

# **Site NGHP-01-01**

By T. Collett, M. Riedel, J. Cochran, R. Boswell, J. Presley, P. Kumar, A. Sathe,  
A. Sethi, M. Lall, and the National Gas Hydrate Program Expedition 01 Scientists

Scientific Investigations Report 2012–5054

**U.S. Department of the Interior**  
**U.S. Geological Survey**



# Contents

|                                                                               |     |
|-------------------------------------------------------------------------------|-----|
| Background and Objectives.....                                                | 113 |
| Operations.....                                                               | 113 |
| Hole NGHP-01-01A.....                                                         | 113 |
| Lithostratigraphy.....                                                        | 117 |
| Lithostratigraphic Units.....                                                 | 119 |
| Lithostratigraphic Unit I.....                                                | 119 |
| Lithostratigraphic Unit II.....                                               | 119 |
| Subunit IIa.....                                                              | 119 |
| Subunit IIb.....                                                              | 119 |
| Lithostratigraphic Unit III.....                                              | 125 |
| Lithostratigraphic Unit IV.....                                               | 127 |
| Sedimentary Environment.....                                                  | 127 |
| Gas Hydrate Occurrence.....                                                   | 127 |
| Inorganic Geochemistry.....                                                   | 127 |
| Results.....                                                                  | 127 |
| Organic Geochemistry.....                                                     | 128 |
| Microbiology.....                                                             | 129 |
| Physical Properties.....                                                      | 130 |
| Infrared (IR) Imaging.....                                                    | 130 |
| IR Images.....                                                                | 130 |
| Core-End Temperature Readings.....                                            | 130 |
| Index Properties.....                                                         | 130 |
| Strength.....                                                                 | 130 |
| Electrical Resistivity.....                                                   | 132 |
| P-Wave Velocity.....                                                          | 134 |
| Magnetic Susceptibility.....                                                  | 134 |
| Thermal Conductivity.....                                                     | 134 |
| Downhole Temperature Measurements.....                                        | 134 |
| Pressure Coring.....                                                          | 146 |
| Pressure-Core Operations and Measurements.....                                | 146 |
| Gas-Hydrate Concentration, Nature, and Distribution from Pressure Coring..... | 156 |
| Downhole Logging.....                                                         | 156 |
| Logging Data Quality.....                                                     | 157 |
| Logging Units.....                                                            | 158 |
| Gas-Hydrate and Free Gas Occurrence.....                                      | 158 |
| References Cited.....                                                         | 164 |

## Figures

|                                                                                                                                                                                                |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 1. Location of Site NGHP-01-01 in the Kerala-Konkan Basin offshore of the west coast of India.....                                                                                             | 114 |
| 2. Seismic line K-95-8B crossing Site NGHP-01-01 in the Kerala-Konkan Basin .....                                                                                                              | 115 |
| 3. Close-up of seismic line K-95-8B showing the detailed sedimentary structures around Site NGHP-01-01.....                                                                                    | 116 |
| 4. Map showing the hole occupied at Site NGHP-01-01A .....                                                                                                                                     | 117 |
| 5. Lithostratigraphic summary of Hole NGHP-01-01A.....                                                                                                                                         | 118 |
| 6. Color cyclicity reflecting variable inputs of terrigenous clays and oxyhydroxides in all units of Hole NGHP-01-01A.....                                                                     | 122 |
| 7. Iron monosulphide A, and $\text{Fe}_2^+$ -rich green clay, B, mottling and bands in Section NGHP-01-01A-15H-1 .....                                                                         | 123 |
| 8. Pyritized burrow in Section NGHP-01-01A-22X-3.....                                                                                                                                          | 123 |
| 9. Abundant bioturbation highlighted by iron monosulphides haloes and mottles or by darker sediment filling burrows in lighter sediments and vice versa .....                                  | 124 |
| 10. White discoloration zones in iron oxyhydroxide-rich sediments of Unit III.....                                                                                                             | 125 |
| 11. Drilling-related fractures zones in sediments.....                                                                                                                                         | 126 |
| 12. Fault in Section NGHP-01-01A-55X-6 .....                                                                                                                                                   | 128 |
| 13. "A Bug's Life:" <i>Zoophycos</i> trace, probably left by a single worm during its entire life span.....                                                                                    | 129 |
| 14. "A (Different) Bug's Tomb": burrow and Fe reduction discoloration halo in Section NGHP-01-01A-35X-5 .....                                                                                  | 129 |
| 15. Concentration depth profiles of A, salinity, B, chloride, C, sulfate, and D, bromide .....                                                                                                 | 131 |
| 16. Concentration depth profile of headspace carbon dioxide.....                                                                                                                               | 133 |
| 17. Profiles of core recovery, index and strength properties for Hole NGHP-01-01A .....                                                                                                        | 138 |
| 18. Profiles of core recovery, electrical resistivity, <i>P</i> -wave velocity, magnetic susceptibility, and thermal conductivity for Hole NGHP-01-01A .....                                   | 139 |
| 19. Shear strengths normalized by the effective vertical stress versus sub-bottom depth for Hole NGHP-01-01A .....                                                                             | 147 |
| 20. Peak and remolded vane shear strengths and sensitivity for Hole NGHP-01-01A.....                                                                                                           | 147 |
| 21. Apparent formation factor versus sub-bottom depth for Hole NGHP-01-01A.....                                                                                                                | 156 |
| 22. Geothermal gradient and estimated depth to the BSR from <i>in situ</i> temperature measurements for Hole NGHP-01-01A.....                                                                  | 158 |
| 23. Temperature and pressure versus elapsed time for each pressure corer deployment as recorded by the corer's internal data logger .....                                                      | 159 |
| 24. Temperature versus pressure for the deployment of successful pressure cores at Site NGHP-01-01, showing trajectories relative to gas hydrate stability at 30 ppt and 35 ppt salinity ..... | 160 |
| 25. Summary of the wire-line logs recorded in Hole NGHP-01-01A.....                                                                                                                            | 161 |
| 26. Sonic waveform amplitude and coherence data and also velocity logs measured by the DSI in Hole NGHP-01-01A.....                                                                            | 162 |
| 27. Water saturations from Archie's equation and wire-line porosity and resistivity logs in Hole NGHP-01-01A.....                                                                              | 163 |

## Tables

|                                                                                                       |     |
|-------------------------------------------------------------------------------------------------------|-----|
| 1. Smear slide data for Hole NGHP-01-01A .....                                                        | 120 |
| 2. Silt laminae and beds at Hole NGHP-01-01A .....                                                    | 125 |
| 3. Interstitial water data for Site NGHP-01-01 .....                                                  | 130 |
| 4. Headspace gas composition for Site NGHP-01-01 .....                                                | 132 |
| 5. Void gas composition for Site NGHP-01-01 .....                                                     | 134 |
| 6. Pressure Core Sampler (PCS) gas composition for Site NGHP-01-01 .....                              | 134 |
| 7. List of microbiological samples taken for Site NGHP-01-01 .....                                    | 135 |
| 8. Average infrared core liner temperature measured on the catwalk .....                              | 136 |
| 9. Core end temperatures measured on the catwalk and percent core recovery .....                      | 137 |
| 10. Moisture and density (MAD) physical properties for Hole NGHP-01-01A .....                         | 140 |
| 11. Vane shear strength results for Hole NGHP-01-01A .....                                            | 143 |
| 12. Torvane strength results for Hole NGHP-01-01A .....                                               | 143 |
| 13. Pocket Penetrometer strength results for Hole NGHP-01-01A .....                                   | 145 |
| 14. Wenner array electrical resistivity and formation factor results for Hole<br>NGHP-01-01A .....    | 148 |
| 15. Contact P-wave velocity results determined on split cores sections from<br>Hole NGHP-01-01A ..... | 156 |
| 16. Thermal conductivity results for Hole NGHP-01-01A .....                                           | 157 |
| 17. <i>In situ</i> temperature tool deployment log .....                                              | 157 |
| 18. Summary of pressure coring operations at Site NGHP-01-01 .....                                    | 160 |



# Site NGHP-01-01

By T. Collett, M. Riedel, J. Cochran, R. Boswell, J. Presley, P. Kumar, A. Sathe, A. Sethi, M. Lall, and the National Gas Hydrate Program Expedition 01 Scientists

## Background and Objectives

Site NGHP-01-01 (Prospectus Site KKGH01) is located at 15° 18.366'N, 070° 54.192'E in the Kerala-Konkan (KK) Basin (fig. 1). The water depth is ~2,663 m. This site located on the west coast of India was the first site visited during NGHP Expedition 01. At this site no LWD/MWD measurements were carried out and drilling and coring were combined with wire-line logging only.

The objectives of the work carried out at this site follow the general objectives of NGHP Expedition 01, excluding the LWD/MWD operations:

- Study the occurrence of gas hydrate and establish the background geophysical, geological, geochemical, and microbiological baselines for gas hydrate studies;
- Define the relationship between the sedimentology and structure of the sediments and the occurrence and concentration of gas hydrate;
- Calibrate remote sensing data such as seismic data by acquiring wire-line log and VSP data.

The seismic data (line K-95-8B) show a widespread but low-amplitude bottom-simulating reflector (BSR) visualized in figure 2. However, all reflections down to a depth of 0.28 s two-way travel time (TWT) below seafloor are parallel to the seafloor and it is difficult to determine the phase of the BSR correctly. It appears the BSR is the same polarity as the seafloor and thus would not mark an impedance reversal (fig. 3). Therefore, it is uncertain if this BSR is actually gas hydrate related. The BSR event occurs at a depth of ~217 mbsf estimated using a velocity of 1560 m/s and a TWT of 0.278 s.

## Operations

This operations summary covers the transit from Mumbai (the mobilization port) to Site NGHP-01-01 (KKGH01), drilling/coring operations for Hole NGHP-01-01A, and the transit from Site NGHP-01-01 to Chennai (fig. 4). Schedule details and statistics for this site can be found as Appendixes:

- Appendix 1: NGHP Expedition 01 Operations Schedules
- Appendix 2: NGHP Expedition 01 Operations Statistics

Included in the Glossary is a list of standard or commonly used operations terms and acronyms.

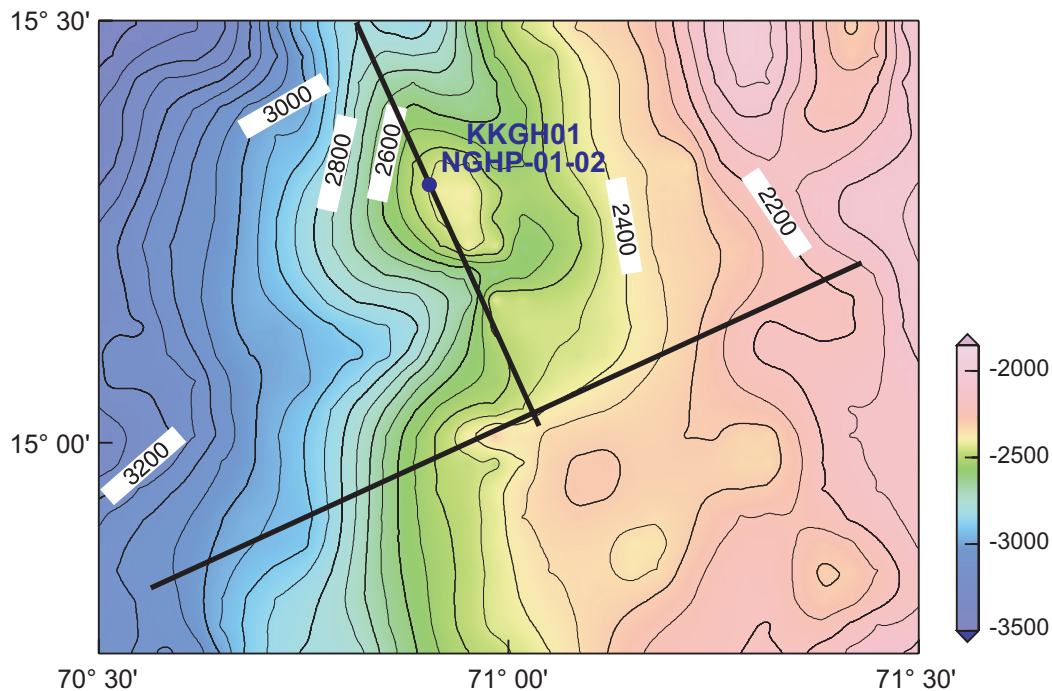
## Hole NGHP-01-01A

The drill ship *JOIDES Resolution* was mobilized in Mumbai in preparation for a planned program of gas hydrate research commissioned by the India National Gas Hydrate Program (NGHP). NGHP Expedition 01 was initially scheduled to begin in Mumbai and end ~83 days later in Port Blair (Andaman Islands). For operational purposes, NGHP Expedition 01 was divided into five segments; Leg 1, Leg 2, Leg 3A, Leg 3B, and Leg 4. Expedition operations were to include Logging-while-drilling (LWD)/Measurement-while-drilling (MWD), standard APC/XCB coring, pressure coring, temperature measurements, wire-line logging, and detailed scientific laboratory analysis of the recovered core samples both aboard ship and ashore.

Leg 1 began with the last line away Indira Dock 22, Mumbai at 0700 hr on May 5, 2006. The 246 NMI transit from Mumbai to Site NGHP-01-01 (KKGH01; fig. 4) was completed in just under 24 hours at an average speed of 10.2 knots. The sea voyage ended at 0600 hr and the vessel was switched from cruise mode to DP control at 0618 hr. By 0640 hr all thrusters and hydrophones were down in the locked position. A positioning beacon was deployed on the prospectus coordinates at 0725 hr. The ice bath was installed in the moon pool and a standard two-stand APC/XCB BHA was made up with a LFV and a typical 11-7/16" APC/XCB C-3 TCI roller cone bit.

Hole NGHP-01-01A was to focus on continuous APC/XCB coring with six PCS pressure cores to be taken within the gas-hydrate stability field. Temperature measurements were also to be taken using the APCT-3, APCT, and DVTP systems to define a thermal gradient from seafloor to total depth (289 mbsf).

This first drill-string trip to the seafloor was slowed by the need to pick-up all drill collars to be used in the BHA from the storage rack and strap and drift all drill pipe and drill collars. In addition, a drill pipe wiper plug "pig" was pumped through the pipe to remove any loose rust that may have accumulated during the long period of storage since the last deployment. Initial contact of the drill pipe with the seafloor indicated an approximate seafloor depth of 2,675.0 mbrf. Based upon that, and a corrected PDR depth of 2,674.0 mbrf, the bit was positioned at 2,665.0 mbrf for the first spud attempt. This barrel was recovered empty so the bit was repositioned 4.0 m lower at 2,669.0 mbrf. Hole NGHP-01-01A was ultimately spudded at 1810 hr on May 6, establishing a seafloor depth of 2,674.2 mbrf.



**Figure 1.** Location of Site NGHP-01-01 (Prospectus Site KKGH01) in the Kerala-Konkan (KK) Basin offshore of the west coast of India.

Core NGHP-01-01A-01H was ondeck at 1810 hr and APC coring continued through Core NGHP-01-01A-19H to a depth of 152.8 mbsf. Core NGHP-01-01A-19H advanced only 2.0 m, marking the maximum depth (or “refusal”) for the APC coring system. Coring continued with the XCB coring system recovering Cores NGHP-01-01A-20X through NGHP-01-01A-36X to a depth of 289.0 mbsf.

Six pressure cores were recovered during the coring operation using the IODP/TAMU PCS system. PCS core NGHP-01-01A-06P reached 43.3 mbsf, PCS core NGHP-01-01A-12P reached 92.8 mbsf, PCS core NGHP-01-01A-20P reached 153.8 mbsf, PCS core NGHP-01-01A-26P reached 204.0 mbsf, and PCS core NGHP-01-01A-31P reached 244.6 mbsf. The last PCS core NGHP-01-01A-37P extended the hole to a total depth of 290.0 mbsf. Each PCS deployment, except the last, included a 1.0 m advance (cored interval) followed by a 1.0 m drilled interval (over cored).

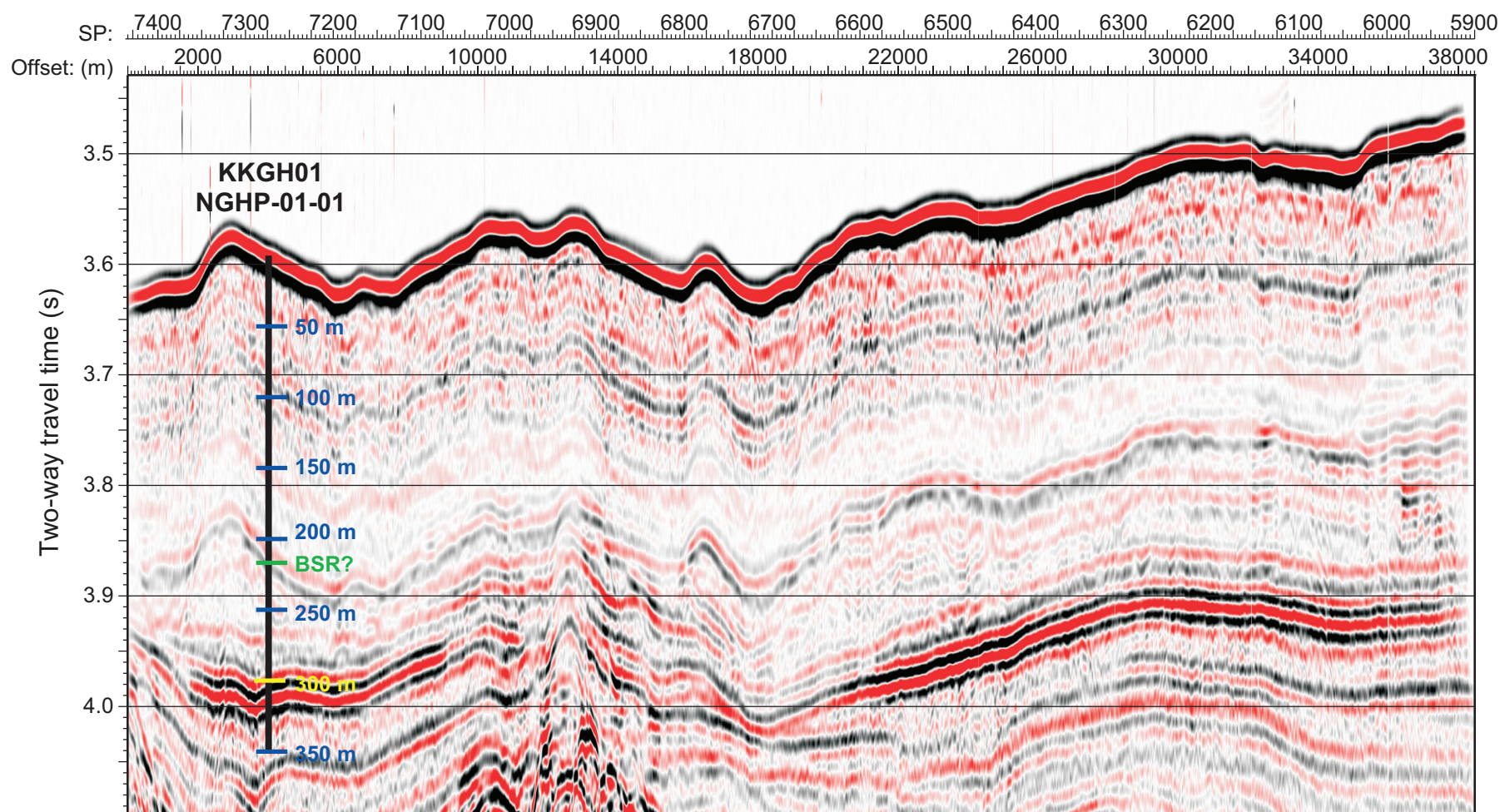
Temperature measurements were taken using the APCT shoe on Cores NGHP-01-01A-04H, NGHP-01-01A-07H, NGHP-01-01A-09H, and NGHP-01-01A-13H at depths of 32.8 mbsf, 53.8 mbsf, 72.8 mbsf, and 103.3 mbsf respectively. These were supplemented with temperatures taken with the DVTP at depths of 164.5 mbsf and 214.6 mbsf.

APC core recovery averaged 97.4 percent and XCB recovery averaged 98.0 percent. Penetration rates with the XCB varied from 11.6 m/h to 38.8 m/h overall averaging 18.2 m/h. Recovery for the six PCS pressure cores averaged only 32.0 percent; subsequent analysis indicated that the ball valve closed prematurely on four of those six deployments. On the remaining two deployments recovery was 96.0 percent and both of those cores were recovered under pressure.

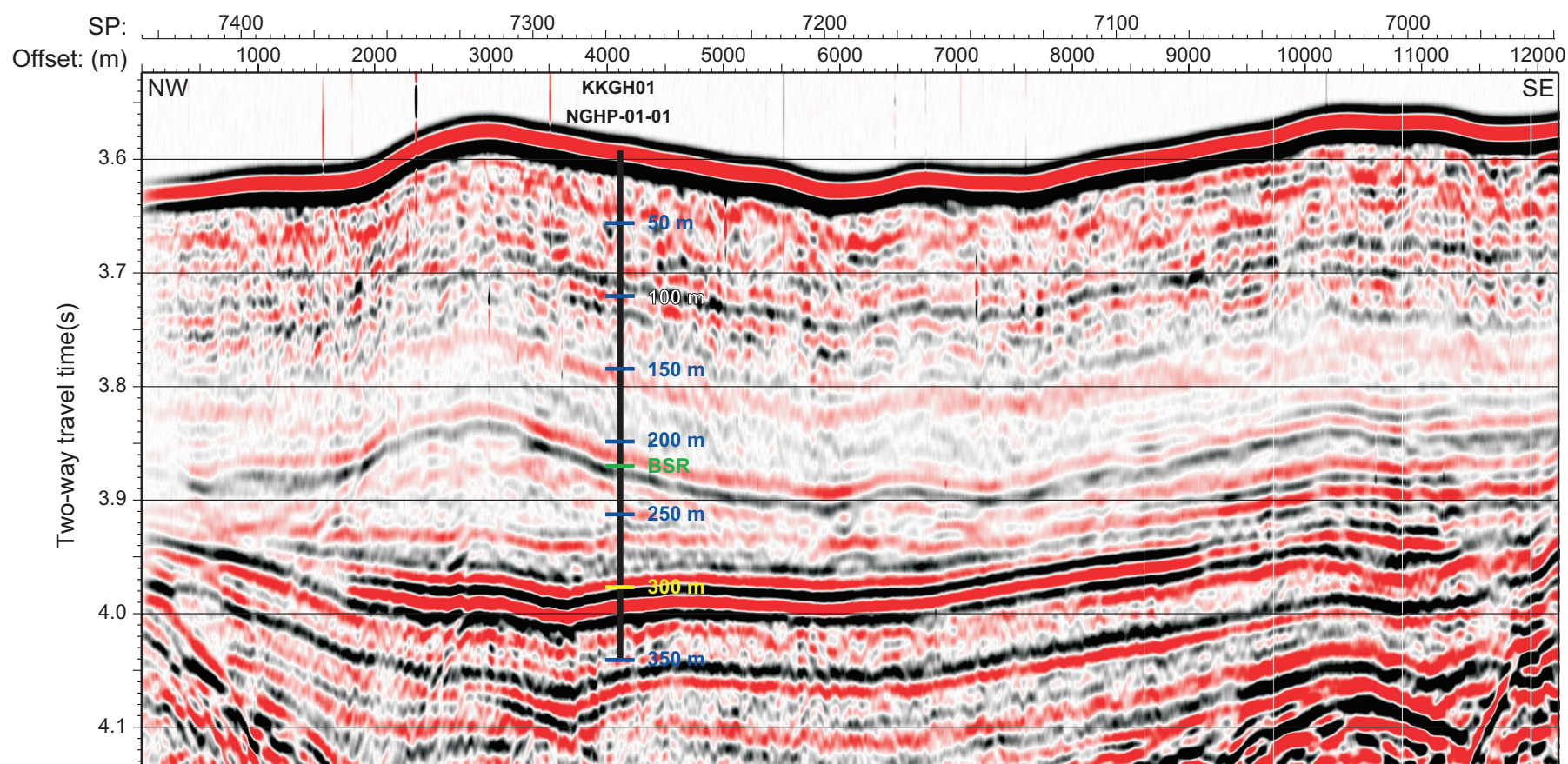
Whirlpaks (microbeads) commonly used for determination of microbiological contamination were not used. Accelerated core barrel handling protocols were used for all core barrels (APC, XCB, and PCS) deployed in this hole. All APC/XCB core barrels were laid down immediately upon arrival at the rig floor before making another drill pipe connection or deploying the next core barrel. Once at the rig floor any PCS core barrel showing signs of proper actuation was placed in the moon pool ice bath.

Coring was completed at 1530 hr 8 May with the recovery of the last PCS core from 290.0 mbsf. The hole was swept with 50 barrels of Sepiolite mud and a wiper trip was conducted with the top drive to logging depth and back to TD. No fill was found on-bottom and the hole was displaced with 123 barrels of 10.5 ppg weighted mud. The drill string was tripped to the surface and the EOP was placed at 83.88 mbsf. Rig-up for wire-line logging began at 2100 hr 8 May.

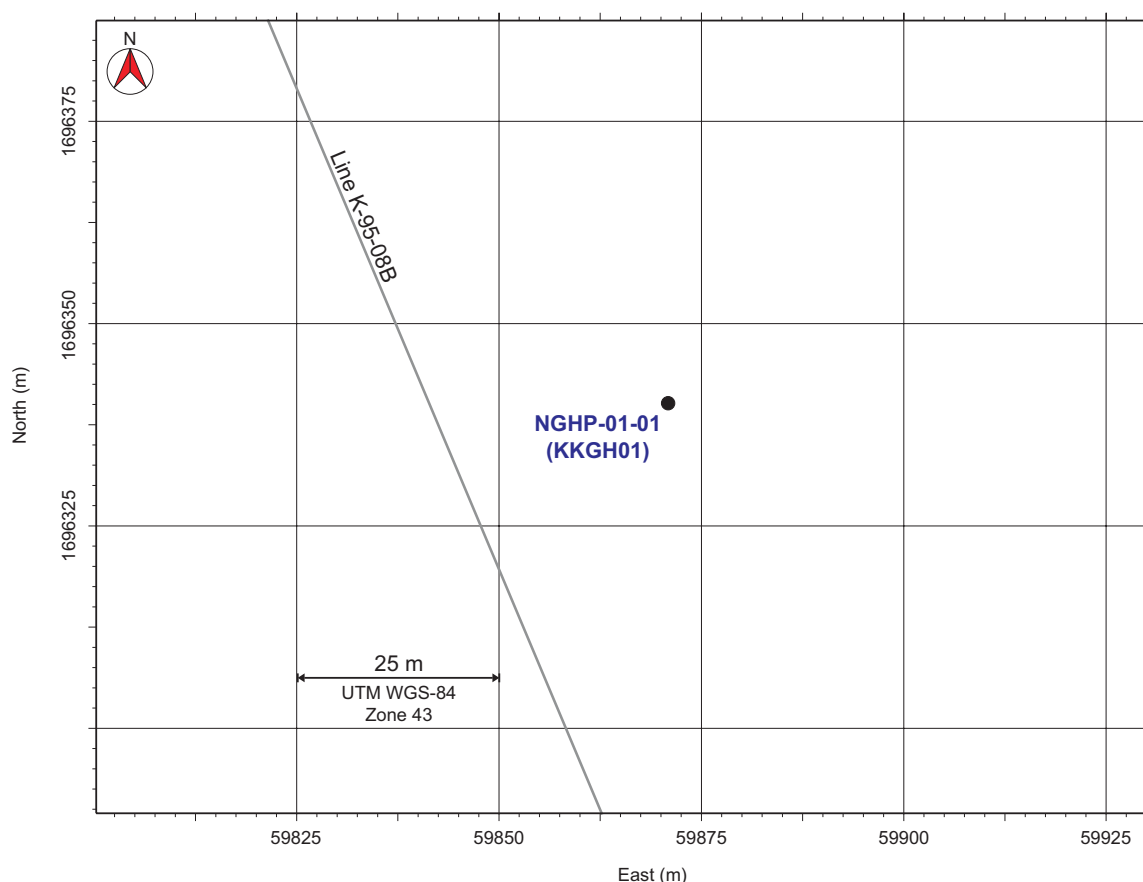
The first logging run, made up of the triple combo tool string, was deployed downhole at 2325 hr and reached 283.8 mbsf or within 6.2 m of TD. Tools were back out at 0420 hr. The triple combo tool string was laid out and the second tool string consisting of the FMS-Sonic was made-up. This tool string was deployed at 0550 hr 9 May and reached 285.8 mbsf (4.2 m off bottom). Tools were out by 1015 hr. The third and final logging run was with the VSP logging string. After troubleshooting a VSP software problem, the logging run was initiated at 1610 hr 9 May. However, the tools hung up at the bit and the VSP logging run was cancelled. Tools were out by 2100 hr. Logging operations were completed at 2200 hr after rigging down the logging sheaves. The drill string was pulled clear of the seafloor at 2220 hr. The



**Figure 2.** Seismic line K-95-8B crossing Site NGHP-01-01 in the Kerala-Konkan (KK) Basin. A bottom-simulating reflector (BSR) appears throughout most of the section but it remains questionable if this event is gas-hydrate related. The phase of the BSR is not necessarily reversed to that of the seafloor reflection and the lack of a cross-cutting nature suggests a possible stratigraphic origin.



**Figure 3.** Close-up of seismic line K-95-8B showing the detailed sedimentary structures around Site NGHP-01-01. Depths were estimated using a uniform seismic velocity of 1,560 m/s. [m/s, meters per second]



**Figure 4.** Map showing the hole occupied at Site NGHP-01-01A (KKGH01). [m, meters]

pipe trip continued to the surface where the BHA was racked back in the derrick and the vessel was secured for transit. Hole NGHP-01-01A and Site NGHP-01-01 were ended as the vessel switched from DP to cruise mode at 0345 hr May 10 and got underway for Chennai.

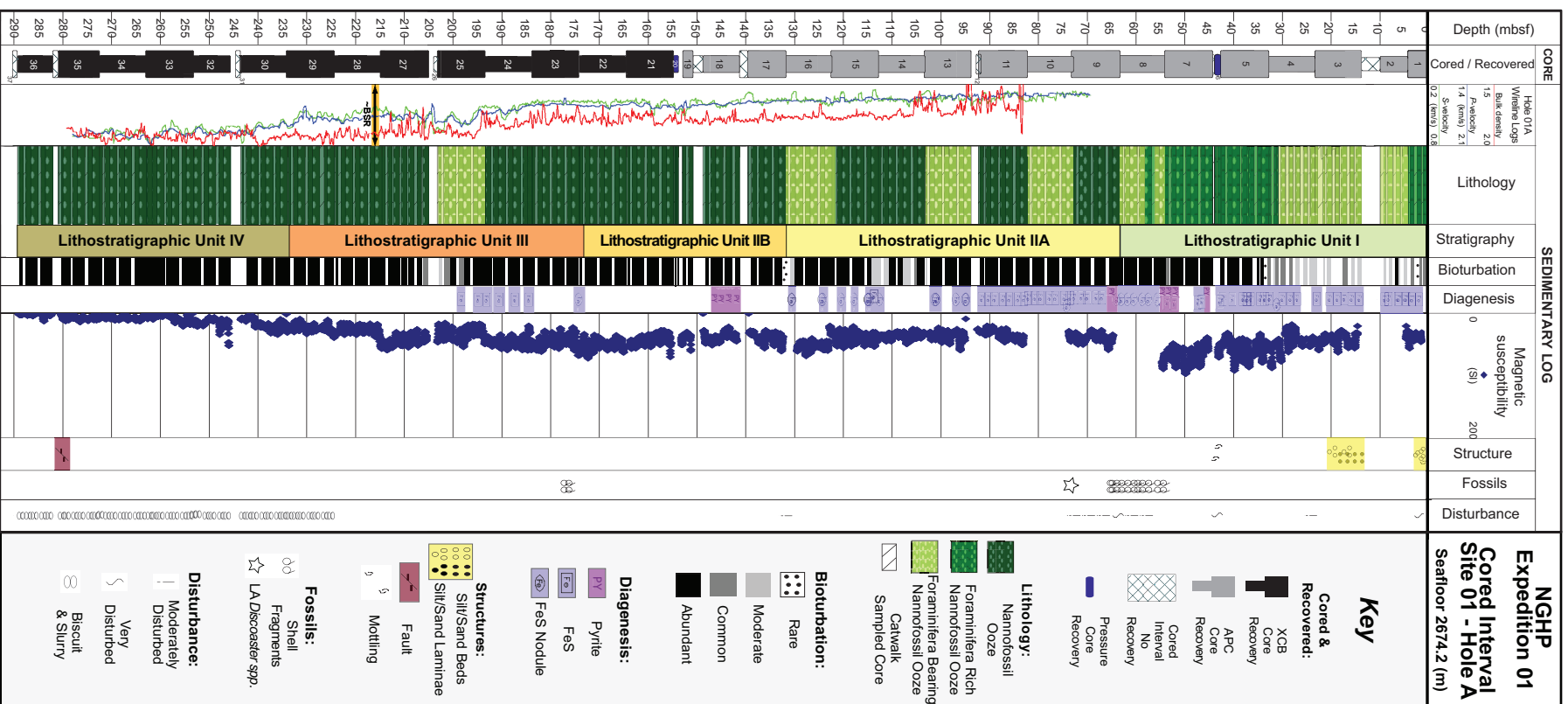
The 1,393 NMI transit from Site NGHP-01-01 to Chennai was completed in 5.3 days at an average speed of 10.9 knots. The sea voyage ended at 1200 hr May 15 as the ship cruised into the Chennai South anchorage. The port anchor was let go at 1310 hr and the vessel remained at the anchorage for ~15.5 hr until notified by harbor control that a berth was available. The anchor was raised at 0440 hr the following morning and the pilot was aboard at 0532 hr. NGHP Expedition 01, Leg 1 officially ended at 0624 hr May 16, with the first line ashore at the Harbor Basin West Quay 4 (passenger terminal) in Chennai.

## Lithostratigraphy

Site NGHP-01-01 is the only site drilled by NGHP Expedition 01 on the western continental margin of India in the Arabian Sea (Kerala-Konkan or KK Basin). Compared to the holes drilled on the eastern continental slope of India, Site NGHP-01-01 stands out as a carbonate rich, pelagic record characterized by low organic matter content, rather

than by a typical hemipelagic continental margin lithology. Hole NGHP-01-01A was cored to 290 mbsf; wire-line logging was performed after coring (see “Operations”).

The sedimentary sequence in Hole NGHP-01-01A was divided into four major lithologic units (I through IV; fig. 5 and Site NGHP-01-01 Visual Core Descriptions [supplementary data files]) based on visual description, biogenic and terrigenous composition determined from smear slides and Munsell color, and further supported by trends in logging and physical properties data. Unit I consists primarily of foraminifera-bearing nannofossil ooze alternating with foraminifera-rich nannofossil ooze. The latter lithology is not found deeper at this site. Unit II is composed of nannofossil ooze and foraminifera-bearing nannofossil ooze. The appearance of foraminifera in greater abundance in the upper part of Unit II justifies discriminating between an upper Subunit IIa and a lower Subunit IIb. Unit III is primarily composed of nannofossil ooze; foraminifera-bearing nannofossil ooze occurs as a ~10 m thick interval in the middle of the unit. Unit III is characterized by local increases in clays and by striking red colors, unique to this unit. Wire-line logging data (fig. 5), MAD density together with penetrometer measurements (see “Physical Properties” and “Downhole Logging”), and visual observation show that Unit III progresses downcore from semi-lithified to entirely lithified (that is, chalks). In the basal Unit IV, composed of chalk with rare and thin foraminifera-bearing



**Figure 5.** Lithostratigraphic summary of Hole NGHP-01-01A. LA *Discoaster* spp., last appearance for *Discoaster* sp. Note: Colored intervals exceed symbol size when there is a range in the occurrence. Center point of each symbol represents true depth of occurrence; therefore, colored bars may slightly exceed core recovery. See Site NGHP-01-01 Visual Core Descriptions (supplementary data files) for the expanded scale, detailed core descriptions; see See NGHP-01-01 Oversized Figure (supplementary data files) for the enlarged version of this summary.

chalk intercalations; the clay content is low and the red colors absent. Core recovery was very good in Hole NGHP-01-01A and the quality of cores are outstanding even in the XCB coring interval, with biscuiting occurring only in the lithified base of the hole (Unit IV). Time within the stratigraphy is constrained by a nannofossil biostratigraphic boundary (observed in smear slides), which occurs in Section NGHP-01-01A-10H-3, 25 cm (fig. 5 and table 1). Above this boundary, only coccolithophorids (coccoliths) are present whereas below this boundary both *Discoaster* spp. (star-shaped) and coccoliths are present. The last appearance (LA) of the *Discoaster* spp. (or their extinction) is observed throughout the ocean basins of the world at the Pliocene-Pleistocene boundary, ~2 Ma (Rothwell, 1989). Thus, the sediments above Section NGHP-01-01A-10H-3, 25 cm are largely Quaternary in age and those below are pre-Quaternary.

## Lithostratigraphic Units

### Lithostratigraphic Unit I

Intervals: Hole NGHP-01-01A, Cores NGHP-01-01A-01H through NGHP-01-01A-08H

Depths: Hole NGHP-01-01A, 0–63.3 mbsf

Age: Quaternary (<2.0 Ma)

Unit I is characterized by alternating foraminifera-rich and foraminifera-bearing nannofossil oozes of Quaternary age (figs. 5, 6, and Site NGHP-01-01 Visual Core Descriptions [supplementary data files]). The rationale for recognizing Unit I is the relatively high abundance of foraminifera (>5 percent) in the nannofossil oozes (table 1). Minor and trace components encountered in smear slides included clays (in one case going up to 70 percent), pyrite, carbonate shell fragments, and volcanic glass (table 1). The color of the sediments (Site NGHP-01-01 Visual Core Descriptions [supplementary data files]) varies from olive to gray with different shades of each and a combination thereof (for example, gray, 5Y 5/1; dark gray, 5Y 4/1; very dark gray, 5Y 3/1; olive gray, 7Y 5/2; olive, 7Y 5/3; light olive gray, 7Y 6/2). A light-dark alteration in color is evident throughout the core with 10 to 30 cm thick individual beds (fig. 6). Darker beds are generally richer in terrigenous clays and poorer in carbonate compared to their lighter counterparts. Iron monosulphide and green mottling and bands with Fe<sub>2</sub><sup>+</sup>-rich clays indicative of reducing conditions (fig. 7; see, for example, Giosan and others, 2002 and references therein) are abundant throughout Unit I, whereas pyritized burrows are common (fig. 8). Bioturbation is abundant at the base of the unit (35 to 63.3 mbsf) and highlighted by iron monosulphides haloes or by the presence of darker sediment filling burrows in lighter sediment beds and vice versa (fig. 9). In the upper part of Unit I bioturbation appears to be common to rare (fig. 5), probably because the color alteration is less defined and burrows are less likely to be highlighted in more uniformly colored sediments. Thin silt laminae (table 2) have been also encountered

in Unit I, but they are very rare (Site NGHP-01-01 Visual Core Descriptions [supplementary data files]). Macroscopic fossils are limited to rare occurrences of shell fragments.

### Lithostratigraphic Unit II

Unit II is characterized by a decreased presence of foraminifera relative to Unit I (fig. 5 and Site NGHP-01-01 Visual Core Descriptions [supplementary data files]). It is composed primarily of nannofossil ooze with intercalated foraminifera-bearing nannofossil ooze occurring in the upper part of the unit. As described above, *Discoaster* spp. first appears near the top of the Unit (Core NGHP-01-01A-10H) indicating that the sediments of the unit are Pliocene or older in age. We divide Unit II into two Subunits (IIa and IIb) based on the characteristics described below.

#### Subunit IIa

Intervals: Hole NGHP-01-01A, Cores NGHP-01-01A-09H through NGHP-01-01A-16H

Depths: Hole NGHP-01-01A, 63.3–131.9 mbsf

Age: >Quaternary (>2.0 Ma)

Subunit IIa is characterized by alternating foraminifera-bearing nannofossil ooze and nannofossil ooze, which differentiates it from the underlying nannofossil ooze that comprises Subunit IIb (figs. 5, 6, and Site NGHP-01-01 Visual Core Descriptions [supplementary data files]). Minor and trace components in smear slides include clays, pyrite, authigenic carbonates, carbonate shell fragments, quartz, feldspar, and volcanic glass (table 1). Lighter sediments (gray, 10Y 5/1) alternate with darker sediments (dark gray, 10Y 4/1) in bedding 10 cm to 30 cm thick (fig. 6 and Site NGHP-01-01 Visual Core Descriptions [supplementary data files]). Occasionally, greenish or olive tints of gray occur (olive gray, 7Y 5/1; greenish gray, 10Y 5/1). Darker beds are generally richer in terrigenous clays and poorer in carbonate compared to their lighter counterparts. Iron monosulphide mottling and green bands continue to be abundant throughout the Subunit. Pyritized burrows are common. Bioturbation is also abundant throughout the unit and highlighted by iron monosulphide haloes or by the presence of darker sediment filling burrows in lighter sediment beds and vice versa.

#### Subunit IIb

Intervals: Cores NGHP-01-01A-17H through NGHP-01-01A-22X

Depths: Hole NGHP-01-01A, 131.9–174 mbsf

Age: >Quaternary (>2.0 Ma)

Subunit IIb has the same characteristics as Subunit IIa with the important difference that foraminifera-bearing nannofossil oozes are not present and all sediments are classified as nannofossil ooze (fig. 10).



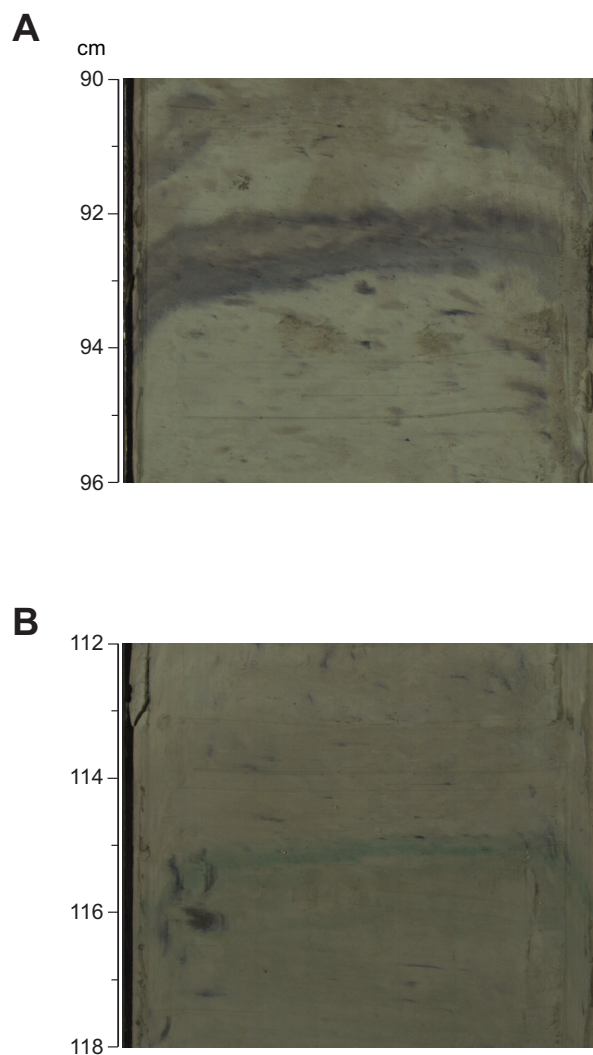
Table 1. Smear slide data for Hole NGHP-01-01A.—Continued

| Sample reference                      |           | Biogenic      |               |                           |         |               |                 |              | Comments                                            |
|---------------------------------------|-----------|---------------|---------------|---------------------------|---------|---------------|-----------------|--------------|-----------------------------------------------------|
| Core, section, depth (cm, in section) | Lithology | Fora-minifera | Nanno-fossils | Carbonate shell fragments | Diatoms | Radio-larians | Sponge spicules | Plant debris |                                                     |
| NGHP-01-01A—Continued                 |           |               |               |                           |         |               |                 |              |                                                     |
| 1H-1,70                               | D         | 25            | 50            |                           |         | 2             | 2               | trace        |                                                     |
| 1H-2,84                               | D         | 20            | 50            |                           |         |               | trace           | trace        |                                                     |
| 2H-1,49                               | D         | 8             | 92            |                           |         |               |                 |              |                                                     |
| 3H-1,60                               | D         | 10            | 90            |                           |         |               |                 |              |                                                     |
| 3H-5,19                               | M         | 8             | 90            |                           |         |               |                 |              | from dark band                                      |
| 4H-1,25                               | D         | 10            | 90            |                           |         |               |                 |              |                                                     |
| 4H-6,52                               | D         | 20            | 80            |                           |         |               |                 |              | forams mostly broken tests                          |
| 5H-1,57                               | D         | 11            | 89            | trace                     |         |               |                 |              | trace framboidal pyrite                             |
| 5H-4,27                               | D         | 12            | 88            | trace                     |         |               |                 |              | trace framboidal pyrite                             |
| 6P-1,40                               | D         | 11            | 89            | trace                     |         |               |                 |              | trace framboidal pyrite                             |
| 7H-5,43                               | D         | 13            | 87            |                           |         |               |                 |              |                                                     |
| 8H-5,40                               | M         | 3             | 20            |                           |         |               |                 | 3            |                                                     |
| 8H-3,50                               | D         | 5             | 95            |                           |         |               |                 |              |                                                     |
| 9H-4,80                               | D         | 4             | 95            |                           |         |               |                 |              |                                                     |
| 10H-3,25                              | M         | 5             | 80            | trace                     |         |               |                 |              | from green band, discoasters 10% of nannofossils    |
| 10H-6,57                              | D         | 5             | 70            |                           |         |               |                 |              | discoasters 10% of nannofossils, framboidal PY      |
| 11H-3,140                             | M         | 3             | 85            |                           |         |               |                 |              | discoasters 10% of nannofossils                     |
| 11H-6,49                              | D         | 3             | 80            |                           |         |               |                 | trace        | discoasters 10% of nannofossils                     |
| 13H-6,4                               | D         | 3             | 94            |                           |         |               |                 | 1            | discoasters present                                 |
| 13H-6,58                              | D         | 5             | 93            |                           |         |               |                 | 1            | discoasters present, calcareous plates              |
| 14H-1,50                              | D         | 3             | 96            |                           |         |               |                 | trace        | discoasters present                                 |
| 14H-2,49                              | D         | 4             | 93            |                           |         |               |                 | trace        | discoasters present                                 |
| 15H-1,18                              | D         | 3             | 95            |                           |         |               |                 | trace        | discoasters present                                 |
| 15H-2,85                              | D         | 2             | 96            |                           |         |               |                 | 1            | discoasters present                                 |
| 15H-5,39                              | M         | 2             | 88            |                           |         |               |                 | 2            | from dark band, discoasters present                 |
| 16H-2,40                              | D         | 5             | 92            |                           |         |               | 1               | 2            | discoasters present                                 |
| 16H-1,66                              | D         | 5             | 92            |                           |         |               |                 | 1            | discoasters present                                 |
| 17H-1,39                              | D         | 3             | 80            |                           |         |               |                 |              | discoasters 20% of nannofossils, trace fram. PY     |
| 17H-3,53                              | D         | 1             | 95            | trace                     |         |               |                 |              | discoasters 25% of nannofossils                     |
| 18H-3,58                              | D         | 1             | 95            |                           |         |               |                 |              | discoasters 20% of nannofossils, trace fram. PY     |
| 18H-4,37                              | D         | 2             | 85            | trace                     |         |               |                 |              | discoasters 20% of nannofossils                     |
| 19H-1,64                              | D         | 3             | 91            | trace                     |         |               |                 |              | discoasters 20% of nannofossils                     |
| 20P-1,16                              | D         | 2             | 95            |                           |         |               |                 |              | discoasters 20% of nannofossils, trace fram. PY     |
| 21X-1,135                             | D         | 1             | 95            |                           |         |               |                 |              | discoasters 20% of nannofossils                     |
| 21X-4,39                              | D         | 1             | 98            |                           |         |               |                 |              | discoasters 10% of nannofossils                     |
| 22X-3,15                              | D         | 2             | 80            |                           |         |               |                 |              | discoasters 10% of nannofossils                     |
| 22X-5,127                             | D         | 1             | 95            |                           |         |               |                 |              | discoasters 40% of nannofossils                     |
| 23X-3,49                              | D         |               | 82            |                           |         |               |                 |              | from darker section, discoasters 7% of nannofossils |
| 23X-6,76                              | D         | 4             | 90            |                           |         |               |                 |              | from lighter sec., discoasters 40% of nannofossils  |
| 23X-1,65                              | D         | 5             | 27            |                           |         |               |                 |              | discoasters present                                 |
| 23X-3,10                              | D         | 4             | 54            |                           |         |               |                 | 1            | discoasters present                                 |
| 25X-1,50                              | D         | 5             | 92            |                           |         |               |                 |              | discoasters present                                 |
| 25X-3,110                             | D         | 6             | 92            |                           |         |               |                 |              | discoasters present                                 |
| 25X-5,25                              | D         | 6             | 94            |                           |         |               |                 | trace        | discoasters present                                 |
| 25X-6,78                              | D         | 5             | 93            |                           |         |               |                 |              | discoasters present                                 |
| 27X-1,56                              | D         |               | 40            |                           |         |               |                 |              | from darker section, discoasters present            |
| 27X-3,27                              | D         |               | 100           |                           |         |               |                 |              | from lighter section, discoasters present           |
| 28X-3,45                              | D         | 1             | 80            |                           |         |               |                 |              | discoasters present                                 |
| 28X-5,30                              | D         |               | 100           |                           |         |               |                 |              | discoasters present                                 |
| 29X-1,37                              | D         | 2             | 95            |                           |         |               |                 |              | discoasters 20%, calcareous needles 15%             |
| 29X-2,61                              | D         | 2             | 95            |                           |         |               |                 |              | discoasters 20%, calcareous needles 20%             |
| 30X-2,31                              | D         | 1             | 95            |                           |         |               |                 |              | discoasters 20%, calcareous needles 10%             |
| 30X-6,50                              | D         | 1             | 95            |                           |         |               |                 |              | discoasters 20%, calcareous needles 7%              |
| 32X-1,60                              | D         | 2             | 95            |                           |         |               |                 |              | discoasters 10%, calcareous needles 5%              |
| 32X-3,93                              | D         | 1             | 96            |                           |         |               |                 |              | from whiter part, discoasters 20% of nannofossils   |
| 33X-1,52                              | D         | 5             | 95            | trace                     |         |               |                 |              |                                                     |
| 33X-5,47                              | D         | 2             | 97            |                           |         |               | 1               |              | discoasters present                                 |
| 34X-3,100                             | D         | 1             | 99            |                           |         |               |                 |              | discoasters present                                 |
| 34X-4,70                              | D         | 3             | 96            |                           |         |               |                 |              | discoasters present                                 |
| 35X-6,18                              | D         | 8             | 92            |                           |         |               |                 |              | discoasters present                                 |
| 35X-3,100                             | D         | 5             | 95            |                           |         |               |                 |              |                                                     |
| 36X-1,35                              | D         | 3             | 97            |                           |         |               |                 |              | discoasters present                                 |
| 36X-1,68                              | D         | 5             | 95            |                           |         |               |                 |              | discoasters present                                 |
| 36X-3,88                              |           | 8             | 92            |                           |         |               |                 |              |                                                     |
| 36X-4,70                              | D         | 3             | 97            |                           |         |               |                 |              | discoasters present                                 |

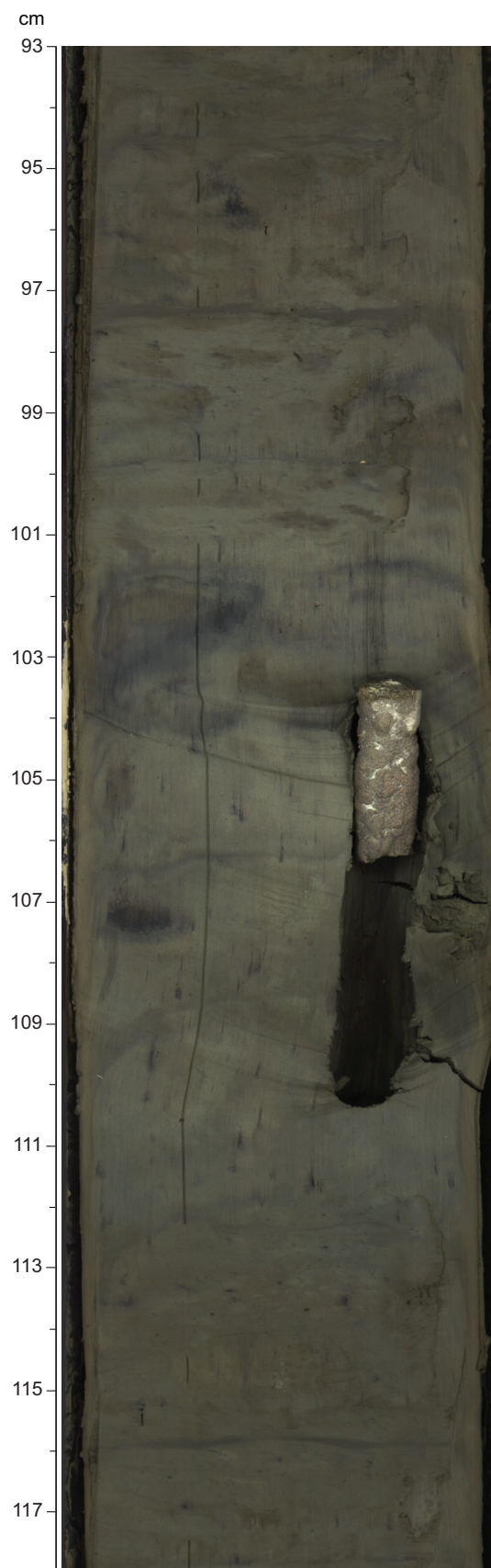
Note: M = minor lithology, D = dominant lithology.



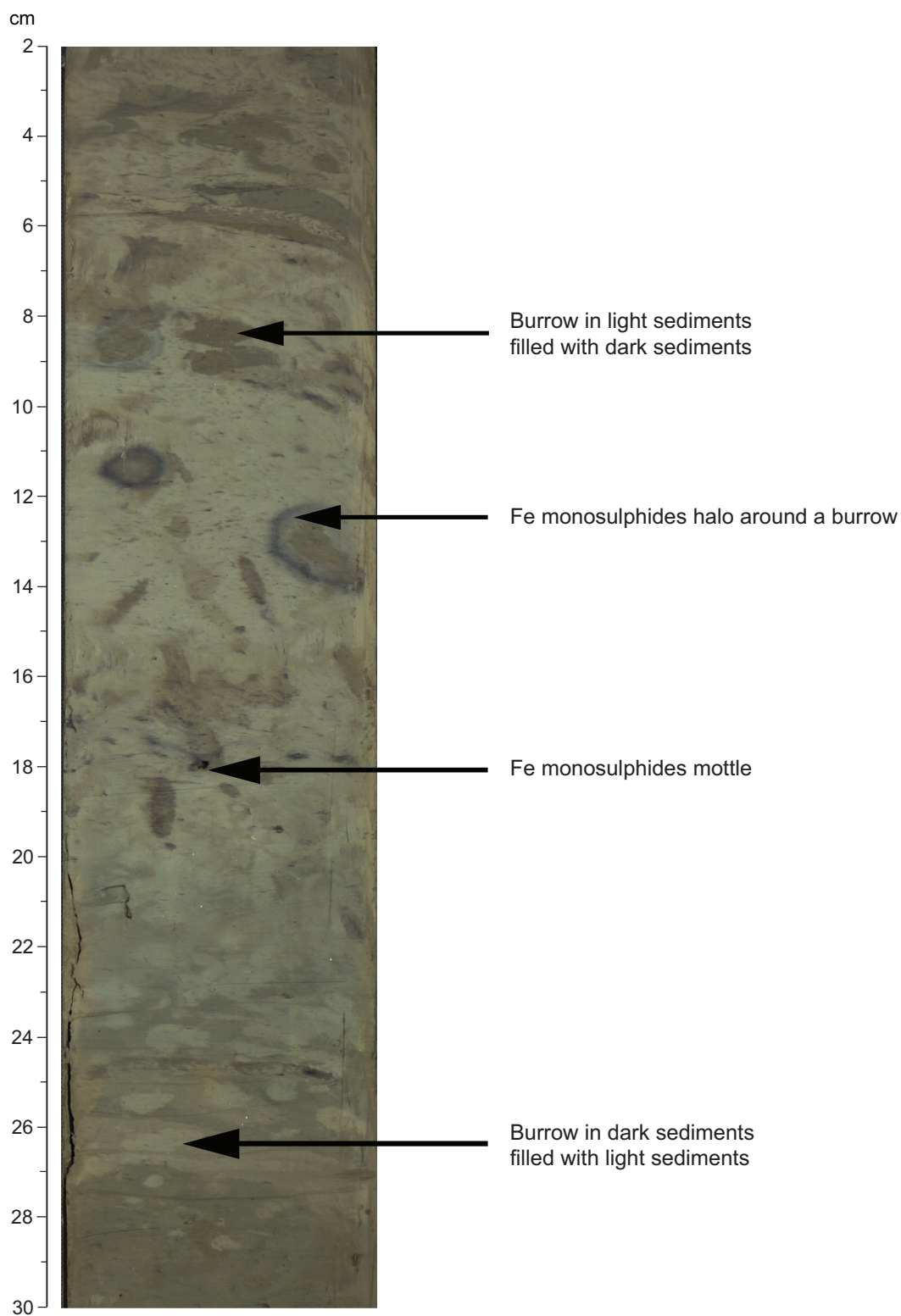
**Figure 6.** Color cyclicity reflecting variable inputs of terrigenous clays and oxyhydroxides in all units of Hole NGHP-01-01A (Unit I, Section NGHP-01-01A-05H-5; Unit II, Section NGHP-01-01A-14H-1; Unit III, Section NGHP-01-01A-23X-5, in the color transition zone and Section NGHP-01-01A-27X-5 in the reddish zone; Unit IV, Section NGHP-01-01A-36X-3).



**Figure 7.** Iron monosulphide A, and  $\text{Fe}_2^+$ -rich green clay, B, mottling and bands in Section NGHP-01-01A-15H-1. [cm, centimeters]



**Figure 8.** Pyritized burrow in Section NGHP-01-01A-22X-3. [cm, centimeters]



**Figure 9.** Abundant bioturbation highlighted by iron monosulphides haloes and mottles or by darker sediment filling burrows in lighter sediments and vice versa (Section NGHP-01-01A-19H-2). [cm, centimeters]

**Table 2.** Silt laminae and beds at Hole NGHP-01-01A.

| Core, section | Position start | Position end | Depth top (mbsf) | Depth base (mbsf) | Type         |
|---------------|----------------|--------------|------------------|-------------------|--------------|
| NGHP-01-01A   |                |              |                  |                   |              |
| 1H-2          | 82             | 82           | 2.32             | 2.32              | silt bed     |
| 1H-2          | 84             | 84           | 2.34             | 2.34              | silt laminae |
| 3H-1          | 60             | 60           | 14.4             | 14.4              | silt bed     |
| 3H-3          | 65             | 65           | 17.45            | 17.45             | silt bed     |
| 3H-4          | 10             | 60           | 18.4             | 18.9              | silt laminae |

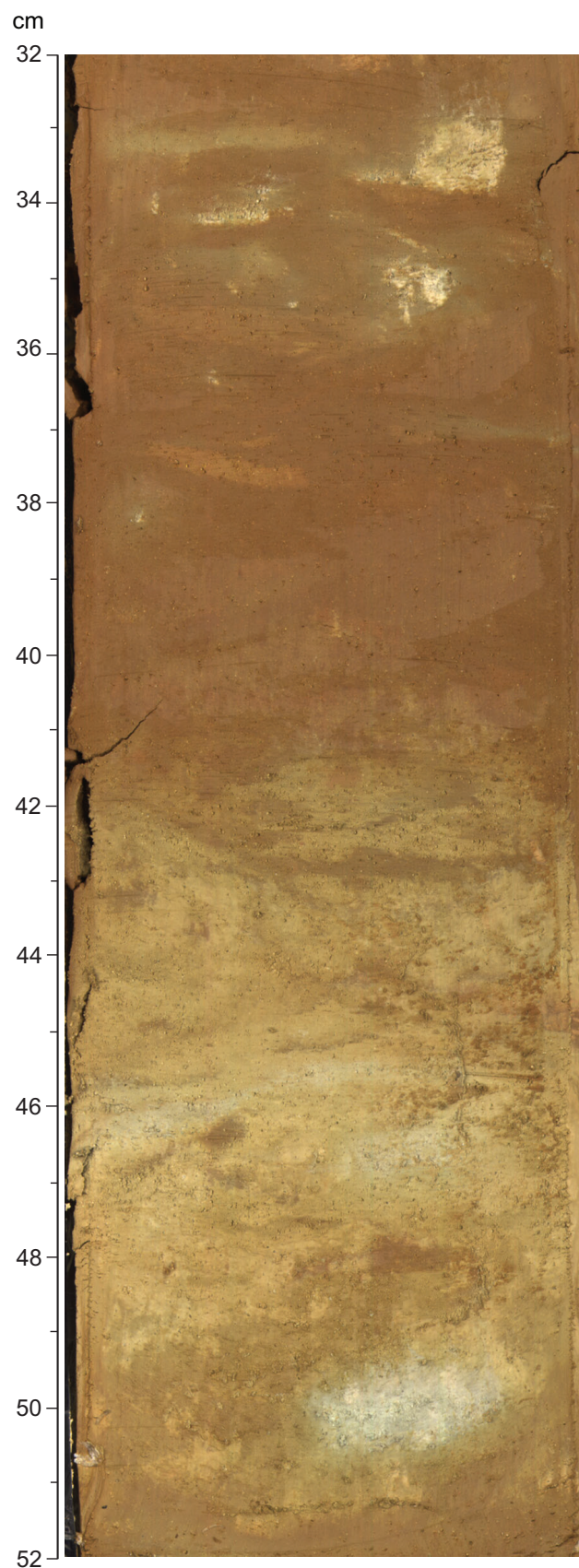
### Lithostratigraphic Unit III

Intervals: Hole NGHP-01-01A, Cores NGHP-01-01A-23X through NGHP-01-01A-29X

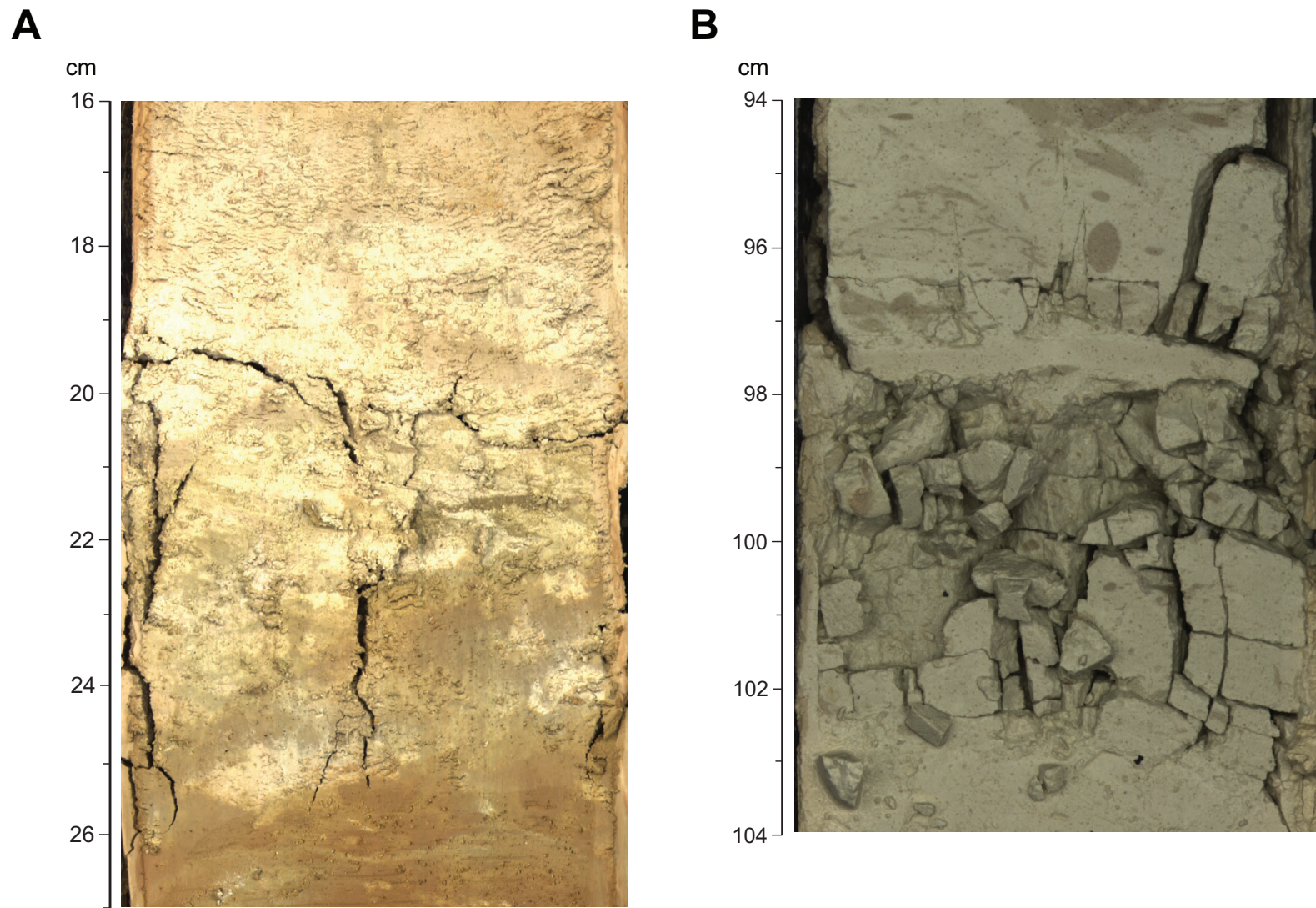
Depths: Hole NGHP-01-01A, 174–234 mbsf

Age: >Quaternary (>2.0 Ma)

Unit III is primarily composed of nannofossil ooze except for a 10 m interval in the middle of the unit (Core NGHP-01-01A-25X, 193–203 mbsf), which is a foraminifera-bearing nannofossil ooze (figs. 5, 6, and Site NGHP-01-01 Visual Core Descriptions [supplementary data files]). Besides its largely uniform biogenic composition, the other rationale for recognizing Unit III is a relatively high abundance of clays and the distinctive red colors of the unit (light brownish gray, 10YR 6/2; very pale brown, 10YR 7/4; pale brown, 10YR 6/3; brown, 7.5 YR 5/4; yellowish brown, 10YR 5/4). Color alterations (that is, lighter- and darker-colored beds) continue to be observed within Unit III at a scale of 10 to 20 cm (fig. 6). Although the increase in clays characterizing the darker beds in these sediments starts with Core NGHP-01-01A-23X, the transition from the gray and the greenish gray colors, typical of Unit II, towards the red colors, of Unit III, starts in Core NGHP-01-01A-24X and is completed in Core NGHP-01-01A-25X (fig. 6). Minor and trace components encountered in smear slides are the same encountered in Unit II: clays, pyrite, carbonate shell fragments, quartz, feldspar, and volcanic glass (table 1). However, iron oxyhydroxides (goethite, hematite) are probably responsible for the red coloration of the sediments. Only minute amounts of oxides are necessary to obtain a strong coloration in a white carbonate matrix (Deaton and Balsam, 1991). Small amounts and the likely fine grain size of the oxyhydroxides are probably the causes for their nondetection in smear slides. Iron monosulphide mottling and  $\text{Fe}_2^{+}$ -rich green bands are much rarer than in the upper units; however, white discoloration spots and bands appear to be indicative of reducing conditions that destroyed oxyhydroxides locally within the sediments (fig. 10). Bioturbation is abundant throughout the unit and it is highlighted by discoloration zones or haloes around burrows or by the presence of redder sediment filling burrows in whiter sediments and vice versa. Sediments in Unit III become progressively more lithified downhole (fig. 11) with drilling-related fractures in sediments evolving from zigzagged in semi-lithified chalks to orthogonal in fully lithified chalks (see also penetrometer and density data in “Physical Properties”). Wire-Line



**Figure 10.** White discoloration zones in iron oxyhydroxide-rich sediments of Unit III (Section NGHP-01-01A-25X-7). [cm, centimeters]



**Figure 11.** Drilling-related fractures zones in sediments: A, zigzagged fractures in semi-lithified chalks (Section NGHP-01-01A-25X-7) and B, orthogonal fractures in fully lithified chalks (Section NGHP-01-01A-36X-3). [cm, centimeters]

Logging-derived densities as well as *P*- and *S*-wave velocities also show an increasing trend from Core NGHP-01-01A-23X to Core NGHP-01-01A-24X followed by strong jump in Core NGHP-01-01A-25X, indicative of an abrupt increase in lithification, given that the lithology remains largely similar to the bottom of the hole (fig. 5).

## Lithostratigraphic Unit IV

Intervals: Hole NGHP-01-01A, Cores NGHP-01-01A-29X through NGHP-01-01A-36X

Depths: Hole NGHP-01-01A, 234–288.9 mbsf

Age: >Quaternary (>2.0 Ma)

Designation of Lithostratigraphic Unit IV was based on the almost general disappearance of the red coloration and of sediments that have high clay concentrations that were typical of Unit III (figs. 5, 6, and Site NGHP-01-01 Visual Core Descriptions [supplementary data files]). Furthermore, sediments in the unit consist almost entirely of nannofossil ooze lithified into chalk. However, there are rare thin intervals where foraminifera reach over 5 percent. Sediments generally alternate between lighter and darker hues every 10–20 cm with colors such as white (10YR 8/1 or N 8/), light greenish gray (10G 7/1), very pale brown (10YR 7/3), brown (7.5 YR 5/3), and light yellowish brown (10YR 6/4). Minor and trace components encountered in smear slides are few: clays, pyrite, and authigenic carbonate (table 1). Bioturbation is also abundant throughout, highlighted by the presence of darker sediment filling burrows in lighter sediment beds and vice versa. A fault was encountered in Core NGHP-01-01A-35X where chalks of different colors are juxtaposed (fig. 12).

## Sedimentary Environment

Site NGHP-01-01 recovered a remarkably homogenous sequence of oozes. Densities measured in the borehole suggest that horizons that have a seismic expression (that is, difference in acoustic impedance) such as the BSR at  $220 \pm 5$  mbsf might be the result of subtle changes in density that we ascribe to changes in clay content in a carbonate-rich sediment. The recovered sequence shows a continuous repetition of clay-rich/clay-poor intervals between ~30 and 10 cm thick. Tentatively, we assign this alternation to climatically-driven cycles related to either variable eolian contributions of terrigenous clays and iron oxyhydroxides and/or carbonate dissolution cycles. Sedimentation rates in the Quaternary are ~3.5 cm/ky based on the last appearance of *Discoaster* spp. (~2 Ma).

Exceptional examples of trace fossils are preserved in cores at Site NGHP-01-01. A *Zoophycos* trace, probably left by a single worm during its entire life span, is encountered in

Core NGHP-01-01A-35X (fig. 13). Another fossil burrow in the same core suggests a link between burrows (and bioturbation in general) and  $\text{Fe}_2^+$  green or discoloration haloes (fig. 14). This link may result from the occurrence within the burrow of increased amounts of organic matter due to the organism's metabolic activities or its death and decomposition within the burrow, ultimately fueling localized Fe reduction.

## Gas Hydrate Occurrence

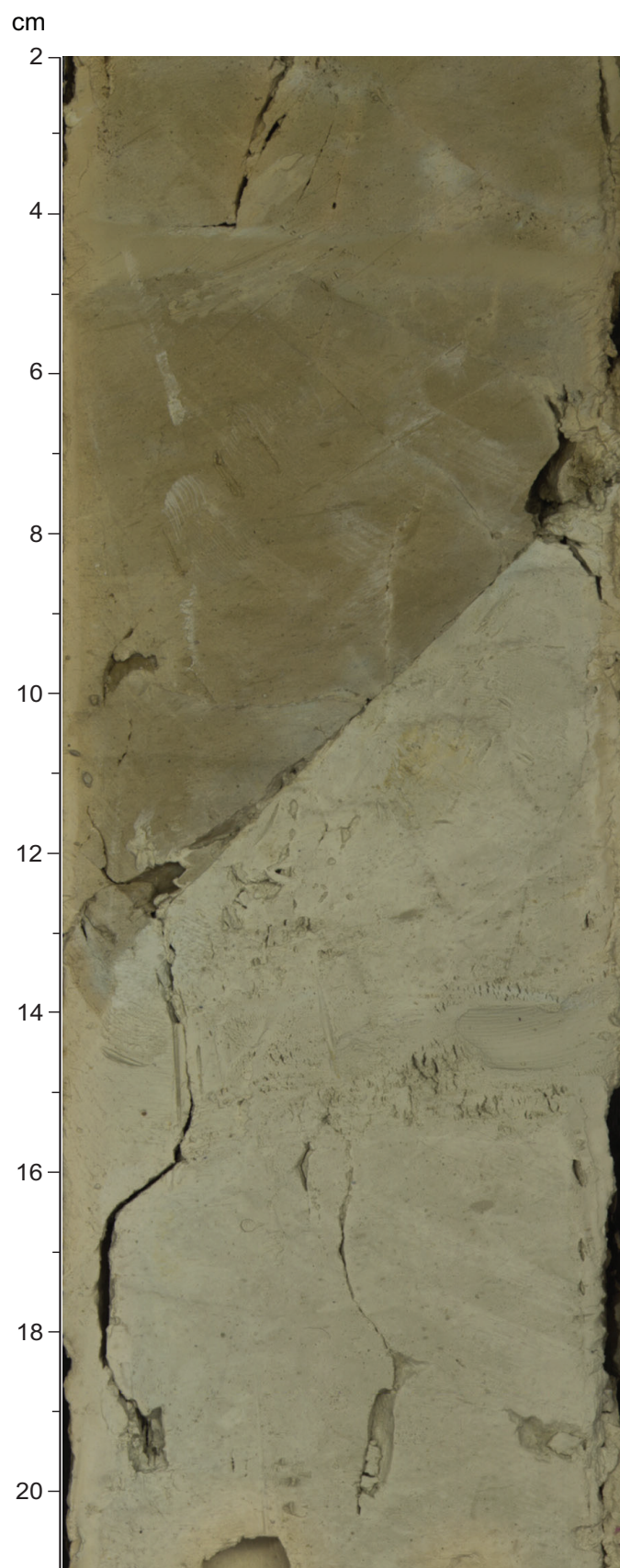
No evidence of or proxies for gas hydrate were observed at this site.

## Inorganic Geochemistry

The main objectives of the interstitial water (IW) program at this site were to obtain overall background information on the geochemistry of the Kerala-Konkan Basin, and to evaluate the potential for gas-hydrate occurrence in this depositional environment, using chloride concentration as a proxy for gas hydrate in the sediment section. A total of 20 whole-round samples, spanning the depth interval drilled, were processed for IW analyses. After collection, the samples were sealed in nitrogen-charged bags and stored at 4 °C for later analysis. Because squeezing of the interstitial waters did not take place until almost three months after they were recovered, full characterization of the pore fluid composition was not possible, and only salinity, chloride, sulfate, and bromide concentration data were obtained.

## Results

The concentration with depth data are summarized in table 3 and illustrated in figure 15. It is important to note that during storage of whole round sediment samples at non-*in situ* conditions, the interstitial water chemistry is being modified by fluid-sediment reactions (for example, carbonate chemistry, ion exchange, and biogeochemical processes) and physical processes (for example, evaporation). Interpretations of the chemical data of such interstitial waters must, therefore, be considered cautiously. The salinity and chloride data do not show any evidence for the presence of gas hydrate (figs. 15A and 15B). The salinity is that of seawater and is constant with depth. The chloride depth profile is also almost constant, but some of the values are ~1.5 percent higher than seawater, suggesting minor evaporation of the interstitial waters during storage of these samples. The sulfate concentration depth profile (fig. 15C) indicates a slow rate of bacterial sulfate reduction with a minimum value of 18.5 mM sulfate (64 percent seawater value) at ~88 mbsf. Below this depth sulfate concentrations are slightly higher, and at total depth sulfate concentration is ~20 mM, suggesting



**Figure 12.** Fault in Section NGHP-01-01A-55X-6.

minor rates of organic matter diagenesis. The presence of such high sulfate concentration throughout the cored sediment section is consistent with the lack of any detectable methane at this site (see “Organic geochemistry”). The slow organic matter diagenesis rate indicated by the sulfate-concentration profile is also observed in the dissolved  $\text{Br}^-$  concentration data (fig. 15D), which remain close to seawater values throughout the sediment section, and show a small maximum concentration, of 1.07 mM, at the depth of the minimum sulfate concentration (seawater value is 0.86 mM).

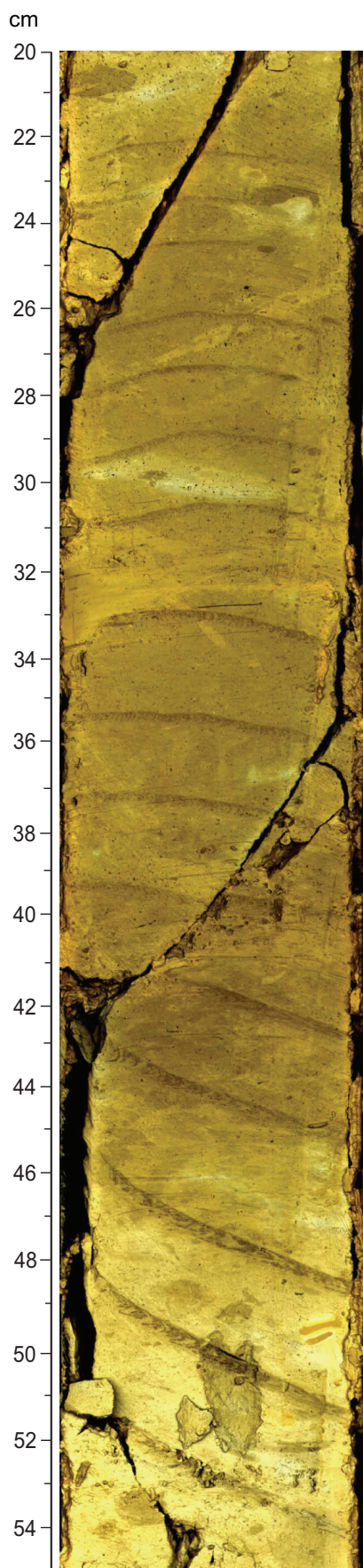
## Organic Geochemistry

Organic geochemical studies at Site NGHP-01-01 (KKGH-01) included analysis of the composition of volatile hydrocarbons including methane, ethane, and propane ( $\text{C}_1\text{--C}_3$ ) and fixed natural gases (that is,  $\text{O}_2$ ,  $\text{CO}_2$ , and  $\text{N}_2+\text{Ar}$ ) from headspace, void gas, and pressure-core sampler (PCS) degassing experiments. In general, these analyses indicate that no hydrocarbon gases can be found in the cores at this site; however, carbon dioxide ( $\text{CO}_2$ ) levels were measurable. The  $\text{CO}_2$  levels increase nearly one order of magnitude at a depth of ~200 mbsf, coinciding with a lithologic change (see below).

Gas headspace analyses were performed on thirty-three samples ranging in depth from 1.05 to 287.55 mbsf. The results listed in table 4 show the sediment did not contain any detectable methane or any other hydrocarbon gas. Carbon dioxide ( $\text{CO}_2$ ) concentrations ranged from 0.02 to 2.32 mM in water contained within the sediment pore space. An equivalent concentration expression of gas volume to sediment volume ranges from 199 to 22,100 microliters  $\text{CO}_2$ /liter wet sediment. There is no consistent trend in the  $\text{CO}_2$  concentration with depth; however, the highest concentrations are found within the interval of about 200 to 280 mbsf corresponding to a major lithology change to carbonate-rich sediment (fig. 16; see also “Lithostratigraphy”). The concentrations given here represent minimum proxy measurements of the actual concentrations due to limitations of the gas headspace method. Air gases are present in all samples as the core plugs were degassed in an air headspace.

Free gas or void gas samples were collected from three different intervals ranging in depth from 22.11 to 121.95 mbsf. Again the results were negative for methane or any other hydrocarbon gas. Carbon dioxide concentrations ranged from 230 to 400 parts per million by volume (ppmv) and are shown tabulated with other gas data in table 5. The air gases ( $\text{N}_2+\text{Ar}$ ), and  $\text{O}_2$  were the balance gases however the ( $\text{N}_2+\text{Ar}$ )/ $\text{O}_2$  ratios are greater than air, reflecting the high ratio in pore fluids or indicating that some air was trapped in the core and some oxygen has likely dissolved into pore water during recovery preferentially compared to  $\text{N}_2$ .

Gas was collected from two pressure core sampler (PCS) cores, NGHP-01-01A-12P and NGHP-01-01A-26P. The results given in table 6 show only air gases, similar to the void gas results. The PCS, while maintaining pressure during

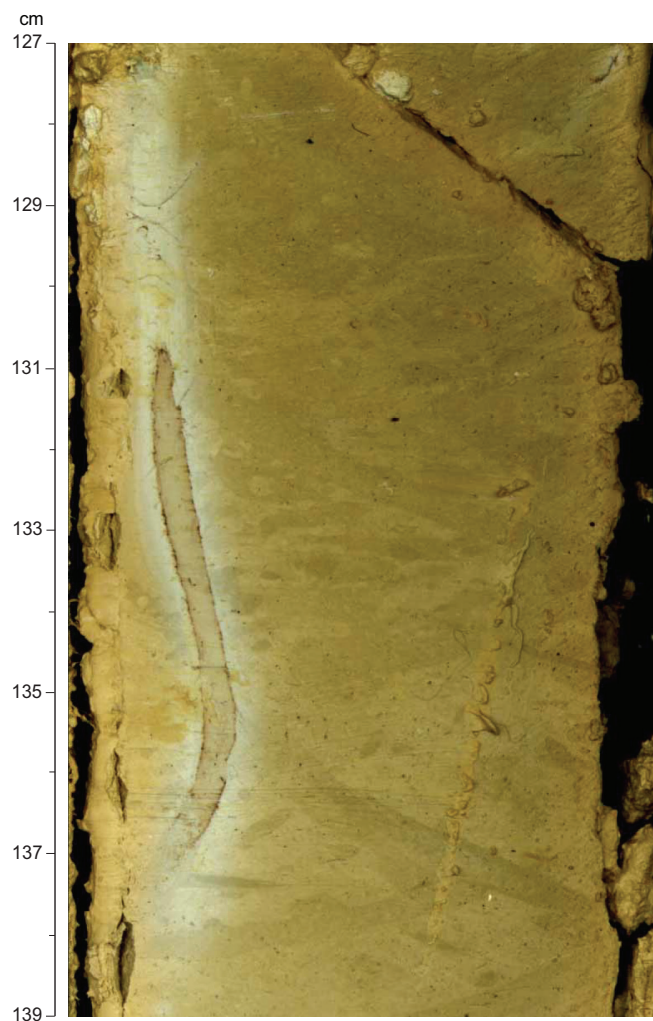


**Figure 13.** “A Bug’s Life:” *Zoophycos* trace, probably left by a single worm during its entire life span (Section NGHP-01-01A-35X-5). Note: Color has been changed from original for optimal illustration of the trace fossil.

recovery contained no core for each of these deployments. Again the  $(N_2 + Ar)/O_2$  ratios exceed that of air likely for the same reason as described above for free gas samples.

## Microbiology

Analysis of all microbiological samples will be shore-based. Eighty-six whole round core samples were collected for shore-based investigation (MBI) (table 7). An additional 109 microbiological samples were taken under lab code JUD. Samples were collected as described in the “Methods” chapter.



**Figure 14.** “A (Different) Bug’s Tomb”: burrow and Fe reduction discoloration halo (brown material delineating the burrow is unknown) in Section NGHP-01-01A-35X-5. Note: Color has been changed from original for optimal illustration of the trace fossil.

**Table 3.** Interstitial water data for Site NGHP-01-01.

[mbsf, meters below sea floor; mL, milliliters; mM, milli-moles]

| Sample name   | Depth (mbsf) | V Samp (mL) | Salinity | Titri Cl (mM) | Br (mM) | SO <sub>4</sub> (mM) | Br/Cl | Comments                        |
|---------------|--------------|-------------|----------|---------------|---------|----------------------|-------|---------------------------------|
| 1H2 90-100    | 2.4          | 11.0        | 34.5     | 559           | 1.04    | 28.38                | 0.002 |                                 |
| 2H2 90-100    | 6.7          | 11.0        | 34.8     | 566           |         |                      |       |                                 |
| 3H4 90-100    | 19.2         | 10.0        | 34.8     | 573           | 0.89    | 23.88                | 0.002 |                                 |
| 4H2 90-100    | 25.7         | 11.0        | 34.8     | 569           |         |                      |       |                                 |
| 5H2 85-100    | 35.2         | 11.0        | 34.8     | 572           |         |                      |       |                                 |
| 7H2 90-100    | 46.7         | 12.0        | 34.8     | 573           | 1.05    | 21.07                | 0.002 |                                 |
| 7H6 100-110   | 52.8         | 11.0        | 34.8     | 572           |         |                      |       |                                 |
| 8H6 100-110   | 62.3         | 12.0        | 34.5     | 571           | 1.08    | 19.41                | 0.002 |                                 |
| 9H6 100-110   | 71.8         | 10.0        | 34.5     | 568           |         |                      |       |                                 |
| 11H4 100-110  | 87.8         | 11.0        | 34.5     | 569           | 1.07    | 18.45                | 0.002 |                                 |
| 13H6 100-110  | 102.3        | 11.0        | 33.5     | 557           | 0.80    | 19.21                | 0.001 |                                 |
| 15H6 100-110  | 121.3        | 11.0        | 34.5     | 566           | 0.89    | 19.63                | 0.002 |                                 |
| 18H3 100-110  | 144.1        | 18.0        | 34.5     | 569           | 0.97    | 22.29                | 0.002 |                                 |
| 21X4 100-110  | 160.3        | 17.0        | 34.5     | 567           | 0.89    | 24.01                | 0.002 | some black FeS pockets          |
| 24X-2 90-110  | 185.7        | 19.0        | 34.8     | 569           | 0.83    | 22.02                | 0.001 | red-brown sediment              |
| 27X-2 90-110  | 207.4        | 18.0        | 34.5     | 566           | 0.90    | 20.34                | 0.002 | red-brown; rather hard sediment |
| 29X-4 100-110 | 229.8        | 12.0        | 34.5     | 567           |         |                      |       | red-brown; rather hard sediment |
| 32X-4 100-110 | 251.1        | 16.0        | 34.8     | 569           | 0.91    | 20.58                | 0.002 | white chalk                     |
| 34X-4 100-110 | 268.4        | 17.0        | 34.8     | 569           |         |                      |       | clayey-chalk/beige              |
| 36X-4 100-110 | 287.6        | 9.0         | 34.8     | 572           | 0.91    | 20.03                | 0.002 | white chalk                     |

## Physical Properties

During Leg 3A, nondestructive measurements were conducted using the MSCL on temperature-equilibrated whole-round core sections that had previously been recovered at NGHP Expedition 01, Site NGHP-01-01 (Leg 1). Thermal conductivity measurements were also conducted on whole-round cores. Various tests were performed on split cores including: electrical resistivity by use of a Wenner array, P-wave velocity by inserted spades, and shear strength by mini-vane, Torvane, and Pocket Penetrometer. Core subsamples were placed in 10-mL beakers and dried at 105 °C to determine water content. Subsequently, the dried samples were analyzed for grain density using gas pycnometers and other sediment parameters were then calculated. See the “Physical Properties” section of the “Methods” chapter for more details.

The physical properties program at Site NGHP-01-01 focused primarily on Hole NGHP-01-01A, which was located in the Arabian Sea on the western continental margin of India within the Kerala-Konkan (KK) Basin. The water depth was 2,663 m. Hole NGHP-01-01A was continuously cored to about 290 mbsf, without recovering gas hydrate, and had an overall core recovery of 98 percent. *In situ* temperature measurements were conducted during drilling operations as was IR imaging of the cores. Wire-line logging was also conducted after coring.

## Infrared (IR) Imaging

### IR Images

APC and XCB cores from Hole NGHP-01-01A were systematically scanned upon arrival on the catwalk using the track-mounted IR camera described in the “Physical Properties” section of the “Methods” chapter. The IR system at Site NGHP-01-01

experienced a power-supply problem and the IR scans were not recorded by the system computer. However, the IR track system was run in manual mode, each core was scanned, and the average core temperature was recorded for many of the runs (table 8).

## Core-End Temperature Readings

Core-end temperature readings were taken on many cores immediately following the IR track imaging. Typically, one or more temperature probes were inserted into the end of one of the sections and allowed to remain there during core processing (table 9).

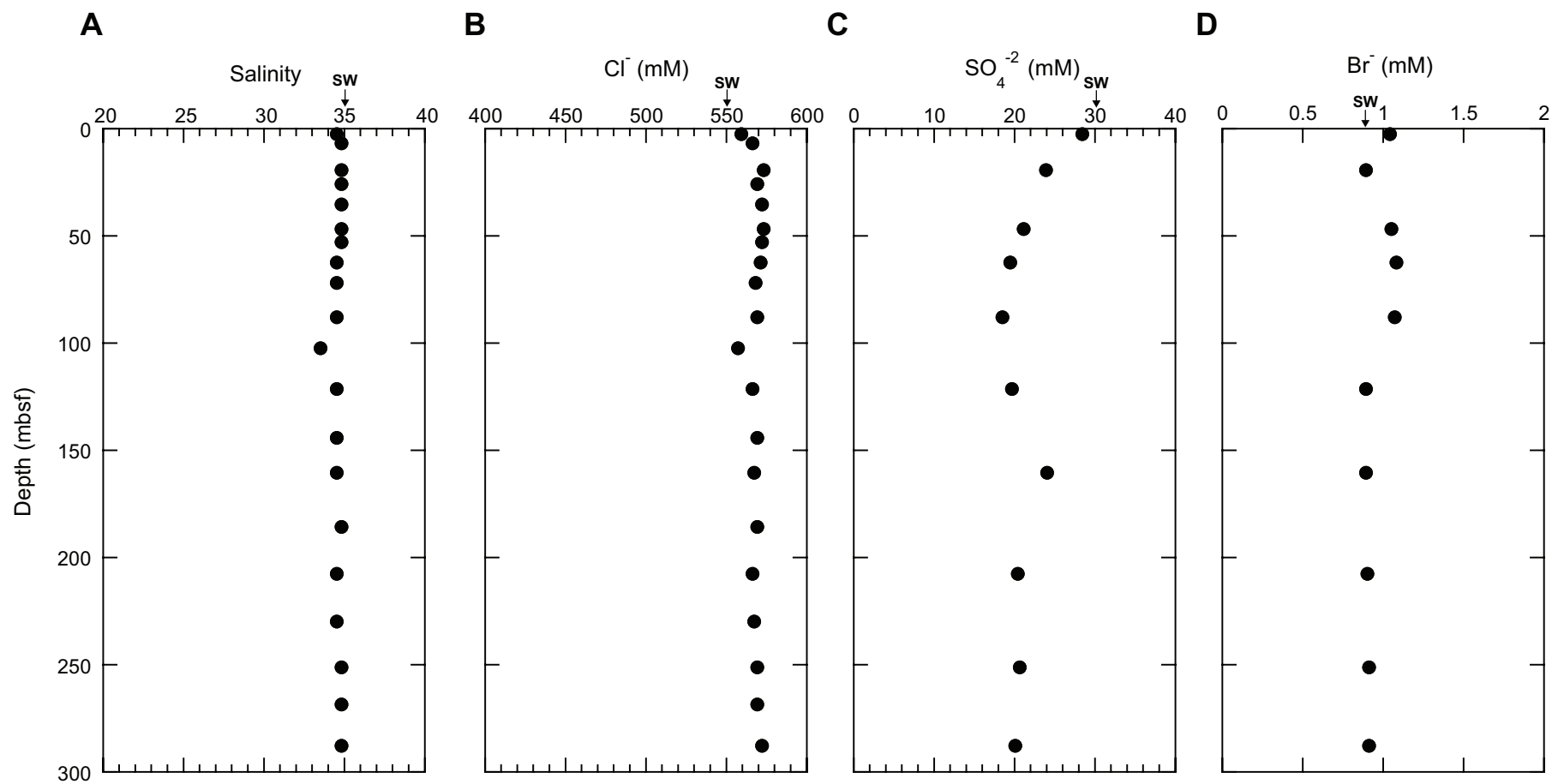
## Index Properties

Overall, water content, porosity, bulk density, grain density, and electrical resistivity varied uniformly downhole (figs. 17 and 18) in nannofossil ooze and related sediment (see “Lithostratigraphy”). This overall trend is also reflected in the wire-line logs.

The water content (92 percent) (related to solids) in the uppermost part of the core decreases rapidly to 70 percent at a depth of ~20 mbsf (table 10) and then linearly at a more gradual rate to the bottom of the hole. Porosity varies from 79 percent to 47 percent downhole. Except for an offset to about 92 mbsf in the MSCL data, bulk densities from wire-line logging, MAD, and MSCL measurements are in close agreement downhole (fig. 17). Grain density varies from 2.58 to 2.83 g/cm<sup>3</sup> with an average value of 2.72 g/cm<sup>3</sup>.

## Strength

Shear strength increased uniformly and linearly with depth to the boundary between APC and XCB coring at about 155 mbsf. Strengths varied widely below that depth illustrating



**Figure 15.** Concentration depth profiles of A, salinity, B, chloride, C, sulfate, and D, bromide. [sw, seawater concentration; mM, milli-moles; mbsf, meters below sea floor]

**Table 4.** Headspace gas composition for Site NGHP-01-01.

| Sample          | Site | Hole | Core | Section | Interval (cm) | Sed wt. (g) | Sample depth (mbsf) | CO <sub>2</sub> | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | O <sub>2</sub> | N <sub>2</sub> +Ar | H <sub>2</sub> S | CO <sub>2</sub> (μL/L WS) | CO <sub>2</sub> (mM PW) |
|-----------------|------|------|------|---------|---------------|-------------|---------------------|-----------------|----------------|----------------|----------------|----------------|--------------------|------------------|---------------------------|-------------------------|
|                 |      |      |      |         |               |             |                     | (ppm-v)         |                |                |                |                |                    |                  |                           |                         |
| 01A-1H1-105-110 | 1    | A    | 1    | 1       | 105–110       | 7.7         | 1.05                | 1,690           | nd             | nd             | nd             | 205,100        | 800,600            | nd               | 5,200                     | 0.3                     |
| 01A-1H3-125-130 | 1    | A    | 1    | 3       | 125–130       | 7.4         | 4.25                | 1,930           | nd             | nd             | nd             | 205,400        | 802,100            | nd               | 6,300                     | 0.4                     |
| 01A-2H4-40-45   | 1    | A    | 2    | 4       | 40–45         | 8           | 9.2                 | 1,990           | nd             | nd             | nd             | 198,600        | 775,200            | nd               | 5,800                     | 0.4                     |
| 01A-3H5-105-100 | 1    | A    | 3    | 5       | 105–110       | 8.5         | 20.85               | 3,890           | nd             | nd             | nd             | 201,900        | 790,000            | nd               | 10,500                    | 0.7                     |
| 01A-3H6-85-90   | 1    | A    | 3    | 6       | 85–90         | 8.7         | 22.15               | 2,760           | nd             | nd             | nd             | 192,300        | 785,600            | nd               | 7,200                     | 0.5                     |
| 01A-4H6-85-90   | 1    | A    | 4    | 6       | 85–90         | 8           | 31.65               | 3,300           | nd             | nd             | nd             | 200,600        | 827,900            | nd               | 9,700                     | 0.7                     |
| 01A-5H6-95-100  | 1    | A    | 5    | 6       | 95–100        | 9.1         | 41.25               | 2,780           | nd             | nd             | nd             | 202,700        | 838,000            | nd               | 6,800                     | 0.5                     |
| 01A-6P-70-80    | 1    | A    | 6    | P       | 70–80         | 8.4         | 43                  | 1,220           | nd             | nd             | nd             | 202,000        | 849,000            | nd               | 3,400                     | 0.2                     |
| 01A-7H6-95-100  | 1    | A    | 7    | 6       | 95–100        | 8.9         | 51.75               | 1,680           | nd             | nd             | nd             | 201,200        | 840,400            | nd               | 4,300                     | 0.3                     |
| 01A-8H6-95-100  | 1    | A    | 8    | 6       | 95–100        | 9.4         | 62.25               | 3,540           | nd             | nd             | nd             | 193,700        | 833,900            | nd               | 8,300                     | 0.6                     |
| 01A-9H6-95-100  | 1    | A    | 9    | 6       | 95–100        | 9.1         | 71.75               | 2,010           | nd             | nd             | nd             | 205,700        | 840,400            | nd               | 4,900                     | 0.4                     |
| 01A-10H6-95-100 | 1    | A    | 10   | 6       | 95–100        | 9.6         | 81.25               | 1,840           | nd             | nd             | nd             | 200,400        | 834,800            | nd               | 4,200                     | 0.3                     |
| 01A-11H6-95-100 | 1    | A    | 11   | 6       | 95–100        | 9.1         | 90.75               | 2,660           | nd             | nd             | nd             | 199,100        | 846,200            | nd               | 6,500                     | 0.5                     |
| 01A-13H6-95-100 | 1    | A    | 13   | 6       | 95–100        | 8.4         | 102.25              | 710             | nd             | nd             | nd             | 195,700        | 824,200            | nd               | 2,000                     | 0.2                     |
| 01A-14H6-95-100 | 1    | A    | 14   | 6       | 95–100        | 8.4         | 111.75              | 1,790           | nd             | nd             | nd             | 191,300        | 774,000            | nd               | 4,900                     | 0.4                     |
| 01A-15H6-95-100 | 1    | A    | 15   | 6       | 95–100        | 14          | 121.25              | 1,810           | nd             | nd             | nd             | 189,000        | 828,200            | nd               | 2,300                     | 0.2                     |
| 01A-16H6-95-100 | 1    | A    | 16   | 6       | 95–100        | 8.3         | 130.75              | 360             | nd             | nd             | nd             | 185,300        | 760,800            | nd               | 1,000                     | 0.1                     |
| 01A-17H4-95-100 | 1    | A    | 17   | 4       | 95–100        | 8.2         | 137.25              | 70              | nd             | nd             | nd             | 190,400        | 769,800            | nd               | 200                       | 0.0                     |
| 01A-18H5-95-100 | 1    | A    | 18   | 5       | 95–100        | 8.5         | 148.25              | 2,990           | nd             | nd             | nd             | 189,400        | 790,000            | nd               | 8,100                     | 0.7                     |
| 01A-19H1-85-90  | 1    | A    | 19   | 1       | 85–90         | 8.8         | 151.65              | 2,250           | nd             | nd             | nd             | 184,500        | 791,500            | nd               | 5,800                     | 0.5                     |
| 01A-20P-70-80   | 1    | A    | 20   | P       | 70–80         | 7.4         | 153.5               | 630             | nd             | nd             | nd             | 201,000        | 794,100            | nd               | 2,100                     | 0.2                     |
| 01A-21X6-95-100 | 1    | A    | 21   | 6       | 95–100        | 9.1         | 163.25              | 780             | nd             | nd             | nd             | 194,900        | 788,200            | nd               | 1,900                     | 0.2                     |
| 01A-22X6-95-100 | 1    | A    | 22   | 6       | 95–100        | 7.3         | 172.95              | 800             | nd             | nd             | nd             | 218,200        | 905,100            | nd               | 2,700                     | 0.3                     |
| 01A-23X6-95-100 | 1    | A    | 23   | 6       | 95–100        | 9.5         | 182.65              | 780             | nd             | nd             | nd             | 219,900        | 886,800            | nd               | 1,800                     | 0.2                     |
| 01A-24X6-95-100 | 1    | A    | 24   | 6       | 95–100        | 9.4         | 192.25              | 2,430           | nd             | nd             | nd             | 206,300        | 839,200            | nd               | 5,700                     | 0.6                     |
| 01A-25X6-95-100 | 1    | A    | 25   | 6       | 95–100        | 3.7         | 201.85              | 2,490           | nd             | nd             | nd             | 204,800        | 803,100            | nd               | 18,700                    | 1.8                     |
| 01A-27X6-85-90  | 1    | A    | 27   | 6       | 85–90         | 10          | 213.35              | 8,610           | nd             | nd             | nd             | 212,800        | 816,900            | nd               | 18,500                    | 2.0                     |
| 01A-28X6-95-100 | 1    | A    | 28   | 6       | 95–100        | 7.1         | 223.05              | 6,420           | nd             | nd             | nd             | 210,600        | 815,900            | nd               | 22,100                    | 2.3                     |
| 01A-29X6-95-100 | 1    | A    | 29   | 6       | 95–100        | 8.8         | 232.75              | 6,000           | nd             | nd             | nd             | 203,300        | 783,400            | nd               | 15,500                    | 1.7                     |
| 01A-30X6-95-100 | 1    | A    | 30   | 6       | 95–100        | 7.2         | 242.35              | 6,030           | nd             | nd             | nd             | 208,700        | 801,500            | nd               | 20,400                    | 2.2                     |
| 01A-32X6-95-100 | 1    | A    | 32   | 6       | 95–100        | 8.2         | 254.05              | 6,330           | nd             | nd             | nd             | 208,800        | 799,900            | nd               | 18,000                    | 2.0                     |
| 01A-33X4-95-100 | 1    | A    | 33   | 4       | 95–100        | 7.8         | 261.65              | 5,030           | nd             | nd             | nd             | 196,900        | 760,100            | nd               | 15,300                    | 1.8                     |
| 01A-34X6-95-100 | 1    | A    | 34   | 6       | 95–100        | 12.3        | 268.35              | 5,040           | nd             | nd             | nd             | 193,600        | 770,100            | nd               | 7,900                     | 1.0                     |
| 01A-35X6-20-25  | 1    | A    | 35   | 6       | 20–25         | 7.5         | 280.95              | 2,590           | nd             | nd             | nd             | 196,500        | 782,500            | nd               | 8,300                     | 1.0                     |
| 01A-36X4-95-100 | 1    | A    | 36   | 4       | 95–100        | 10.6        | 287.55              | 440             | nd             | nd             | nd             | 183,700        | 759,800            | nd               | 900                       | 0.1                     |

Note: nd = not detected; WS = wet sediment; PW = porewater. Approximate detection limits are about 15 ppmv for methane, 30 ppmv for ethane, 50 ppmv for propane, and 20 ppmv for hydrogen sulfide.

the effect of disturbance caused by rotary coring on sediment (tables 11, 12, and 13 and fig. 17). Although testing was to be restricted to intact biscuits, it was occasionally difficult to differentiate between biscuits and adjacent disturbed sediment.

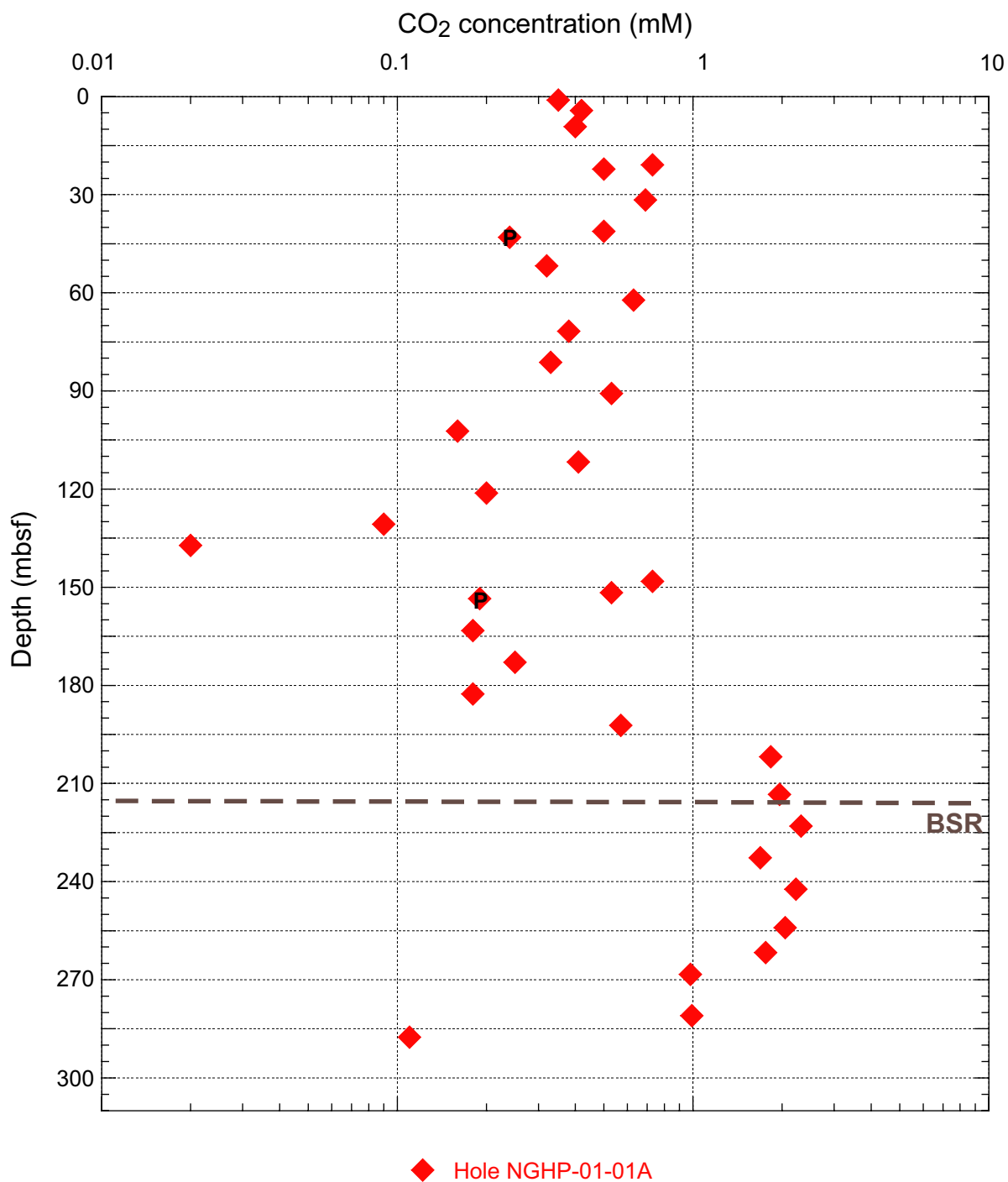
The measured shear strengths were normalized to the effective vertical stress ( $\sigma'_v$ ) (fig. 19) to provide qualitative information on the stress history of the sediment. The strength/effective vertical stress ratios ranges from approximately 1.3 at the top of the hole to an average of about 0.1 near the bottom of the hole. Most of these values are in agreement with a number of other normally consolidated clays (Holtz and Kovacs, 1981). Hunt (1984) states that the strength/effective vertical stress ratio typically is between 0.4 and 0.16. Because almost all of the values are below 0.4, the implication is that these sediments have not experienced a vertical effective stress greater than what is now being applied *in situ*. They have not been overconsolidated by erosional or other geologic processes.

The peak ( $S_v$ ) and remolded ( $S_{rem}$ ) vane shear strengths clearly increase with subbottom depth (fig. 20) and the sensitivity ( $St$ ), which equals  $S_v/S_{rem}$ , typically varies between 2

and 7. Sensitivity values represent the amount of strength loss after remolding, and in extreme examples can reach values of 500 (Lambe and Whitman, 1969). This sediment has low to medium sensitivity (Holtz and Kovacs, 1981). High values of sensitivity are indicative of good quality core recovery because the sediment has not been highly disturbed.

## Electrical Resistivity

Electrical resistivity values produced by wire-line logging, MSCL, and Wenner array are in agreement, although there is a slight offset between values determined using the Wenner array on split cores and MSCL values from about 20 to 53 mbsf (fig. 18). The Wenner measurements are lower than the MSCL values because they are conducted on intact core material, rather than a wider portion of core that may contain voids or small expansion cracks. Lower MSCL values are more representative of undisturbed sediment as they are less impacted by the presence of such micro voids caused by



**Figure 16.** Concentration (mM) depth profile of headspace carbon dioxide. Data points annotated with “P” correspond to PCS samples. Note the increase in CO<sub>2</sub> concentration above the inferred BSR (217 mbsf). This change corresponds to a major change in lithology from foram-rich to foram-poor, clay rich sediments (see “Lithostratigraphy”). [PCS, Pressure Core Sampler]

**Table 5.** Void gas composition for Site NGHP-01-01.

| Sample                              | Site | Hole | Core | Section | Interval (cm) | Sample depth (mbsf) | CO <sub>2</sub> | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | O <sub>2</sub> | N <sub>2</sub> +Ar | H <sub>2</sub> S |
|-------------------------------------|------|------|------|---------|---------------|---------------------|-----------------|----------------|----------------|----------------|----------------|--------------------|------------------|
| (ppmv) normalized to nitrogen+argon |      |      |      |         |               |                     |                 |                |                |                |                |                    |                  |
| 01A-3H6-81                          | 1    | A    | 3H   | 6       | 81            | 22.11               | 403             | nd             | nd             | nd             | 118,800        | 880,300            | nd               |
| 01A-13H6-20                         | 1    | A    | 13H  | 6       | 20            | 101.5               | 318             | nd             | nd             | nd             | 152,700        | 847,000            | nd               |
| 01A-15H6-165                        | 1    | A    | 15H  | 6       | 165           | 121.95              | 228             | nd             | nd             | nd             | 167,600        | 832,100            | nd               |

Notes: nd = not detected; nr = not recorded. Approximate detection limits are about 15 ppmv for methane, 30 ppmv for ethane, 50 ppmv for propane, and 20 ppmv for hydrogen sulfide.

**Table 6.** Pressure Core Sampler (PCS) gas composition for Site NGHP-01-01.

| Sample                              | Site | Hole | Core | Section | Sample depth<br>(mbsf) | Time | Gas vol.<br>(ml) | CO <sub>2</sub> | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | O <sub>2</sub> | N <sub>2</sub> +Ar | H <sub>2</sub> S |
|-------------------------------------|------|------|------|---------|------------------------|------|------------------|-----------------|----------------|----------------|----------------|----------------|--------------------|------------------|
| (ppmv) normalized to nitrogen+argon |      |      |      |         |                        |      |                  |                 |                |                |                |                |                    |                  |
| 01A-12P-T1                          | 1    | A    | 12P  | 1       | 91.8                   | 0    | 220              | 865             | nd             | nd             | nd             | 191,000        | 808,200            | nd               |
| 01A-12P-T2                          | 1    | A    | 12P  | 1       | 91.8                   | 1    | 35               | 821             | nd             | nd             | nd             | 183,500        | 815,700            | nd               |
| 01A-26P-21:00                       | 1    | A    | 26P  | 1       | 203                    | 0    | 97               | 927             | nd             | nd             | nd             | 192,000        | 807,100            | nd               |
| 01A-26P-21:10                       | 1    | A    | 26P  | 1       | 203                    | 1    | 397              | 171             | nd             | nd             | nd             | 148,600        | 851,300            | nd               |
| 01A-26P-21:21                       | 1    | A    | 26P  | 1       | 203                    | 2    | 37               | 345             | nd             | nd             | nd             | 161,400        | 838,300            | nd               |

(Note: 12P contained NO core.)

(Note: 26P contained NO core.)

Note: nd = not detected. Approximate detection limits are about 15 ppmv for methane, 30 ppmv for ethane, 50 ppmv for propane, and 20 ppmv for hydrogen sulfide.

gas expansion. Unlike other holes (for example, Hole NGHP-01-10B) the low wire-line resistivity values do not reflect exceptionally high zones of gas-hydrate concentration in Hole NGHP-01-01A.

The apparent formation factor is the ratio of the resistivity of a saturated sediment to the resistivity of the pore fluid and provides an indication of the relationships between sediment structure, void space, tortuosity, and other factors, and the ability of fluid to flow through the formation. Because pore-water salinity typically varies a small amount in the recovered sediment and is similar to that of seawater (see “Inorganic geochemistry” section), we have normalized the measured Wenner resistivity values by that of seawater (approximately 0.2  $\Omega$ ·m; table 14). Values range from about 2.0 at the top of the core to 4.0 at the bottom, with a spike between 65 and 68 mbsf (fig. 21). Other equations and methods exist for calculating formation factors; however, they require the use of empirical constants that have not yet been determined for the sediments at this particular location.

## P-Wave Velocity

Because of the lack of interstitial gas at this site, P-wave velocity ( $V_p$ ) measured with the MSCL extends to a depth of about 140 m. It increased from 1.52 km/s in the top of the hole (fig. 18) to 1.57 km/s at the bottom of the measurements. MSCL measurements are present below 140 mbsf, but are sparse. The contact  $V_p$  values range from 1.48 to 1.59 km/s (table 15). Valid contact  $V_p$  measurements could not be determined below 40 mbsf.

## Magnetic Susceptibility

Magnetic susceptibility (MS) trends towards lower values with subbottom depth (fig. 18). Because of the lack of primary and secondary magnetic minerals in this nannofossil ooze (see “Lithostratigraphy”), MS is lower than at any other NGHP Expedition 01 site except at Hole NGHP-01-17A.

## Thermal Conductivity

Thermal conductivities vary between 0.439 and 1.174 W/(m·K) and alternate between high and low values with subbottom depth (table 16 and fig. 18). Such values are well within the range of marine sediments (see, for example, Novosel and others, 2007), although they are almost all lower than values determined by Davis and others (1990) for sediment from Cascadia and the Nankai Trough.

## Downhole Temperature Measurements

A number of different tools are available for determining downhole sediment temperature (see the “Physical Properties” section of “Methods” chapter). Both APCT and DVTP tools were used to measure temperatures at five subbottom depths in Site NGHP-01-01. Seafloor temperature was determined to be  $2.4 \pm 0.5$  °C and the geothermal gradient was calculated as  $52 \pm 2$  °C/km (table 17 and fig. 22). The intersection of the geothermal gradient with the gas-hydrate pressure (depth) temperature-stability field from Sloan (1998) provides an estimated depth to the BGHS of 360 mbsf.

**Table 7.** List of microbiological samples taken for Site NGHP-01-01.

| Core, section | Sample code | Sample reference |             |              |             | Comments | Core, section | Sample code | Sample reference |             |              |             | Comments |
|---------------|-------------|------------------|-------------|--------------|-------------|----------|---------------|-------------|------------------|-------------|--------------|-------------|----------|
|               |             | Top (cm)         | Bottom (cm) | Depth (mbsf) | Volume (cc) |          |               |             | Top (cm)         | Bottom (cm) | Depth (mbsf) | Volume (cc) |          |
| NGHP-01-1A    |             |                  |             |              |             |          |               |             |                  |             |              |             |          |
| 1H-2          | MBI         | 100              | 110         | 2.5          | 374         |          | 27X-2         | MBI         | 100              | 105         | 207.5        | 187         |          |
| 2H-2          | MBI         | 100              | 110         | 6.8          | 374         |          | 27X-4         | MBI         | 110              | 120         | 210.6        | 374         |          |
| 2H-4          | MBI         | 55               | 65          | 9.35         | 374         |          | 27X-6         | MBI         | 100              | 110         | 213.5        | 374         |          |
| 3H-2          | MBI         | 100              | 110         | 16.3         | 374         |          | 28X-2         | MBI         | 100              | 110         | 217.1        | 374         |          |
| 3H-4          | MBI         | 100              | 110         | 19.3         | 374         |          | 28X-4         | MBI         | 110              | 120         | 220.2        | 374         |          |
| 3H-6          | MBI         | 100              | 110         | 22.3         | 374         |          | 28X-6         | MBI         | 100              | 110         | 223.1        | 374         |          |
| 4H-2          | MBI         | 100              | 110         | 25.8         | 374         |          | 29X-2         | MBI         | 100              | 110         | 226.8        | 374         |          |
| 4H-4          | MBI         | 100              | 110         | 28.8         | 374         |          | 29X-4         | MBI         | 110              | 120         | 229.9        | 374         |          |
| 4H-6          | MBI         | 100              | 110         | 31.8         | 374         |          | 29X-6         | MBI         | 110              | 120         | 232.9        | 374         |          |
| 5H-2          | MBI         | 100              | 110         | 35.3         | 374         |          | 30X-2         | MBI         | 100              | 110         | 236.4        | 374         |          |
| 5H-4          | MBI         | 110              | 120         | 38.4         | 374         |          | 30X-4         | MBI         | 110              | 120         | 239.5        | 374         |          |
| 5H-6          | MBI         | 110              | 120         | 41.4         | 374         |          | 30X-6         | MBI         | 110              | 120         | 242.5        | 374         |          |
| 7H-2          | MBI         | 100              | 110         | 46.8         | 374         |          | 32X-2         | MBI         | 100              | 110         | 248.1        | 374         |          |
| 7H-4          | MBI         | 110              | 120         | 49.9         | 374         |          | 32X-4         | MBI         | 110              | 120         | 251.2        | 374         |          |
| 7H-6          | MBI         | 110              | 120         | 52.9         | 374         |          | 32X-6         | MBI         | 50               | 120         | 253.6        | 374         |          |
| 8H-2          | MBI         | 100              | 110         | 56.3         | 374         |          | 33X-2         | MBI         | 100              | 110         | 255.7        | 374         |          |
| 8H-4          | MBI         | 110              | 120         | 59.4         | 374         |          | 33X-4         | MBI         | 110              | 120         | 258.8        | 374         |          |
| 8H-6          | MBI         | 110              | 120         | 62.4         | 374         |          | 34X-2         | MBI         | 100              | 110         | 265.4        | 374         |          |
| 9H-2          | MBI         | 100              | 110         | 65.8         | 374         |          | 34X-4         | MBI         | 110              | 120         | 268.5        | 374         |          |
| 9H-4          | MBI         | 110              | 120         | 68.9         | 374         |          | 34X-6         | MBI         | 110              | 120         | 271.5        | 374         |          |
| 9H-6          | MBI         | 110              | 120         | 71.9         | 374         |          | 35X-2         | MBI         | 100              | 110         | 275          | 374         |          |
| 10H-2         | MBI         | 100              | 110         | 75.3         | 374         |          | 35X-4         | MBI         | 110              | 120         | 278.1        | 374         |          |
| 10H-4         | MBI         | 110              | 120         | 78.4         | 374         |          | 35X-6         | MBI         | 35               | 45          | 280.35       | 374         |          |
| 10H-6         | MBI         | 110              | 120         | 81.4         | 374         |          | 36X-2         | MBI         | 100              | 110         | 284.6        | 374         |          |
| 11H-2         | MBI         | 100              | 110         | 84.8         | 374         |          | 36X-4         | MBI         | 110              | 120         | 287.7        | 374         |          |
| 11H-4         | MBI         | 110              | 120         | 87.9         | 374         |          | 1H-1          | JUD         | 0                | 10          | 0            | 374         |          |
| 11H-6         | MBI         | 110              | 120         | 90.9         | 374         |          | 1H-1          | JUD         | 10               | 20          | 0.1          | 374         |          |
| 13H-2         | MBI         | 100              | 110         | 96.3         | 374         |          | 1H-1          | JUD         | 20               | 30          | 0.2          | 374         |          |
| 13H-4         | MBI         | 110              | 120         | 99.4         | 374         |          | 1H-1          | JUD         | 30               | 40          | 0.3          | 374         |          |
| 13H-6         | MBI         | 110              | 120         | 102.4        | 374         |          | 1H-1          | JUD         | 40               | 50          | 0.4          | 374         |          |
| 14H-2         | MBI         | 100              | 110         | 105.8        | 374         |          | 1H-1          | JUD         | 140              | 150         | 1.4          | 374         |          |
| 14H-4         | MBI         | 110              | 120         | 108.9        | 374         |          | 1H-2          | JUD         | 140              | 150         | 2.9          | 374         |          |
| 14H-6         | MBI         | 110              | 120         | 111.9        | 374         |          | 1H-3          | JUD         | 115              | 125         | 4.15         | 374         |          |
| 15H-2         | MBI         | 100              | 110         | 115.3        | 374         |          | 2H-1          | JUD         | 140              | 150         | 5.7          | 374         |          |
| 15H-4         | MBI         | 110              | 120         | 118.4        | 374         |          | 2H-2          | JUD         | 140              | 150         | 7.2          | 374         |          |
| 15H-6         | MBI         | 110              | 120         | 121.4        | 374         |          | 2H-3          | JUD         | 140              | 150         | 8.7          | 374         |          |
| 16H-2         | MBI         | 100              | 110         | 124.8        | 374         |          | 2H-4          | JUD         | 95               | 105         | 9.75         | 374         |          |
| 16H-4         | MBI         | 110              | 120         | 127.9        | 374         |          | 3H-1          | JUD         | 140              | 150         | 15.2         | 374         |          |
| 16H-6         | MBI         | 110              | 120         | 130.9        | 374         |          | 3H-2          | JUD         | 140              | 150         | 16.7         | 374         |          |
| 17H-2         | MBI         | 100              | 110         | 134.3        | 374         |          | 3H-3          | JUD         | 140              | 150         | 18.2         | 374         |          |
| 17H-4         | MBI         | 110              | 120         | 137.4        | 374         |          | 3H-4          | JUD         | 140              | 150         | 19.7         | 374         |          |
| 17H-6         | MBI         | 26               | 36          | 139.06       | 374         |          | 3H-5          | JUD         | 140              | 150         | 21.2         | 374         |          |
| 18H-1         | MBI         | 100              | 110         | 142.3        | 374         |          | 3H-6          | JUD         | 55               | 65          | 21.85        | 374         |          |
| 18H-3         | MBI         | 110              | 120         | 144.24       | 374         |          | 3H-6          | JUD         | 65               | 80          | 21.95        | 561         |          |
| 18H-5         | MBI         | 110              | 120         | 147.24       | 374         |          | 3H-6          | JUD         | 80               | 90          | 22.1         | 374         |          |
| 19H-1         | MBI         | 100              | 110         | 151.8        | 374         |          | 3H-6          | JUD         | 140              | 150         | 22.7         | 374         |          |
| 21X-2         | MBI         | 100              | 110         | 157.3        | 374         |          | 4H-1          | JUD         | 140              | 150         | 24.7         | 374         |          |
| 21X-4         | MBI         | 110              | 120         | 160.4        | 374         |          | 4H-2          | JUD         | 140              | 150         | 26.2         | 374         |          |
| 21X-6         | MBI         | 110              | 120         | 163.4        | 374         |          | 4H-3          | JUD         | 140              | 150         | 27.7         | 374         |          |
| 22X-2         | MBI         | 100              | 110         | 167          | 374         |          | 4H-4          | JUD         | 140              | 150         | 29.2         | 374         |          |
| 22X-4         | MBI         | 110              | 120         | 170.1        | 374         |          | 4H-5          | JUD         | 140              | 150         | 30.7         | 374         |          |
| 22X-6         | MBI         | 110              | 120         | 173.1        | 374         |          | 4H-6          | JUD         | 140              | 150         | 32.2         | 374         |          |
| 23X-2         | MBI         | 100              | 110         | 176.7        | 374         |          | 5H-2          | JUD         | 140              | 150         | 35.7         | 374         |          |
| 23X-4         | MBI         | 110              | 120         | 179.8        | 374         |          | 5H-4          | JUD         | 140              | 150         | 38.7         | 374         |          |
| 23X-6         | MBI         | 110              | 120         | 182.8        | 374         |          | 5H-6          | JUD         | 140              | 150         | 41.7         | 374         |          |
| 24X-2         | MBI         | 100              | 110         | 185.75       | 374         |          | 6P-1          | JUD         | 30               | 35          | 42.6         | 187         |          |
| 24X-4         | MBI         | 110              | 120         | 188.85       | 374         |          | 7H-2          | JUD         | 140              | 150         | 47.2         | 374         |          |
| 24X-6         | MBI         | 110              | 120         | 191.85       | 374         |          | 7H-4          | JUD         | 140              | 150         | 50.2         | 374         |          |
| 25X-2         | MBI         | 100              | 110         | 195.9        | 374         |          | 7H-6          | JUD         | 140              | 150         | 53.2         | 374         |          |
| 25X-4         | MBI         | 110              | 120         | 199          | 374         |          | 8H-2          | JUD         | 140              | 150         | 56.7         | 374         |          |
| 25X-6         | MBI         | 110              | 120         | 202          | 374         |          | 8H-4          | JUD         | 140              | 150         | 59.7         | 374         |          |

**Table 7.** List of microbiological samples taken for Site NGHP-01-01.—Continued

| Sample reference     |             |          |             |              |             | Comments | Sample reference |             |          |             |              |             | Comments |
|----------------------|-------------|----------|-------------|--------------|-------------|----------|------------------|-------------|----------|-------------|--------------|-------------|----------|
| Core, section        | Sample code | Top (cm) | Bottom (cm) | Depth (mbsf) | Volume (cc) |          | Core, section    | Sample code | Top (cm) | Bottom (cm) | Depth (mbsf) | Volume (cc) |          |
| NGHP-01-1A—Continued |             |          |             |              |             |          |                  |             |          |             |              |             |          |
| 8H-6                 | JUD         | 140      | 150         | 62.7         | 374         |          | 23X-4            | JUD         | 140      | 150         | 180.1        | 374         |          |
| 9H-2                 | JUD         | 140      | 150         | 66.2         | 374         |          | 23X-6            | JUD         | 140      | 150         | 183.1        | 374         |          |
| 9H-4                 | JUD         | 140      | 150         | 69.2         | 374         |          | 24X-2            | JUD         | 140      | 150         | 186.15       | 374         |          |
| 9H-6                 | JUD         | 140      | 150         | 72.2         | 374         |          | 24X-4            | JUD         | 140      | 150         | 189.15       | 374         |          |
| 10H-2                | JUD         | 140      | 150         | 75.7         | 374         |          | 24X-6            | JUD         | 140      | 150         | 192.15       | 374         |          |
| 10H-4                | JUD         | 140      | 150         | 78.7         | 374         |          | 25X-2            | JUD         | 140      | 150         | 196.3        | 374         |          |
| 10H-6                | JUD         | 140      | 150         | 81.7         | 374         |          | 25X-4            | JUD         | 140      | 150         | 199.3        | 374         |          |
| 11H-2                | JUD         | 140      | 150         | 85.2         | 374         |          | 25X-6            | JUD         | 140      | 150         | 202.3        | 374         |          |
| 11H-4                | JUD         | 140      | 150         | 88.2         | 374         |          | 27X-1            | JUD         | 140      | 150         | 206.4        | 374         |          |
| 11H-6                | JUD         | 140      | 150         | 91.2         | 374         |          | 27X-2            | JUD         | 140      | 150         | 207.9        | 374         |          |
| 13H-2                | JUD         | 140      | 150         | 96.7         | 374         |          | 27X-3            | JUD         | 140      | 150         | 209.4        | 374         |          |
| 13H-4                | JUD         | 140      | 150         | 99.7         | 374         |          | 27X-4            | JUD         | 140      | 150         | 210.9        | 374         |          |
| 13H-6                | JUD         | 140      | 150         | 102.7        | 374         |          | 27X-5            | JUD         | 140      | 150         | 212.4        | 374         |          |
| 14H-2                | JUD         | 140      | 150         | 106.2        | 374         |          | 27X-6            | JUD         | 140      | 150         | 213.9        | 374         |          |
| 14H-4                | JUD         | 140      | 150         | 109.2        | 374         |          | 28X-2            | JUD         | 140      | 150         | 217.5        | 374         |          |
| 14H-6                | JUD         | 140      | 150         | 112.2        | 374         |          | 28X-4            | JUD         | 140      | 150         | 220.5        | 374         |          |
| 15H-2                | JUD         | 140      | 150         | 115.7        | 374         |          | 28X-6            | JUD         | 140      | 150         | 223.5        | 374         |          |
| 15H-4                | JUD         | 140      | 150         | 118.7        | 374         |          | 29X-2            | JUD         | 140      | 150         | 227.2        | 374         |          |
| 15H-6                | JUD         | 140      | 150         | 121.7        | 374         |          | 29X-4            | JUD         | 140      | 150         | 230.2        | 374         |          |
| 16H-2                | JUD         | 140      | 150         | 125.2        | 374         |          | 29X-6            | JUD         | 140      | 150         | 233.2        | 374         |          |
| 16H-4                | JUD         | 140      | 150         | 128.2        | 374         |          | 30X-2            | JUD         | 140      | 150         | 236.8        | 374         |          |
| 16H-6                | JUD         | 140      | 150         | 131.2        | 374         |          | 30X-4            | JUD         | 140      | 150         | 239.8        | 374         |          |
| 17H-2                | JUD         | 140      | 150         | 134.7        | 374         |          | 30X-6            | JUD         | 140      | 150         | 242.8        | 374         |          |
| 17H-4                | JUD         | 140      | 150         | 137.7        | 374         |          | 32X-2            | JUD         | 140      | 150         | 248.5        | 374         |          |
| 17H-6                | JUD         | 56       | 66          | 139.36       | 374         |          | 32X-4            | JUD         | 140      | 150         | 251.5        | 374         |          |
| 18H-1                | JUD         | 140      | 150         | 142.7        | 374         |          | 32X-6            | JUD         | 80       | 90          | 253.9        | 374         |          |
| 18H-3                | JUD         | 140      | 150         | 144.54       | 374         |          | 33X-2            | JUD         | 140      | 150         | 256.1        | 374         |          |
| 18H-5                | JUD         | 140      | 150         | 147.54       | 374         |          | 33X-4            | JUD         | 140      | 150         | 259.1        | 374         |          |
| 19H-1                | JUD         | 140      | 150         | 152.2        | 374         |          | 34X-2            | JUD         | 140      | 150         | 265.8        | 374         |          |
| 20P-1                | JUD         | 30       | 35          | 154.1        | 187         |          | 34X-4            | JUD         | 140      | 150         | 268.8        | 374         |          |
| 21X-2                | JUD         | 140      | 150         | 157.7        | 374         |          | 34X-6            | JUD         | 140      | 150         | 271.8        | 374         |          |
| 21X-4                | JUD         | 140      | 150         | 160.7        | 374         |          | 35X-2            | JUD         | 140      | 150         | 275.4        | 374         |          |
| 21X-6                | JUD         | 140      | 150         | 163.7        | 374         |          | 35X-4            | JUD         | 140      | 150         | 278.4        | 374         |          |
| 22X-2                | JUD         | 140      | 150         | 167.4        | 374         |          | 35X-6            | JUD         | 65       | 75          | 280.65       | 374         |          |
| 22X-4                | JUD         | 140      | 150         | 170.4        | 374         |          | 36X-2            | JUD         | 140      | 150         | 285          | 374         |          |
| 22X-6                | JUD         | 140      | 150         | 173.4        | 374         |          | 36X-4            | JUD         | 140      | 150         | 288          | 374         |          |
| 23X-2                | JUD         | 140      | 150         | 177.1        | 374         |          |                  |             |          |             |              |             |          |

**Table 8.** Average infrared core liner temperature measured on the catwalk.

| Core           | Temperature (°C) | Core           | Temperature (°C) |
|----------------|------------------|----------------|------------------|
| NGHP-01-01A-01 | N/A              | NGHP-01-01A-20 | N/A              |
| NGHP-01-01A-02 | N/A              | NGHP-01-01A-21 | 23.1             |
| NGHP-01-01A-03 | N/A              | NGHP-01-01A-22 | 22               |
| NGHP-01-01A-04 | N/A              | NGHP-01-01A-23 | 20               |
| NGHP-01-01A-05 | N/A              | NGHP-01-01A-24 | 17               |
| NGHP-01-01A-06 | N/A              | NGHP-01-01A-25 | N/A              |
| NGHP-01-01A-07 | N/A              | NGHP-01-01A-26 | N/A              |
| NGHP-01-01A-08 | N/A              | NGHP-01-01A-27 | N/A              |
| NGHP-01-01A-09 | N/A              | NGHP-01-01A-28 | 21               |
| NGHP-01-01A-10 | N/A              | NGHP-01-01A-29 | 23               |
| NGHP-01-01A-11 | 22               | NGHP-01-01A-30 | N/A              |
| NGHP-01-01A-12 | N/A              | NGHP-01-01A-31 | N/A              |
| NGHP-01-01A-13 | 22               | NGHP-01-01A-32 | 24               |
| NGHP-01-01A-14 | 23.8             | NGHP-01-01A-33 | 23.1             |
| NGHP-01-01A-15 | 22.5             | NGHP-01-01A-34 | 23               |
| NGHP-01-01A-16 | 23               | NGHP-01-01A-35 | 23.3             |
| NGHP-01-01A-17 | 23               | NGHP-01-01A-36 | 23.2             |
| NGHP-01-01A-18 | 24               | NGHP-01-01A-37 | N/A              |
| NGHP-01-01A-19 | N/A              |                |                  |

**Table 9.** Core end temperatures measured on the catwalk and percent core recovery.

| Core | Time on deck |      | Top     | Bottom  | BSF   | Advanced | Cored | Received | Percent | Core temperature |
|------|--------------|------|---------|---------|-------|----------|-------|----------|---------|------------------|
|      | Time         | Date |         |         |       |          |       |          |         |                  |
| 1H   | 18:10        | 5/6  | 2,674.2 | 2,678.5 | 4.3   | 4.3      | 4.3   | 4.35     | 101%    | NO               |
| 2H   | 20:50        | 5/6  | 2,678.5 | 2,688.0 | 13.8  | 9.5      | 9.5   | 5.65     | 59%     | NO               |
| 3H   | 22:20        | 5/6  | 2,688.0 | 2,697.5 | 23.3  | 9.5      | 9.5   | 9.55     | 101%    | NO               |
| 4H   | 23:30        | 5/6  | 2,697.5 | 2,707.0 | 32.8  | 9.5      | 9.5   | 9.75     | 103%    | NO               |
| 5H   | 01:15        | 5/7  | 2,707.0 | 2,716.5 | 42.3  | 9.5      | 9.5   | 9.85     | 104%    | NO               |
| 6P   | 2:50         | 5/7  | 2,716.5 | 2,717.5 | 43.3  | 1.0      | 1.0   | 0.91     | 91%     | APCM             |
| DI   | 2:55         | 5/7  | 2,717.5 | 2,718.5 | 44.3  | 1.0      | -     | -        | -       | NA               |
| 7H   | 04:10        | 5/7  | 2,718.5 | 2,728.0 | 53.8  | 9.5      | 9.5   | 9.88     | 104%    | NO               |
| 8H   | 05:05        | 5/7  | 2,728.0 | 2,737.5 | 63.3  | 9.5      | 9.5   | 9.76     | 103%    | NO               |
| 9H   | 06:20        | 5/7  | 2,737.5 | 2,747.0 | 72.8  | 9.5      | 9.5   | 10.01    | 105%    | YES              |
| 10H  | 07:15        | 5/7  | 2,747.0 | 2,756.5 | 82.3  | 9.5      | 9.5   | 9.84     | 104%    | YES              |
| 11H  | 08:05        | 5/7  | 2,756.5 | 2,766.0 | 91.8  | 9.5      | 9.5   | 10.02    | 105%    | YES              |
| 12P  | 9:10         | 5/7  | 2,766.0 | 2,767.0 | 92.8  | 1.0      | 1.0   | 0.00     | 0%      | APCM             |
| DI   | 9:15         | 5/7  | 2,767.0 | 2,768.0 | 93.8  | 1.0      | -     | -        | -       | NA               |
| 13H  | 10:25        | 5/7  | 2,768.0 | 2,777.5 | 103.3 | 9.5      | 9.5   | 9.59     | 101%    | YES              |
| 14H  | 11:20        | 5/7  | 2,777.5 | 2,787.0 | 112.8 | 9.5      | 9.5   | 10.06    | 106%    | YES              |
| 15H  | 12:10        | 5/7  | 2,787.0 | 2,796.5 | 122.3 | 9.5      | 9.5   | 9.74     | 103%    | NO               |
| 16H  | 13:05        | 5/7  | 2,796.5 | 2,806.0 | 131.8 | 9.5      | 9.5   | 10.14    | 107%    | YES              |
| 17H  | 13:45        | 5/7  | 2,806.0 | 2,815.5 | 141.3 | 9.5      | 9.5   | 7.76     | 82%     | YES              |
| 18H  | 14:25        | 5/7  | 2,815.5 | 2,825.0 | 150.8 | 9.5      | 9.5   | 7.50     | 79%     | YES              |
| 19H  | 15:10        | 5/7  | 2,825.0 | 2,827.0 | 152.8 | 2.0      | 2.0   | 2.13     | 107%    | YES              |
| 20P  | 16:25        | 5/7  | 2,827.0 | 2,828.0 | 153.8 | 1.0      | 1.0   | 1.01     | 101%    | APCM             |
| DI   | 16:30        | 5/7  | 2,828.0 | 2,829.0 | 154.8 | 1.0      | -     | -        | -       | NA               |
| 21X  | 18:00        | 5/7  | 2,829.0 | 2,838.7 | 164.5 | 9.7      | 9.7   | 9.78     | 101%    | YES              |
| 22X  | 21:30        | 5/7  | 2,838.7 | 2,848.4 | 174.2 | 9.7      | 9.7   | 9.67     | 100%    | YES              |
| 23X  | 22:50        | 5/7  | 2,848.4 | 2,858.0 | 183.8 | 9.6      | 9.6   | 9.68     | 101%    | YES              |
| 24X  | 0:05         | 5/8  | 2,858.0 | 2,867.6 | 193.4 | 9.6      | 9.6   | 9.75     | 102%    | YES              |
| 25X  | 1:15         | 5/8  | 2,867.6 | 2,877.2 | 203.0 | 9.6      | 9.6   | 9.83     | 102%    | YES              |
| 26P  | 2:25         | 5/8  | 2,877.2 | 2,878.2 | 204.0 | 1.0      | 1.0   | 0.00     | 0%      | APCM             |
| DI   | 2:30         | 5/8  | 2,878.2 | 2,879.2 | 205.0 | 1.0      | -     | -        | -       | NA               |
| 27X  | 3:40         | 5/8  | 2,879.2 | 2,888.8 | 214.6 | 9.6      | 9.6   | 9.93     | 103%    | YES              |
| 28X  | 6:15         | 5/8  | 2,888.8 | 2,898.5 | 224.3 | 9.7      | 9.7   | 9.92     | 102%    | YES              |
| 29X  | 7:35         | 5/8  | 2,898.5 | 2,908.1 | 233.9 | 9.6      | 9.6   | 9.89     | 103%    | YES              |
| 30X  | 8:45         | 5/8  | 2,908.1 | 2,917.8 | 243.6 | 9.7      | 9.7   | 9.65     | 99%     | YES              |
| 31P  | 9:40         | 5/8  | 2,917.8 | 2,918.8 | 244.6 | 1.0      | 1.0   | 0.00     | 0%      | APCM             |
| DI   | 9:45         | 5/8  | 2,918.8 | 2,919.8 | 245.6 | 1.0      | -     | -        | -       | NA               |
| 32X  | 10:35        | 5/8  | 2,919.8 | 2,927.4 | 253.2 | 7.6      | 7.6   | 8.80     | 116%    | YES              |
| 33X  | 11:30        | 5/8  | 2,927.4 | 2,937.1 | 262.9 | 9.7      | 9.7   | 9.40     | 97%     | YES              |
| 34X  | 12:30        | 5/8  | 2,937.1 | 2,946.7 | 272.5 | 9.6      | 9.6   | 9.84     | 103%    | YES              |
| 35X  | 13:30        | 5/8  | 2,946.7 | 2,956.3 | 282.1 | 9.6      | 9.6   | 8.45     | 88%     | YES              |
| 36X  | 14:35        | 5/8  | 2,956.3 | 2,963.2 | 289.0 | 6.9      | 6.9   | 7.17     | 104%    | YES              |
| 37P  | 15:30        | 5/8  | 2,963.2 | 2,964.2 | 290.0 | 1.0      | 1.0   | 0.00     | 0%      | APCM             |

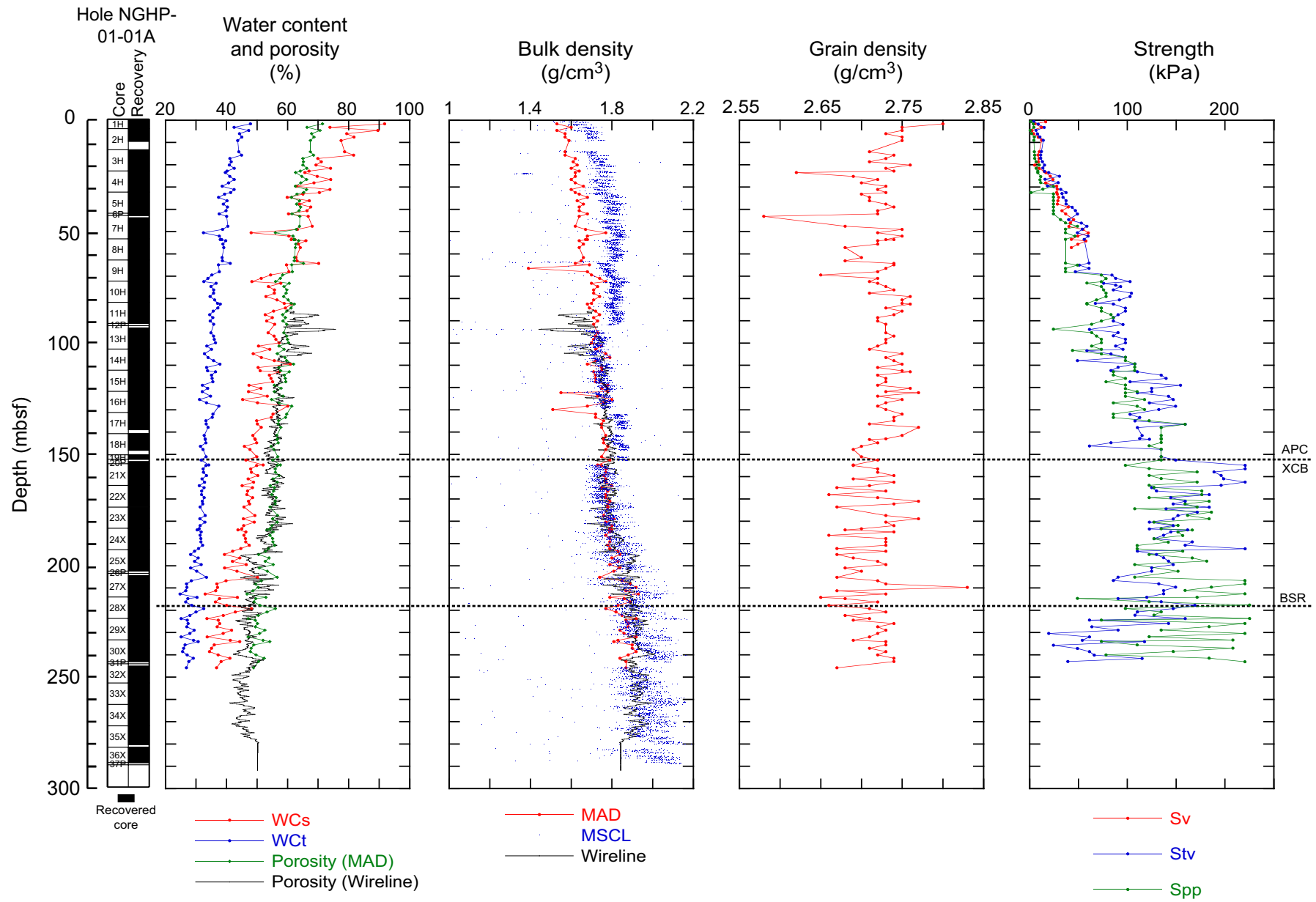
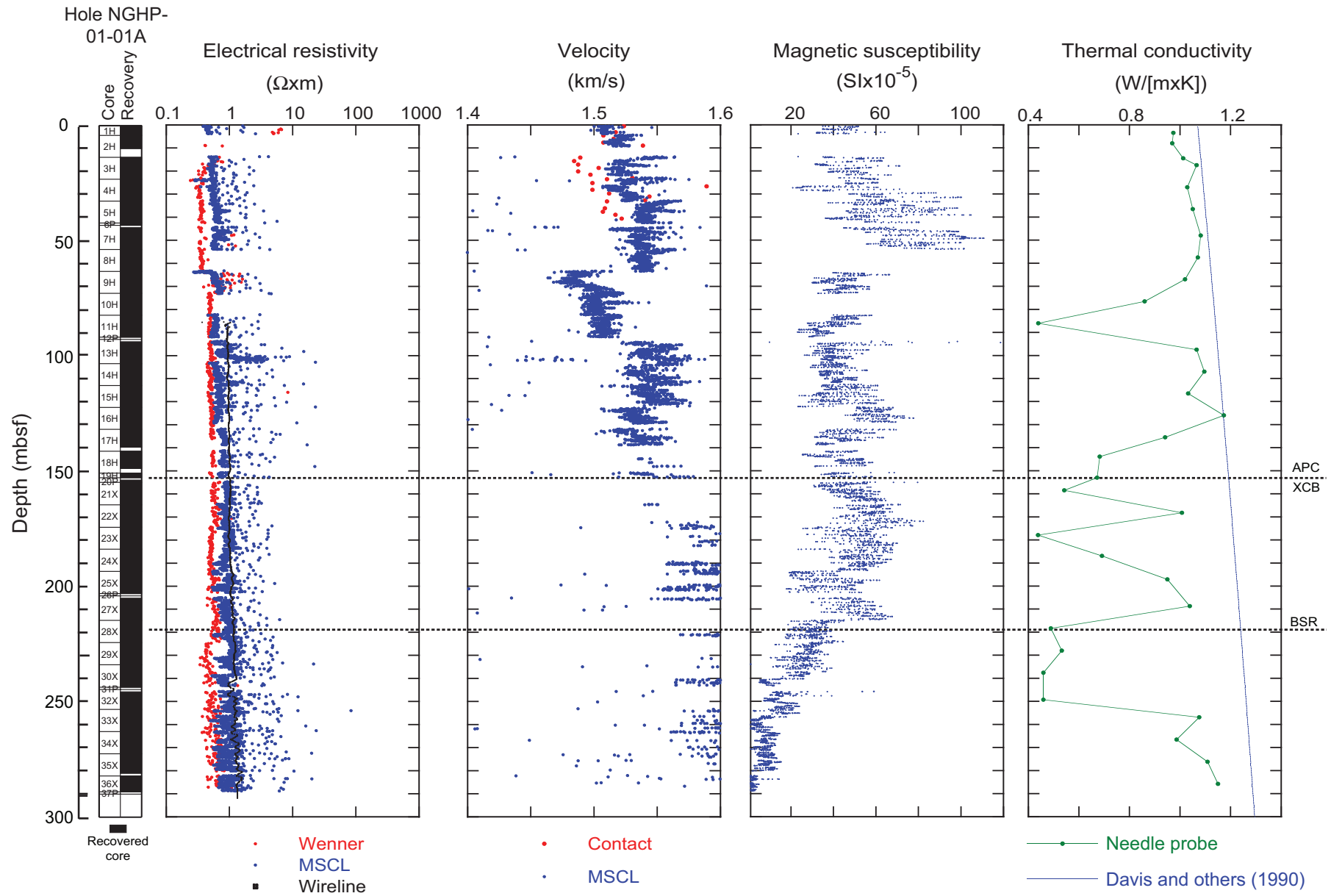


Figure 17. Profiles of core recovery, index and strength properties for Hole NGHP-01-01A.



**Figure 18.** Profiles of core recovery, electrical resistivity,  $P$ -wave velocity, magnetic susceptibility, and thermal conductivity for Hole NGHP-01-01A.

**Table 10.** Moisture and density (MAD) physical properties for Hole NGHP-01-01A.

| Core, section,<br>interval<br>(cm) | Sample<br>code | Depth<br>(mbsf) | WCt<br>(%) | WCs<br>(%) | Grain<br>density<br>(g/cm <sup>3</sup> ) | Bulk<br>density<br>(g/cm <sup>3</sup> ) | Dry bulk<br>density<br>(g/cm <sup>3</sup> ) | Porosity<br>(%) | Void<br>ratio | Unit<br>weight<br>(kN/m <sup>3</sup> ) |
|------------------------------------|----------------|-----------------|------------|------------|------------------------------------------|-----------------------------------------|---------------------------------------------|-----------------|---------------|----------------------------------------|
| NGHP-01-01A                        |                |                 |            |            |                                          |                                         |                                             |                 |               |                                        |
| 1H-2,13-15                         | MAD            | 1.63            | 47.86      | 91.78      | 2.8                                      | 1.53                                    | 0.8                                         | 71.48           | 2.51          | 15.04                                  |
| 1H-3,15-17                         | MAD            | 3.15            | 42.49      | 73.9       | 2.75                                     | 1.6                                     | 0.92                                        | 66.42           | 1.98          | 15.74                                  |
| 2H-1,31-33                         | MAD            | 4.61            | 47.25      | 89.59      | 2.75                                     | 1.53                                    | 0.81                                        | 70.62           | 2.4           | 15.05                                  |
| 2H-2,29-31                         | MAD            | 6.09            | 44.27      | 79.43      | 2.73                                     | 1.57                                    | 0.88                                        | 67.88           | 2.11          | 15.44                                  |
| 2H-3,33-35                         | MAD            | 7.63            | 44.99      | 81.8       | 2.75                                     | 1.57                                    | 0.86                                        | 68.65           | 2.19          | 15.36                                  |
| 2H-4,32-34                         | MAD            | 9.12            | 43.68      | 77.55      | 2.75                                     | 1.59                                    | 0.89                                        | 67.5            | 2.08          | 15.56                                  |
| 3H-1,39-41                         | MAD            | 14.19           | 44.03      | 78.67      | 2.71                                     | 1.57                                    | 0.88                                        | 67.48           | 2.08          | 15.43                                  |
| 3H-2,40-42                         | MAD            | 15.7            | 44.95      | 81.64      | 2.74                                     | 1.57                                    | 0.86                                        | 68.56           | 2.18          | 15.36                                  |
| 3H-3,45-47                         | MAD            | 17.25           | 41.15      | 69.94      | 2.73                                     | 1.62                                    | 0.95                                        | 65.05           | 1.86          | 15.91                                  |
| 3H-4,39-41                         | MAD            | 18.69           | 41.54      | 71.05      | 2.71                                     | 1.61                                    | 0.94                                        | 65.21           | 1.87          | 15.81                                  |
| 3H-5,33-35                         | MAD            | 20.13           | 40.95      | 69.35      | 2.76                                     | 1.63                                    | 0.96                                        | 65.06           | 1.86          | 16                                     |
| 3H-6,29-31                         | MAD            | 21.59           | 42.57      | 74.12      | 2.73                                     | 1.6                                     | 0.92                                        | 66.37           | 1.97          | 15.7                                   |
| 3H-7,7-9                           | MAD            | 22.87           | 40.15      | 67.09      | 2.74                                     | 1.64                                    | 0.98                                        | 64.19           | 1.79          | 16.1                                   |
| 4H-1,18-20                         | MAD            | 23.48           | 39.64      | 65.68      | 2.62                                     | 1.62                                    | 0.98                                        | 62.67           | 1.68          | 15.92                                  |
| 4H-2,44-46                         | MAD            | 25.24           | 41.1       | 69.77      | 2.69                                     | 1.62                                    | 0.95                                        | 64.65           | 1.83          | 15.84                                  |
| 4H-3,32-34                         | MAD            | 26.62           | 42.57      | 74.13      | 2.72                                     | 1.6                                     | 0.92                                        | 66.3            | 1.97          | 15.68                                  |
| 4H-4,33-35                         | MAD            | 28.13           | 40.72      | 68.7       | 2.7                                      | 1.62                                    | 0.96                                        | 64.41           | 1.81          | 15.92                                  |
| 4H-5,36-38                         | MAD            | 29.66           | 38.64      | 62.98      | 2.73                                     | 1.66                                    | 1.02                                        | 62.59           | 1.67          | 16.31                                  |
| 4H-6,30-32                         | MAD            | 31.1            | 42.51      | 73.94      | 2.72                                     | 1.6                                     | 0.92                                        | 66.25           | 1.96          | 15.69                                  |
| 4H-7,22-24                         | MAD            | 32.52           | 41.35      | 70.49      | 2.73                                     | 1.62                                    | 0.95                                        | 65.25           | 1.88          | 15.89                                  |
| 5H-1,38-40                         | MAD            | 33.18           | 39.4       | 65.03      | 2.7                                      | 1.64                                    | 1                                           | 63.1            | 1.71          | 16.12                                  |
| 5H-2,36-38                         | MAD            | 34.66           | 37.46      | 59.91      | 2.71                                     | 1.68                                    | 1.05                                        | 61.29           | 1.58          | 16.47                                  |
| 5H-3,38-40                         | MAD            | 36.18           | 40.17      | 67.15      | 2.71                                     | 1.63                                    | 0.98                                        | 63.97           | 1.78          | 16.03                                  |
| 5H-4,39-41                         | MAD            | 37.69           | 39         | 63.92      | 2.73                                     | 1.66                                    | 1.01                                        | 62.93           | 1.7           | 16.25                                  |
| 5H-5,20-22                         | MAD            | 39              | 40.34      | 67.63      | 2.74                                     | 1.64                                    | 0.98                                        | 64.35           | 1.8           | 16.06                                  |
| 5H-6,39-41                         | MAD            | 40.69           | 39.9       | 66.39      | 2.72                                     | 1.64                                    | 0.99                                        | 63.76           | 1.76          | 16.09                                  |
| 5H-7,27-29                         | MAD            | 42.07           | 37.63      | 60.32      | 2.72                                     | 1.68                                    | 1.05                                        | 61.47           | 1.6           | 16.45                                  |
| 6P-1,91-93                         | MAD            | 43.21           | 40.03      | 66.75      | 2.58                                     | 1.64                                    | 0.98                                        | 64.02           | 1.78          | 16.1                                   |
| 7H-3,34-36                         | MAD            | 47.64           | 40.5       | 68.07      | 2.68                                     | 1.62                                    | 0.96                                        | 63.97           | 1.78          | 15.9                                   |
| 7H-4,23-25                         | MAD            | 49.03           | 38.73      | 63.22      | 2.75                                     | 1.67                                    | 1.02                                        | 62.91           | 1.7           | 16.35                                  |
| 7H-5,23-25                         | MAD            | 50.53           | 32.47      | 48.09      | 2.72                                     | 1.77                                    | 1.2                                         | 56.03           | 1.27          | 17.37                                  |
| 7H-6,27-29                         | MAD            | 52.07           | 37.66      | 60.42      | 2.75                                     | 1.68                                    | 1.05                                        | 61.79           | 1.62          | 16.52                                  |
| 7H-7,28-30                         | MAD            | 53.58           | 38.43      | 62.42      | 2.73                                     | 1.67                                    | 1.03                                        | 62.39           | 1.66          | 16.35                                  |
| 7H-7,30-32                         | MAD            | 53.6            | 37.96      | 61.2       | 2.74                                     | 1.68                                    | 1.04                                        | 62.03           | 1.63          | 16.45                                  |
| 8H-1,35-37                         | MAD            | 54.15           | 39.78      | 66.06      | 2.72                                     | 1.64                                    | 0.99                                        | 63.64           | 1.75          | 16.11                                  |
| 8H-2,36-38                         | MAD            | 55.66           | 38.85      | 63.54      | 2.72                                     | 1.66                                    | 1.01                                        | 62.7            | 1.68          | 16.25                                  |
| 8H-3,36-38                         | MAD            | 57.16           | 39.09      | 64.19      | 2.68                                     | 1.64                                    | 1                                           | 62.61           | 1.67          | 16.12                                  |
| 8H-6,36-38                         | MAD            | 61.66           | 38.56      | 62.76      | 2.7                                      | 1.66                                    | 1.02                                        | 62.28           | 1.65          | 16.26                                  |
| 8H-7,36-38                         | MAD            | 63.16           | 38.69      | 63.11      | 2.68                                     | 1.65                                    | 1.01                                        | 62.24           | 1.65          | 16.2                                   |
| 9H-1,99-101                        | MAD            | 64.29           | 41.26      | 70.24      | 2.74                                     | 1.62                                    | 0.95                                        | 65.19           | 1.87          | 15.91                                  |
| 9H-2,18-20                         | MAD            | 64.98           | 37.37      | 59.68      | 2.74                                     | 1.69                                    | 1.06                                        | 61.43           | 1.59          | 16.55                                  |
| 9H-3,18-20                         | MAD            | 66.48           | 58.05      | 138.37     | 2.73                                     | 1.39                                    | 0.58                                        | 78.65           | 3.68          | 13.64                                  |
| 9H-4,21-23                         | MAD            | 68.01           | 37.68      | 60.46      | 2.72                                     | 1.68                                    | 1.05                                        | 61.55           | 1.6           | 16.45                                  |
| 9H-5,18-20                         | MAD            | 69.48           | 35.26      | 54.46      | 2.65                                     | 1.7                                     | 1.1                                         | 58.45           | 1.41          | 16.69                                  |
| 9H-6,19-21                         | MAD            | 70.99           | 33.93      | 51.37      | 2.72                                     | 1.74                                    | 1.15                                        | 57.65           | 1.36          | 17.1                                   |
| 9H-7,15-17                         | MAD            | 72.45           | 32.59      | 48.34      | 2.71                                     | 1.77                                    | 1.19                                        | 56.07           | 1.28          | 17.33                                  |
| 10H-1,39-41                        | MAD            | 73.19           | 36.63      | 57.8       | 2.72                                     | 1.7                                     | 1.08                                        | 60.54           | 1.53          | 16.64                                  |
| 10H-2,40-42                        | MAD            | 74.7            | 34.96      | 53.75      | 2.73                                     | 1.73                                    | 1.12                                        | 58.81           | 1.43          | 16.94                                  |
| 10H-3,37-39                        | MAD            | 76.17           | 35.8       | 55.76      | 2.74                                     | 1.71                                    | 1.1                                         | 59.79           | 1.49          | 16.82                                  |
| 10H-4,38-40                        | MAD            | 77.68           | 35.76      | 55.67      | 2.71                                     | 1.71                                    | 1.1                                         | 59.53           | 1.47          | 16.76                                  |
| 10H-5,39-41                        | MAD            | 79.19           | 34.61      | 52.92      | 2.76                                     | 1.74                                    | 1.14                                        | 58.72           | 1.42          | 17.08                                  |
| 10H-6,38-40                        | MAD            | 80.68           | 36.12      | 56.55      | 2.75                                     | 1.71                                    | 1.09                                        | 60.2            | 1.51          | 16.78                                  |
| 10H-7,43-45                        | MAD            | 82.23           | 37.07      | 58.9       | 2.75                                     | 1.7                                     | 1.07                                        | 61.24           | 1.58          | 16.63                                  |

**Table 10.** Moisture and density (MAD) physical properties for Hole NGHP-01-01A.—Continued

| Core, section,<br>interval<br>(cm) | Sample<br>code | Depth<br>(mbsf) | WCt<br>(%) | WCs<br>(%) | Grain<br>density<br>(g/cm <sup>3</sup> ) | Bulk<br>density<br>(g/cm <sup>3</sup> ) | Dry bulk<br>density<br>(g/cm <sup>3</sup> ) | Porosity<br>(%) | Void<br>ratio | Unit<br>weight<br>(kN/m <sup>3</sup> ) |
|------------------------------------|----------------|-----------------|------------|------------|------------------------------------------|-----------------------------------------|---------------------------------------------|-----------------|---------------|----------------------------------------|
| NGHP-01-01A—Continued              |                |                 |            |            |                                          |                                         |                                             |                 |               |                                        |
| 11H-1,26-28                        | MAD            | 82.56           | 37.99      | 61.26      | 2.76                                     | 1.68                                    | 1.04                                        | 62.22           | 1.65          | 16.49                                  |
| 11H-2,52-54                        | MAD            | 84.32           | 37.22      | 59.3       | 2.73                                     | 1.69                                    | 1.06                                        | 61.17           | 1.58          | 16.55                                  |
| 11H-3,48-50                        | MAD            | 85.78           | 35.66      | 55.41      | 2.75                                     | 1.72                                    | 1.11                                        | 59.76           | 1.49          | 16.88                                  |
| 11H-4,53-55                        | MAD            | 87.33           | 34.5       | 52.67      | 2.74                                     | 1.74                                    | 1.14                                        | 58.41           | 1.4           | 17.05                                  |
| 11H-5,35-37                        | MAD            | 88.65           | 35.5       | 55.04      | 2.72                                     | 1.71                                    | 1.11                                        | 59.29           | 1.46          | 16.82                                  |
| 11H-6,35-37                        | MAD            | 90.15           | 34.72      | 53.19      | 2.72                                     | 1.73                                    | 1.13                                        | 58.53           | 1.41          | 16.97                                  |
| 11H-7,36-38                        | MAD            | 91.66           | 35.82      | 55.81      | 2.73                                     | 1.71                                    | 1.1                                         | 59.74           | 1.48          | 16.79                                  |
| 13H-2,12-14                        | MAD            | 95.42           | 34.93      | 53.68      | 2.73                                     | 1.73                                    | 1.12                                        | 58.76           | 1.43          | 16.94                                  |
| 13H-3,12-14                        | MAD            | 96.92           | 35.74      | 55.62      | 2.74                                     | 1.72                                    | 1.1                                         | 59.74           | 1.48          | 16.83                                  |
| 13H-4,13-15                        | MAD            | 98.43           | 35.99      | 56.23      | 2.73                                     | 1.71                                    | 1.09                                        | 59.95           | 1.5           | 16.77                                  |
| 13H-5,13-15                        | MAD            | 99.93           | 36.4       | 57.23      | 2.73                                     | 1.7                                     | 1.08                                        | 60.34           | 1.52          | 16.69                                  |
| 13H-6,12-14                        | MAD            | 101.42          | 33.54      | 50.47      | 2.72                                     | 1.75                                    | 1.16                                        | 57.2            | 1.34          | 17.17                                  |
| 13H-7,9-11                         | MAD            | 102.89          | 35.13      | 54.16      | 2.71                                     | 1.72                                    | 1.12                                        | 58.87           | 1.43          | 16.87                                  |
| 14H-2,7-9                          | MAD            | 104.87          | 32.79      | 48.79      | 2.75                                     | 1.77                                    | 1.19                                        | 56.64           | 1.31          | 17.39                                  |
| 14H-3,22-24                        | MAD            | 106.52          | 33.97      | 51.43      | 2.73                                     | 1.79                                    | 1.18                                        | 59.15           | 1.45          | 17.53                                  |
| 14H-4,22-24                        | MAD            | 108.02          | 35.76      | 55.67      | 2.74                                     | 1.72                                    | 1.1                                         | 59.75           | 1.48          | 16.82                                  |
| 14H-5,21-23                        | MAD            | 109.51          | 37.86      | 60.93      | 2.75                                     | 1.68                                    | 1.05                                        | 62.02           | 1.63          | 16.49                                  |
| 14H-6,22-24                        | MAD            | 111.02          | 33.49      | 50.36      | 2.72                                     | 1.75                                    | 1.16                                        | 57.12           | 1.33          | 17.17                                  |
| 14H-7,21-23                        | MAD            | 112.51          | 33.79      | 51.04      | 2.75                                     | 1.75                                    | 1.16                                        | 57.75           | 1.37          | 17.21                                  |
| 15H-1,16-18                        | MAD            | 112.96          | 36.43      | 57.3       | 2.76                                     | 1.71                                    | 1.09                                        | 60.61           | 1.54          | 16.75                                  |
| 15H-2,16-18                        | MAD            | 114.46          | 35.1       | 54.07      | 2.72                                     | 1.72                                    | 1.12                                        | 58.87           | 1.43          | 16.89                                  |
| 15H-3,16-18                        | MAD            | 115.96          | 35.31      | 54.59      | 2.73                                     | 1.72                                    | 1.11                                        | 59.23           | 1.45          | 16.89                                  |
| 15H-4,16-18                        | MAD            | 117.46          | 35.54      | 55.13      | 2.73                                     | 1.72                                    | 1.11                                        | 59.44           | 1.47          | 16.84                                  |
| 15H-5,16-18                        | MAD            | 118.96          | 32.16      | 47.4       | 2.72                                     | 1.78                                    | 1.21                                        | 55.66           | 1.26          | 17.43                                  |
| 15H-6,8-10                         | MAD            | 120.38          | 33.88      | 51.25      | 2.76                                     | 1.75                                    | 1.16                                        | 57.9            | 1.38          | 17.21                                  |
| 15H-7,8-10                         | MAD            | 121.88          | 32.07      | 47.21      | 2.73                                     | 1.78                                    | 1.21                                        | 55.7            | 1.26          | 17.49                                  |
| 16H-1,8-10                         | MAD            | 122.38          | 46.69      | 87.6       | 2.77                                     | 1.55                                    | 0.82                                        | 70.27           | 2.36          | 15.15                                  |
| 16H-2,8-10                         | MAD            | 123.88          | 34.8       | 53.37      | 2.72                                     | 1.73                                    | 1.13                                        | 58.55           | 1.41          | 16.94                                  |
| 16H-3,8-10                         | MAD            | 125.38          | 31.17      | 45.3       | 2.75                                     | 1.8                                     | 1.24                                        | 54.78           | 1.21          | 17.69                                  |
| 16H-4,8-10                         | MAD            | 126.88          | 33.43      | 50.21      | 2.73                                     | 1.76                                    | 1.17                                        | 57.15           | 1.33          | 17.22                                  |
| 16H-5,8-10                         | MAD            | 128.38          | 37.52      | 60.06      | 2.72                                     | 1.68                                    | 1.05                                        | 61.43           | 1.59          | 16.48                                  |
| 16H-6,8-10                         | MAD            | 129.88          | 49.01      | 96.12      | 2.73                                     | 1.51                                    | 0.77                                        | 71.91           | 2.56          | 14.77                                  |
| 17H-1,14-16                        | MAD            | 131.94          | 35.59      | 55.26      | 2.75                                     | 1.72                                    | 1.11                                        | 59.72           | 1.48          | 16.89                                  |
| 17H-2,14-16                        | MAD            | 133.44          | 35.38      | 54.75      | 2.74                                     | 1.72                                    | 1.11                                        | 59.37           | 1.46          | 16.9                                   |
| 17H-3,14-16                        | MAD            | 134.94          | 33.28      | 49.89      | 2.74                                     | 1.76                                    | 1.18                                        | 57.1            | 1.33          | 17.27                                  |
| 17H-4,14-16                        | MAD            | 136.44          | 33.38      | 50.11      | 2.71                                     | 1.75                                    | 1.17                                        | 56.93           | 1.32          | 17.17                                  |
| 17H-5,14-16                        | MAD            | 137.94          | 33.95      | 51.41      | 2.77                                     | 1.75                                    | 1.15                                        | 57.82           | 1.37          | 17.15                                  |
| 18H-1,24-26                        | MAD            | 141.54          | 32.72      | 48.63      | 2.75                                     | 1.77                                    | 1.19                                        | 56.53           | 1.3           | 17.4                                   |
| 18H-2,24-26                        | MAD            | 143.04          | 33.02      | 49.29      | 2.73                                     | 1.76                                    | 1.18                                        | 56.74           | 1.31          | 17.3                                   |
| 18H-3,24-26                        | MAD            | 143.38          | 33.07      | 49.41      | 2.71                                     | 1.76                                    | 1.18                                        | 56.59           | 1.3           | 17.23                                  |
| 18H-4,24-26                        | MAD            | 144.88          | 33.28      | 49.87      | 2.72                                     | 1.76                                    | 1.17                                        | 56.96           | 1.32          | 17.23                                  |
| 18H-5,24-26                        | MAD            | 146.38          | 31.46      | 45.89      | 2.7                                      | 1.78                                    | 1.22                                        | 54.67           | 1.21          | 17.5                                   |
| 18H-6,24-26                        | MAD            | 147.88          | 32.29      | 47.7       | 2.69                                     | 1.77                                    | 1.2                                         | 55.55           | 1.25          | 17.32                                  |
| 19H-1,31-33                        | MAD            | 151.11          | 33.31      | 49.96      | 2.7                                      | 1.75                                    | 1.17                                        | 56.8            | 1.31          | 17.17                                  |
| 19H-2,27-29                        | MAD            | 152.57          | 31.69      | 46.39      | 2.72                                     | 1.79                                    | 1.22                                        | 55.12           | 1.23          | 17.52                                  |
| 20P-1,98-100                       | MAD            | 154.78          | 34.24      | 52.06      | 2.69                                     | 1.73                                    | 1.14                                        | 57.73           | 1.37          | 16.98                                  |
| 21X-1,26-28                        | MAD            | 155.06          | 33.28      | 49.88      | 2.69                                     | 1.75                                    | 1.17                                        | 56.69           | 1.31          | 17.15                                  |
| 21X-2,26-28                        | MAD            | 156.56          | 32.39      | 47.91      | 2.72                                     | 1.77                                    | 1.2                                         | 55.96           | 1.27          | 17.4                                   |
| 21X-3,26-28                        | MAD            | 158.06          | 32.5       | 48.15      | 2.72                                     | 1.77                                    | 1.2                                         | 56.05           | 1.28          | 17.37                                  |
| 21X-4,26-28                        | MAD            | 159.56          | 33.44      | 50.24      | 2.74                                     | 1.76                                    | 1.17                                        | 57.31           | 1.34          | 17.26                                  |
| 21X-5,26-28                        | MAD            | 161.06          | 32.03      | 47.12      | 2.69                                     | 1.77                                    | 1.2                                         | 55.27           | 1.24          | 17.37                                  |
| 21X-6,26-28                        | MAD            | 162.56          | 32.82      | 48.86      | 2.74                                     | 1.77                                    | 1.19                                        | 56.64           | 1.31          | 17.37                                  |
| 21X-7,26-28                        | MAD            | 164.06          | 31.1       | 45.13      | 2.71                                     | 1.8                                     | 1.24                                        | 54.39           | 1.19          | 17.61                                  |
| 22X-1,44-46                        | MAD            | 164.94          | 32.66      | 48.5       | 2.67                                     | 1.75                                    | 1.18                                        | 55.76           | 1.26          | 17.19                                  |

**Table 10.** Moisture and density (MAD) physical properties for Hole NGHP-01-01A.—Continued

| Core, section,<br>interval<br>(cm) | Sample<br>code | Depth<br>(mbsf) | WCt<br>(%) | WCs<br>(%) | Grain<br>density<br>(g/cm <sup>3</sup> ) | Bulk<br>density<br>(g/cm <sup>3</sup> ) | Dry bulk<br>density<br>(g/cm <sup>3</sup> ) | Porosity<br>(%) | Void<br>ratio | Unit<br>weight<br>(kN/m <sup>3</sup> ) |
|------------------------------------|----------------|-----------------|------------|------------|------------------------------------------|-----------------------------------------|---------------------------------------------|-----------------|---------------|----------------------------------------|
| NGHP-01-01A—Continued              |                |                 |            |            |                                          |                                         |                                             |                 |               |                                        |
| 22X-2,48-50                        | MAD            | 166.48          | 31.92      | 46.89      | 2.73                                     | 1.78                                    | 1.21                                        | 55.46           | 1.25          | 17.49                                  |
| 22X-3,58-60                        | MAD            | 168.08          | 31.82      | 46.68      | 2.66                                     | 1.77                                    | 1.2                                         | 54.76           | 1.21          | 17.33                                  |
| 22X-4,48-50                        | MAD            | 169.48          | 32.7       | 48.59      | 2.72                                     | 1.77                                    | 1.19                                        | 56.3            | 1.29          | 17.33                                  |
| 22X-5,57-59                        | MAD            | 171.07          | 32.07      | 47.21      | 2.77                                     | 1.79                                    | 1.22                                        | 56              | 1.27          | 17.58                                  |
| 22X-6,30-32                        | MAD            | 172.3           | 32.23      | 47.56      | 2.74                                     | 1.78                                    | 1.21                                        | 55.91           | 1.27          | 17.46                                  |
| 22X-7,18-20                        | MAD            | 173.68          | 31.37      | 45.71      | 2.67                                     | 1.78                                    | 1.22                                        | 54.29           | 1.19          | 17.42                                  |
| 23X-3,28-30                        | MAD            | 177.48          | 33.02      | 49.31      | 2.73                                     | 1.76                                    | 1.18                                        | 56.76           | 1.31          | 17.31                                  |
| 23X-4,28-30                        | MAD            | 178.98          | 31.28      | 45.52      | 2.77                                     | 1.81                                    | 1.24                                        | 55.11           | 1.23          | 17.74                                  |
| 23X-5,28-30                        | MAD            | 180.48          | 32.94      | 49.11      | 2.73                                     | 1.77                                    | 1.18                                        | 56.63           | 1.31          | 17.31                                  |
| 23X-6,28-30                        | MAD            | 181.98          | 31.36      | 45.69      | 2.74                                     | 1.8                                     | 1.23                                        | 54.92           | 1.22          | 17.63                                  |
| 23X-7,28-30                        | MAD            | 183.48          | 31.04      | 45.02      | 2.7                                      | 1.79                                    | 1.24                                        | 54.23           | 1.18          | 17.59                                  |
| 24X-1,10-12                        | MAD            | 183.9           | 30.43      | 43.75      | 2.68                                     | 1.8                                     | 1.25                                        | 53.29           | 1.14          | 17.63                                  |
| 24X-2,10-12                        | MAD            | 184.85          | 31.69      | 46.4       | 2.74                                     | 1.79                                    | 1.22                                        | 55.29           | 1.24          | 17.56                                  |
| 24X-3,10-12                        | MAD            | 186.35          | 31.38      | 45.72      | 2.66                                     | 1.77                                    | 1.22                                        | 54.23           | 1.19          | 17.4                                   |
| 24X-4,10-12                        | MAD            | 187.85          | 31.6       | 46.2       | 2.73                                     | 1.79                                    | 1.23                                        | 55.17           | 1.23          | 17.58                                  |
| 24X-5,10-12                        | MAD            | 189.35          | 31.66      | 46.33      | 2.73                                     | 1.79                                    | 1.22                                        | 55.19           | 1.23          | 17.55                                  |
| 24X-6,10-12                        | MAD            | 190.85          | 32.17      | 47.44      | 2.73                                     | 1.78                                    | 1.21                                        | 55.82           | 1.26          | 17.47                                  |
| 24X-7,10-12                        | MAD            | 192.35          | 30.89      | 44.7       | 2.67                                     | 1.79                                    | 1.23                                        | 53.72           | 1.16          | 17.51                                  |
| 25X-1,12-14                        | MAD            | 193.52          | 29.58      | 42         | 2.73                                     | 1.83                                    | 1.29                                        | 52.8            | 1.12          | 17.97                                  |
| 25X-2,12-14                        | MAD            | 195.02          | 28.24      | 39.34      | 2.67                                     | 1.84                                    | 1.32                                        | 50.55           | 1.02          | 18.03                                  |
| 25X-3,12-14                        | MAD            | 196.52          | 30.75      | 44.4       | 2.69                                     | 1.8                                     | 1.25                                        | 53.96           | 1.17          | 17.67                                  |
| 25X-4,12-14                        | MAD            | 198.02          | 29.56      | 41.97      | 2.72                                     | 1.83                                    | 1.29                                        | 52.69           | 1.11          | 17.94                                  |
| 25X-5,12-14                        | MAD            | 199.52          | 31.74      | 46.51      | 2.73                                     | 1.79                                    | 1.22                                        | 55.33           | 1.24          | 17.55                                  |
| 25X-6,12-14                        | MAD            | 201.02          | 28.27      | 39.41      | 2.68                                     | 1.84                                    | 1.32                                        | 50.74           | 1.03          | 18.07                                  |
| 25X-7,12-14                        | MAD            | 202.52          | 30.3       | 43.48      | 2.7                                      | 1.81                                    | 1.26                                        | 53.39           | 1.15          | 17.74                                  |
| 27X-1,24-26                        | MAD            | 205.24          | 33.42      | 50.2       | 2.67                                     | 1.74                                    | 1.16                                        | 56.66           | 1.31          | 17.07                                  |
| 27X-2,24-26                        | MAD            | 206.74          | 28.51      | 39.89      | 2.72                                     | 1.85                                    | 1.32                                        | 51.42           | 1.06          | 18.16                                  |
| 27X-3,24-26                        | MAD            | 208.24          | 26.92      | 36.84      | 2.73                                     | 1.89                                    | 1.38                                        | 49.49           | 0.98          | 18.51                                  |
| 27X-4,24-26                        | MAD            | 209.74          | 27.06      | 37.1       | 2.83                                     | 1.92                                    | 1.4                                         | 50.52           | 1.02          | 18.8                                   |
| 27X-5,24-26                        | MAD            | 211.24          | 26.72      | 36.47      | 2.67                                     | 1.87                                    | 1.37                                        | 48.72           | 0.95          | 18.36                                  |
| 27X-6,24-26                        | MAD            | 212.74          | 24.82      | 33.02      | 2.73                                     | 1.93                                    | 1.45                                        | 46.73           | 0.88          | 18.95                                  |
| 27X-7,24-26                        | MAD            | 214.24          | 30.34      | 43.56      | 2.65                                     | 1.79                                    | 1.25                                        | 52.91           | 1.12          | 17.56                                  |
| 28X-1,22-24                        | MAD            | 214.82          | 27.39      | 37.73      | 2.68                                     | 1.86                                    | 1.35                                        | 49.58           | 0.98          | 18.22                                  |
| 28X-2,22-24                        | MAD            | 216.32          | 26.66      | 36.34      | 2.72                                     | 1.89                                    | 1.38                                        | 49.02           | 0.96          | 18.52                                  |
| 28X-3,22-24                        | MAD            | 217.82          | 28.6       | 40.06      | 2.66                                     | 1.83                                    | 1.31                                        | 50.95           | 1.04          | 17.93                                  |
| 28X-4,22-24                        | MAD            | 219.32          | 32.55      | 48.25      | 2.71                                     | 1.77                                    | 1.19                                        | 56.04           | 1.27          | 17.34                                  |
| 28X-5,22-24                        | MAD            | 220.82          | 30.04      | 42.94      | 2.73                                     | 1.82                                    | 1.27                                        | 53.28           | 1.14          | 17.86                                  |
| 28X-6,22-24                        | MAD            | 222.32          | 28.04      | 38.97      | 2.68                                     | 1.85                                    | 1.33                                        | 50.45           | 1.02          | 18.11                                  |
| 28X-7,22-24                        | MAD            | 223.82          | 25.18      | 33.65      | 2.71                                     | 1.92                                    | 1.44                                        | 47.07           | 0.89          | 18.82                                  |
| 29X-1,18-20                        | MAD            | 224.48          | 27.19      | 37.34      | 2.69                                     | 1.87                                    | 1.36                                        | 49.44           | 0.98          | 18.31                                  |
| 29X-2,18-20                        | MAD            | 225.98          | 27.42      | 37.77      | 2.74                                     | 1.88                                    | 1.36                                        | 50.18           | 1.01          | 18.43                                  |
| 29X-3,18-20                        | MAD            | 227.48          | 27         | 36.98      | 2.72                                     | 1.88                                    | 1.37                                        | 49.47           | 0.98          | 18.45                                  |
| 29X-4,18-20                        | MAD            | 228.98          | 29.4       | 41.65      | 2.73                                     | 1.84                                    | 1.3                                         | 52.56           | 1.11          | 18                                     |
| 29X-5,18-20                        | MAD            | 230.48          | 28.03      | 38.95      | 2.72                                     | 1.86                                    | 1.34                                        | 50.83           | 1.03          | 18.26                                  |
| 29X-6,18-20                        | MAD            | 231.98          | 25.18      | 33.66      | 2.71                                     | 1.92                                    | 1.44                                        | 47.09           | 0.89          | 18.83                                  |
| 29X-7,18-20                        | MAD            | 233.48          | 29.2       | 41.25      | 2.69                                     | 1.83                                    | 1.29                                        | 51.97           | 1.08          | 17.92                                  |
| 30X-1,18-20                        | MAD            | 234.08          | 30.74      | 44.38      | 2.73                                     | 1.81                                    | 1.25                                        | 54.17           | 1.18          | 17.74                                  |
| 30X-2,18-20                        | MAD            | 235.58          | 26.49      | 36.03      | 2.73                                     | 1.9                                     | 1.39                                        | 48.92           | 0.96          | 18.6                                   |
| 30X-3,18-20                        | MAD            | 237.08          | 25.99      | 35.11      | 2.71                                     | 1.9                                     | 1.41                                        | 48.13           | 0.93          | 18.65                                  |
| 30X-4,18-20                        | MAD            | 238.58          | 25.62      | 34.45      | 2.73                                     | 1.92                                    | 1.43                                        | 47.81           | 0.92          | 18.79                                  |
| 30X-5,18-20                        | MAD            | 240.08          | 27.14      | 37.24      | 2.72                                     | 1.88                                    | 1.37                                        | 49.68           | 0.99          | 18.43                                  |
| 30X-6,18-20                        | MAD            | 241.58          | 29.15      | 41.15      | 2.74                                     | 1.84                                    | 1.31                                        | 52.32           | 1.1           | 18.07                                  |
| 30X-7,18-20                        | MAD            | 243.08          | 27.69      | 38.28      | 2.74                                     | 1.87                                    | 1.36                                        | 50.53           | 1.02          | 18.38                                  |
| 32X-1,25-27                        | MAD            | 245.85          | 26.91      | 36.81      | 2.67                                     | 1.87                                    | 1.36                                        | 48.88           | 0.96          | 18.29                                  |

**Table 11.** Vane shear strength results for Hole NGHP-01-01A.

| Core, section | Sample | Top | Depth (mbsf) | Sv (kPa) | Sres (kPa) | Srem (kPa) | St  | Core, section | Sample | Top | Depth (mbsf) | Sv (kPa) | Sres (kPa) | Srem (kPa) | St  |
|---------------|--------|-----|--------------|----------|------------|------------|-----|---------------|--------|-----|--------------|----------|------------|------------|-----|
| NGHP-01-01A   |        |     |              |          |            |            |     |               |        |     |              |          |            |            |     |
| 1H-1          | VS     | 70  | 0.7          | 16.5     | 6.6        | 4.9        | 3.3 | 4H-6          | VS     | 21  | 31.01        | 28.5     | 13.9       | 8.4        | 3.4 |
| 1H-2          | VS     | 17  | 1.67         | 5.3      | 4.1        | 1.6        | 3.3 | 4H-7          | VS     | 23  | 32.53        | 27.8     | 19.7       | 11.5       | 2.4 |
| 1H-3          | VS     | 17  | 3.17         | 12.3     | 5.8        | 3.3        | 3.8 | 5H-1          | VS     | 40  | 33.2         | 28.5     | 11.9       | 9.8        | 2.9 |
| 2H-1          | VS     | 35  | 4.65         | 2.5      | 1.6        | 0.8        | 3.0 | 5H-2          | VS     | 36  | 34.66        | 29.8     | 11.1       | 6.6        | 4.5 |
| 2H-2          | VS     | 28  | 6.08         | 4.1      | 2.5        | 1.6        | 2.5 | 5H-3          | VS     | 39  | 36.19        | 28.9     | 17.9       | 13.6       | 2.1 |
| 2H-3          | VS     | 35  | 7.65         | 9.1      | 8.2        | 3.3        | 2.8 | 5H-4          | VS     | 40  | 37.7         | 28.6     | 13.8       | 8.1        | 3.5 |
| 2H-4          | VS     | 16  | 8.96         | 12.3     | 10.7       | 4.9        | 2.5 | 5H-5          | VS     | 20  | 39           | 39.5     | 17.3       | 9.9        | 4.0 |
| 3H-1          | VS     | 40  | 14.2         | 9.9      | 6.6        | 3.5        | 2.9 | 5H-6          | VS     | 40  | 40.7         | 33.3     | 18.1       | 14.0       | 2.4 |
| 3H-2          | VS     | 33  | 15.63        | 8.6      | 6.6        | 3.2        | 2.7 | 5H-7          | VS     | 28  | 42.08        | 37.0     | 16.5       | 8.2        | 4.5 |
| 3H-3          | VS     | 46  | 17.26        | 9.8      | 4.8        | 1.8        | 5.4 | 7H-1          | VS     | 35  | 44.65        | 45.3     | 18.1       | 13.2       | 3.4 |
| 3H-4          | VS     | 40  | 18.7         | 9.1      | 5.1        | 3.5        | 2.6 | 7H-2          | VS     | 29  | 46.09        | 41.8     | 26.3       | 18.1       | 2.3 |
| 3H-5          | VS     | 40  | 20.2         | 5.1      | 4.1        | 1.6        | 3.1 | 7H-3          | VS     | 40  | 47.7         | 40.3     | 31.3       | 22.9       | 1.8 |
| 3H-6          | VS     | 34  | 21.64        | 9.9      | 6.6        | 3.2        | 3.1 | 7H-4          | VS     | 20  | 49           | 54.6     | 27.5       | 13.6       | 4.0 |
| 3H-7          | VS     | 20  | 23           | 15.0     | 6.6        | 3.3        | 4.6 | 7H-5          | VS     | 31  | 50.61        | 60.1     | 24.7       | 13.2       | 4.6 |
| 4H-1          | VS     | 26  | 23.56        | 16.6     | 7.4        | 4.1        | 4.0 | 7H-6          | VS     | 24  | 52.04        | 49.4     | 29.6       | 20.7       | 2.4 |
| 4H-2          | VS     | 36  | 25.16        | 21.4     | 9.1        | 4.9        | 4.3 | 7H-7          | VS     | 23  | 53.53        | 42.8     | 28.0       | 18.6       | 2.3 |
| 4H-3          | VS     | 33  | 26.63        | 23.9     | 6.7        | 3.3        | 7.3 | 8H-1          | VS     | 40  | 54.2         | 57.6     | 26.3       | 18.1       | 3.2 |
| 4H-4          | VS     | 35  | 28.15        | 16.5     | 8.1        | 4.9        | 3.3 | 8H-2          | VS     | 40  | 55.7         | 49.4     | 31.3       | 17.3       | 2.9 |
| 4H-5          | VS     | 29  | 29.59        | 27.8     | 12.2       | 4.9        | 5.6 | 8H-3          | VS     | 40  | 57.2         | 42.8     | 32.9       | 18.9       | 2.3 |

**Table 12.** Torvane strength results for Hole NGHP-01-01A.

| Core, section | Sample | Top (cm) | Bottom (cm) | Depth (mbsf) | Stv (kPa) | Core, section | Sample | Top (cm) | Bottom (cm) | Depth (mbsf) | Stv (kPa) |
|---------------|--------|----------|-------------|--------------|-----------|---------------|--------|----------|-------------|--------------|-----------|
| NGHP-01-01A   |        |          |             |              |           |               |        |          |             |              |           |
| 1H-1          | TV     | 58       | 60          | 0.58         | 4.3       | 5H-7          | TV     | 36       | 38          | 42.16        | 49.0      |
| 1H-2          | TV     | 29       | 31          | 1.79         | 8.8       | 7H-1          | TV     | 32       | 34          | 44.62        | 40.2      |
| 1H-3          | TV     | 21       | 23          | 3.21         | 14.9      | 7H-2          | TV     | 37       | 39          | 46.17        | 53.0      |
| 2H-1          | TV     | 23       | 25          | 4.53         | 6.7       | 7H-3          | TV     | 36       | 38          | 47.66        | 58.8      |
| 2H-2          | TV     | 34       | 36          | 6.14         | 8.0       | 7H-4          | TV     | 16       | 18          | 48.96        | 53.9      |
| 2H-3          | TV     | 21       | 23          | 7.51         | 10.6      | 7H-5          | TV     | 25       | 27          | 50.55        | 49.0      |
| 2H-4          | TV     | 26       | 28          | 9.06         | 14.1      | 7H-6          | TV     | 25       | 27          | 52.05        | 59.8      |
| 3H-1          | TV     | 31       | 33          | 14.11        | 12.2      | 7H-7          | TV     | 25       | 27          | 53.55        | 55.9      |
| 3H-2          | TV     | 31       | 33          | 15.61        | 11.4      | 9H-1          | TV     | 81       | 83          | 64.11        | 60.8      |
| 3H-3          | TV     | 31       | 33          | 17.11        | 11.4      | 9H-2          | TV     | 23       | 25          | 65.03        | 51.0      |
| 3H-4          | TV     | 30       | 32          | 18.6         | 13.0      | 9H-3          | TV     | 23       | 25          | 66.53        | 60.8      |
| 3H-5          | TV     | 39       | 41          | 20.19        | 15.3      | 9H-4          | TV     | 26       | 28          | 68.06        | 47.1      |
| 3H-6          | TV     | 22       | 24          | 21.52        | 13.7      | 9H-5          | TV     | 23       | 25          | 69.53        | 84.3      |
| 3H-7          | TV     | 13       | 15          | 22.93        | 15.3      | 9H-6          | TV     | 23       | 25          | 71.03        | 88.3      |
| 4H-1          | TV     | 19       | 21          | 23.49        | 19.6      | 9H-7          | TV     | 19       | 21          | 72.49        | 103.0     |
| 4H-2          | TV     | 37       | 39          | 25.17        | 30.6      | 10H-1         | TV     | 43       | 45          | 73.23        | 76.0      |
| 4H-3          | TV     | 27       | 29          | 26.57        | 15.9      | 10H-1         | TV     | 123      | 125         | 74.03        | 88.3      |
| 4H-4          | TV     | 25       | 27          | 28.05        | 29.4      | 10H-2         | TV     | 37       | 39          | 74.67        | 93.2      |
| 4H-5          | TV     | 25       | 27          | 29.55        | 18.4      | 10H-3         | TV     | 39       | 41          | 76.19        | 85.8      |
| 4H-6          | TV     | 23       | 25          | 31.03        | 31.9      | 10H-4         | TV     | 39       | 41          | 77.69        | 104.2     |
| 4H-7          | TV     | 19       | 21          | 32.49        | 37.3      | 10H-5         | TV     | 41       | 43          | 79.21        | 103.0     |
| 5H-1          | TV     | 20       | 22          | 33           | 33.3      | 10H-6         | TV     | 40       | 42          | 80.7         | 91.9      |
| 5H-2          | TV     | 31       | 33          | 34.61        | 34.3      | 10H-7         | TV     | 45       | 47          | 82.25        | 67.4      |
| 5H-3          | TV     | 28       | 30          | 36.08        | 37.3      | 11H-1         | TV     | 28       | 30          | 82.58        | 85.8      |
| 5H-4          | TV     | 30       | 32          | 37.6         | 37.3      | 11H-2         | TV     | 54       | 56          | 84.34        | 98.1      |
| 5H-5          | TV     | 29       | 31          | 39.09        | 43.6      | 11H-3         | TV     | 48       | 50          | 85.78        | 98.1      |
| 5H-6          | TV     | 31       | 33          | 40.61        | 47.1      | 11H-4         | TV     | 52       | 54          | 87.32        | 90.7      |

**Table 12.** Torvane strength results for Hole NGHP-01-01A.—Continued

| Core, section         | Sample | Top (cm) | Bottom (cm) | Depth (mbsf) | Stv (kPa) | Core, section | Sample | Top (cm) | Bottom (cm) | Depth (mbsf) | Stv (kPa) |
|-----------------------|--------|----------|-------------|--------------|-----------|---------------|--------|----------|-------------|--------------|-----------|
| NGHP-01-01A—Continued |        |          |             |              |           |               |        |          |             |              |           |
| 11H-5                 | TV     | 37       | 39          | 88.67        | 85.8      | 22X-4         | TV     | 50       | 52          | 169.5        | 144.6     |
| 11H-6                 | TV     | 37       | 39          | 90.17        | 85.8      | 22X-5         | TV     | 59       | 61          | 171.09       | 159.4     |
| 11H-7                 | TV     | 38       | 40          | 91.68        | 95.6      | 22X-6         | TV     | 34       | 36          | 172.34       | 147.1     |
| 13H-1                 | TV     | 10       | 12          | 93.9         | 61.3      | 22X-7         | TV     | 29       | 31          | 173.79       | 183.9     |
| 13H-2                 | TV     | 10       | 12          | 95.4         | 90.7      | 23X-1         | TV     | 30       | 32          | 174.5        | 139.7     |
| 13H-3                 | TV     | 5        | 7           | 96.85        | 85.8      | 23X-2         | TV     | 30       | 32          | 176          | 171.6     |
| 13H-4                 | TV     | 5        | 7           | 98.35        | 98.1      | 23X-3         | TV     | 30       | 32          | 177.5        | 152.0     |
| 13H-5                 | TV     | 13       | 15          | 99.93        | 98.1      | 23X-4         | TV     | 30       | 32          | 179          | 147.1     |
| 13H-6                 | TV     | 13       | 15          | 101.43       | 88.3      | 23X-5         | TV     | 30       | 32          | 180.5        | 122.6     |
| 13H-7                 | TV     | 10       | 12          | 102.9        | 95.6      | 23X-6         | TV     | 30       | 32          | 182          | 147.1     |
| 14H-1                 | TV     | 16       | 18          | 103.46       | 58.8      | 23X-7         | TV     | 30       | 32          | 183.5        | 122.6     |
| 14H-2                 | TV     | 16       | 18          | 104.96       | 83.4      | 24X-1         | TV     | 12       | 14          | 183.92       | 161.8     |
| 14H-3                 | TV     | 16       | 18          | 106.46       | 98.1      | 24X-2         | TV     | 12       | 14          | 184.87       | 144.6     |
| 14H-4                 | TV     | 16       | 18          | 107.96       | 49.0      | 24X-3         | TV     | 12       | 14          | 186.37       | 137.3     |
| 14H-5                 | TV     | 15       | 17          | 109.45       | 107.9     | 24X-4         | TV     | 12       | 14          | 187.87       | 127.5     |
| 14H-6                 | TV     | 15       | 17          | 110.95       | 90.7      | 24X-5         | TV     | 12       | 14          | 189.37       | 166.7     |
| 14H-7                 | TV     | 15       | 17          | 112.45       | 83.4      | 24X-6         | TV     | 12       | 14          | 190.87       | 159.4     |
| 15H-1                 | TV     | 15       | 17          | 112.95       | 110.3     | 24X-7         | TV     | 12       | 14          | 192.37       | 220.6     |
| 15H-2                 | TV     | 16       | 18          | 114.46       | 134.8     | 25X-1         | TV     | 7        | 9           | 193.47       | 110.3     |
| 15H-3                 | TV     | 16       | 18          | 115.96       | 139.7     | 25X-2         | TV     | 7        | 9           | 194.97       | 129.9     |
| 15H-4                 | TV     | 16       | 18          | 117.46       | 103.0     | 25X-3         | TV     | 7        | 9           | 196.47       | 137.3     |
| 15H-5                 | TV     | 16       | 18          | 118.96       | 154.5     | 25X-4         | TV     | 7        | 9           | 197.97       | 142.2     |
| 15H-6                 | TV     | 7        | 9           | 120.37       | 125.0     | 25X-5         | TV     | 7        | 9           | 199.47       | 147.1     |
| 15H-7                 | TV     | 8        | 10          | 121.88       | 125.0     | 25X-6         | TV     | 7        | 9           | 200.97       | 125.0     |
| 16H-1                 | TV     | 12       | 14          | 122.42       | 110.3     | 25X-7         | TV     | 7        | 9           | 202.47       | 125.0     |
| 16H-2                 | TV     | 12       | 14          | 123.92       | 142.2     | 27X-1         | TV     | 16       | 18          | 205.16       | 90.7      |
| 16H-3                 | TV     | 12       | 14          | 125.42       | 147.1     | 27X-2         | TV     | 16       | 18          | 206.66       | 85.8      |
| 16H-4                 | TV     | 12       | 14          | 126.92       | 122.6     | 27X-3         | TV     | 16       | 18          | 208.16       | 132.4     |
| 16H-5                 | TV     | 12       | 14          | 128.42       | 149.6     | 27X-4         | TV     | 16       | 18          | 209.66       | 149.6     |
| 16H-6                 | TV     | 12       | 14          | 129.92       | 132.4     | 27X-5         | TV     | 16       | 18          | 211.16       | 137.3     |
| 17H-1                 | TV     | 23       | 25          | 132.03       | 103.0     | 27X-6         | TV     | 16       | 18          | 212.66       | 137.3     |
| 17H-2                 | TV     | 23       | 25          | 133.53       | 112.8     | 27X-7         | TV     | 16       | 18          | 214.16       | 120.1     |
| 17H-3                 | TV     | 23       | 25          | 135.03       | 107.9     | 28X-1         | TV     | 16       | 18          | 214.76       | 90.7      |
| 17H-4                 | TV     | 23       | 25          | 136.53       | 159.4     | 28X-2         | TV     | 16       | 18          | 216.26       | 134.8     |
| 17H-5                 | TV     | 23       | 25          | 138.03       | 110.3     | 28X-3         | TV     | 16       | 18          | 217.76       | 169.2     |
| 18H-1                 | TV     | 33       | 35          | 141.63       | 115.2     | 28X-4         | TV     | 16       | 18          | 219.26       | 147.1     |
| 18H-2                 | TV     | 14       | 16          | 142.94       | 112.8     | 28X-5         | TV     | 16       | 18          | 220.76       | 110.3     |
| 18H-3                 | TV     | 14       | 16          | 143.28       | 122.6     | 28X-6         | TV     | 16       | 18          | 222.26       | 107.9     |
| 18H-4                 | TV     | 14       | 16          | 144.78       | 83.4      | 28X-7         | TV     | 16       | 18          | 223.76       | 159.4     |
| 18H-5                 | TV     | 14       | 16          | 146.28       | 61.3      | 29X-1         | TV     | 13       | 15          | 224.43       | 61.3      |
| 18H-6                 | TV     | 14       | 16          | 147.78       | 134.8     | 29X-2         | TV     | 14       | 16          | 225.94       | 142.2     |
| 19H-1                 | TV     | 29       | 31          | 151.09       | 134.8     | 29X-3         | TV     | 15       | 17          | 227.45       | 63.7      |
| 19H-2                 | TV     | 28       | 30          | 152.58       | 149.6     | 29X-4         | TV     | 15       | 17          | 228.95       | 90.7      |
| 21X-1                 | TV     | 17       | 19          | 154.97       | 220.6     | 29X-5         | TV     | 15       | 17          | 230.45       | 19.6      |
| 21X-2                 | TV     | 17       | 19          | 156.47       | 220.6     | 29X-6         | TV     | 14       | 16          | 231.94       | 61.3      |
| 21X-3                 | TV     | 17       | 19          | 157.97       | 188.8     | 29X-7         | TV     | 21       | 23          | 233.51       | 53.9      |
| 21X-4                 | TV     | 17       | 19          | 159.47       | 196.1     | 30X-1         | TV     | 22       | 24          | 234.12       | 117.7     |
| 21X-5                 | TV     | 17       | 19          | 160.97       | 198.6     | 30X-2         | TV     | 29       | 31          | 235.69       | 24.5      |
| 21X-6                 | TV     | 17       | 19          | 162.47       | 220.6     | 30X-3         | TV     | 23       | 25          | 237.13       | 49.0      |
| 21X-7                 | TV     | 12       | 14          | 163.92       | 196.1     | 30X-4         | TV     | 21       | 23          | 238.61       | 61.3      |
| 22X-1                 | TV     | 44       | 46          | 164.94       | 125.0     | 30X-5         | TV     | 28       | 30          | 240.18       | 66.2      |
| 22X-2                 | TV     | 46       | 48          | 166.46       | 129.9     | 30X-6         | TV     | 24       | 26          | 241.64       | 115.2     |
| 22X-3                 | TV     | 60       | 62          | 168.1        | 183.9     | 30X-7         | TV     | 16       | 18          | 243.06       | 39.2      |

**Table 13.** Pocket Penetrometer strength results for Hole NGHP-01-01A.

| Core, section | Sample | Top | Depth (mbsf) | Spp (kPa) | Core, section | Sample | Top | Depth (mbsf) | Spp (kPa) |
|---------------|--------|-----|--------------|-----------|---------------|--------|-----|--------------|-----------|
| NGHP-01-01A   |        |     |              |           |               |        |     |              |           |
| 1H-1          | PP     | 63  | 0.63         | 1.2       | 11H-5         | PP     | 36  | 88.66        | 85.8      |
| 1H-2          | PP     | 21  | 1.71         | 4.0       | 11H-6         | PP     | 39  | 90.19        | 73.5      |
| 1H-3          | PP     | 18  | 3.18         | 4.3       | 11H-7         | PP     | 36  | 91.66        | 63.7      |
| 2H-1          | PP     | 28  | 4.58         | 0.6       | 13H-1         | PP     | 8   | 93.88        | 24.5      |
| 2H-2          | PP     | 22  | 6.02         | 2.1       | 13H-2         | PP     | 8   | 95.38        | 63.7      |
| 2H-3          | PP     | 25  | 7.55         | 4.9       | 13H-3         | PP     | 8   | 96.88        | 68.6      |
| 2H-4          | PP     | 22  | 9.02         | 4.3       | 13H-4         | PP     | 8   | 98.38        | 73.5      |
| 3H-1          | PP     | 39  | 14.19        | 4.9       | 13H-5         | PP     | 11  | 99.91        | 73.5      |
| 3H-2          | PP     | 40  | 15.7         | 5.4       | 13H-6         | PP     | 13  | 101.43       | 63.7      |
| 3H-3          | PP     | 36  | 17.16        | 5.4       | 13H-7         | PP     | 10  | 102.9        | 73.5      |
| 3H-4          | PP     | 39  | 18.69        | 6.9       | 14H-1         | PP     | 12  | 103.42       | 44.1      |
| 3H-5          | PP     | 33  | 20.13        | 10.0      | 14H-2         | PP     | 12  | 104.92       | 73.5      |
| 3H-6          | PP     | 29  | 21.59        | 6.9       | 14H-3         | PP     | 12  | 106.42       | 98.0      |
| 3H-7          | PP     | 7   | 22.87        | 8.4       | 14H-4         | PP     | 12  | 107.92       | 98.0      |
| 4H-1          | PP     | 25  | 23.55        | 8.4       | 14H-5         | PP     | 12  | 109.42       | 107.8     |
| 4H-2          | PP     | 53  | 25.33        | 11.5      | 14H-6         | PP     | 12  | 110.92       | 107.8     |
| 4H-3          | PP     | 46  | 26.76        | 10.7      | 14H-7         | PP     | 12  | 112.42       | 107.8     |
| 4H-4          | PP     | 26  | 28.06        | 11.5      | 15H-1         | PP     | 13  | 112.93       | 85.8      |
| 4H-5          | PP     | 47  | 29.77        | 24.5      | 15H-2         | PP     | 13  | 114.43       | 85.8      |
| 4H-6          | PP     | 20  | 31           | 13.8      | 15H-3         | PP     | 13  | 115.93       | 98.0      |
| 4H-7          | PP     | 24  | 32.54        | 24.5      | 15H-4         | PP     | 13  | 117.43       | 78.4      |
| 5H-1          | PP     | 33  | 33.13        | 24.5      | 15H-5         | PP     | 13  | 118.93       | 98.0      |
| 5H-2          | PP     | 29  | 34.59        | 24.5      | 15H-6         | PP     | 18  | 120.48       | 98.0      |
| 5H-3          | PP     | 33  | 36.13        | 24.5      | 15H-7         | PP     | 7   | 121.87       | 110.3     |
| 5H-4          | PP     | 33  | 37.63        | 24.5      | 16H-1         | PP     | 13  | 122.43       | 98.0      |
| 5H-5          | PP     | 23  | 39.03        | 24.5      | 16H-2         | PP     | 13  | 123.93       | 98.0      |
| 5H-6          | PP     | 29  | 40.59        | 24.5      | 16H-3         | PP     | 13  | 125.43       | 117.6     |
| 5H-7          | PP     | 24  | 42.04        | 24.5      | 16H-4         | PP     | 13  | 126.93       | 85.8      |
| 7H-1          | PP     | 37  | 44.67        | 31.9      | 16H-5         | PP     | 13  | 128.43       | 110.3     |
| 7H-2          | PP     | 29  | 46.09        | 36.8      | 16H-6         | PP     | 13  | 129.93       | 117.6     |
| 7H-3          | PP     | 34  | 47.64        | 49.0      | 17H-1         | PP     | 18  | 131.98       | 85.8      |
| 7H-4          | PP     | 14  | 48.94        | 36.8      | 17H-2         | PP     | 18  | 133.48       | 85.8      |
| 7H-5          | PP     | 24  | 50.54        | 36.8      | 17H-3         | PP     | 18  | 134.98       | 122.5     |
| 7H-6          | PP     | 25  | 52.05        | 46.6      | 17H-4         | PP     | 18  | 136.48       | 159.3     |
| 7H-7          | PP     | 25  | 53.55        | 36.8      | 17H-5         | PP     | 18  | 137.98       | 134.8     |
| 9H-1          | PP     | 86  | 64.16        | 36.8      | 18H-1         | PP     | 21  | 141.51       | 134.8     |
| 9H-2          | PP     | 27  | 65.07        | 49.0      | 18H-2         | PP     | 12  | 142.92       | 134.8     |
| 9H-3          | PP     | 27  | 66.57        | 36.8      | 18H-3         | PP     | 11  | 143.25       | 134.8     |
| 9H-4          | PP     | 25  | 68.05        | 36.8      | 18H-4         | PP     | 12  | 144.76       | 134.8     |
| 9H-5          | PP     | 22  | 69.52        | 73.5      | 18H-5         | PP     | 7   | 146.21       | 122.5     |
| 9H-6          | PP     | 28  | 71.08        | 78.4      | 18H-6         | PP     | 6   | 147.7        | 134.8     |
| 9H-7          | PP     | 23  | 72.53        | 73.5      | 19H-1         | PP     | 28  | 151.08       | 134.8     |
| 10H-1         | PP     | 35  | 73.15        | 58.8      | 19H-2         | PP     | 28  | 152.58       | 134.8     |
| 10H-2         | PP     | 34  | 74.64        | 73.5      | 21X-1         | PP     | 14  | 154.94       | 98.0      |
| 10H-3         | PP     | 38  | 76.18        | 76.0      | 21X-2         | PP     | 14  | 156.44       | 122.5     |
| 10H-4         | PP     | 39  | 77.69        | 78.4      | 21X-3         | PP     | 14  | 157.94       | 171.5     |
| 10H-5         | PP     | 40  | 79.2         | 78.4      | 21X-4         | PP     | 14  | 159.44       | 122.5     |
| 10H-6         | PP     | 39  | 80.69        | 68.6      | 21X-5         | PP     | 14  | 160.94       | 134.8     |
| 10H-7         | PP     | 44  | 82.24        | 58.8      | 21X-6         | PP     | 14  | 162.44       | 171.5     |
| 11H-1         | PP     | 27  | 82.57        | 58.8      | 21X-7         | PP     | 14  | 163.94       | 122.5     |
| 11H-2         | PP     | 53  | 84.33        | 73.5      | 22X-1         | PP     | 40  | 164.9        | 127.4     |
| 11H-3         | PP     | 47  | 85.77        | 73.5      | 22X-2         | PP     | 44  | 166.44       | 176.4     |
| 11H-4         | PP     | 50  | 87.3         | 83.3      | 22X-3         | PP     | 59  | 168.09       | 176.4     |

**Table 13.** Pocket Penetrometer strength results for Hole NGHP-01-01A.—Continued

| Core, section         | Sample | Top | Depth (mbsf) | Spp (kPa) |
|-----------------------|--------|-----|--------------|-----------|
| NGHP-01-01A—Continued |        |     |              |           |
| 22X-4                 | PP     | 48  | 169.48       | 122.5     |
| 22X-5                 | PP     | 57  | 171.07       | 183.8     |
| 22X-6                 | PP     | 32  | 172.32       | 159.3     |
| 22X-7                 | PP     | 18  | 173.68       | 171.5     |
| 23X-1                 | PP     | 26  | 174.46       | 107.8     |
| 23X-2                 | PP     | 26  | 175.96       | 186.2     |
| 23X-3                 | PP     | 26  | 177.46       | 161.7     |
| 23X-4                 | PP     | 26  | 178.96       | 183.8     |
| 23X-5                 | PP     | 26  | 180.46       | 127.4     |
| 23X-6                 | PP     | 26  | 181.96       | 151.9     |
| 23X-7                 | PP     | 27  | 183.47       | 134.8     |
| 24X-1                 | PP     | 16  | 183.96       | 166.6     |
| 24X-2                 | PP     | 16  | 184.91       | 151.9     |
| 24X-3                 | PP     | 16  | 186.41       | 156.8     |
| 24X-4                 | PP     | 16  | 187.91       | 127.4     |
| 24X-5                 | PP     | 16  | 189.41       | 142.1     |
| 24X-6                 | PP     | 16  | 190.91       | 110.3     |
| 24X-7                 | PP     | 16  | 192.41       | 110.3     |
| 25X-1                 | PP     | 10  | 193.5        | 156.8     |
| 25X-2                 | PP     | 10  | 195          | 122.5     |
| 25X-3                 | PP     | 10  | 196.5        | 166.6     |
| 25X-4                 | PP     | 10  | 198          | 181.3     |
| 25X-5                 | PP     | 10  | 199.5        | 107.8     |
| 25X-7                 | PP     | 10  | 202.5        | 151.9     |
| 27X-1                 | PP     | 15  | 205.15       | 107.8     |
| 27X-2                 | PP     | 15  | 206.65       | 220.5     |
| 27X-3                 | PP     | 15  | 208.15       | 220.5     |
| 27X-4                 | PP     | 15  | 209.65       | 186.2     |
| 27X-5                 | PP     | 15  | 211.15       | 159.3     |
| 27X-6                 | PP     | 15  | 212.65       | 220.5     |
| 27X-7                 | PP     | 15  | 214.15       | 171.5     |
| 28X-1                 | PP     | 12  | 214.72       | 49.0      |
| 28X-2                 | PP     | 12  | 216.22       | 122.5     |
| 28X-3                 | PP     | 12  | 217.72       | 225.4     |
| 28X-4                 | PP     | 12  | 219.22       | 98.0      |
| 28X-5                 | PP     | 12  | 220.72       | 134.8     |
| 28X-6                 | PP     | 12  | 222.22       | 127.4     |
| 28X-7                 | PP     | 12  | 223.72       | 225.4     |
| 29X-1                 | PP     | 12  | 224.42       | 73.5      |
| 29X-2                 | PP     | 12  | 225.92       | 220.5     |
| 29X-3                 | PP     | 12  | 227.42       | 183.8     |
| 29X-4                 | PP     | 12  | 228.92       | 134.8     |
| 29X-5                 | PP     | 12  | 230.42       | 220.5     |
| 29X-6                 | PP     | 12  | 231.92       | 122.5     |
| 29X-7                 | PP     | 12  | 233.42       | 208.3     |
| 30X-1                 | PP     | 17  | 234.07       | 73.5      |
| 30X-2                 | PP     | 13  | 235.53       | 110.3     |
| 30X-3                 | PP     | 14  | 237.04       | 208.3     |
| 30X-4                 | PP     | 14  | 238.54       | 147.0     |
| 30X-5                 | PP     | 15  | 240.05       | 78.4      |
| 30X-6                 | PP     | 13  | 241.53       | 183.8     |
| 30X-7                 | PP     | 20  | 243.1        | 220.5     |

## Pressure Coring

The main objectives of pressure coring during NGHP Expedition 01 were to quantify natural-gas composition and concentration in sediments and to determine the nature and distribution of gas hydrate and free gas within the sediment matrix. Secondary objectives were to obtain measurements of physical properties on gas-hydrate-bearing sediments under *in situ* conditions, which can be used to help interpret regional seismic data, and to obtain samples under full pressure for shorebased studies. At Site NGHP-01-01, we conducted depressurization experiments and captured resultant gas to calculate gas-hydrate quantity. No nondestructive measurements were made on pressure cores at this site.

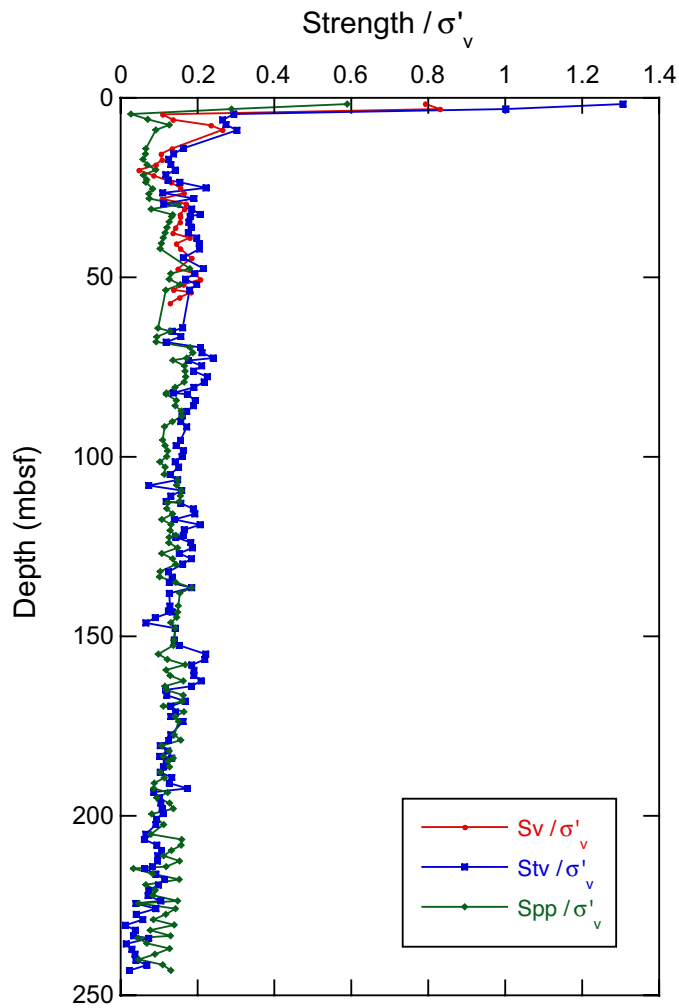
The BSR at Site NGHP-01-01, located off the west coast of India, was a strong reflector with an estimated depth of 217 mbsf. There was no LWD data for this site. A specific objective at Site NGHP-01-01 was to determine whether or not the BSR was a gas-hydrate-related feature.

## Pressure-Core Operations and Measurements

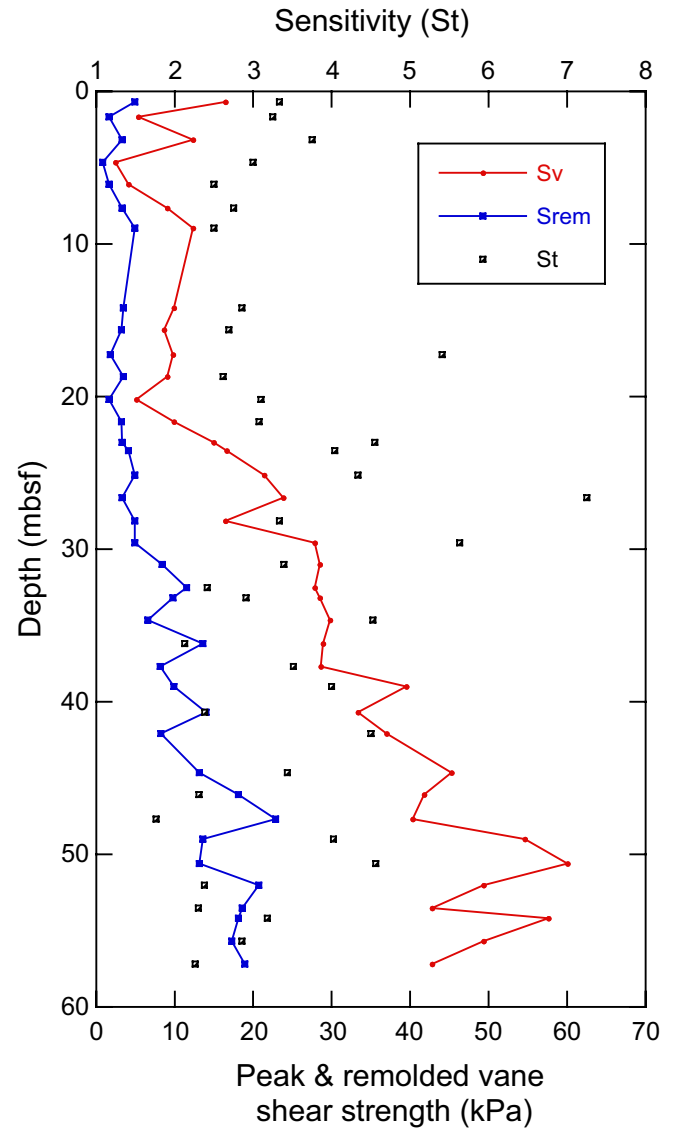
The PCS was deployed six times in Hole NGHP-01-01A. Figures 23 and 24 show the pressure and temperature history of the cores during deployment, coring, recovery, and chilling (in the ice shuck) of the pressure cores. The depressurization of the cores took place in the refrigerated van on top of the laboratory stack. For this site only, the depressurization manifold was filled with helium rather than water.

Core NGHP-01-01A-06P (43.3 mbsf) retrieved a core (0.91 m) at pressure (table 18). This core experienced extended handling time on deck before being inserted in the ice shuck. The core was depressurized but released no gas. After depressurization, the outer barrel was removed and the core was extruded from the inner barrel. Water from the outer barrel was collected but the volume measurement was compromised by additional water during core pumpout. No chlorinity measurements were made on this core. A headspace measurement made on this core showed no evidence of methane.

Core NGHP-01-01A-20P (153.3 mbsf) retrieved a full core (1.00 m) at pressure (table 18). The core was depressurized and released only 15 mL of gas. After depressurization, the outer barrel was removed and the core was extruded from the inner barrel. The water inside the outer barrel was collected (2,300 mL) and compared to the total volume of the outer core barrel (2,850 mL); approximately 550 mL of gas remained in the PCS outer barrel after depressurization was complete. No chlorinity measurements were made on this core. A headspace measurement made on this core showed no evidence of methane.



**Figure 19.** Shear strengths normalized by the effective vertical stress versus sub-bottom depth for Hole NGHP-01-01A.



**Figure 20.** Peak and remolded vane shear strengths and sensitivity for Hole NGHP-01-01A.

**Table 14.** Wenner array electrical resistivity and formation factor results for Hole NGHP-01-01A.

| Core, section | Sample | Top (cm) | Depth (mbsf) | Electrical resistivity ( $\Omega \times m$ ) | Apparent formation factor | Core, section | Sample | Top (cm) | Depth (mbsf) | Electrical resistivity ( $\Omega \times m$ ) | Apparent formation factor |
|---------------|--------|----------|--------------|----------------------------------------------|---------------------------|---------------|--------|----------|--------------|----------------------------------------------|---------------------------|
| NGHP-01-01A   |        |          |              |                                              |                           |               |        |          |              |                                              |                           |
| 2H-4          | ER     | 10       | 8.9          | 0.412                                        | 2.06                      | 4H-6          | ER     | 57       | 31.37        | 0.335                                        | 1.675                     |
| 2H-4          | ER     | 15       | 8.95         | 0.417                                        | 2.085                     | 4H-6          | ER     | 60       | 31.4         | 0.315                                        | 1.575                     |
| 2H-4          | ER     | 35       | 9.15         | 0.775                                        | 3.875                     | 4H-6          | ER     | 75       | 31.55        | 0.342                                        | 1.71                      |
| 3H-1          | ER     | 20       | 14           | 0.696                                        | 3.48                      | 5H-1          | ER     | 20       | 33           | 0.377                                        | 1.885                     |
| 3H-1          | ER     | 40       | 14.2         | 0.494                                        | 2.47                      | 5H-1          | ER     | 40       | 33.2         | 0.354                                        | 1.77                      |
| 3H-1          | ER     | 60       | 14.4         | 0.561                                        | 2.805                     | 5H-1          | ER     | 60       | 33.4         | 0.368                                        | 1.84                      |
| 3H-1          | ER     | 80       | 14.6         | 0.509                                        | 2.545                     | 5H-1          | ER     | 80       | 33.6         | 0.372                                        | 1.86                      |
| 3H-1          | ER     | 100      | 14.8         | 0.527                                        | 2.635                     | 5H-1          | ER     | 100      | 33.8         | 0.36                                         | 1.8                       |
| 3H-2          | ER     | 20       | 15.5         | 0.659                                        | 3.295                     | 5H-1          | ER     | 120      | 34           | 0.342                                        | 1.71                      |
| 3H-2          | ER     | 40       | 15.7         | 0.641                                        | 3.205                     | 5H-1          | ER     | 140      | 34.2         | 0.359                                        | 1.795                     |
| 3H-2          | ER     | 60       | 15.9         | 0.747                                        | 3.735                     | 5H-2          | ER     | 20       | 34.5         | 0.381                                        | 1.905                     |
| 3H-2          | ER     | 80       | 16.1         | 0.789                                        | 3.945                     | 5H-2          | ER     | 43       | 34.73        | 0.357                                        | 1.785                     |
| 3H-3          | ER     | 20       | 17           | 0.377                                        | 1.885                     | 5H-2          | ER     | 60       | 34.9         | 0.353                                        | 1.765                     |
| 3H-3          | ER     | 43       | 17.23        | 0.524                                        | 2.62                      | 5H-2          | ER     | 77       | 35.07        | 0.368                                        | 1.84                      |
| 3H-3          | ER     | 60       | 17.4         | 0.587                                        | 2.935                     | 5H-3          | ER     | 20       | 36           | 0.348                                        | 1.74                      |
| 3H-3          | ER     | 80       | 17.6         | 0.461                                        | 2.305                     | 5H-3          | ER     | 40       | 36.2         | 0.362                                        | 1.81                      |
| 3H-3          | ER     | 102      | 17.82        | 0.574                                        | 2.87                      | 5H-3          | ER     | 60       | 36.4         | 0.377                                        | 1.885                     |
| 3H-4          | ER     | 20       | 18.5         | 0.397                                        | 1.985                     | 5H-3          | ER     | 82       | 36.62        | 0.363                                        | 1.815                     |
| 3H-4          | ER     | 40       | 18.7         | 0.409                                        | 2.045                     | 5H-3          | ER     | 100      | 36.8         | 0.347                                        | 1.735                     |
| 3H-4          | ER     | 60       | 18.9         | 0.411                                        | 2.055                     | 5H-3          | ER     | 120      | 37           | 0.363                                        | 1.815                     |
| 3H-4          | ER     | 80       | 19.1         | 0.413                                        | 2.065                     | 5H-3          | ER     | 140      | 37.2         | 0.386                                        | 1.93                      |
| 3H-5          | ER     | 20       | 20           | 0.327                                        | 1.635                     | 5H-4          | ER     | 20       | 37.5         | 0.398                                        | 1.99                      |
| 3H-5          | ER     | 20       | 20           | 0.405                                        | 2.025                     | 5H-4          | ER     | 40       | 37.7         | 0.359                                        | 1.795                     |
| 3H-5          | ER     | 60       | 20.4         | 0.384                                        | 1.92                      | 5H-4          | ER     | 60       | 37.9         | 0.362                                        | 1.81                      |
| 3H-5          | ER     | 80       | 20.6         | 0.386                                        | 1.93                      | 5H-4          | ER     | 80       | 38.1         | 0.369                                        | 1.845                     |
| 3H-5          | ER     | 100      | 20.8         | 0.422                                        | 2.11                      | 5H-5          | ER     | 20       | 39           | 0.356                                        | 1.78                      |
| 3H-6          | ER     | 20       | 21.5         | 0.33                                         | 1.65                      | 5H-5          | ER     | 40       | 39.2         | 0.36                                         | 1.8                       |
| 3H-6          | ER     | 40       | 21.7         | 0.374                                        | 1.87                      | 5H-5          | ER     | 60       | 39.4         | 0.361                                        | 1.805                     |
| 3H-7          | ER     | 20       | 23           | 0.355                                        | 1.775                     | 5H-5          | ER     | 80       | 39.6         | 0.352                                        | 1.76                      |
| 4H-1          | ER     | 20       | 23.5         | 0.37                                         | 1.85                      | 5H-5          | ER     | 100      | 39.8         | 0.351                                        | 1.755                     |
| 4H-1          | ER     | 40       | 23.7         | 0.343                                        | 1.715                     | 5H-5          | ER     | 120      | 40           | 0.352                                        | 1.76                      |
| 4H-1          | ER     | 60       | 23.9         | 0.267                                        | 1.335                     | 5H-6          | ER     | 20       | 40.5         | 0.352                                        | 1.76                      |
| 4H-1          | ER     | 80       | 24.1         | 0.243                                        | 1.215                     | 5H-6          | ER     | 40       | 40.7         | 0.364                                        | 1.82                      |
| 4H-1          | ER     | 100      | 24.3         | 0.597                                        | 2.985                     | 5H-6          | ER     | 60       | 40.9         | 0.337                                        | 1.685                     |
| 4H-2          | ER     | 20       | 25           | 0.381                                        | 1.905                     | 5H-6          | ER     | 80       | 41.1         | 0.331                                        | 1.655                     |
| 4H-2          | ER     | 20       | 25           | 0.379                                        | 1.895                     | 5H-7          | ER     | 18       | 41.98        | 0.386                                        | 1.93                      |
| 4H-2          | ER     | 30       | 25.1         | 0.383                                        | 1.915                     | 5H-7          | ER     | 40       | 42.2         | 0.366                                        | 1.83                      |
| 4H-2          | ER     | 40       | 25.2         | 0.365                                        | 1.825                     | 5H-7          | ER     | 60       | 42.4         | 0.409                                        | 2.045                     |
| 4H-2          | ER     | 60       | 25.4         | 0.368                                        | 1.84                      | 7H-1          | ER     | 10       | 44.4         | 0.328                                        | 1.64                      |
| 4H-2          | ER     | 80       | 25.6         | 0.386                                        | 1.93                      | 7H-1          | ER     | 40       | 44.7         | 0.357                                        | 1.785                     |
| 4H-3          | ER     | 20       | 26.5         | 0.336                                        | 1.68                      | 7H-1          | ER     | 60       | 44.9         | 0.361                                        | 1.805                     |
| 4H-3          | ER     | 45       | 26.75        | 0.306                                        | 1.53                      | 7H-1          | ER     | 108      | 45.38        | 0.348                                        | 1.74                      |
| 4H-3          | ER     | 65       | 26.95        | 0.342                                        | 1.71                      | 7H-2          | ER     | 27       | 46.07        | 0.352                                        | 1.76                      |
| 4H-3          | ER     | 85       | 27.15        | 0.326                                        | 1.63                      | 7H-2          | ER     | 55       | 46.35        | 0.359                                        | 1.795                     |
| 4H-3          | ER     | 105      | 27.35        | 0.295                                        | 1.475                     | 7H-3          | ER     | 25       | 47.55        | 0.719                                        | 3.595                     |
| 4H-4          | ER     | 20       | 28           | 0.335                                        | 1.675                     | 7H-3          | ER     | 40       | 47.7         | 1.18                                         | 5.9                       |
| 4H-4          | ER     | 40       | 28.2         | 0.335                                        | 1.675                     | 7H-3          | ER     | 60       | 47.9         | 1.084                                        | 5.42                      |
| 4H-4          | ER     | 60       | 28.4         | 0.343                                        | 1.715                     | 7H-3          | ER     | 90       | 48.2         | 0.734                                        | 3.67                      |
| 4H-4          | ER     | 80       | 28.6         | 0.332                                        | 1.66                      | 7H-3          | ER     | 110      | 48.4         | 0.728                                        | 3.64                      |
| 4H-5          | ER     | 20       | 29.5         | 0.341                                        | 1.705                     | 7H-4          | ER     | 18       | 48.98        | 0.406                                        | 2.03                      |
| 4H-5          | ER     | 42       | 29.72        | 0.356                                        | 1.78                      | 7H-4          | ER     | 38       | 49.18        | 0.419                                        | 2.095                     |
| 4H-5          | ER     | 90       | 30.2         | 0.332                                        | 1.66                      | 7H-4          | ER     | 58       | 49.38        | 0.43                                         | 2.15                      |
| 4H-6          | ER     | 20       | 31           | 0.34                                         | 1.7                       | 7H-5          | ER     | 20       | 50.5         | 0.348                                        | 1.74                      |
| 4H-6          | ER     | 20       | 31           | 0.324                                        | 1.62                      | 7H-5          | ER     | 40       | 50.7         | 0.337                                        | 1.685                     |
| 4H-6          | ER     | 37       | 31.17        | 0.355                                        | 1.775                     | 7H-5          | ER     | 60       | 50.9         | 0.35                                         | 1.75                      |
| 4H-6          | ER     | 40       | 31.2         | 0.339                                        | 1.695                     | 7H-5          | ER     | 98       | 51.28        | 0.336                                        | 1.68                      |

**Table 14.** Wenner array electrical resistivity and formation factor results for Hole NGHP-01-01A.—Continued

| Core, section         | Sample | Top (cm) | Depth (mbsf) | Electrical resistivity ( $\Omega \times m$ ) | Apparent formation factor | Core, section | Sample | Top (cm) | Depth (mbsf) | Electrical resistivity ( $\Omega \times m$ ) | Apparent formation factor |
|-----------------------|--------|----------|--------------|----------------------------------------------|---------------------------|---------------|--------|----------|--------------|----------------------------------------------|---------------------------|
| NGHP-01-01A—Continued |        |          |              |                                              |                           |               |        |          |              |                                              |                           |
| 7H-5                  | ER     | 120      | 51.5         | 0.351                                        | 1.755                     | 9H-3          | ER     | 120      | 67.5         | 0.531                                        | 2.655                     |
| 7H-6                  | ER     | 20       | 52           | 0.973                                        | 4.865                     | 9H-3          | ER     | 140      | 67.7         | 0.947                                        | 4.735                     |
| 7H-6                  | ER     | 70       | 52.5         | 1.25                                         | 6.25                      | 9H-4          | ER     | 22       | 68.02        | 0.764                                        | 3.82                      |
| 7H-7                  | ER     | 20       | 53.5         | 0.331                                        | 1.655                     | 9H-4          | ER     | 42       | 68.22        | 1.543                                        | 7.715                     |
| 7H-7                  | ER     | 45       | 53.75        | 0.341                                        | 1.705                     | 9H-4          | ER     | 62       | 68.42        | 0.574                                        | 2.87                      |
| 8H-1                  | ER     | 20       | 54           | 0.404                                        | 2.02                      | 9H-4          | ER     | 82       | 68.62        | 1.216                                        | 6.08                      |
| 8H-1                  | ER     | 40       | 54.2         | 0.348                                        | 1.74                      | 9H-5          | ER     | 20       | 69.5         | 0.469                                        | 2.345                     |
| 8H-1                  | ER     | 60       | 54.4         | 0.355                                        | 1.775                     | 9H-5          | ER     | 20       | 69.5         | 1.047                                        | 5.235                     |
| 8H-1                  | ER     | 80       | 54.6         | 0.369                                        | 1.845                     | 9H-5          | ER     | 40       | 69.7         | 0.546                                        | 2.73                      |
| 8H-1                  | ER     | 100      | 54.8         | 0.345                                        | 1.725                     | 9H-5          | ER     | 60       | 69.9         | 0.583                                        | 2.915                     |
| 8H-1                  | ER     | 120      | 55           | 0.356                                        | 1.78                      | 9H-5          | ER     | 80       | 70.1         | 0.728                                        | 3.64                      |
| 8H-1                  | ER     | 140      | 55.2         | 0.365                                        | 1.825                     | 9H-5          | ER     | 100      | 70.3         | 0.394                                        | 1.97                      |
| 8H-2                  | ER     | 20       | 55.5         | 0.364                                        | 1.82                      | 9H-5          | ER     | 120      | 70.5         | 0.86                                         | 4.3                       |
| 8H-2                  | ER     | 40       | 55.7         | 0.379                                        | 1.895                     | 9H-5          | ER     | 141      | 70.71        | 1.039                                        | 5.195                     |
| 8H-2                  | ER     | 60       | 55.9         | 0.359                                        | 1.795                     | 9H-6          | ER     | 20       | 71           | 0.828                                        | 4.14                      |
| 8H-2                  | ER     | 80       | 56.1         | 0.354                                        | 1.77                      | 9H-6          | ER     | 40       | 71.2         | 0.741                                        | 3.705                     |
| 8H-3                  | ER     | 20       | 57           | 0.361                                        | 1.805                     | 9H-6          | ER     | 60       | 71.4         | 0.695                                        | 3.475                     |
| 8H-3                  | ER     | 40       | 57.2         | 0.357                                        | 1.785                     | 9H-6          | ER     | 80       | 71.6         | 0.745                                        | 3.725                     |
| 8H-3                  | ER     | 60       | 57.4         | 0.345                                        | 1.725                     | 9H-6          | ER     | 100      | 71.8         | 0.806                                        | 4.03                      |
| 8H-3                  | ER     | 80       | 57.6         | 0.352                                        | 1.76                      | 9H-7          | ER     | 20       | 72.5         | 0.594                                        | 2.97                      |
| 8H-3                  | ER     | 100      | 57.8         | 0.358                                        | 1.79                      | 9H-7          | ER     | 40       | 72.7         | 0.59                                         | 2.95                      |
| 8H-3                  | ER     | 120      | 58           | 0.366                                        | 1.83                      | 9H-7          | ER     | 60       | 72.9         | 0.646                                        | 3.23                      |
| 8H-3                  | ER     | 140      | 58.2         | 0.347                                        | 1.735                     | 9H-7          | ER     | 80       | 73.1         | 0.646                                        | 3.23                      |
| 8H-4                  | ER     | 20       | 58.5         | 0.46                                         | 2.3                       | 10H-1         | ER     | 18       | 72.98        | 0.489                                        | 2.445                     |
| 8H-4                  | ER     | 40       | 58.7         | 0.374                                        | 1.87                      | 10H-1         | ER     | 29       | 73.09        | 0.49                                         | 2.45                      |
| 8H-4                  | ER     | 60       | 58.9         | 0.361                                        | 1.805                     | 10H-1         | ER     | 39       | 73.19        | 0.469                                        | 2.345                     |
| 8H-4                  | ER     | 80       | 59.1         | 0.394                                        | 1.97                      | 10H-1         | ER     | 49       | 73.29        | 0.474                                        | 2.37                      |
| 8H-5                  | ER     | 20       | 60           | 0.372                                        | 1.86                      | 10H-1         | ER     | 59       | 73.39        | 0.482                                        | 2.41                      |
| 8H-5                  | ER     | 40       | 60.2         | 0.384                                        | 1.92                      | 10H-1         | ER     | 70       | 73.5         | 0.496                                        | 2.48                      |
| 8H-5                  | ER     | 60       | 60.4         | 0.372                                        | 1.86                      | 10H-1         | ER     | 76       | 73.56        | 0.507                                        | 2.535                     |
| 8H-5                  | ER     | 80       | 60.6         | 0.376                                        | 1.88                      | 10H-1         | ER     | 86       | 73.66        | 0.503                                        | 2.515                     |
| 8H-5                  | ER     | 100      | 60.8         | 0.371                                        | 1.855                     | 10H-1         | ER     | 96       | 73.76        | 0.508                                        | 2.54                      |
| 8H-5                  | ER     | 120      | 61           | 0.363                                        | 1.815                     | 10H-1         | ER     | 106      | 73.86        | 0.494                                        | 2.47                      |
| 8H-5                  | ER     | 140      | 61.2         | 0.352                                        | 1.76                      | 10H-1         | ER     | 116      | 73.96        | 0.49                                         | 2.45                      |
| 8H-6                  | ER     | 20       | 61.5         | 0.348                                        | 1.74                      | 10H-1         | ER     | 126      | 74.06        | 0.503                                        | 2.515                     |
| 8H-6                  | ER     | 20       | 61.5         | 0.358                                        | 1.79                      | 10H-1         | ER     | 136      | 74.16        | 0.522                                        | 2.61                      |
| 8H-6                  | ER     | 40       | 61.7         | 0.371                                        | 1.855                     | 10H-2         | ER     | 10       | 74.4         | 0.48                                         | 2.4                       |
| 8H-6                  | ER     | 60       | 61.9         | 0.37                                         | 1.85                      | 10H-2         | ER     | 30       | 74.6         | 0.495                                        | 2.475                     |
| 8H-6                  | ER     | 80       | 62.1         | 0.352                                        | 1.76                      | 10H-2         | ER     | 50       | 74.8         | 0.456                                        | 2.28                      |
| 8H-7                  | ER     | 20       | 63           | 0.38                                         | 1.9                       | 10H-2         | ER     | 70       | 75           | 0.503                                        | 2.515                     |
| 8H-7                  | ER     | 40       | 63.2         | 0.385                                        | 1.925                     | 10H-2         | ER     | 90       | 75.2         | 0.504                                        | 2.52                      |
| 8H-7                  | ER     | 60       | 63.4         | 0.381                                        | 1.905                     | 10H-3         | ER     | 10       | 75.9         | 0.539                                        | 2.695                     |
| 9H-1                  | ER     | 20       | 63.5         | 0.347                                        | 1.735                     | 10H-3         | ER     | 28       | 76.08        | 0.5                                          | 2.5                       |
| 9H-1                  | ER     | 80       | 64.1         | 0.406                                        | 2.03                      | 10H-3         | ER     | 50       | 76.3         | 0.491                                        | 2.455                     |
| 9H-1                  | ER     | 100      | 64.3         | 0.933                                        | 4.665                     | 10H-3         | ER     | 70       | 76.5         | 0.486                                        | 2.43                      |
| 9H-1                  | ER     | 120      | 64.5         | 0.795                                        | 3.975                     | 10H-3         | ER     | 90       | 76.7         | 0.497                                        | 2.485                     |
| 9H-1                  | ER     | 140      | 64.7         | 1.454                                        | 7.27                      | 10H-3         | ER     | 110      | 76.9         | 0.496                                        | 2.48                      |
| 9H-2                  | ER     | 20       | 65           | 0.991                                        | 4.955                     | 10H-3         | ER     | 129      | 77.09        | 0.485                                        | 2.425                     |
| 9H-2                  | ER     | 40       | 65.2         | 1.159                                        | 5.795                     | 10H-4         | ER     | 18       | 77.48        | 0.473                                        | 2.365                     |
| 9H-2                  | ER     | 60       | 65.4         | 0.839                                        | 4.195                     | 10H-4         | ER     | 40       | 77.7         | 0.492                                        | 2.46                      |
| 9H-2                  | ER     | 80       | 65.6         | 1.415                                        | 7.075                     | 10H-4         | ER     | 59       | 77.89        | 0.508                                        | 2.54                      |
| 9H-3                  | ER     | 20       | 66.5         | 0.619                                        | 3.095                     | 10H-4         | ER     | 81       | 78.11        | 0.499                                        | 2.495                     |
| 9H-3                  | ER     | 40       | 66.7         | 0.734                                        | 3.67                      | 10H-5         | ER     | 8        | 78.88        | 0.506                                        | 2.53                      |
| 9H-3                  | ER     | 60       | 66.9         | 1.613                                        | 8.065                     | 10H-5         | ER     | 30       | 79.1         | 0.516                                        | 2.58                      |
| 9H-3                  | ER     | 80       | 67.1         | 0.923                                        | 4.615                     | 10H-5         | ER     | 50       | 79.3         | 0.511                                        | 2.555                     |
| 9H-3                  | ER     | 100      | 67.3         | 1.106                                        | 5.53                      | 10H-5         | ER     | 70       | 79.5         | 0.52                                         | 2.6                       |

**Table 14.** Wenner array electrical resistivity and formation factor results for Hole NGHP-01-01A.—Continued

| Core, section         | Sample | Top (cm) | Depth (mbsf) | Electrical resistivity ( $\Omega \times m$ ) | Apparent formation factor | Core, section | Sample | Top (cm) | Depth (mbsf) | Electrical resistivity ( $\Omega \times m$ ) | Apparent formation factor |
|-----------------------|--------|----------|--------------|----------------------------------------------|---------------------------|---------------|--------|----------|--------------|----------------------------------------------|---------------------------|
| NGHP-01-01A—Continued |        |          |              |                                              |                           |               |        |          |              |                                              |                           |
| 10H-5                 | ER     | 90       | 79.7         | 0.491                                        | 2.455                     | 13H-5         | ER     | 140      | 101.2        | 0.601                                        | 3.005                     |
| 10H-5                 | ER     | 110      | 79.9         | 0.474                                        | 2.37                      | 13H-6         | ER     | 20       | 101.5        | 0.501                                        | 2.505                     |
| 10H-5                 | ER     | 130      | 80.1         | 0.48                                         | 2.4                       | 13H-6         | ER     | 40       | 101.7        | 0.556                                        | 2.78                      |
| 10H-6                 | ER     | 10       | 80.4         | 0.502                                        | 2.51                      | 13H-6         | ER     | 60       | 101.9        | 0.512                                        | 2.56                      |
| 10H-6                 | ER     | 51       | 80.81        | 0.495                                        | 2.475                     | 13H-6         | ER     | 80       | 102.1        | 0.53                                         | 2.65                      |
| 10H-6                 | ER     | 84       | 81.14        | 0.486                                        | 2.43                      | 13H-7         | ER     | 20       | 103          | 0.616                                        | 3.08                      |
| 10H-7                 | ER     | 13       | 81.93        | 0.49                                         | 2.45                      | 13H-7         | ER     | 20       | 103          | 0.464                                        | 2.32                      |
| 10H-7                 | ER     | 46       | 82.26        | 0.466                                        | 2.33                      | 13H-7         | ER     | 40       | 103.2        | 0.467                                        | 2.335                     |
| 11H-1                 | ER     | 29       | 82.59        | 0.499                                        | 2.495                     | 13H-7         | ER     | 60       | 103.4        | 0.47                                         | 2.35                      |
| 11H-1                 | ER     | 71       | 83.01        | 0.526                                        | 2.63                      | 13H-7         | ER     | 80       | 103.6        | 0.455                                        | 2.275                     |
| 11H-1                 | ER     | 103      | 83.33        | 0.513                                        | 2.565                     | 13H-7         | ER     | 100      | 103.8        | 0.445                                        | 2.225                     |
| 11H-2                 | ER     | 19       | 83.99        | 0.496                                        | 2.48                      | 13H-7         | ER     | 120      | 104          | 0.46                                         | 2.3                       |
| 11H-2                 | ER     | 55       | 84.35        | 0.503                                        | 2.515                     | 13H-7         | ER     | 140      | 104.2        | 0.465                                        | 2.325                     |
| 11H-3                 | ER     | 22       | 85.52        | 0.515                                        | 2.575                     | 14H-2         | ER     | 20       | 105          | 0.452                                        | 2.26                      |
| 11H-3                 | ER     | 50       | 85.8         | 0.479                                        | 2.395                     | 14H-2         | ER     | 40       | 105.2        | 0.45                                         | 2.25                      |
| 11H-3                 | ER     | 88       | 86.18        | 0.475                                        | 2.375                     | 14H-2         | ER     | 60       | 105.4        | 0.485                                        | 2.425                     |
| 11H-3                 | ER     | 124      | 86.54        | 0.495                                        | 2.475                     | 14H-2         | ER     | 80       | 105.6        | 0.542                                        | 2.71                      |
| 11H-4                 | ER     | 27       | 87.07        | 0.513                                        | 2.565                     | 14H-3         | ER     | 20       | 106.5        | 0.489                                        | 2.445                     |
| 11H-4                 | ER     | 52       | 87.32        | 0.5                                          | 2.5                       | 14H-3         | ER     | 40       | 106.7        | 0.454                                        | 2.27                      |
| 11H-4                 | ER     | 84       | 87.64        | 0.47                                         | 2.35                      | 14H-3         | ER     | 60       | 106.9        | 0.451                                        | 2.255                     |
| 11H-5                 | ER     | 27       | 88.57        | 0.471                                        | 2.355                     | 14H-3         | ER     | 80       | 107.1        | 0.452                                        | 2.26                      |
| 11H-5                 | ER     | 62       | 88.92        | 0.489                                        | 2.445                     | 14H-3         | ER     | 100      | 107.3        | 0.497                                        | 2.485                     |
| 11H-5                 | ER     | 95       | 89.25        | 0.479                                        | 2.395                     | 14H-3         | ER     | 120      | 107.5        | 0.491                                        | 2.455                     |
| 11H-5                 | ER     | 134      | 89.64        | 0.466                                        | 2.33                      | 14H-3         | ER     | 140      | 107.7        | 0.475                                        | 2.375                     |
| 11H-6                 | ER     | 21       | 90.01        | 0.473                                        | 2.365                     | 14H-4         | ER     | 20       | 108          | 0.478                                        | 2.39                      |
| 11H-6                 | ER     | 50       | 90.3         | 0.496                                        | 2.48                      | 14H-4         | ER     | 40       | 108.2        | 0.552                                        | 2.76                      |
| 11H-6                 | ER     | 89       | 90.69        | 0.471                                        | 2.355                     | 14H-4         | ER     | 60       | 108.4        | 0.518                                        | 2.59                      |
| 11H-7                 | ER     | 6        | 91.36        | 0.495                                        | 2.475                     | 14H-4         | ER     | 100      | 108.8        | 0.489                                        | 2.445                     |
| 11H-7                 | ER     | 62       | 91.92        | 0.478                                        | 2.39                      | 14H-5         | ER     | 20       | 109.5        | 0.541                                        | 2.705                     |
| 13H-1                 | ER     | 20       | 94           | 0.505                                        | 2.525                     | 14H-5         | ER     | 40       | 109.7        | 0.52                                         | 2.6                       |
| 13H-1                 | ER     | 40       | 94.2         | 0.517                                        | 2.585                     | 14H-5         | ER     | 60       | 109.9        | 0.537                                        | 2.685                     |
| 13H-1                 | ER     | 60       | 94.4         | 0.518                                        | 2.59                      | 14H-5         | ER     | 80       | 110.1        | 0.569                                        | 2.845                     |
| 13H-1                 | ER     | 80       | 94.6         | 0.502                                        | 2.51                      | 14H-5         | ER     | 100      | 110.3        | 0.512                                        | 2.56                      |
| 13H-1                 | ER     | 100      | 94.8         | 0.492                                        | 2.46                      | 14H-5         | ER     | 120      | 110.5        | 0.516                                        | 2.58                      |
| 13H-1                 | ER     | 120      | 95           | 0.472                                        | 2.36                      | 14H-5         | ER     | 140      | 110.7        | 0.503                                        | 2.515                     |
| 13H-1                 | ER     | 140      | 95.2         | 0.517                                        | 2.585                     | 14H-6         | ER     | 40       | 111.2        | 0.522                                        | 2.61                      |
| 13H-2                 | ER     | 20       | 95.5         | 0.507                                        | 2.535                     | 14H-6         | ER     | 40       | 111.2        | 0.527                                        | 2.635                     |
| 13H-2                 | ER     | 40       | 95.7         | 0.486                                        | 2.43                      | 14H-6         | ER     | 60       | 111.4        | 0.525                                        | 2.625                     |
| 13H-2                 | ER     | 60       | 95.9         | 0.503                                        | 2.515                     | 14H-6         | ER     | 60       | 111.4        | 0.497                                        | 2.485                     |
| 13H-2                 | ER     | 160      | 96.9         | 0.509                                        | 2.545                     | 14H-6         | ER     | 83       | 111.63       | 0.477                                        | 2.385                     |
| 13H-3                 | ER     | 20       | 97           | 0.477                                        | 2.385                     | 14H-7         | ER     | 20       | 112.5        | 0.503                                        | 2.515                     |
| 13H-3                 | ER     | 40       | 97.2         | 0.493                                        | 2.465                     | 14H-7         | ER     | 40       | 112.7        | 0.486                                        | 2.43                      |
| 13H-3                 | ER     | 60       | 97.4         | 0.528                                        | 2.64                      | 14H-7         | ER     | 60       | 112.9        | 0.513                                        | 2.565                     |
| 13H-3                 | ER     | 80       | 97.6         | 0.524                                        | 2.62                      | 15H-1         | ER     | 20       | 113          | 0.479                                        | 2.395                     |
| 13H-3                 | ER     | 100      | 97.8         | 0.517                                        | 2.585                     | 15H-1         | ER     | 40       | 113.2        | 0.497                                        | 2.485                     |
| 13H-3                 | ER     | 140      | 98.2         | 0.533                                        | 2.665                     | 15H-1         | ER     | 60       | 113.4        | 0.472                                        | 2.36                      |
| 13H-4                 | ER     | 20       | 98.5         | 0.51                                         | 2.55                      | 15H-1         | ER     | 80       | 113.6        | 0.536                                        | 2.68                      |
| 13H-4                 | ER     | 60       | 98.9         | 0.508                                        | 2.54                      | 15H-1         | ER     | 100      | 113.8        | 0.494                                        | 2.47                      |
| 13H-4                 | ER     | 80       | 99.1         | 0.541                                        | 2.705                     | 15H-1         | ER     | 120      | 114          | 0.539                                        | 2.695                     |
| 13H-5                 | ER     | 40       | 100.2        | 0.504                                        | 2.52                      | 15H-1         | ER     | 140      | 114.2        | 0.515                                        | 2.575                     |
| 13H-5                 | ER     | 60       | 100.4        | 0.53                                         | 2.65                      | 15H-2         | ER     | 20       | 114.5        | 0.507                                        | 2.535                     |
| 13H-5                 | ER     | 80       | 100.6        | 0.524                                        | 2.62                      | 15H-2         | ER     | 40       | 114.7        | 0.513                                        | 2.565                     |
| 13H-5                 | ER     | 100      | 100.8        | 0.557                                        | 2.785                     | 15H-2         | ER     | 60       | 114.9        | 0.534                                        | 2.67                      |
| 13H-5                 | ER     | 120      | 101          | 0.537                                        | 2.685                     | 15H-3         | ER     | 20       | 116          | 0.461                                        | 2.305                     |

**Table 14.** Wenner array electrical resistivity and formation factor results for Hole NGHP-01-01A.—Continued

| Core, section         | Sample | Top (cm) | Depth (mbsf) | Electrical resistivity ( $\Omega \times m$ ) | Apparent formation factor | Core, section | Sample | Top (cm) | Depth (mbsf) | Electrical resistivity ( $\Omega \times m$ ) | Apparent formation factor |
|-----------------------|--------|----------|--------------|----------------------------------------------|---------------------------|---------------|--------|----------|--------------|----------------------------------------------|---------------------------|
| NGHP-01-01A—Continued |        |          |              |                                              |                           |               |        |          |              |                                              |                           |
| 15H-3                 | ER     | 40       | 116.2        | 0.466                                        | 2.33                      | 17H-1         | ER     | 60       | 132.4        | 0.516                                        | 2.58                      |
| 15H-3                 | ER     | 60       | 116.4        | 0.468                                        | 2.34                      | 17H-1         | ER     | 80       | 132.6        | 0.526                                        | 2.63                      |
| 15H-3                 | ER     | 80       | 116.6        | 0.473                                        | 2.365                     | 17H-1         | ER     | 100      | 132.8        | 0.515                                        | 2.575                     |
| 15H-3                 | ER     | 100      | 116.8        | 0.509                                        | 2.545                     | 17H-1         | ER     | 120      | 133          | 0.52                                         | 2.6                       |
| 15H-3                 | ER     | 120      | 117          | 0.482                                        | 2.41                      | 17H-1         | ER     | 140      | 133.2        | 0.56                                         | 2.8                       |
| 15H-4                 | ER     | 20       | 117.5        | 0.466                                        | 2.33                      | 17H-2         | ER     | 11       | 133.41       | 0.525                                        | 2.625                     |
| 15H-4                 | ER     | 40       | 117.7        | 0.497                                        | 2.485                     | 17H-2         | ER     | 30       | 133.6        | 0.533                                        | 2.665                     |
| 15H-4                 | ER     | 60       | 117.9        | 0.507                                        | 2.535                     | 17H-2         | ER     | 50       | 133.8        | 0.561                                        | 2.805                     |
| 15H-4                 | ER     | 90       | 118.2        | 0.491                                        | 2.455                     | 17H-2         | ER     | 70       | 134          | 0.505                                        | 2.525                     |
| 15H-5                 | ER     | 20       | 119          | 0.514                                        | 2.57                      | 17H-2         | ER     | 81       | 134.11       | 0.503                                        | 2.515                     |
| 15H-5                 | ER     | 40       | 119.2        | 0.494                                        | 2.47                      | 17H-3         | ER     | 10       | 134.9        | 0.515                                        | 2.575                     |
| 15H-5                 | ER     | 60       | 119.4        | 0.538                                        | 2.69                      | 17H-3         | ER     | 30       | 135.1        | 0.511                                        | 2.555                     |
| 15H-5                 | ER     | 80       | 119.6        | 0.495                                        | 2.475                     | 17H-3         | ER     | 50       | 135.3        | 0.522                                        | 2.61                      |
| 15H-5                 | ER     | 100      | 119.8        | 0.481                                        | 2.405                     | 17H-3         | ER     | 70       | 135.5        | 0.542                                        | 2.71                      |
| 15H-5                 | ER     | 120      | 120          | 0.5                                          | 2.5                       | 17H-3         | ER     | 90       | 135.7        | 0.583                                        | 2.915                     |
| 15H-6                 | ER     | 32       | 120.62       | 0.519                                        | 2.595                     | 17H-3         | ER     | 110      | 135.9        | 0.54                                         | 2.7                       |
| 15H-6                 | ER     | 50       | 120.8        | 0.546                                        | 2.73                      | 17H-3         | ER     | 128      | 136.08       | 0.532                                        | 2.66                      |
| 15H-6                 | ER     | 70       | 121          | 0.516                                        | 2.58                      | 18H-1         | ER     | 25       | 141.55       | 0.56                                         | 2.8                       |
| 15H-7                 | ER     | 17       | 121.97       | 0.555                                        | 2.775                     | 18H-1         | ER     | 45       | 141.75       | 0.562                                        | 2.81                      |
| 16H-1                 | ER     | 20       | 122.5        | 0.499                                        | 2.495                     | 18H-1         | ER     | 65       | 141.95       | 0.552                                        | 2.76                      |
| 16H-1                 | ER     | 40       | 122.7        | 0.526                                        | 2.63                      | 18H-1         | ER     | 80       | 142.1        | 0.573                                        | 2.865                     |
| 16H-1                 | ER     | 60       | 122.9        | 0.516                                        | 2.58                      | 18H-2         | ER     | 16       | 142.96       | 0.533                                        | 2.665                     |
| 16H-1                 | ER     | 80       | 123.1        | 0.512                                        | 2.56                      | 18H-3         | ER     | 20       | 143.34       | 0.525                                        | 2.625                     |
| 16H-1                 | ER     | 100      | 123.3        | 0.538                                        | 2.69                      | 18H-3         | ER     | 40       | 143.54       | 0.526                                        | 2.63                      |
| 16H-1                 | ER     | 120      | 123.5        | 0.511                                        | 2.555                     | 18H-3         | ER     | 60       | 143.74       | 0.538                                        | 2.69                      |
| 16H-1                 | ER     | 140      | 123.7        | 0.511                                        | 2.555                     | 18H-3         | ER     | 86       | 144          | 0.559                                        | 2.795                     |
| 16H-2                 | ER     | 20       | 124          | 0.525                                        | 2.625                     | 18H-4         | ER     | 20       | 144.84       | 0.55                                         | 2.75                      |
| 16H-2                 | ER     | 40       | 124.2        | 0.508                                        | 2.54                      | 18H-4         | ER     | 40       | 145.04       | 0.561                                        | 2.805                     |
| 16H-2                 | ER     | 60       | 124.4        | 0.533                                        | 2.665                     | 18H-4         | ER     | 60       | 145.24       | 0.559                                        | 2.795                     |
| 16H-2                 | ER     | 80       | 124.6        | 0.564                                        | 2.82                      | 18H-4         | ER     | 80       | 145.44       | 0.552                                        | 2.76                      |
| 16H-3                 | ER     | 20       | 125.5        | 0.518                                        | 2.59                      | 18H-4         | ER     | 100      | 145.64       | 0.572                                        | 2.86                      |
| 16H-3                 | ER     | 40       | 125.7        | 0.528                                        | 2.64                      | 18H-4         | ER     | 119      | 145.83       | 0.558                                        | 2.79                      |
| 16H-3                 | ER     | 60       | 125.9        | 0.523                                        | 2.615                     | 18H-4         | ER     | 140      | 146.04       | 0.567                                        | 2.835                     |
| 16H-3                 | ER     | 80       | 126.1        | 0.572                                        | 2.86                      | 18H-5         | ER     | 20       | 146.34       | 0.543                                        | 2.715                     |
| 16H-3                 | ER     | 100      | 126.3        | 0.547                                        | 2.735                     | 18H-5         | ER     | 40       | 146.54       | 0.555                                        | 2.775                     |
| 16H-3                 | ER     | 120      | 126.5        | 0.528                                        | 2.64                      | 18H-5         | ER     | 60       | 146.74       | 0.533                                        | 2.665                     |
| 16H-3                 | ER     | 140      | 126.7        | 0.553                                        | 2.765                     | 18H-5         | ER     | 80       | 146.94       | 0.539                                        | 2.695                     |
| 16H-4                 | ER     | 20       | 127          | 0.526                                        | 2.63                      | 18H-6         | ER     | 20       | 147.84       | 0.607                                        | 3.035                     |
| 16H-4                 | ER     | 40       | 127.2        | 0.538                                        | 2.69                      | 18H-6         | ER     | 40       | 148.04       | 0.544                                        | 2.72                      |
| 16H-4                 | ER     | 60       | 127.4        | 0.508                                        | 2.54                      | 19H-1         | ER     | 10       | 150.9        | 0.486                                        | 2.43                      |
| 16H-4                 | ER     | 80       | 127.6        | 0.535                                        | 2.675                     | 19H-1         | ER     | 30       | 151.1        | 0.518                                        | 2.59                      |
| 16H-5                 | ER     | 20       | 128.5        | 0.531                                        | 2.655                     | 19H-1         | ER     | 50       | 151.3        | 0.516                                        | 2.58                      |
| 16H-5                 | ER     | 40       | 128.7        | 0.54                                         | 2.7                       | 19H-1         | ER     | 70       | 151.5        | 0.507                                        | 2.535                     |
| 16H-5                 | ER     | 40       | 128.7        | 0.519                                        | 2.595                     | 19H-2         | ER     | 11       | 152.41       | 0.539                                        | 2.695                     |
| 16H-5                 | ER     | 60       | 128.9        | 0.552                                        | 2.76                      | 19H-2         | ER     | 30       | 152.6        | 0.546                                        | 2.73                      |
| 16H-5                 | ER     | 80       | 129.1        | 0.537                                        | 2.685                     | 21X-1         | ER     | 20       | 155          | 0.705                                        | 3.525                     |
| 16H-5                 | ER     | 100      | 129.3        | 0.507                                        | 2.535                     | 21X-1         | ER     | 40       | 155.2        | 0.67                                         | 3.35                      |
| 16H-5                 | ER     | 140      | 129.7        | 0.506                                        | 2.53                      | 21X-1         | ER     | 60       | 155.4        | 0.571                                        | 2.855                     |
| 16H-6                 | ER     | 20       | 130          | 0.546                                        | 2.73                      | 21X-1         | ER     | 80       | 155.6        | 0.59                                         | 2.95                      |
| 16H-6                 | ER     | 40       | 130.2        | 0.519                                        | 2.595                     | 21X-1         | ER     | 100      | 155.8        | 0.581                                        | 2.905                     |
| 16H-6                 | ER     | 60       | 130.4        | 0.563                                        | 2.815                     | 21X-1         | ER     | 120      | 156          | 0.555                                        | 2.775                     |
| 16H-6                 | ER     | 80       | 130.6        | 0.535                                        | 2.675                     | 21X-2         | ER     | 20       | 156.5        | 0.601                                        | 3.005                     |
| 17H-1                 | ER     | 13       | 131.93       | 0.509                                        | 2.545                     | 21X-2         | ER     | 40       | 156.7        | 0.558                                        | 2.79                      |
| 17H-1                 | ER     | 40       | 132.2        | 0.545                                        | 2.725                     | 21X-2         | ER     | 60       | 156.9        | 0.552                                        | 2.76                      |

**Table 14.** Wenner array electrical resistivity and formation factor results for Hole NGHP-01-01A.—Continued

| Core, section         | Sample | Top (cm) | Depth (mbsf) | Electrical resistivity ( $\Omega \times m$ ) | Apparent formation factor | Core, section | Sample | Top (cm) | Depth (mbsf) | Electrical resistivity ( $\Omega \times m$ ) | Apparent formation factor |
|-----------------------|--------|----------|--------------|----------------------------------------------|---------------------------|---------------|--------|----------|--------------|----------------------------------------------|---------------------------|
| NGHP-01-01A—Continued |        |          |              |                                              |                           |               |        |          |              |                                              |                           |
| 21X-2                 | ER     | 82       | 157.12       | 0.57                                         | 2.85                      | 22X-6         | ER     | 30       | 172.3        | 0.594                                        | 2.97                      |
| 21X-3                 | ER     | 20       | 158          | 0.668                                        | 3.34                      | 22X-6         | ER     | 50       | 172.5        | 0.625                                        | 3.125                     |
| 21X-3                 | ER     | 56       | 158.36       | 0.609                                        | 3.045                     | 22X-6         | ER     | 70       | 172.7        | 0.603                                        | 3.015                     |
| 21X-3                 | ER     | 80       | 158.6        | 0.518                                        | 2.59                      | 22X-6         | ER     | 90       | 172.9        | 0.628                                        | 3.14                      |
| 21X-3                 | ER     | 100      | 158.8        | 0.545                                        | 2.725                     | 22X-7         | ER     | 10       | 173.6        | 0.631                                        | 3.155                     |
| 21X-3                 | ER     | 120      | 159          | 0.537                                        | 2.685                     | 22X-7         | ER     | 30       | 173.8        | 0.659                                        | 3.295                     |
| 21X-4                 | ER     | 20       | 159.5        | 0.595                                        | 2.975                     | 23X-1         | ER     | 20       | 174.4        | 0.511                                        | 2.555                     |
| 21X-4                 | ER     | 40       | 159.7        | 0.521                                        | 2.605                     | 23X-1         | ER     | 40       | 174.6        | 0.539                                        | 2.695                     |
| 21X-4                 | ER     | 60       | 159.9        | 0.557                                        | 2.785                     | 23X-1         | ER     | 60       | 174.8        | 0.537                                        | 2.685                     |
| 21X-4                 | ER     | 80       | 160.1        | 0.546                                        | 2.73                      | 23X-1         | ER     | 80       | 175          | 0.494                                        | 2.47                      |
| 21X-5                 | ER     | 20       | 161          | 0.595                                        | 2.975                     | 23X-1         | ER     | 100      | 175.2        | 0.531                                        | 2.655                     |
| 21X-5                 | ER     | 42       | 161.22       | 0.572                                        | 2.86                      | 23X-1         | ER     | 120      | 175.4        | 0.515                                        | 2.575                     |
| 21X-5                 | ER     | 64       | 161.44       | 0.531                                        | 2.655                     | 23X-1         | ER     | 140      | 175.6        | 0.509                                        | 2.545                     |
| 21X-5                 | ER     | 83       | 161.63       | 0.558                                        | 2.79                      | 23X-2         | ER     | 20       | 175.9        | 0.534                                        | 2.67                      |
| 21X-5                 | ER     | 103      | 161.83       | 0.647                                        | 3.235                     | 23X-2         | ER     | 40       | 176.1        | 0.539                                        | 2.695                     |
| 21X-5                 | ER     | 121      | 162.01       | 0.563                                        | 2.815                     | 23X-2         | ER     | 60       | 176.3        | 0.546                                        | 2.73                      |
| 21X-6                 | ER     | 20       | 162.5        | 0.588                                        | 2.94                      | 23X-2         | ER     | 80       | 176.5        | 0.599                                        | 2.995                     |
| 21X-6                 | ER     | 40       | 162.7        | 0.552                                        | 2.76                      | 23X-3         | ER     | 20       | 177.4        | 0.531                                        | 2.655                     |
| 21X-6                 | ER     | 60       | 162.9        | 0.525                                        | 2.625                     | 23X-3         | ER     | 40       | 177.6        | 0.541                                        | 2.705                     |
| 21X-6                 | ER     | 78       | 163.08       | 0.581                                        | 2.905                     | 23X-3         | ER     | 60       | 177.8        | 0.538                                        | 2.69                      |
| 21X-7                 | ER     | 15       | 163.95       | 0.609                                        | 3.045                     | 23X-3         | ER     | 80       | 178          | 0.535                                        | 2.675                     |
| 21X-7                 | ER     | 32       | 164.12       | 0.606                                        | 3.03                      | 23X-3         | ER     | 100      | 178.2        | 0.54                                         | 2.7                       |
| 22X-1                 | ER     | 10       | 164.6        | 0.749                                        | 3.745                     | 23X-3         | ER     | 120      | 178.4        | 0.525                                        | 2.625                     |
| 22X-1                 | ER     | 30       | 164.8        | 0.751                                        | 3.755                     | 23X-3         | ER     | 140      | 178.6        | 0.511                                        | 2.555                     |
| 22X-1                 | ER     | 50       | 165          | 0.771                                        | 3.855                     | 23X-4         | ER     | 20       | 178.9        | 0.486                                        | 2.43                      |
| 22X-1                 | ER     | 71       | 165.21       | 0.691                                        | 3.455                     | 23X-4         | ER     | 40       | 179.1        | 0.535                                        | 2.675                     |
| 22X-1                 | ER     | 90       | 165.4        | 0.673                                        | 3.365                     | 23X-4         | ER     | 60       | 179.3        | 0.539                                        | 2.695                     |
| 22X-1                 | ER     | 110      | 165.6        | 0.646                                        | 3.23                      | 23X-4         | ER     | 80       | 179.5        | 0.517                                        | 2.585                     |
| 22X-1                 | ER     | 130      | 165.8        | 0.603                                        | 3.015                     | 23X-5         | ER     | 20       | 180.4        | 0.485                                        | 2.425                     |
| 22X-2                 | ER     | 10       | 166.1        | 0.547                                        | 2.735                     | 23X-5         | ER     | 40       | 180.6        | 0.476                                        | 2.38                      |
| 22X-2                 | ER     | 30       | 166.3        | 0.618                                        | 3.09                      | 23X-5         | ER     | 60       | 180.8        | 0.516                                        | 2.58                      |
| 22X-2                 | ER     | 50       | 166.5        | 0.772                                        | 3.86                      | 23X-5         | ER     | 80       | 181          | 0.526                                        | 2.63                      |
| 22X-2                 | ER     | 70       | 166.7        | 0.674                                        | 3.37                      | 23X-5         | ER     | 100      | 181.2        | 0.511                                        | 2.555                     |
| 22X-2                 | ER     | 81       | 166.81       | 0.685                                        | 3.425                     | 23X-5         | ER     | 120      | 181.4        | 0.528                                        | 2.64                      |
| 22X-3                 | ER     | 10       | 167.6        | 0.537                                        | 2.685                     | 23X-5         | ER     | 140      | 181.6        | 0.494                                        | 2.47                      |
| 22X-3                 | ER     | 30       | 167.8        | 0.571                                        | 2.855                     | 23X-6         | ER     | 20       | 181.9        | 0.544                                        | 2.72                      |
| 22X-3                 | ER     | 50       | 168          | 0.567                                        | 2.835                     | 23X-6         | ER     | 40       | 182.1        | 0.519                                        | 2.595                     |
| 22X-3                 | ER     | 70       | 168.2        | 0.612                                        | 3.06                      | 23X-6         | ER     | 60       | 182.3        | 0.54                                         | 2.7                       |
| 22X-3                 | ER     | 90       | 168.4        | 0.572                                        | 2.86                      | 23X-6         | ER     | 80       | 182.5        | 0.515                                        | 2.575                     |
| 22X-3                 | ER     | 110      | 168.6        | 0.593                                        | 2.965                     | 23X-7         | ER     | 20       | 183.4        | 0.501                                        | 2.505                     |
| 22X-3                 | ER     | 130      | 168.8        | 0.748                                        | 3.74                      | 23X-7         | ER     | 40       | 183.6        | 0.548                                        | 2.74                      |
| 22X-4                 | ER     | 10       | 169.1        | 0.559                                        | 2.795                     | 24X-1         | ER     | 20       | 184          | 0.512                                        | 2.56                      |
| 22X-4                 | ER     | 30       | 169.3        | 0.592                                        | 2.96                      | 24X-1         | ER     | 40       | 184.2        | 0.509                                        | 2.545                     |
| 22X-4                 | ER     | 50       | 169.5        | 0.6                                          | 3                         | 24X-1         | ER     | 60       | 184.4        | 0.519                                        | 2.595                     |
| 22X-4                 | ER     | 70       | 169.7        | 0.572                                        | 2.86                      | 24X-1         | ER     | 80       | 184.6        | 0.501                                        | 2.505                     |
| 22X-4                 | ER     | 90       | 169.9        | 0.651                                        | 3.255                     | 24X-2         | ER     | 20       | 184.95       | 0.533                                        | 2.665                     |
| 22X-5                 | ER     | 10       | 170.6        | 1.084                                        | 5.42                      | 24X-2         | ER     | 40       | 185.15       | 0.522                                        | 2.61                      |
| 22X-5                 | ER     | 30       | 170.8        | 0.719                                        | 3.595                     | 24X-2         | ER     | 60       | 185.35       | 0.485                                        | 2.425                     |
| 22X-5                 | ER     | 50       | 171          | 0.653                                        | 3.265                     | 24X-2         | ER     | 80       | 185.55       | 0.512                                        | 2.56                      |
| 22X-5                 | ER     | 70       | 171.2        | 0.648                                        | 3.24                      | 24X-3         | ER     | 20       | 186.45       | 0.519                                        | 2.595                     |
| 22X-5                 | ER     | 90       | 171.4        | 0.592                                        | 2.96                      | 24X-3         | ER     | 40       | 186.65       | 0.489                                        | 2.445                     |
| 22X-5                 | ER     | 110      | 171.6        | 0.601                                        | 3.005                     | 24X-3         | ER     | 60       | 186.85       | 0.5                                          | 2.5                       |
| 22X-5                 | ER     | 130      | 171.8        | 0.582                                        | 2.91                      | 24X-3         | ER     | 80       | 187.05       | 0.508                                        | 2.54                      |
| 22X-6                 | ER     | 10       | 172.1        | 0.57                                         | 2.85                      | 24X-3         | ER     | 100      | 187.25       | 0.503                                        | 2.515                     |

**Table 14.** Wenner array electrical resistivity and formation factor results for Hole NGHP-01-01A.—Continued

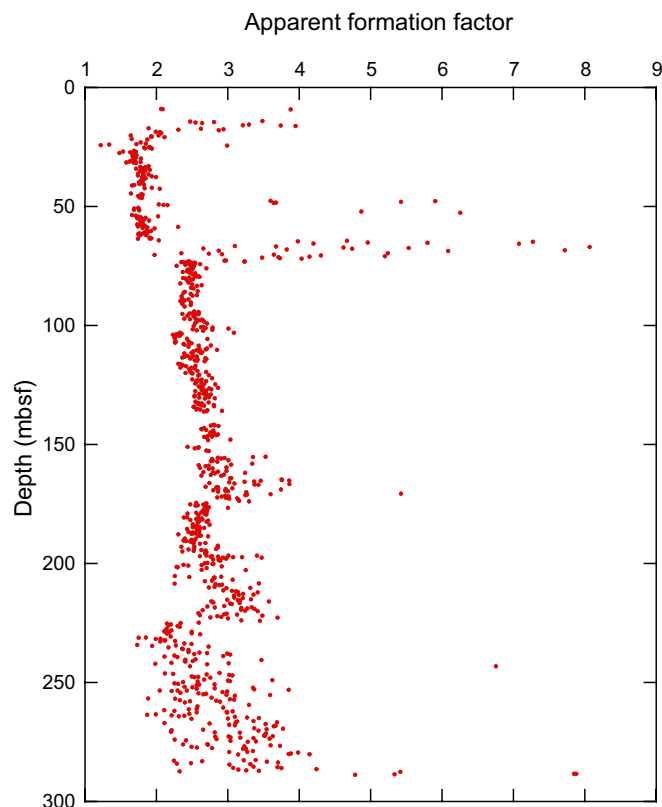
| Core,<br>section      | Sample | Top<br>(cm) | Depth<br>(mbsf) | Electrical<br>resistivity<br>( $\Omega \times m$ ) | Apparent<br>formation<br>factor | Core,<br>section | Sample | Top<br>(cm) | Depth<br>(mbsf) | Electrical<br>resistivity<br>( $\Omega \times m$ ) | Apparent<br>formation<br>factor |
|-----------------------|--------|-------------|-----------------|----------------------------------------------------|---------------------------------|------------------|--------|-------------|-----------------|----------------------------------------------------|---------------------------------|
| NGHP-01-01A—Continued |        |             |                 |                                                    |                                 |                  |        |             |                 |                                                    |                                 |
| 24X-3                 | ER     | 120         | 187.45          | 0.497                                              | 2.485                           | 25X-5            | ER     | 120         | 200.6           | 0.526                                              | 2.63                            |
| 24X-3                 | ER     | 140         | 187.65          | 0.461                                              | 2.305                           | 25X-5            | ER     | 140         | 200.8           | 0.488                                              | 2.44                            |
| 24X-4                 | ER     | 20          | 187.95          | 0.519                                              | 2.595                           | 25X-6            | ER     | 20          | 201.1           | 0.582                                              | 2.91                            |
| 24X-4                 | ER     | 40          | 188.15          | 0.518                                              | 2.59                            | 25X-6            | ER     | 40          | 201.3           | 0.456                                              | 2.28                            |
| 24X-4                 | ER     | 40          | 188.15          | 0.524                                              | 2.62                            | 25X-6            | ER     | 60          | 201.5           | 0.459                                              | 2.295                           |
| 24X-4                 | ER     | 60          | 188.35          | 0.515                                              | 2.575                           | 25X-6            | ER     | 93          | 201.83          | 0.54                                               | 2.7                             |
| 24X-4                 | ER     | 80          | 188.55          | 0.544                                              | 2.72                            | 25X-7            | ER     | 11          | 202.51          | 0.526                                              | 2.63                            |
| 24X-5                 | ER     | 20          | 189.45          | 0.479                                              | 2.395                           | 25X-7            | ER     | 31          | 202.71          | 0.649                                              | 3.245                           |
| 24X-5                 | ER     | 40          | 189.65          | 0.509                                              | 2.545                           | 27X-1            | ER     | 20          | 205.2           | 0.451                                              | 2.255                           |
| 24X-5                 | ER     | 60          | 189.85          | 0.497                                              | 2.485                           | 27X-1            | ER     | 40          | 205.4           | 0.581                                              | 2.905                           |
| 24X-5                 | ER     | 80          | 190.05          | 0.507                                              | 2.535                           | 27X-1            | ER     | 60          | 205.6           | 0.491                                              | 2.455                           |
| 24X-5                 | ER     | 100         | 190.25          | 0.475                                              | 2.375                           | 27X-1            | ER     | 80          | 205.8           | 0.562                                              | 2.81                            |
| 24X-5                 | ER     | 120         | 190.45          | 0.483                                              | 2.415                           | 27X-1            | ER     | 100         | 206             | 0.56                                               | 2.8                             |
| 24X-5                 | ER     | 140         | 190.65          | 0.494                                              | 2.47                            | 27X-2            | ER     | 20          | 206.7           | 0.613                                              | 3.065                           |
| 24X-6                 | ER     | 20          | 190.95          | 0.499                                              | 2.495                           | 27X-2            | ER     | 40          | 206.9           | 0.556                                              | 2.78                            |
| 24X-6                 | ER     | 40          | 191.15          | 0.504                                              | 2.52                            | 27X-2            | ER     | 60          | 207.1           | 0.555                                              | 2.775                           |
| 24X-6                 | ER     | 60          | 191.35          | 0.536                                              | 2.68                            | 27X-2            | ER     | 80          | 207.3           | 0.535                                              | 2.675                           |
| 24X-6                 | ER     | 80          | 191.55          | 0.521                                              | 2.605                           | 27X-3            | ER     | 20          | 208.2           | 0.686                                              | 3.43                            |
| 24X-7                 | ER     | 20          | 192.45          | 0.571                                              | 2.855                           | 27X-3            | ER     | 40          | 208.4           | 0.45                                               | 2.25                            |
| 24X-7                 | ER     | 40          | 192.65          | 0.505                                              | 2.525                           | 27X-3            | ER     | 60          | 208.6           | 0.565                                              | 2.825                           |
| 24X-7                 | ER     | 60          | 192.85          | 0.469                                              | 2.345                           | 27X-3            | ER     | 80          | 208.8           | 0.583                                              | 2.915                           |
| 24X-7                 | ER     | 80          | 193.05          | 0.572                                              | 2.86                            | 27X-3            | ER     | 100         | 209             | 0.575                                              | 2.875                           |
| 25X-1                 | ER     | 20          | 193.6           | 0.505                                              | 2.525                           | 27X-4            | ER     | 20          | 209.7           | 0.562                                              | 2.81                            |
| 25X-1                 | ER     | 40          | 193.8           | 0.566                                              | 2.83                            | 27X-4            | ER     | 40          | 209.9           | 0.546                                              | 2.73                            |
| 25X-1                 | ER     | 60          | 194             | 0.489                                              | 2.445                           | 27X-4            | ER     | 60          | 210.1           | 0.662                                              | 3.31                            |
| 25X-1                 | ER     | 80          | 194.2           | 0.525                                              | 2.625                           | 27X-4            | ER     | 80          | 210.3           | 0.595                                              | 2.975                           |
| 25X-1                 | ER     | 100         | 194.4           | 0.537                                              | 2.685                           | 27X-5            | ER     | 20          | 211.2           | 0.586                                              | 2.93                            |
| 25X-1                 | ER     | 120         | 194.6           | 0.504                                              | 2.52                            | 27X-5            | ER     | 40          | 211.4           | 0.611                                              | 3.055                           |
| 25X-1                 | ER     | 140         | 194.8           | 0.472                                              | 2.36                            | 27X-5            | ER     | 60          | 211.6           | 0.622                                              | 3.11                            |
| 25X-2                 | ER     | 20          | 195.1           | 0.539                                              | 2.695                           | 27X-5            | ER     | 80          | 211.8           | 0.627                                              | 3.135                           |
| 25X-2                 | ER     | 40          | 195.3           | 0.536                                              | 2.68                            | 27X-5            | ER     | 100         | 212             | 0.683                                              | 3.415                           |
| 25X-2                 | ER     | 80          | 195.7           | 0.536                                              | 2.68                            | 27X-6            | ER     | 20          | 212.7           | 0.642                                              | 3.21                            |
| 25X-2                 | ER     | 160         | 196.5           | 0.539                                              | 2.695                           | 27X-6            | ER     | 40          | 212.9           | 0.671                                              | 3.355                           |
| 25X-3                 | ER     | 20          | 196.6           | 0.681                                              | 3.405                           | 27X-6            | ER     | 60          | 213.1           | 0.63                                               | 3.15                            |
| 25X-3                 | ER     | 22          | 196.62          | 0.601                                              | 3.005                           | 27X-6            | ER     | 80          | 213.3           | 0.617                                              | 3.085                           |
| 25X-3                 | ER     | 40          | 196.8           | 0.521                                              | 2.605                           | 27X-7            | ER     | 20          | 214.2           | 0.617                                              | 3.085                           |
| 25X-3                 | ER     | 42          | 196.82          | 0.555                                              | 2.775                           | 27X-7            | ER     | 40          | 214.4           | 0.641                                              | 3.205                           |
| 25X-3                 | ER     | 60          | 197             | 0.551                                              | 2.755                           | 28X-1            | ER     | 30          | 214.9           | 0.664                                              | 3.32                            |
| 25X-3                 | ER     | 62          | 197.02          | 0.572                                              | 2.86                            | 28X-1            | ER     | 50          | 215.1           | 0.597                                              | 2.985                           |
| 25X-3                 | ER     | 80          | 197.2           | 0.639                                              | 3.195                           | 28X-1            | ER     | 70          | 215.3           | 0.627                                              | 3.135                           |
| 25X-3                 | ER     | 82          | 197.22          | 0.614                                              | 3.07                            | 28X-1            | ER     | 90          | 215.5           | 0.633                                              | 3.165                           |
| 25X-3                 | ER     | 100         | 197.4           | 0.694                                              | 3.47                            | 28X-1            | ER     | 110         | 215.7           | 0.553                                              | 2.765                           |
| 25X-3                 | ER     | 102         | 197.42          | 0.585                                              | 2.925                           | 28X-1            | ER     | 130         | 215.9           | 0.714                                              | 3.57                            |
| 25X-3                 | ER     | 122         | 197.62          | 0.595                                              | 2.975                           | 28X-2            | ER     | 20          | 216.3           | 0.559                                              | 2.795                           |
| 25X-3                 | ER     | 142         | 197.82          | 0.594                                              | 2.97                            | 28X-2            | ER     | 40          | 216.5           | 0.632                                              | 3.16                            |
| 25X-4                 | ER     | 20          | 198.1           | 0.574                                              | 2.87                            | 28X-2            | ER     | 60          | 216.7           | 0.606                                              | 3.03                            |
| 25X-4                 | ER     | 40          | 198.3           | 0.558                                              | 2.79                            | 28X-2            | ER     | 80          | 216.9           | 0.611                                              | 3.055                           |
| 25X-4                 | ER     | 60          | 198.5           | 0.574                                              | 2.87                            | 28X-3            | ER     | 20          | 217.8           | 0.589                                              | 2.945                           |
| 25X-4                 | ER     | 80          | 198.7           | 0.578                                              | 2.89                            | 28X-3            | ER     | 40          | 218             | 0.542                                              | 2.71                            |
| 25X-5                 | ER     | 20          | 199.6           | 0.542                                              | 2.71                            | 28X-3            | ER     | 60          | 218.2           | 0.666                                              | 3.33                            |
| 25X-5                 | ER     | 40          | 199.8           | 0.534                                              | 2.67                            | 28X-3            | ER     | 80          | 218.4           | 0.563                                              | 2.815                           |
| 25X-5                 | ER     | 60          | 200             | 0.559                                              | 2.795                           | 28X-3            | ER     | 100         | 218.6           | 0.637                                              | 3.185                           |
| 25X-5                 | ER     | 80          | 200.2           | 0.557                                              | 2.785                           | 28X-3            | ER     | 120         | 218.8           | 0.654                                              | 3.27                            |
| 25X-5                 | ER     | 100         | 200.4           | 0.475                                              | 2.375                           | 28X-3            | ER     | 140         | 219             | 0.674                                              | 3.37                            |

**Table 14.** Wenner array electrical resistivity and formation factor results for Hole NGHP-01-01A.—Continued

| Core, section         | Sample | Top (cm) | Depth (mbsf) | Electrical resistivity ( $\Omega \times m$ ) | Apparent formation factor | Core, section | Sample | Top (cm) | Depth (mbsf) | Electrical resistivity ( $\Omega \times m$ ) | Apparent formation factor |
|-----------------------|--------|----------|--------------|----------------------------------------------|---------------------------|---------------|--------|----------|--------------|----------------------------------------------|---------------------------|
| NGHP-01-01A—Continued |        |          |              |                                              |                           |               |        |          |              |                                              |                           |
| 28X-4                 | ER     | 20       | 219.3        | 0.636                                        | 3.18                      | 30X-3         | ER     | 104      | 237.94       | 0.505                                        | 2.525                     |
| 28X-4                 | ER     | 40       | 219.5        | 0.529                                        | 2.645                     | 30X-3         | ER     | 124      | 238.14       | 0.606                                        | 3.03                      |
| 28X-4                 | ER     | 60       | 219.7        | 0.647                                        | 3.235                     | 30X-4         | ER     | 20       | 238.6        | 0.449                                        | 2.245                     |
| 28X-4                 | ER     | 80       | 219.9        | 0.683                                        | 3.415                     | 30X-4         | ER     | 40       | 238.8        | 0.586                                        | 2.93                      |
| 28X-5                 | ER     | 20       | 220.8        | 0.517                                        | 2.585                     | 30X-4         | ER     | 60       | 239          | 0.422                                        | 2.11                      |
| 28X-5                 | ER     | 40       | 221          | 0.596                                        | 2.98                      | 30X-4         | ER     | 80       | 239.2        | 0.458                                        | 2.29                      |
| 28X-5                 | ER     | 60       | 221.2        | 0.589                                        | 2.945                     | 30X-5         | ER     | 20       | 240.1        | 0.509                                        | 2.545                     |
| 28X-5                 | ER     | 80       | 221.4        | 0.625                                        | 3.125                     | 30X-5         | ER     | 41       | 240.31       | 0.48                                         | 2.4                       |
| 28X-5                 | ER     | 100      | 221.6        | 0.521                                        | 2.605                     | 30X-5         | ER     | 60       | 240.5        | 0.693                                        | 3.465                     |
| 28X-5                 | ER     | 120      | 221.8        | 0.696                                        | 3.48                      | 30X-5         | ER     | 81       | 240.71       | 0.479                                        | 2.395                     |
| 28X-5                 | ER     | 140      | 222          | 0.57                                         | 2.85                      | 30X-5         | ER     | 100      | 240.9        | 0.501                                        | 2.505                     |
| 28X-6                 | ER     | 20       | 222.3        | 0.581                                        | 2.905                     | 30X-5         | ER     | 120      | 241.1        | 0.48                                         | 2.4                       |
| 28X-6                 | ER     | 40       | 222.5        | 0.55                                         | 2.75                      | 30X-6         | ER     | 20       | 241.6        | 0.441                                        | 2.205                     |
| 28X-6                 | ER     | 60       | 222.7        | 0.738                                        | 3.69                      | 30X-6         | ER     | 40       | 241.8        | 0.602                                        | 3.01                      |
| 28X-6                 | ER     | 80       | 222.9        | 0.599                                        | 2.995                     | 30X-6         | ER     | 60       | 242          | 0.396                                        | 1.98                      |
| 28X-7                 | ER     | 20       | 223.8        | 0.637                                        | 3.185                     | 30X-6         | ER     | 80       | 242.2        | 0.541                                        | 2.705                     |
| 28X-7                 | ER     | 40       | 224          | 0.689                                        | 3.445                     | 30X-7         | ER     | 20       | 243.1        | 1.35                                         | 6.75                      |
| 29X-1                 | ER     | 47       | 224.77       | 0.518                                        | 2.59                      | 30X-7         | ER     | 20       | 243.1        | 0.493                                        | 2.465                     |
| 29X-1                 | ER     | 67       | 224.97       | 0.467                                        | 2.335                     | 32X-1         | ER     | 25       | 245.85       | 0.576                                        | 2.88                      |
| 29X-1                 | ER     | 87       | 225.17       | 0.429                                        | 2.145                     | 32X-1         | ER     | 50       | 246.1        | 0.423                                        | 2.115                     |
| 29X-1                 | ER     | 120      | 225.5        | 0.44                                         | 2.2                       | 32X-1         | ER     | 70       | 246.3        | 0.446                                        | 2.23                      |
| 29X-2                 | ER     | 20       | 226          | 0.433                                        | 2.165                     | 32X-1         | ER     | 90       | 246.5        | 0.54                                         | 2.7                       |
| 29X-2                 | ER     | 40       | 226.2        | 0.459                                        | 2.295                     | 32X-1         | ER     | 110      | 246.7        | 0.603                                        | 3.015                     |
| 29X-2                 | ER     | 66       | 226.46       | 0.465                                        | 2.325                     | 32X-1         | ER     | 130      | 246.9        | 0.612                                        | 3.06                      |
| 29X-3                 | ER     | 22       | 227.52       | 0.427                                        | 2.135                     | 32X-2         | ER     | 20       | 247.3        | 0.498                                        | 2.49                      |
| 29X-3                 | ER     | 41       | 227.71       | 0.427                                        | 2.135                     | 32X-2         | ER     | 40       | 247.5        | 0.516                                        | 2.58                      |
| 29X-3                 | ER     | 66       | 227.96       | 0.441                                        | 2.205                     | 32X-2         | ER     | 60       | 247.7        | 0.506                                        | 2.53                      |
| 29X-3                 | ER     | 105      | 228.35       | 0.421                                        | 2.105                     | 32X-2         | ER     | 75       | 247.85       | 0.55                                         | 2.75                      |
| 29X-3                 | ER     | 128      | 228.58       | 0.498                                        | 2.49                      | 32X-3         | ER     | 10       | 248.7        | 0.533                                        | 2.665                     |
| 29X-4                 | ER     | 20       | 229          | 0.434                                        | 2.17                      | 32X-3         | ER     | 30       | 248.9        | 0.724                                        | 3.62                      |
| 29X-4                 | ER     | 38       | 229.18       | 0.498                                        | 2.49                      | 32X-3         | ER     | 50       | 249.1        | 0.599                                        | 2.995                     |
| 29X-4                 | ER     | 58       | 229.38       | 0.429                                        | 2.145                     | 32X-3         | ER     | 70       | 249.3        | 0.605                                        | 3.025                     |
| 29X-4                 | ER     | 76       | 229.56       | 0.522                                        | 2.61                      | 32X-3         | ER     | 90       | 249.5        | 0.515                                        | 2.575                     |
| 29X-5                 | ER     | 30       | 230.6        | 0.439                                        | 2.195                     | 32X-3         | ER     | 110      | 249.7        | 0.474                                        | 2.37                      |
| 29X-5                 | ER     | 62       | 230.92       | 0.37                                         | 1.85                      | 32X-4         | ER     | 14       | 250.24       | 0.449                                        | 2.245                     |
| 29X-5                 | ER     | 82       | 231.12       | 0.35                                         | 1.75                      | 32X-4         | ER     | 30       | 250.4        | 0.46                                         | 2.3                       |
| 29X-5                 | ER     | 115      | 231.45       | 0.411                                        | 2.055                     | 32X-4         | ER     | 52       | 250.62       | 0.562                                        | 2.81                      |
| 29X-5                 | ER     | 129      | 231.59       | 0.397                                        | 1.985                     | 32X-4         | ER     | 70       | 250.8        | 0.519                                        | 2.595                     |
| 29X-6                 | ER     | 25       | 232.05       | 0.424                                        | 2.12                      | 32X-4         | ER     | 90       | 251          | 0.512                                        | 2.56                      |
| 29X-6                 | ER     | 47       | 232.27       | 0.422                                        | 2.11                      | 32X-5         | ER     | 10       | 251.7        | 0.478                                        | 2.39                      |
| 29X-6                 | ER     | 69       | 232.49       | 0.452                                        | 2.26                      | 32X-5         | ER     | 30       | 251.9        | 0.5                                          | 2.5                       |
| 29X-6                 | ER     | 87       | 232.67       | 0.41                                         | 2.05                      | 32X-5         | ER     | 50       | 252.1        | 0.67                                         | 3.35                      |
| 29X-7                 | ER     | 16       | 233.46       | 0.477                                        | 2.385                     | 32X-5         | ER     | 69       | 252.29       | 0.563                                        | 2.815                     |
| 29X-7                 | ER     | 37       | 233.67       | 0.497                                        | 2.485                     | 32X-5         | ER     | 95       | 252.55       | 0.512                                        | 2.56                      |
| 30X-1                 | ER     | 20       | 234.1        | 0.345                                        | 1.725                     | 32X-5         | ER     | 115      | 252.75       | 0.673                                        | 3.365                     |
| 30X-1                 | ER     | 43       | 234.33       | 0.454                                        | 2.27                      | 32X-5         | ER     | 130      | 252.9        | 0.77                                         | 3.85                      |
| 30X-1                 | ER     | 63       | 234.53       | 0.387                                        | 1.935                     | 32X-6         | ER     | 10       | 253.2        | 0.459                                        | 2.295                     |
| 30X-1                 | ER     | 91       | 234.81       | 0.545                                        | 2.725                     | 32X-6         | ER     | 19       | 253.29       | 0.484                                        | 2.42                      |
| 30X-1                 | ER     | 129      | 235.19       | 0.433                                        | 2.165                     | 33X-1         | ER     | 7        | 253.27       | 0.409                                        | 2.045                     |
| 30X-2                 | ER     | 22       | 235.62       | 0.471                                        | 2.355                     | 33X-1         | ER     | 30       | 253.5        | 0.442                                        | 2.21                      |
| 30X-2                 | ER     | 49       | 235.89       | 0.473                                        | 2.365                     | 33X-1         | ER     | 50       | 253.7        | 0.597                                        | 2.985                     |
| 30X-2                 | ER     | 75       | 236.15       | 0.489                                        | 2.445                     | 33X-1         | ER     | 73       | 253.93       | 0.584                                        | 2.92                      |
| 30X-3                 | ER     | 20       | 237.1        | 0.489                                        | 2.445                     | 33X-1         | ER     | 100      | 254.2        | 0.466                                        | 2.33                      |
| 30X-3                 | ER     | 44       | 237.34       | 0.52                                         | 2.6                       | 33X-1         | ER     | 120      | 254.4        | 0.517                                        | 2.585                     |
| 30X-3                 | ER     | 64       | 237.54       | 0.541                                        | 2.705                     | 33X-1         | ER     | 140      | 254.6        | 0.538                                        | 2.69                      |
| 30X-3                 | ER     | 84       | 237.74       | 0.597                                        | 2.985                     | 33X-2         | ER     | 10       | 254.8        | 0.531                                        | 2.655                     |

**Table 14.** Wenner array electrical resistivity and formation factor results for Hole NGHP-01-01A.—Continued

| Core, section         | Sample | Top (cm) | Depth (mbsf) | Electrical resistivity ( $\Omega \times m$ ) | Apparent formation factor | Core, section | Sample | Top (cm) | Depth (mbsf) | Electrical resistivity ( $\Omega \times m$ ) | Apparent formation factor |
|-----------------------|--------|----------|--------------|----------------------------------------------|---------------------------|---------------|--------|----------|--------------|----------------------------------------------|---------------------------|
| NGHP-01-01A—Continued |        |          |              |                                              |                           |               |        |          |              |                                              |                           |
| 33X-2                 | ER     | 30       | 255          | 0.595                                        | 2.975                     | 34X-7         | ER     | 20       | 272.1        | 0.701                                        | 3.505                     |
| 33X-2                 | ER     | 50       | 255.2        | 0.718                                        | 3.59                      | 34X-7         | ER     | 40       | 272.3        | 0.703                                        | 3.515                     |
| 33X-2                 | ER     | 70       | 255.4        | 0.619                                        | 3.095                     | 34X-7         | ER     | 45       | 272.35       | 0.725                                        | 3.625                     |
| 33X-3                 | ER     | 10       | 256.3        | 0.554                                        | 2.77                      | 34X-7         | ER     | 65       | 272.55       | 0.602                                        | 3.01                      |
| 33X-3                 | ER     | 34       | 256.54       | 0.376                                        | 1.88                      | 35X-1         | ER     | 20       | 272.7        | 0.564                                        | 2.82                      |
| 33X-3                 | ER     | 50       | 256.7        | 0.452                                        | 2.26                      | 35X-1         | ER     | 40       | 272.9        | 0.607                                        | 3.035                     |
| 33X-3                 | ER     | 70       | 256.9        | 0.605                                        | 3.025                     | 35X-1         | ER     | 60       | 273.1        | 0.634                                        | 3.17                      |
| 33X-3                 | ER     | 90       | 257.1        | 0.617                                        | 3.085                     | 35X-1         | ER     | 80       | 273.3        | 0.671                                        | 3.355                     |
| 33X-3                 | ER     | 110      | 257.3        | 0.465                                        | 2.325                     | 35X-1         | ER     | 100      | 273.5        | 0.716                                        | 3.58                      |
| 33X-3                 | ER     | 130      | 257.5        | 0.567                                        | 2.835                     | 35X-1         | ER     | 120      | 273.7        | 0.568                                        | 2.84                      |
| 33X-4                 | ER     | 10       | 257.8        | 0.493                                        | 2.465                     | 35X-1         | ER     | 140      | 273.9        | 0.45                                         | 2.25                      |
| 33X-4                 | ER     | 30       | 258          | 0.577                                        | 2.885                     | 35X-2         | ER     | 20       | 274.2        | 0.482                                        | 2.41                      |
| 33X-4                 | ER     | 58       | 258.28       | 0.479                                        | 2.395                     | 35X-2         | ER     | 40       | 274.4        | 0.607                                        | 3.035                     |
| 33X-5                 | ER     | 10       | 259.3        | 0.659                                        | 3.295                     | 35X-2         | ER     | 60       | 274.6        | 0.678                                        | 3.39                      |
| 33X-5                 | ER     | 67       | 259.87       | 0.514                                        | 2.57                      | 35X-2         | ER     | 80       | 274.8        | 0.655                                        | 3.275                     |
| 33X-5                 | ER     | 124      | 260.44       | 0.586                                        | 2.93                      | 35X-3         | ER     | 20       | 275.7        | 0.542                                        | 2.71                      |
| 33X-6                 | ER     | 25       | 260.95       | 0.512                                        | 2.56                      | 35X-3         | ER     | 40       | 275.9        | 0.474                                        | 2.37                      |
| 33X-6                 | ER     | 50       | 261.2        | 0.49                                         | 2.45                      | 35X-3         | ER     | 60       | 276.1        | 0.543                                        | 2.715                     |
| 33X-6                 | ER     | 80       | 261.5        | 0.421                                        | 2.105                     | 35X-3         | ER     | 80       | 276.3        | 0.719                                        | 3.595                     |
| 33X-7                 | ER     | 7        | 261.77       | 0.449                                        | 2.245                     | 35X-3         | ER     | 100      | 276.5        | 0.745                                        | 3.725                     |
| 33X-7                 | ER     | 29       | 261.99       | 0.613                                        | 3.065                     | 35X-3         | ER     | 120      | 276.7        | 0.645                                        | 3.225                     |
| 33X-7                 | ER     | 50       | 262.2        | 0.596                                        | 2.98                      | 35X-3         | ER     | 140      | 276.9        | 0.497                                        | 2.485                     |
| 33X-7                 | ER     | 70       | 262.4        | 0.512                                        | 2.56                      | 35X-4         | ER     | 20       | 277.2        | 0.513                                        | 2.565                     |
| 33X-7                 | ER     | 86       | 262.56       | 0.597                                        | 2.985                     | 35X-4         | ER     | 40       | 277.4        | 0.555                                        | 2.775                     |
| 34X-1                 | ER     | 20       | 263.1        | 0.491                                        | 2.455                     | 35X-4         | ER     | 60       | 277.6        | 0.649                                        | 3.245                     |
| 34X-1                 | ER     | 40       | 263.3        | 0.397                                        | 1.985                     | 35X-4         | ER     | 80       | 277.8        | 0.642                                        | 3.21                      |
| 34X-1                 | ER     | 60       | 263.5        | 0.373                                        | 1.865                     | 35X-5         | ER     | 20       | 278.7        | 0.67                                         | 3.35                      |
| 34X-1                 | ER     | 80       | 263.7        | 0.442                                        | 2.21                      | 35X-5         | ER     | 45       | 278.95       | 0.654                                        | 3.27                      |
| 34X-1                 | ER     | 100      | 263.9        | 0.477                                        | 2.385                     | 35X-5         | ER     | 65       | 279.15       | 0.603                                        | 3.015                     |
| 34X-1                 | ER     | 120      | 264.1        | 0.462                                        | 2.31                      | 35X-5         | ER     | 85       | 279.35       | 0.796                                        | 3.98                      |
| 34X-1                 | ER     | 140      | 264.3        | 0.619                                        | 3.095                     | 35X-5         | ER     | 125      | 279.75       | 0.776                                        | 3.88                      |
| 34X-2                 | ER     | 20       | 264.6        | 0.653                                        | 3.265                     | 35X-5         | ER     | 145      | 279.95       | 0.77                                         | 3.85                      |
| 34X-2                 | ER     | 40       | 264.8        | 0.686                                        | 3.43                      | 35X-6         | ER     | 7        | 280.07       | 0.828                                        | 4.14                      |
| 34X-2                 | ER     | 60       | 265          | 0.6                                          | 3                         | 35X-6         | ER     | 17       | 280.17       | 0.628                                        | 3.14                      |
| 34X-2                 | ER     | 80       | 265.2        | 0.497                                        | 2.485                     | 36X-1         | ER     | 25       | 282.35       | 0.677                                        | 3.385                     |
| 34X-3                 | ER     | 20       | 266.1        | 0.671                                        | 3.355                     | 36X-1         | ER     | 45       | 282.55       | 0.644                                        | 3.22                      |
| 34X-3                 | ER     | 42       | 266.32       | 0.625                                        | 3.125                     | 36X-1         | ER     | 65       | 282.75       | 0.448                                        | 2.24                      |
| 34X-3                 | ER     | 62       | 266.52       | 0.737                                        | 3.685                     | 36X-1         | ER     | 85       | 282.95       | 0.527                                        | 2.635                     |
| 34X-3                 | ER     | 82       | 266.72       | 0.621                                        | 3.105                     | 36X-1         | ER     | 105      | 283.15       | 0.709                                        | 3.545                     |
| 34X-3                 | ER     | 102      | 266.92       | 0.422                                        | 2.11                      | 36X-1         | ER     | 138      | 283.48       | 0.74                                         | 3.7                       |
| 34X-3                 | ER     | 122      | 267.12       | 0.548                                        | 2.74                      | 36X-2         | ER     | 20       | 283.8        | 0.496                                        | 2.48                      |
| 34X-3                 | ER     | 142      | 267.32       | 0.705                                        | 3.525                     | 36X-2         | ER     | 40       | 284          | 0.457                                        | 2.285                     |
| 34X-4                 | ER     | 20       | 267.6        | 0.603                                        | 3.015                     | 36X-2         | ER     | 60       | 284.2        | 0.662                                        | 3.31                      |
| 34X-4                 | ER     | 44       | 267.84       | 0.619                                        | 3.095                     | 36X-2         | ER     | 80       | 284.4        | 0.604                                        | 3.02                      |
| 34X-4                 | ER     | 64       | 268.04       | 0.733                                        | 3.665                     | 36X-3         | ER     | 20       | 285.3        | 0.671                                        | 3.355                     |
| 34X-4                 | ER     | 84       | 268.24       | 0.728                                        | 3.64                      | 36X-3         | ER     | 40       | 285.5        | 0.738                                        | 3.69                      |
| 34X-5                 | ER     | 20       | 269.1        | 0.673                                        | 3.365                     | 36X-3         | ER     | 60       | 285.7        | 0.614                                        | 3.07                      |
| 34X-5                 | ER     | 40       | 269.3        | 0.754                                        | 3.77                      | 36X-3         | ER     | 80       | 285.9        | 0.749                                        | 3.745                     |
| 34X-5                 | ER     | 60       | 269.5        | 0.708                                        | 3.54                      | 36X-3         | ER     | 120      | 286.3        | 0.847                                        | 4.235                     |
| 34X-5                 | ER     | 80       | 269.7        | 0.53                                         | 2.65                      | 36X-4         | ER     | 140      | 286.5        | 0.629                                        | 3.145                     |
| 34X-5                 | ER     | 102      | 269.92       | 0.442                                        | 2.21                      | 36X-4         | ER     | 20       | 286.8        | 0.651                                        | 3.255                     |
| 34X-5                 | ER     | 122      | 270.12       | 0.685                                        | 3.425                     | 36X-4         | ER     | 40       | 287          | 0.686                                        | 3.43                      |
| 34X-6                 | ER     | 26       | 270.66       | 0.44                                         | 2.2                       | 36X-4         | ER     | 60       | 287.2        | 0.464                                        | 2.32                      |
| 34X-6                 | ER     | 44       | 270.84       | 0.563                                        | 2.815                     | 36X-4         | ER     | 89       | 287.49       | 1.082                                        | 5.41                      |
| 34X-6                 | ER     | 64       | 271.04       | 0.633                                        | 3.165                     | 36X-5         | ER     | 20       | 288.3        | 1.575                                        | 7.875                     |
| 34X-6                 | ER     | 84       | 271.24       | 0.706                                        | 3.53                      | 36X-5         | ER     | 20       | 288.3        | 1.569                                        | 7.845                     |
|                       |        |          |              |                                              |                           | 36X-5         | ER     | 40       | 288.5        | 1.066                                        | 5.33                      |
|                       |        |          |              |                                              |                           | 36X-5         | ER     | 60       | 288.7        | 0.956                                        | 4.78                      |



**Figure 21.** Apparent formation factor versus sub-bottom depth for Hole NGHP-01-01A.

**Table 15.** Contact P-wave velocity results determined on split cores sections from Hole NGHP-01-01A.

| Core, section | Sample | Top (cm) | Depth (mbsf) | Vp (km/s) |
|---------------|--------|----------|--------------|-----------|
| NGHP-01-01A   |        |          |              |           |
| 1H-1          | VP     | 60       | 0.6          | 1.52      |
| 1H-2          | VP     | 17       | 1.67         | 1.51      |
| 1H-3          | VP     | 17       | 3.17         | 1.52      |
| 2H-1          | VP     | 35       | 4.65         | 1.51      |
| 2H-2          | VP     | 28       | 6.08         | 1.52      |
| 2H-3          | VP     | 35       | 7.65         | 1.51      |
| 2H-4          | VP     | 16       | 8.96         | 1.54      |
| 3H-1          | VP     | 40       | 14.2         | 1.49      |
| 3H-2          | VP     | 40       | 15.7         | 1.48      |
| 3H-3          | VP     | 46       | 17.26        | 1.49      |
| 3H-4          | VP     | 40       | 18.7         | 1.50      |
| 3H-5          | VP     | 40       | 20.2         | 1.49      |
| 3H-6          | VP     | 30       | 21.6         | 1.50      |
| 3H-7          | VP     | 20       | 23           | 1.53      |
| 4H-1          | VP     | 26       | 23.56        | 1.51      |
| 4H-2          | VP     | 46       | 25.26        | 1.50      |
| 4H-3          | VP     | 35       | 26.65        | 1.59      |
| 4H-4          | VP     | 35       | 28.15        | 1.50      |
| 4H-5          | VP     | 45       | 29.75        | 1.51      |
| 4H-6          | VP     | 25       | 31.05        | 1.54      |
| 4H-7          | VP     | 40       | 32.7         | 1.54      |
| 5H-1          | VP     | 40       | 33.2         | 1.51      |
| 5H-3          | VP     | 40       | 36.2         | 1.51      |
| 5H-4          | VP     | 40       | 37.7         | 1.51      |
| 5H-5          | VP     | 19       | 38.99        | 1.52      |
| 5H-6          | VP     | 40       | 40.7         | 1.52      |

Two other PCS autoclaves which contained pressure but no core were depressurized (Cores NGHP-01-01A-12P and NGHP-01-01A-26P). These empty autoclaves released 311 and 603 mL of gas, respectively, which was mainly air. The two final PCS deployments (Cores NGHP-01-01A-31P and NGHP-01-01A-37P) prematurely actuated before acquiring a core.

## Gas-Hydrate Concentration, Nature, and Distribution from Pressure Coring

Two of the six pressure cores at Site NGHP-01-01 recovered core at pressure sufficient to estimate the concentration of gas hydrate in the sediments. There was no indication of methane in either of these cores (or any of the APC or XCB cores; see “Organic geochemistry”), and thus no gas hydrate in the sediment. Examination of the split cores revealed that the BSR was correlated with a lithological boundary (see “Lithostratigraphy”).

It has been suggested that the PCS captures air during deployment. Cores taken at Site NGHP-01-01 released air, substantiating this possibility; however, PCS deployments at other sites on NGHP Expedition 01 did not show evidence of captured air.

It is unclear why the PCS captured air when deployed at Site NGHP-01-01 and not at other sites.

## Downhole Logging

After the last core in Hole NGHP-01-01A was recovered from 290 meters below seafloor (mbsf) at 1530 hr on May 8, the hole was conditioned for logging with a 50 bbl Sepiolite sweep and a wiper trip to 80 mbsf that found no possible trouble spots. The hole was then displaced with 10.5 ppg barite and the bit was pulled to the logging depth of 2,758 mbrf (83.9 mbsf).

With calm seas, logging preparations started at 2055 hr on May 8. After spooling the wire-line and configuring the rigfloor for logging operations, assembly of the first tool string, the triple combo, started at 2220 hr. By 2325 hr, the tool was made up and running in hole (RIH), with a go-devil attached at the bottom to open the lockable flapper valve at the end of the pipe. After the tool string cleared the bit at 0055 hr on May 9, the pipe was raised by 16 m, the wire-line heave compensator (WHC) was activated, and the triple combo was run to the bottom of the hole (2,958 mbrf) without any difficulty. The uplog started at 0125 hr and by 0205 hr the caliper had been closed and the WHC turned off before entering the pipe. With the tool string only 8 m inside the pipe, an obstruction prevented pulling the tool any further, and the pipe had to be lowered and rotated 180° before the tool string could be brought fully inside at 0300 hr. The pass was complete when the Gamma-ray log indicated the seafloor at 2,666 mbrf; the tool was back at the surface at 0420 hr and completely rigged down at 0445 hr. The caliper showed a relatively smooth, slightly enlarged borehole (roughly 13.5 in in diameter), and there were no tight spots while running in hole or logging up.

**Table 16.** Thermal conductivity results for Hole NGHP-01-01A.

| Core, section | Sample | Top (cm) | Depth (mbsf) | Thermal conductivity (W/[m×K]) |
|---------------|--------|----------|--------------|--------------------------------|
| NGHP-01-01A   |        |          |              |                                |
| 1H-3          | TC     | 50       | 3.5          | 0.974                          |
| 2H-3          | TC     | 75       | 8.05         | 0.97                           |
| 3H-1          | TC     | 75       | 14.55        | 1.013                          |
| 3H-3          | TC     | 75       | 17.55        | 1.066                          |
| 4H-3          | TC     | 75       | 27.05        | 1.029                          |
| 5H-3          | TC     | 75       | 36.55        | 1.051                          |
| 7H-3          | TC     | 75       | 48.05        | 1.082                          |
| 8H-3          | TC     | 75       | 57.55        | 1.071                          |
| 9H-3          | TC     | 75       | 67.05        | 1.02                           |
| 10H-3         | TC     | 75       | 76.55        | 0.86                           |
| 11H-3         | TC     | 75       | 86.05        | 0.44                           |
| 13H-3         | TC     | 75       | 97.55        | 1.066                          |
| 14H-3         | TC     | 75       | 107.05       | 1.096                          |
| 15H-3         | TC     | 75       | 116.55       | 1.032                          |
| 16H-3         | TC     | 75       | 126.05       | 1.174                          |
| 17H-3         | TC     | 75       | 135.55       | 0.941                          |
| 18H-3         | TC     | 75       | 143.89       | 0.683                          |
| 19H-2         | TC     | 75       | 153.05       | 0.672                          |
| 21X-3         | TC     | 75       | 158.55       | 0.543                          |
| 22X-3         | TC     | 75       | 168.25       | 1.008                          |
| 23X-3         | TC     | 75       | 177.95       | 0.439                          |
| 24X-3         | TC     | 75       | 187          | 0.692                          |
| 25X-3         | TC     | 75       | 197.15       | 0.95                           |
| 27X-3         | TC     | 75       | 208.75       | 1.039                          |
| 28X-3         | TC     | 75       | 218.35       | 0.49                           |
| 29X-3         | TC     | 75       | 228.05       | 0.533                          |
| 30X-3         | TC     | 75       | 237.65       | 0.46                           |
| 32X-3         | TC     | 75       | 249.35       | 0.46                           |
| 33X-3         | TC     | 75       | 256.95       | 1.076                          |
| 34X-3         | TC     | 75       | 266.65       | 0.987                          |
| 35X-3         | TC     | 75       | 276.25       | 1.109                          |
| 36X-3         | TC     | 75       | 285.85       | 1.151                          |

Rigup of the FMS-sonic tool string started immediately after completing the triple combo and the string was RIH at 0550 hr. The bottom of the hole (2,961 mbrf) was reached at 0712 hr and two passes were recorded successfully with the DSI configured for the following acquisition modes: low frequency upper dipole, regular frequency lower dipole, medium frequency monopole, and Stoneley. Near the end of the second pass at 0850 hr the calipers were closed and the WHC turned off before entering the pipe. As in the previous run, it took several attempts to bring the tool string fully inside the pipe. It was back at the surface at 1015 hr and completely laid down at 1045 hr.

**Table 17.** *In situ* temperature tool deployment log.

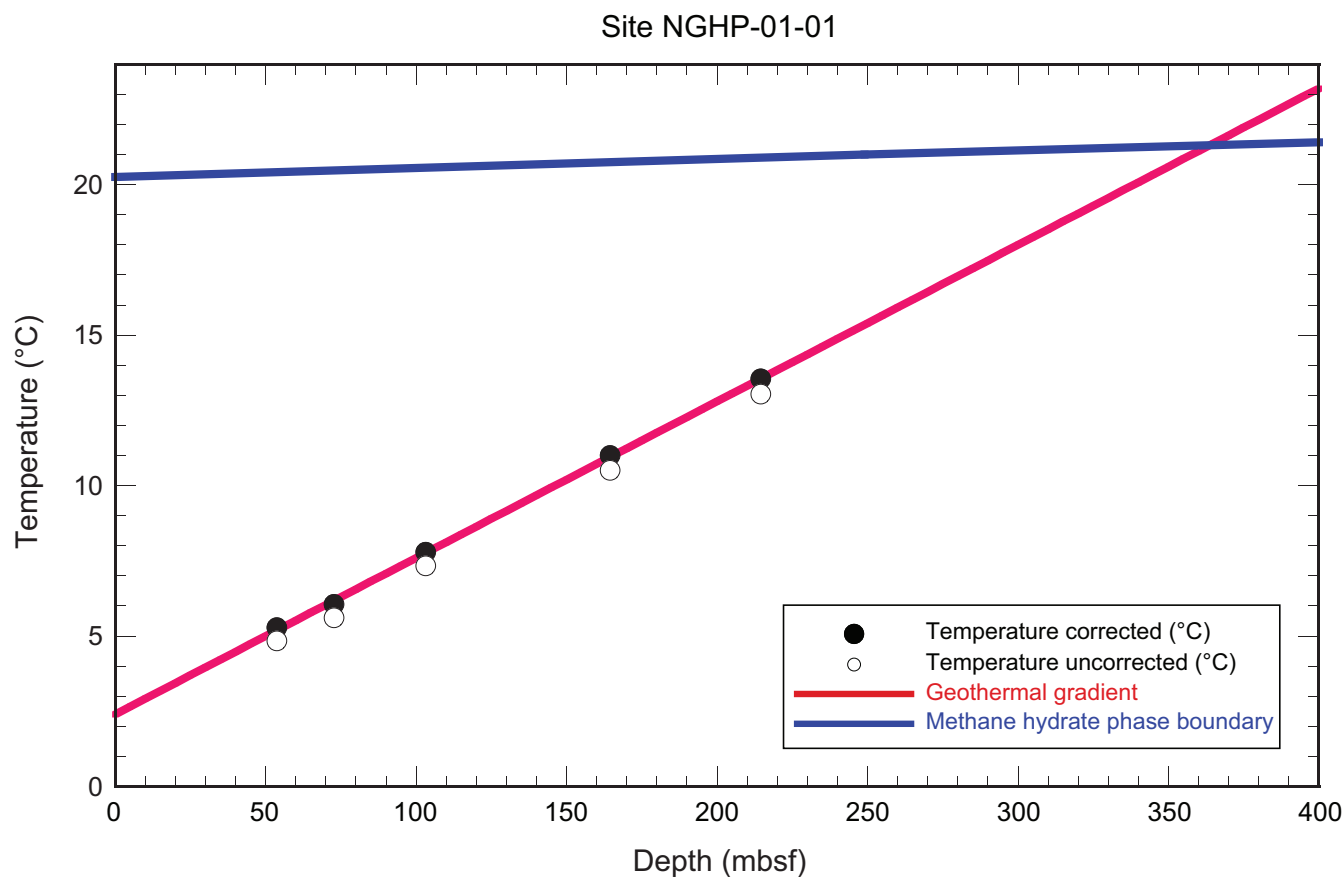
| Depth (mbsf) | Core | Thermal conductivity (W/[m×K]) | Tool | Temp (°C) | Correction applied | Temp (°C) | Estimated uncertainty | Data quality |
|--------------|------|--------------------------------|------|-----------|--------------------|-----------|-----------------------|--------------|
|              | A04  |                                | APCT |           |                    |           |                       | run failed   |
| 53.8         | A07  | 1.05                           | APCT | 5.29      | 0.45               | 4.84      | 0.05                  | excellent    |
| 72.8         | A09  | 1.05                           | APCT | 6.06      | 0.45               | 5.61      | 0.08                  | excellent    |
| 103.3        | A13  | 1.05                           | APCT |           | 0.45               | 7.34      | 0.08                  | excellent    |
| 164.5        | A21  | 1.0*                           | DVTP | 12.01     | 0.5                | 11.51     | 0.05                  | excellent    |
| 214.6        | A27  | 1.05                           | DVTP | 13.55     | 0.5                | 13.05     | 0.05                  | excellent    |

The third logging run scheduled was a vertical seismic profile (VSP) with the VSI. At 0930 hr, while the FMS-sonic was still being pulled to the surface, a watch for marine mammal activity was initiated to prevent any firing if marine mammals were in sight. The VSI was made up shortly after the FMS-sonic tool string was rigged down, but problems with the acquisition software delayed RIH until 1610 hr. Because of the light weight of the tool and of the go-devil attached to its bottom, the VSI did not reach the bottom of the pipe before 1755 hr, and then could not exit the pipe until pumping at high regime pushed it through. By this time it was too dark to continue the marine mammal watch and it was decided to terminate the VSP. Bringing the VSI inside the pipe again proved difficult and resulted in some damage to the cable head that was observed when the tool reached the surface at 2055 hr. The VSI was then rigged down, and by 2200 hr the rig floor was clear to prepare for transit.

## Logging Data Quality

Figure 25 shows some of the main logs recorded with the triple combo. The caliper log shows that the hole was slightly larger than the bit size, but very regular with only a few enlargements where the caliper arm kept good contact with the formation. As a result the data are of good quality, which is confirmed by the good agreement between the density log and the discrete density measurements made on core samples. Using a grain density of 2.72 g/cm<sup>3</sup>, which corresponds to the average of the values measured on the core samples, we derived a density-porosity log that is also in good agreement with the core-measured porosity values. Despite the good hole conditions, the neutron porosity is seriously affected by the high clay content of the formation and is consistently higher than the porosity derived from the core or from the density log.

The strong amplitude and the good coherence shown by the monopole and upper dipole waveforms in figure 26 confirms the good hole conditions and indicate that the velocity logs are of very high quality. In particular, the two clear high-coherence trends in the monopole data show that the acquisition software was able to differentiate between the mud and formation compressional arrivals.



**Figure 22.** Geothermal gradient and estimated depth to the BSR from *in situ* temperature measurements for Hole NGHP-01-01A. [BSR, bottom-simulating reflector]

## Logging Units

The trends in the main logs displayed in figures 25 and 26 (particularly the gamma-ray, resistivity, and velocity logs) allow the definition of three logging units with distinct characteristics:

Logging unit 1 (65–195 mbsf) can be characterized overall by a steady increase with depth in resistivity and density, and can be divided into two subunits showing some more specific character. In addition to this general trend, Subunit 1A (65–160 mbsf) shows a gradual increase with depth in gamma ray and compressional velocity ( $V_p$ ). Below a small but clear local maximum in velocity and density at 160 mbsf that marks the top of Subunit 1B, the velocity logs remain almost uniform over most of this subunit (160–195 mbsf), while the gamma-ray log decreases with depth.

The top of Logging unit 2 (195–240 mbsf) is defined by a very distinct increase in  $V_p$ ,  $V_s$ , and in density at 195 mbsf, which also coincides with a slight change in the trend of the resistivity log. It seems to correspond to a change in lithology indicated by a decrease in gamma-ray counts that is mostly due to lower uranium content. The lower gamma-ray counts in this unit can be interpreted as a lower clay content that contributes to reducing the difference between the neutron porosity and the density- and core-derived porosities in this unit and below. While the changes in velocity in particular are very clear, the

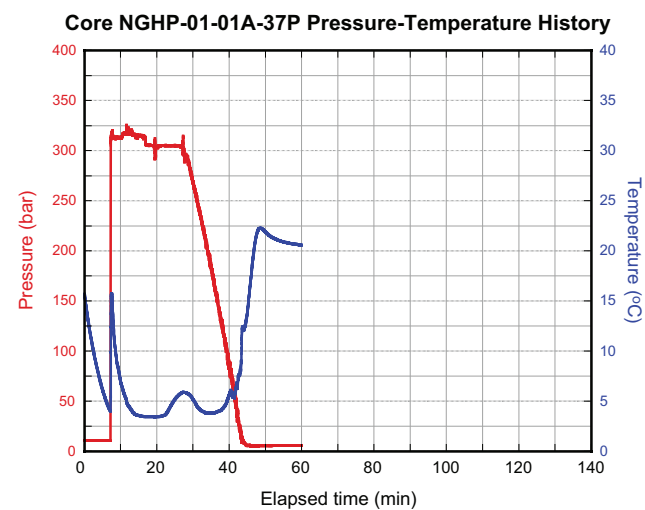
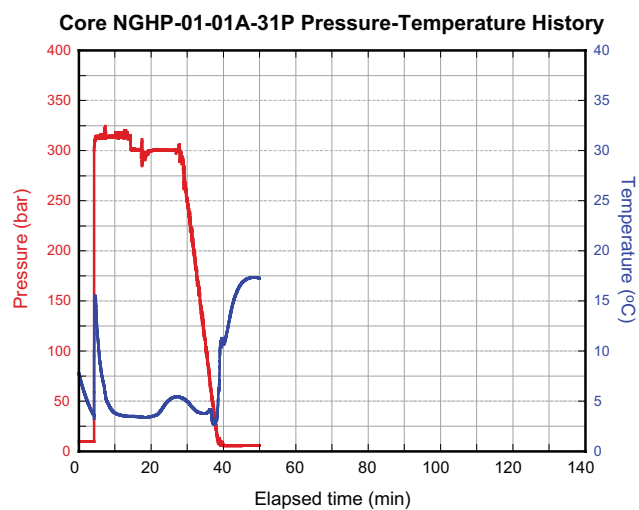
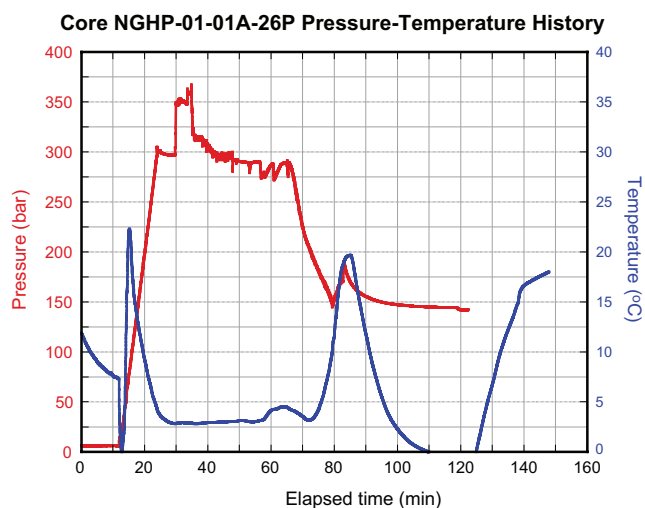
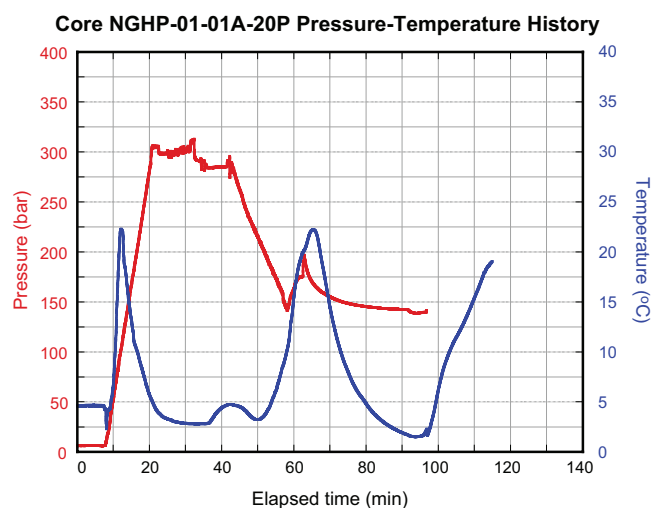
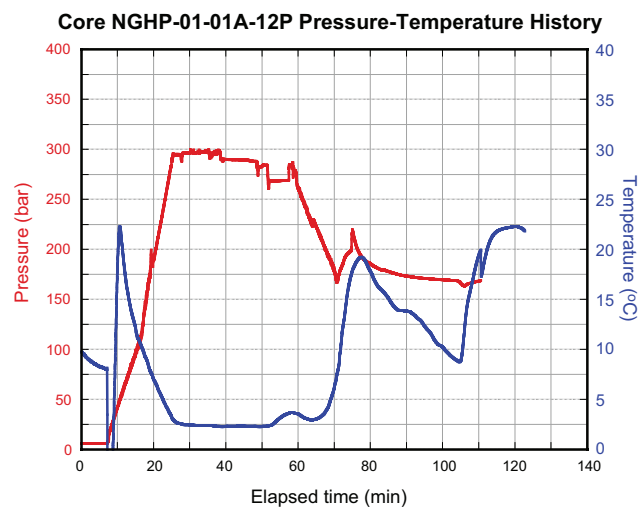
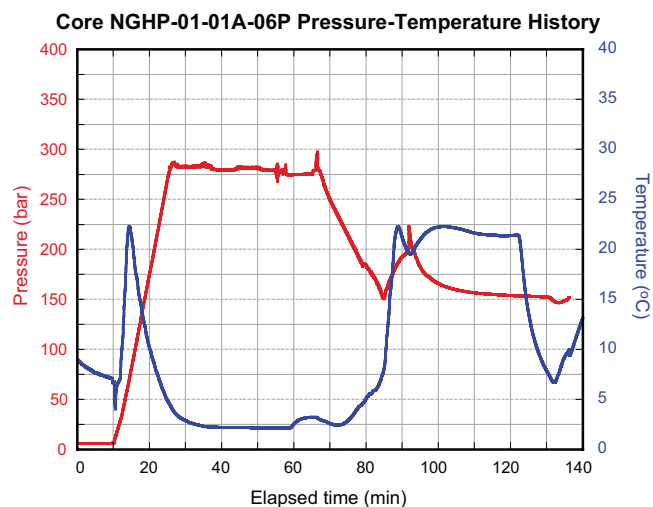
nature of the lithological change at 195 mbsf must be subtle because it was not identified in the core description (see the “Lithostratigraphy” section).

Finally, Logging unit 3 (240–290 mbsf) is defined by a sharp resistivity drop at 240 mbsf overlaying a subunit with highly variable resistivity values. At the top of this unit the gamma-ray and density logs also show a distinct decrease, and remain almost uniform over the rest of the unit. This logging unit mostly coincides with Lithostratigraphic Unit IV.

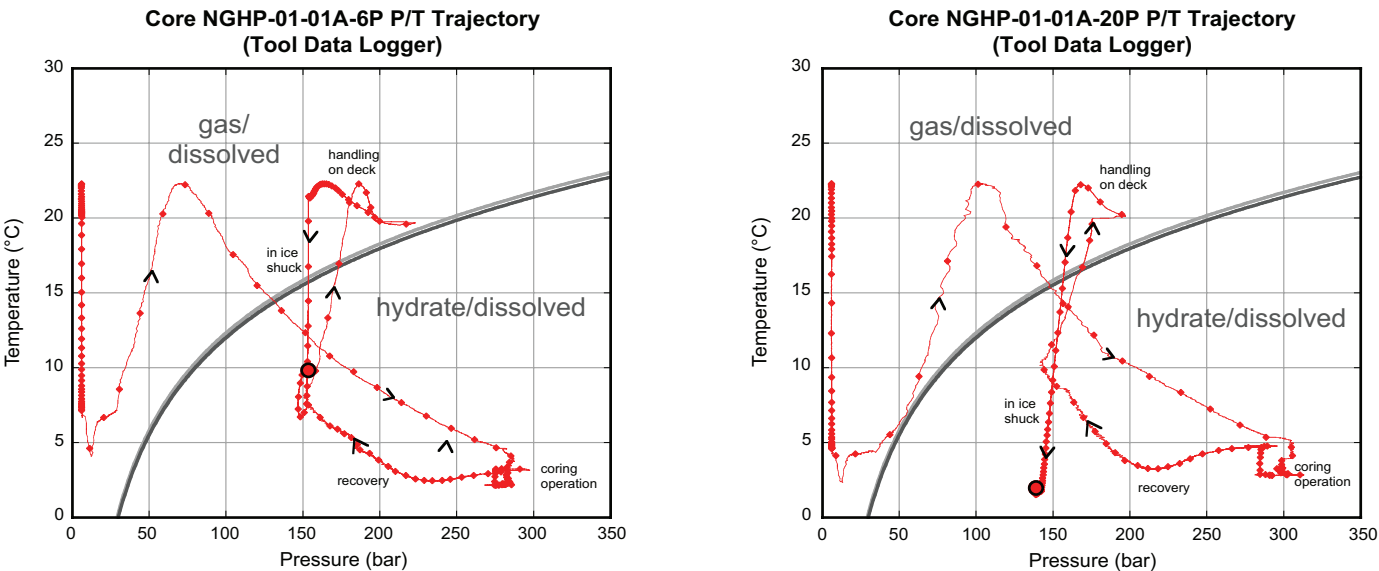
## Gas-Hydrate and Free Gas Occurrence

As previously discussed (see “Downhole logging” in the “Methods” chapter), the presence of gas hydrate is generally identified by increases in electrical resistivities and acoustic velocities that are not accompanied by a corresponding porosity decrease. A decrease in porosity alone in water-saturated sediments can result in an increase in resistivity and acoustic velocity. Resistivities logged in Hole NGHP-01-01A show a general negative correlation with porosity (fig. 25), suggesting that little or no gas hydrate is present.

To make a quantitative estimate of the amount of gas hydrate at Hole NGHP-01-01A, we followed the procedure described in “Downhole logging”, in the “Methods” chapter, to apply the Archie relationship to the resistivity and porosity logs



**Figure 23.** Temperature and pressure versus elapsed time for each pressure corer deployment as recorded by the corer's internal data logger.



**Figure 24.** Temperature versus pressure for the deployment of successful pressure cores at Site NGHP-01-01, showing trajectories relative to gas hydrate stability at 30 ppt and 35 ppt salinity, calculated from Xu (2002, 2004). Small dots represent approximate one minute intervals. Large dot is final temperature and pressure of autoclave prior to data logger removal.

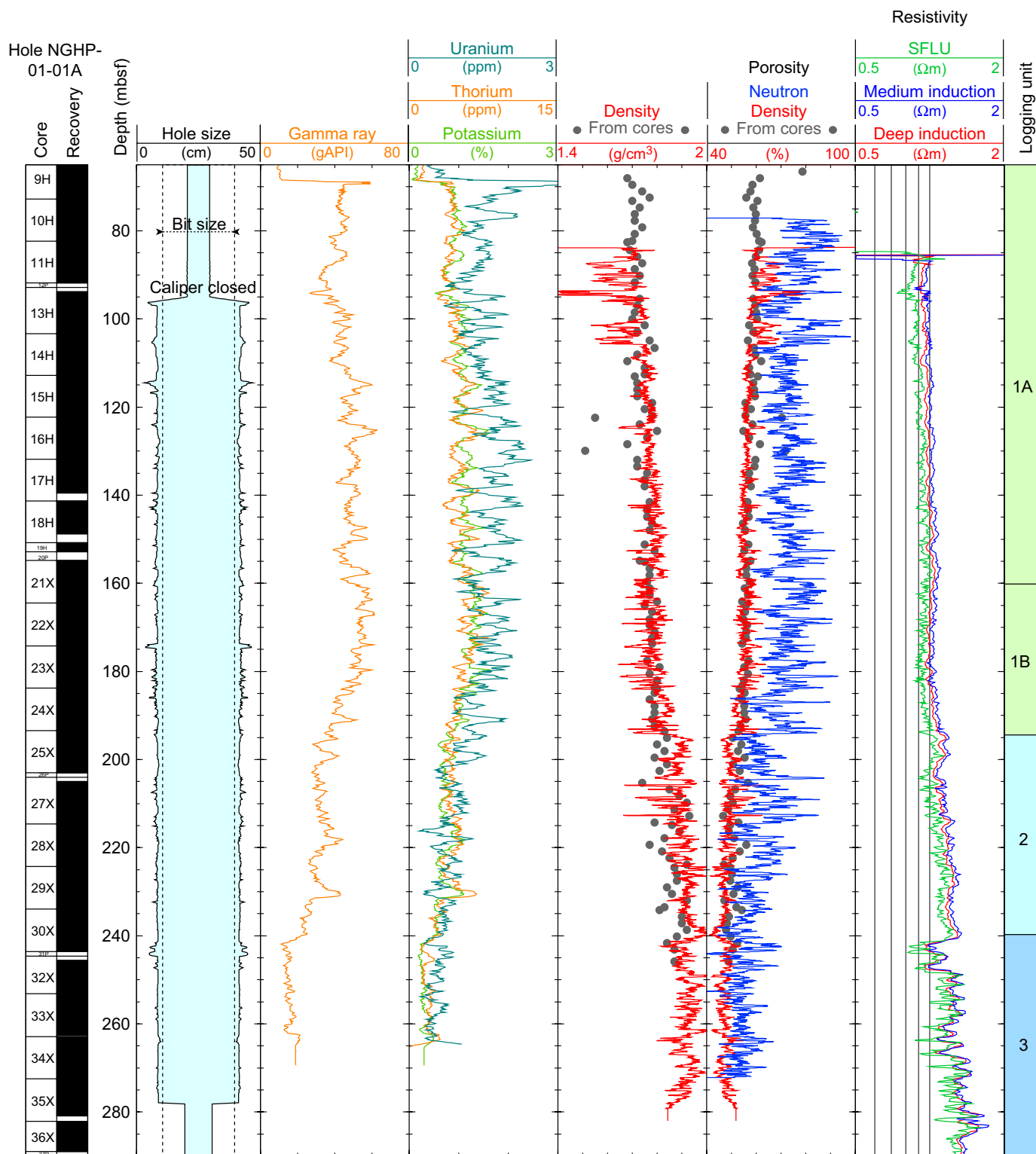
**Table 18.** Summary of pressure coring operations at Site NGHP-01-01.

| Core ID     | Top of core (mbsf) | Length curated (cm) | Pressure at core depth (bar) | Pressure recovered (bar) |        | Comments                                                               |
|-------------|--------------------|---------------------|------------------------------|--------------------------|--------|------------------------------------------------------------------------|
|             |                    |                     |                              | logged*                  | deck** |                                                                        |
|             |                    |                     |                              |                          |        |                                                                        |
| NGHP-01-01A |                    |                     |                              |                          |        |                                                                        |
| 06P         | 43.3               | 91                  | 268                          | 151                      | @7 °C  | 135 normal operation                                                   |
| 12P         | 92.8               | 0                   | 273                          | 169                      |        | 152 normal operation                                                   |
| 20P         | 153.3              | 101                 | 279                          | 140                      |        | 254 normal operation                                                   |
| 26P         | 204.0              | 0                   | 284                          | 142                      |        | 137 normal operation                                                   |
| 31P         | 244.6              | 0                   | 289                          | 0                        |        | -- missing o-ring in actuator; premature actuation                     |
| 37P         | 290.0              | 0                   | 293                          | 0                        |        | -- premature actuation; piston in actuator remachined after deployment |

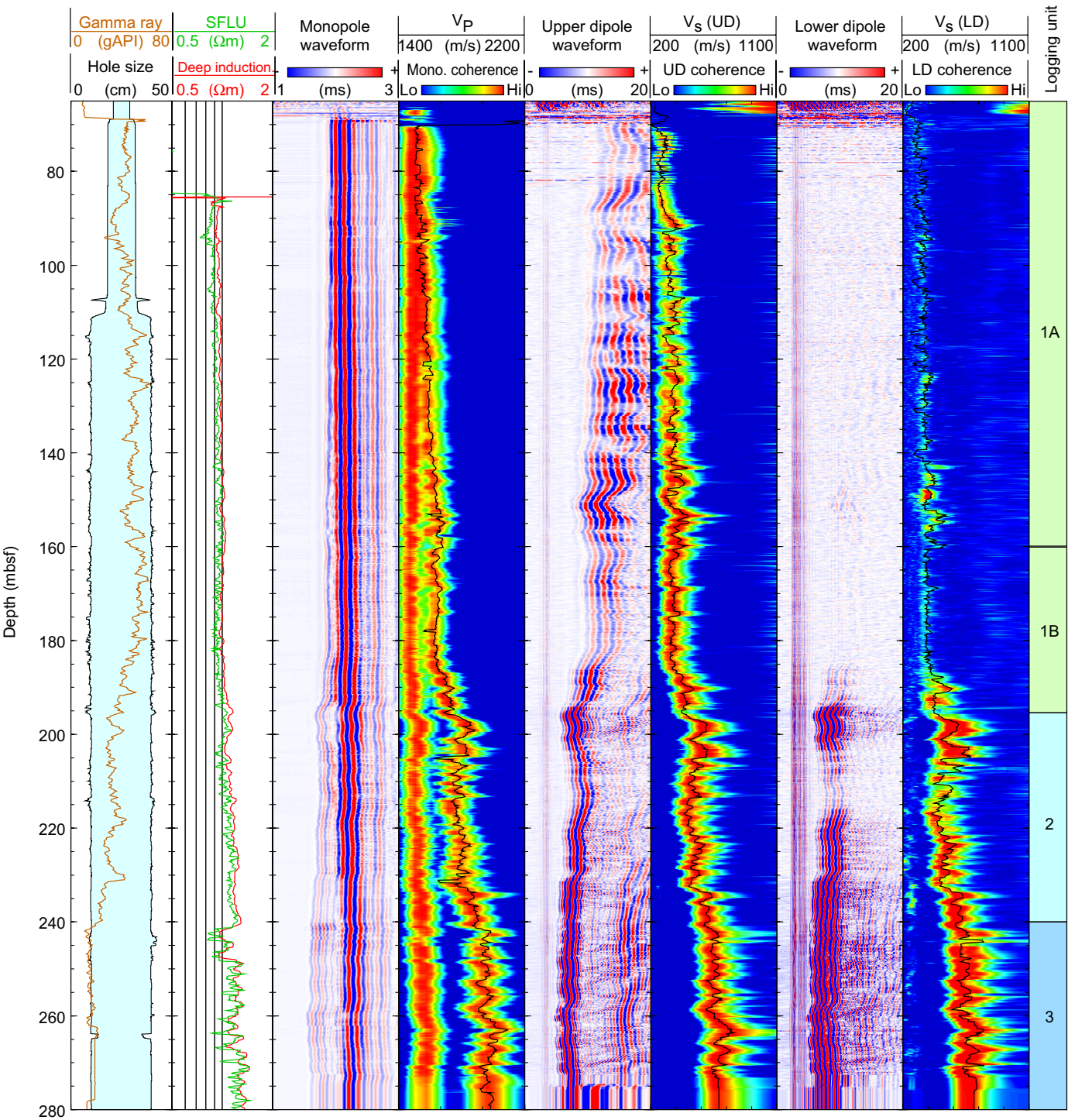
Notes:  
Water depth at Site NGHP-01-01 is 2631 m. P=PCS.  
\*Last pressure recorded before data logger disconnected from corer autoclave. Temperature 0–4 °C unless otherwise noted.  
\*\*Pressure measured when autoclave pressure transducer connected to external computer. Pressure measured at 7 °C unless otherwise noted.

recorded in Hole NGHP-01-01A. Because no LWD logs were recorded in this site, we used the wire-line resistivity logs to derive the gas-hydrate saturation estimates. The procedure and the results are illustrated in figure 27. The pore fluid resistivity ( $R_w$ ) was estimated from Fofonoff (1985) using a temperature profile derived from a linear fit of the *in situ* temperature measurements (3 °C at the seafloor; gradient of 55 °C/km, see “Physical Properties”) and assuming a water salinity of 30 ppt. The estimated  $m$  curve is derived from  $R_w$ , the porosity ( $\phi$ ) and resistivity ( $R_t$ ) logs ( $m_{est} = -\log F / \log \phi$ , where  $F = R_t / R_w$ ). The chosen value of  $m = 2.0$  is given by the baseline of this curve in the low-resistivity water-saturated formation. Using the porosity log and Archie’s equation ( $R_0 = (a R_w) / \phi^m$ ), we derive the predicted resistivity of the water-saturated formation  $R_o$ . A qualitative influence of gas hydrate on the resistivity log is indicated by the difference between the  $R_0$  and the measured resistivity  $R_t$ . The actual water saturation, assumed to be the numerical complement

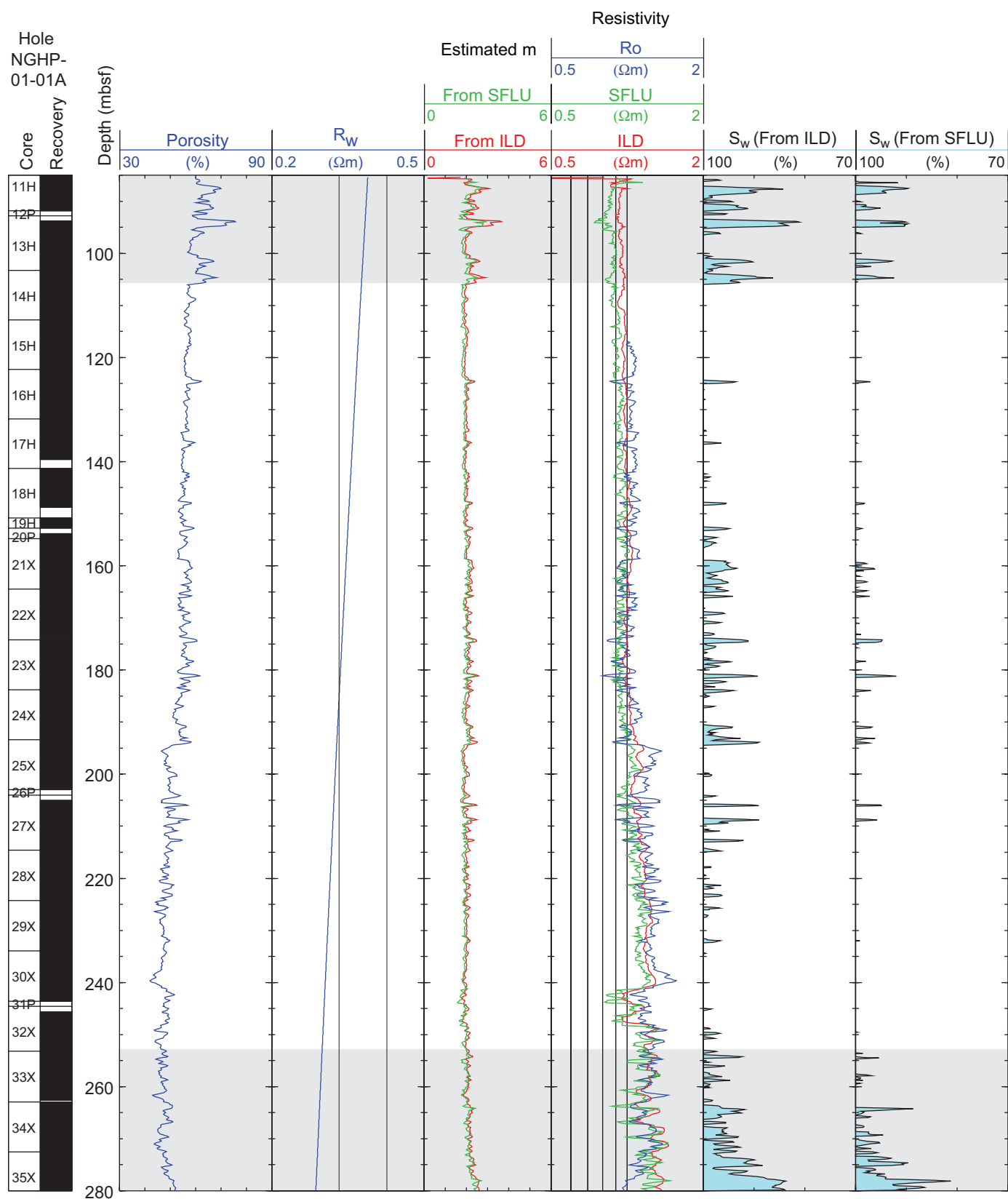
of the hydrate saturation, is  $S_w = (R_o / R_t)^{1/n}$ , where  $n = 2$  (Pearson and others, 1983). We used the density porosity and two resistivity measurements to derive the results shown in figure 27. The Spherically Focused unaveraged resistivity (SFLU) has the highest resolution, but the shallowest penetration of the resistivity measurements made by the DIT tool and is more sensitive to drilling disturbances; the Deep Induction log (ILD) has the deepest penetration, but a lower vertical resolution. The combination of these two estimates provides a possible range of gas-hydrate distribution around Hole NGHP-01-01A. As noted earlier, no occurrence of gas hydrate was detected in the cores recovered in this hole, and while remaining low, these values are likely overestimating the possible amounts, if there is any. In particular, higher values in the shallowest part of the hole correspond to high porosity derived from anomalously low density measurements that do not match the core data and are likely faulty.



**Figure 25.** Summary of the wire-line logs recorded in Hole NGHP-01-01A. The density and porosity measurements made on core samples are shown for comparison. [SFLU, Spherically focused unaveraged resistivity]



**Figure 26.** Sonic waveform amplitude and coherence data and also velocity logs measured by the DSI in Hole NGHP-01-01A. The hole size and the gamma ray and resistivity logs are shown for quality control and correlation. [DSI, Dipole Shear Sonic Imager;  $V_p$ ,  $P$ -wave velocity;  $V_s$ ,  $S$ -wave velocity; LD, Lower dipole; UD, Upper dipole]



**Figure 27.** Water saturations from Archie's equation and wire-line porosity and resistivity logs in Hole NGHP-01-01A. The gray area indicates degraded data quality. [ $R_w$ , Formation water resistivity;  $R_o$ , Computed formation resistivity for 100 percent water saturation;  $R_t$ , Measured resistivity;  $S_w$ , water saturation; SFLU, Spherically focused unaveraged resistivity; ILD, Deep induction resistivity log]

## References Cited

- Bjerrum, L., 1972, Embankments on soft ground: Proceedings of the ASCE Specialty Conference on Performance of Earth and Earth-Supported Structures, Purdue University, v. II, p. 1–54.
- Davis, E.E., Hyndman, R.D., and Villinger, H., 1990, Rates of fluid expulsion across the northern Cascadia accretionary prism—Constraints from new heat flow and multichannel seismic reflection data: *Journal of Geophysical Research*, v. 95, p. 8869–8889.
- Deaton, B.C., and Balsam, W.L., 1991, Visible spectroscopy: a rapid method for determining hematite and goethite concentrations in geological materials: *Journal of Sedimentary Petrology*, v. 61, p. 628–632.
- Fofonoff, N.P., 1985, Physical properties of seawater: *Journal of Geophysical Research*, v. 90, no. C2, p. 3332–3342.
- Giosan, L., Flood, R.D., Grützner, J., and Mudie, P., 2002, Paleoceanographic significance of sediment color on western North Atlantic Drifts—I. Origin of color: *Marine Geology*, v. 189 p. 25–41.
- Holtz, R.D., and Kovacs, W.D., 1981, An introduction to geotechnical engineering: Englewood Cliffs, N.J., Prentice-Hall, Inc., 733 p.
- Hunt, R.E., 1984, Geotechnical engineering investigation manual: New York, McGraw-Hill Book Company, 983 p.
- Ladd, C.C., Foote, R., Ishihara, K., Schlosser, F., and Poulos, H.G., 1977, Stress-deformation and strength characteristics: State-of-the-art report, Proceedings of the Ninth International Conference on Soil Mechanics and Foundation Engineering, Tokyo, v. 2, p. 421–494.
- Lambe, T. W., Whitman, R.V., 1969, Soil mechanics: New York, John Wiley and Sons, 553 p.
- Novosel, I., Winters, W.J., Boldina, O.M., Labails, C., and Geli, L., 2007, Thermal conductivity of sediment recovered from the IMAGES VIII/PAGE 127 Gas Hydrate and Paleoclimate Cruise on the *R/V Marion Dufresne* in the Gulf of Mexico, 2–18 July 2002, in Winters, W.J., Lorenson, T.D., and Paull, C.K., eds., Initial report of the IMAGES VIII/PAGE 127 gas hydrate and paleoclimate cruise on the RV Marion Dufresne in the Gulf of Mexico, 2–18 July 2002: U.S. Geological Survey Open-File Report 2004–1358.
- Pearson, C.F., Halleck, P.M., McGuire, P.L., Hermes, R., and Mathews, M., 1983, Natural gas hydrate deposits—A review of *in situ* properties: *Journal of Physical Chemistry*, v. 87, p. 4180–4185.
- Rothwell, R.G., 1989, Minerals and mineraloids in marine sediments—An optical identification guide: Elsevier Science Publishers, 279 p.
- Sloan, E.D., 1998, Clathrate Hydrates of Natural Gases (2d ed.): New York (Marcel Dekker), 705 p.
- Xu, W., 2002, Phase balance and dynamic equilibrium during formation and dissociation of methane gas hydrate, in International Conference on Gas Hydrates, 4th, Yokohama, Japan, May 2002, Proceedings: Yokohama, Japan, International Conference on Gas Hydrates, p. 195–200.
- Xu, W., 2004, Modeling dynamic marine gas hydrate systems: *American Mineralogist*, v. 89, p. 1271–1279.