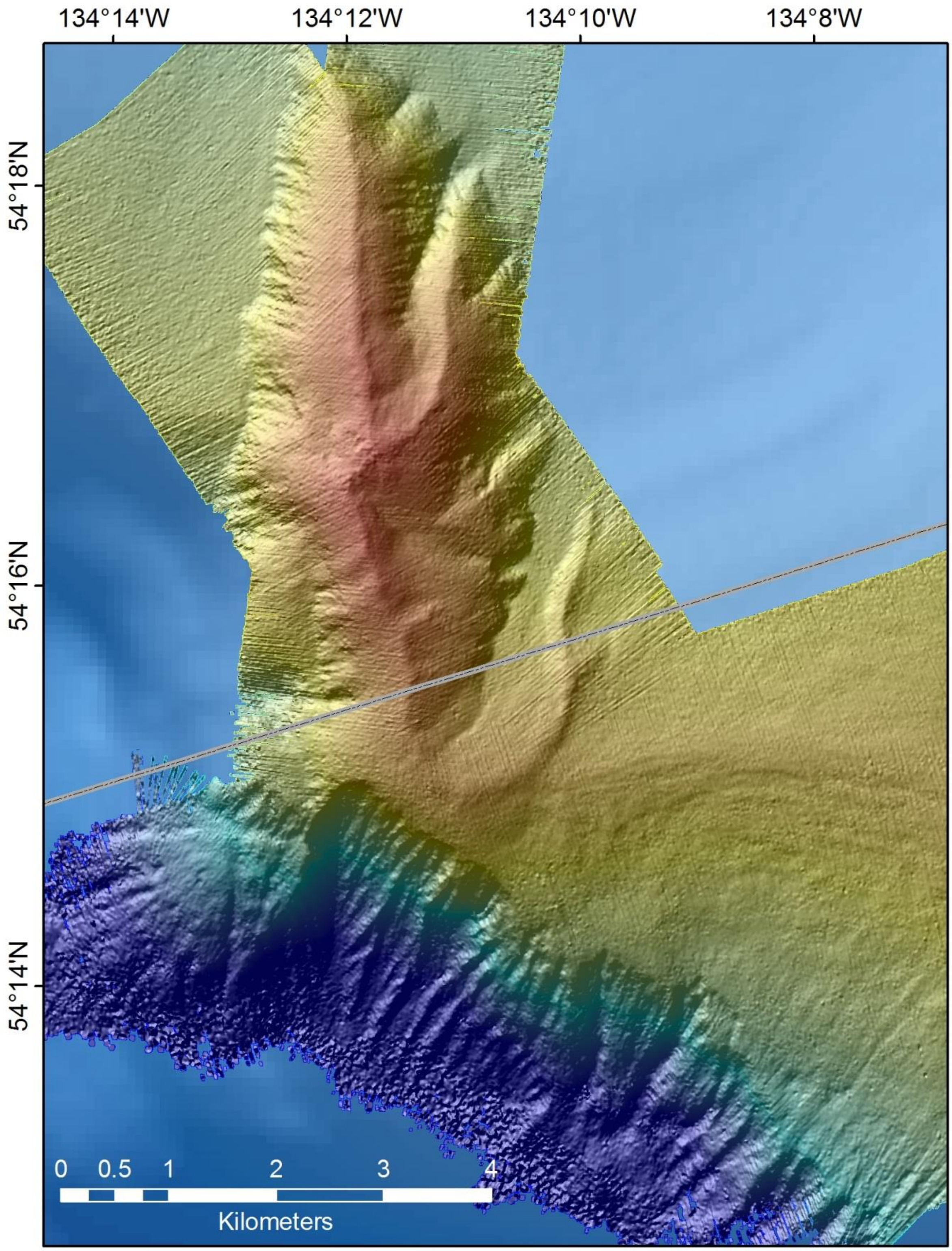


Figure 2h. Area 7 – Mud Volcano

3.5 kHz CHIRP Data Coverage

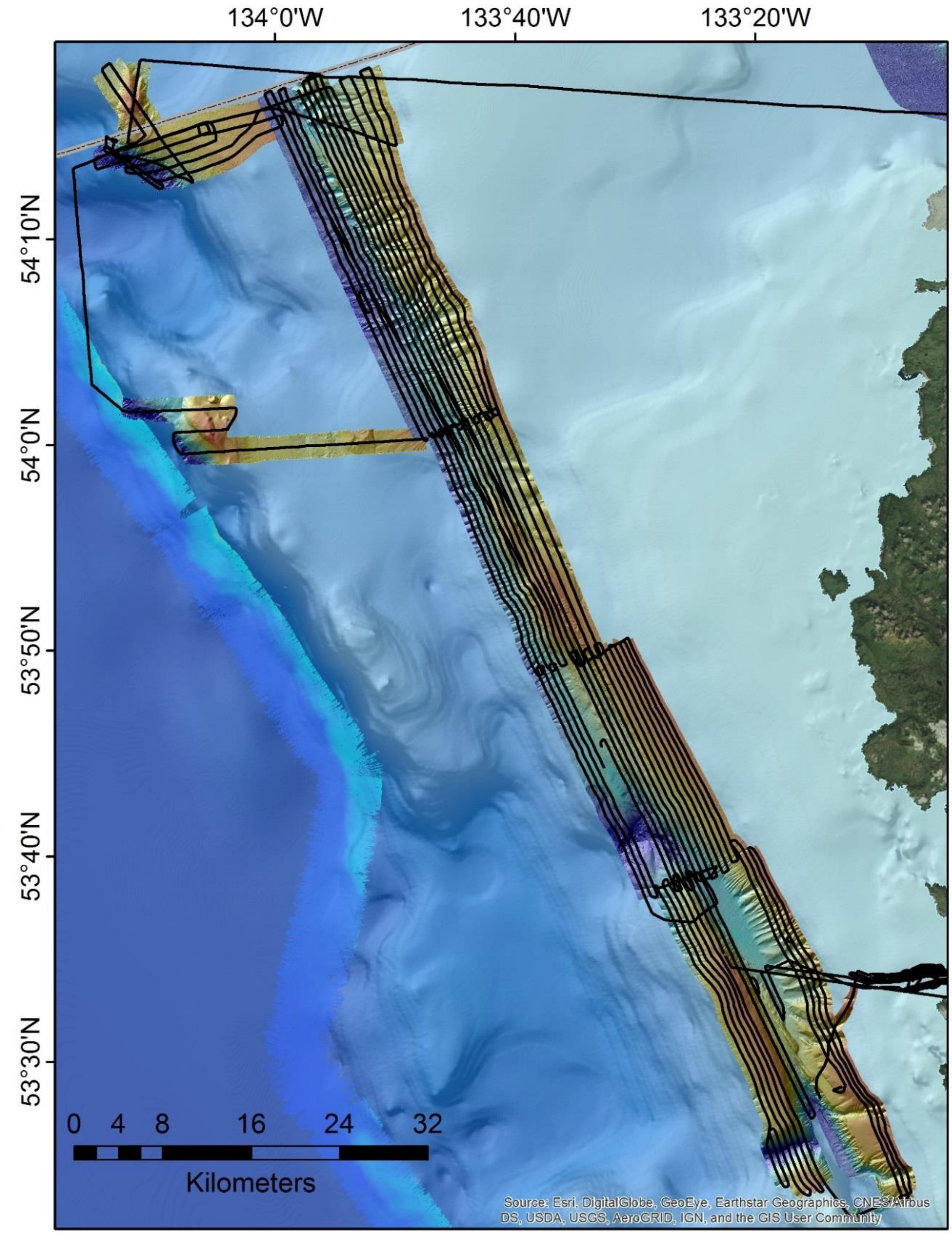


Figure 3. Location map of 3.5 kHz CHIRP Data Coverage

2017004PGC *CCGS John P. Tully*

Survey Equipment

Benthos Piston Corer (model #2540; system is modified Kullenburg)
IKU grab ½ cubic meter sampler
4K HD camera system
SonarDyne USBL transponder (8098 Navigation Sensor Hub)
Conductivity, Temperature and Depth (CTD) Seabird rosette (Institute of Ocean Sciences)
GeoTek multiscanning core logger
Rizon pore fluid samplers
Multichannel Streamer Array: 48-channel GeoEel Solid (6 x 8-channel sections)
Acoustic Source: 1.2 kJ Applied Acoustics power supply and SIG minisparker
Sub-bottom profiler: Knudsen Chirp 3260 3.5 kHz
Multichannel acquisition software: Geometrics GeoEel Control Interface (GCI)
Underway Navigation: YoNav and NRCan Regulas Navigation system
Konsberg EK60 12 kHz and ships echosounder
Konsberg ER600 18 kHz ships echosounder

Field Party (Fig. 4)

Natural Resources Canada (Geological Survey of Canada, Pacific):
- J. Vaughn Barrie (research scientist)
- Kim Conway (research scientist)
- Randy Enkin (research scientist)
- Peter Neelands (data management/technician)
- Robert Kung (GIS specialist)
- Brett Pickrill (core technician)
- Scott Rose (CTD technician)
- Bob Murphy (core technician)

U.S. Geological Survey
- Danny Brothers (research scientist)
- Jamie Conrad (research scientist)
- Amy East (research scientist)
- Mary McGann (research scientist)
- Rachel Marcuson (electronics technician)

Sitka Sound Science Center:
- Gary Greene (research scientist)

University of Calgary:
- Rachel Lauer (professor)

Figure 4. 2017004PGC *CCGS John P. Tully* field party

Narrative of Events

September 12 - Day 255

- Load Scientific Equipment in afternoon at IOS
- Delay departure to September 13 in order to complete loading and setup

September 13 – Day 256

- Finish loading and setup
- Science Meeting
- Depart IOS for survey of Devils Mountain Fault just offshore Victoria
- Multichannel and 3.5 kHz survey (Lines 1 – 7)
- Depart for western Haida Gwaii

September 14 – Day 257

- Piston core (STN 1) offshore western Vancouver Island
- Depart for southern Haida Gwaii

September 15 – Day 258

- Transit to primary working area along Queen Charlotte Fault

September 16 – Day 259

- Transit up western Haida Gwaii
- Multichannel and 3.5 kHz survey along fault off northern Haida Gwaii (Line 8) to pick core site
- Weather and sea state will not allow coring (SE winds, 3 m seas)

- Multichannel and 3.5 kHz survey along fault off northern Haida Gwaii (Lines 9 - 14)

September 17 – Day 260

- Coring still not possible due to sea state and strong NW winds– transit to mud volcano off Dixon Entrance
- CTD (STN 2) within seep at the center of mud volcano
- Piston core (STN 3) at mud volcano
- Transit north into SE Alaska to find better weather conditions along fault

September 18 – Day 261

- Weather improved so stop off Chatham Sound to initiate coring
- 3.5 kHz survey over raised bathymetric spine with a gas seep (Lines 15 - 16)
- Piston core (STN 4) at gas seep – cored into carbonate crust
- Piston Core (STN 5) above headwall of large slide
- Piston Core (STN 6) within the slide scar
- Camera transect (STN 7) over STN 4 within the gas seep using a star pattern
- Piston Core (STN 8) on the slope below the slide sampled at STN 6
- Transit north to offshore Mt. Edgecumbe

September 19 – Day 262

- 3.5 kHz survey to confirm coring sites (Line 17)
- Camera transect (STN 9) over volcanic cone
- Piston Core (STN 10) on the inshore flank of volcanic cone
- IKU Grab (STN 11) on the upper of edifice of the volcanic cone
- IKU Grab (STN 12) just off the cone centre
- Piston Core (STN 13) on the downslope flank of the cone
- Piston Core (STN 14) on the slope seaward of the volcanic cone at 925 m water depth
- IKU Grab (STN 15) on seep site located on bathymetric ridge
- IKU Grab (STN 16) along ridge (spine) upslope of seep
- Camera transect (STN 17) along ridge and over the seep site of STN 15
- Depart north for the Cross Sound area

September 20 – Day 263

- 3.5 kHz survey to confirm coring sites (Lines 18 - 20)
- Piston Cores (STNs 18 – 23) within and along the flanks of a small pull-apart basin located just south of Icy Point
- Piston Cores (STNs 24 - 26) south of the basin following the same stratigraphic units
- Multichannel and 3.5 kHz survey (Lines 21 – 32) towards Cross Sound and the Yakobi Sea Valley

September 21 – Day 264

- Complete Multichannel and 3.5 kHz survey
- Piston Core (STN 27) on outwash apron at the entrance to Cross Sound
- Attempted camera transect, but camera failed to trigger
- IKU Grab (STN 28) at base of slope in the Cross Sound (Yakobi) valley
- IKU Grab (STNs 29 - 30) on fault escarpment slope and on top of the escarpment

- Camera transect (STN 31) up escarpment between STNs 28 – 31
- 3.5 kHz survey to confirm coring and camera sites along escarpment (Line 33)
- Piston Cores (STNs 32 - 33) below the escarpment
- Camera transect (STN 34) up fault scarp along intersection of the offset escarpment
- Transit to Sitka

September 22 – Day 265
- 08:00 arrive Sitka (strong SE winds) - Randy Enkin departs ship
- 10:00 depart Sitka
- 3.5 kHz survey (Lines 34 – 36) of a potential gas seep site near the fault along lava field, west of Mt. Edgecumbe
- Camera transect (STN 35) over gas seep site
- Piston Core (STN 36) adjacent to seep in small depression
- CTD (STN 37) within gas seep
- Transit south along fault to Chatham slope fan

September 23 – Day 266
- 3.5 kHz survey (Line 37) on Chatham slope fan
- Piston Core (STN 38) on lower slope
- 3.5 kHz survey (Line 38) up slope to prominent seep site
- Camera transect (STN 39) over large gas seep site (mud volcano)
- IKU Grab (STNs 40 - 41) within the vent of the gas seep (mud volcano)
- 3.5 kHz survey (Line 39) downslope to deep water core site
- Piston Core (STN 42) lower slope core
- 3.5 kHz survey (Line 40) across STN 42 and upslope to the gas seep site of STN 39
- CTD (STNs 43 - 44) within gas seep and just adjacent to the seep
- Multichannel and 3.5 kHz survey parallel to the fault north of Noyes Canyon (Lines 41-42)

September 24 – Day 267
- End of Multichannel and 3.5 kHz survey
- Piston Cores (STNs 45 - 46) along slope fan crossing the fault
- 3.5 kHz survey (Line 43) downslope to mid slope basin
- Piston Core (STN 47) in mid slope basin
- Piston Cores (STNs 48 - 50) on gullies and interfluves that cross the fault
- Multichannel and 3.5 kHz survey on the slope west of the fault south of Noyes Canyon (Lines 44 – 49)

September 25 – Day 268
- End of Multichannel and 3.5 kHz survey
- Piston Cores (STNs 51 - 54) on slope seaward of Noyes Canyon
- 3.5 kHz survey (Line 50) between core STNs 53 and 54
- Transit south to survey of mud volcanos
- Multichannel and 3.5 kHz survey south within the transboundary area across possibly 4 mud volcanos (Lines 51 -57)

September 26 – Day 269

- End of Multichannel and 3.5 kHz survey
- Camera transect (STN 55) over recently discovered mud volcano south of the US/Canada boundary
- Camera stopped triggering with deteriorating weather (SE gale) and the camera transect had to be ended early
- Camera repaired but the second deployment had to be terminated due to weather
- CTD (STN 56) within seep at the center of the mud volcano
- Depart to southern Haida Gwaii while awaiting better weather conditions

September 27 – Day 270

- 3.5 kHz survey (Lines 58 - 65) across two volcanic cones seaward of the fault of Cape St. James to accurately locate gas plumes
- Camera transect (STN 57) over southern volcanic cone across the gas seep
- IKU Grab (STN 58) within seep on volcanic cone
- CTD (STN 59) within seep
- Camera transect (STN 60) over a gas seep east of the fault on a terrace just off Cape St. James
- CTD (STN 61) within gas seep – plume very limited
- Multichannel and 3.5 kHz survey west, from the fault across the Queen Charlotte Terrace to the Delwood Fault (Lines 66 – 68)

September 28 – Day 271

- Piston Cores (STNs 62 - 63) in deep water basin seaward of the volcanic cones
- Camera transect (STN 64) at same site at STN 57 across the seep of the southern volcanic cone in hopes of getting more bottom photos
- IKU Grab (STN 65) within the center of the volcanic crater
- Begin transit to IOS via Johnstone Strait

September 29 – Day 272

- Transit to IOS down Johnstone Strait

September 30 – Day 273

- 09:00 off Nanaimo – drop off Mary McGann
- 16:00 arrive IOS

October 1 – Day 274

- 12:00 offloaded and away from the ship

Data Collection

Geophysical Surveys

The USGS deployed a 48-ch MCS array (mixed group spacing between 1.5625m and 3.125m) and 1.2 kilo-Joule minisparker acoustic source. The MCS streamer was towed from the portside stern and the sparker from the starboard. A total of 32 lines were collected (Figs. 5 to 10) simultaneously with *Tully* 3.5 kHz CHIRP data. Following are the lines of data collected:

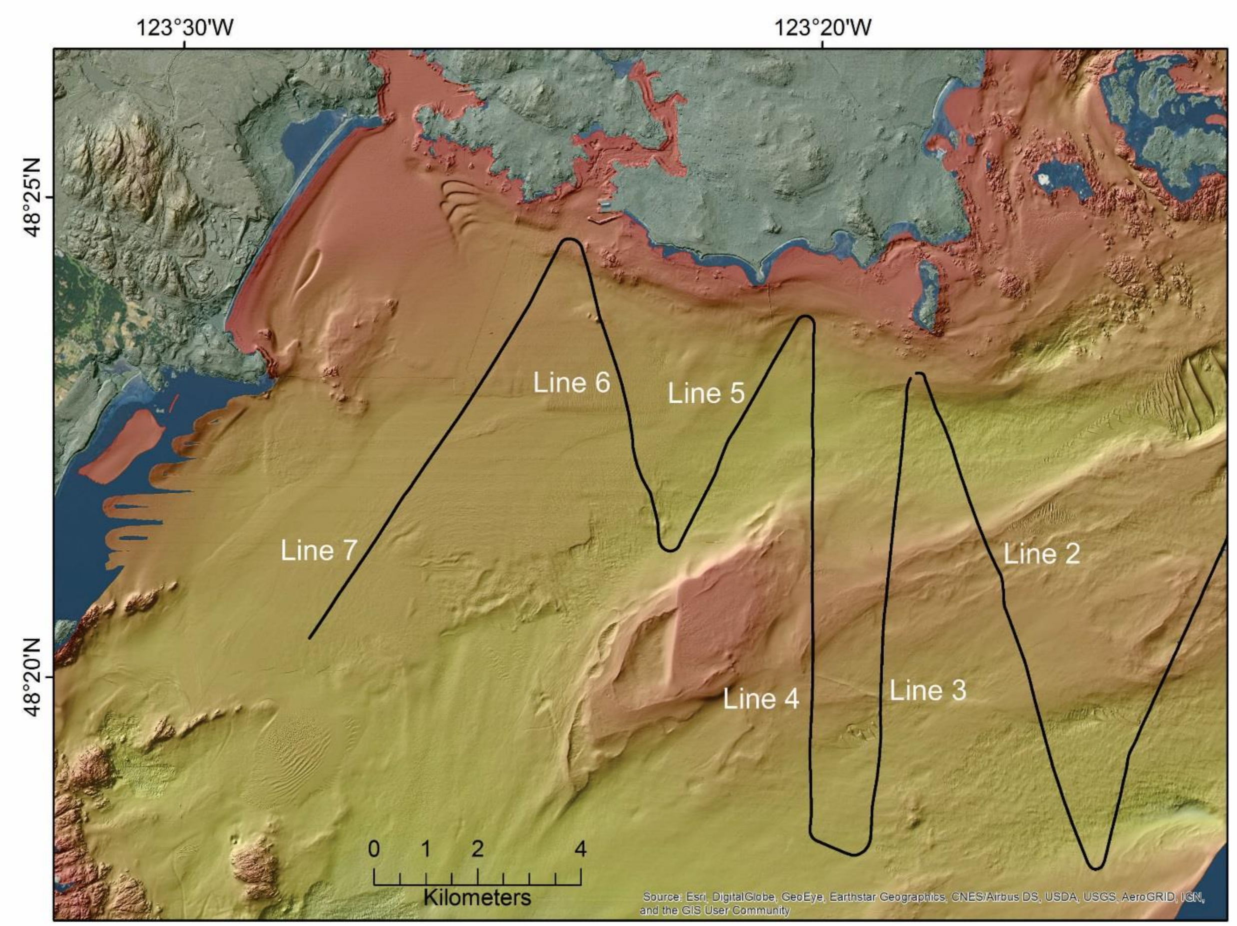


Figure 5. Lines 2 to 7 were collected near the city and port of Victoria BC to determine if the Devils Mountain Fault and Leech River Fault that crosses Vancouver Island are the same fault system.

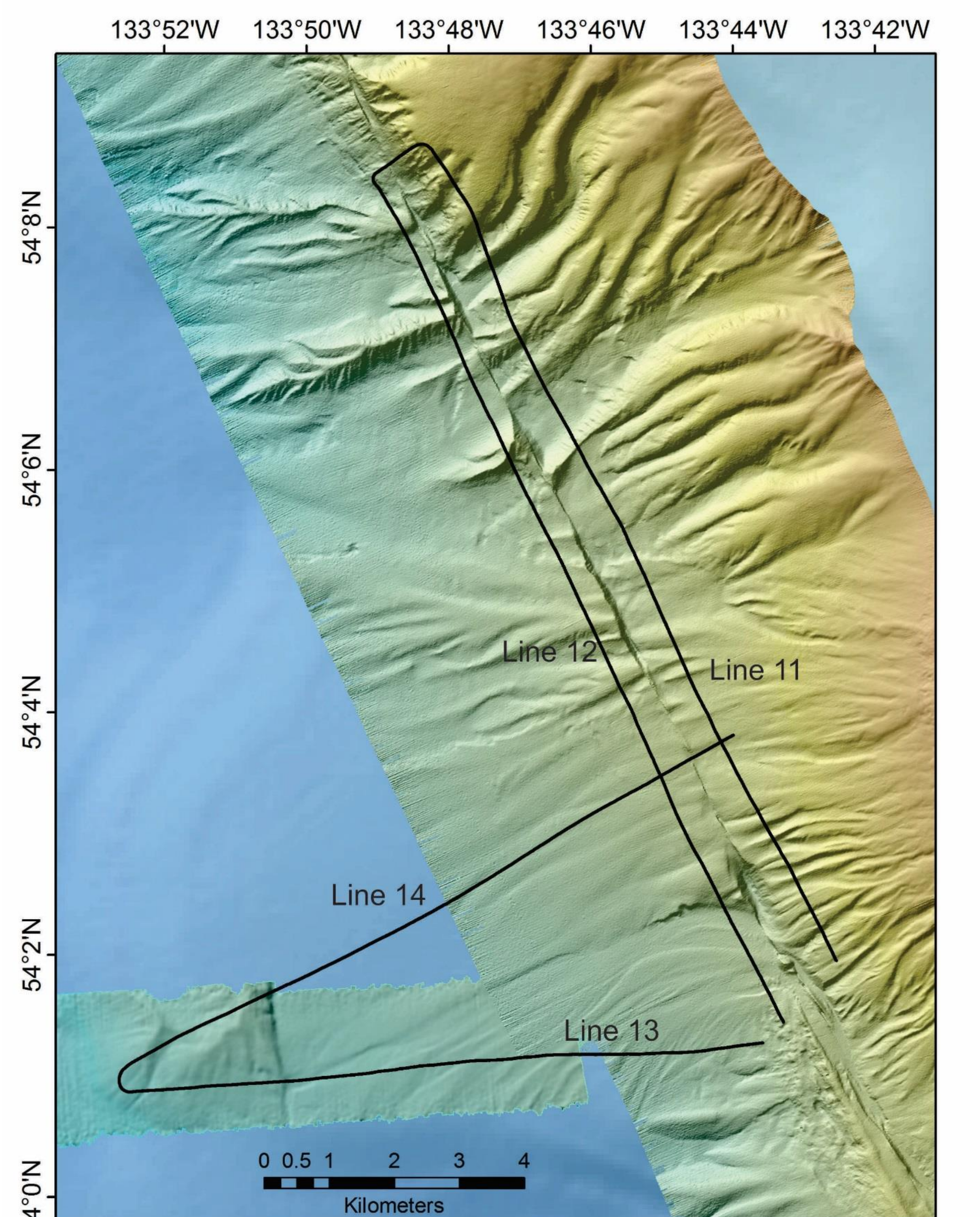


Figure 6. Location of lines 11 to 14

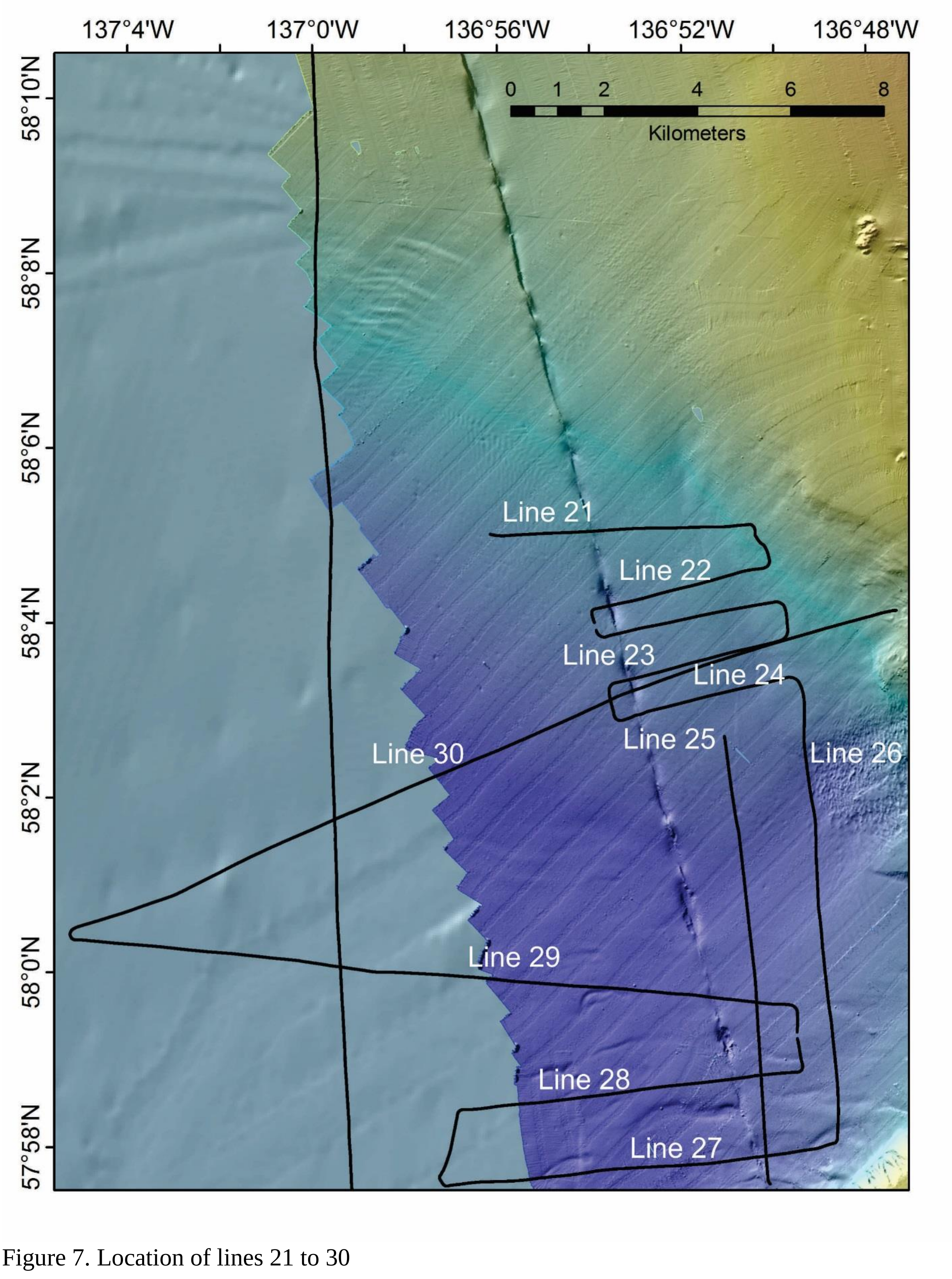


Figure 7. Location of lines 21 to 30

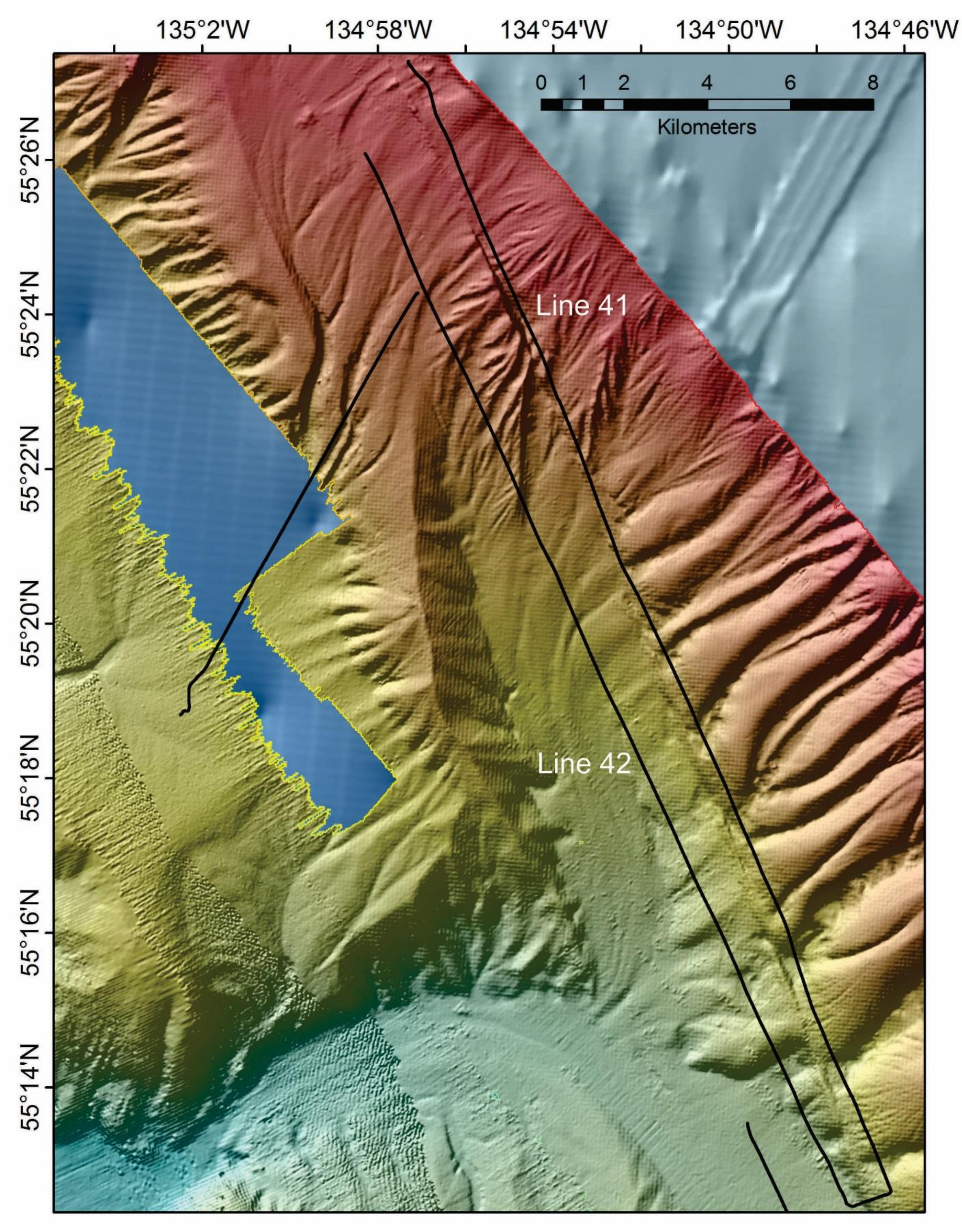


Figure 8. Location of lines 41 to 42

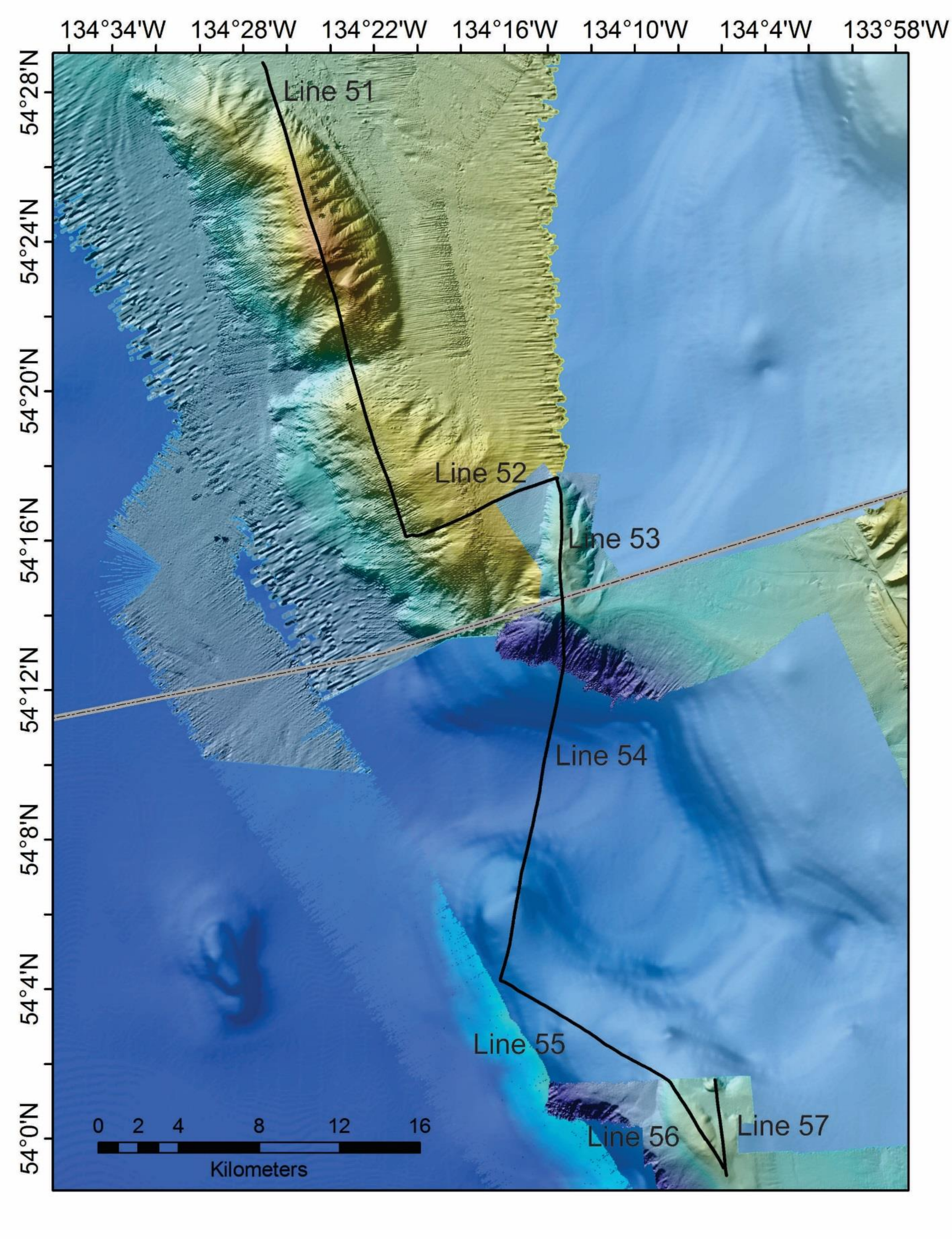


Figure 9. Location of lines 51 to 57

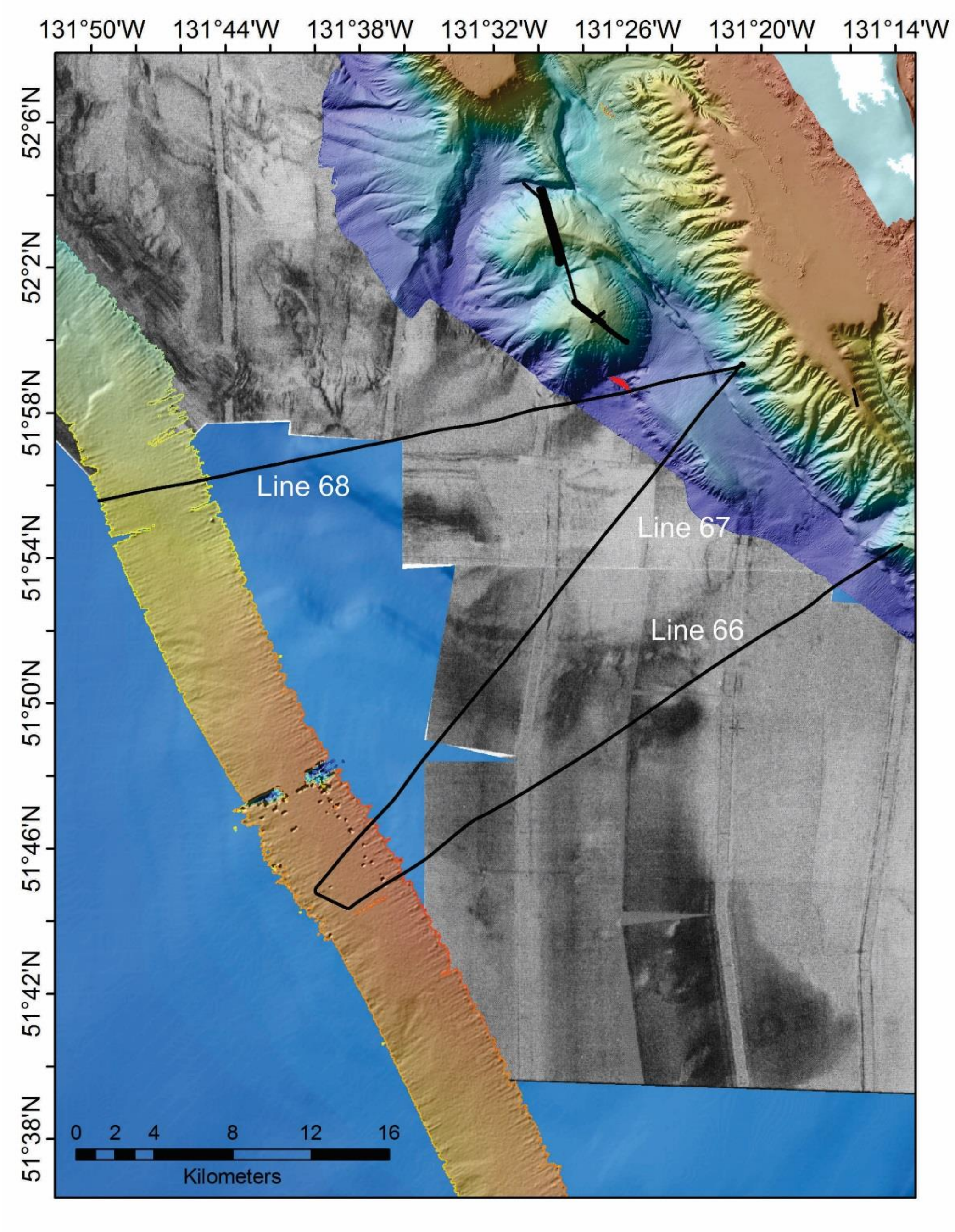
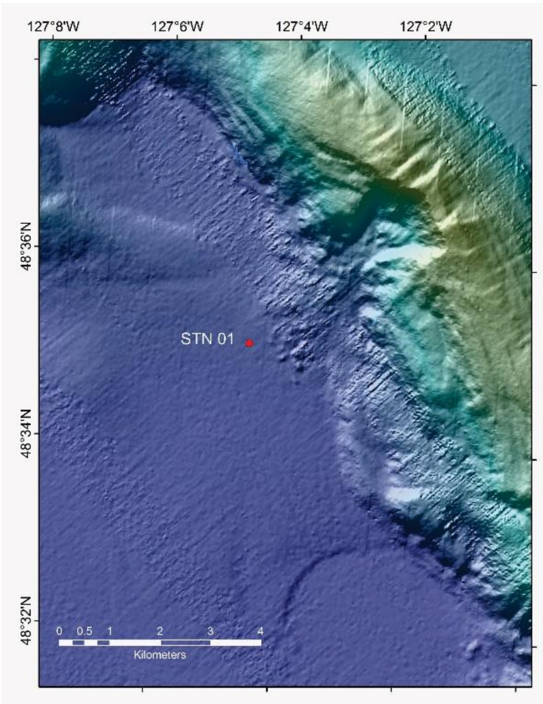


Figure 10. Location of lines 61 to 68

In addition 44 lines of 3.5 kHz CHIRP data were collected to identify coring sites and gas seeps (see *Sediment Cores, IKU Grabs, and CTD Stations*).

Sediment Cores, IKU Grabs, and CTD Stations

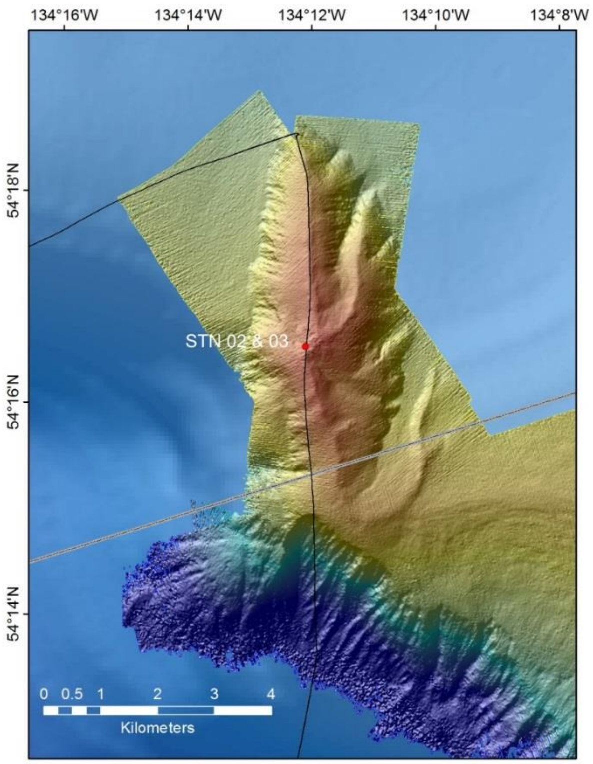
- Station information shown in Appendix 1 (page 64)



Station 001 - September 14, 2017 @ 21:41 Cascadia Paleo-seismicity - Depth: 2502 m (Fig. 11)

Sequence of turbidites from 30 to 110 cm.

Figure 11. Location of station 01



Station 002 – CTD Rosette (Fig. 12)

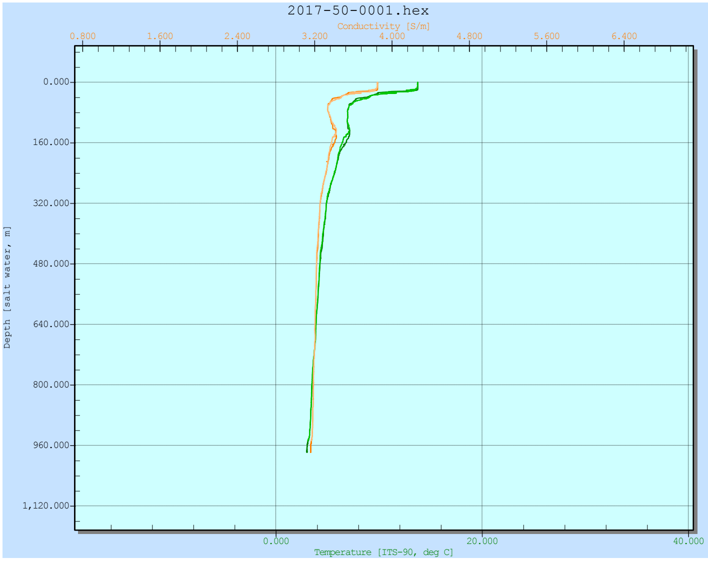


Figure 12. Location of stations 02 and 03 and CTD water column profile from station 03

Station 003 – September 17, 2017 @ 20:33
Mud Volcano - Depth: 993 m (Fig. 12)
0 - 13 Unit 5 – poorly sorted, olive gravelly medium sand with forams (Holocene)
13 - 115 Unit 4 – dark grey laminated silty clay with gravel and large IRD clasts (glaciomarine)
115 - 125 Unit 3 – well sorted, grey clay (event marker)
125 - 197 Unit 2 – dark grey clay with minor gravel (IRD) (glaciomarine)
197 - 209 Unit 1 – hard gravelly medium sand (mud volcano)

TWC
0 - 7 Unit 2 – dark grey muddy gravelly medium sand
7 - 88 Unit 1 – dark grey silty clay with gravel (glaciomarine)

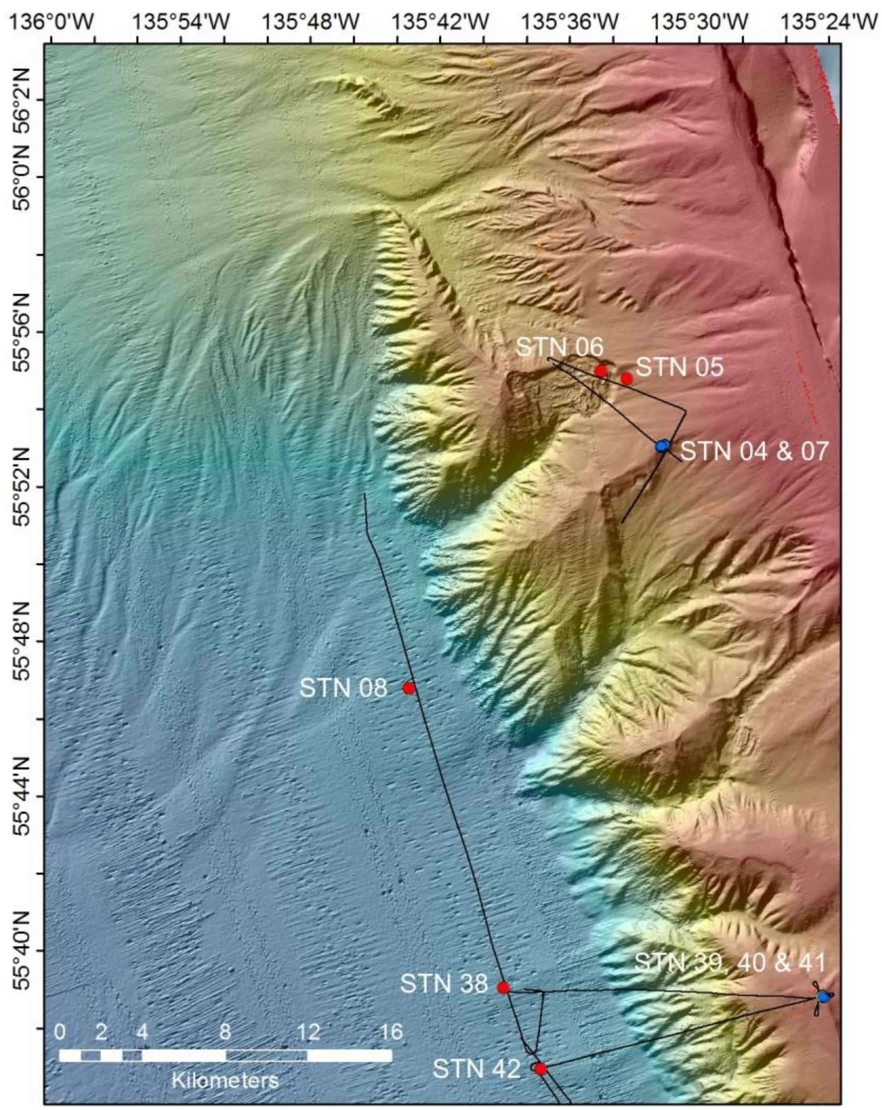


Figure 13. Location of stations 04 to 08 and 38 to 42

Station 004 – September 18, 2017 @ 15:36
Chatham Fan Gas Seep - Depth: 700 m (Fig. 13)

Core: Bent core cutter. Carbonate concretions 0.5 to 5 cm, including bivalve shells.

Station 005 – September 18, 2017 @ 17:07
Above headwall of large slide - Depth: 814 m (Fig. 13)

0 - 4 Unit 2 – dark olive green gravelly fine sand (Holocene)
4 - 370 Unit 1 – very dark grey massive silty clay with sand and gravel (IRD), clasts up to 5cm (glaciomarine)

TWC

0 - 5 Unit 2 – dark olive grey gravelly coarse sand
5 - 23 Unit 1 – dark grey clayey silt, massive, sand and gravel

Station 006 – September 18, 2017 @ 19:31
Large slide - Depth: 925 m (Fig. 13)

0 - 77 Unit 3d – olive massive bioturbated clayey silt (Holocene)
77 - 106 Unit 3c – olive laminated silty clay to fine sand with laminations to 1 cm thick (graded sharp bases (turbidites (Holocene))
106 - 168 Unit 3b – olive grey bioturbated clayey silt (Holocene)
168 - 170 Unit 3a – olive grey laminated silt (Holocene)
170 - 185 Unit 2 – dark grey laminated clayey silt (glaciomarine transition)
185 - 198 Unit 1d – very dark grey gravelly sandy mud with IRD (glaciomarine)
198 - 253 Unit 1c – massive dark grey clay with sand and gravel (IRD) to 3 cm (glaciomarine)
253 - 267 Unit 1b – very dark grey clayey silt (glaciomarine)
267 - 339 Unit 1a – massive dark grey clay with IRD to 5 cm (glaciomarine)

Station 007 – Camera (see page 50) (Fig. 13)

Station 008 – September 19, 2017 @ 01:17
Distal end of slide at foot of slope - Depth: 2488 m (Fig. 13)

0 - 454 Unit 1 – olive grey clayey silt, massive to faintly laminated and bioturbated, minor sand flecks, very fine sand beds and laminations towards base of core (Holocene?)

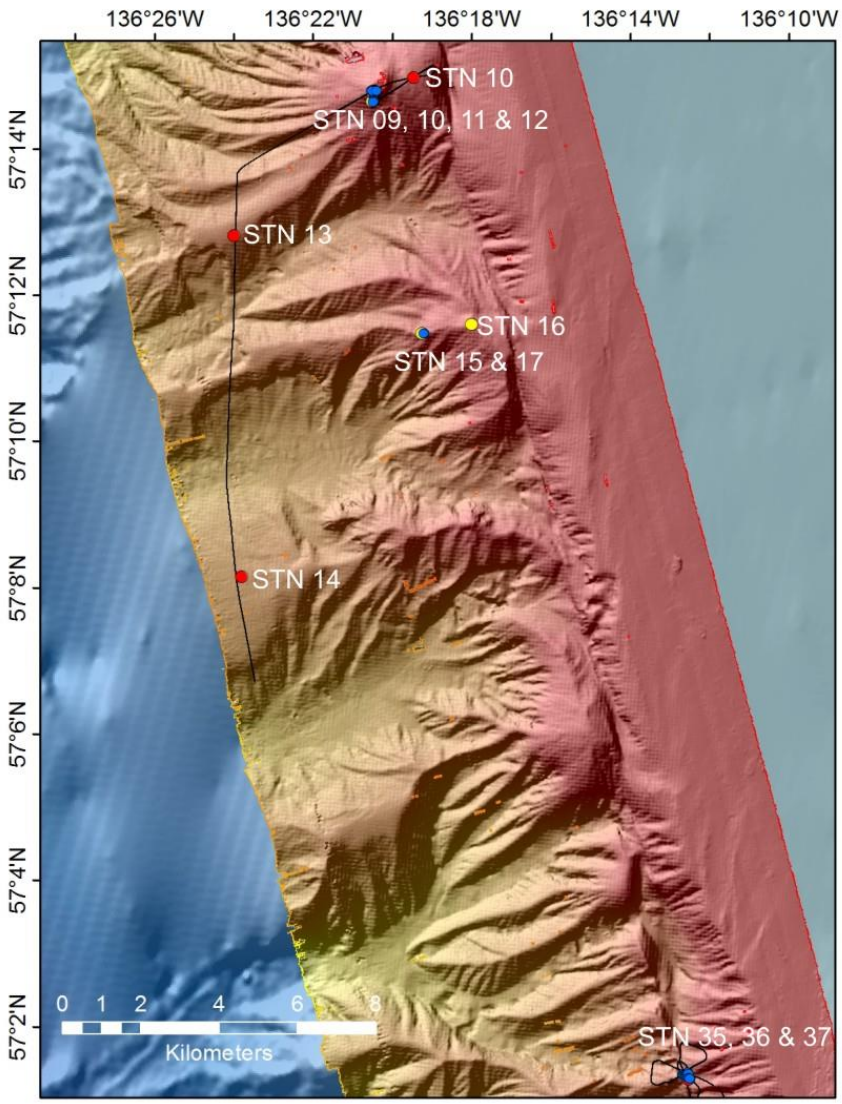


Figure 14. Location of stations 9 to 17 and 35 to 37

Station 009 – Camera (see page 51) (Fig. 14)

Station 010 – September 19, 2017 @ 17:17
Flank of volcanic cone - Depth: 305 m (Fig. 14)

3 - 11 Unit 3 – very dark grey fine sand (mass flow, Holocene)
11 - 13 Unit 2 – olive sand with forams (Holocene)
13 - 32 Unit 1e – dark grey sandy mud (glaciomarine)
32 - 42 Unit 1d – very dark grey gravel to 3 cm, clast supported (glaciomarine)
42 - 63 Unit 1c – very dark grey gravelly mud with minor shells (glaciomarine)
63 - 75 Unit 1b – very dark grey gravel to 2 cm, clast supported, shells (glaciomarine)
75 - 138 Unit 1a – dark grey sandy, gravelly (2 to 4 cm clasts), mud and shell (glaciomarine)

Station 011 – September 19, 2017 @ 18:08
Depth: 357 m (Fig. 14)
IKU Grab: Upper flank of volcano cone

- Basalts with manganese crust (Fig. 15)

Figure 15. Basalts in IKU grab

Station 012 – September 19, 2017 @ 19:32
Depth: 303 m (Fig. 14)
IKU Grab: Near center of volcano cone

- Basalts and other varied lithologies

Station 013 – September 19, 2017 @ 20:43
Lower flank of volcanic cone - Depth: 740 m (Fig. 13)

0 - 34	Unit 4 – dark grey laminated silt with some very fine sand
34 - 39	Unit 3 – grey massive ash deposit

39 - 41 Unit 2 – olive grey coarse to fine sand, graded bed (turbidite)
197 - 209 Unit 1 – dark grey laminated silt with some very fine sand laminae and minor shell flecks, bioturbated – some laminae are slightly deformed (Holocene)

Station 014 – September 19, 2017 @ 22:19
Continental slope - Depth: 925 m (Fig. 14)

0 - 5 Unit 6 – olive grey bioturbated silt
5 - 61 Unit 5 – dark grey laminated clayey silt with bioturbated intervals
61 - 63 Unit 4 – grey massive ash layer
63 - 65 Unit 3 – dark grey laminated clayey silt
65 - 68 Unit 2 – grey graded medium sand bed (turbidite)
68 - 278 Unit 1 – dark grey laminated clayey silt with bioturbated layers and minor shell debris

TWC
0 - 8 Unit 2 – dark olive grey sandy silt, bioturbated (Holocene)
8 - 33 Unit 1 – dark grey clayey silt, massive, minor sand

Station 015 – September 19, 2017 @ 23:48
Depth: 492 m (Fig. 13)
IKU Grab: Seep site on ridge spine
- Recovered large piece of carbonate crust (Fig. 16)

Figure 16. Carbonate crust on ships deck

Station 016 – September 20, 2017 @ 01:02
Depth: 322 m (Fig. 14)

IKU Grab: Upslope of Station 015

0 - 8 Unit 2 – dark grey clayey silt, stiff
8 - 10 Unit 1 – olive grey gravelly sand
Note: Sequence probably inverted

Station 017 – Camera (see page 52) (Fig. 14)

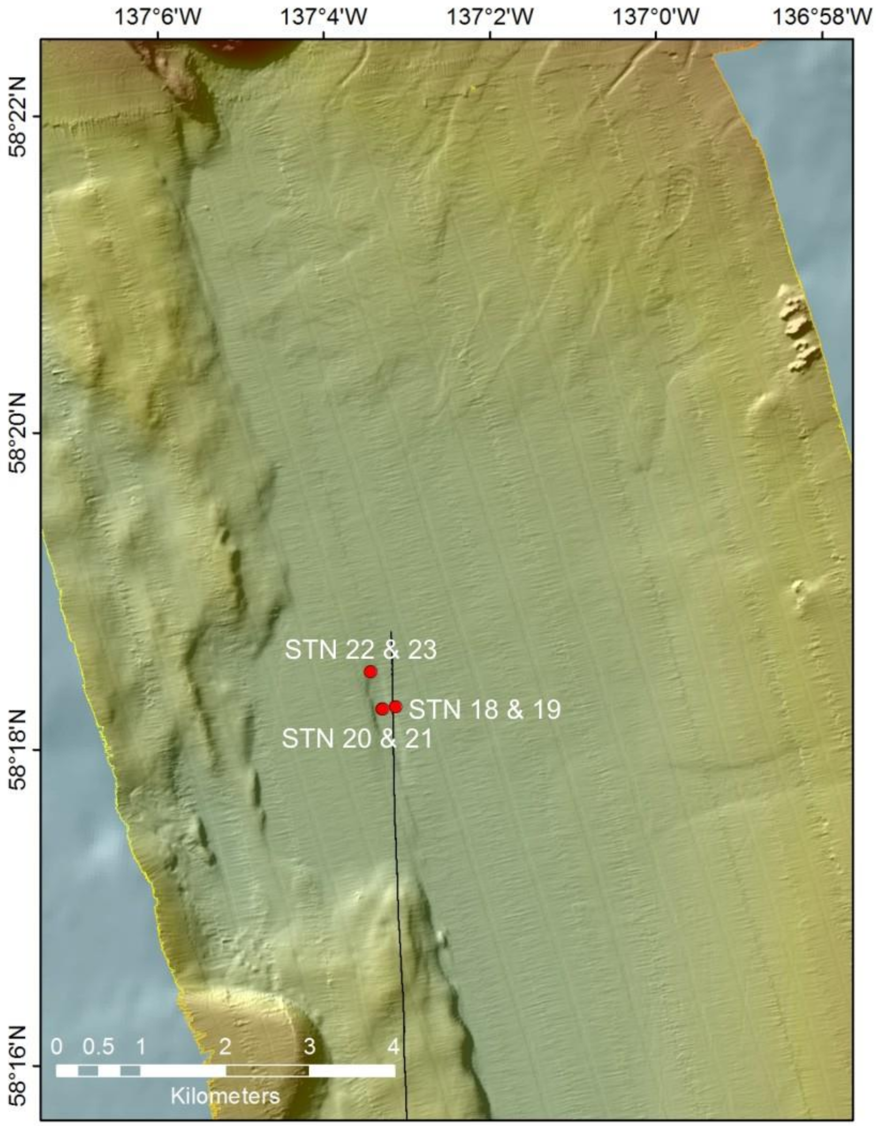


Figure 17. Location of stations 18 to 23

Station 018 – September 20, 2017 @ 14:42
Eastern flank of pull-apart - Depth: 182 m (Fig. 17)

0 - 30 Unit 3 – dark grey bioturbated faintly laminated clay

30 - 37 Unit 2 – very dark grey fine to very fine sand with shell fragments (turbidite)
37 - 48 Unit 1c – dark grey bioturbated clay
48 - 50 Unit 1b – dark grey laminated clayey silt
50 - 92 Unit 1a – dark grey bioturbated clay with black mottling (organics)

TWC
0 - 100 Unit 1 – very dark grey to black bioturbated silty clay, with faint laminations and black mottling

Station 019 – September 20, 2017 @ 15:39
Same site as 018 - Depth: 182 m (Fig. 17)

0 - 100 Unit 3 – dark grey silty clay, mottled, faintly laminated, bioturbated and soft
100 - 112 Unit 2 – very dark grey fine to very fine graded sand (turbidite)
112 - 384 Unit 1 – dark grey to black silty clay, massive to faintly laminated and mottled, bioturbated, soft

TWC
0 - 96 Unit 1 – dark grey to black bioturbated silty clay, mottled, soft

Station 020 – September 20, 2017 @ 17:06
Centre of pull-apart - Depth: 185 m (Fig. 17)

0 - 111 Unit 1 – grey to dark grey laminated clay, massive and black where bioturbated, some shell flecks

TWC
0 - 96 Unit 1 – grey to dark grey mottled clay, massive to faintly laminated, bioturbated, some shell flecks

Station 021 – September 20, 2017 @ 18:19
Same site as 020 - Depth: 185 m (Fig. 17)

0 - 62 Unit 1 – dark grey to black soft sticky clay, massive where bioturbated, minor laminations

TWC
0 - 94 Unit 1 – dark grey to black soft sticky clay, massive where bioturbated, minor silt and shell debris

Station 022 – September 20, 2017 @ 20:10
North end of pull-apart - Depth: 182 m (Fig. 17)

0 - 57 Unit 5 – dark grey to black bioturbatted clay with minor banding or laminations
57 - 63 Unit 4 – very dark grey fine to very fine sand, graded bed and sharp contact (turbidite)
63 - 112 Unit 3 – dark grey to black bioturbated clay, laminated to massive, gradual contact
112 - 172 Unit 2 – dark grey bioturbated clayey silt with very fine sand lamination at base (forams)
172 - 175 Unit 1 – grey clay, massive

TWC
0 - 109 Unit 1 – dark grey to black bioturbated soft clay, minor colour banding

Station 023 – September 20, 2017 @ 21:11
Same site as 022 - Depth: 183 m (Fig. 17)

0 - 94 Unit 3 – dark grey to black bioturbated soft clay with minor banding
94 - 101 Unit 2 – very dark grey fine sand, graded bed and sharp contact (turbidite)
101 - 324 Unit 1 – dark grey to black bioturbated soft clay, massive with minor colour banding

TWC
0 - 109 Unit 1 – dark grey to black bioturbated soft clay, minor shell debris

Station 024 – September 20, 2017 @22:59
South of pull-apart (sediment wedge downlap) - Depth: 203 m (Fig. 18)

0 - 26 Unit 4 – dark grey to black bioturbated clay with minor banding
26 - 33 Unit 3 – olive grey massive silt
33 - 42 Unit 2 – olive grey laminated sandy silt
42 - 61 Unit 1 – dark grey bioturbatted silty clay with minor laminations

TWC
4 - 10 Unit 4 – olive grey laminated silt
10 - 74 Unit 3 – dark grey to black bioturbated soft clay with minor banding and gravel at top
74 - 90 Unit 2 – olive grey laminated silt with minor shell
90 - 95 Unit 1 – dark grey clay with minor laminations

Station 025 – September 20, 2017 @ 23:52
Same site as 024 - Depth: 203 m (Fig. 18)

TWC
0 - 63 Unit 2 – dark grey to black soft clay, massive to color banded, bioturbated
63 - 75 Unit 1 – olive grey silt with minor gravel to 5 mm

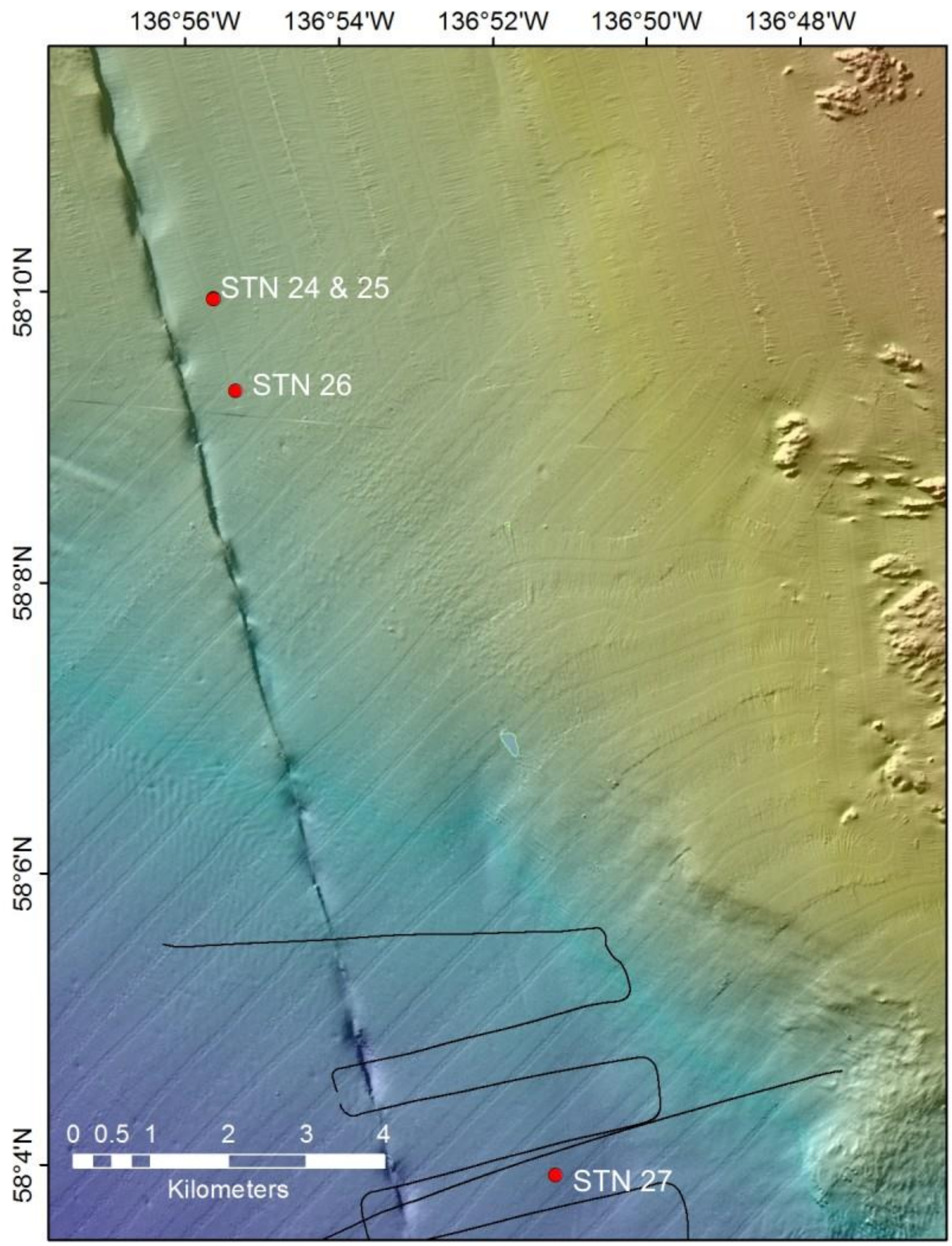


Figure 18. Location of stations 24 to 27

Station 026 – September 21, 2017 @ 01:27
Down section from 024 and 025 - Depth: 209 m (Fig. 18)

0 - 32	Unit 3 – very dark grey well sorted fine sand and angular gravel to 3 cm at base, massive
32 - 42	Unit 2 – dark grey silt with fine sand laminations
42 - 63	Unit 1 – very dark grey fine sand with mud clasts/beds

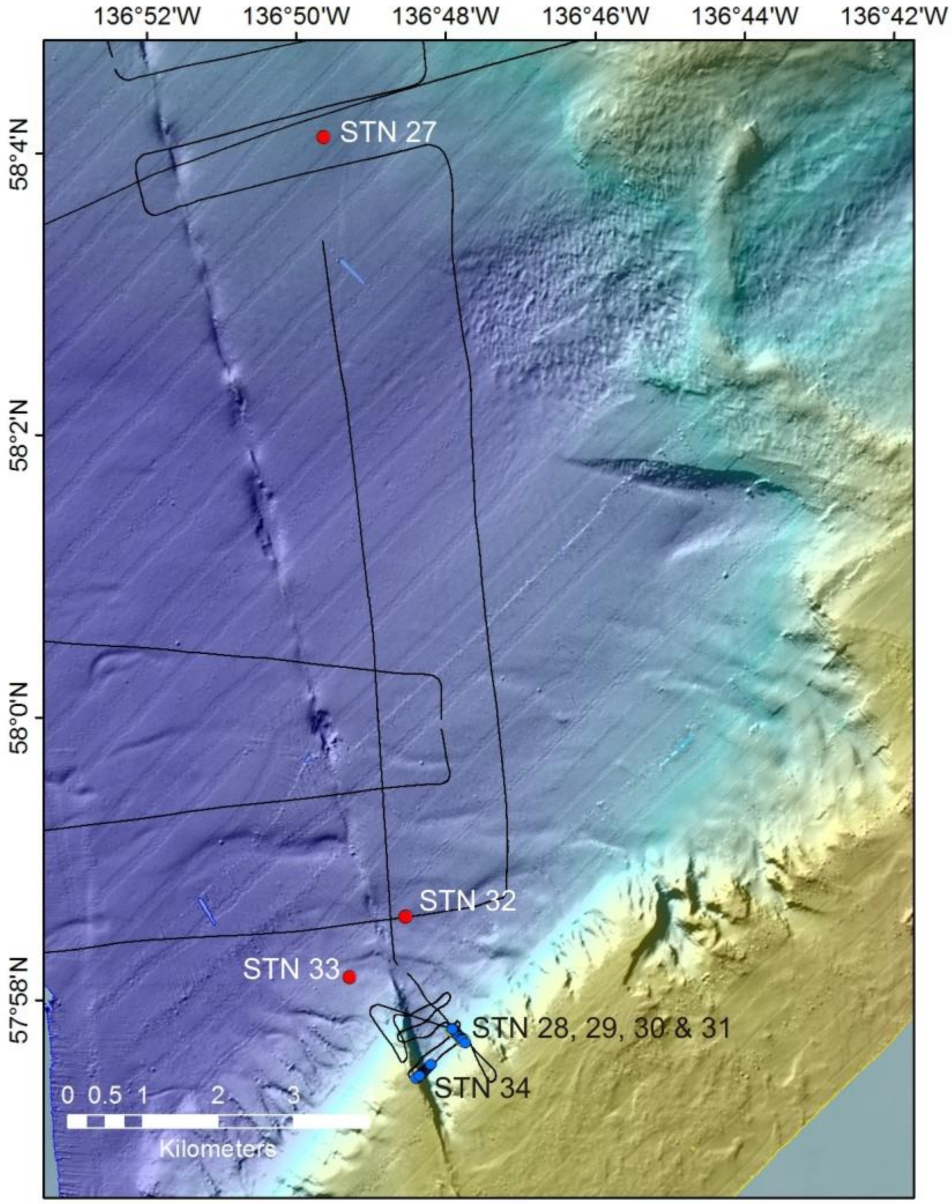


Figure 19. Location of stations 27 to 34

Station 027 – September 21, 2017 @ 14:47
Outwash apron - Depth: 309 m (Figs. 18 and 19)

0 - 22	Unit 8 – olive grey bioturbated silt
22 - 46	Unit 7 – dark grey to black soft clay
46 - 62	Unit 6 – olive grey bioturbated silt
62 - 72	Unit 5 – olive grey sandy mud, laminated
72 - 92	Unit 4 – grey to dark grey clay, massive
92 - 183	Unit 3 – dark grey bioturbated silt, black mottling where bioturbated

183 - 192 Unit 2 – grey to dark grey clay, massive
192 - 259 Unit 1 – dark olive grey to dark grey interbedded silty very fine sand and grey silt, silt intervals bioturbated

TWC
0 - 20 Unit 3 – dark grey massive clayey silt, bioturbated, gravel at base
20 - 82 Unit 2 – dark grey to black soft clay, bioturbated, laminations
82 - 95 Unit 1 – olive grey clay becoming silt

Station 028 – September 21, 2017 @ 17:27
Depth: 285 m (Fig. 19)
Grab: base of slope in the Cross Sound (Yakobi) valley
- Sandy, muddy gravel

Station 029 – September 21, 2017 @ 18:20
Depth: 238 m (Fig. 19)
IKU Grab: fault escarpment slope
- Gravel and mudstone

Station 030 – September 21, 2017 @ 19:58
Depth: 229 m (Fig. 19)
IKU Grab: above glacial escarpment
- gravel

Station 031 – Camera (see page 53) (Fig. 19)

Station 032 – September 21, 2017 @ 22:24
Fan apron below escarpment - Depth: 354 m (Fig. 19)
0 - 15 Unit 3 – dark grey to black soft clay, bioturbated, gravel at base
15 - 36 Unit 2 – olive grey to dark olive grey silt with very fine sand beds
36 - 44 Unit 1 – dark olive grey very fine silty sand

TWC
0 – 5 Unit 3 – olive grey silt
5 - 34 Unit 2 – dark grey bioturbated clay, black where bioturbated
34 - 58 Unit 1 – olive grey to dark olive grey interbedded silt and very fine sand

Station 033 – September 21, 2017 @ 23:28
Depth: 354 m (Fig. 19)
Core: Failed

Station 034 – Camera (see page 54) (Fig. 19)

Station 035 – Camera (see page 55) (Fig. 14)

Station 036 – September 23, 2017 @ 01:05
Small depression adjacent seep site - Depth: 596 m (Fig. 14)
0 - 165 Unit 1 – dark olive grey massive sand, minor silt and grey mud clast at base
Note: it is possible the core is Flow In

Station 037 – CTD Rosette (Figs. 14 and 20)

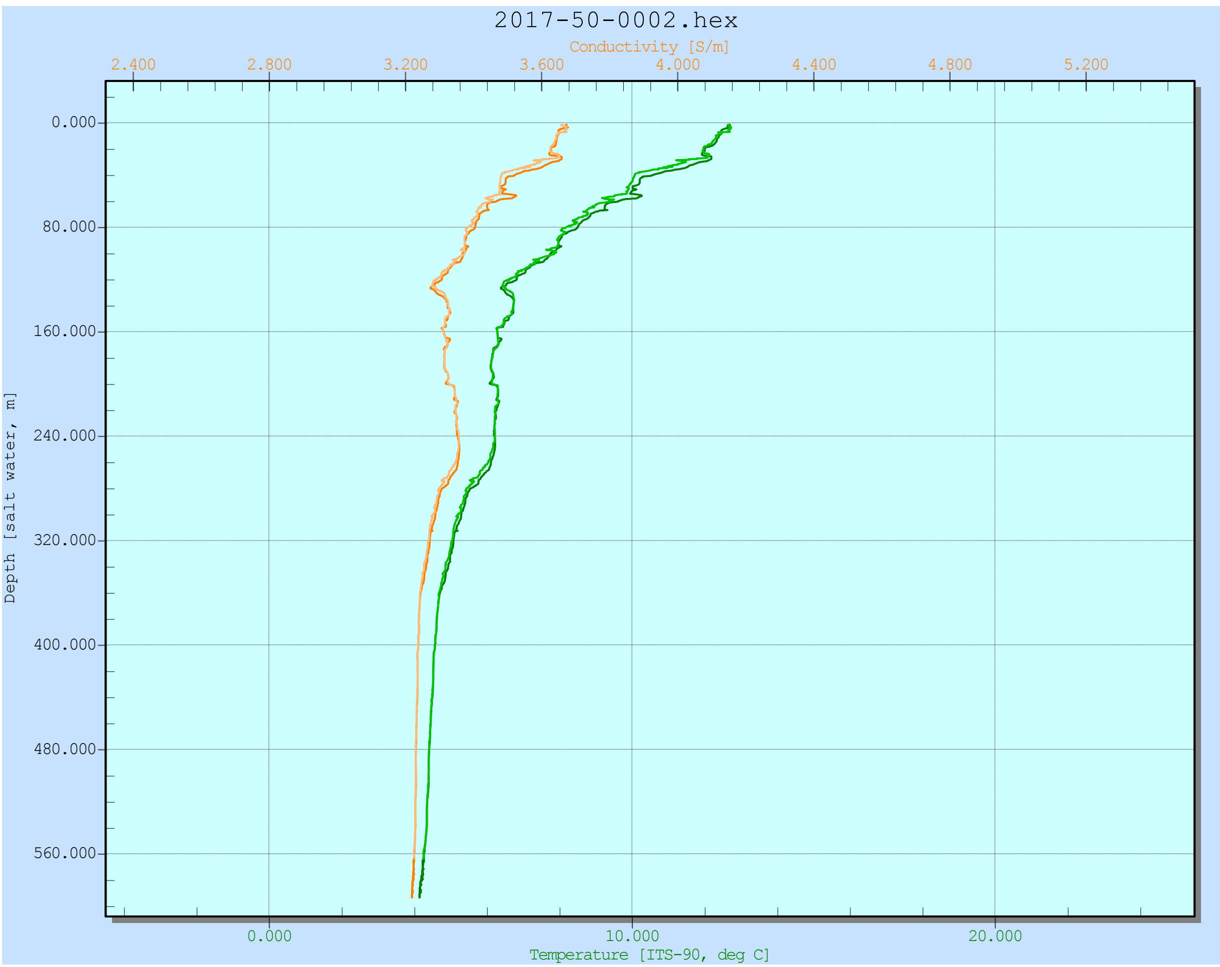


Figure 20. Station 37 CTD water column profile

Station 038 – September 23, 2017 @ 15:31
Depth: 2514 m (Figs. 13)
0 - 307 Unit 4 – olive to olive grey silty clay, massive and bioturbated
silty-sand beds at 58 cm and 162 cm
307 - 368 Unit 3 – interbedded very dark grey silty very fine sand and dark grey silt, some sand beds, bioturbated
368 - 412 Unit 2 – deformed and faulted interbedded very fine sand and grey mud, offset by 1 cm
412 - 517 Unit 1 – interbedded and laminated dark grey silt and silty very fine sand beds to 2 cm, bioturbated

TWC
0 - 5 Unit 1 – olive clayey silt, massive and soft, bioturbated (Holocene)

Station 039 – Camera (see page 56) (Fig. 13)

Station 040 – September 23, 2017 @ 20:56
Depth: 626 m (Fig. 13)
IKU Grab – seep site
- gravel and carbonates crust

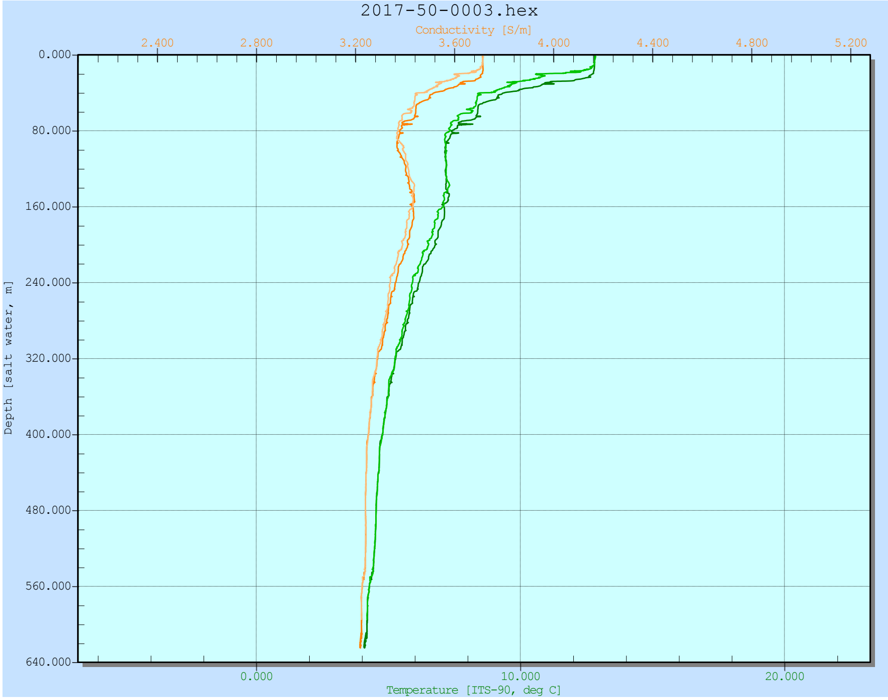
Station 041 – September 23, 2017 @ 21:44
Depth: 627 m (Fig. 13)
IKU Grab – seep site
- carbonate crust

Station 042 – September 24, 2017 @ 00:25
Depth: 2516 m (Fig. 13)
0 - 287 Unit 2 – olive to olive grey clayey silt, bioturbated, massive, minor shell flakes
287 - 355 Unit 1 – very dark grey to dark olive grey interbedded and laminated very fine sand and clayey silt, beds are up to 3 cm thick

TWC
0 - 5 Unit 1 – olive clayey silt, soft, bioturbated (Holocene)

Station 043 – Rosette (Figs. 13 and 21)

Station 044 – Rosette (Figs. 13 and 21)



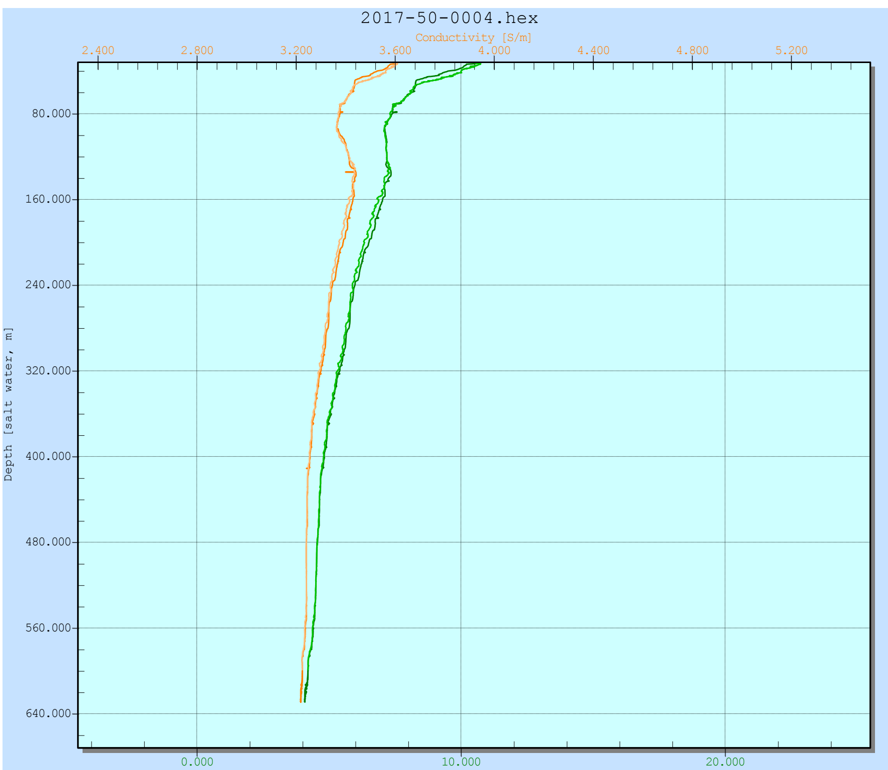


Figure 21. Stations 43 and 44 CTD water column profiles

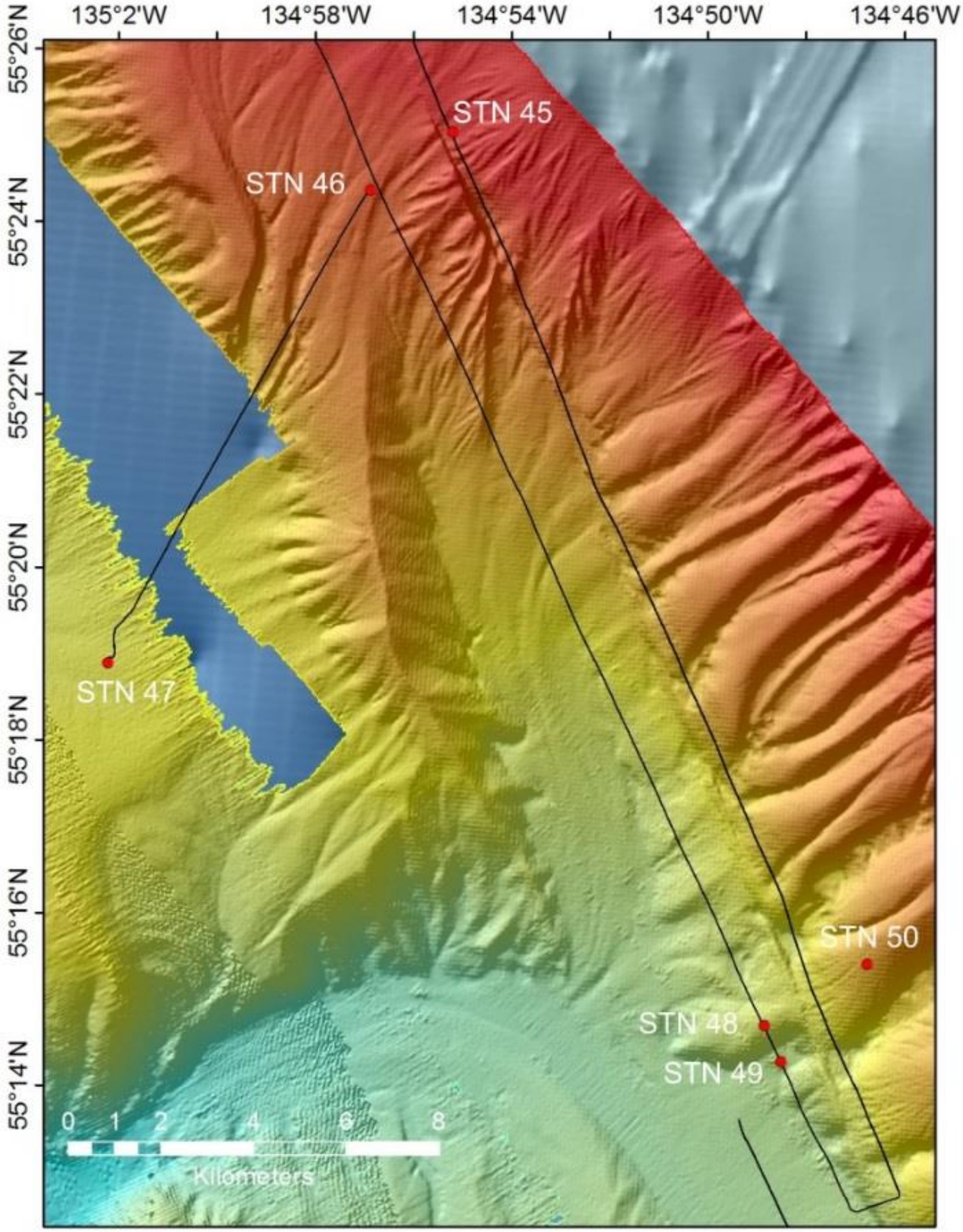


Figure 22. Location of stations 45 to 50

Station 045 – September 24, 2017 15:15
Slope fan - Depth: 536 m (Fig. 22)
0 - 289 Unit 1 – dark grey massive sandy clayey silt with gravel clasts to 4 cm, shell flecks (glaciomarine)

TWC
0 - 6 Unit 2 – dark olive grey medium sand
6 - 23 Unit 1 – dark grey sandy silt with sand laminations

Station 046 – September 24, 2017 @ 16:32
Slope fan - Depth: 654 m (Fig. 22)
0 - 6 Unit 2 – olive grey gravelly sand, gravel to 3 cm
6 - 200 Unit 1 – dark grey sandy mud with gravel to 2 cm, zones of gravel concentration (IRD)

TWC
0 - 5 Unit 4 – olive grey sandy silt with gravel
5 - 34 Unit 3 – dark grey sandy mud with minor gravel
34 - 36 Unit 2 – olive grey medium muddy sand with gravel
36 - 67 Unit 1 – dark grey sandy mud. Gravelly at base

Station 047 – September 24, 2017 @ 19:33
Mid-slope basin - Depth: 1455 m (Fig. 22)
0 - 55 Unit 3c – olive clayey silt, massive, bioturbated, soft
55 - 81 Unit 3b – olive silty clay, massive
81 - 182 Unit 3a – olive to grey clayey silt, bioturbated, massive, gradual color change
182 - 292 Unit 2 – olive grey to black laminated silt and very fine sand, (1 – 10 m thickness)
292 - 403 Unit 1 – dark grey sandy mud with minor gravel to 2 cm, massive, few shells

TWC
0 - 32 Unit 3 – olive clayey silt, massive, soft
32 - 104 Unit 2 – olive grey clay, bioturbated, soft to firm, massive
104 - 135 Unit 1 – olive clayey silt, massive, soft

Station 048 – September 24, 2017 @ 21:59
Interfluves west of fault - Depth: 1577 m (Fig. 22)
0 - 118 Unit 2 – olive clayey silt, massive to laminated, soft
118 - 257 Unit 1 – olive grey to dark olive grey laminated/interbedded silt and very fine sand, beds to 2 cm thickness

TWC
0 - 64 Unit 1 – olive clayey silt, massive to laminated, bioturbated intervals

Station 049 – September 24, 2017 @ 23:42
Thalweg of gully - Depth: 1758 m (Fig. 22)
0 - 23 Unit 3c – olive clayey silt, massive, bioturbated, soft
23 - 32 Unit 3b – olive mud, bioturbated, firm
32 - 64 Unit 3a – dark olive to olive grey silt, dewatered, stiff
64 - 281 Unit 2 – olive to olive grey silt, laminated with some very fine sand beds (graded), minor gravel, rip-up clasts
281 - 344 Unit 1 – deformed olive grey laminated silt, very firm

TWC
0 - 14 Unit 1 – olive clayey silt, massive, bioturbated

Station 050 – September 25, 2017 @ 01:32
Interfluve east of fault - Depth: 1079 m (Fig. 22)
0 - 11 Unit 3 – olive grey silt, minor sand, firm
11 - 156 Unit 2 – olive grey to dark grey laminated to massive clayey silt, bioturbated, minor shells
156 - 212 Unit 1 – dark grey massive silt, fine gravel and medium to coarse sand (IRD)

TWC
0 - 8 Unit 2 – olive grey interbedded fine sand and silt
8 - 29 Unit 1 – dark grey laminated clayey silt and very fine sand

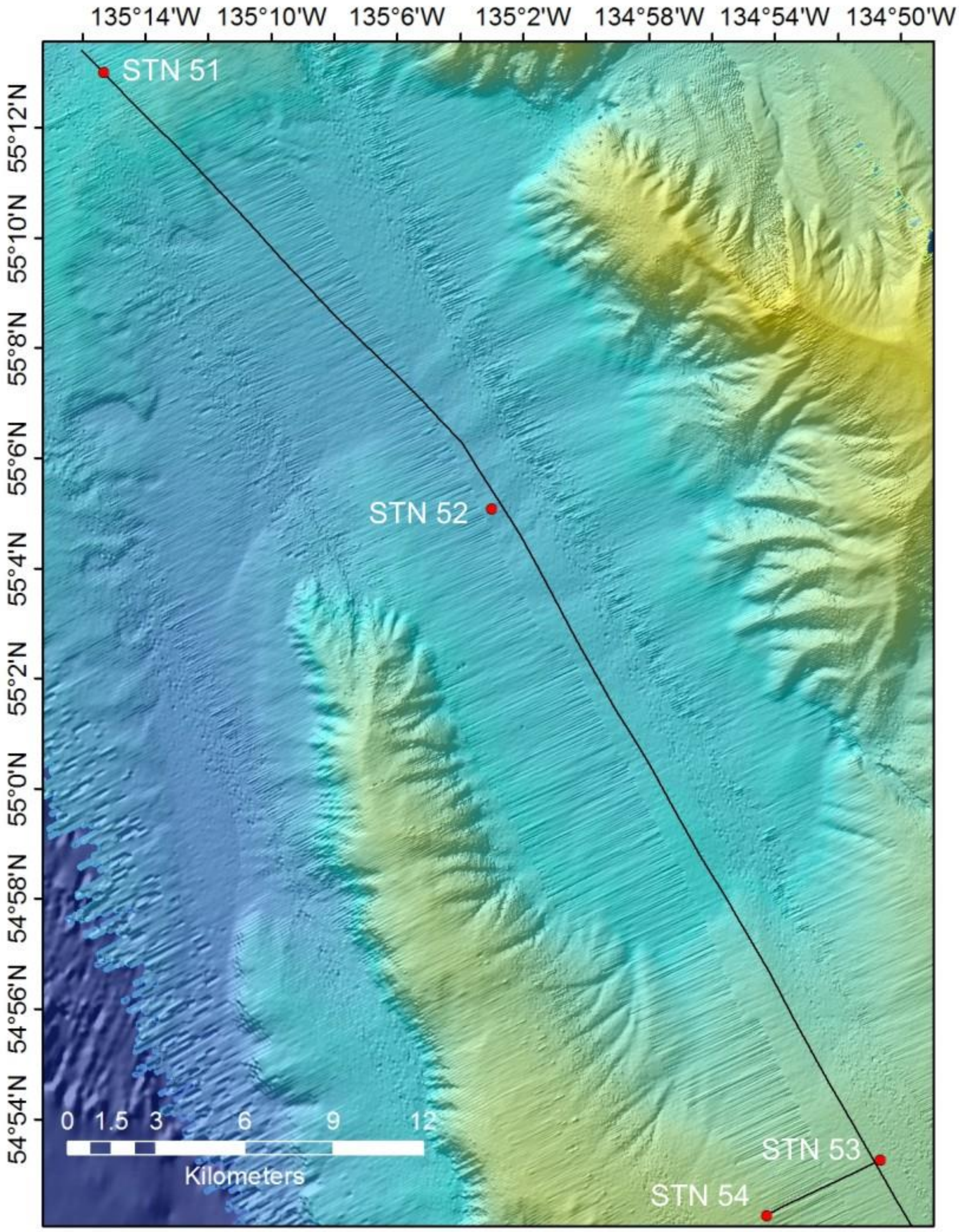


Figure 23. Location of stations 51 to 54

Station 051 – September 25, 2017 @ 15:15
Depth: 2337 m (Fig. 23)
0 - 65 Unit 2 – light olive brown to olive soft mud, massive, bioturbated
65 - 165 Unit 1 – olive grey mud with sandy intervals and beds, bioturbated

TWC
0 - 61 Unit 2 – light olive brown to olive soft mud, massive, bioturbated
61 - 129 Unit 1 – olive grey mud with sandy intervals and beds, bioturbated

Station 052 – September 25, 2017 @ 18:26
Depth: 2488 m (Fig. 23)
0 - 109 Unit 3 – olive silty clay, massive soft, bioturbated, minor shell flecks
109 - 233 Unit 2 – olive grey clayey silt, bioturbated, massive, minor shell flecks
233 - 436 Unit 1 – olive grey to dark grey interbedded and laminated silt and very fine sand to fine sand, sand beds are graded and up to 4 cm thick, minor gravel to 4 cm

TWC
0 - 108 Unit 1 – olive silty clay, minor shell flecks, bioturbated

Station 053 – September 25, 2017 @ 21:44
Depth: 1986 m (Fig. 23)
0 - 28 Unit 2b – olive silty clay, soft, bioturbated, massive
28 - 212 Unit 2a – olive clayey silt, soft, massive, bioturbated
212 - 304 Unit 1 – dark grey laminated and interbedded silt sand, sand beds are fine to very fine and up to 5 cm thick, minor gravel to 2 cm diameter (IRD)

Station 054 – September 25, 2017 @ 23:52
Depth: 1874 m (Fig. 23)
0 - 67 Unit 2b – olive clay, massive soft
67 - 118 Unit 2a – olive grey clayey silt, bioturbated, soft
118 - 263 Unit 1b – dark grey laminated clayey silt with sand and gravel (IRD), gravel to 4 cm
263 - 492 Unit 1a – dark grey laminated silty clay, minor sand and gravel (IRD)

TWC
0 - 40 Unit 3 – light olive brown to olive soft clay, massive
40 - 84 Unit 2 – olive grey clayey silt, massive
84 - 125 Unit 1 – dark grey clayey silt, gravel to 2 cm (IRD)

Station 055 – Camera (see page 57) (Fig. 25)

Station 056 – CTD Rosette (Figs. 24 and 25)

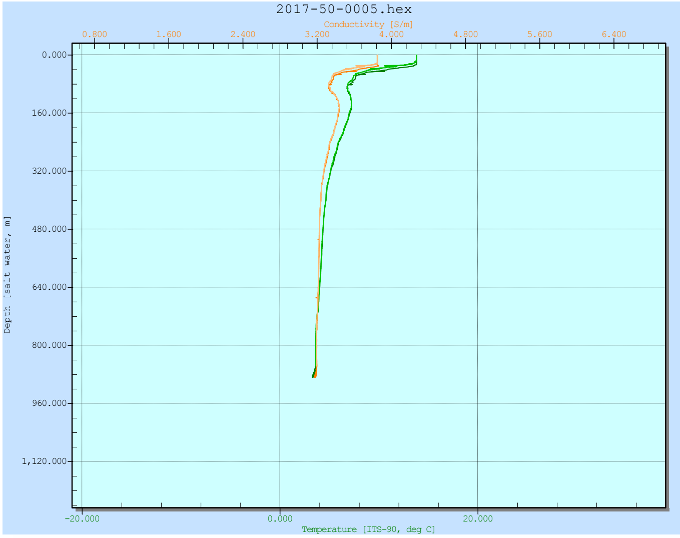


Figure 24. Station 56 CTD water column profile

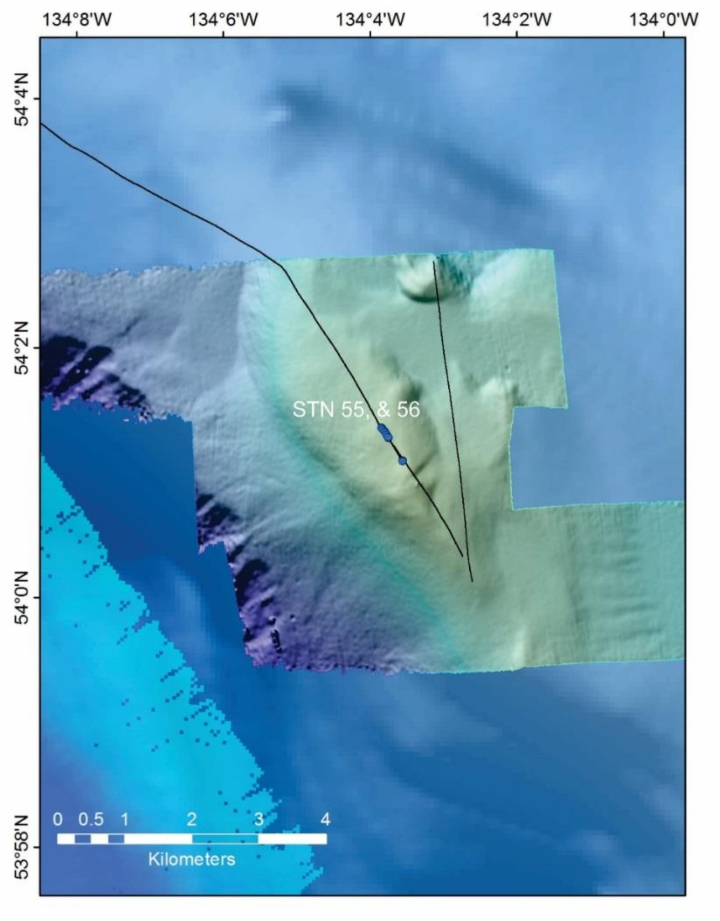


Figure 25. Location of stations 55 and 56

Station 057 – Camera (failed due to weather) (Fig. 26)

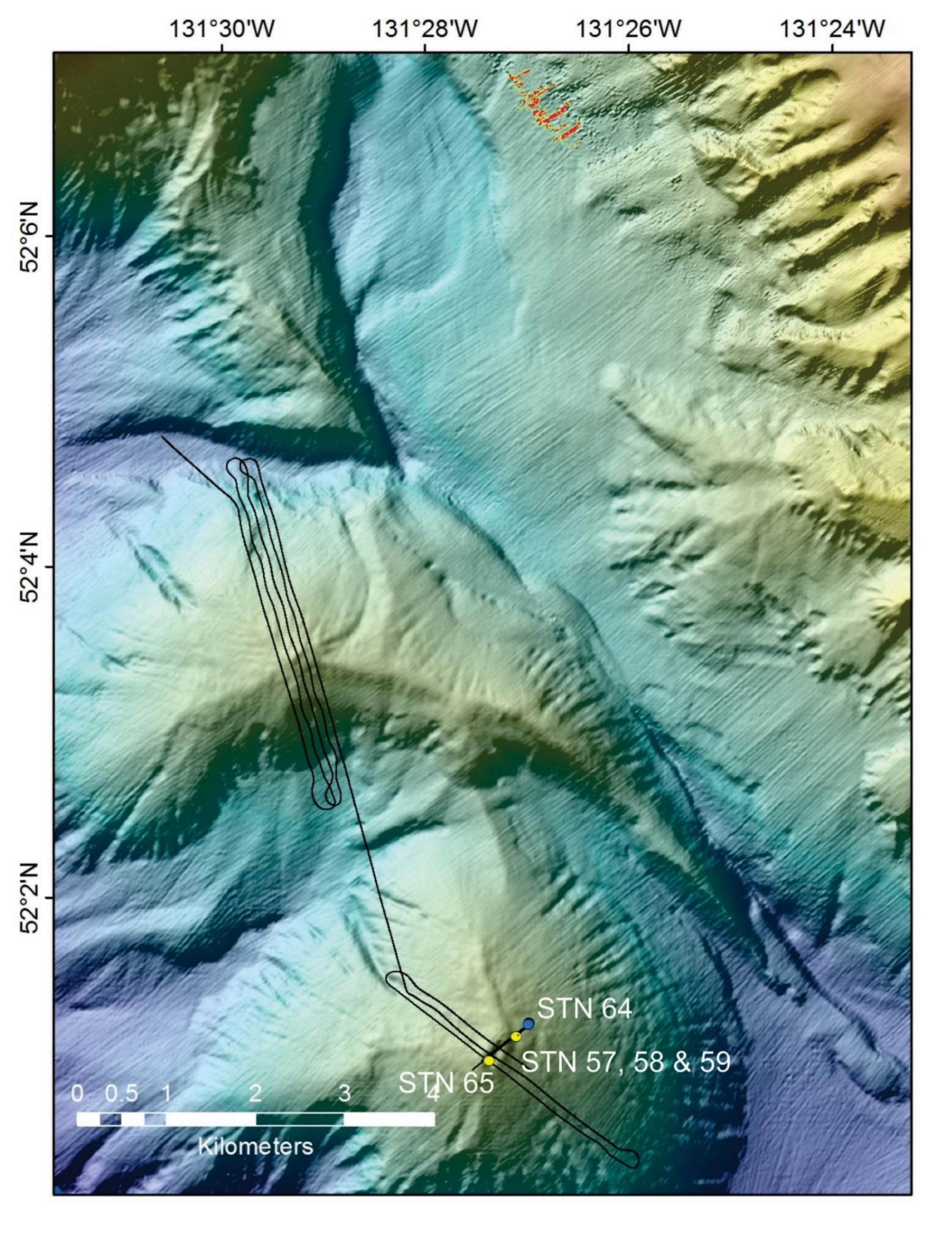
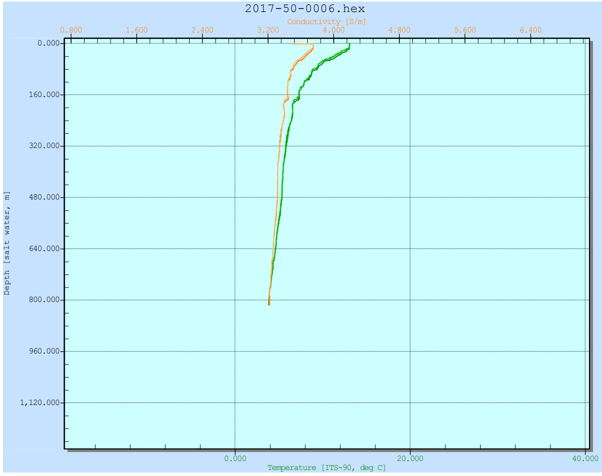


Figure 26. Location of stations 57 to 59 and 64 to 65

Station 058 – September 27, 2017 @ 20:42
Depth: 800 m (Fig. 26)
IKU Grab – seep site within volcanic cone
- no sample

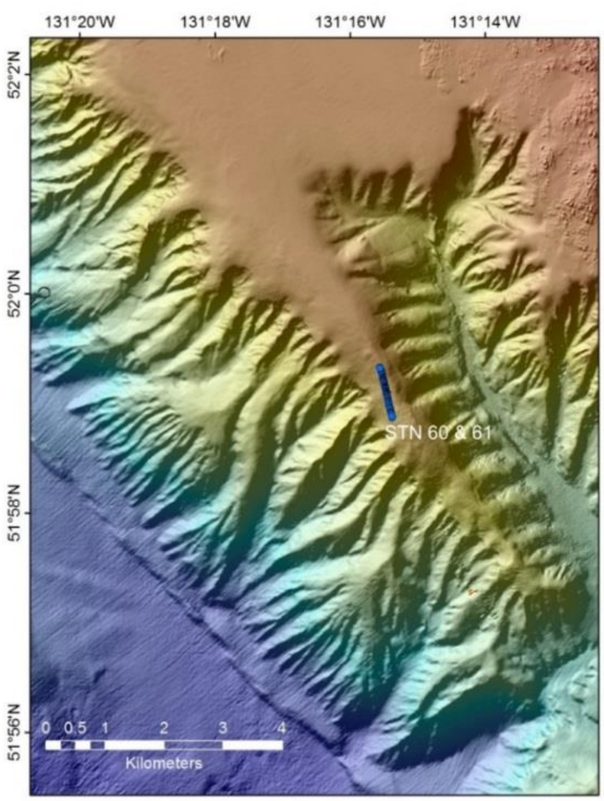


Station 059 – CTD Rosette (Figs. 26 and 27)

Figure 27. Station 59 CTD water column profile

Station 60 – Camera (see page 58) (Fig. 28)

Station 61 – CTD Rosette (Fig. 28)



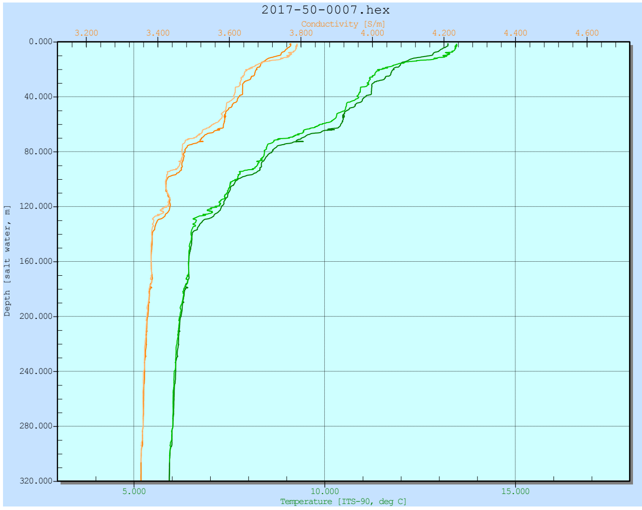


Figure 28. Location of Stations 60 and 61 and CTD water column profile for Station 6

Station 062 – September 28, 2017 @ 16:45
Depth: 2276m (Fig. 29)
0 - 245 Unit 1 – olive grey firm to stiff silt, massive, bioturbated, blobs of white mineral paste, lined voids (dissolution)

TWC
0 - 121 Unit 1 – olive soft to firm clayey silt, bioturbated, minor flecks of white mineral paste

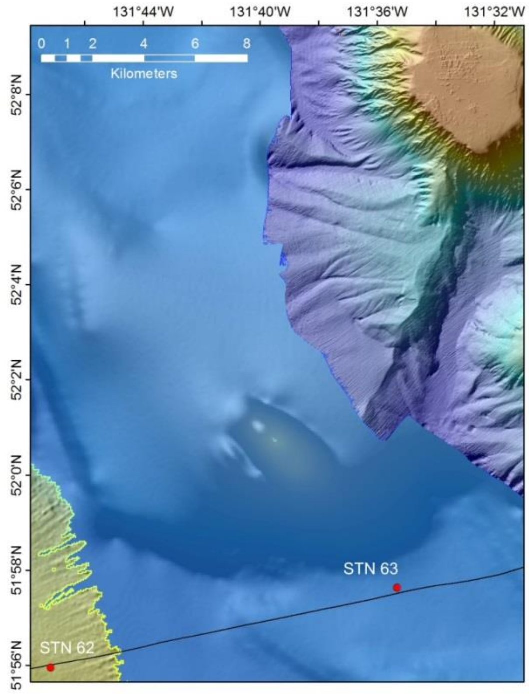


Figure 29. Location of stations 62 and 63

Station 063 – September 28, 2017 @ 19:59
Depth: 2145 m (Fig. 26)
0 - 102 Unit 3 – olive clayey silt, massive soft, bioturbated
102 - 417 Unit 2 – olive silt interbedded with dark olive grey fine to very fine sand, laminae and beds, soft, beds to 3 cm (graded), abundant white mineral paste, bioturbated
417 - 444 Unit 1 – dark grey clay with sand and gravel (IRD), minor shell

TWC
0 - 72 Unit 2 – olive grey clayey silt, massive
72 - 94 Unit 1 – olive clayey silt and deformed fine sand beds

Station 064 – Camera (see page 59) (Fig. 26)

Station 065 – September 29, 2017 @ 01:00 Depth: 802m (Fig. 26)
IKU Grab – Center of crater

- carbonates, lithified mudstone and gravel

Camera Stations (Figs. 30 to 39)

Figure 30. Station 7

Photograph 18 taken on Sept 18, 2017. Image shows a continuous layered carbonate crust with minor gravel to 2 cm and living bivalves, empty bivalve shells, and encrusting sponges.

The camera transect at Station 7 was performed to image the Chatham Fan seep site that was cored at Station 4. The transect was performed in a star pattern crossing over the seep site multiple times and 54 images were collected. The area was largely dominated by various carbonates (67%), however various gravels (33%) were present at what may be the outermost ends of some of the arms of the star, where the transect had come off of the carbonate deposit. The average grain size of the gravels was 7cm ± 5cm. Encrusting sponges were the most abundant orgamisms, present in 68% of the images. Many bivalves such as clams or remnants of bivalves such as shell fragments were present (40%). Seastar, shrimp, ophiuroid, clams, chitons, corals, and larvacean webs were also present in 10-35% of the images.

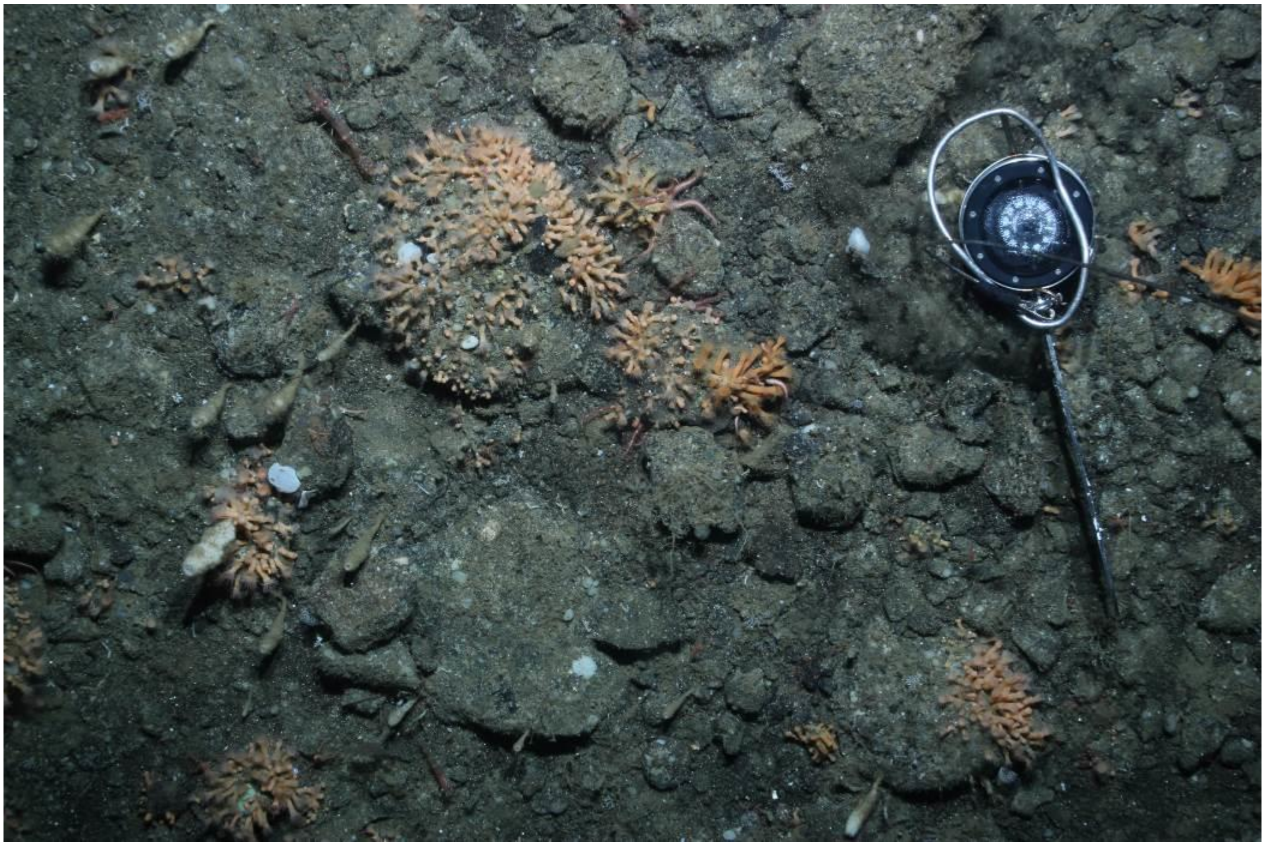


Figure 31. Station 9

Image 67 photographed on Sept 19, 2017. Image shows gravel pavement with gravel clasts to 20 cm and zooanthids, bryozoans, shrimp, demosponges, and ophiuroids.

The camera transect at Station 9 was performed to image up the flank of a volcanic cone approximately 20 km northwest of Mt. Edgecumbe volcano, on the west side of the Queen Charlotte Fault. 74 images were collected. The bottom sediment lithology transitioned from sandy gravel (57%) to gravel (25%) at (57.25359, -136.338575). Weathered carbonate crust was present in 18% of the images, between (57.253802, -136.338555) and (57.254668, -136.338567), as well as between (57.254878, -136.339303) and (57.254722, -136.339787). The average grain size of the gravels was 12 cm ± 6 cm. Ophiuroids and glass sponges were both abundant, being present in more than 50% of the images each. Anemones, shrimp, and worm tubes were present in 25-50% of the images, while encrusting sponge, zooanthids, demosponge, and serpulid worms were present in 10-25% of the images. Serpulid worms were present only in sandy gravel substrates, while zooanthids were only present at second carbonate outcrop, and demosponges at both carbonate outcrops. Otherwise the biological composition was fairly consistent throughout the camera transect with many glass sponges and ophiuroids.

Figure 32. Station 17

Photograph 1taken on Sept 19, 2017. Image shows sandy gravel with gravel to 30 cm and abundant anemones with shrimp and seastar.

The camera transect at Station 17 was performed to image a seep site that was previously sampled with the IKU grab at Station 15. The transect was cut short due to damage to the camera pinger, and only six images were collected, of which one had very poor visibility. The bottom lithology in the images was 100% sandy gravel with gravel decreasing in size from 30 cm to 5 cm along the course of the short transect. The last photograph at (57.200728, -136.306852) had single large (20 cm) carbonate clast. Anemones were present in all five clear images, ophiuroids in three, and shrimp, seastar, and white coral were present in two images each. The shrimp were only present in the images with a larger gravel size (30-20 cm), while ophiuroids were present only in the last three images which had a 5 cm gravel size.

Figure 33. Station 31

Image photographed on Sept 21, 2017. Image shows well sorted muddy sand with tracks and trails, worm tubes, ophiuroids, shrimp, kelp, and urchin.

The photo transect at Station 31 was performed to image the terrace slope and glacial escarpment at the east wall of the Yakobi Sea Valley, adjacent to the Queen Charlotte Fault. 35 images were collected. There was a general transition from silty or muddy sand to gravelly sand along the transect. Rippled silty sand (16%) was present between (57.96896, -136.773148) and (57.968898, -136.772852), and muddy sand with tracks and trails (22%) was present at (57.968962, -136.773112) and between (57.968895, -136.772847) and (57.968667, -136.772248). Otherwise the bottom lithology was largely variations of sandy, muddy, gravel (63%). Ophiuroids were the most common organisms, present in 90% of the images. Ophiuroids, anemone, shrimp, and various fish were also common, being present in more than 15% of the images. The biological assemblage was relatively consistent across the transect.

Figure 34. Station 34

Image 49 photographed on Sept 21, 2017. Image shows a stiff muddy sand scarp with crinoids and squat lobsters.

The camera transect at Station 34 was performed to image the terrace slope along the fault displacement of the escarpment at the east side of the Yakobi Sea Valley. 62 images were collected showing a variety of bottom types, including glacial tills and scarps. The lithology starting from the beginning of the transect to about (57.963363, -136.778363) is a silt veneer on sand and gravel (44%), with some sandy mud and mixed sediment. Some areas of sediment were covering hard glacial surfaces at (57.963445, -136.778242) and (57.963415, -136.778295). Further along the transect the silt veneer transitions to sandy gravelly mud (28%) and then to primarily muddy sand with scarps (22%) and a single glacial deposit of boulder lag on till at (57.962905, -136.779052). There was several abundant taxa present along the transect; ophiuroid (37%), worm tube (35%), shrimp (27%), and squat lobster (20%) were the most abundant, however prawn, rockfish, crinoid, hydroid, bryozoan, urchin, thornyhead, and some others were present in a few (<10%) of the images. There was a distinct but gradual variation in the biological communities corresponding to the lithology changes along the transect, beginning with ophiuroids as the most common in the silt veneer section up to around (57.963593, -136.777995), then transitioning to worm tubes as the dominant taxon at the transition from silt veneer to sandy gravelly mud between (57.963593, -136.777995) and (57.963162, -136.778647). Squat lobsters were present in many of the muddy sand and scarp photographs after about (57.963162, -136.778647), while the fourth abundant group, shrimp, were relatively evenly distributed along the entire transect.

Figure 35. Station 35

Image 87 photographed on Sept 22, 2017. Image shows sandy mud with clams, spider crab, and bacterial mats.

The camera transect at Station 35 was performed to capture imagery of a potential seep site located along the fault below the Mt. Edgecumbe lava field. 95 images were collected, with several showing strong evidence of chemosynthetic communities. The bottom lithology was dominantly various muds (96%), however there was an area of bacterial mats (3%) between (57.03769, -136.163137) and (57.03764, -136.162925). The biological communities were generally dominated by worm tubes (86%) and to a lesser extent shrimp (64%), ophiuroids (40%), and prawns (35%). There was a distinct chemosynthetic assemblage of bacterial mats and bivalves (<10% of total) between (57.03769, -136.163137) and (57.03764, -136.162925).

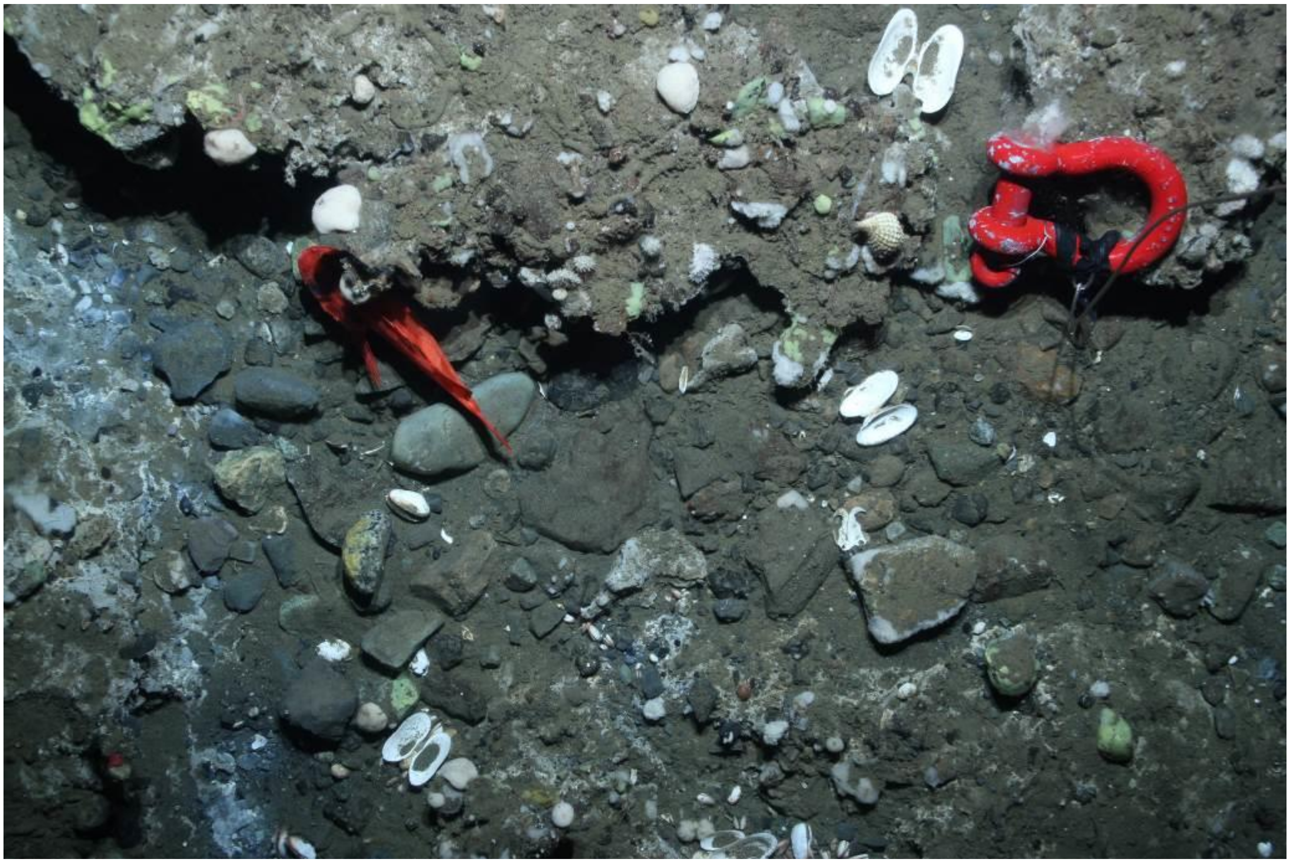


Figure 36. Station 39

Image 25 photographed on Sept 23, 2017. Image shows carbonate ledge with sponges, bacteria mats, fusitriton, and a thornyhead.

The camera transect at Station 39 was performed to capture images of the seep site seaward of the Chatham Strait sea valley. 48 images were collected showing gravel and cobble beds (68%), authigenic carbonates (11%), and chemosynthetic communities (20%) around the plume. Gravels were roughly 12 cm ± 8 cm in size. The transect begins with gravels, but enters a carbonate sequence at (55.679268, -135.337087). A carbonate chemo community is present inside this larger carbonate section between (55.679237, -135.336932) and (55.67917, -135.336613). The lithology transitions back from carbonates to gravel and boulders at (55.679095, -135.336295), and into sandy gravel at (55.678942, -135.335573). Shrimp, seastar, and ophiuroids were present in 15-30% of the images and dominated the gravel and sand terrain; bacterial mats and clams (15-30% of total) as well as sponges and fusitriton (<15% of total) were more dominant on the carbonate sequences and in the chemosynthetic communities. There was no particular dominant species across the transect as a whole - the most common (ophiuroid) was only present in 30% of photographs.

Figure 37. Station 55

Image 5 photographed on Sept 26, 2017. Image shows sandy gravel on carbonate with ophiuroids.

The camera transect at Station 55 was performed to image a new seep site west of Haida Gwaii. The transect was cut short by rough weather - only 15 images were collected, none of which showed the seep. The bottom lithology showed sections of sandy gravel (50% of total) between (54.025963, -134.057595) and (54.024998, -134.056332), a single image of sandy gravel on carbonate was captured at (54.02551, -134.056918), but otherwise the bottom lithology was largely gravel lag or boulders (42%). Some of the large cobbles appeared to be mafic, and the grain size of the gravel fraction was roughly 5 cm ± 2 cm. Ophiuroids were dominant and present through most of the transect (79%), squat lobsters were present in 36% of the images but only in areas with boulder or gravel lag substrate, and sponges, anemone, coral, and flounder were present in smaller abundances, appearing in <15% of the images.

Figure 38. Station 60

Image 103 photographed on Sept 28, 2017. Image shows sandy gravel with gravel to 20 cm and anemones, four tritons, sponges, and ophiuroids.

The camera transect at Station 60 was performed to gather images of a gas seep site southwest of Moresby Island. 103 images were collected. The bottom lithology was largely sandy gravel (88%) with some gravel or boulder gravel (12%) located between (51.990325, -131.256667) and (51.989623, -131.256277), and between (51.987217, -131.255207) and (51.984812, -131.254208). Gravel grain sizes averaged at 11 cm ± 8 cm. Anemone and ophiuroid were equally dominant in the images (~40% of the total each), stylaster coral, sponge, and crinoid were all present in smaller quantities (10-20%), and seastar, cup coral, worm tube, triton, glass sponge, prawn, shrimp, and several other taxa were also present in <5% of the images. Cup corals were only present in gravel or boulder gravel substrates, otherwise the rest of the organisms were fairly evenly distributed along the transect. Hints of bacterial mats were present but no other signs of seep-associated chemosynthetic communities were imaged.

Figure 39. Station 64

Image 1 photographed on Sept 28, 2017. Image shows thin sandy silt on carbonate with a stalked coral.

The camera transect at Station 64 was performed to gather more data on the gas seep from the submarine volcano unsuccessfully imaged in the camera transect at Station 57, offshore of southern Moresby Island. Six images were collected before the transect had to be abandoned due to poor weather and ship motion. The bottom geology was entirely carbonate with a thin sediment veneer, though there was a transition in the sediment veneer composition from thin sandy silt to thin sandy silt with gravel at (52.022372, -131.44427). Ophiuroids were present in four of the six photographs, cup corals in two, and crinoids, stalked coral, and thornyhead in one each.

PRELIMINARY RESULTS

The cruise data collection began with MCS seismic profiling along the Devils Mountain Fault, a transpressive fault zone along the northern side of the Strait of Juan de Fuca immediately offshore of Victoria. Initial data confirmed that the Devils Mountain Fault and re-activated Leech River Fault are the same system. After transiting west through the Strait of Juan de Fuca, we cored a submarine landslide for paleo-seismicity, Lopez Slide, west of Vancouver Island, and then proceeded north along the western side of Haida Gwaii and obtained MCS data over the area of deformed seafloor at the site of the 1949 M_S 8.1 earthquake epicenter. We then obtained a CTD rosette cast and one core over a previously identified mud volcano west of Haida Gwaii, and then began seismic surveys in the same region, working toward the north. Coring targets during the first (northward) part of the cruise were focused on areas north of Dixon Entrance, because a previous cruise in 2015 had collected 27 cores in the region offshore of Haida Gwaii and other areas south of Dixon Entrance. The survey then progressed to just north of the U.S-Canada international boundary (near the mouth of Dixon Entrance) and progressively moved northward toward Baranof Island and eventually to Yakobi Sea Valley (Fig. 40). A sub-bottom chirp survey was conducted in the Yakobi Sea Valley during the northernmost two days of the cruise to tie shallow stratigraphy throughout the basin to a radiocarbon-dated stratigraphy near the shelf edge (jumbo piston core EW0408-66JC; Barron et al., 2009).

The coring effort successfully recovered piston cores from 34 sites, with core recovery ranging from < 1 m to a maximum of 5.18 m. Given expected sedimentation rates in the deepest water from which we recovered cores, we anticipate that the core materials span the Holocene and Late Pleistocene sedimentary record to a greater or lesser extent depending on the specific location. Several additional sites resulted in IKU grab samples having been recovered, and camera-tow transects successfully returned images from a variety of sites, revealing details of seafloor substrate, fault scarps and biologic communities, as well as any seep activity present at the camera-transect location. We recovered photographs from a scarp along the eastern wall of the Yakobi Sea Valley, Alaska, that show an nearly vertical, fresh-looking surface that we interpret to have been offset by motion along the QC-FW; the site was previously identified as an important piercing point in reconstruction of fault motion since Late Pleistocene time.

One new mud volcano was discovered south of the large transboundary volcano discovered in 2015. This is the southernmost mud volcano that forms a linear group that aligns parallel to the central portion of the QC-FW, 15 to 20 km to the west and straddles the international boundary. All three mud volcanos are elongate in shape orientated in a NW-SE direction with plumes reaching up to 700 m in the water column. The venting volcano identified in 2015 has not changed in the 2 years between surveys. There are likely more volcanos along this chain, as much of the area has not been surveyed with multibeam swath bathymetry. Three seep sites (Stations 7, 17, 39) were also investigated all along ridge spines just west of the fault, north of the chain of mud volcanos. All were actively venting, had bacterial mats and chemosynthetic biological communities. One active seep site occurred right on the fault (Station 35) where a core and CTD rosette were collected.

In addition, two areas where volcanic cones occur, 2 to 3 km seaward of the fault, were surveyed and sampled. A cone located 20 km northwest of the Mt. Edgecumbe volcano was sampled and a camera site collected images along the flank of the cone (Station 9). At the southern end of the QC-FW fault zone two volcanic cones, discovered in 2011, were surveyed and active seeps on both cones identified and CTD rosette casts obtained.

Although the results are dependent upon shore-based analyses and interpretations of the collected data, these preliminary results already provide a unique insight into the workings of the QC-FW fault system. For example, the role of venting gas and fluids may facilitate future earthquakes, by reducing friction along the plate margin and may be contributing to ocean acidification and global warming by contributing CO2 to the water and atmosphere in the vicinity of the fault. Methane appears to be the gas that is coming out of the vents as indicated by the benthic communities found that utilize methane for living. In addition, we found submarine landslides that are primarily concentrated between Chatham Strait and Dixon Entrance and are the size from which substantial tsunamis could have been generated (Brothers et al. 2018; Greene et al., 2018).

Figure 40. Photo of the southernmost Fairweather Range near Icy Point (Mt. La Perouse), Alaska taken from the stern of *CCGS John P. Tully*.

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Appendices

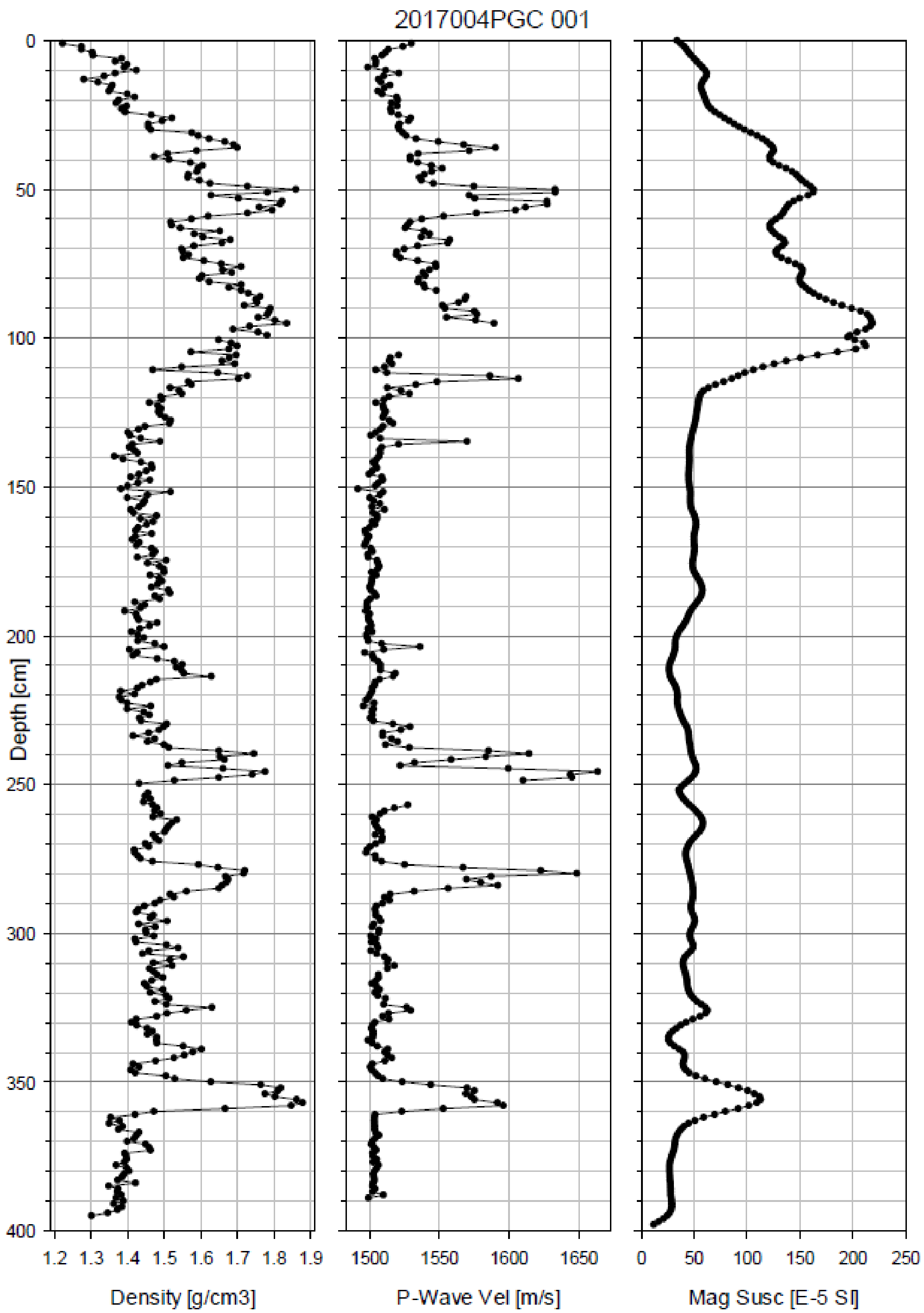
Appendix 1

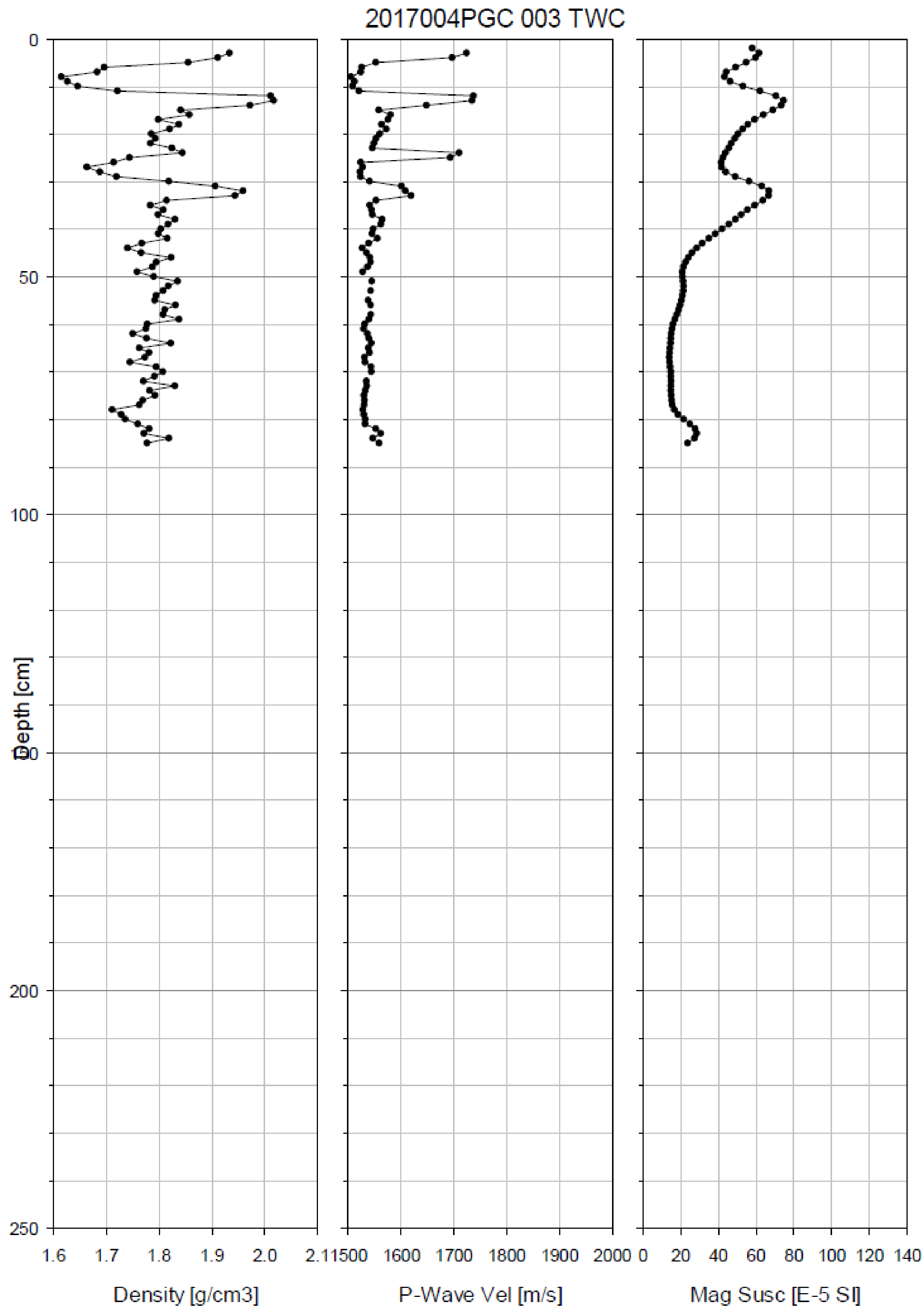
Core, IKU Grab, and CTD Rosette Stations

Station	Sample Type	Depth (m)	Latitude	Longitude
001	Core	2502	48.584823	-127.076097
002	Rossette	979	54.279500	-134.192833
003	Core	993	54.278667	-134.195333
004	Core	700	55.910000	-135.500167
005	Core	814	55.937877	-135.531388
006	Core	925	55.939898	-135.551738
008	core	2488	55.795667	-135.675667
010	Core	305	57.258667	-136.322667
011	Grab	257	57.254163	-136.338865
012	Grab	303	57.252333	-136.338833
013	Core	740	57.218333	-136.391000
014	Core	925	57.140812	-136.372192
015	Grab	492	57.200667	-136.307667
016	Grab	322	57.204000	-136.287167
018	Core	182	58.309027	-137.035960
019	Core	182	58.309023	-137.035897
020	Core	185	58.308633	-137.038578
021	Core	185	58.308667	-137.038500
022	Core	182	58.312402	-137.041740
023	Core	183	58.312387	-137.041742
024	Core	203	58.168037	-136.920720
025	Core	203	58.168000	-136.920667
026	Core	209	58.157833	-136.913500
027	Core	309	58.072360	-136.824508
028	Grab	285	57.968667	-136.772667
029	Grab	238	57.967833	-136.770682
030	Grab	229	57.967667	-136.770000
032	Core	354	57.981500	-136.786167
033	Core	354	57.973612	-136.797022
036	Core	596	57.037333	-136.162667
037	Rossette	589	57.038333	-136.164667
038	Core	2514	55.670335	-135.581547
040	Grab	626	55.679500	-135.337500
041	Grab	627	55.679500	-135.337333
042	Core	2516	55.637000	-135.547167
043	Rossette	630	55.679667	-135.337167

044	Rossette	636	55.678500	-135.337667
045	Core	536	55.423833	-134.917000
046	Core	654	55.411333	-134.943333
047	Core	1455	55.315833	-135.018500
048	Core	1577	55.256833	-134.786333
049	Core	1758	55.250017	-134.779660
050	Core	1079	55.270272	-134.753172
051	Core	2337	55.218333	-135.253500
052	Core	2488	55.096560	-135.028228
053	Core	1986	54.909500	-134.794833
054	Core	1874	54.88988	-134.851995
056	Rossette	902	54.018833	-134.048333
058	Grab	800	52.021000	-131.446333
059	Rossette	801	52.021166	-131.445957
061	Rossette	345	51.986833	-131.253833
062	Core	2276	51.932833	-131.772000
063	Core	2145	51.965333	-131.577167
065	Grab	802	52.018477	-131.450573

Appendix 2 - Core Physical Properties





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1.9
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2.1
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1600
1700
1800
1900
2000
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20
40
60
80
100
120
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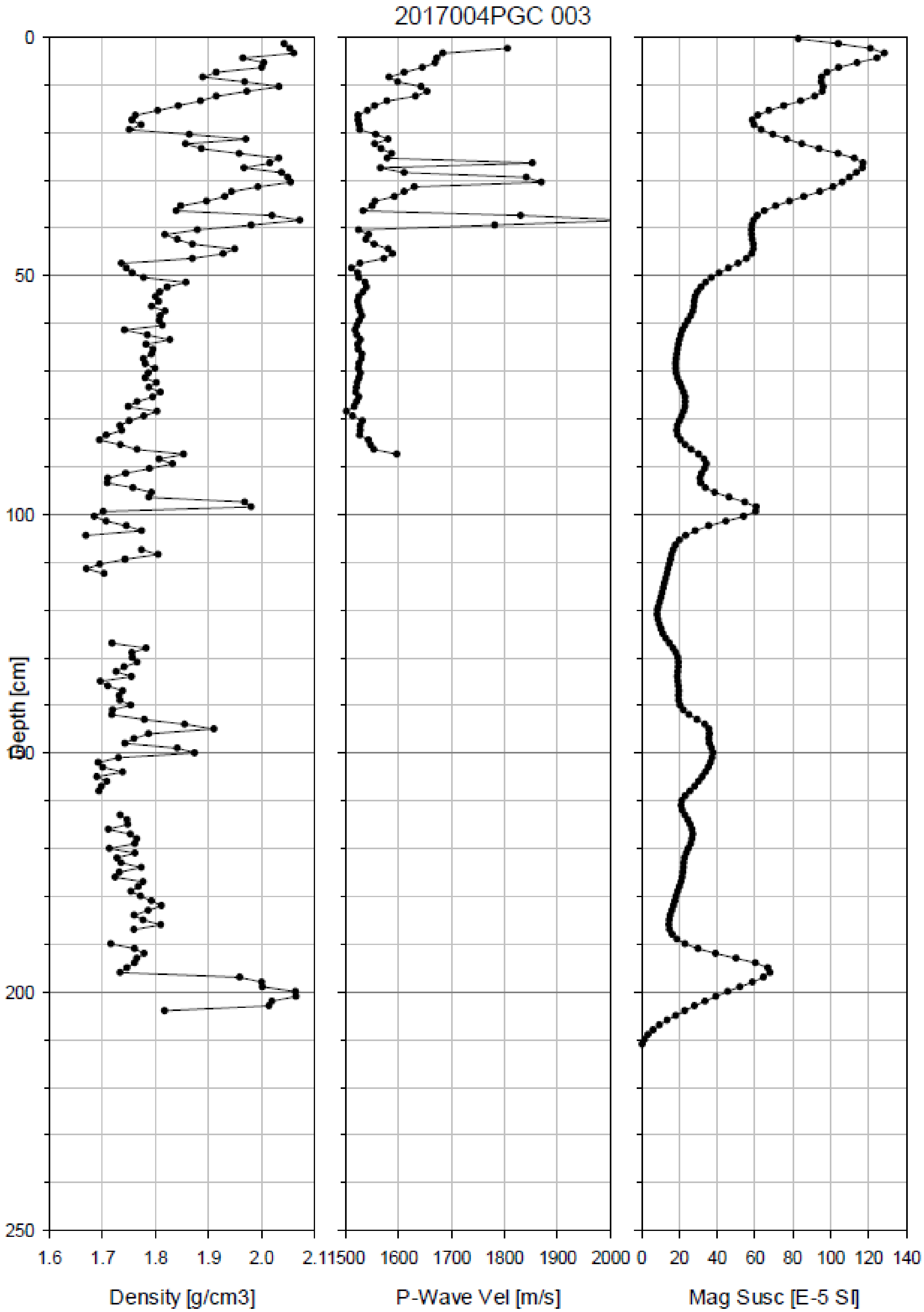
Density [g/cm3]
P-Wave Vel [m/s]
Mag Susc [E-5 SI]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Density [g/cm3]
1500
1600
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P-Wave Vel [m/s]
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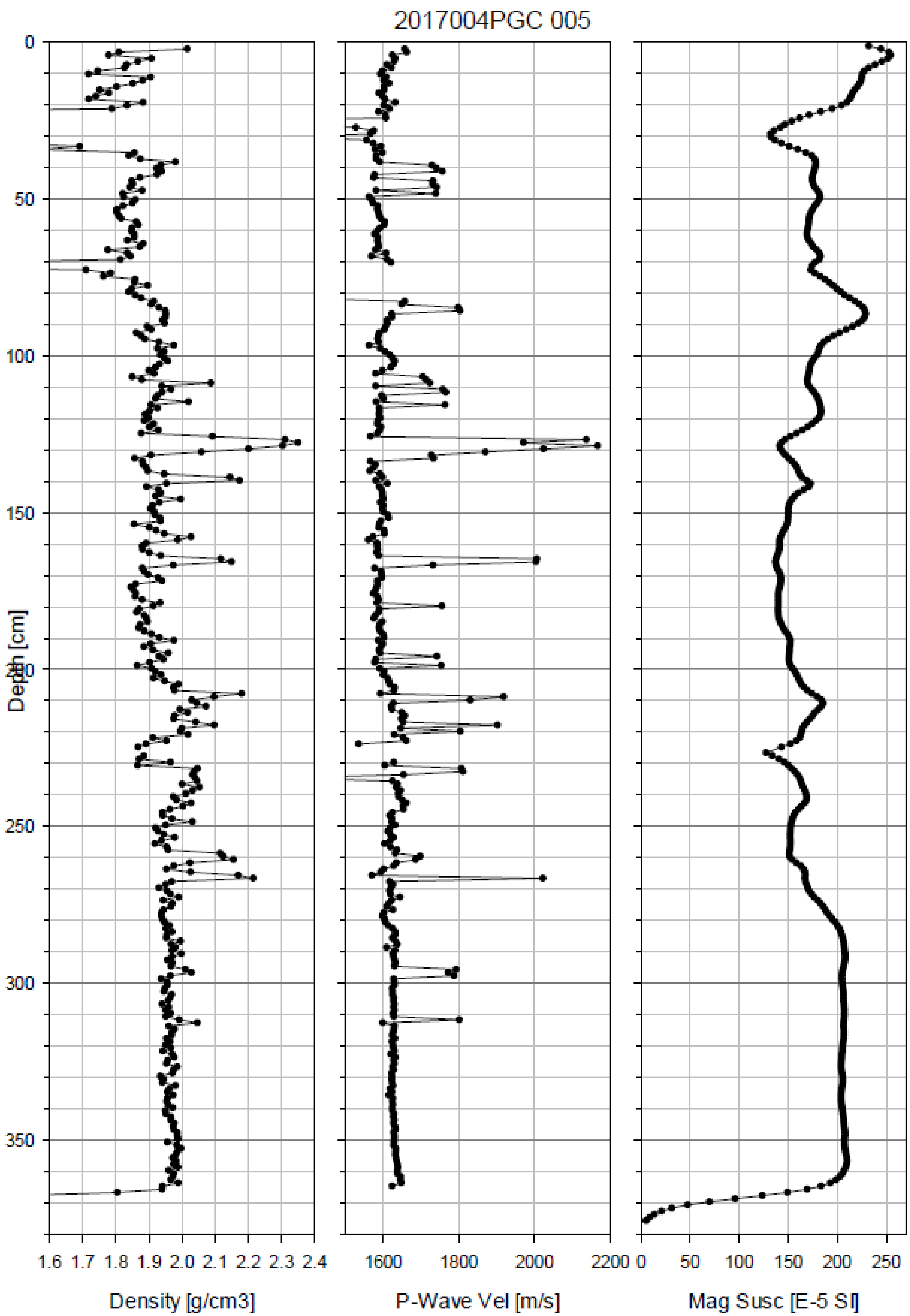
Mag Susc [E-5 SI]



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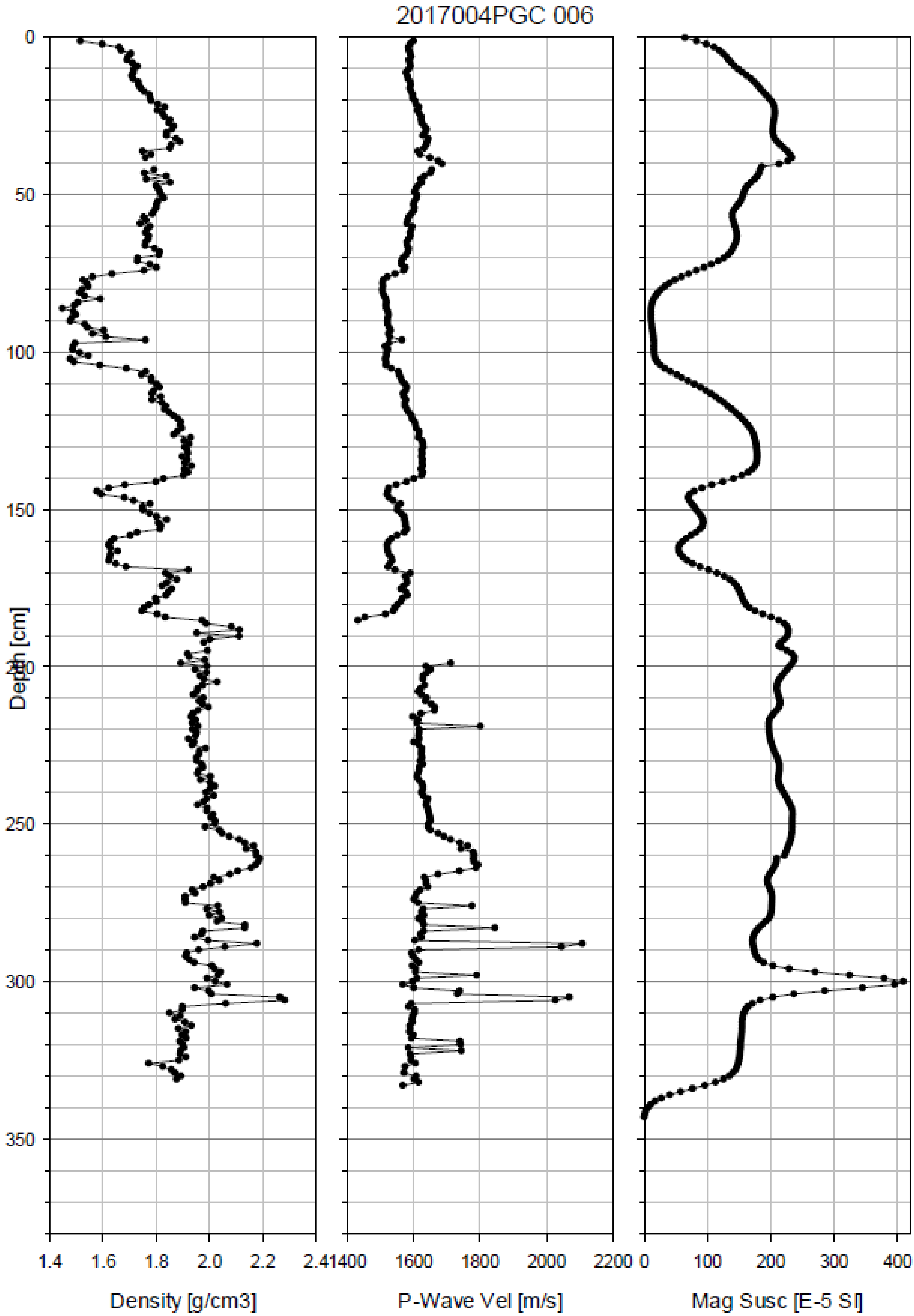
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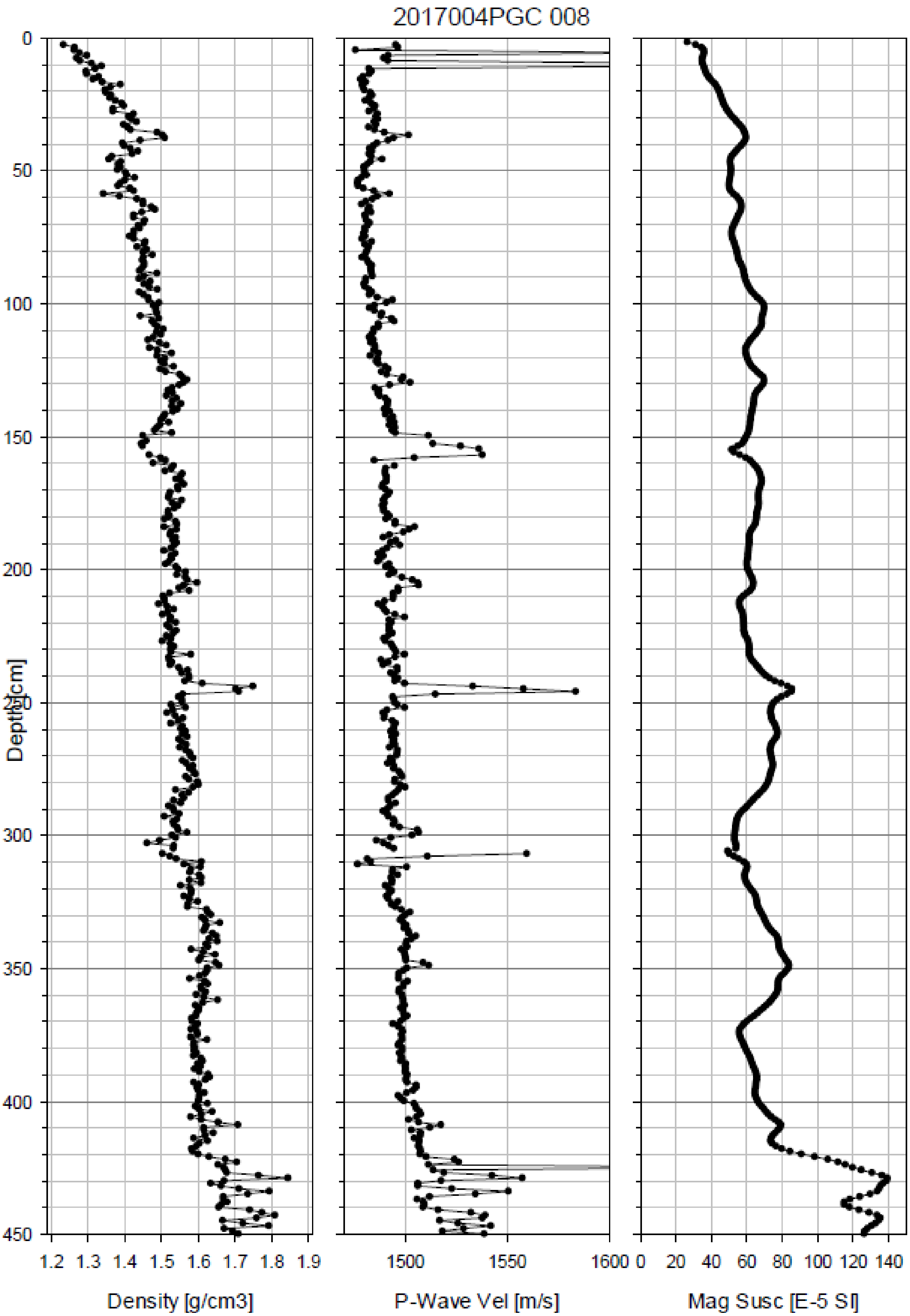

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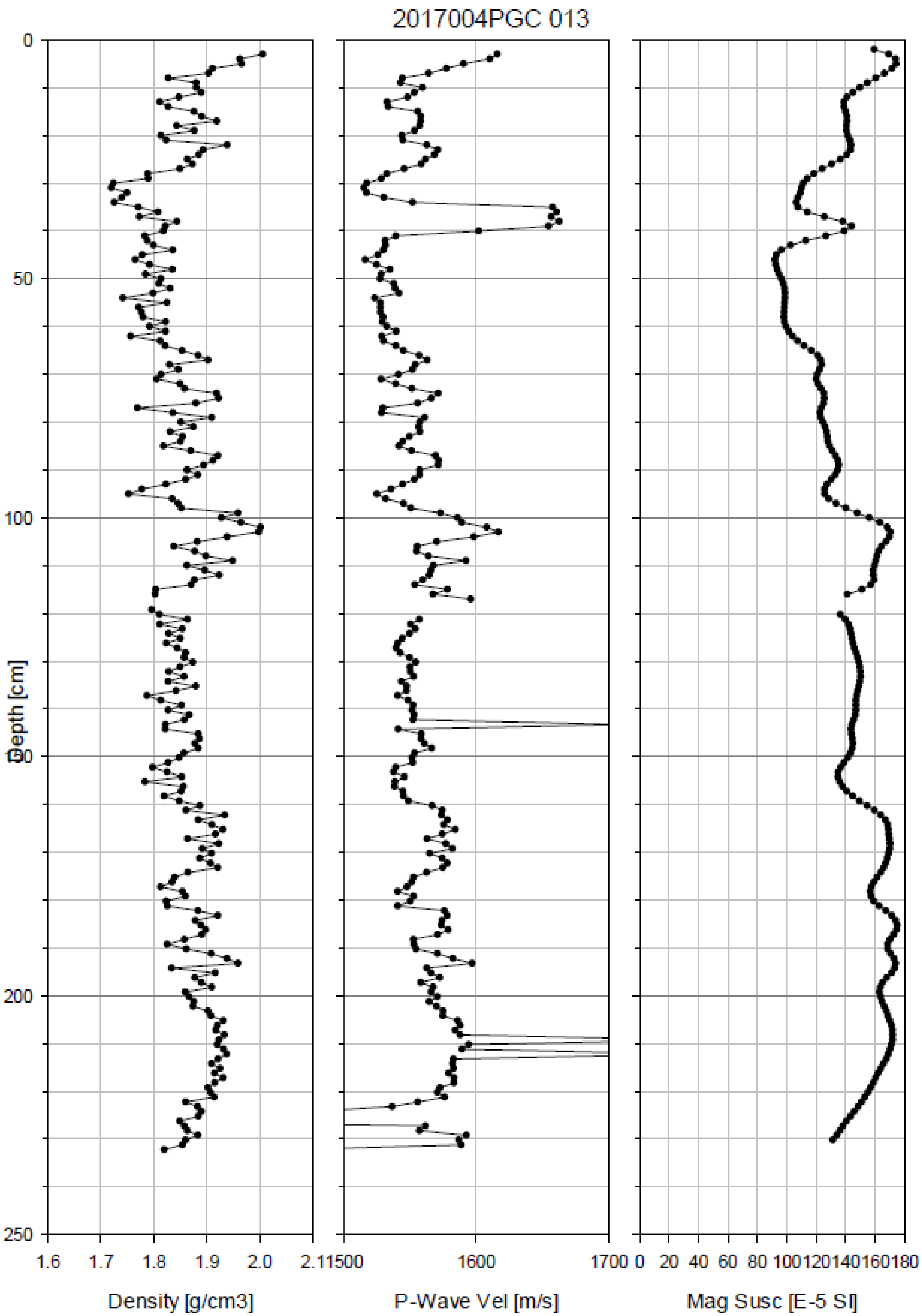
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120
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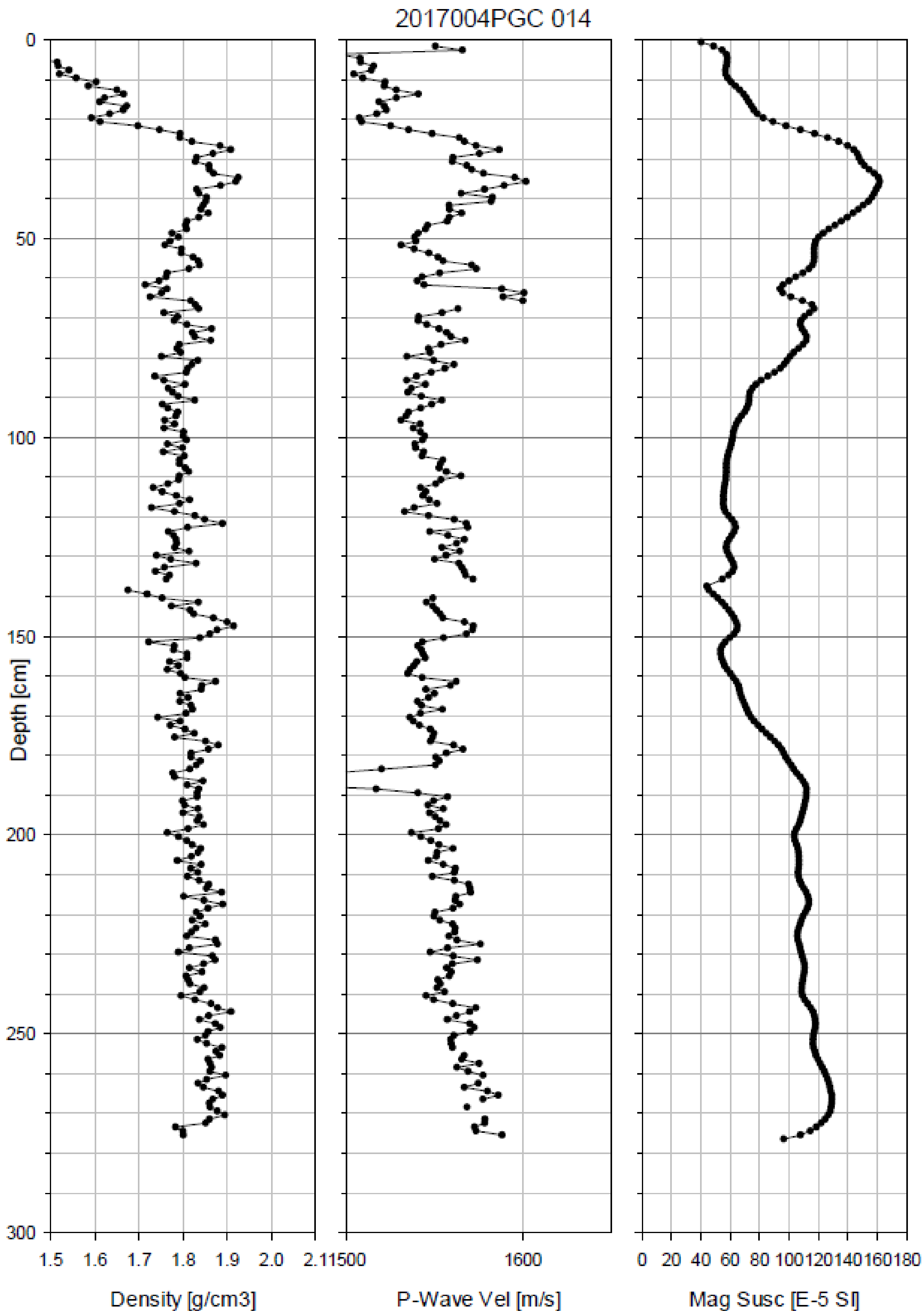
Mag Susc [E-5 SI]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P-Wave Vel [m/s]
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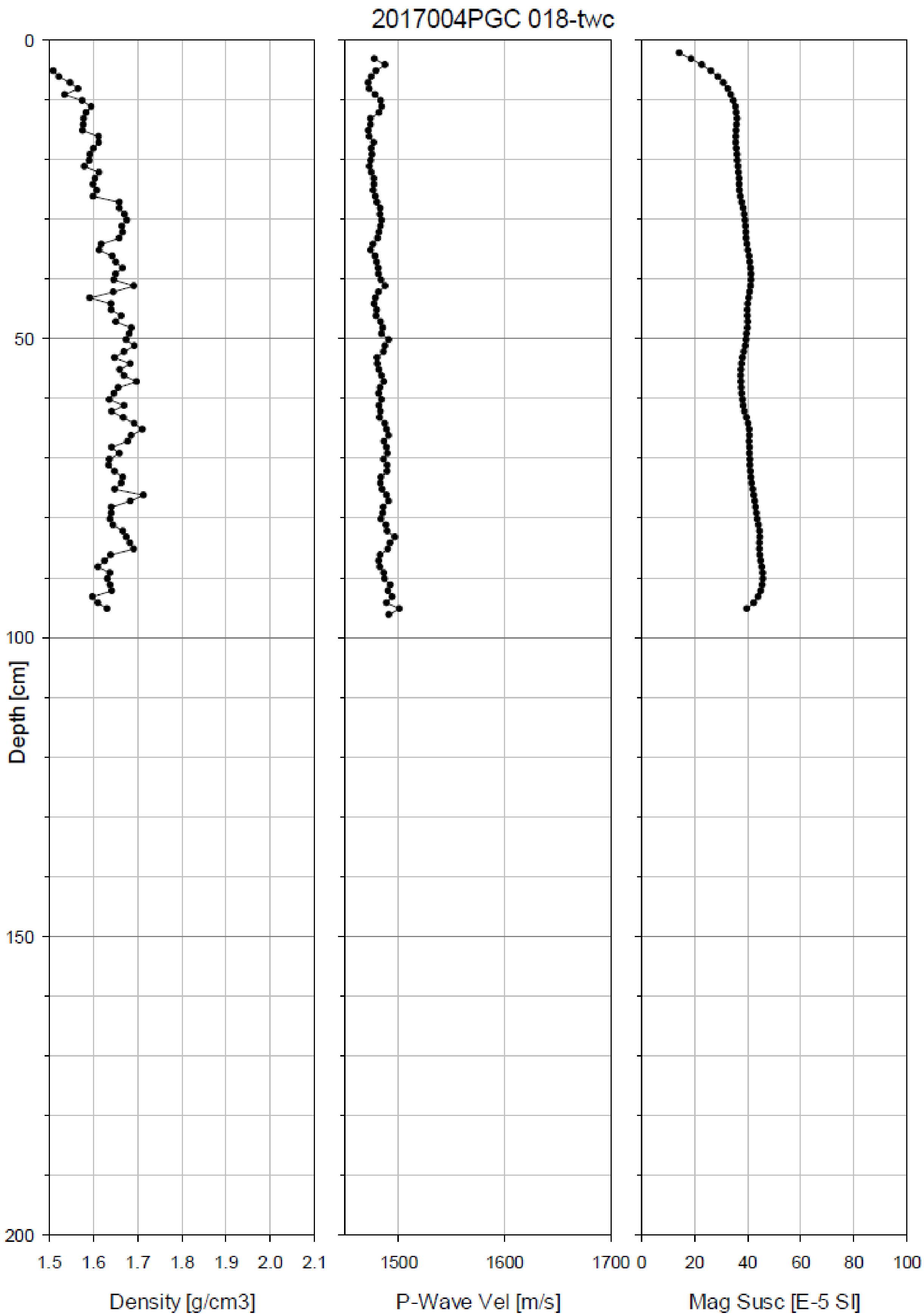
Mag Susc [E-5 SI]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Density [g/cm3]
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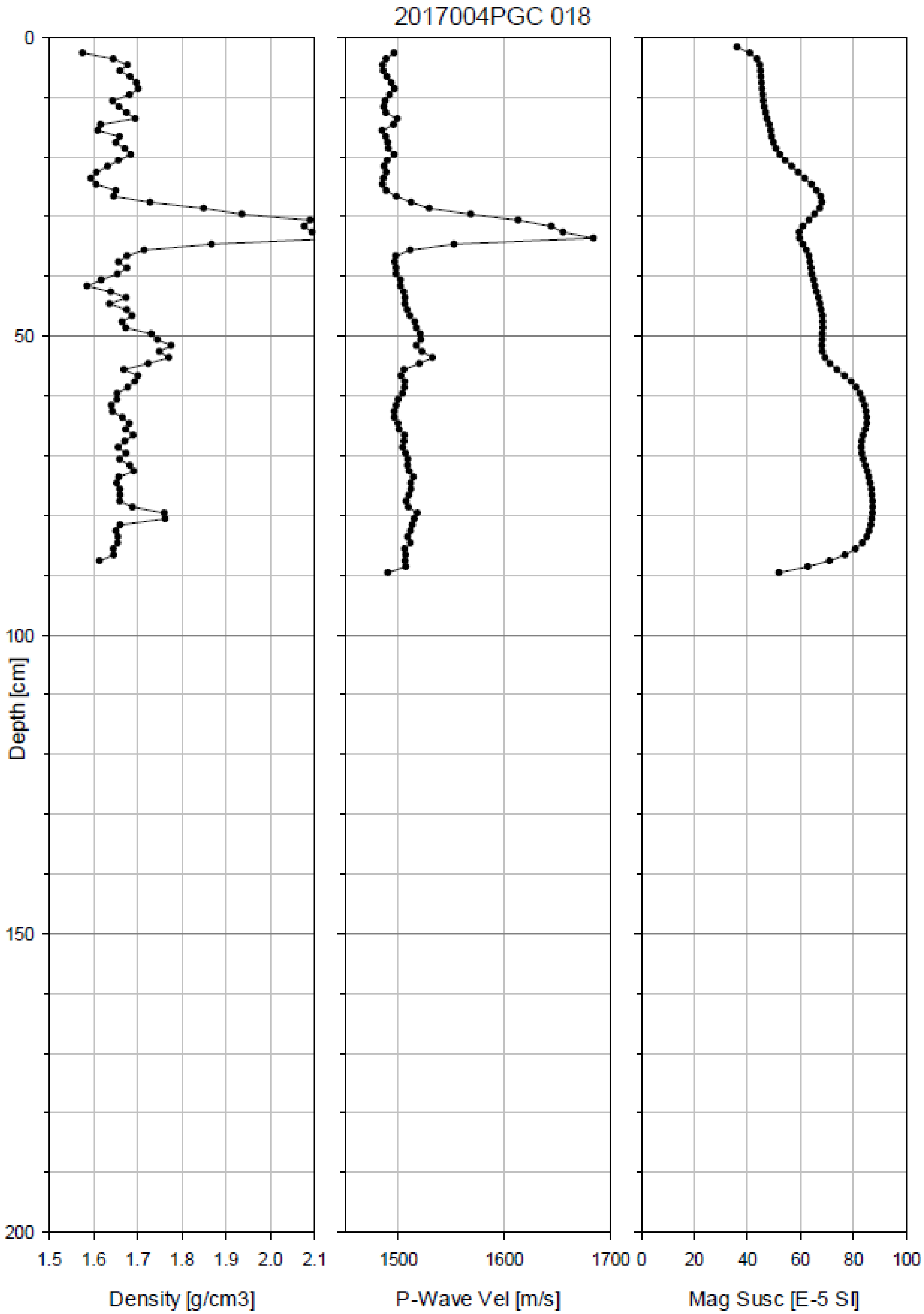
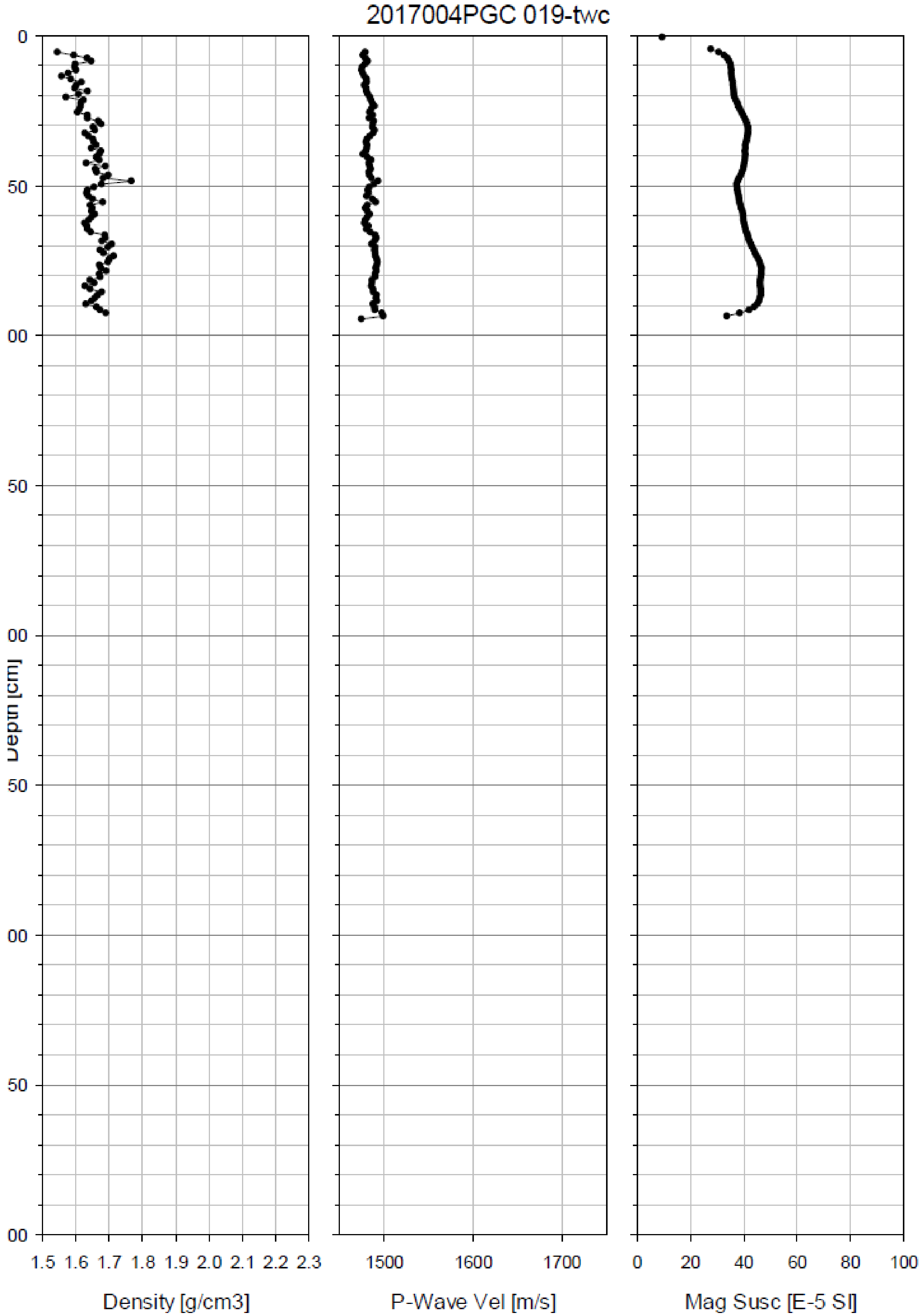
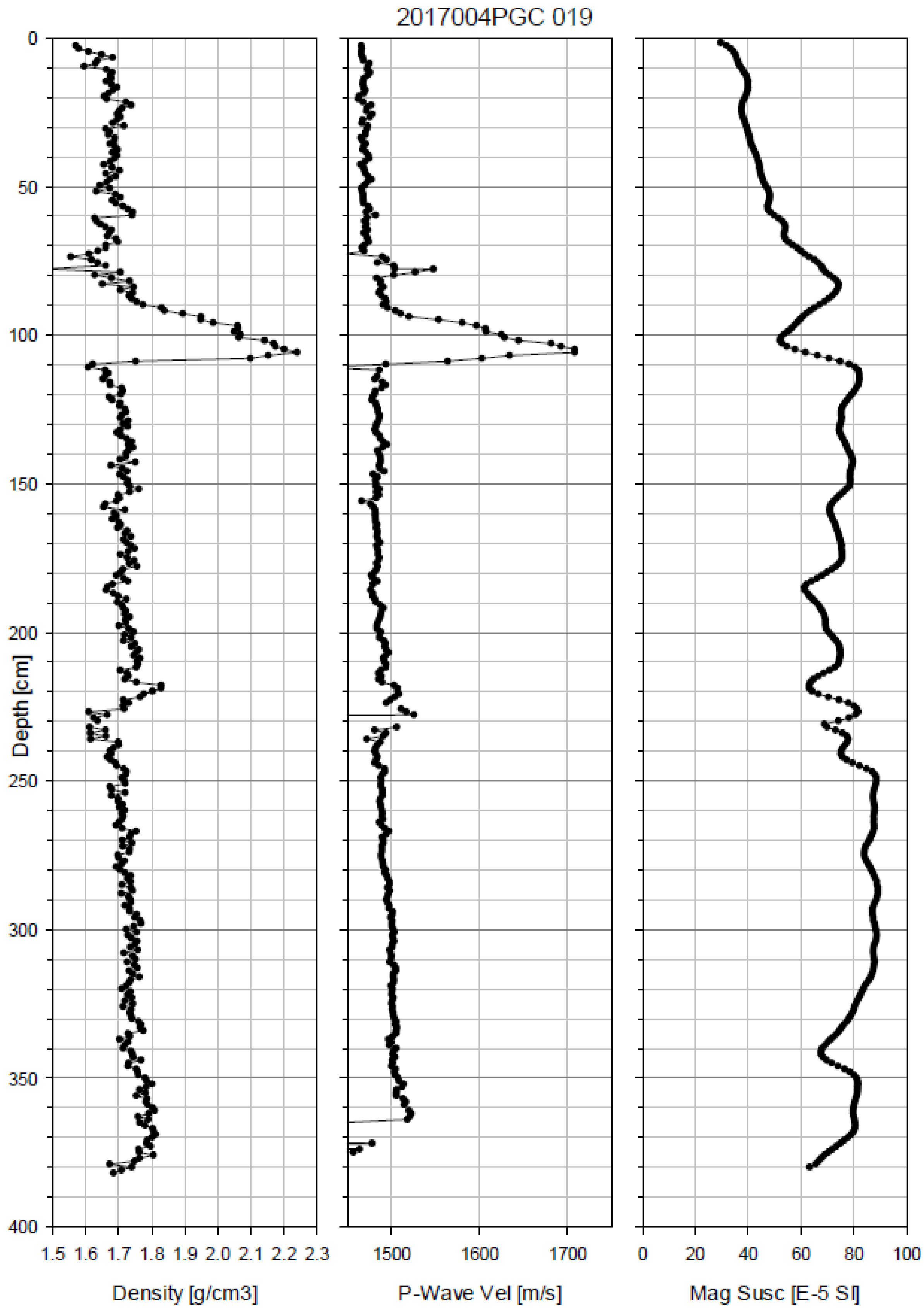
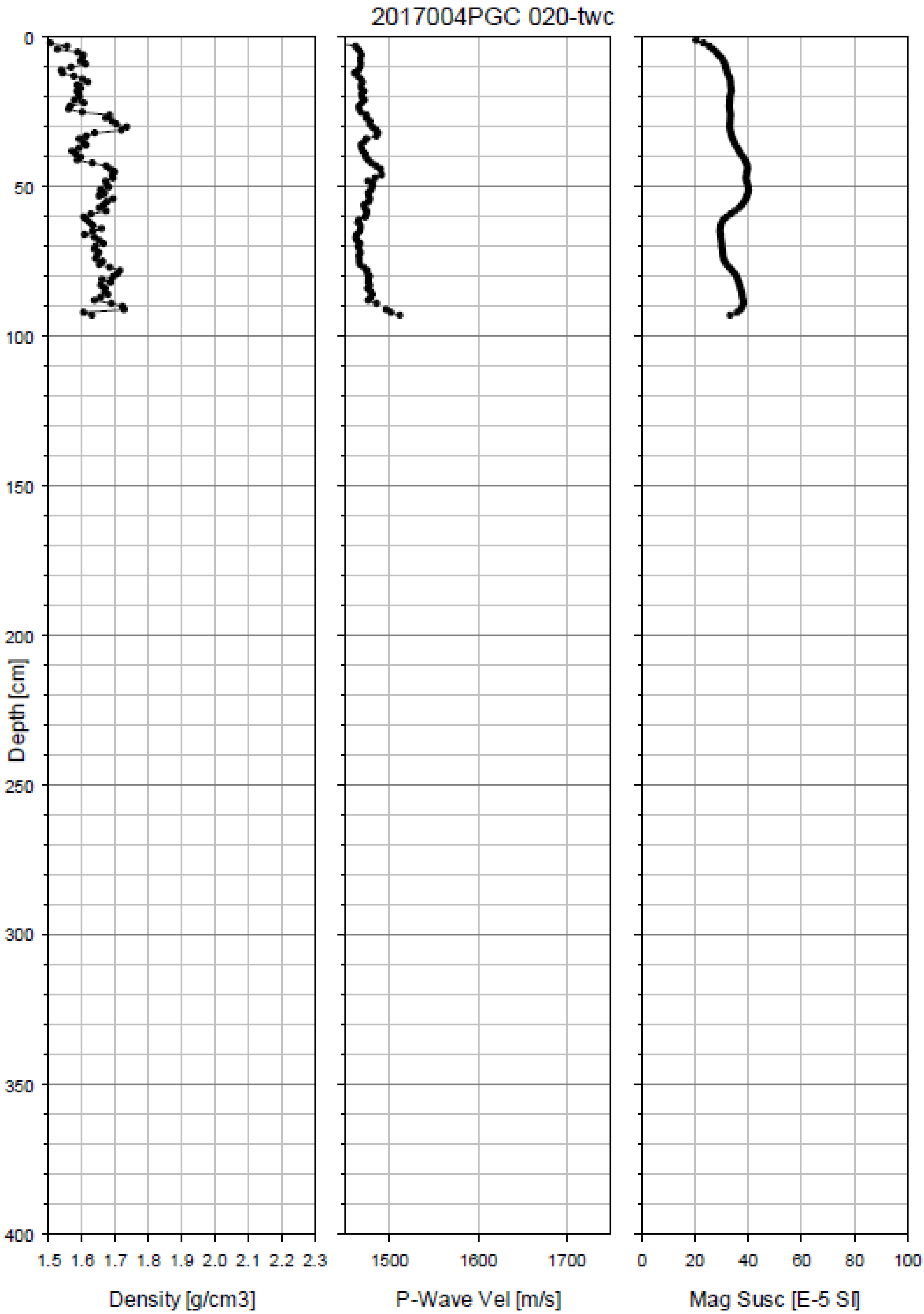
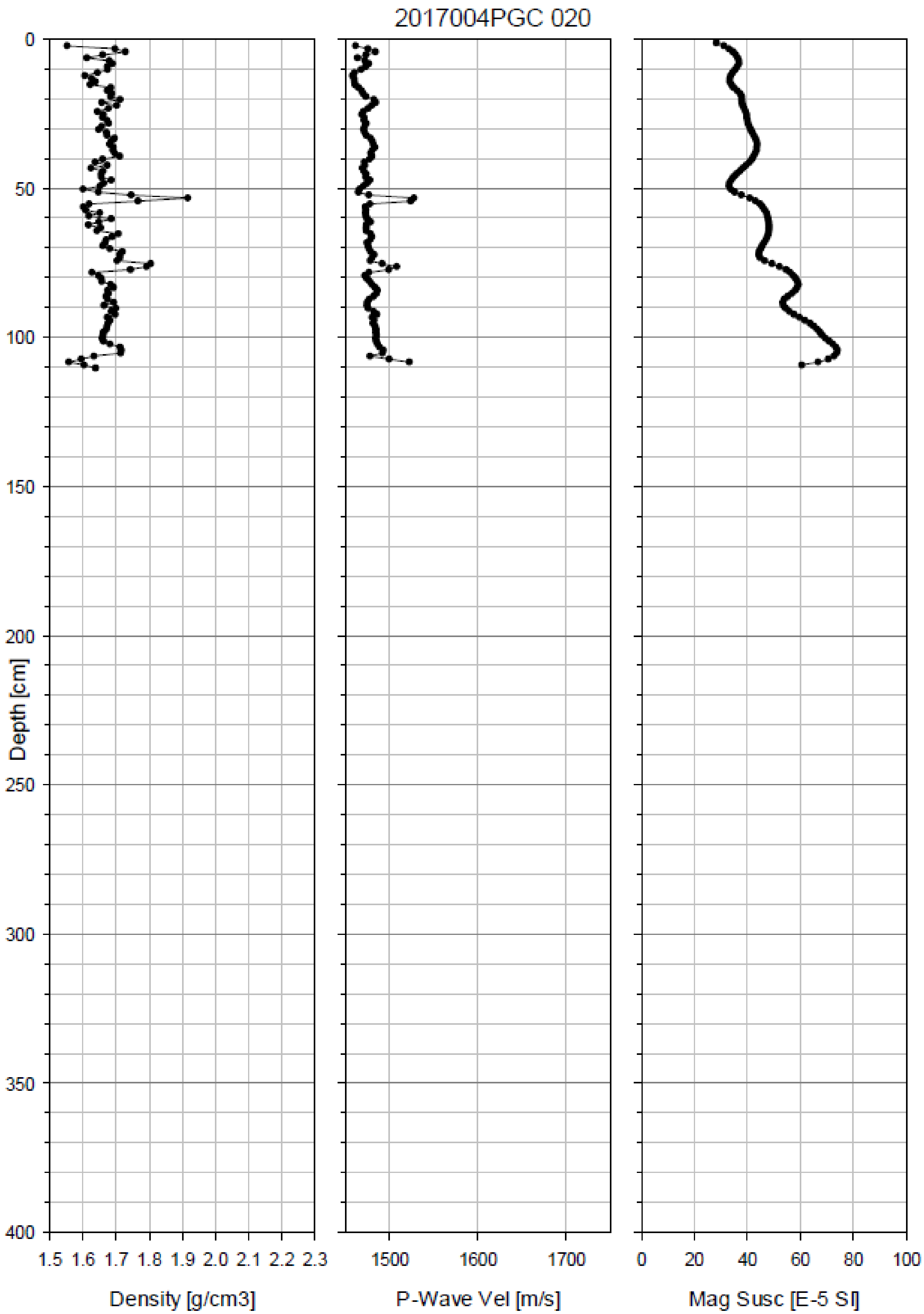
1600
1700
P-Wave Vel [m/s]
0
20
40
60
80
100
Mag Susc [E-5 SI]


2017004PGC 018
Depth [cm]
0
50
100
150
200
1.5 1.6 1.7 1.8 1.9 2.0 2.1
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 20 40 60 80 100
Mag Susc [E-5 SI]

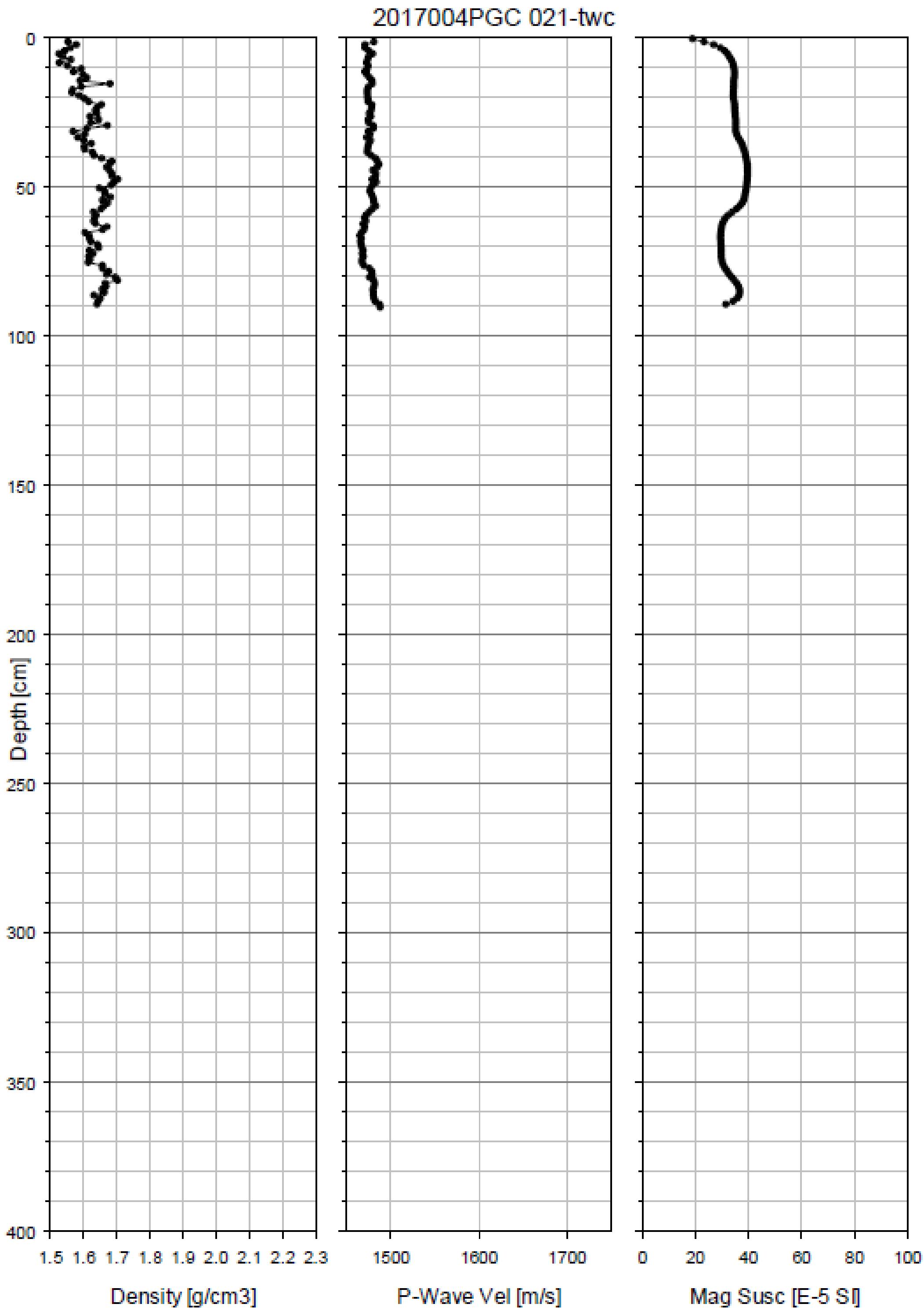

2017004PGC 019-twc
Depth [cm]
Density [g/cm3]
P-Wave Vel [m/s]
Mag Susc [E-5 SI]


2017004PGC 019
Depth [cm]
0
50
100
150
200
250
300
350
400
1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 20 40 60 80 100
Mag Susc [E-5 SI]

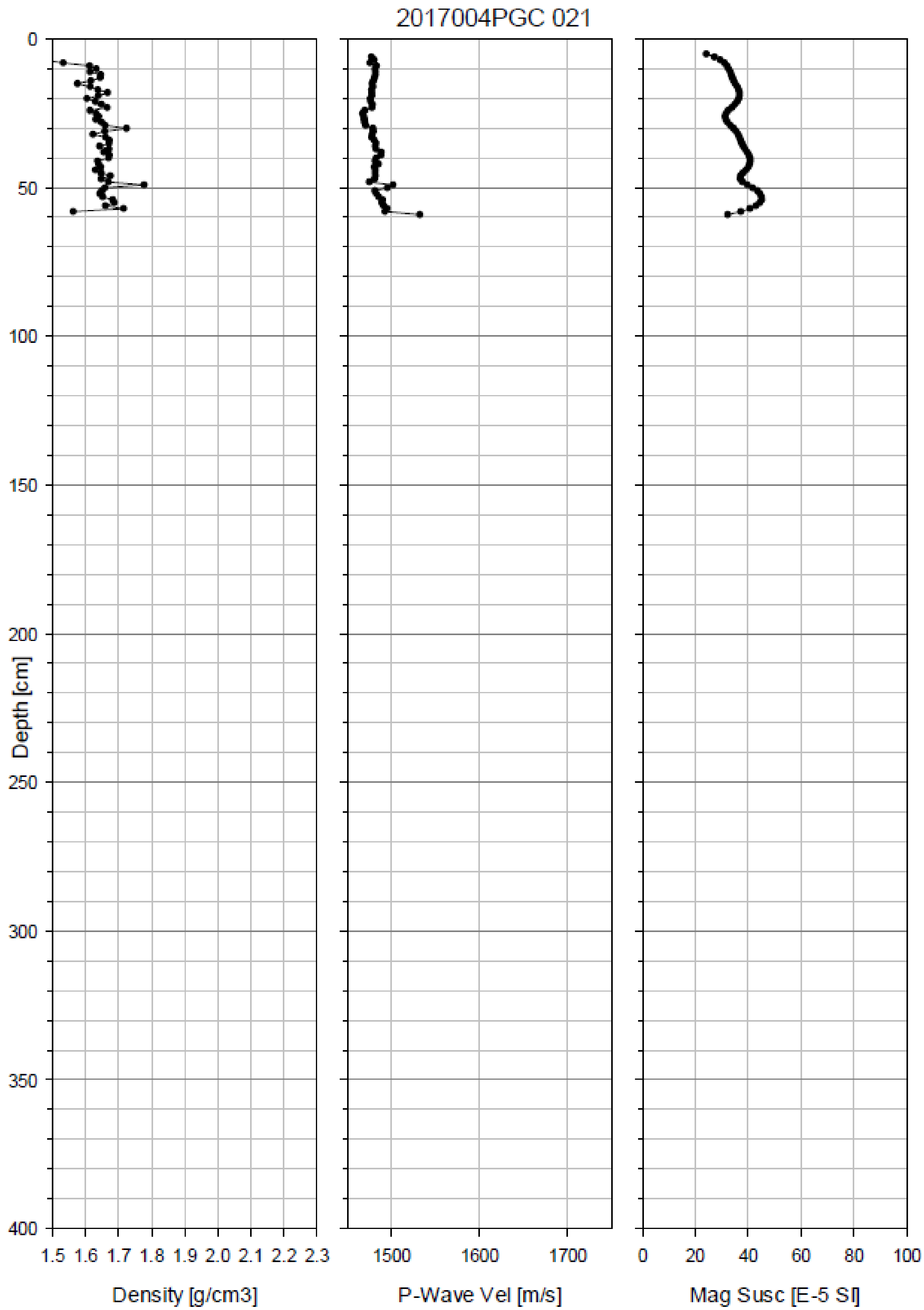

2017004PGC 020-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 20 40 60 80 100
Mag Susc [E-5 SI]

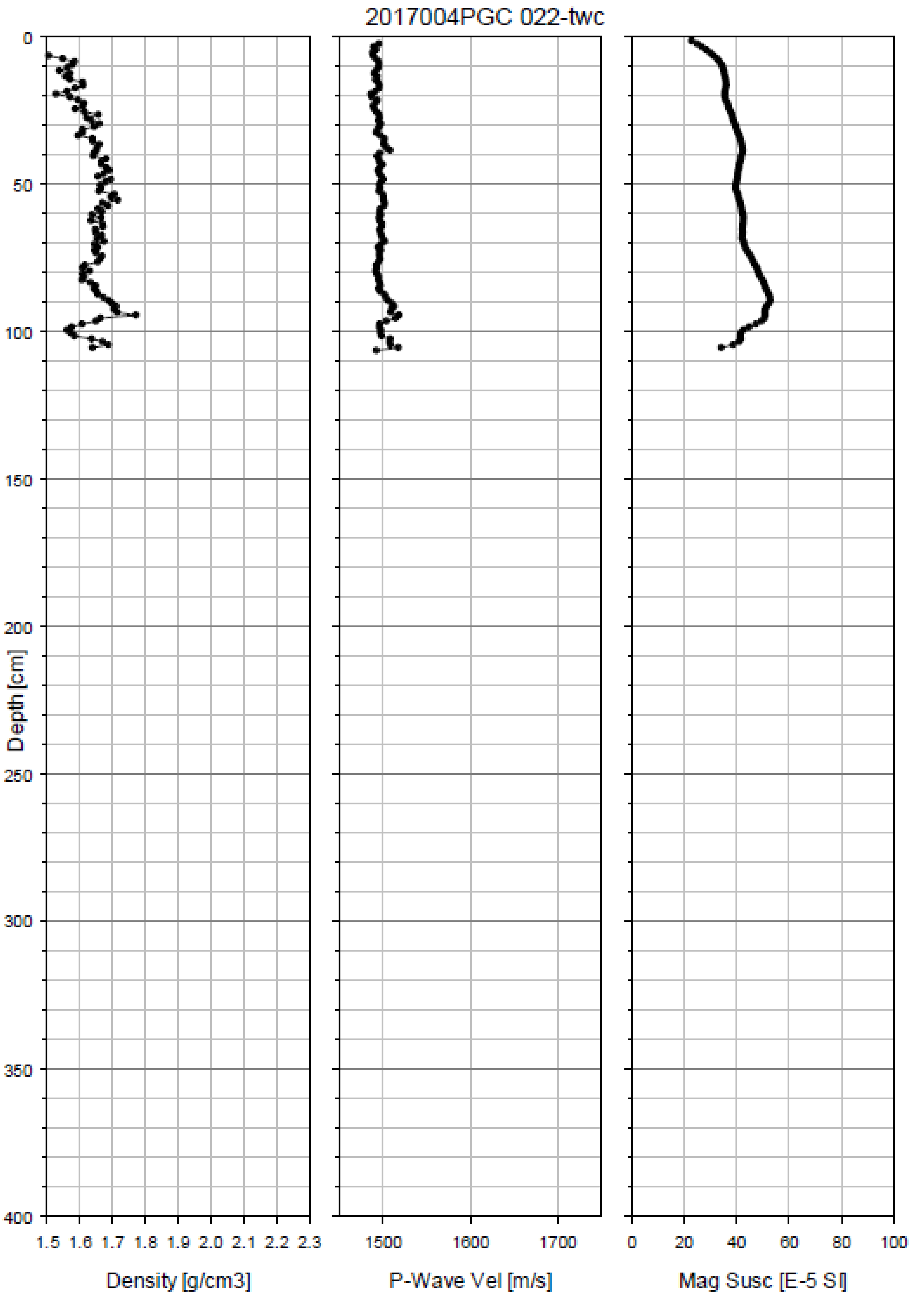


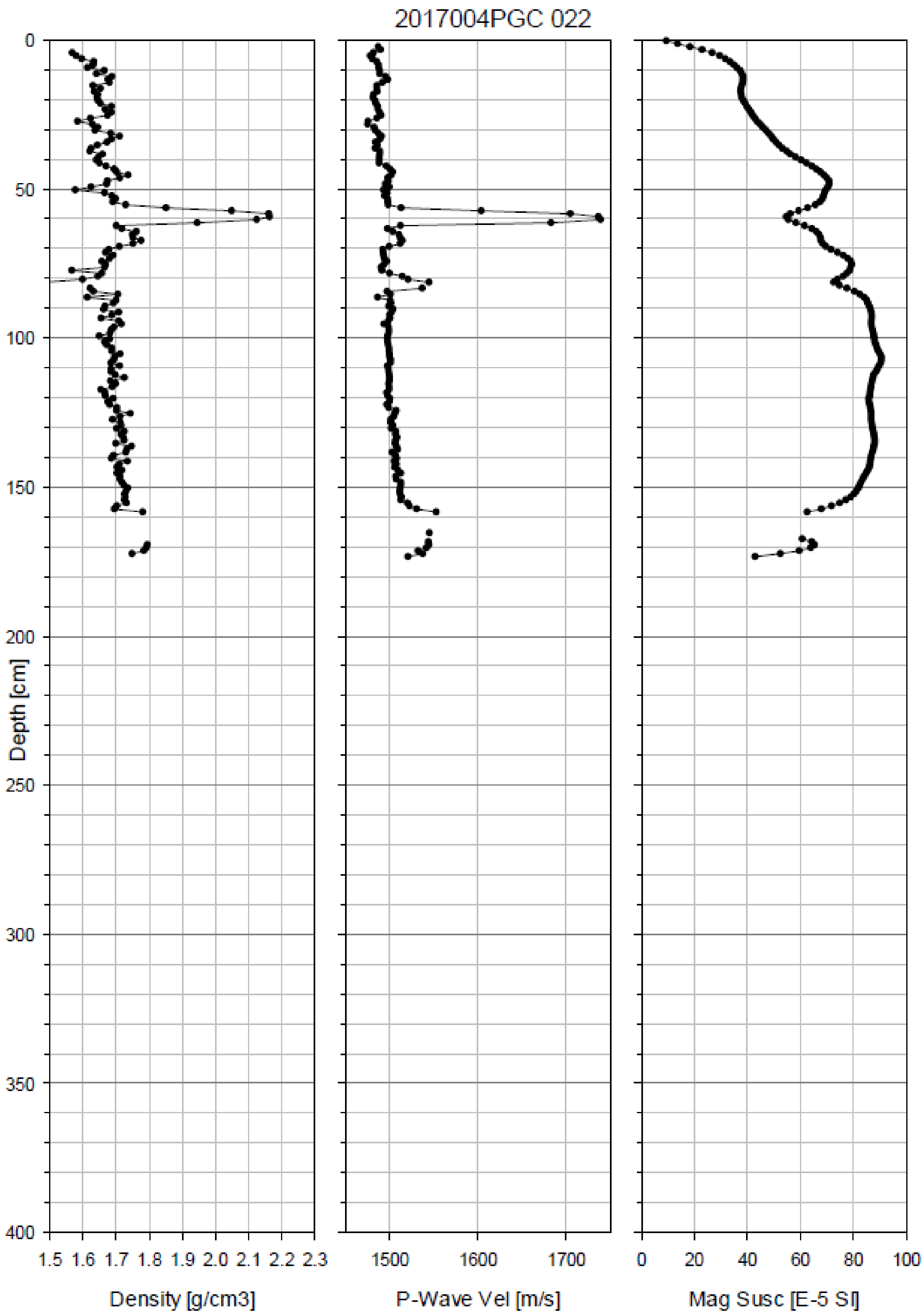
2017004PGC 020
Depth [cm]
0
50
100
150
200
250
300
350
400
1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 20 40 60 80 100
Mag Susc [E-5 SI]

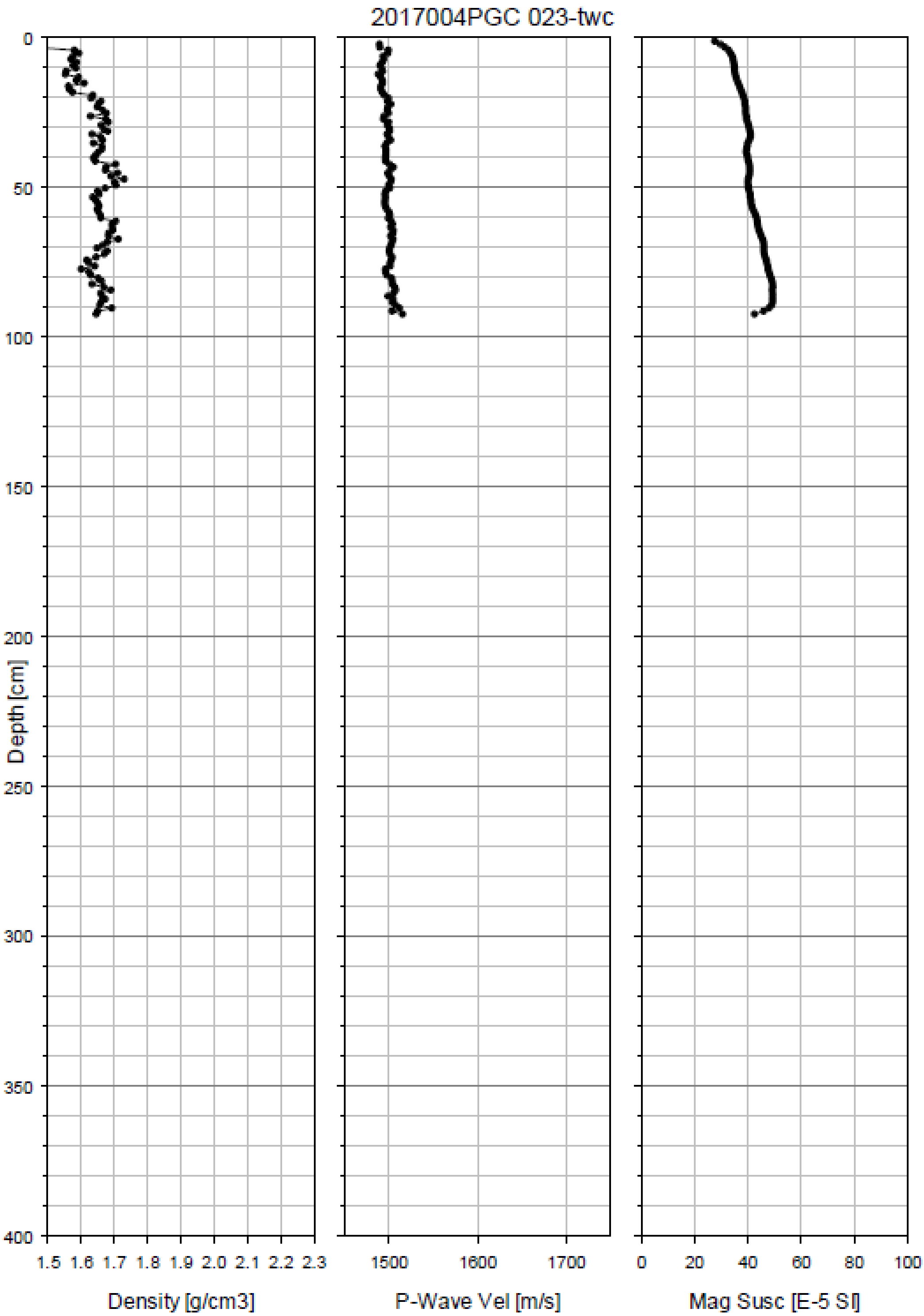


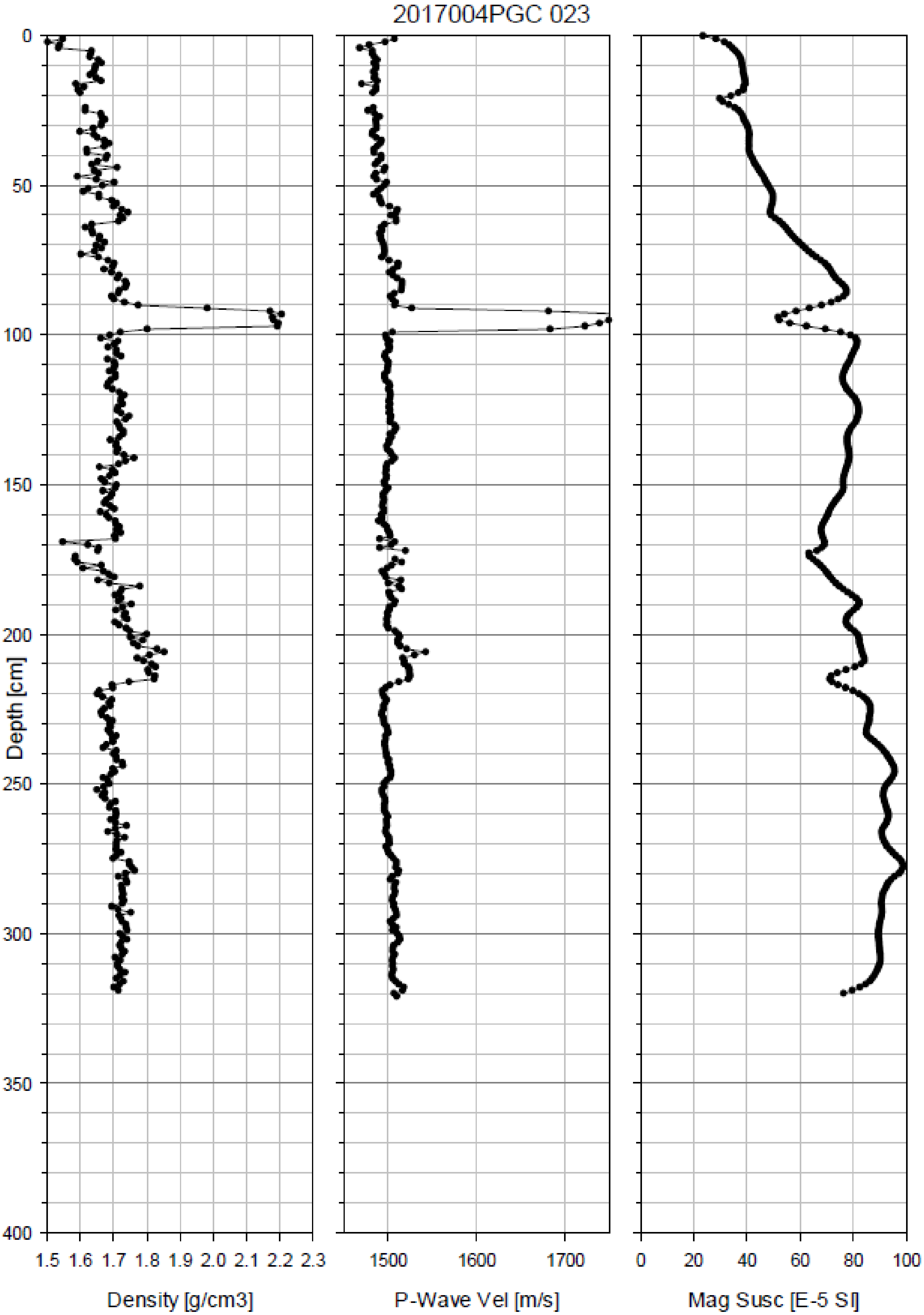
2017004PGC 021-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 20 40 60 80 100
Mag Susc [E-5 SI]

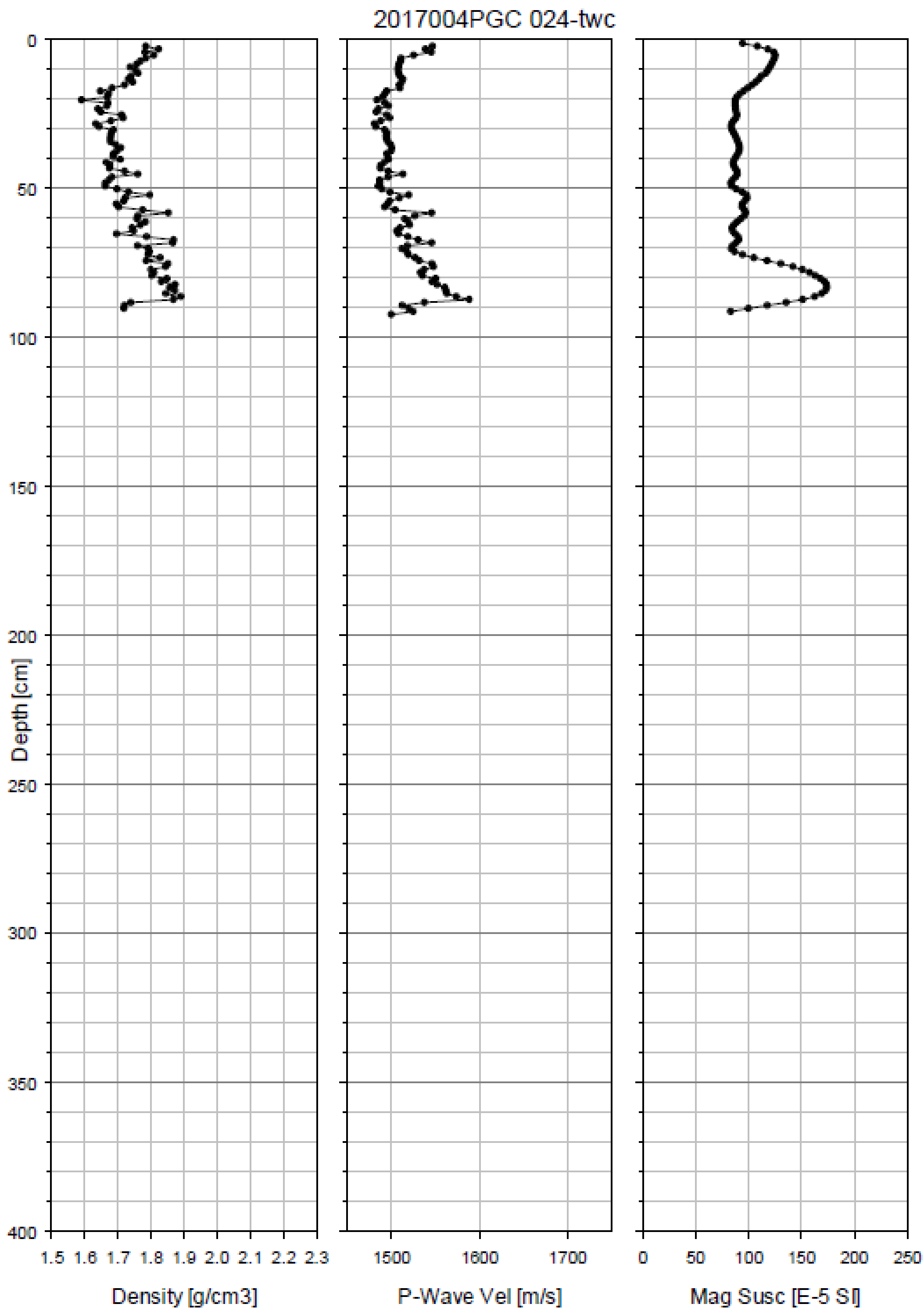

2017004PGC 021
Depth [cm]
0
50
100
150
200
250
300
350
400
1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 20 40 60 80 100
Mag Susc [E-5 SI]

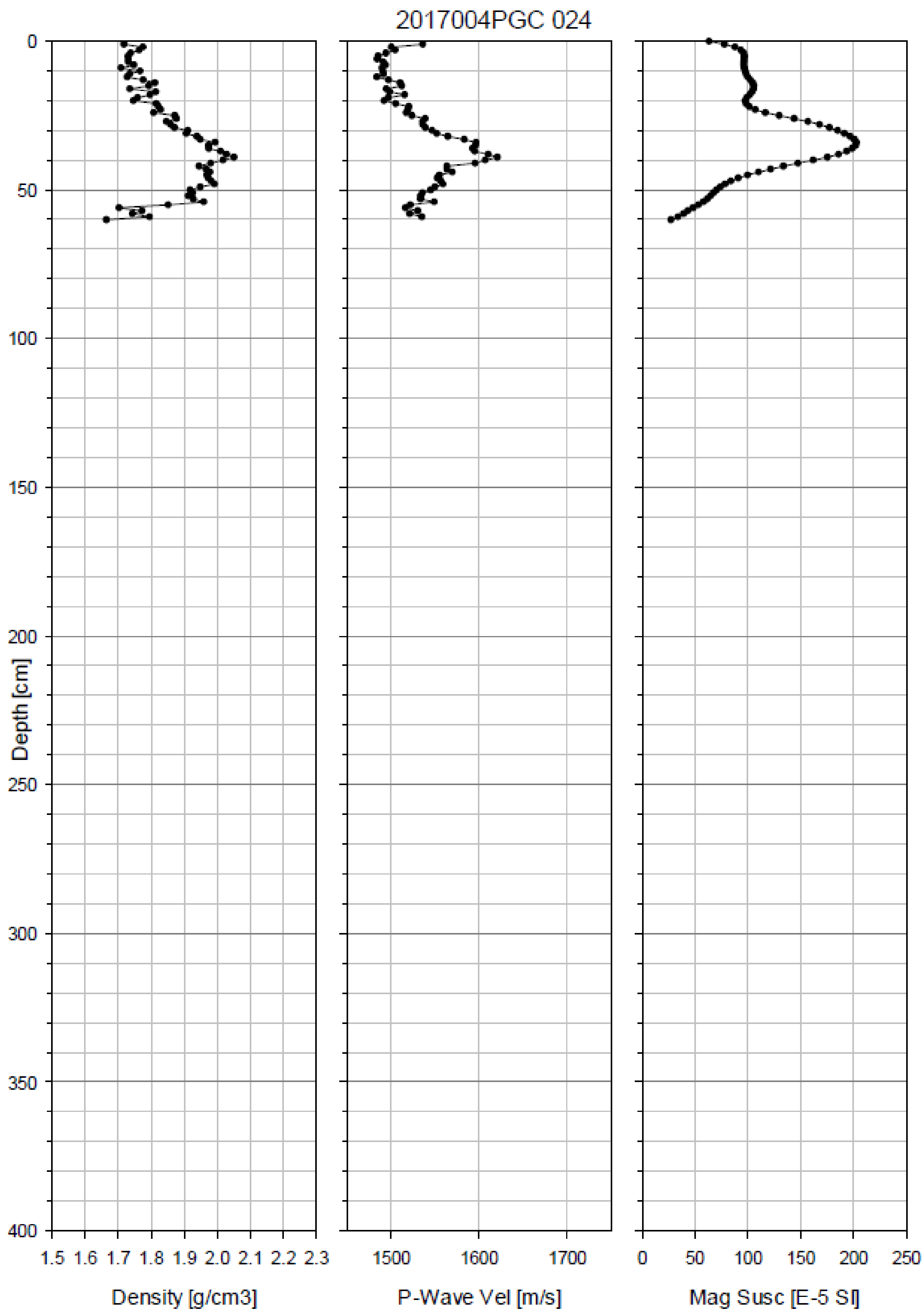

2017004PGC 022-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 20 40 60 80 100
Mag Susc [E-5 SI]

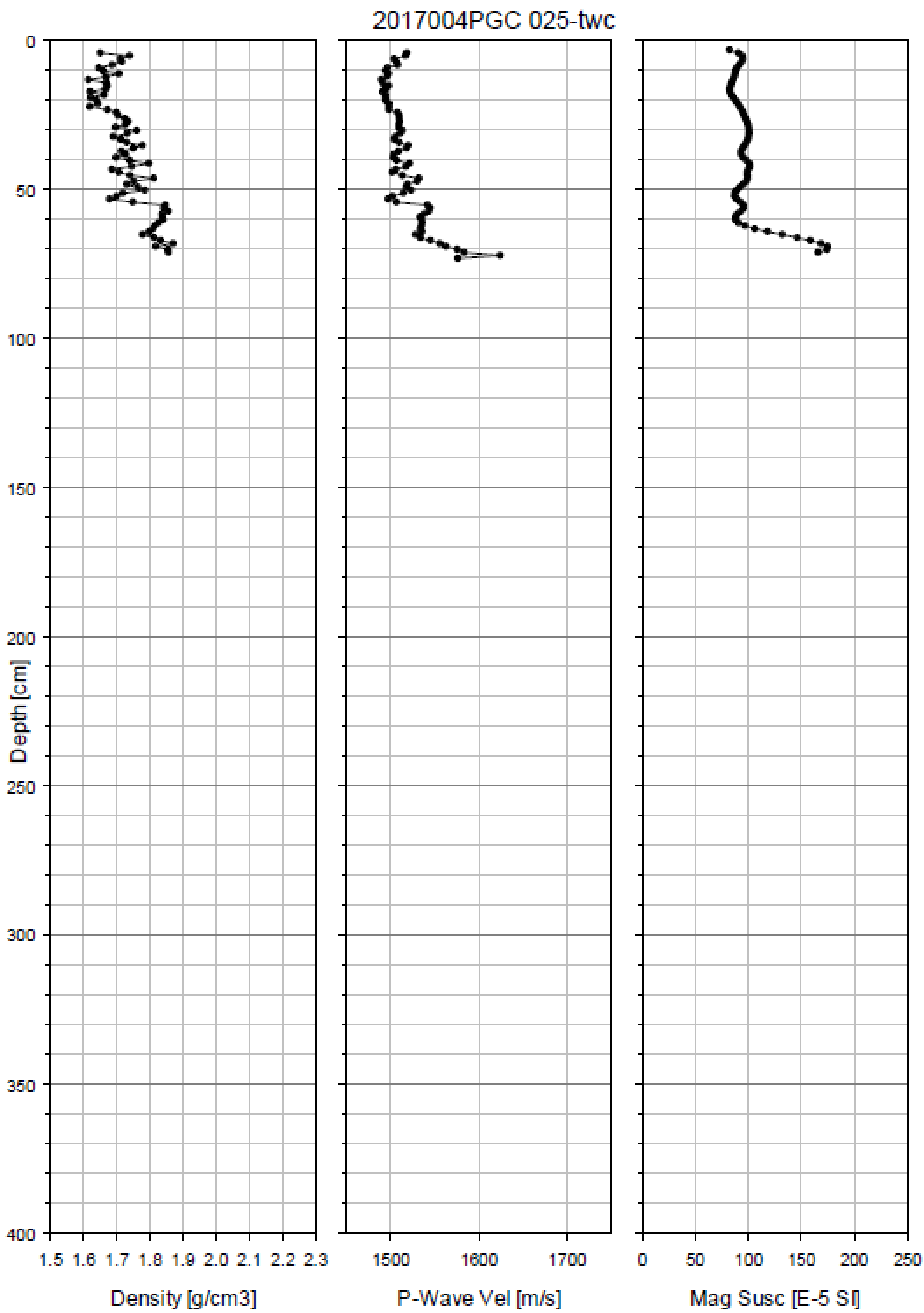

2017004PGC 022
Depth [cm]
0
50
100
150
200
250
300
350
400
1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 20 40 60 80 100
Mag Susc [E-5 SI]


2017004PGC 023-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 20 40 60 80 100
Mag Susc [E-5 SI]


2017004PGC 023
Depth [cm]
0
50
100
150
200
250
300
350
400
1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 20 40 60 80 100
Mag Susc [E-5 SI]

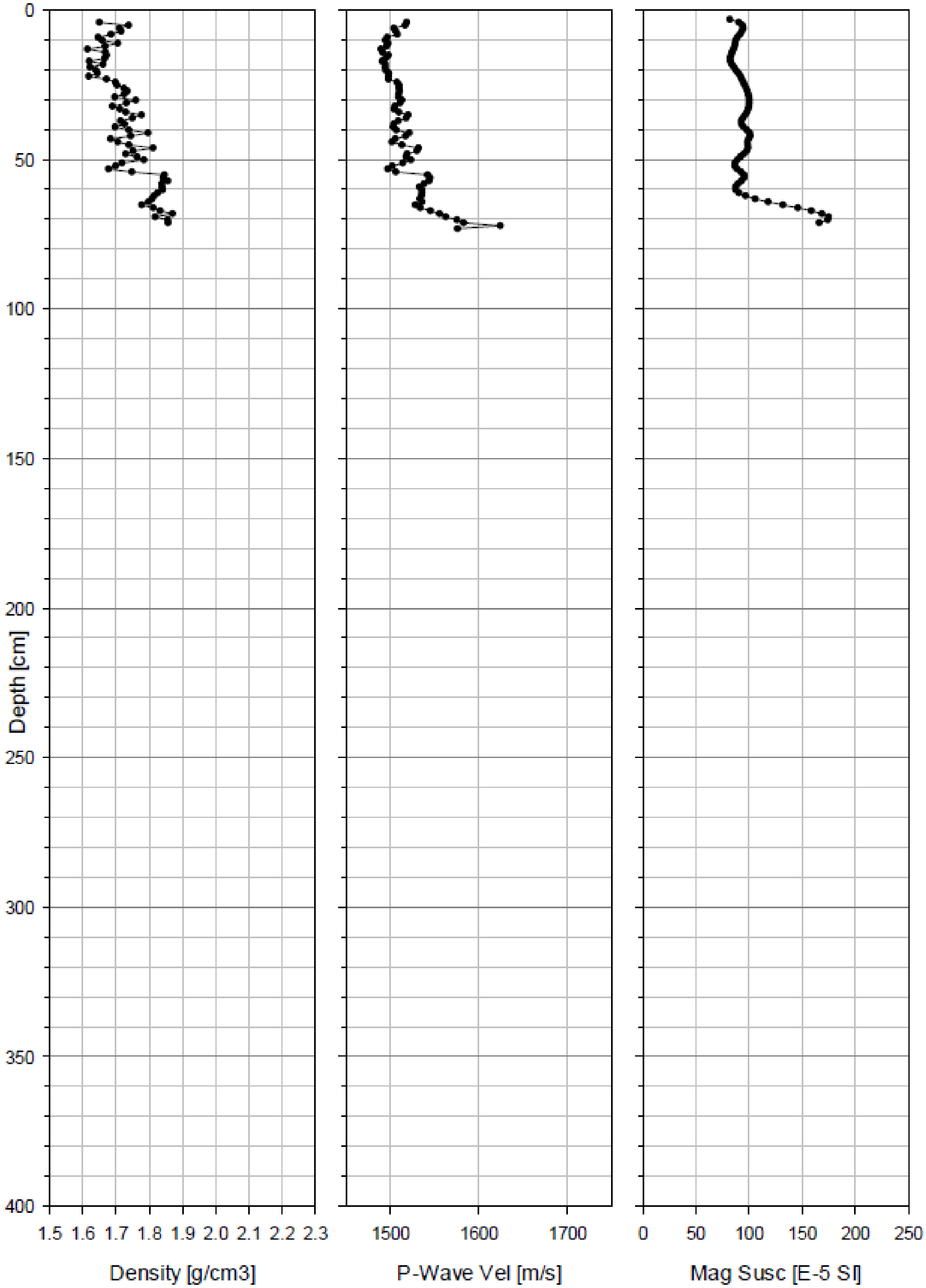

2017004PGC 024-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 50 100 150 200 250
Mag Susc [E-5 SI]

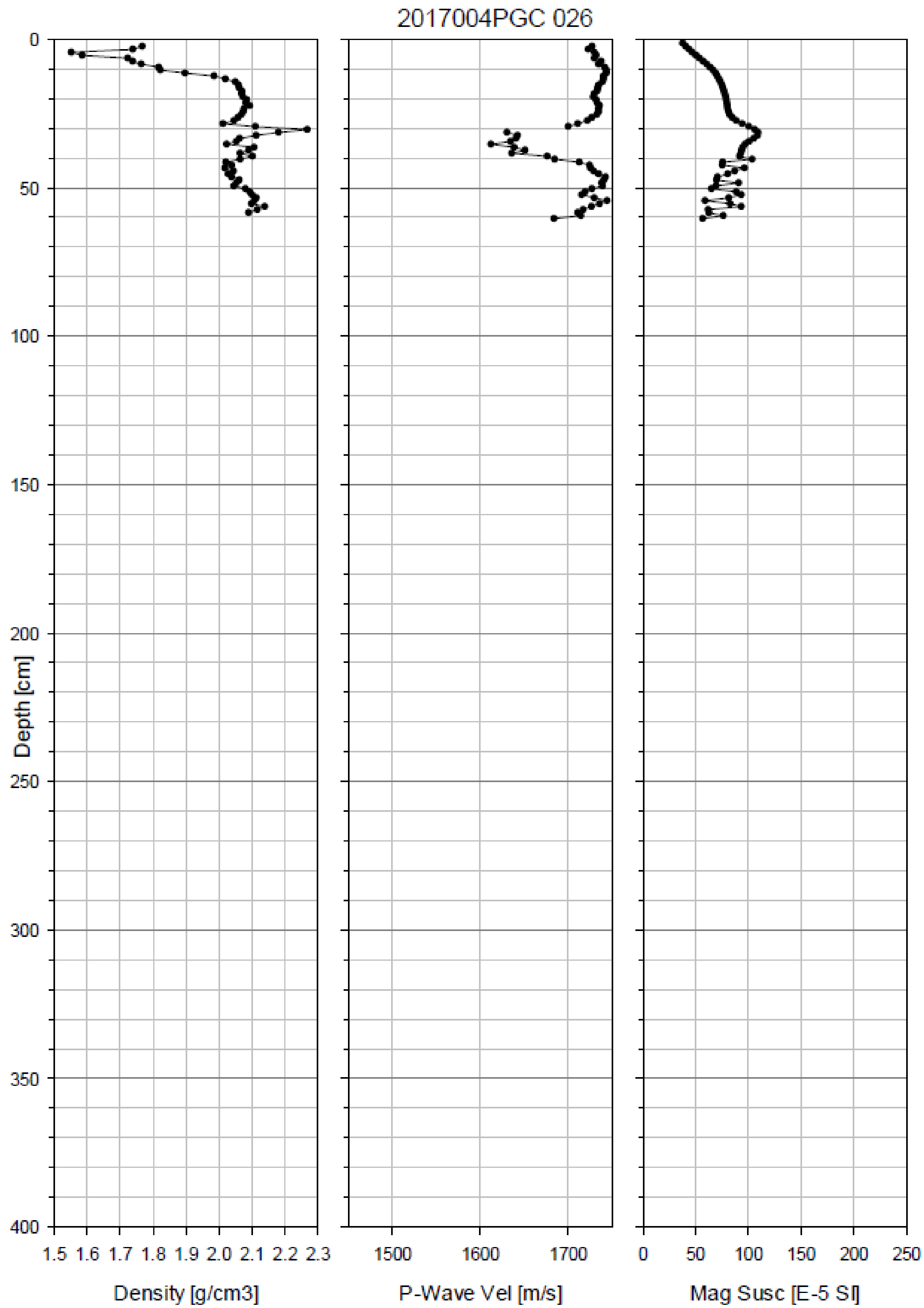

2017004PGC 024
Depth [cm]
0
50
100
150
200
250
300
350
400
1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
50
100
150
200
250
Mag Susc [E-5 SI]

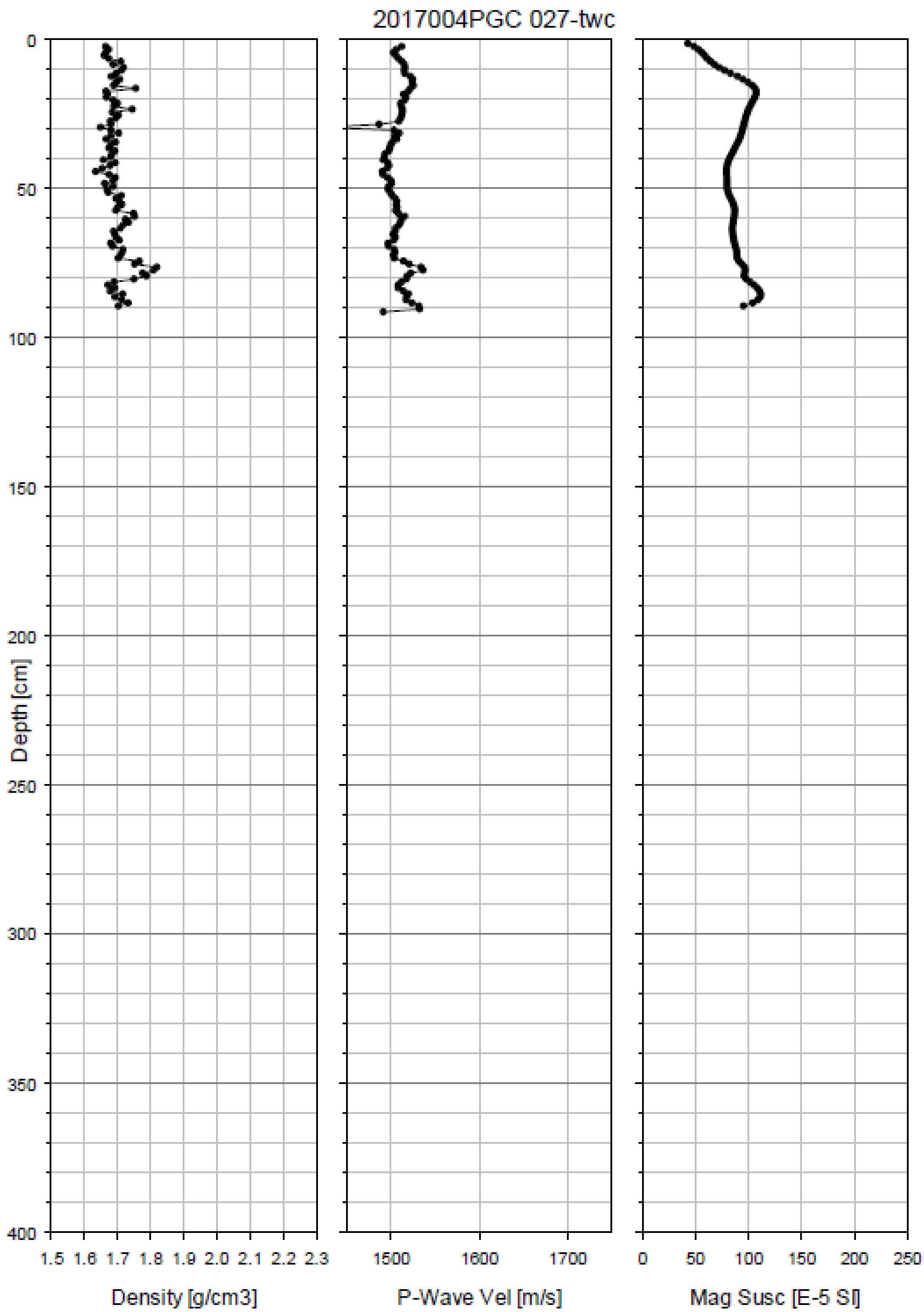


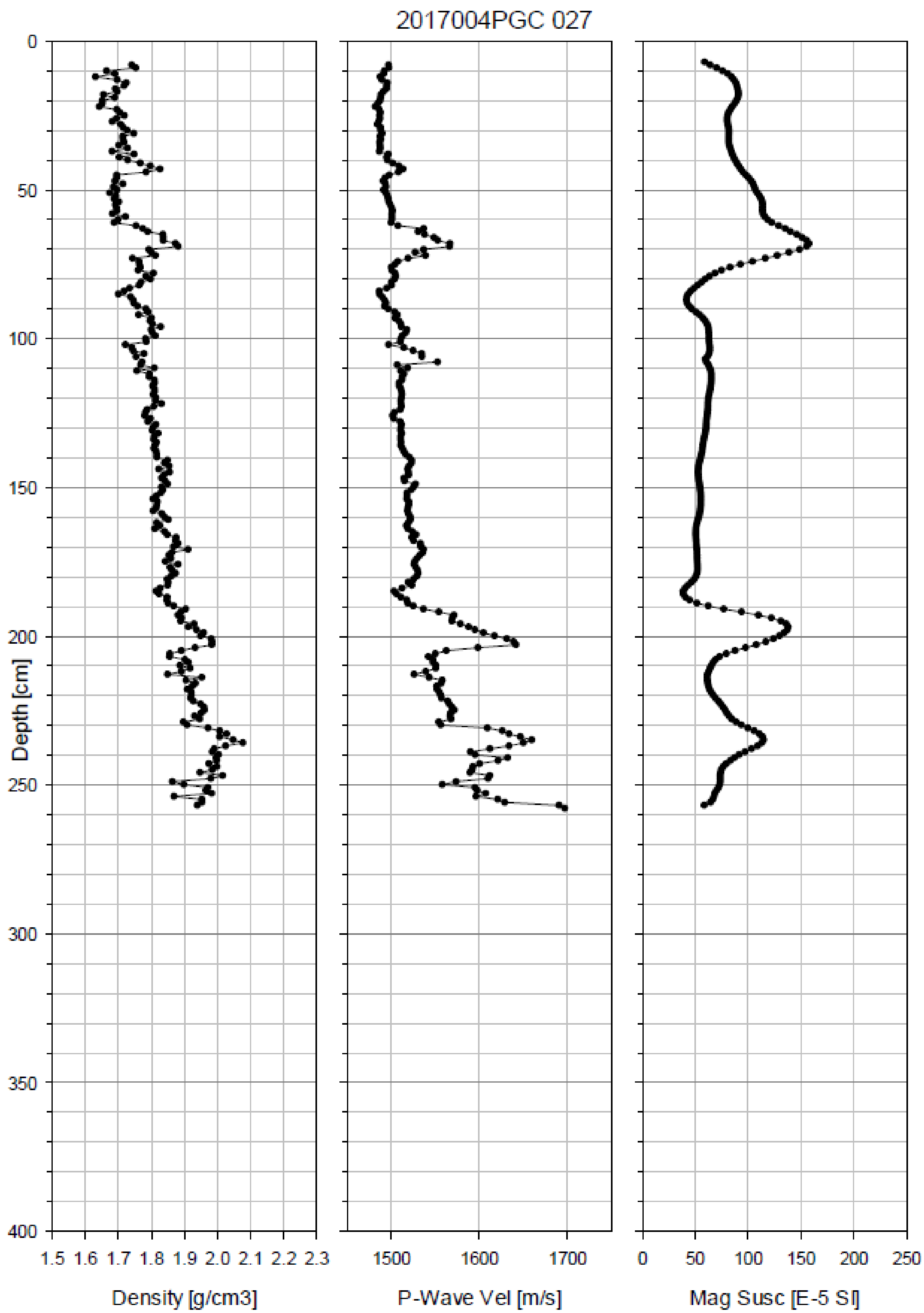
2017004PGC 025-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0 50 100 150 200 250
Mag Susc [E-5 SI]

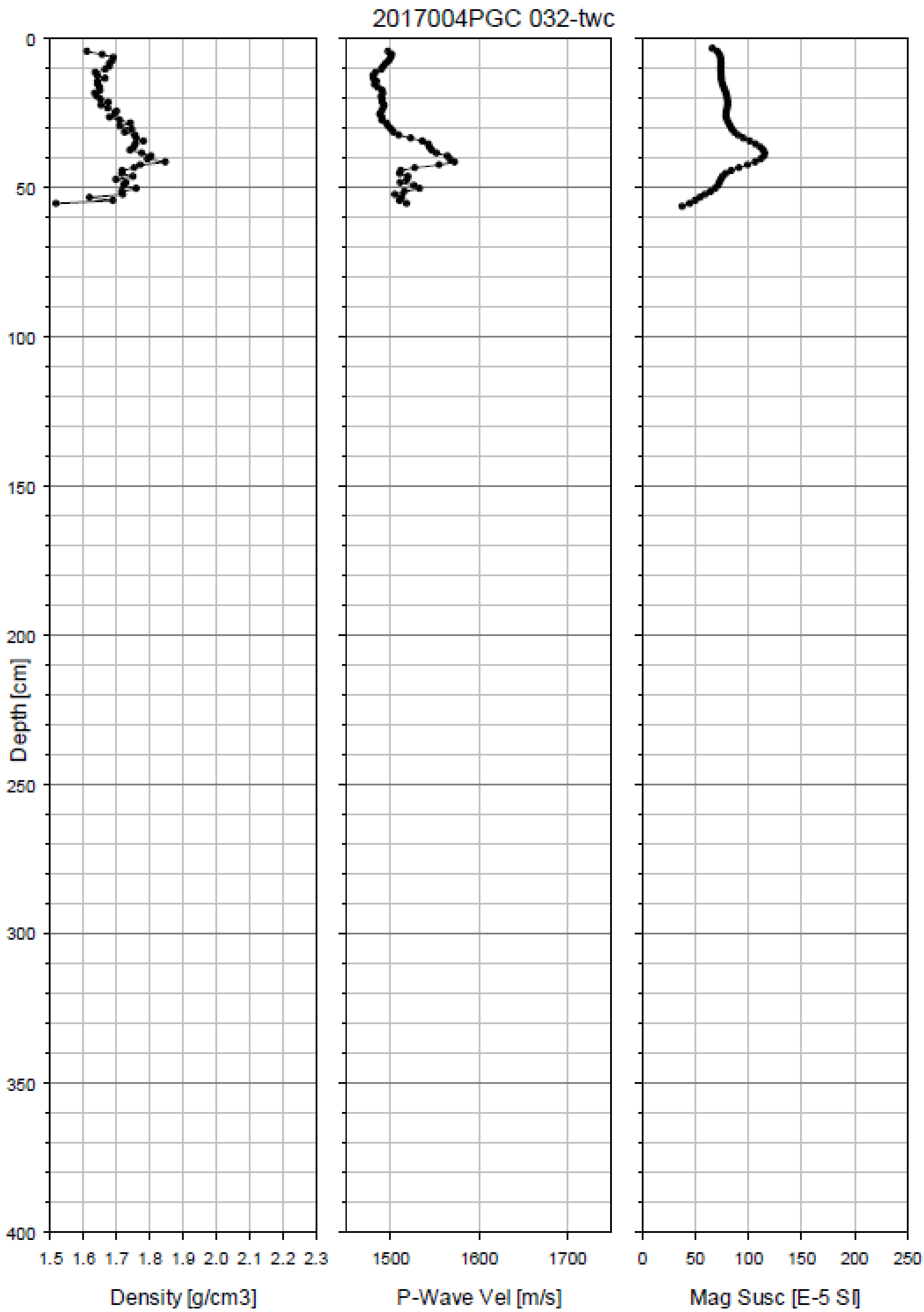
2017004PGC 025-twc

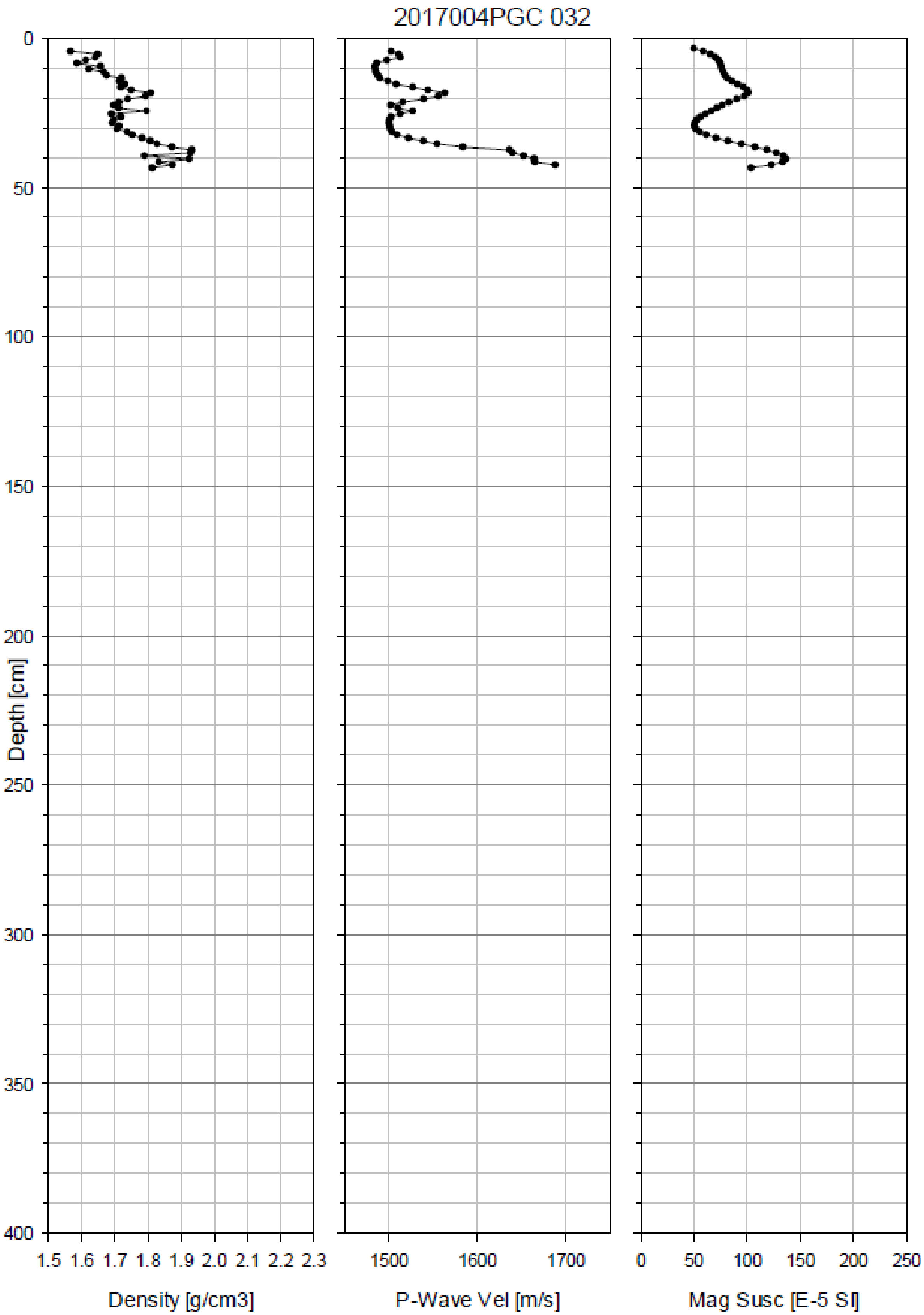


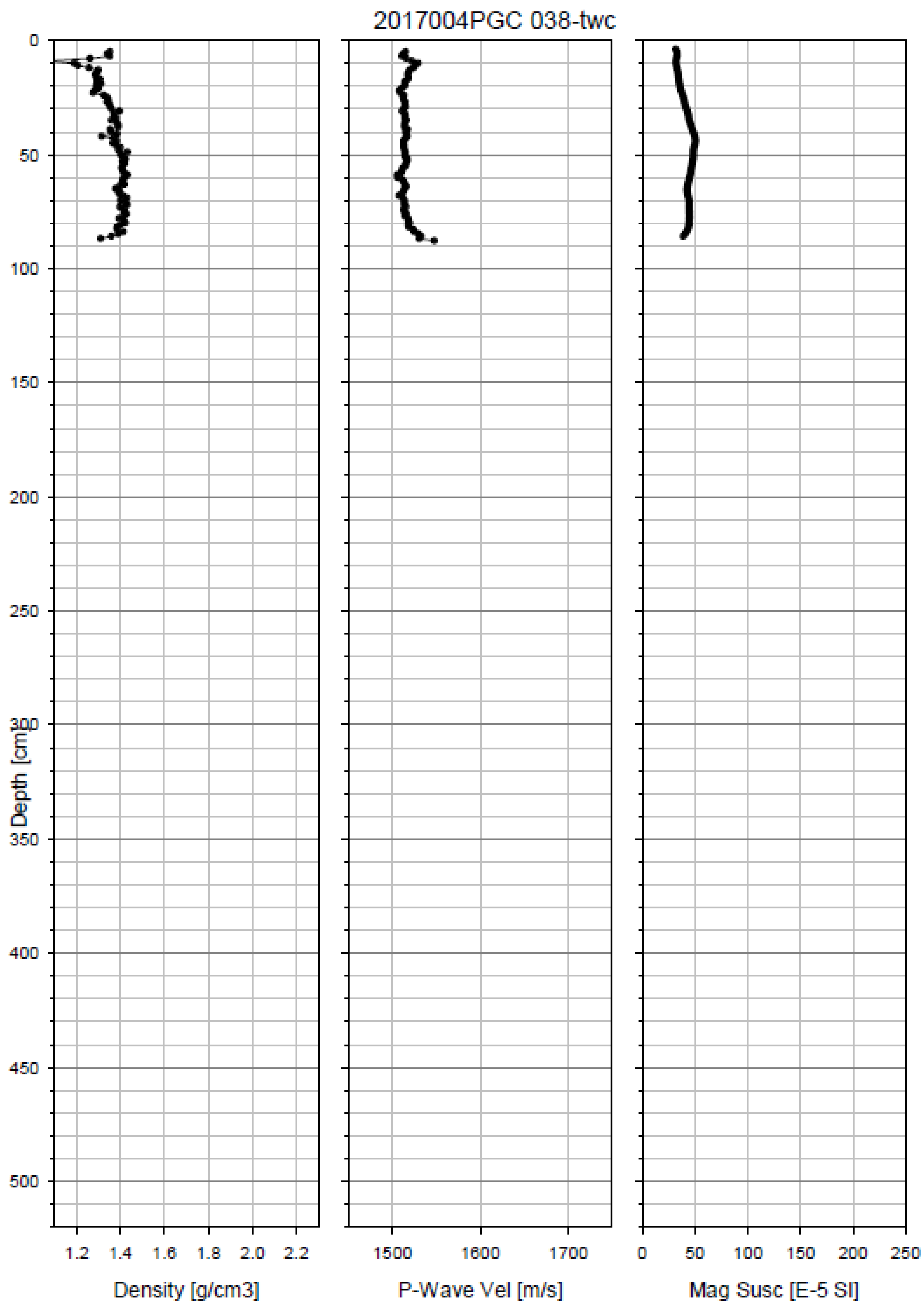

2017004PGC 026
Depth [cm]
0
50
100
150
200
250
300
350
400
1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 50 100 150 200 250
Mag Susc [E-5 SI]


2017004PGC 027-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 50 100 150 200 250
Mag Susc [E-5 SI]

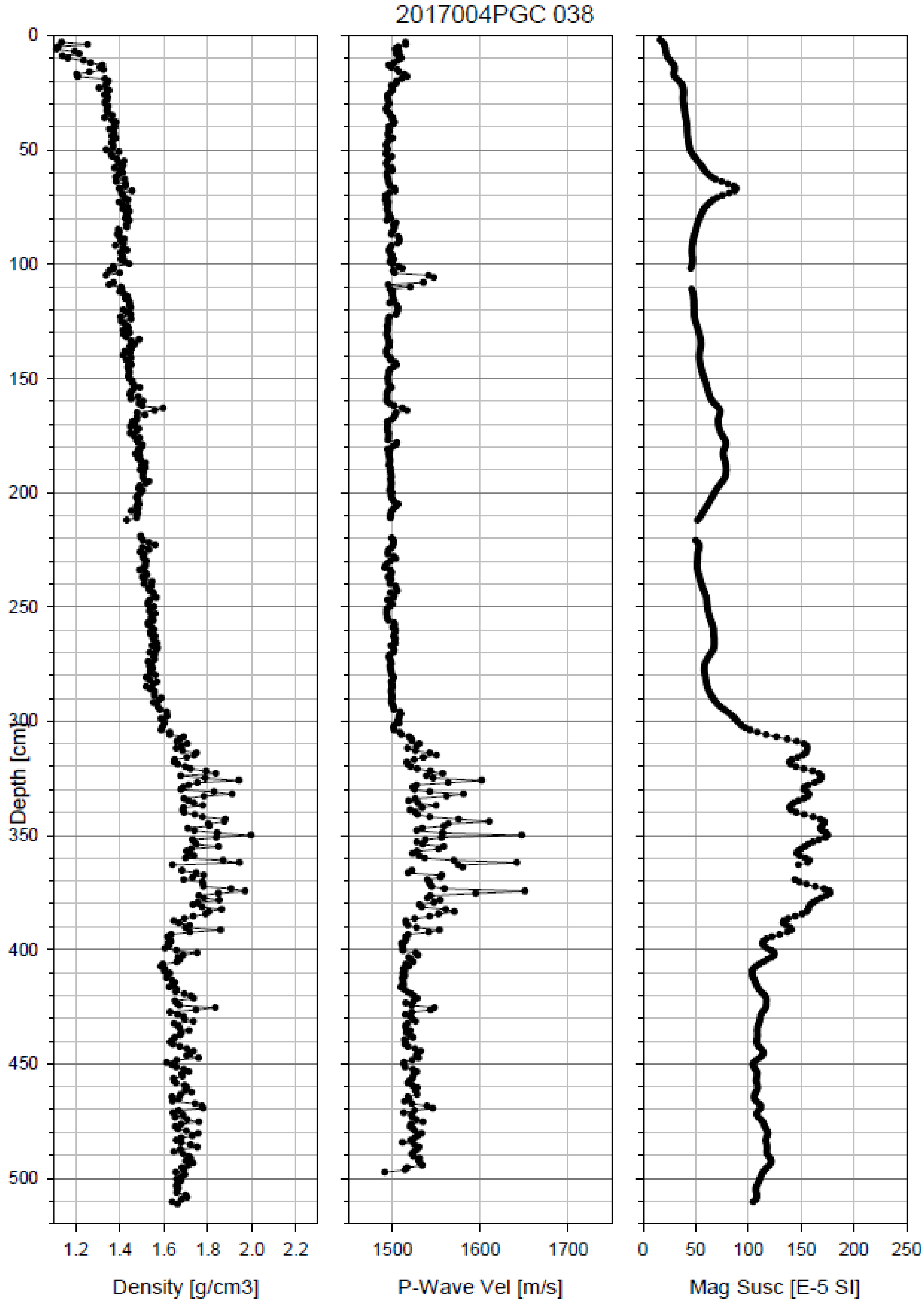

2017004PGC 027
Depth [cm]
0
50
100
150
200
250
300
350
400
1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 50 100 150 200 250
Mag Susc [E-5 SI]


2017004PGC 032-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 50 100 150 200 250
Mag Susc [E-5 SI]

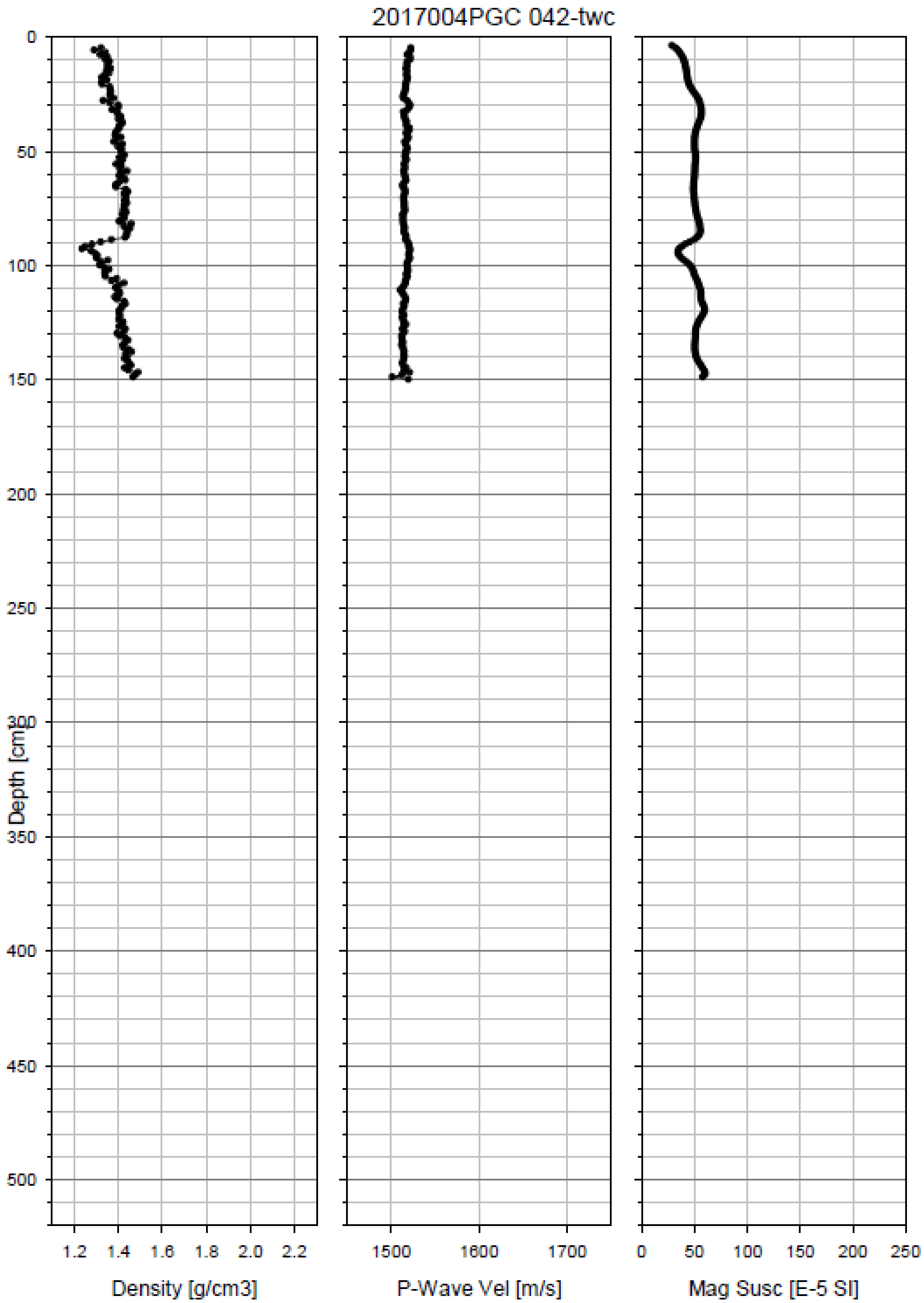

2017004PGC 032
Depth [cm]
0
50
100
150
200
250
300
350
400
1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 50 100 150 200 250
Mag Susc [E-5 SI]

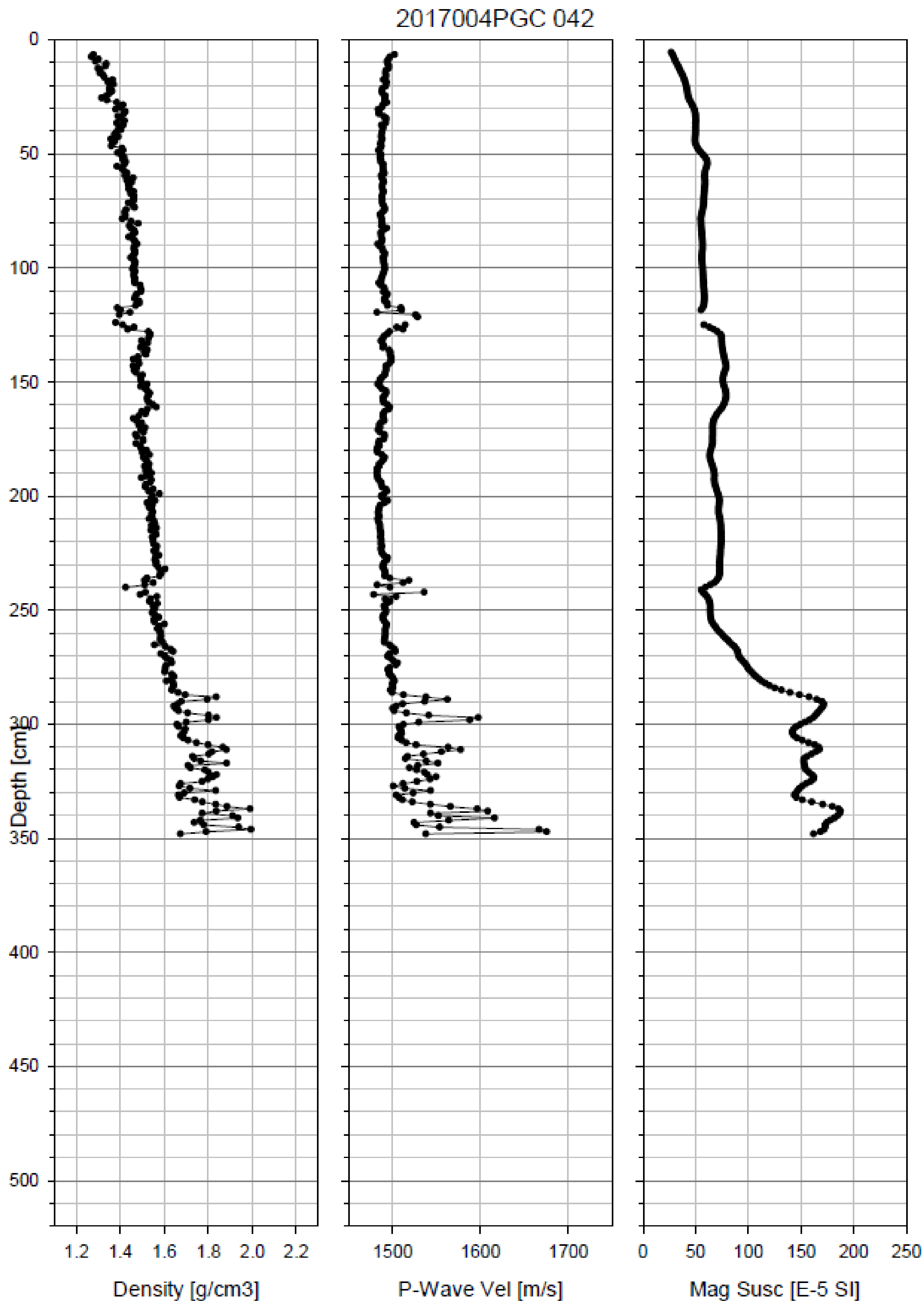


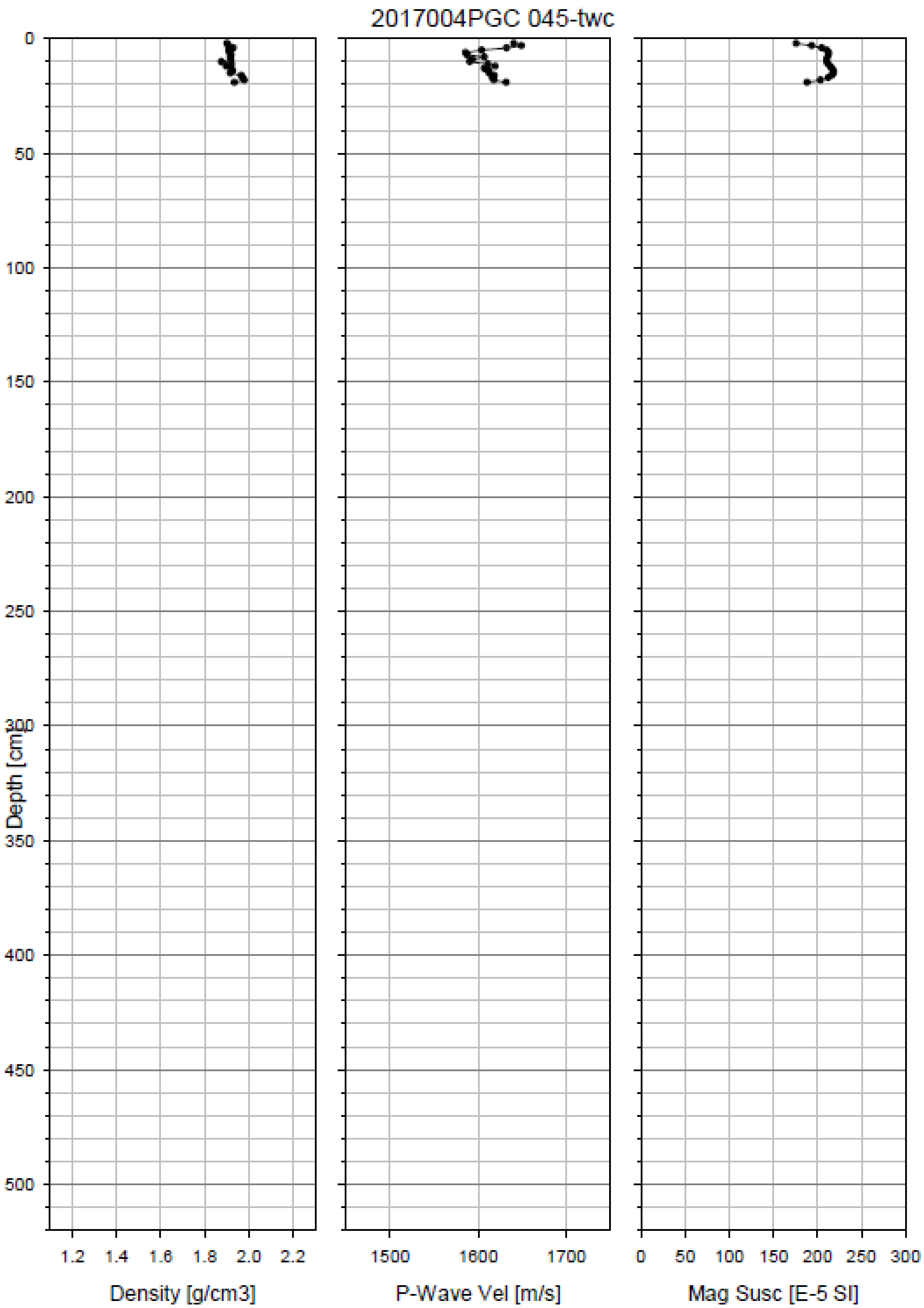
2017004PGC 038-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
50
100
150
200
250
Mag Susc [E-5 SI]



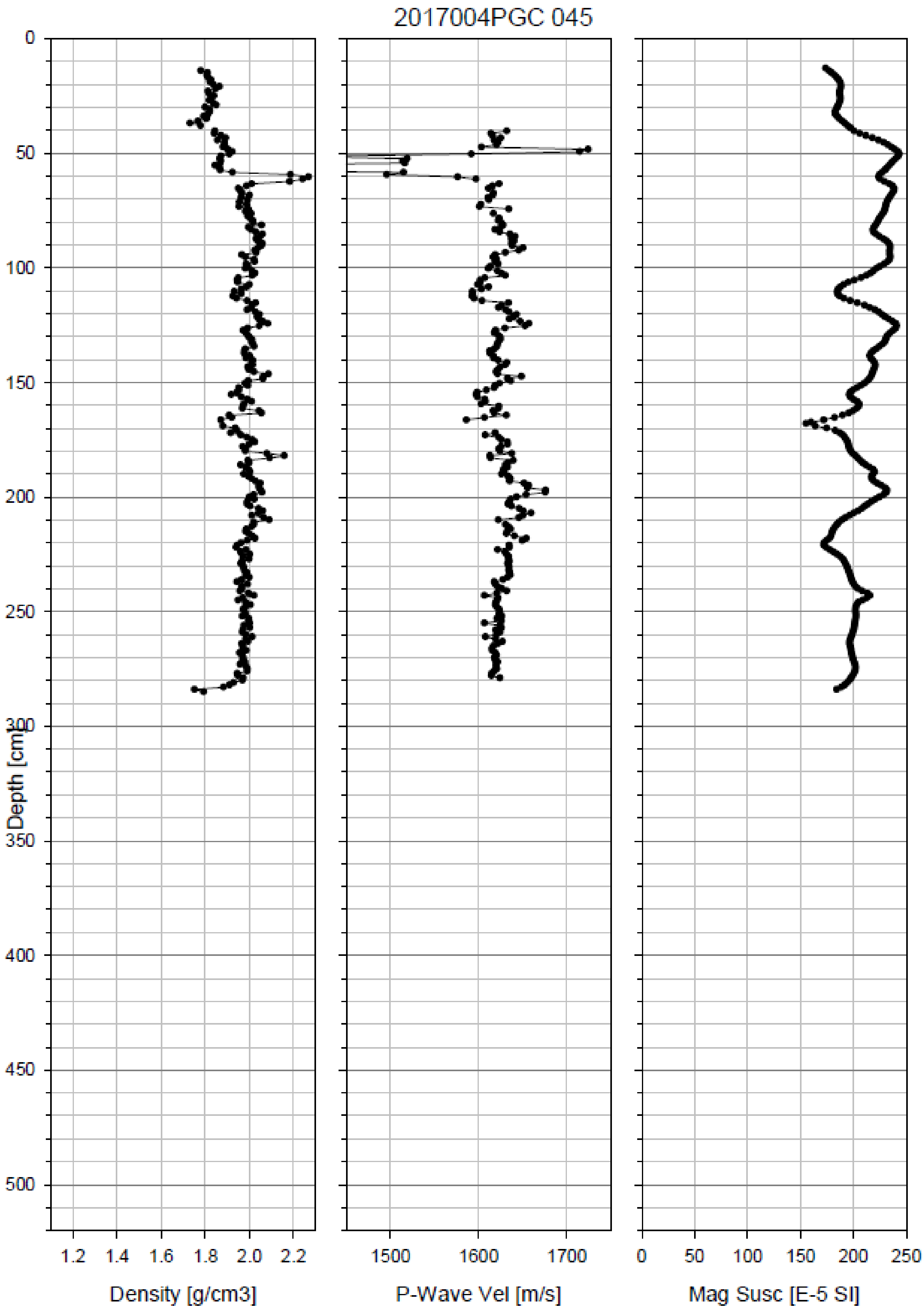
2017004PGC 038
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
50
100
150
200
250
Mag Susc [E-5 SI]


2017004PGC 042-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2 1.4 1.6 1.8 2.0 2.2
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 50 100 150 200 250
Mag Susc [E-5 SI]

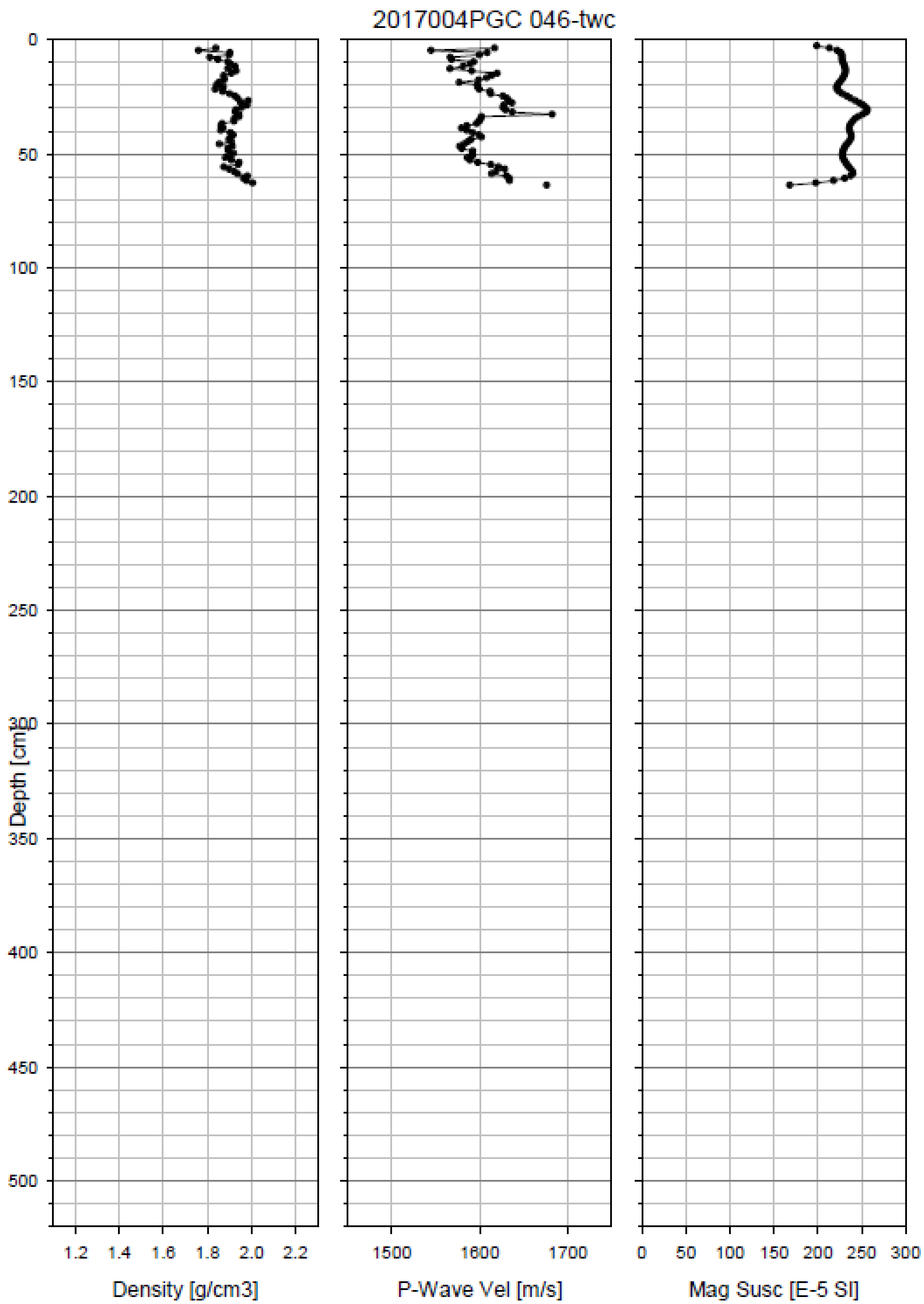

2017004PGC 042
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
50
100
150
200
250
Mag Susc [E-5 SI]



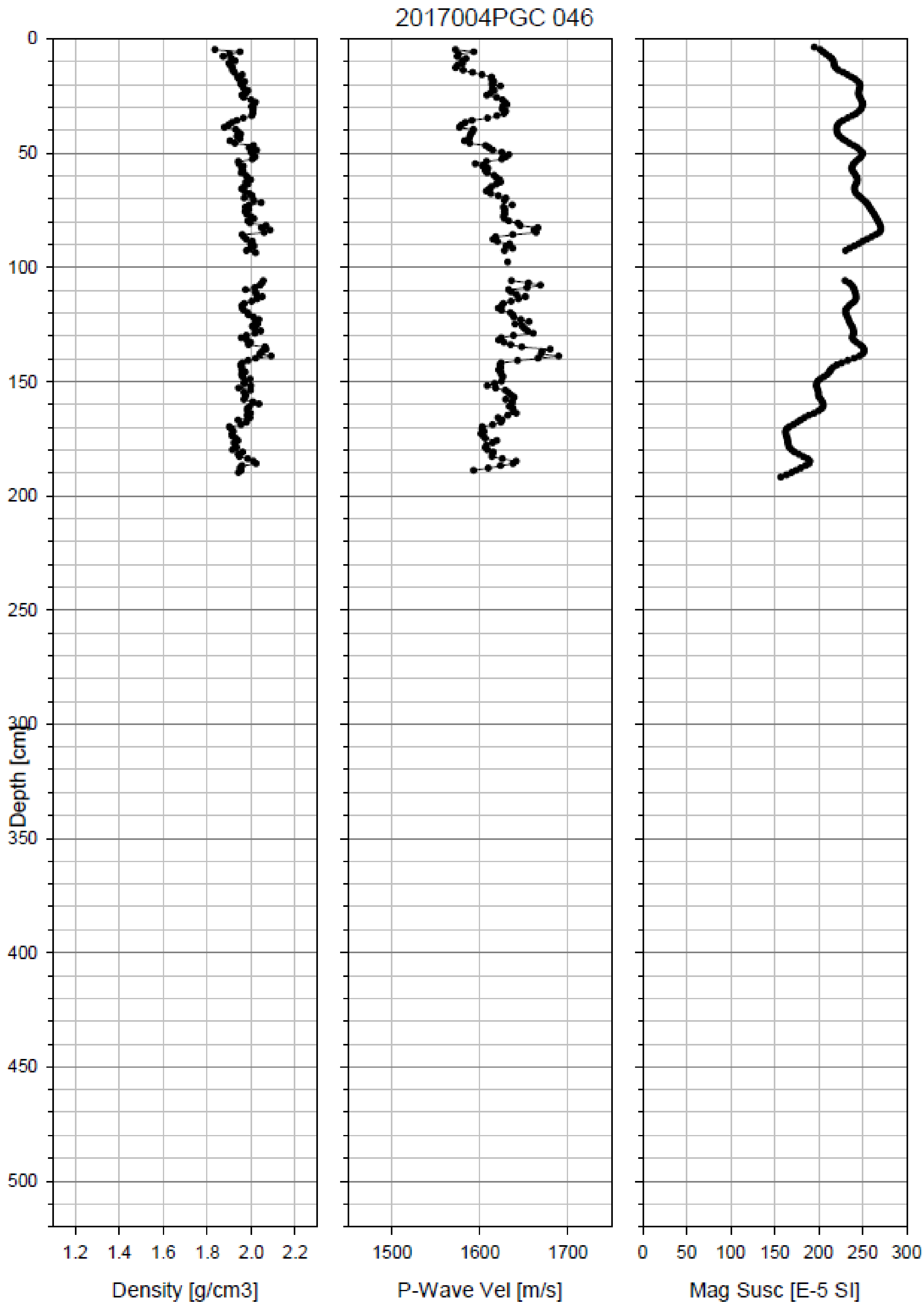
2017004PGC 045-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2 1.4 1.6 1.8 2.0 2.2
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 50 100 150 200 250 300
Mag Susc [E-5 SI]



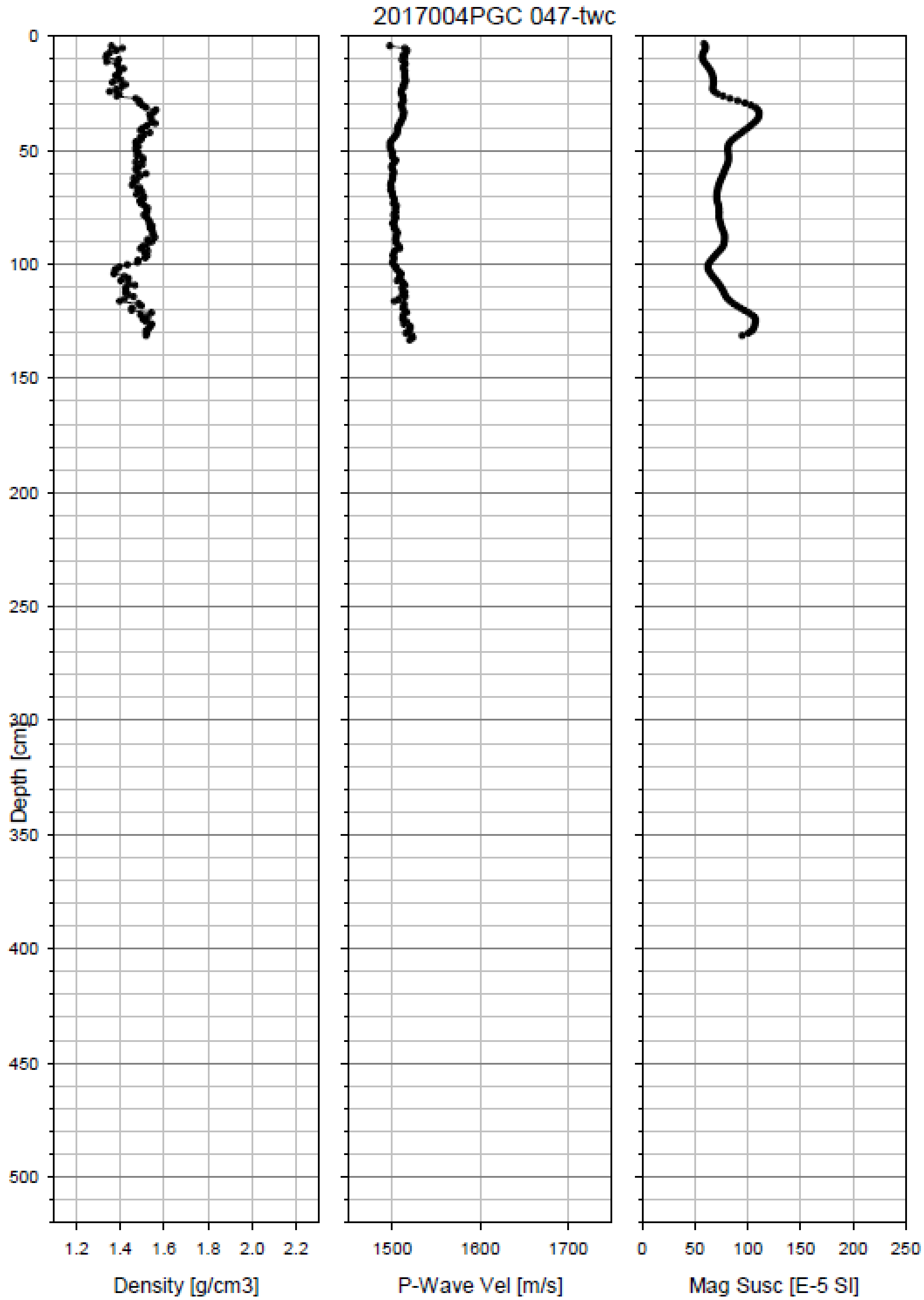
2017004PGC 045
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
50
100
150
200
250
Mag Susc [E-5 SI]



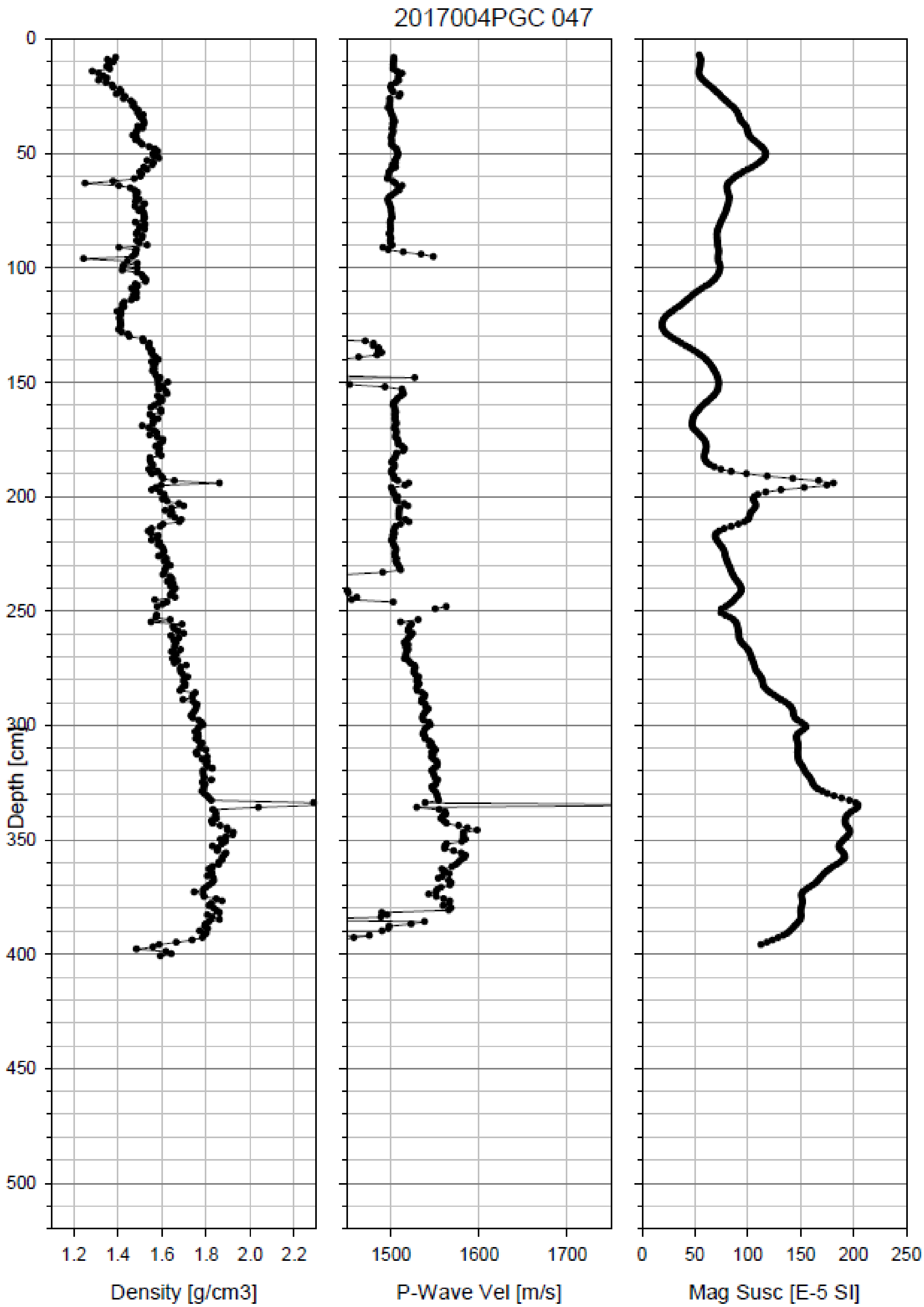
2017004PGC 046-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2 1.4 1.6 1.8 2.0 2.2
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 50 100 150 200 250 300
Mag Susc [E-5 SI]



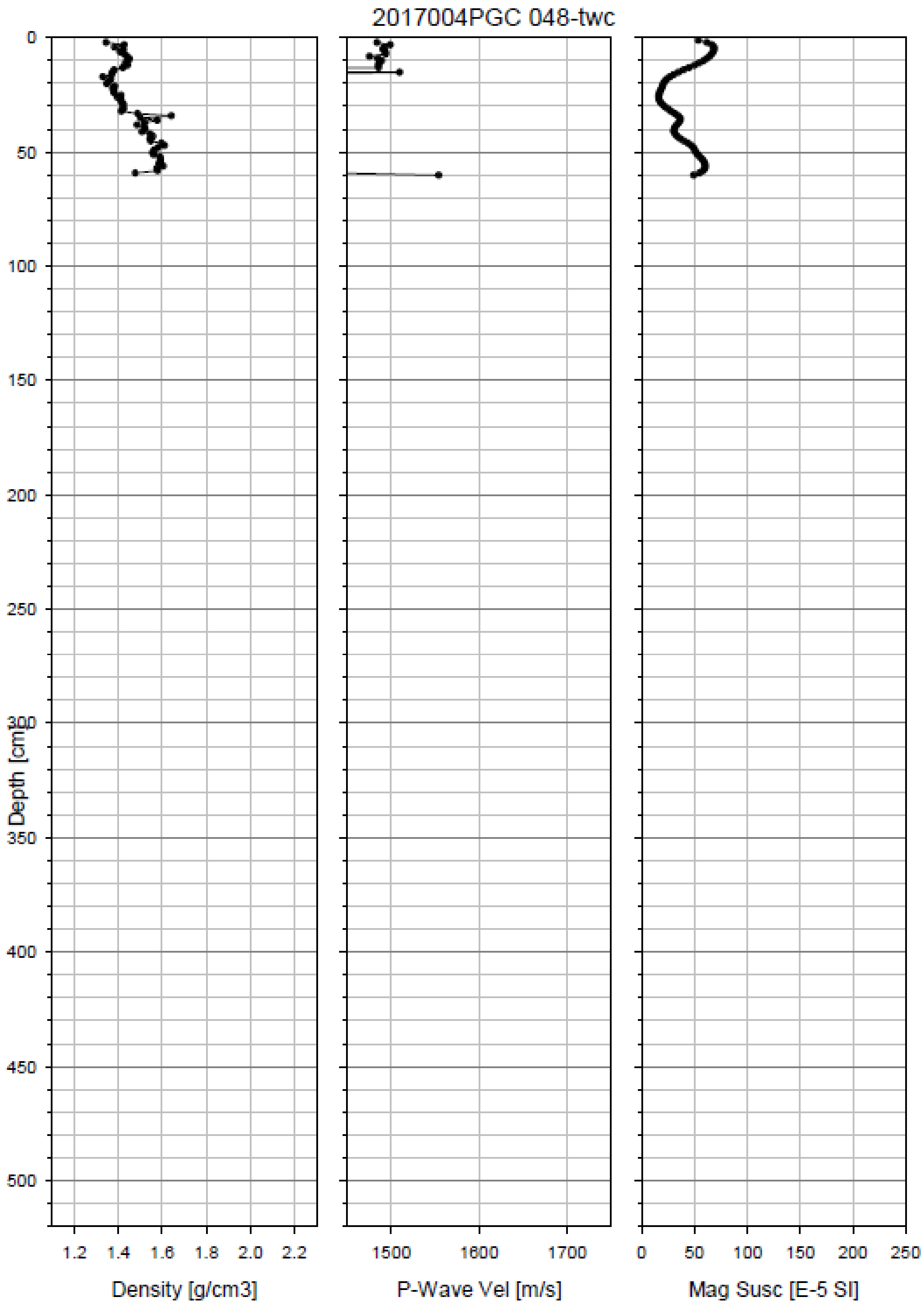
2017004PGC 046
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
50
100
150
200
250
300
Mag Susc [E-5 SI]

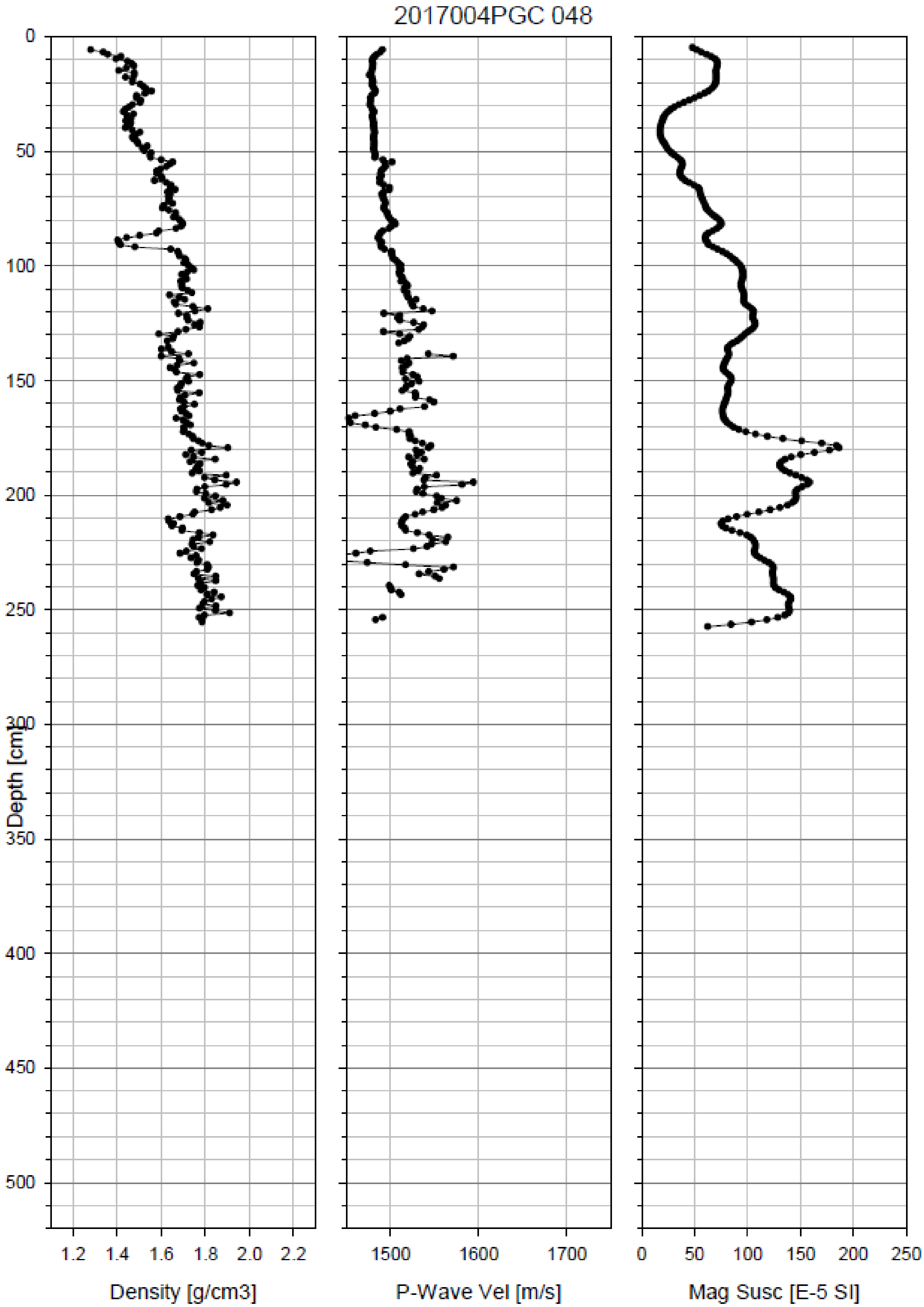


2017004PGC 047-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
50
100
150
200
250
Mag Susc [E-5 SI]

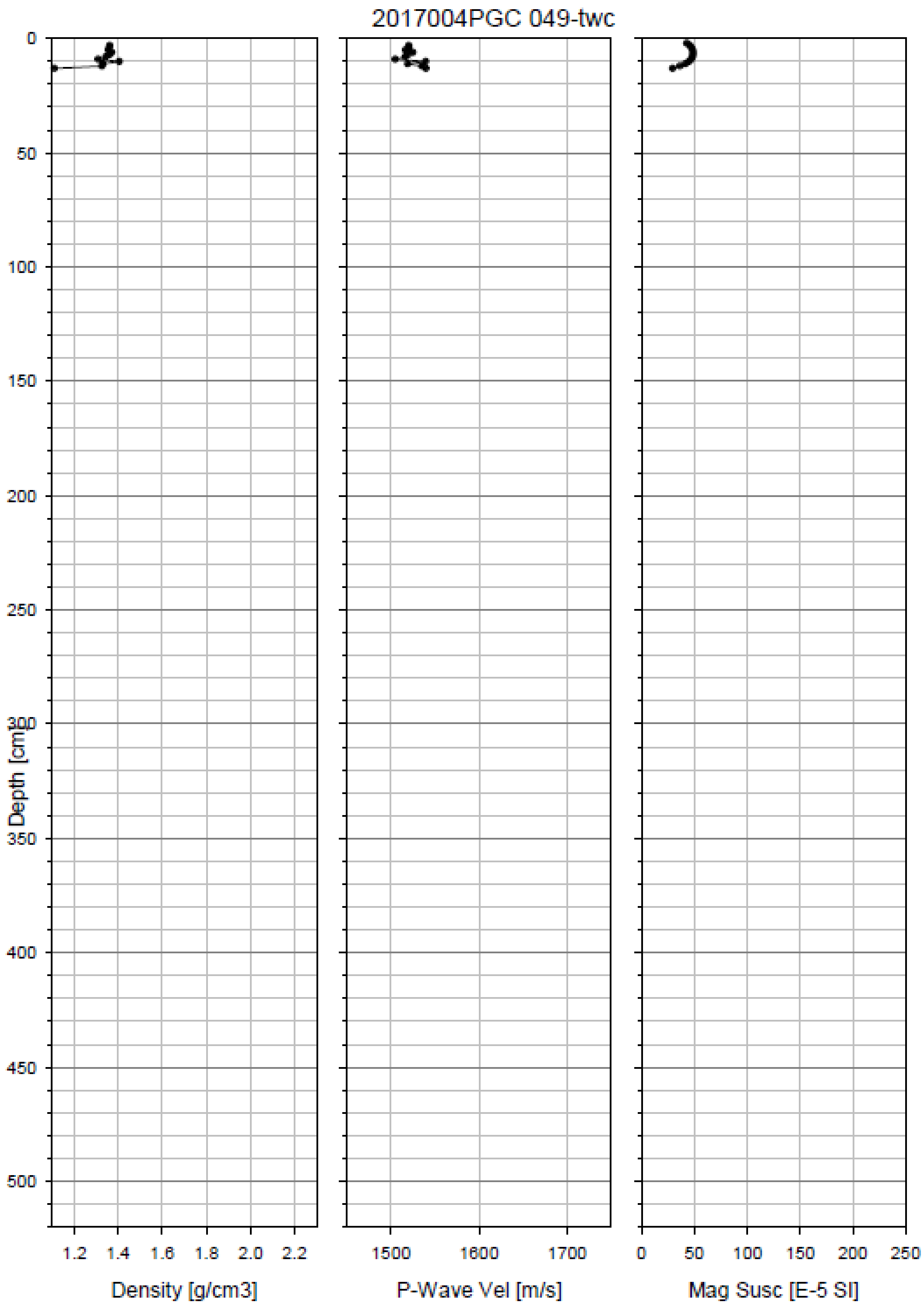


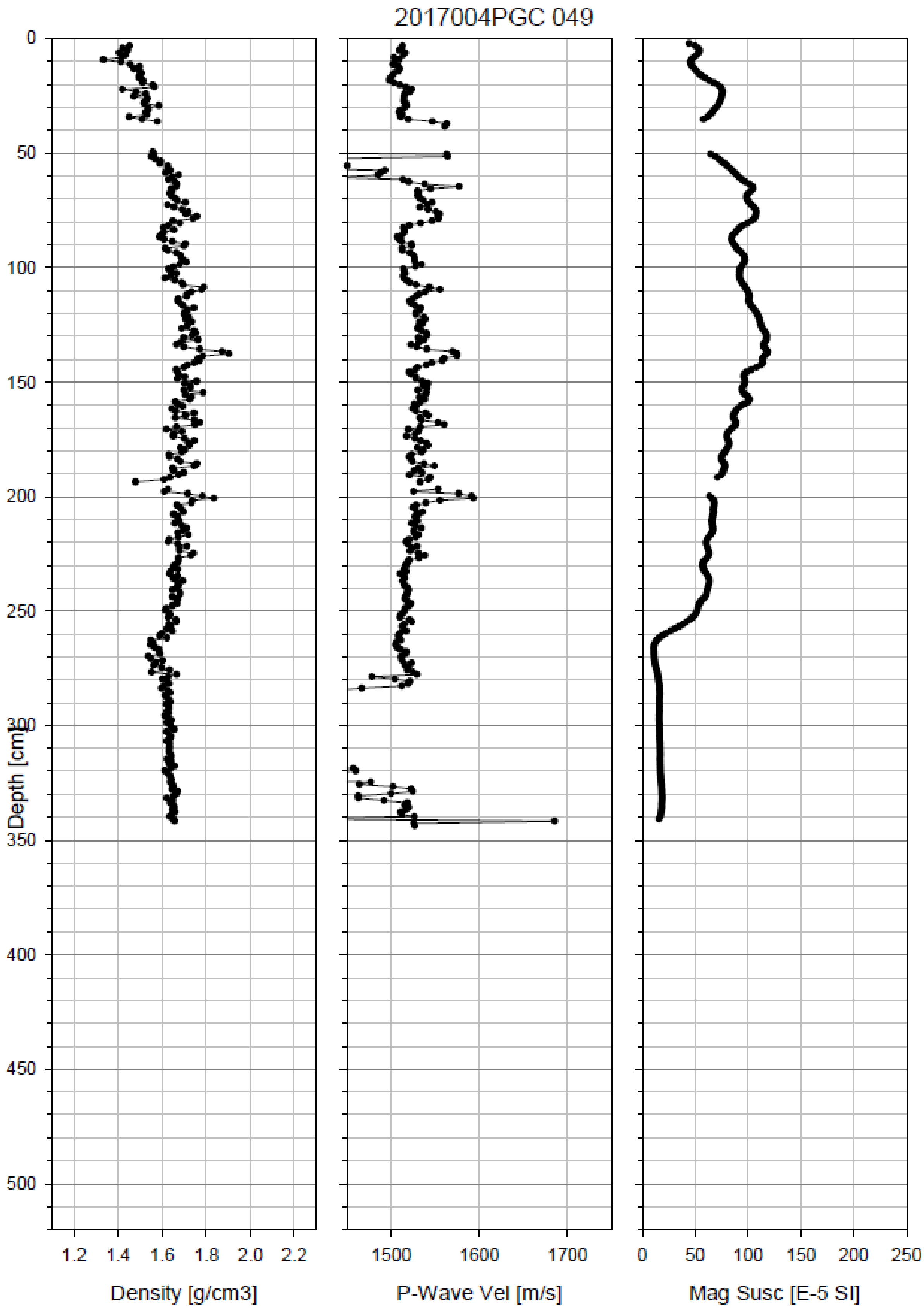
2017004PGC 047
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
50
100
150
200
250
Mag Susc [E-5 SI]


2017004PGC 048-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
50
100
150
200
250
Mag Susc [E-5 SI]

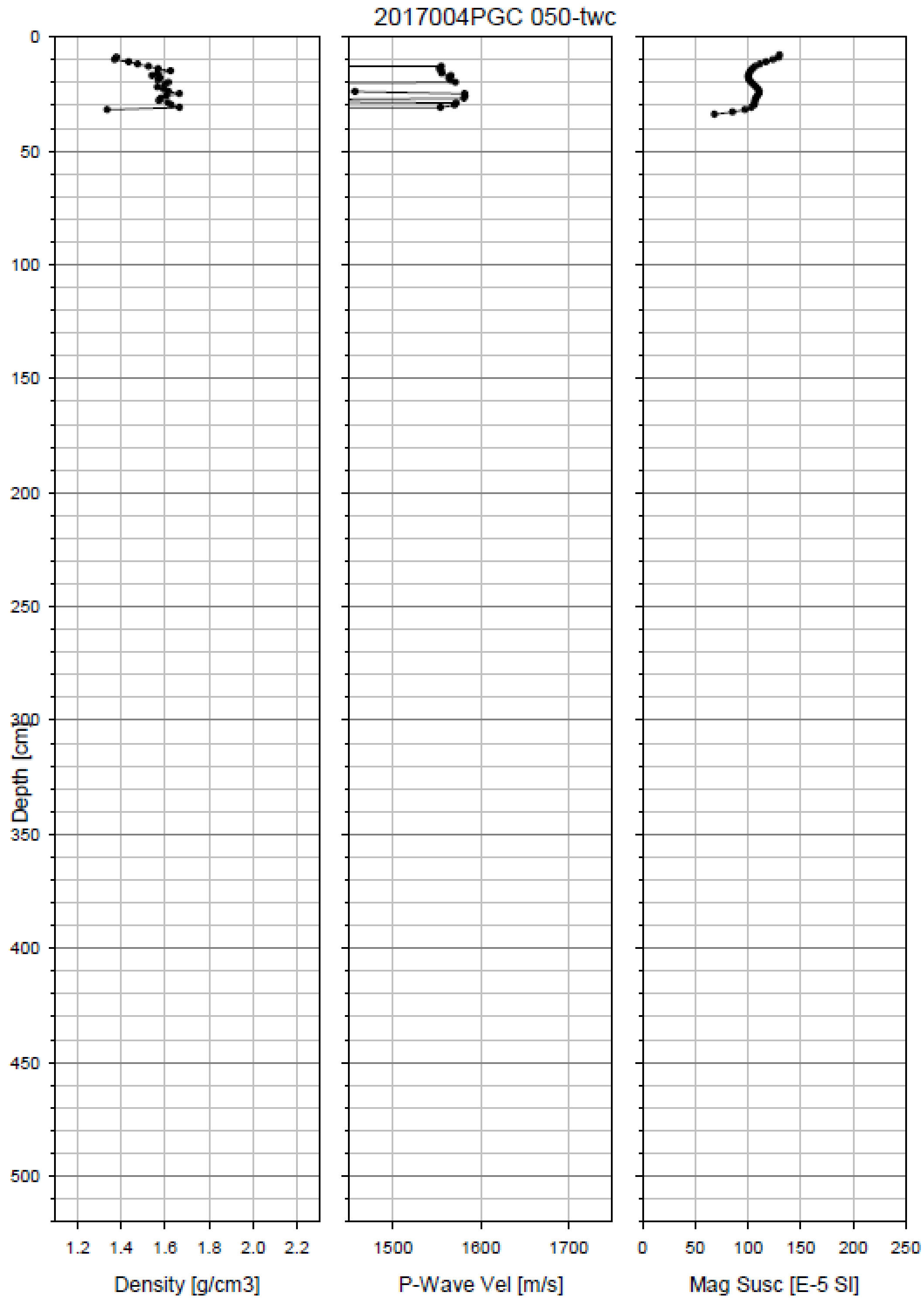


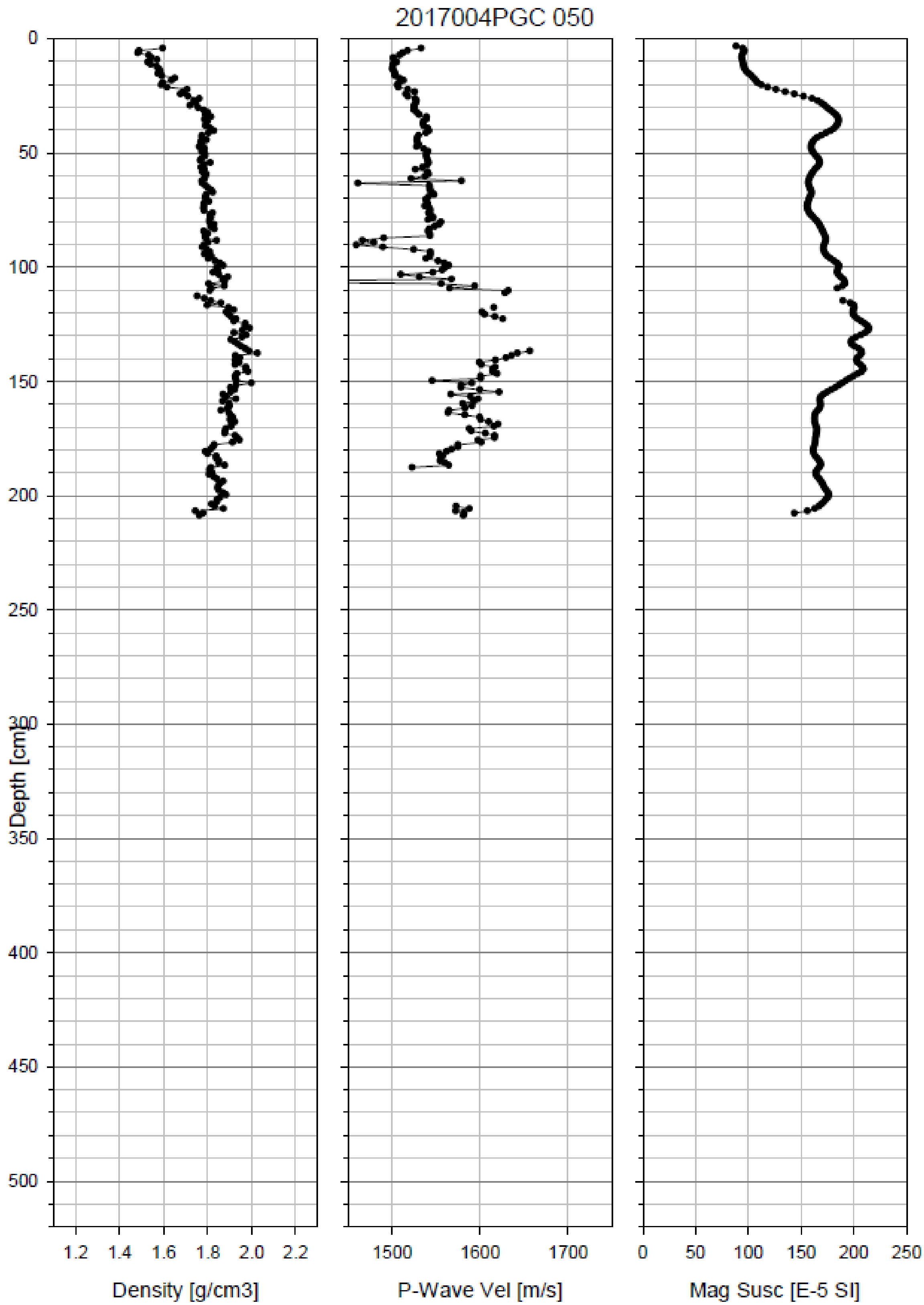
2017004PGC 048
0
50
100
150
200
250
300
350
400
450
500
Depth [cm]
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
50
100
150
200
250
Mag Susc [E-5 SI]


2017004PGC 049-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
50
100
150
200
250
Mag Susc [E-5 SI]

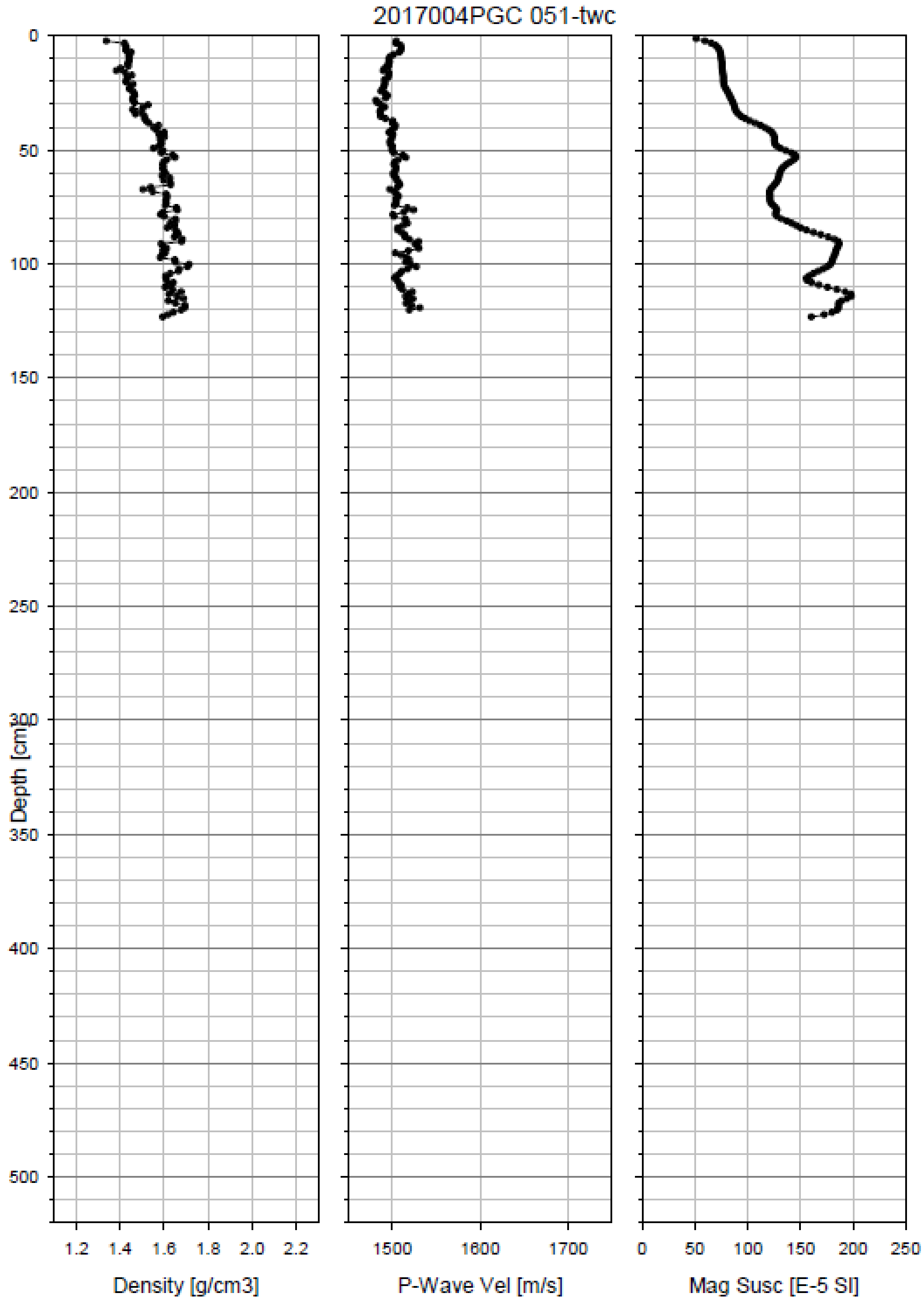


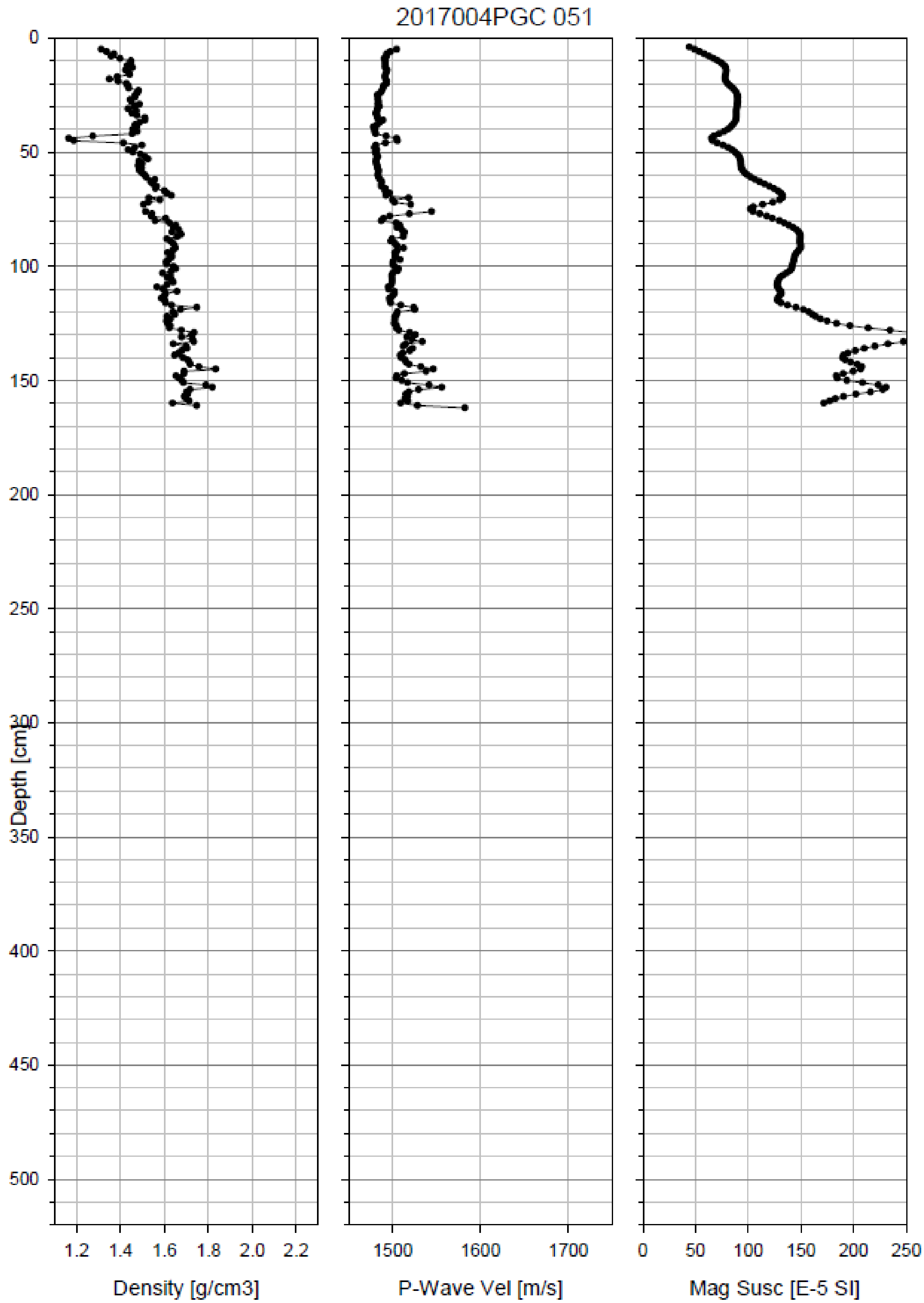
2017004PGC 049
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
50
100
150
200
250
Mag Susc [E-5 SI]


2017004PGC 050-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
50
100
150
200
250
Mag Susc [E-5 SI]

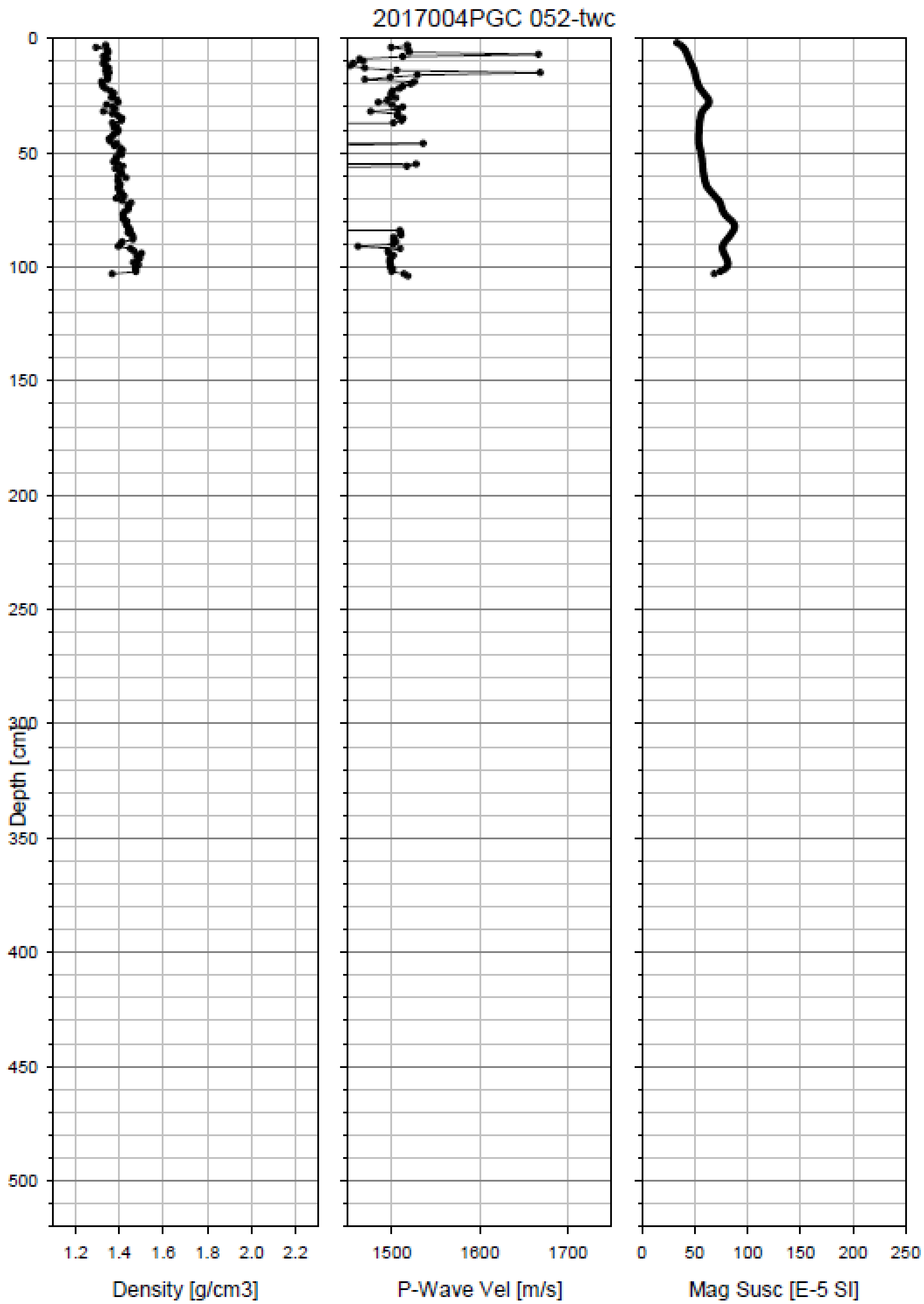


2017004PGC 050
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
50
100
150
200
250
Mag Susc [E-5 SI]

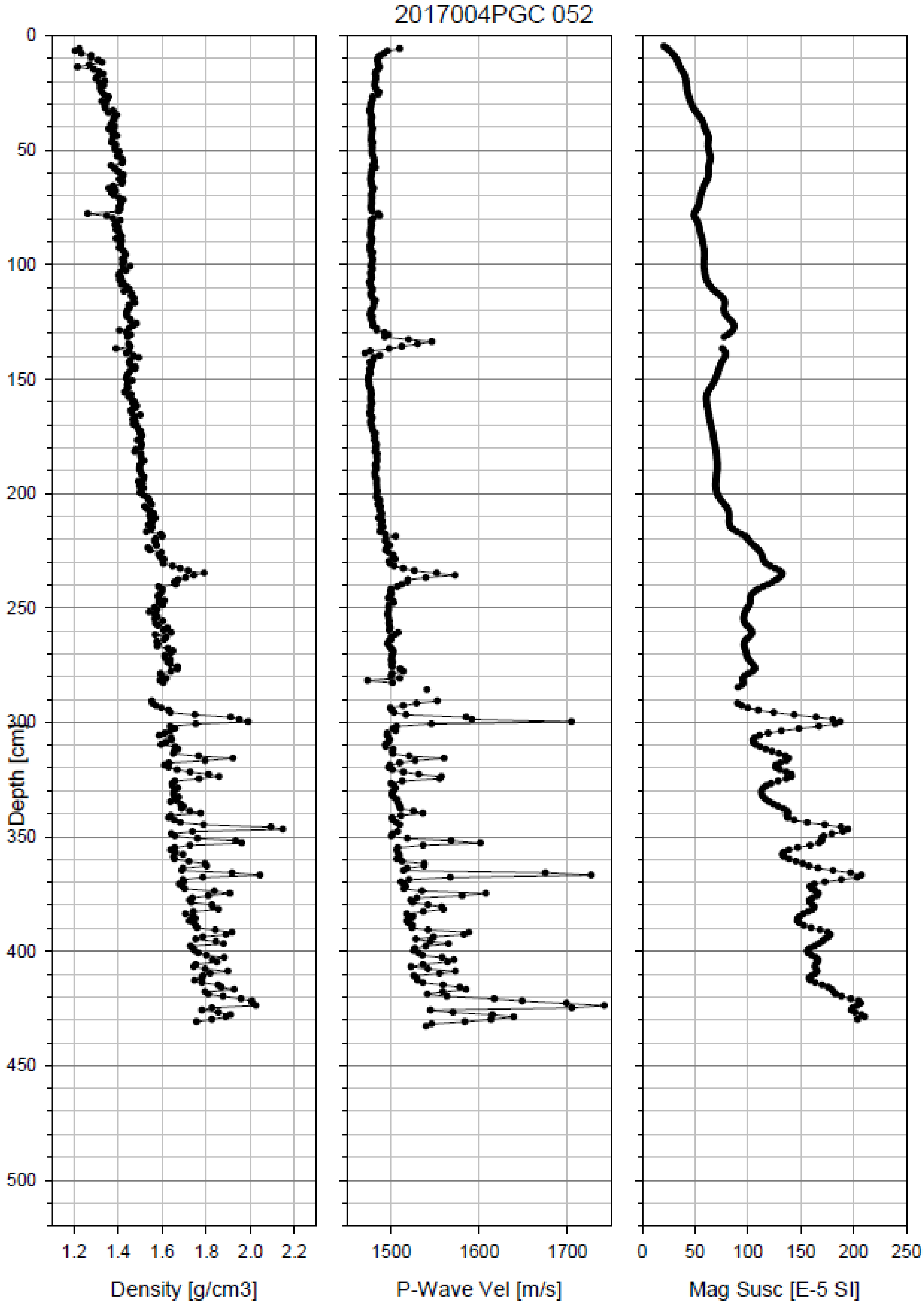

2017004PGC 051-twc
Depth [cm]
Density [g/cm3]
P-Wave Vel [m/s]
Mag Susc [E-5 SI]

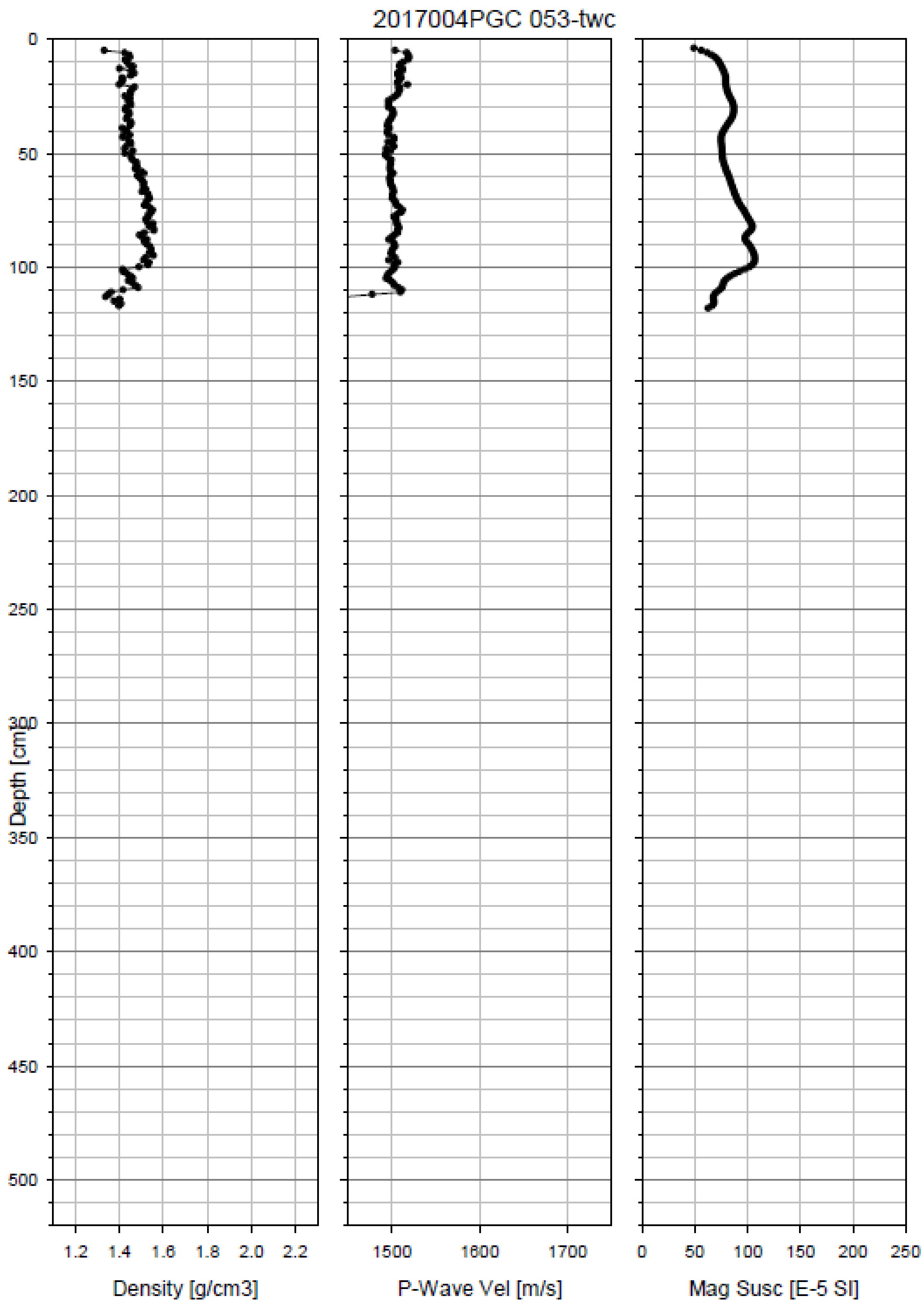


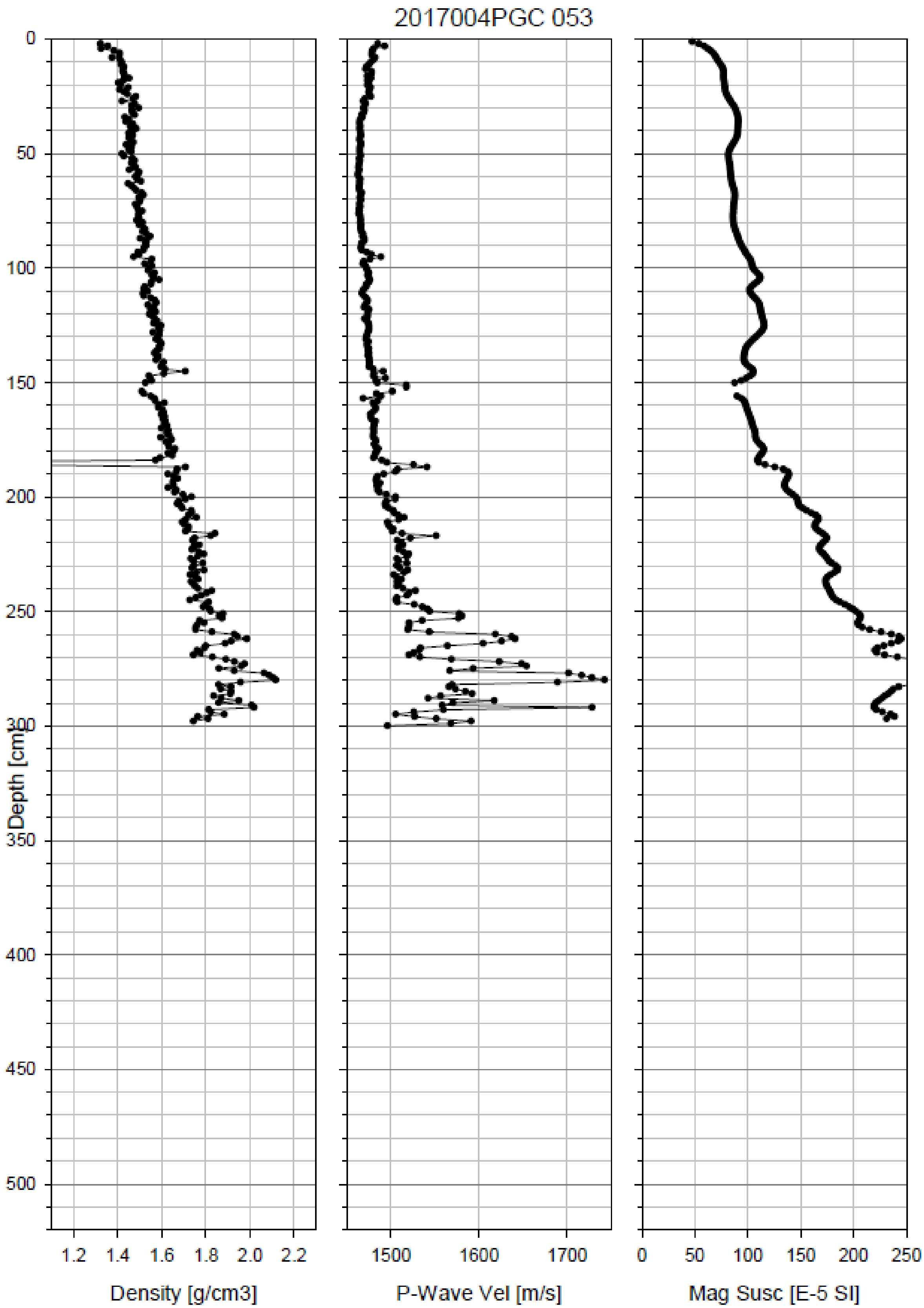
2017004PGC 051
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2 1.4 1.6 1.8 2.0 2.2
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 50 100 150 200 250
Mag Susc [E-5 SI]



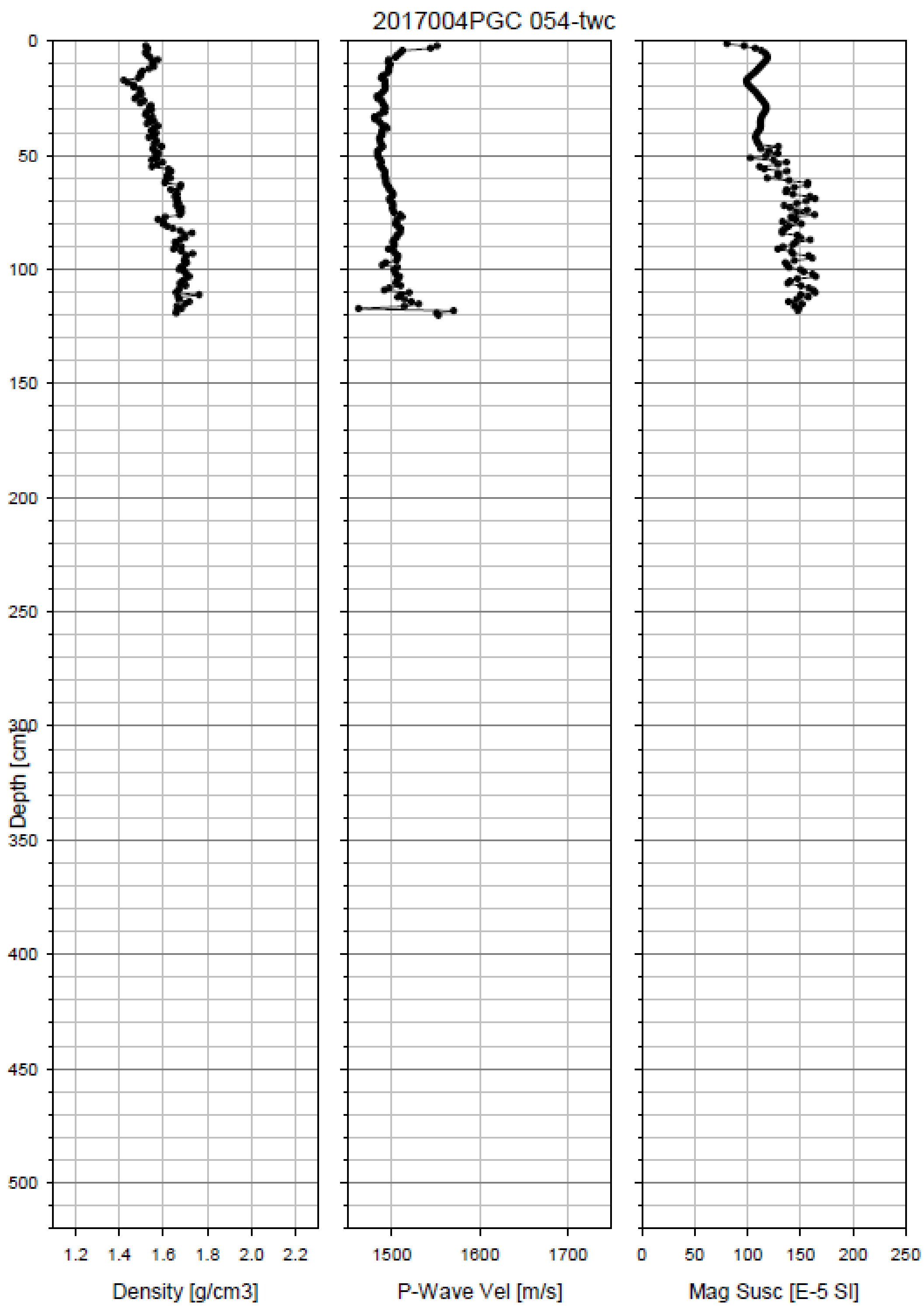
2017004PGC 052-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
50
100
150
200
250
Mag Susc [E-5 SI]

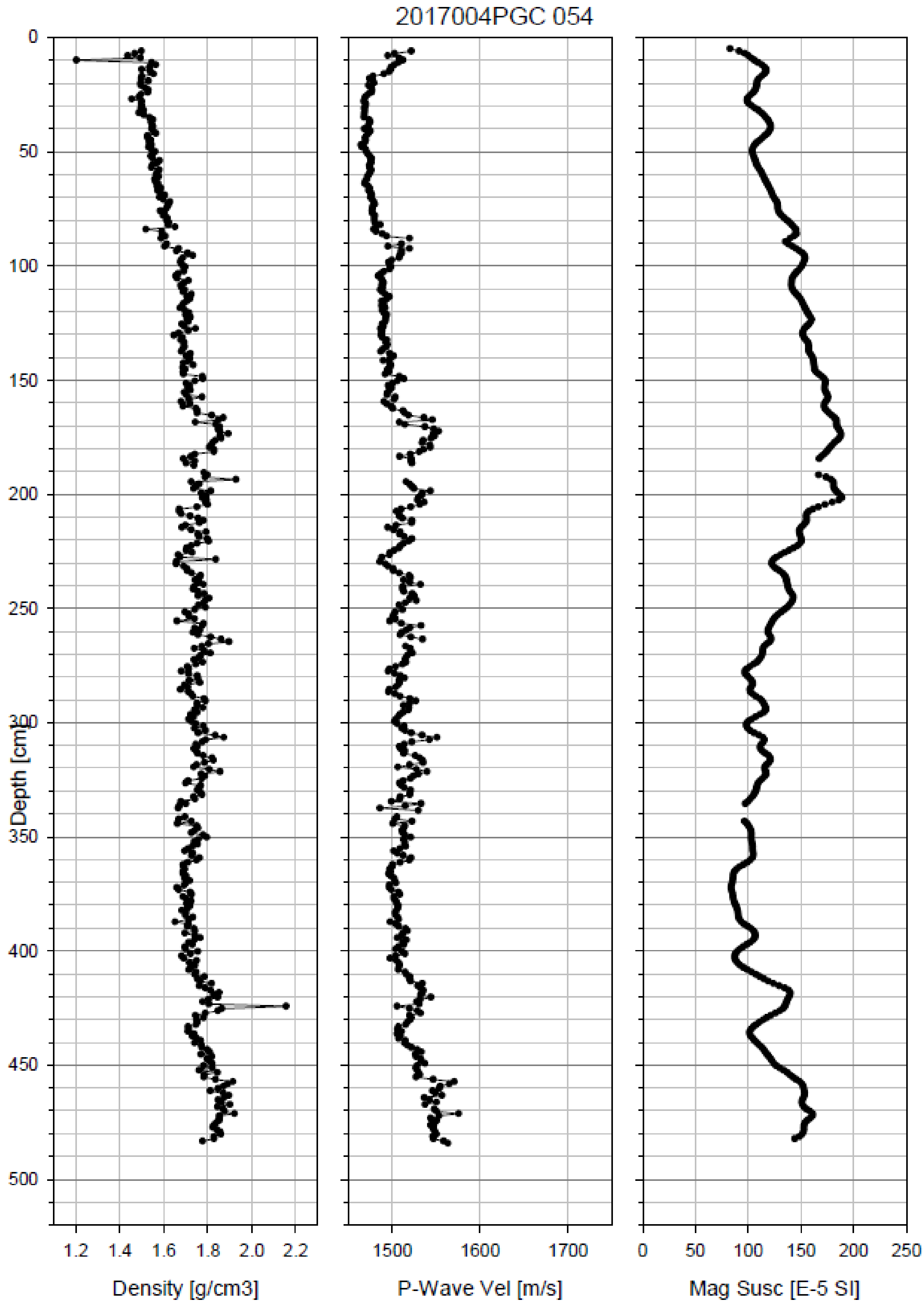

2017004PGC 052
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2 1.4 1.6 1.8 2.0 2.2
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 50 100 150 200 250
Mag Susc [E-5 SI]

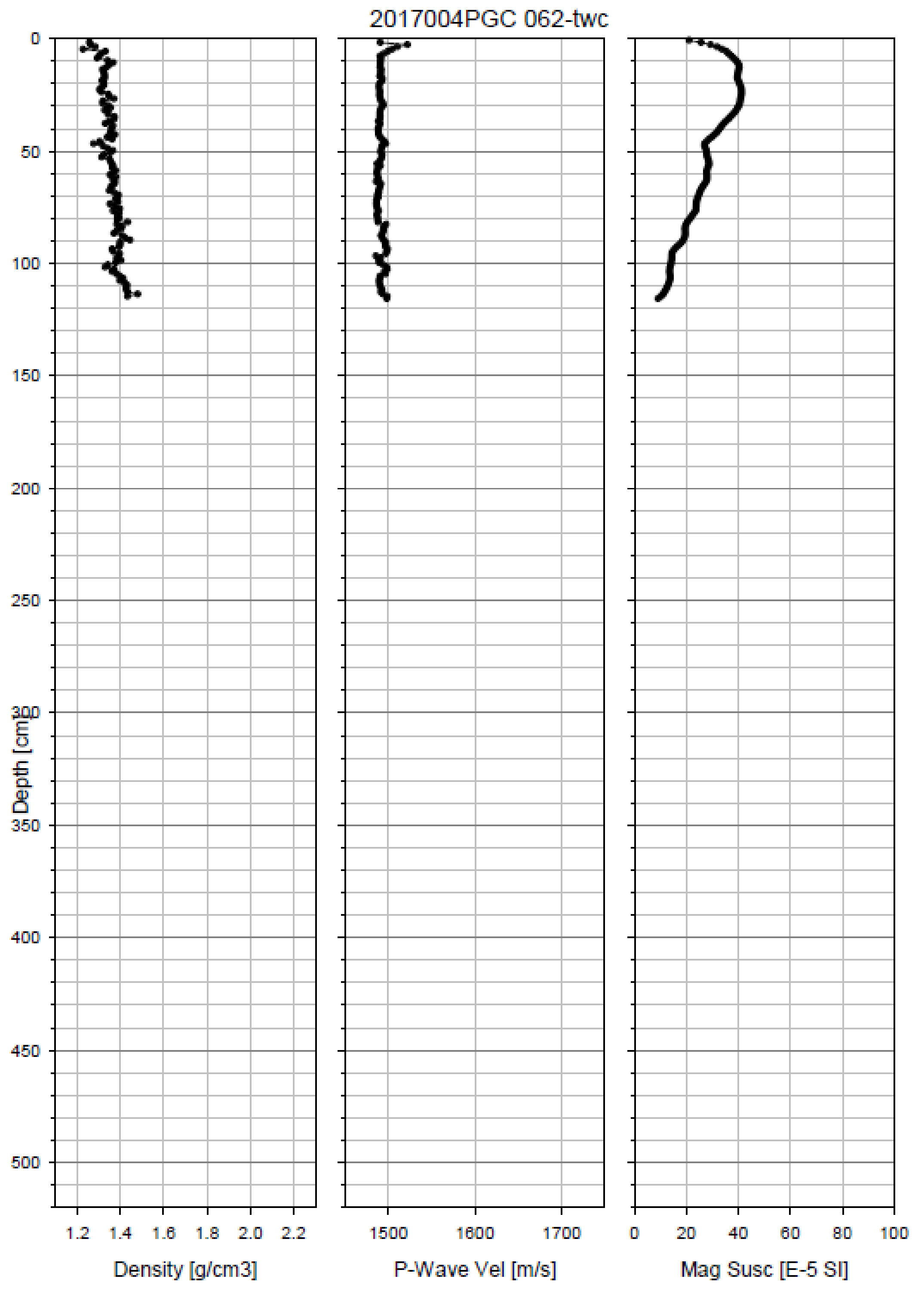

2017004PGC 053-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
50
100
150
200
250
Mag Susc [E-5 SI]



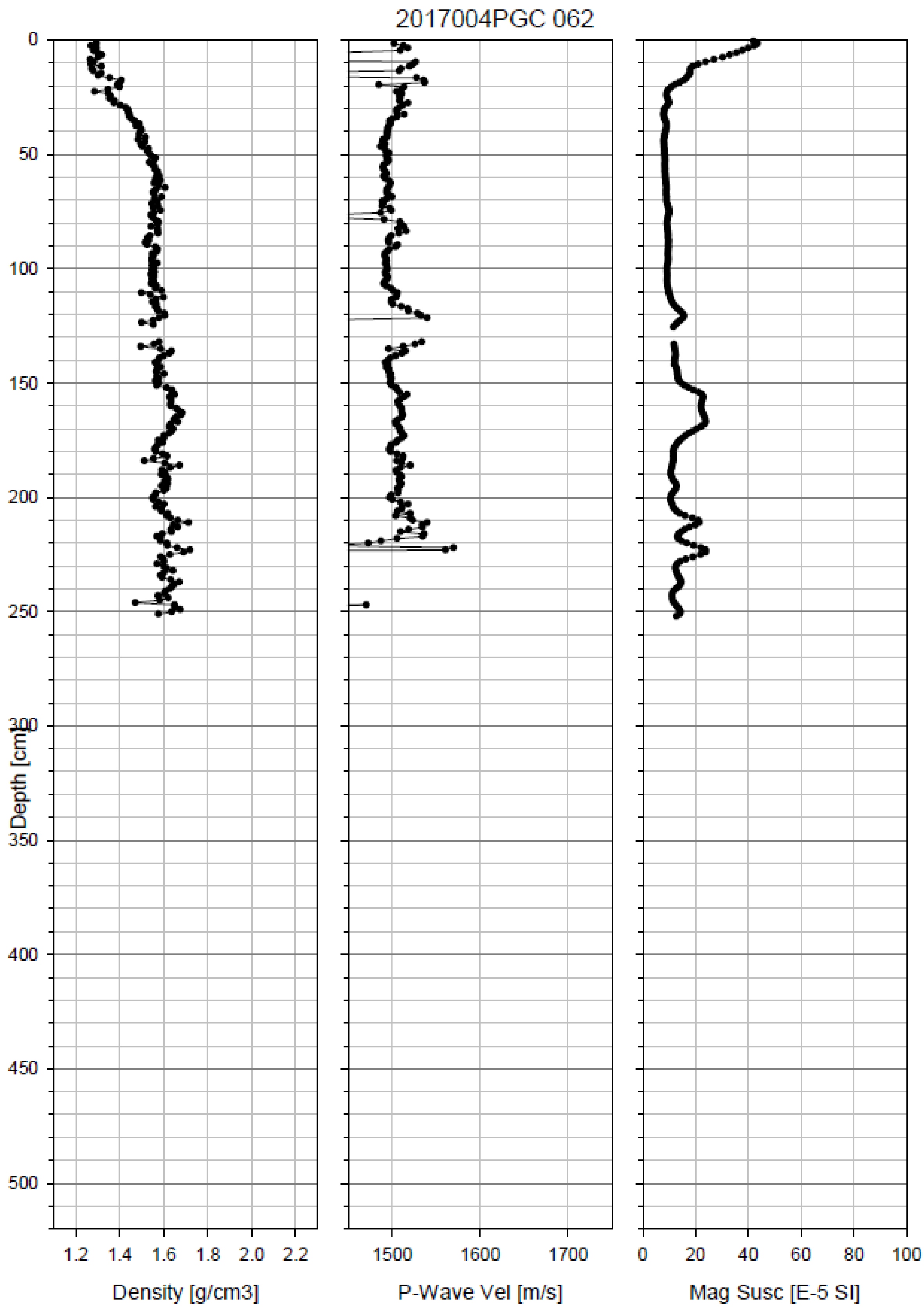
2017004PGC 053
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
50
100
150
200
250
Mag Susc [E-5 SI]


2017004PGC 054-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2 1.4 1.6 1.8 2.0 2.2
Density [g/cm3]
1500 1600 1700
P-Wave Vel [m/s]
0 50 100 150 200 250
Mag Susc [E-5 SI]

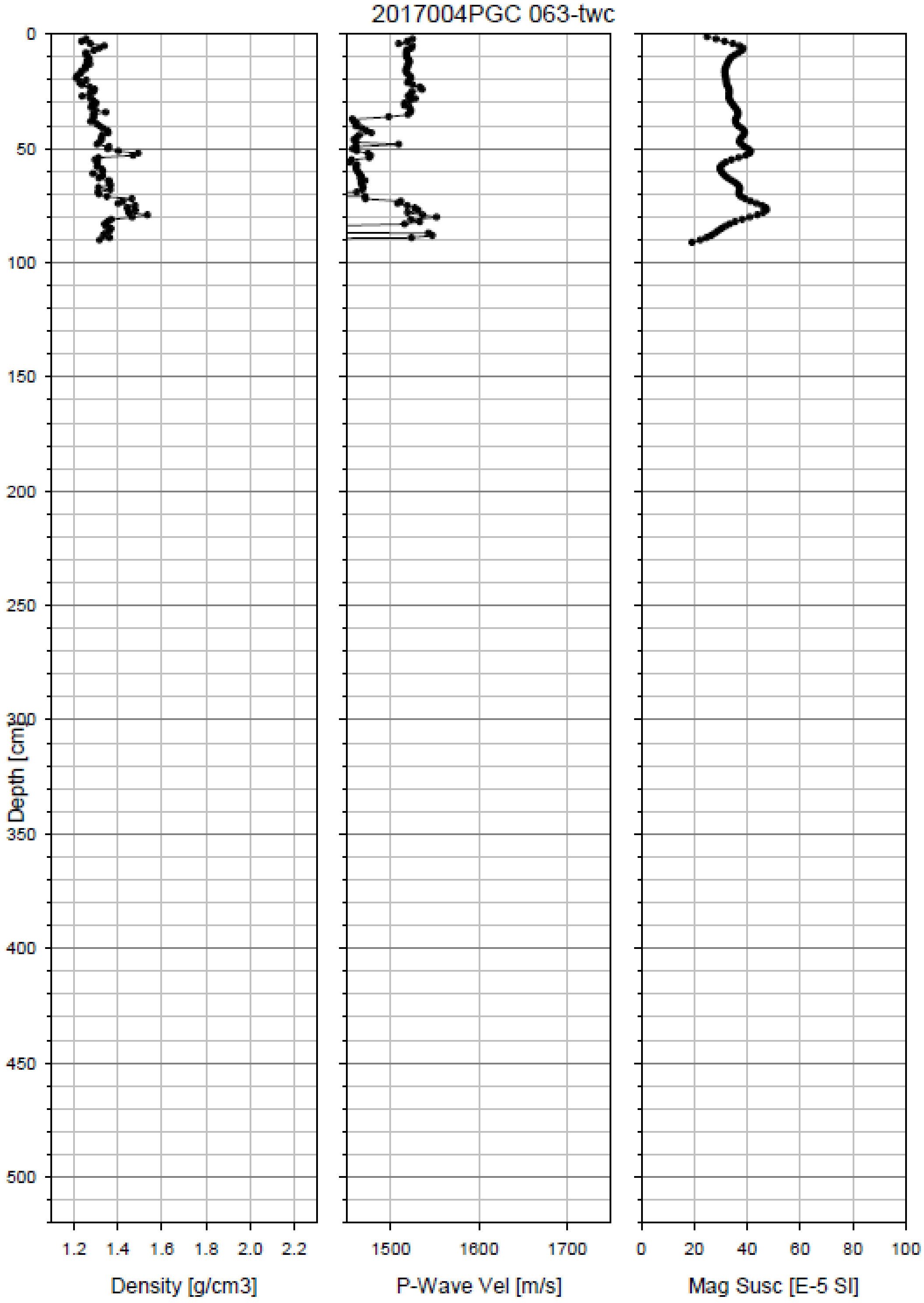

2017004PGC 054
Depth [cm]
Density [g/cm3]
P-Wave Vel [m/s]
Mag Susc [E-5 SI]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
1500
1600
1700
0
50
100
150
200
250

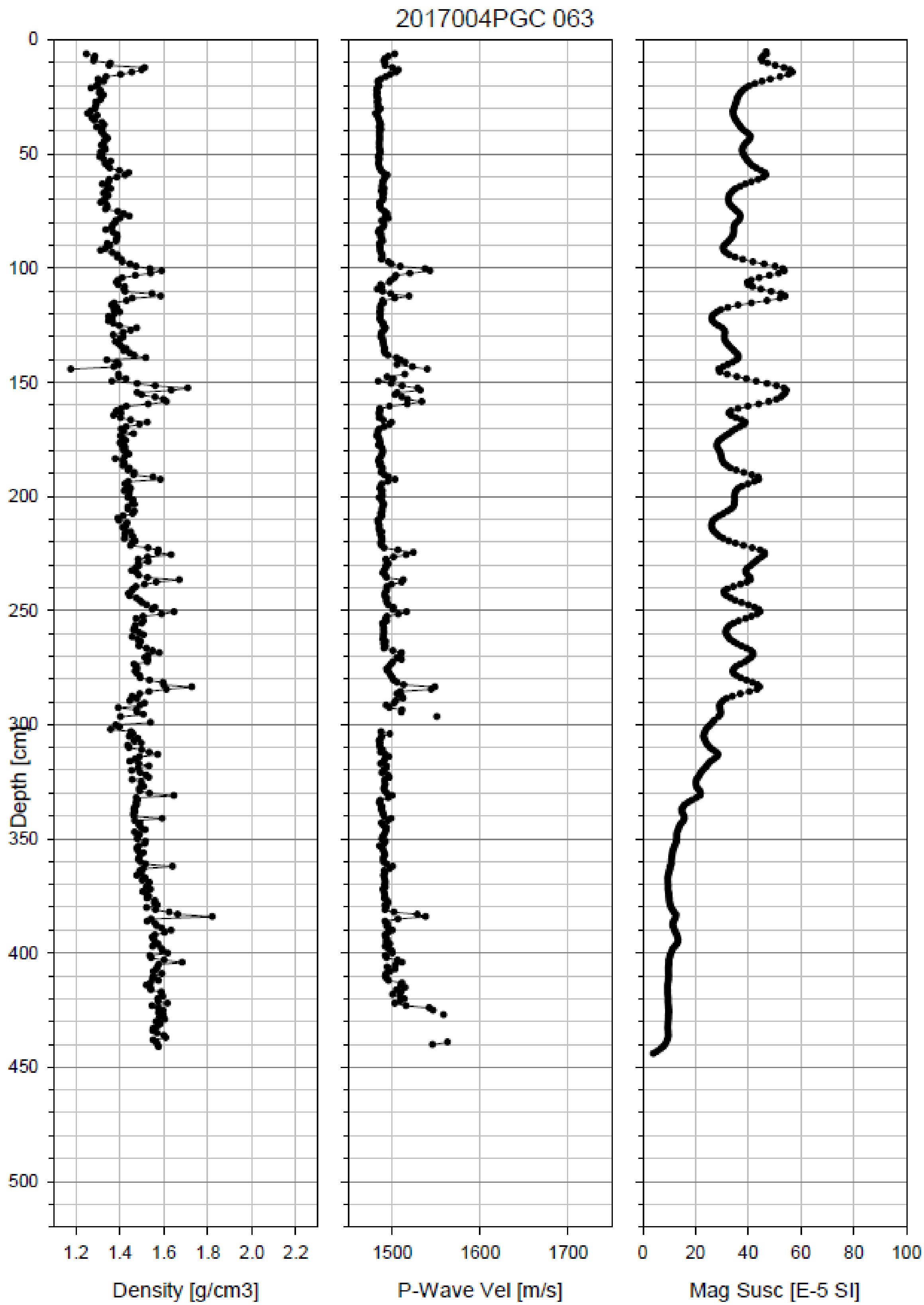


2017004PGC 062-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
20
40
60
80
100
Mag Susc [E-5 SI]



2017004PGC 062
0
50
100
150
200
250
300
350
400
450
500
Depth [cm]
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
20
40
60
80
100
Mag Susc [E-5 SI]


2017004PGC 063-twc
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
20
40
60
80
100
Mag Susc [E-5 SI]


2017004PGC 063
Depth [cm]
0
50
100
150
200
250
300
350
400
450
500
1.2
1.4
1.6
1.8
2.0
2.2
Density [g/cm3]
1500
1600
1700
P-Wave Vel [m/s]
0
20
40
60
80
100
Mag Susc [E-5 SI]

Appendix 3 - Core Sub-Samples

Station	TWC	Sample Top	Sample Bottom	Forams	Pb210	Wet Mass	Other Samples
001		7	9	y			
001		107	109	y			
001		132	134	y			
001		265	267	y			
001		362	365	y			
001		391	393	y			
003	y	9	11		y		
003	y	11	13		y		
003	y	13	15		y		
003	y	15	17		y		
003	y	17	19		y		
003	y	19	21		y		
003	y	21	23		y		
003	y	23	25		y		
003	y	25	27		y		
003	y	27	29		y		
003		0	3	y			
003		16	18	y			
003		23	25	y			
003		28	28				Rock
003		32	34	y			
003		40	41				Rock
003		98	100	y			
003		128	128				Rock
003		200	202	y			
003		Cutter	Cutter				Mudstone
005	y	0	2	y			
005	y	0	2		y		
005	y	2	4		y		
005	y	4	6		y		
005	y	6	8		y		
005	y	8	10		y		
005	y	10	12		y		
005	y	12	14		y		
005	y	14	16		y		
005	y	16	18		y		
005	y	18	20		y		
005		1	3	y			
005		5	7		Y		

Station	TWC	Sample Top	Sample Bottom	Forams	Pb210	Wet Mass	Other Samples
005		9	11		Y		
005		11	13		Y		
005		13	15		Y		
005		15	17		Y		
005		17	19		Y		
005		19	21		Y		
005		21	23		Y		
005		23	25		Y		
005		40	42		Y		
005		50	52		Y		
005		60	62		Y		
005		150	152	y			
005		366	368	y			
006		3	5	y			
006		3	5		Y		
006		5	7		Y		
006		7	9		Y		
006		9	11		Y		
006		11	13		Y		
006		13	15		Y		
006		15	17		Y		
006		17	19		Y		
006		19	21		Y		
006		21	23		Y		
006		23	25		Y		
006		30	32		Y		
006		39	41		Y		
006		167	169	y			
006		172	174	y			
006		336	338	Y			
008	y	2.5	4.5	y			
008		4	6	core top			
008		241	243	above sand			
008		244	246	sand			
008		248	250	below sand			
008		450	452	core bottom			
010		67	67				Shell C14 Date
010		73	73				Shell C14 Date
010		83	83				Shell C14 Date

Station	TWC	Sample Top	Sample Bottom	Forams	Pb210	Wet Mass	Other Samples
013		31	33	y			
013		35	37	ash			
013		39	41	sand			
013		42	44	y			
013		231	233	y			
014		6	8	y			
014		59	61	y			
014		65.5	66.5	y			
014		68	70	y			
014		275	277	y			
018	y	4	6		y		
018	y	6	8		y		
018	y	8	10		y		
018	y	10	12		y		
018	y	12	14		y		
018	y	14	16		y		
018	y	16	18		y		
018	y	18	20		y		
018	y	25	27		y		
018	y	30	32		y		
018	y	35	37		y		
018	y	40	42		y		
018	y	96	98	y			
018		4	6	core top			
018		5	7	y			
018		27	29	y			
018		33	33				Shell C14 Date
018		33	35	sand			
018		37.5	39.5	y			
018		88	90	core bottom			
019	y	6	8	y			
019	y	93	95	y			
019		30	32	y			
019		91	93	y			
019		107	109	y			
019		112	114	y			
019		381	383	y			
020	y	4	6		y		
020	y	4	6	core top			
020	y	6	8		y		

Station	TWC	Sample Top	Sample Bottom	Forams	Pb210	Wet Mass	Other Samples
020	Y	9	9				Shell C14 Date
020	y	10	12		y		
020	y	12	14		y		
020	y	14	16		y		
020	y	16	18		y		
020	y	18	20		y		
020	y	25	27		y		
020	y	30	32		y		
020	y	35	37		y		
020	y	40	42		y		
020	y	93	96	y			
020		2	4	y			
020		51	53	y			
020		56	58	y			
020		109	111	y			
021	y	3	5	core top			
021	y	91	94	y			
021	Y	92	92				Shell C14 Date
021		5	7	core top			
021		13	13				Shell C14 Date
021		58	60	y			
022	Y	5	8	y			
022	Y	6	7		y	22.329	
022	Y	7	8		y	16.267	
022	Y	8	9		y	15.753	
022	Y	9	10		y	14.047	
022	Y	10	11		y	14.906	
022	Y	11	12		y	15.359	
022	Y	12	13		y	13.968	
022	Y	13	14		y	14.266	
022	Y	14	15		y	13.374	
022	Y	15	16		y	14.272	
022	Y	16	17		y	16.961	
022	Y	17	18		y	14.367	
022	Y	18	19		y	15.976	
022	Y	19	20		y	16.255	
022	Y	20	21		y	15.227	
022	Y	21	22		y	16.146	
022	Y	22	23		y	14.457	
022	Y	23	24		y	16.552	
022	Y	24	25		y	15.144	

Station	TWC	Sample Top	Sample Bottom	Forams	Pb210	Wet Mass	Other Samples
022	Y	34	35		y	15.458	
022	Y	39	40		y	15.29	
022		55	57	y			
022		60	62	sand			
022		64	66	y			
022		170	172	y			
023	Y	0	1		y	16.084	
023	Y	1	2		y	13.943	
023	Y	2	3		y	17.645	
023	Y	3	4		y	15.233	
023	Y	4	5		y	16.006	
023	Y	5	6		y	16.842	
023	Y	6	7		y	16.165	
023	Y	7	8		y	15.739	
023	Y	8	9		y	15.414	
023	Y	9	10		y	15.12	
023	Y	10	11		y	17.378	
023	Y	11	12		y	14.618	
023	Y	12	13		y	15.081	
023	Y	13	14		y	16.247	
023	Y	14	15		y	16.769	
023	Y	15	16		y	16.582	
023	Y	16	17		y	17.639	
023	Y	17	18		y	14.073	
023	Y	18	19		y	16.081	
023	Y	19	20		y	16.34	
023	Y	25	26		y	18.055	
023	Y	30	31		y	18.581	
023	Y	35	36		y	17.96	
023	Y	40	41		y	17.812	
023	Y	94	94				Shell C14 Date
023		0	2		Y		
023		0	2	Y			
023		10	12		Y		
023		20	21		Y		
023		30	32		Y		
023		40	42		Y		
023		50	52		Y		
023		60	62		Y		
023		70	72		Y		
023		80	82		Y		

Station	TWC	Sample Top	Sample Bottom	Forams	Pb210	Wet Mass	Other Samples
023		90	92		Y		
023		97	99	sand			
023		101	103		y		
023		101	103	Y			
023		111	113		Y		
023		121	123		Y		
023		131	133		Y		
023		324	326	Y			
024	y	5	7	y			
024	Y	89	89				Shell C14 Date
024	y	92	94	y			
024		0	2	y			
024		59	61	y			
025	y	0	3		y		
025	y	3	5		y		
025	y	5	7		y		
025	y	7	9		y		
025	y	9	11		y		
025	y	11	13		y		
025	y	13	15		y		
025	y	15	17		y		
025	y	17	19		y		
025	y	19	21		y		
025	y	25	27		y		
025	y	30	32		y		
025	y	35	37		y		
025	y	40	42		y		
025	y	45	47		y		
025	y	50	52		y		
025	y	55	57		y		
027	y	2	4				
027	y	90	92				
027		8	10	core top			
027		61	63	above sand			
027		66	68	sand			
027		76	78	below sand			
027		188	190	above sand			
027		195	197	sand			
027		207	209	below			

Station	TWC	Sample Top	Sample Bottom	Forams	Pb210	Wet Mass	Other Samples
027		234	236	sand			
027		256	258	Y			
028		Top	1				Shell C14 Date
032		3	5	y			
032		4	6	y			
032		14	16	y			
032		18	18				Shell C14 Date
032		33	35	y			
032		42	44	y			
038	Y	2	4		Y		
038	Y	4	6		Y		
038	Y	6	8		Y		
038	Y	8	10		Y		
038	Y	10	12		Y		
038	Y	12	14		Y		
038	Y	14	16		Y		
038	Y	16	18		Y		
038	Y	18	20		Y		
038	Y	25	27		Y		
038	Y	30	32		Y		
038	Y	35	37		Y		
038	Y	40	42		Y		
038	Y	45	47		Y		
038	Y	50	52		Y		
038		3	5	y			
038		63	65	Y			
038		66.5	67.5	sand			
038		70	72	Y			
038		161	163	Y			
038		163.5	164.5	sand below			
038		166	168	sand			
038		238	240	Y			
038		305	307	Y			
038		326	327	sand			
038		343	344	sand above			
038		348	349	sand			
038		350	351	sand below			
038		352	354	sand			
038		362	363	sand			

Station	TWC	Sample Top	Sample Bottom	Forams	Pb210	Wet Mass	Other Samples
038		373.5	375.5	sand			
038		376	378	below sand			
038		423	425	above sand			
038		425	426	sand			
038		427	429	below sand			
038		513	515	core base			
042	y	2	4	core top			
042	y	150	152	core base			
042		2	4	y			
042		7	9	y			
042		118	120	y			
042		150	152	y			
042		180	182	y			
042		275	277	y			
042		291	293	y			
042		314	316	y			
042		317	318	sand			
042		319	321	below sand			
042		343	345	y			
042		346	347	sand			
042		348	350	y			
045	y	0	3	y			
045	y	20	22	y			
045		0	3	y			
045		8	10	sand			
045		17	17				Shell C14 Date
045		47	47				Shell C14 Date
045		48	50	shell frags			
045		87	89	rock clasts			
045		166	168	y			
045		199	201	rock clasts			
045		287	289	y			
046	y	4	6	y			
046	y	31	33	y			
046	y	33	34	sand			
046	y	35	37	y			

Station	TWC	Sample Top	Sample Bottom	Forams	Pb210	Wet Mass	Other Samples
046		8	10	y			
046		103	105	y			
046		195	197	y			
047	y	0	2	y			
047	y	131	133	y			
047		6	8	y			
047		94	96	y			
047		190	192	y			
047		194	195	sand			
047		197	199	y			
047		295	297	y			
047		307	307				Shell C14 Date
047		401	403	y			
048	y	0	2	y			
048	y	60	62	y			
048		0	3	y			
048		100	102	y			
048		175	177	y			
048		179	181	sand			
048		183	185	sand			
048		255	257	y			
049	y	0	2	y			
049	y	0	2		y		
049	y	2	4		y		
049	y	4	6		y		
049	y	6	8		y		
049	y	8	10		y		
049	y	10	12		y		
049	y	11	13	y			
049	y	12	13		y		
049		0	2		y		
049		2	4		y		
049		3	5	y			
049		4	6		y		
049		6	8		y		
049		8	10		y		
049		10	12		y		
049		12	14		y		
049		14	16		y		
049		16	18		y		
049		18	20		y		

Station	TWC	Sample Top	Sample Bottom	Forams	Pb210	Wet Mass	Other Samples
049		30	32		y		
049		114	116	y			
049		219	221	y			
049		275	277	y			
050		6	8	y			
050		52	52				Shell C14 Date
050		57	59	y			
050		116	118	y			
050		207	209	y			
051	y	0	2	y			
051	y	0	2		y		
051	y	2	4		y		
051	y	4	6		y		
051	y	6	8		y		
051	y	8	10		y		
051	y	10	12		y		
051	y	12	14		y		
051	y	14	16		y		
051	y	16	18		y		
051	y	18	20		y		
051	y	25	27		y		
051	y	30	32		y		
051	y	35	37		y		
051	y	40	42		y		
051	y	125	127	y			
051		5	7	y			
051		95	97	y			
051		159	161	y			
052	y	1	3		y		
052	y	1	3	y			
052	y	3	5		y		
052	y	5	7		y		
052	y	7	9		y		
052	y	9	11		y		
052	y	11	13		y		
052	y	13	15		y		
052	y	15	17		y		
052	y	17	19		y		
052	y	19	21		y		
052	y	25	27		y		
052	y	30	32		y		

Station	TWC	Sample Top	Sample Bottom	Forams	Pb210	Wet Mass	Other Samples
052		6	8	y			
052		131	133	y			
052		229	231	above sand			
052		239	241	below sand			
052		293	295	y			
052		297	299	y			
052		300	302	y			
052		429	431	y			
053	y	1	3	y			
053	y	116	118	y			
053		3	5	y			
053		150	152	y			
053		302	304	y			
054	y	3	5	y			
054	y	119	121	y			
054		5	7	y			
054		145	147	y			
054		303	305	y			
054		483	485	y			
062	y	5	7	y			
062	y	115	117	y			
062		2	4	y			
062		126	128	y			
062		250	252	y			
063	y	4	6	core top			
063	y	4	6		y		
063	y	6	8		y		
063	y	8	10		y		
063	y	10	12		y		
063	y	12	14		y		
063	y	14	16		y		
063	y	16	18		y		
063	y	18	20		y		
063	y	25	27		y		
063	y	30	32		y		
063	y	35	37		y		
063	y	40	42		y		
063	y	45	47		y		
063	y	50	52		y		

Station	TWC	Sample Top	Sample Bottom	Forams	Pb210	Wet Mass	Other Samples
063		8	10	y			
063		149	151	y			
063		260	260				Shell C14 Date
063		287	289	below sand			
063		379	382	y			
063		383	385	sand			
063		386	388	y			
063		421	421				Shell C14 Date
063		440	442	y			
065		Top	1				Shell C14 Date
065		16	16				Shell C14 Date
065		20	22	y			

Appendix 4 - Camera Stations

Station	Number of Pictures	Start Time	End Time	Starting Latitude	Starting Longitude	Ending Latitude	Ending Longitude
7	54	Sept 18 21:06:14	Sept 18 21:58:31	55.910578	-135.500482	55.911057	-135.497387
9	74	Sept 19 14:47:49	Sept 19 16:07:11	57.252257	-136.338505	57.254798	-136.33766
17	6	Sept 19 02:23:31	Sept 19 02:29:55	57.200692	-136.306682	57.200748	-136.307088
31	35	Sept 21 20:46:28	Sept 21 21:23:14	57.968962	-136.773112	57.967452	-136.76966
34	62	Sept 21 01:06:08	Sept 21 01:46:47	57.964447	-136.77673	57.962547	-136.779855
35	95	Sept 22 21:46:01	Sept 22 23:33:55	57.03887	-136.163257	57.037423	-136.16202
39	48	Sept 23 18:43:37	Sept 23 19:48:43	55.67943	-135.337582	55.678935	-135.33551
55	15	Sept 26 15:58:02	Sept 26 18:22:47	54.025963	-134.057603	54.021727	-134.052353
60	103	Sept 27 23:11:53	Sept 28 00:26:30	51.990498	-131.256768	51.982855	-131.253358
64	6	Sept 28 22:34:55	Sept 28 22:39:05	52.022387	-131.444268	52.022227	-131.444468

Appendix 5 - Geochemical Samples

Collection Date	Cruise	Station	Data Type	Core Sec.	Rhizon No.	Depth In Core	DOC 2 ml Vial	DIC/Nuts 2 ml Vial	Sulfide 15 ml Vial
2017-09-14	2017004PGC	001	Core	1	1	2	X	X	X
2017-09-14	2017004PGC	001	Core	1	2	12	X	X	X
2017-09-14	2017004PGC	001	Core	1	3	22	X	X	X
2017-09-14	2017004PGC	001	Core	1	4	32	X	X	X
2017-09-14	2017004PGC	001	Core	1	5	42	X	X	X
2017-09-14	2017004PGC	001	Core	1	6	52	X	X	X
2017-09-14	2017004PGC	001	Core	1	7	62	X	X	X
2017-09-14	2017004PGC	001	Core	1	8	72	X	X	X
2017-09-14	2017004PGC	001	Core	1	9	82	X	X	X
2017-09-14	2017004PGC	001	Core	1	10	92	X	X	X
2017-09-14	2017004PGC	001	Core	2	11	112	X	X	X
2017-09-14	2017004PGC	001	Core	2	12	132	X	X	X
2017-09-14	2017004PGC	001	Core	2	13	152	X	X	X
2017-09-14	2017004PGC	001	Core	2	14	172	X	X	X
2017-09-14	2017004PGC	001	Core	2	15	192	X	X	X
2017-09-14	2017004PGC	001	Core	2	16	212	X	X	X
2017-09-14	2017004PGC	001	Core	2	17	232	X	X	X
2017-09-14	2017004PGC	001	Core	3	18	257	X	X	X
2017-09-14	2017004PGC	001	Core	3	19	282	X	X	X
2017-09-14	2017004PGC	001	Core	3	20	307	X	X	X
2017-09-14	2017004PGC	001	Core	3	21	332	X	X	X

Collection Date	Cruise	Station	Data Type	Core Sec.	Rhizon No.	Depth In Core	DOC 2 ml Vial	DIC/Nuts 2 ml Vial	Sulfide 15 ml Vial
2017-09-14	2017004PGC	001	Core	3	22	357	X	X	X
2017-09-14	2017004PGC	001	Core	3	23	382	X	X	X
2017-09-14	2017004PGC	001	Core	TWC	24	72	X	X	X
2017-09-17	2017004PGC	002	CTD						
2017-09-17	2017004PGC	003	Core	1	25	2	X	X	X
2017-09-17	2017004PGC	003	Core	1	26	7	X	X	X
2017-09-17	2017004PGC	003	Core	1	27	12	X	X	X
2017-09-17	2017004PGC	003	Core	1	28	17	X	X	X
2017-09-17	2017004PGC	003	Core	1	29	22	X	X	X
2017-09-17	2017004PGC	003	Core	1	30	27	X	X	X
2017-09-17	2017004PGC	003	Core	1	31	32	X	X	X
2017-09-17	2017004PGC	003	Core	1	32	37	X	X	X
2017-09-17	2017004PGC	003	Core	1	33	42	X	X	X
2017-09-17	2017004PGC	003	Core	1	34	47	X	X	X
2017-09-17	2017004PGC	003	Core	1	35	52	X	X	X
2017-09-17	2017004PGC	003	Core	1	36	62	X	X	X
2017-09-17	2017004PGC	003	Core	1	37	72	X	X	X
2017-09-17	2017004PGC	003	Core	1	38	82	X	X	X
2017-09-17	2017004PGC	003	Core	1	39	92	X	X	X
2017-09-17	2017004PGC	003	Core	1	40	102	X	X	X
2017-09-17	2017004PGC	003	Core	1	41	112	X	X	X
2017-09-17	2017004PGC	003	Core	2	42	137	X	X	X

Collection Date	Cruise	Station	Data Type	Core Sec.	Rhizon No.	Depth In Core	DOC 2 ml Vial	DIC/Nuts 2 ml Vial	Sulfide 15 ml Vial
2017-09-17	2017004PGC	003	Core	2	43	162	X	X	X
2017-09-17	2017004PGC	003	Core	2	44	187	X	X	X
2017-09-17	2017004PGC	003	Core	TWC	45	2	X	X	X
2017-09-17	2017004PGC	003	Core	TWC	46	12	X	X	X
2017-09-17	2017004PGC	003	Core	TWC	47	22	X	X	X
2017-09-17	2017004PGC	003	Core	TWC	48	32	X	X	X
2017-09-17	2017004PGC	003	Core	TWC	49	42	X	X	X
2017-09-17	2017004PGC	003	Core	TWC	50	52	X	X	X
2017-09-17	2017004PGC	003	Core	TWC	51	72	X	X	X
2017-09-18	2017004PGC	004	Core	no recovery					
2017-09-18	2017004PGC	005	Core	1	52	2	X	X	X
2017-09-18	2017004PGC	005	Core	1	53	22	X	X	X
2017-09-18	2017004PGC	005	Core	1	54	42	X	X	X
2017-09-18	2017004PGC	005	Core	1	55	62	X	X	X
2017-09-18	2017004PGC	005	Core	2	56	82	X	X	X
2017-09-18	2017004PGC	005	Core	2	57	102	X	X	X
2017-09-18	2017004PGC	005	Core	2	58	122	X	X	X
2017-09-18	2017004PGC	005	Core	2	59	142	X	X	X
2017-09-18	2017004PGC	005	Core	2	60	162	X	X	X
2017-09-18	2017004PGC	005	Core	2	61	182	X	X	X
2017-09-18	2017004PGC	005	Core	2	62	202	X	X	X
2017-09-18	2017004PGC	005	Core	2	63	222	X	X	X

Collection Date	Cruise	Station	Data Type	Core Sec.	Rhizon No.	Depth In Core	DOC 2 ml Vial	DIC/Nuts 2 ml Vial	Sulfide 15 ml Vial
2017-09-18	2017004PGC	005	Core	3	64	242	X	X	X
2017-09-18	2017004PGC	005	Core	3	65	262	X	X	X
2017-09-18	2017004PGC	005	Core	3	66	282	X	X	X
2017-09-18	2017004PGC	005	Core	3	67	302	X	X	X
2017-09-18	2017004PGC	005	Core	3	68	322	X	X	X
2017-09-18	2017004PGC	005	Core	3	69	342	X	X	X
2017-09-18	2017004PGC	005	Core	3	70	362	X	X	X
2017-09-18	2017004PGC	006	Core	1	71	2	X	X	X
2017-09-18	2017004PGC	006	Core	1	72	22	X	X	X
2017-09-18	2017004PGC	006	Core	2	73	42	X	X	X
2017-09-18	2017004PGC	006	Core	2	74	62	X	X	X
2017-09-18	2017004PGC	006	Core	2	75	82	X	X	X
2017-09-18	2017004PGC	006	Core	2	76	102	X	X	X
2017-09-18	2017004PGC	006	Core	2	77	127	X	X	X
2017-09-18	2017004PGC	006	Core	2	78	152	X	X	X
2017-09-18	2017004PGC	006	Core	2	79	177	X	X	X
2017-09-18	2017004PGC	006	Core	3	80	202			NO
2017-09-18	2017004PGC	006	Core	3	81	227	X	X	X
2017-09-18	2017004PGC	006	Core	3	82	252	X	X	X
2017-09-18	2017004PGC	006	Core	3	83	277	X	X	X
2017-09-18	2017004PGC	006	Core	3	84	302	X	X	X
2017-09-18	2017004PGC	006	Core	3	85	327	X	X	X

Collection Date	Cruise	Station	Data Type	Core Sec.	Rhizon No.	Depth In Core	DOC 2 ml Vial	DIC/Nuts 2 ml Vial	Sulfide 15 ml Vial
2017-09-18	2017004PGC	007	camera tow						
2017-09-18	2017004PGC	008	Core	1	86	3	X	X	X
2017-09-18	2017004PGC	008	Core	1	87	28	X	X	X
2017-09-18	2017004PGC	008	Core	1	88	53	X	X	X
2017-09-18	2017004PGC	008	Core	1	89	78	X	X	X
2017-09-18	2017004PGC	008	Core	1	90	103	X	X	X
2017-09-18	2017004PGC	008	Core	1	91	152	X	X	X
2017-09-18	2017004PGC	008	Core	2	92	203	X	X	X
2017-09-18	2017004PGC	008	Core	2	93	253	X	X	X
2017-09-18	2017004PGC	008	Core	2	94	303	X	X	X
2017-09-18	2017004PGC	008	Core	3	95	353	X	X	X
2017-09-18	2017004PGC	008	Core	3	96	403	X	X	X
2017-09-18	2017004PGC	009	camera tow						
2017-09-19	2017004PGC	010	Core	1	97	2	X	X	X
2017-09-19	2017004PGC	010	Core	1	98	32	X	X	X
2017-09-19	2017004PGC	010	Core	1	99	60	X	X	X
2017-09-19	2017004PGC	010	Core	1	100	92	X	X	X
2017-09-19	2017004PGC	010	Core	1	101	122	X	X	X
2017-09-19	2017004PGC	011	IKU grab						
2017-09-19	2017004PGC	012	IKU grab						
2017-09-19	2017004PGC	013	Core	1	102	2	X	X	X
2017-09-19	2017004PGC	013	Core	1	103	22	X	X	X

Collection Date	Cruise	Station	Data Type	Core Sec.	Rhizon No.	Depth In Core	DOC 2 ml Vial	DIC/Nuts 2 ml Vial	Sulfide 15 ml Vial
2017-09-19	2017004PGC	013	Core	1	104	42	X	X	X
2017-09-19	2017004PGC	013	Core	1	105	62	X	X	X
2017-09-19	2017004PGC	013	Core	1	106	82	X	X	X
2017-09-19	2017004PGC	013	Core	1	107	102	X	X	X
2017-09-19	2017004PGC	013	Core	2	108	132	X	X	X
2017-09-19	2017004PGC	013	Core	2	109	162	X	X	X
2017-09-19	2017004PGC	013	Core	2	110	192	X	X	X
2017-09-19	2017004PGC	013	Core	2	111	222	X	X	X
2017-09-19	2017004PGC	014	Core	1	112	2	X	X	X
2017-09-19	2017004PGC	014	Core	1	113	22	X	X	X
2017-09-19	2017004PGC	014	Core	1	114	42	X	X	X
2017-09-19	2017004PGC	014	Core	1	115	62	X	X	X
2017-09-19	2017004PGC	014	Core	1	116	82	X	X	X
2017-09-19	2017004PGC	014	Core	1	117	102	X	X	X
2017-09-19	2017004PGC	014	Core	1	118	132	X	X	X
2017-09-19	2017004PGC	014	Core	2	119	162	X	X	X
2017-09-19	2017004PGC	014	Core	2	120	192	X	X	X
2017-09-19	2017004PGC	014	Core	2	121	222	X	X	X
2017-09-19	2017004PGC	014	Core	2	122	252	X	X	X
2017-09-19	2017004PGC	014	Core	TWC					
2017-09-19	2017004PGC	015	IKU grab						
2017-09-19	2017004PGC	016	Push core 1		123	3.5	X	X	X

Collection Date	Cruise	Station	Data Type	Core Sec.	Rhizon No.	Depth In Core	DOC 2 ml Vial	DIC/Nuts 2 ml Vial	Sulfide 15 ml Vial
2017-09-19	2017004PGC	016	Push core 1		124	7	X	X	X
2017-09-19	2017004PGC	017	camera tow						
2017-09-20	2017004PGC	018	Core						
2017-09-20	2017004PGC	019	Core	1	125	2	X	X	X
2017-09-20	2017004PGC	019	Core	1	126	22	X	X	X
2017-09-20	2017004PGC	019	Core	1	127	42	X	X	X
2017-09-20	2017004PGC	019	Core	1	128	62	X	X	X
2017-09-20	2017004PGC	019	Core	2	129	82	X	X	X
2017-09-20	2017004PGC	019	Core	2	130	102	X	X	X
2017-09-20	2017004PGC	019	Core	2	131	132	X	X	X
2017-09-20	2017004PGC	019	Core	2	132	162	X	X	X
2017-09-20	2017004PGC	019	Core	2	133	192	X	X	X
2017-09-20	2017004PGC	019	Core	2	134	222	X	X	X
2017-09-20	2017004PGC	019	Core	3	135	252	X	X	X
2017-09-20	2017004PGC	019	Core	3	136	282	X	X	X
2017-09-20	2017004PGC	019	Core	3	137	312	X	X	X
2017-09-20	2017004PGC	019	Core	3	138	342	X	X	X
2017-09-20	2017004PGC	019	Core	3	139	372	X	X	X
2017-09-20	2017004PGC	020	Core	TWC	140	3	X	X	X
2017-09-20	2017004PGC	020	Core	TWC	141	13	X	X	X
2017-09-20	2017004PGC	020	Core	TWC	142	23	X	X	X
2017-09-20	2017004PGC	020	Core	TWC	143	33	X	X	X

Collection Date	Cruise	Station	Data Type	Core Sec.	Rhizon No.	Depth In Core	DOC 2 ml Vial	DIC/Nuts 2 ml Vial	Sulfide 15 ml Vial
2017-09-20	2017004PGC	020	Core	TWC	144	43	X	X	X
2017-09-20	2017004PGC	020	Core	TWC	145	53	X	X	X
2017-09-20	2017004PGC	020	Core	TWC	146	73	X	X	X
2017-09-20	2017004PGC	020	Core	TWC	147	93	X	X	X
2017-09-20	2017004PGC	021	Core						
2017-09-20	2017004PGC	022	Core	1	148	2	X	X	X
2017-09-20	2017004PGC	022	Core	1	149	12	X	X	X
2017-09-20	2017004PGC	022	Core	1	150	22	X	X	X
2017-09-20	2017004PGC	022	Core	1	151	32	X	X	X
2017-09-20	2017004PGC	022	Core	1	152	42	X	X	X
2017-09-20	2017004PGC	022	Core	1	153	52	X	X	X
2017-09-20	2017004PGC	022	Core	1	154	62	X	X	X
2017-09-20	2017004PGC	022	Core	1	155	72	X	X	X
2017-09-20	2017004PGC	022	Core	2	156	84	X	X	X
2017-09-20	2017004PGC	022	Core	2	157	94	X	X	X
2017-09-20	2017004PGC	022	Core	2	158	104	X	X	X
2017-09-20	2017004PGC	022	Core	2	159	124	X	X	X
2017-09-20	2017004PGC	022	Core	2	160	144	X	X	X
2017-09-20	2017004PGC	022	Core	2	161	162	X	X	X
2017-09-20	2017004PGC	022	Core	3					
2017-09-20	2017004PGC	023	Core	1	162	3	X	X	X
2017-09-20	2017004PGC	023	Core	1	163	13	X	X	X

Collection Date	Cruise	Station	Data Type	Core Sec.	Rhizon No.	Depth In Core	DOC 2 ml Vial	DIC/Nuts 2 ml Vial	Sulfide 15 ml Vial
2017-09-20	2017004PGC	023	Core	2	164	24	X	X	X
2017-09-20	2017004PGC	023	Core	2	165	33	X	X	X
2017-09-20	2017004PGC	023	Core	2	166	43	X	X	X
2017-09-20	2017004PGC	023	Core	2	167	53	X	X	X
2017-09-20	2017004PGC	023	Core	2	168	73	X	X	X
2017-09-20	2017004PGC	023	Core	2	169	93	X	X	X
2017-09-20	2017004PGC	023	Core	2	170	113	X	X	X
2017-09-20	2017004PGC	023	Core	2	171	138	X	X	X
2017-09-20	2017004PGC	023	Core	2	172	163	X	X	X
2017-09-20	2017004PGC	023	Core	3	173	188	X	X	X
2017-09-20	2017004PGC	023	Core	3	174	213	X	X	X
2017-09-20	2017004PGC	023	Core	3	175	238	X	X	X
2017-09-20	2017004PGC	023	Core	3	176	263	X	X	X
2017-09-20	2017004PGC	023	Core	3	177	288	X	X	X
2017-09-20	2017004PGC	023	Core	3	178	313	X	X	X
2017-09-20	2017004PGC	024	Core	1	179	3	X	X	X
2017-09-20	2017004PGC	024	Core	1	180	20	X	X	X
2017-09-20	2017004PGC	024	Core	1	181	40	X	X	X
2017-09-20	2017004PGC	024	Core	1	182	60	X	X	X
2017-09-20	2017004PGC	024	Core	1	183	80	X	X	X
2017-09-20	2017004PGC	025	Core	poor recovery					
2017-09-20	2017004PGC	026	Core	poor recovery					

Collection Date	Cruise	Station	Data Type	Core Sec.	Rhizon No.	Depth In Core	DOC 2 ml Vial	DIC/Nuts 2 ml Vial	Sulfide 15 ml Vial
2017-09-21	2017004PGC	027	Core	1	184	3	X	X	X
2017-09-21	2017004PGC	027	Core	1	185	28	X	X	X
2017-09-21	2017004PGC	027	Core	1	186	53	X	X	X
2017-09-21	2017004PGC	027	Core	1	187	78	X	X	X
2017-09-21	2017004PGC	027	Core	1	188	103	X	X	X
2017-09-21	2017004PGC	027	Core	2	189	133	X	X	X
2017-09-21	2017004PGC	027	Core	2	190	163	X	X	X
2017-09-21	2017004PGC	027	Core	2	191	193	X	X	X
2017-09-21	2017004PGC	027	Core	2	192	223	X	X	X
2017-09-21	2017004PGC	027	Core	2	193	253	X	X	X
2017-09-21	2017004PGC	028	IKU grab						
2017-09-21	2017004PGC	029	IKU grab						
2017-09-21	2017004PGC	030	IKU grab						
2017-09-21	2017004PGC	031	camera tow						
2017-09-21	2017004PGC	032	Core	TWC	194	3	X	X	X
2017-09-21	2017004PGC	032	Core	TWC	195	10	X	X	X
2017-09-21	2017004PGC	032	Core	TWC	196	20	X	X	X
2017-09-21	2017004PGC	032	Core	TWC	197	30	X	X	X
2017-09-21	2017004PGC	032	Core	TWC	198	40	X	X	X
2017-09-21	2017004PGC	032	Core	TWC	199	50	X	X	X
2017-09-22	2017004PGC	033	camera tow						
2017-09-22	2017004PGC	034	camera tow						

Collection Date	Cruise	Station	Data Type	Core Sec.	Rhizon No.	Depth In Core	DOC 2 ml Vial	DIC/Nuts 2 ml Vial	Sulfide 15 ml Vial
2017-09-22	2017004PGC	035	IKU grab						
2017-09-22	2017004PGC	036	IKU grab						
2017-09-22	2017004PGC	037	CTD						
2017-09-23	2017004PGC	038	Core	1	200	3	X	X	X
2017-09-23	2017004PGC	038	Core	1	201	20	X	X	X
2017-09-23	2017004PGC	038	Core	1	202	40	X	X	X
2017-09-23	2017004PGC	038	Core	1	203	60	X	X	X
2017-09-23	2017004PGC	038	Core	1	204	80	X	X	X
2017-09-23	2017004PGC	038	Core	1	205	100	X	X	X
2017-09-23	2017004PGC	038	Core	2	206	125	X	X	X
2017-09-23	2017004PGC	038	Core	2	207	150	X	X	X
2017-09-23	2017004PGC	038	Core	2	208	175	X	X	X
2017-09-23	2017004PGC	038	Core	2	209	200	X	X	X
2017-09-23	2017004PGC	038	Core	3	210	225	X	X	X
2017-09-23	2017004PGC	038	Core	3	211	250	X	X	X
2017-09-23	2017004PGC	038	Core	3	212	275	X	X	X
2017-09-23	2017004PGC	038	Core	3	213	310	X	X	X
2017-09-23	2017004PGC	038	Core	3	214	335	X	X	X
2017-09-23	2017004PGC	038	Core	3	215	360	X	X	X
2017-09-23	2017004PGC	038	Core	4	216	375	X	X	X
2017-09-23	2017004PGC	038	Core	4	217	400	X	X	X
2017-09-23	2017004PGC	038	Core	4	218	425	X	X	X

Collection Date	Cruise	Station	Data Type	Core Sec.	Rhizon No.	Depth In Core	DOC 2 ml Vial	DIC/Nuts 2 ml Vial	Sulfide 15 ml Vial
2017-09-23	2017004PGC	038	Core	4	219	450	X	X	X
2017-09-23	2017004PGC	038	Core	4	220	475	X	X	
2017-09-23	2017004PGC	038	Core	4	221	500	X	X	
2017-09-23	2017004PGC	039	camera tow						
2017-09-23	2017004PGC	040	IKU grab						
2017-09-23	2017004PGC	041	camera tow						
2017-09-23	2017004PGC	042	Core	1	222	2	X	X	
2017-09-23	2017004PGC	042	Core	1	223	25	X	X	
2017-09-23	2017004PGC	042	Core	1	224	50	X	X	
2017-09-23	2017004PGC	042	Core	1	225	75	X	X	
2017-09-23	2017004PGC	042	Core	1	226	100	X	X	
2017-09-23	2017004PGC	042	Core	2	227	130	X	X	
2017-09-23	2017004PGC	042	Core	2	228	160	X	X	
2017-09-23	2017004PGC	042	Core	2	229	190	X	X	
2017-09-23	2017004PGC	042	Core	2	230	220	X	X	
2017-09-23	2017004PGC	042	Core	3	231	250	X	X	
2017-09-23	2017004PGC	042	Core	3	232	280	X	X	
2017-09-23	2017004PGC	042	Core	3	233	310	X	X	
2017-09-23	2017004PGC	042	Core	3	234	340	X	X	
2017-09-23	2017004PGC	043	CTD						
2017-09-23	2017004PGC	044	CTD						
2017-09-24	2017004PGC	045	Core						

Collection Date	Cruise	Station	Data Type	Core Sec.	Rhizon No.	Depth In Core	DOC 2 ml Vial	DIC/Nuts 2 ml Vial	Sulfide 15 ml Vial
2017-09-24	2017004PGC	046	Core	1	235	3	X	X	
2017-09-24	2017004PGC	046	Core	1	236	20	X	X	
2017-09-24	2017004PGC	046	Core	1	237	40	X	X	
2017-09-24	2017004PGC	046	Core	1	238	60	X	X	
2017-09-24	2017004PGC	046	Core	1	239	80	X	X	
2017-09-24	2017004PGC	046	Core	1	240	95	X	X	
2017-09-24	2017004PGC	046	Core	2	241	105	X	X	
2017-09-24	2017004PGC	046	Core	2	242	125	X	X	
2017-09-24	2017004PGC	046	Core	2	243	145	X	X	
2017-09-24	2017004PGC	046	Core	2	244	170	X	X	
2017-09-24	2017004PGC	046	Core	2	245	195	X	X	
2017-09-24	2017004PGC	047	Core	1	246	3	X	X	
2017-09-24	2017004PGC	047	Core	1	247	28	X	X	
2017-09-24	2017004PGC	047	Core	1	248	53	X	X	
2017-09-24	2017004PGC	047	Core	1	249	78	X	X	
2017-09-24	2017004PGC	047	Core	2	250	100	X	X	
2017-09-24	2017004PGC	047	Core	2	251	125	X	X	
2017-09-24	2017004PGC	047	Core	2	252	150	X	X	
2017-09-24	2017004PGC	047	Core	2	253	175	X	X	
2017-09-24	2017004PGC	047	Core	2	254	200	X	X	
2017-09-24	2017004PGC	047	Core	2	255	225	X	X	
2017-09-24	2017004PGC	047	Core	2	256	250	X	X	

Collection Date	Cruise	Station	Data Type	Core Sec.	Rhizon No.	Depth In Core	DOC 2 ml Vial	DIC/Nuts 2 ml Vial	Sulfide 15 ml Vial
2017-09-24	2017004PGC	047	Core	3	257	300	X	X	
2017-09-24	2017004PGC	047	Core	3	258	350	X	X	
2017-09-24	2017004PGC	047	Core	3	259	400	X	X	
2017-09-24	2017004PGC	048	Core						
2017-09-24	2017004PGC	049	Core						
2017-09-24	2017004PGC	050	Core						
2017-09-25	2017004PGC	051	Core						
2017-09-25	2017004PGC	052	Core						
2017-09-25	2017004PGC	053	Core	1	260	3	X	X	
2017-09-25	2017004PGC	053	Core	1	261	50	X	X	
2017-09-25	2017004PGC	053	Core	1	262	100	X	X	
2017-09-25	2017004PGC	053	Core	1	263	150	X	X	
2017-09-25	2017004PGC	053	Core	2	264	200	X	X	
2017-09-25	2017004PGC	053	Core	2	265	250	X	X	
2017-09-25	2017004PGC	053	Core	2	266	295	X	X	
2017-09-25	2017004PGC	054	Core						
2017-09-26	2017004PGC	055	camera tow						
2017-09-26	2017004PGC	056	CTD						
2017-09-27	2017004PGC	057	camera tow						
2017-09-27	2017004PGC	058	IKU grab						
2017-09-27	2017004PGC	059	CTD						
2017-09-27	2017004PGC	060	camera tow						

Collection Date	Cruise	Station	Data Type	Core Sec.	Rhizon No.	Depth In Core	DOC 2 ml Vial	DIC/Nuts 2 ml Vial	Sulfide 15 ml Vial
2017-09-27	2017004PGC	061	CTD						
2017-09-28	2017004PGC	062	Core	1	267	3	X	X	
2017-09-28	2017004PGC	062	Core	1	268	40	X	X	
2017-09-28	2017004PGC	062	Core	1	269	80	X	X	
2017-09-28	2017004PGC	062	Core	1	270	120	X	X	
2017-09-28	2017004PGC	062	Core	2	271	160	X	X	
2017-09-28	2017004PGC	062	Core	2	272	200	X	X	
2017-09-28	2017004PGC	062	Core	2	273	240	X	X	
2017-09-28	2017004PGC	063	Core	1	274	5	X	X	
2017-09-28	2017004PGC	063	Core	1	275	25	X	X	
2017-09-28	2017004PGC	063	Core	1	276	50	X	X	
2017-09-28	2017004PGC	063	Core	1	277	75	X	X	
2017-09-28	2017004PGC	063	Core	1	278	100	X	X	
2017-09-28	2017004PGC	063	Core	2	279	200	X	X	
2017-09-28	2017004PGC	063	Core	3	280	302	X	X	
2017-09-28	2017004PGC	064	camera tow						
2017-09-28	2017004PGC	065	IKU grab 1		281	1			
2017-09-28	2017004PGC	065	IKU grab 1		282	5			
2017-09-28	2017004PGC	065	IKU grab 1		283	10			
2017-09-28	2017004PGC	065	IKU grab 1		284	15			

Appendix 6

Gas Samples from CTD Rosette

Collection Date	Cruise Locator	Station No.	Core or CTD	Core section	depth bsf [cm]	Notes
2017-09-17	2017004PGC	002	CTD			Collected 2 glass vials and 1 centrifuge tube of water.
2017-09-17	2017004PGC	003	Core	2	160	attempted gas sample at 160cm, sample for helium, and collected sample from core catcher, frozen in seawater after adding salt
2017-09-22	2017004PGC	037	CTD			2 bottles collected-sampled fluids and gas from each bottle
2017-09-23	2017004PGC	043	CTD			2 bottles collected-sampled fluids and gas from each bottle
2017-09-23	2017004PGC	044	CTD			reference site outside of plume, 2 bottles triggered with gas and water samples from each
2017-09-26	2017004PGC	056	CTD			2 bottles collected-sampled fluids and gas from each bottle
2017-09-27	2017004PGC	059	CTD			2 bottles collected-sampled fluids and gas from each bottle
2017-09-27	2017004PGC	061	CTD			2 bottles collected-sampled fluids and gas from each bottle

Appendix 7

Volcanic Rock Ar/Ar Dating

Cruise	Station	Sample Collected	Comments
2011002PGC	42	4 rocks 20-50 mm	basalt (volcanic cone)
2011002PGC	43	1 rock ~20 mm	volcanic (cone)
2015004PGC	32	1 rock 5 – 7 cm	basalt (mud volcano)
2015004PGC	35	1 thin cobble 6-8 cm	basalt (mud volcano)
2017004PGC	11	bucket of pebbles and cobbles	various rocks
2017004PGC	12	bucket of pebbles and cobbles	various rocks
2017004PGC	40	3 rocks 4-6 cm	various rocks
2017004PGC	41	5 rocks 20-40 mm; 1 rock 6-8 cm	various rocks

Appendix 8

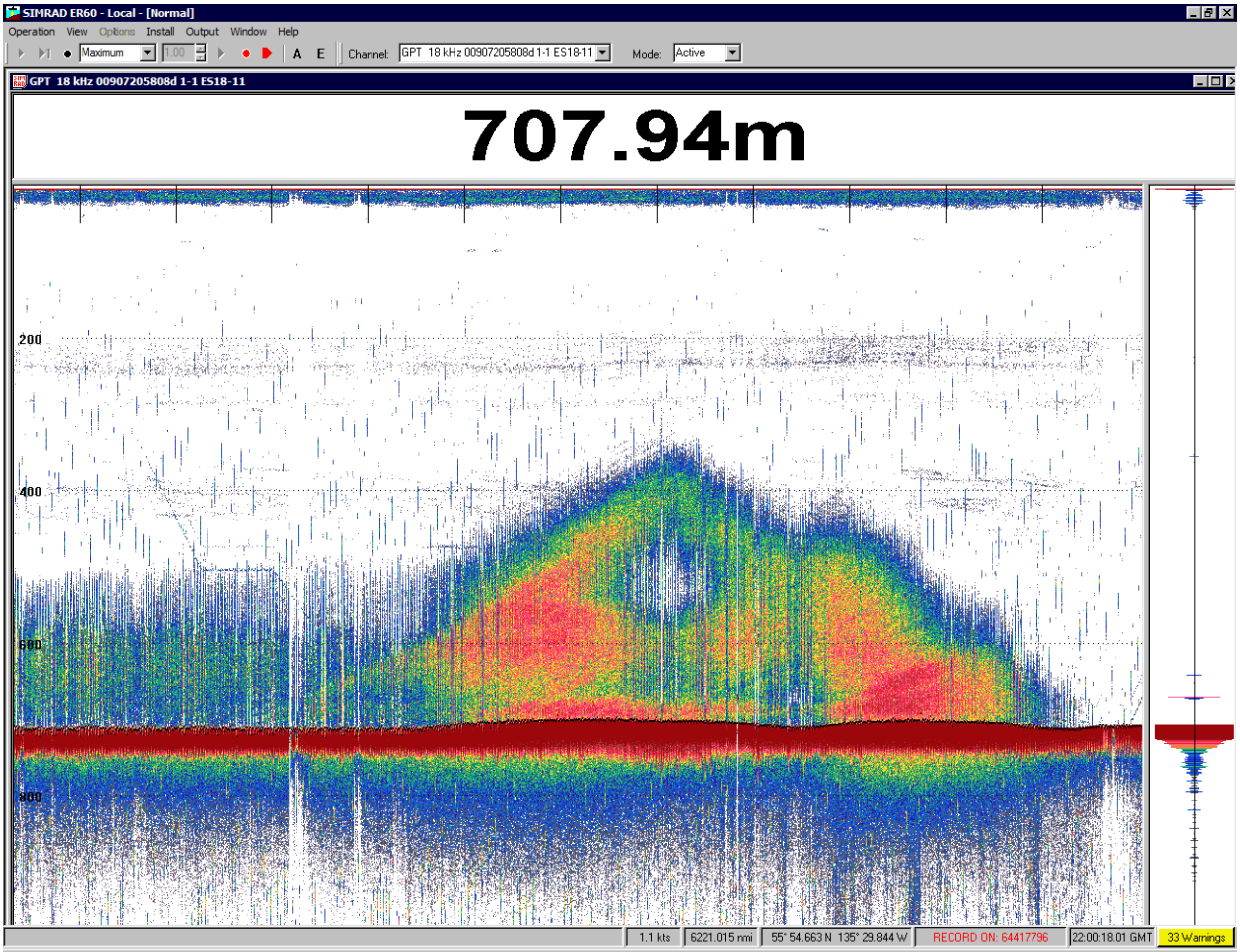
Carbonate Isotope and XRD Analyses

Isotope Analyses (C, O, and Sr) and XRD for calcite/dolomite/aragonites

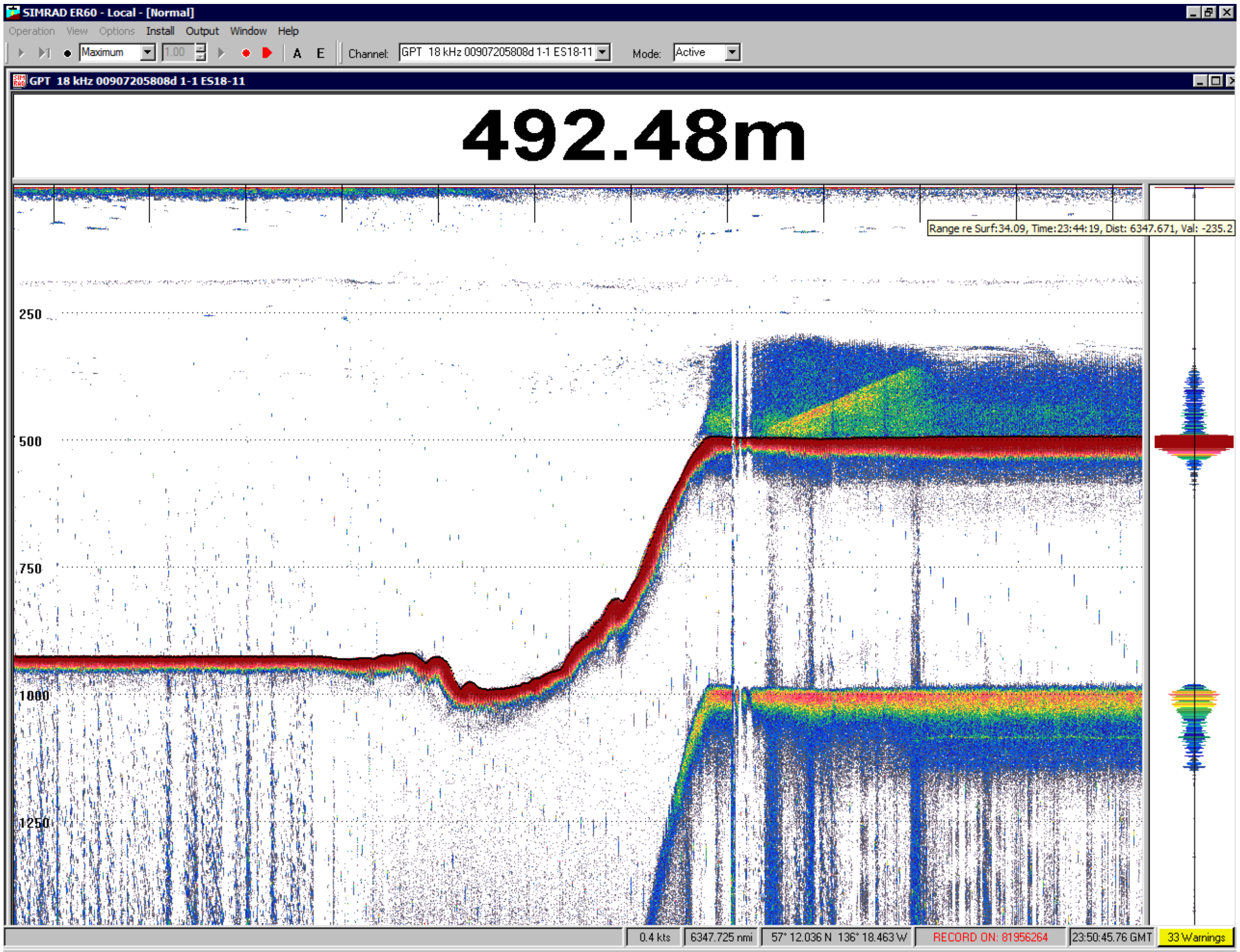
Cruise	Station	Comments
2011002PGC	43	Volcanic cone carbonate crust from IKU sample
2015004PGC	34	Mud Volcano carbonate crust from IKU sample
2015004PGC	35	Mud Volcano carbonate crust from IKU sample
2017004PGC	04	Carbonate mudstone from piston core cutter
2017004PGC	15	Seep carbonate crust from IKU sample
2017004PGC	40	Seep carbonate crust from IKU sample
2017004PGC	41	Seep carbonate crust from IKU sample
2017004PGC	65	Volcanic cone carbonate crust from IKU sample

Appendix 9 - Gas Plumes from 18 kHz Sounder

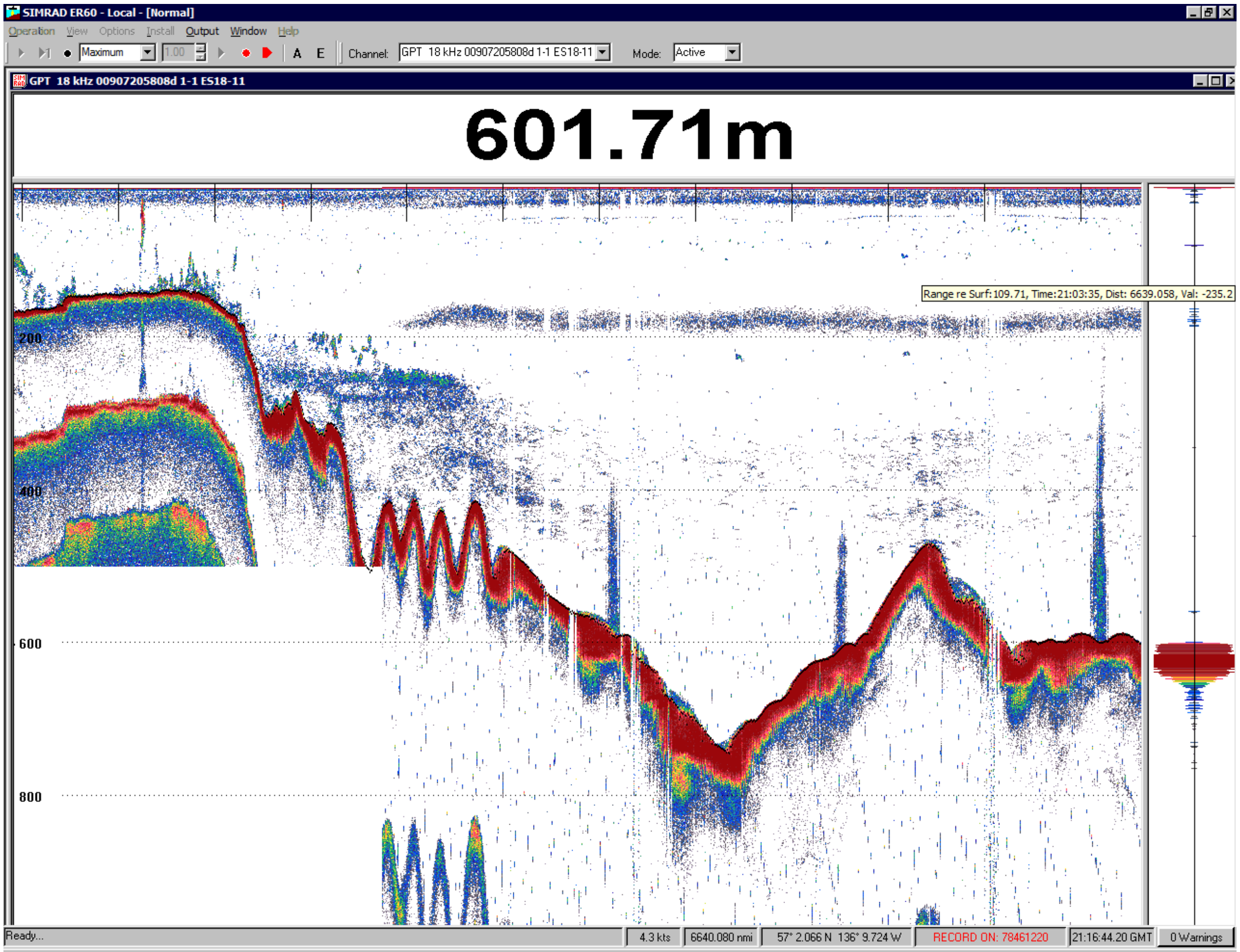
Camera Station 7



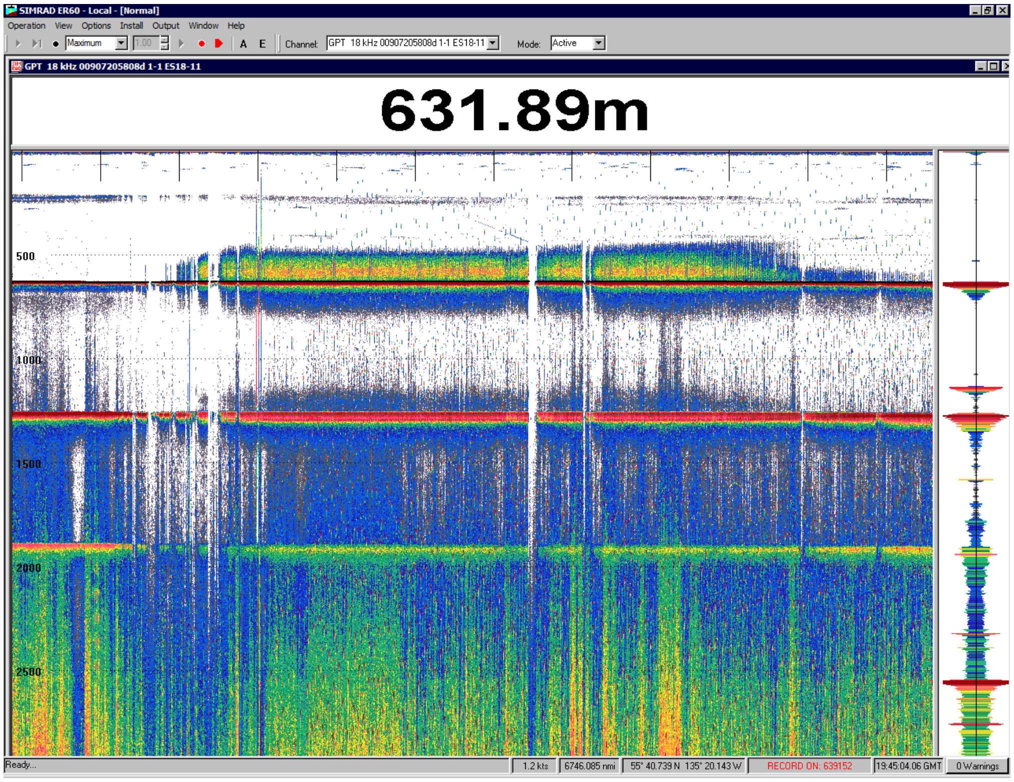
Camera Station 17

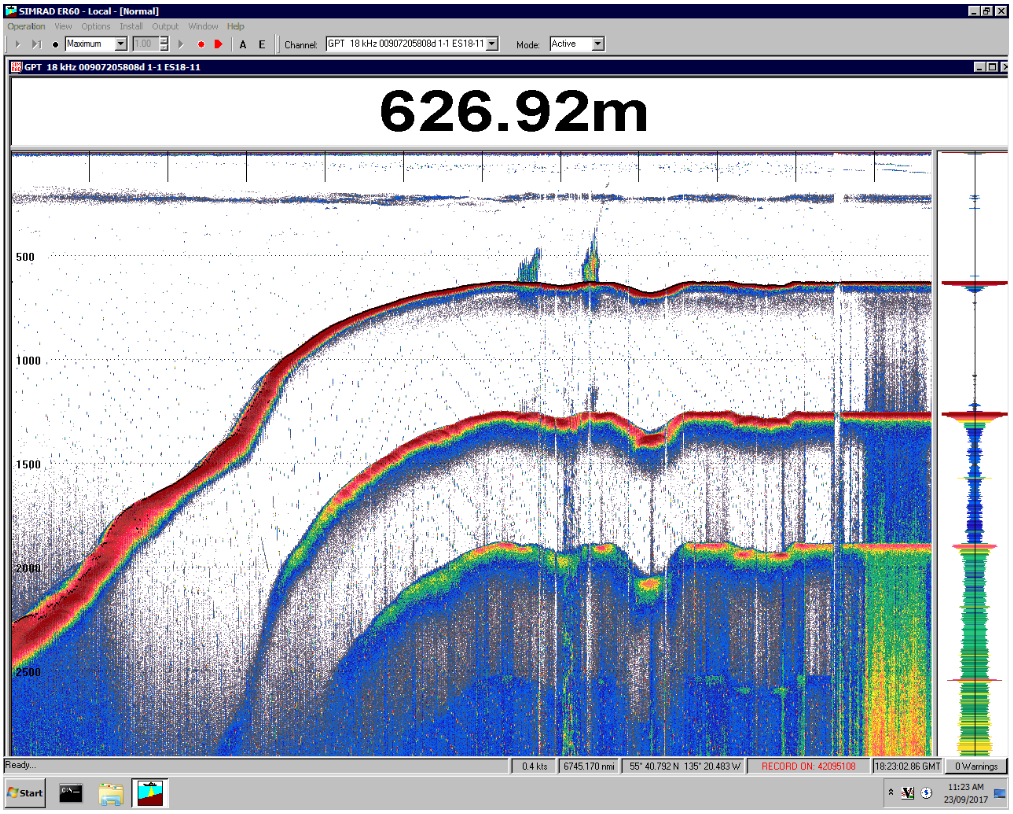


Camera Station 35

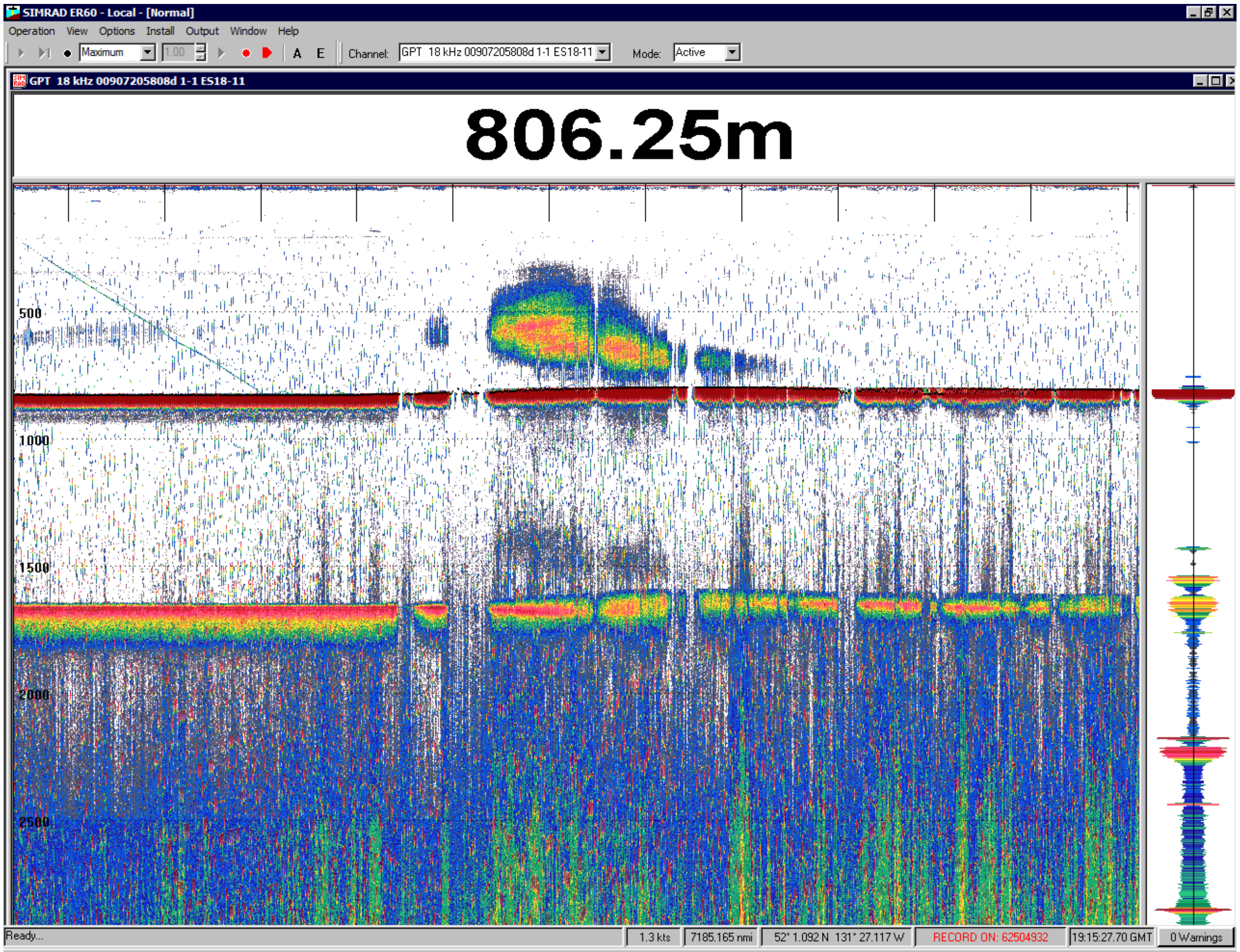


Camera Station 39

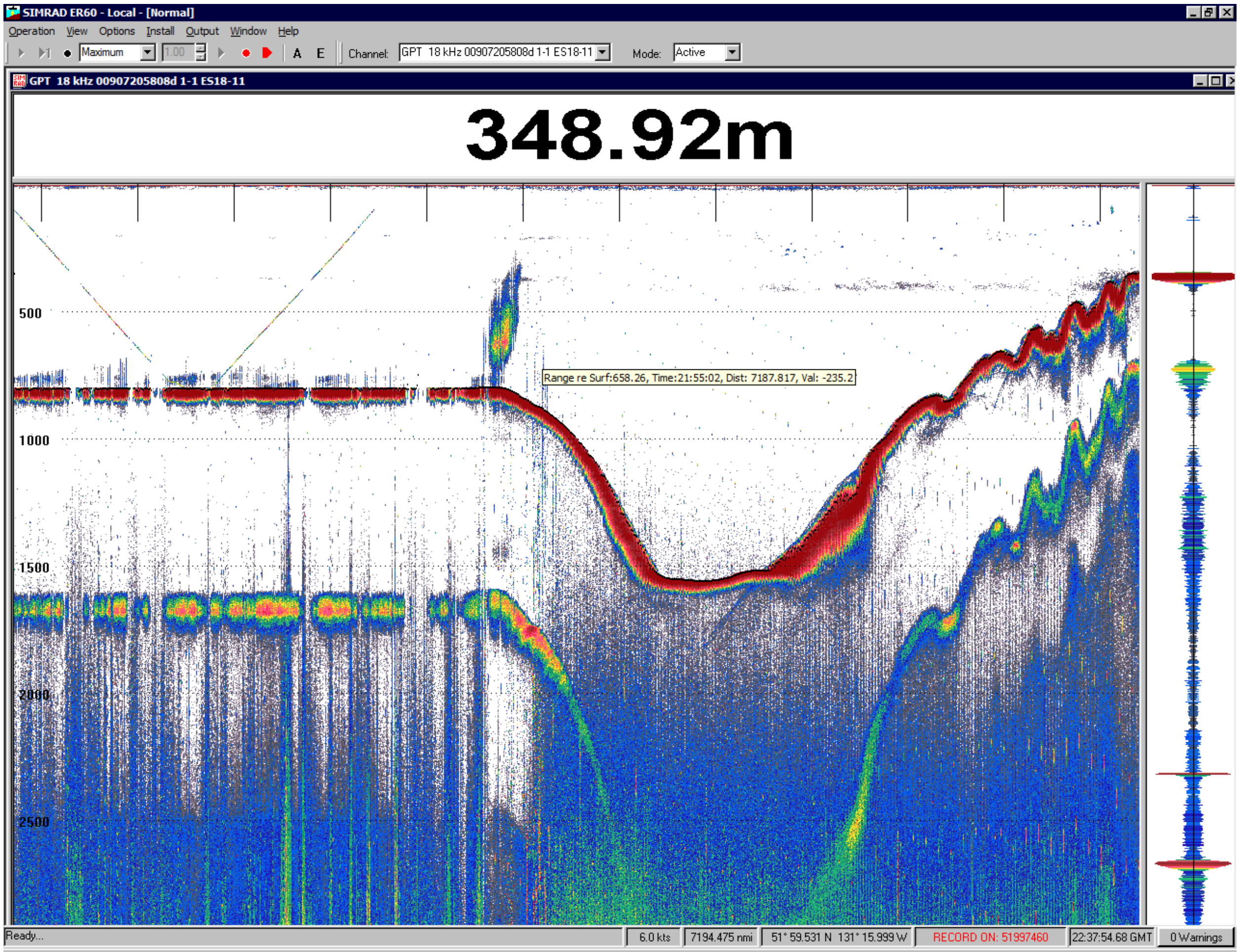




Camera Station 55 (Mud Volcano)



Camera Station 64



South Haida Gwaii Volcanic Cones (see page 47)