IODP Expedition 314 processing note

Operation summary

Hole C0002A

Latitude: 33°18.0192′N

Longitude: 136°38.1810′E

Seafloor (drill pipe measurement from rig floor, m): 1964.5

Distance between rig floor and sea level (m): 28.5

Water depth (drill pipe measurement from sea level, m): 1936

Logging run

8-1/2 inch LWD(GVR-sonic-SVWD-ADN)-MWD-APWD

Available data

Hole C0002A was drilled with LWD-MWD-APWD tools. MWD-APWD data were transmitted in real time with a limited set of LWD data.

Depth shift

The mudline (seafloor) was identified from the first break in the gamma ray (GR) and resistivity logs (**Fig. 2**). In Hole C0002A, the mudline was picked at 1964.5 m DRF, showing no discrepancy with drillers depth (water depth = 1964.5 m DRF; 1936 meters below sea level [mbsl]). The depth-shifted versions of the main drilling data and geophysical logs are given in **Fig. 3** and **Fig. 4**, respectively. **Fig. 5** presents the time-depth relationship linking the time (**Fig. 1**) and depth version (**Fig. 3**, **Fig. 4**) of the data from Hole C0002A.

Logging data quality

Fig. **3** shows the drilling control logs. The target ROP of 30 m/h (±5 m/h) was generally achieved until TD (1401.5 m LSF). This ROP was sufficient to record one sample per 4 cm over the majority of the hole. WOB was set to a minimal value (<5 kkgf for most of the drilled interval). Surface pump pressure (SPPA) was maintained at constant value (~15–18 MPa) for the entire drilling period, and a normal (hydrostatic) increasing trend in APRS and ECD was observed. The four azimuthal calipers (C15, C26, C37, and C48) showed poor borehole condition with washouts exceeding 2 inches (5.08 cm) in most places except between 830 and 930 m LSF, where the hole was almost in gauge (stand-off < 1 inch [2.54 cm]). Stick-slip and friction increased linearly with the length of the penetrated interval but never exceeded the critical limit of 250 rpm that could impair geoVISION resistivity tool (GVR) image quality. In the washed out lower section of the hole (950–1400 m LSF), the GVR experienced numerous shocks with peak intensity sometimes >25 g without any failure. Time after bit (TAB) measurements were ~5–10 min for the gamma ray log, except in a short depth interval corresponding to pipe connections where they sometimes exceeded 1 h. The gamma ray log is highly correlated to borehole shape, suggesting lithology-controlled washouts of sandy layers. TAB measurements for density and neutron porosity logs are ~45 min. In spite of the major washouts, the image-derived density (four bin average maximum azimuthal density [IDRO]) and image stand-off correction (IDDR) provide valuable logs. TAB measurements for resistivity were between 5 and 10 min. Where hole conditions were good, comparison between deep button (RES_BD) and shallow button (RES_BS) resistivity values showed that drilling fluid invasion was not significant, consistent with the short TAB readings. Elsewhere, the discrepancy between deep and shallow readings reflects possible invasion in permeable (sandy) layers or poor hole conditions (washouts, also associated with sandy layers). The sonicVISION data for Hole C0002A were processed by the

Schlumberger Data Consulting Services (DCS) specialist on board the *Chikyu*. Three products were produced. The first analysis relies on a broad band-pass filter on the data acquired during drilling, referred to here as "wide." The second relies on a very narrow bandpass filter, designed to pass only the leaky *P*-wave arrival on the data acquired during drilling, referred to as "leaky-P." The third relies on the wide filtering on the data acquired at high speed while pulling out of the hole, referred to as "widefast." As a result, the composite sonic velocity curve for this site includes data from all three processed logs (**Table 1**). In the upper half of the hole (0–634m LSF), the results of all three processed logs were used. The leaky-P data were only used for intervals where neither of the other logs allowed reliable picks. The wide data were the most reliable in the bottom half of the hole, so these data were used to assemble the composite log from 634 to 1293 m LSF. The quality control analysis of the sonic data is based on examination of the plots showing the sonic waveforms and the slowness coherence images for the common receiver data and the common source data (**Fig. 6**). The full versions of these three plots are available as picture description standard (Schlumberger) format files in the raw data for the expedition (available at *sedis.iodp.org*). **Fig. 6** illustrates a typical example of an interval in which few if any picks are possible (Quality Type 3 in **Table 1**). Examples of Types 0–2, are shown in "Data and log quality" in the "Expedition 314 Site C0001" chapter. Density, gamma ray, and resistivity images are of very good quality. However, depth shifts of several tens of centimeters are observed in these images. These depth shifts are neither systematic nor constant with depth. They even occur within the images from the same tool (e.g., geoVISION deep, medium, and shallow resistivity images). All images and scalar logs were processed with the same time-depth conversion files; however, the origin of these local depth shifts is not clear and can not be realistically attributed to preprocessing of the data. At first, these depth shifts seemed localized in zones of high contrast (resistivity, density, and gamma ray values) suggesting a possible combination of (1) tool deviation in respect to layering and (2) shoulder effect. Selected examples were sent to a Schlumberger DCS specialist on shore for further investigation. He reported similar observations on past drillship expeditions, suggesting that incomplete heave compensation and rapid vertical movements between the sampling of all data (sampling rate = 5 s) are the origins of the depth shifts. Most of the analyses conducted on board were done on the shallow resistivity image. Density (density correction and photoelectric factor [PEF]) and gamma ray images have not been used for log characterization, physical properties, structural analyses, or log-seismic integration. The resistivity image log from Hole C0002A extends from 129 to 1398 m LSF (**Table 2**). Overall, the quality of the image data is excellent (except isolated spurious depth shifts discussed above). The log is marked by three 1 m intervals of poor quality where the image is smeared, perhaps because of lack of rotation. A short section of variable resistivity around the hole circumference occurs from 129 to 197 m LSF, probably because of hole eccentricity. Sharp changes in resistivity along knife-edge planar horizontal surfaces, typically bounding decimeter or thicker domains, are suspected to be drilling artifacts. Centimeter-scale horizontal variations in resistivity are also suspected to be artifacts because of their thinness, regularity, and horizontal orientation. Overall, the general structural patterns and sedimentary features are apparent. Interpretation of resistivity image data is further discussed in "Structural geology and geomechanics" in the "Expedition 314 Site C0001" chapter.

This note is extracted from

Kinoshita, M., Tobin, H., Ashi, J., Kimura, G., Lallement, S., Screaton, E.J., Curewitz, D.,Masago, H., Moe, K.T., and the Expedition 314/315/316 Scientists, Proceedings of the Integrated Ocean Drilling Program, Volume 314/315/316.

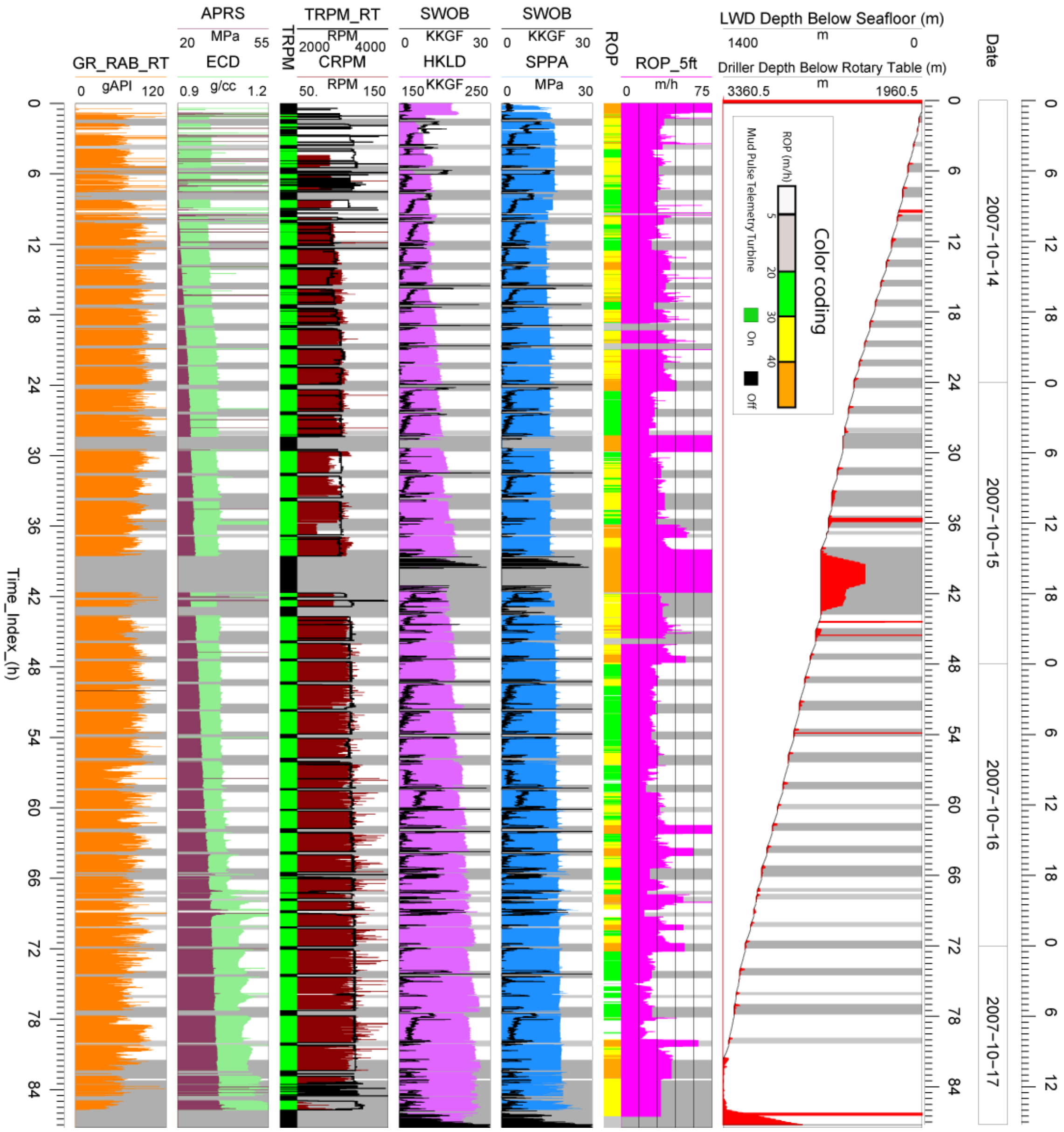

Figure 1. Drilling parameters and gamma ray log plotted vs. time for LWD-MWD-APWD operations in Hole C0002A. GR_RAB_RT = gamma ray resistivity-at-the-bit (real time), ECD = equivalent circulating density, APRS = average annular pressure, TRPM = MWD turbine rotation speed (off = <1500 or >4500 rpm, on = 1500–4500 rpm), TRPM_RT = TRPM (real time), CRPM = collar rotation, SWOB = surface weight on bit, HKLD = hook load, SPPA = standpipe pressure, ROP = rate of penetration, ROP_5ft = 5 ft averaged ROP, LSF = LWD depth below seafloor, DRF = drillers depth below rig floor.

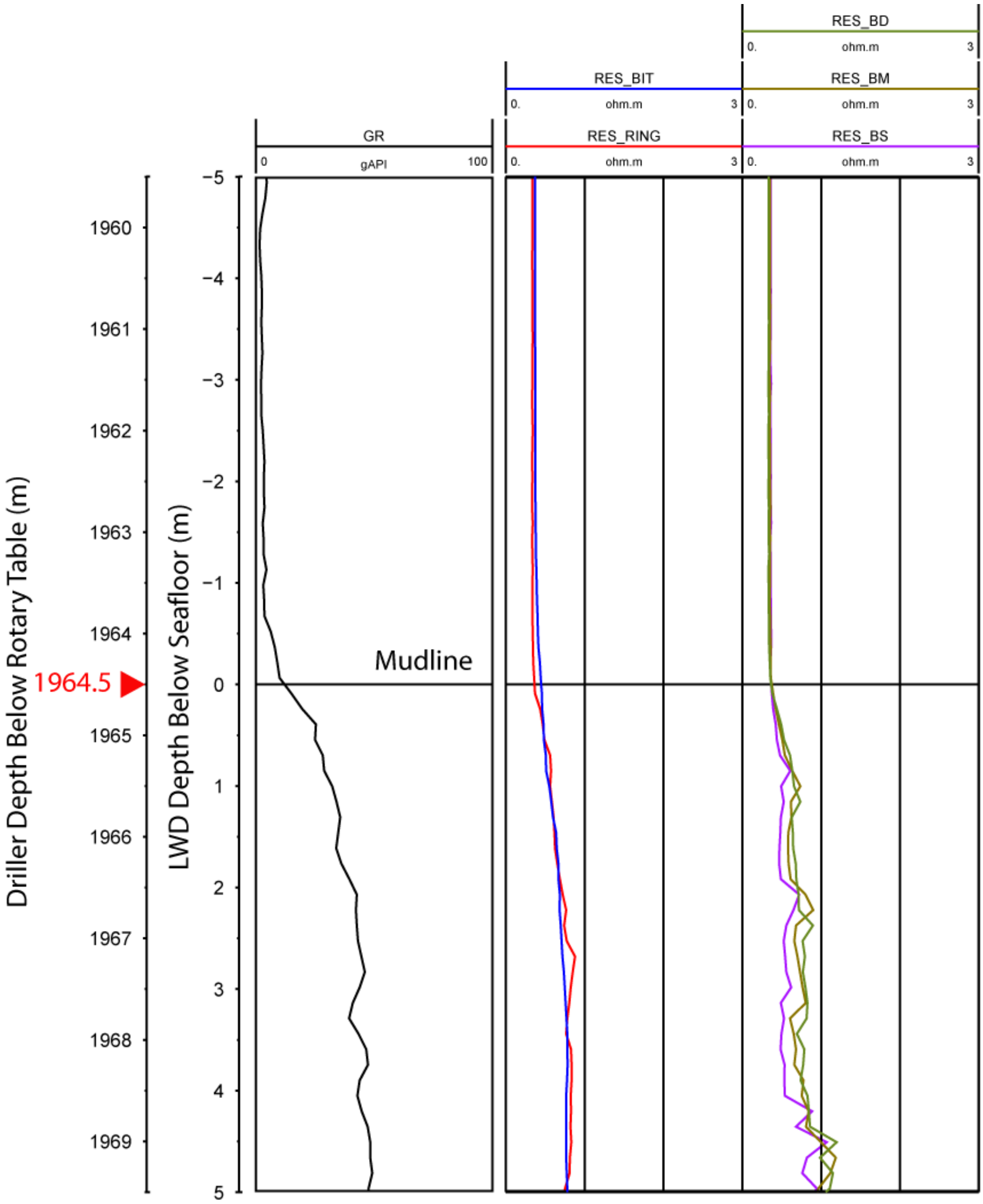

Figure 2. Mudline (seafloor) identification in Hole C0002A using natural gamma ray and resistivity logs of the geoVISION resistivity tool (memory data). The seafloor is defined by a break in the natural gamma ray and resistivity logs at 1964.5 m drillers depth below rig floor (DRF). Resistivity data are plotted on a linear scale.

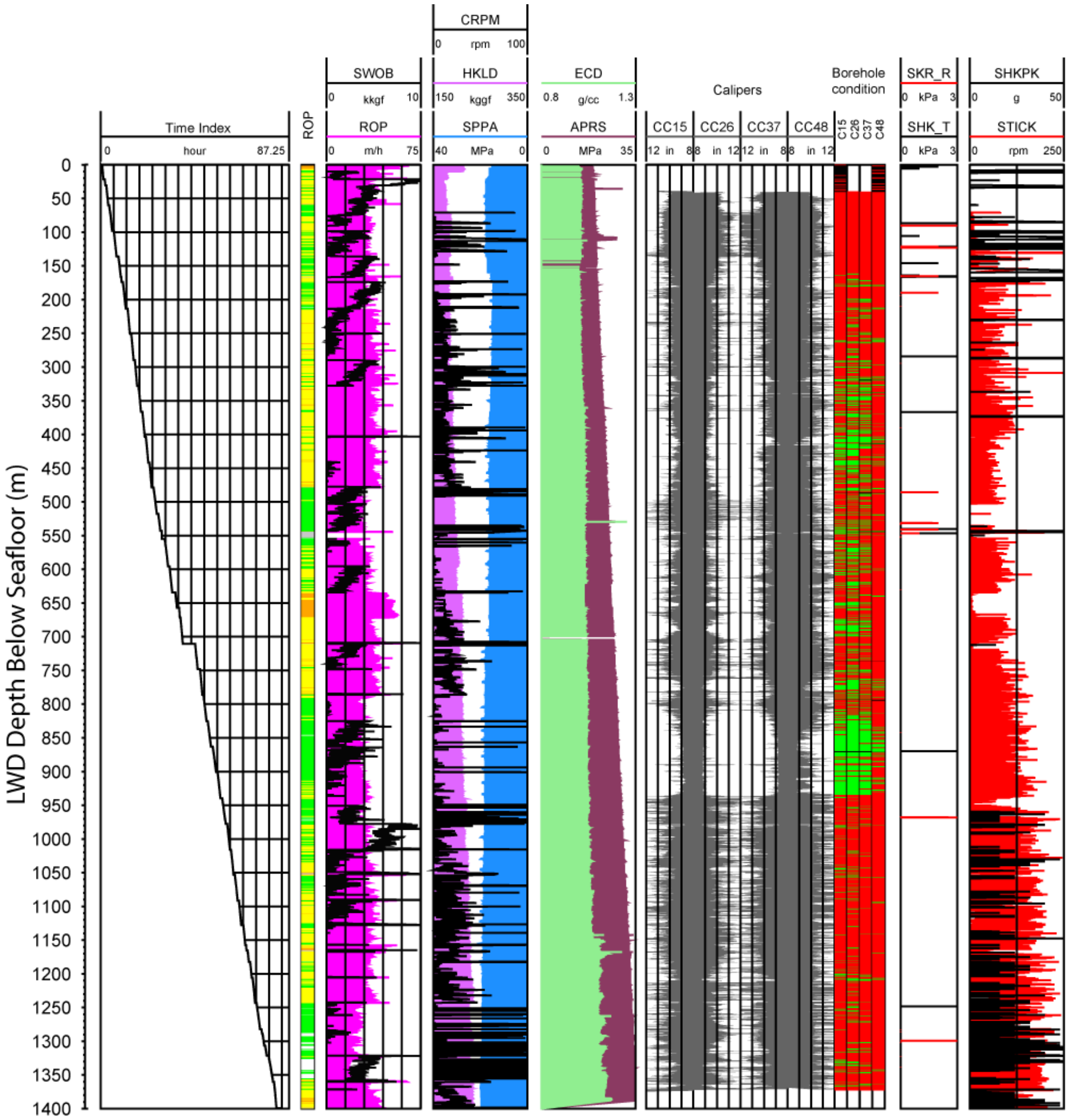

Figure 3. Control logs of Hole C0002A. LSF = LWD depth below seafloor; ROP = rate of penetration; SWOB = surface weight on bit; CRPM = drilling collar (bit) rotation; HKLD = hookload; SPPA = standpipe pressure; ECD = equivalent circulating density; CC15, CC26, CC37 and CC48 = ADN tool ultrasonic calipers; SKR_T and SHK_R = transverse and radial shocks experienced by the geoVISION resistivity tool; SHKPK = shock peak; STICK = stick-slip indicator.

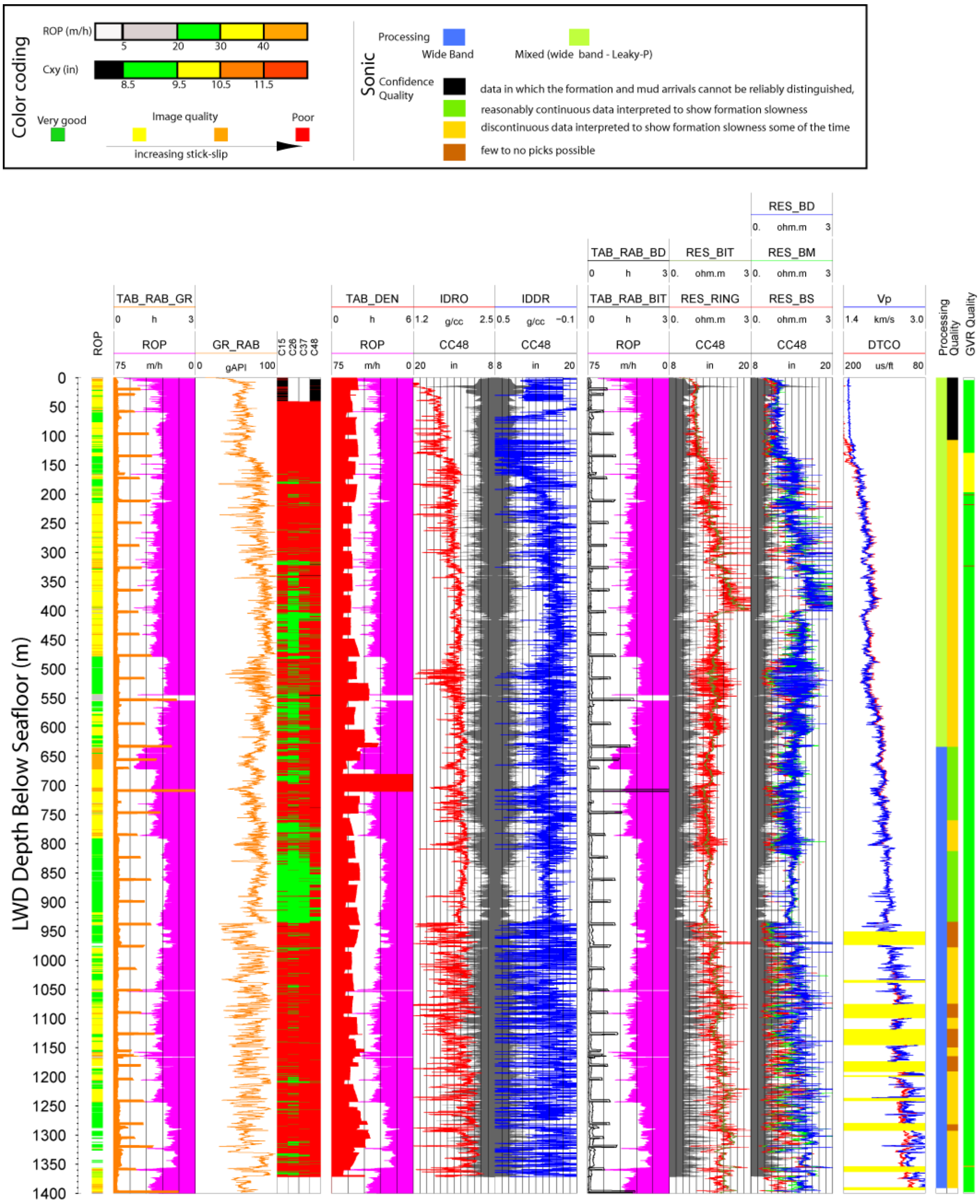

Figure 4. Geophysical logs in Hole C0002A. LSF = LWD depth below seafloor, ROP = rate of penetration; TAB_RAB_GR = time after bit (TAB) of gamma ray measurement by the geoVISION resistivity (GVR) tool, GR_RAB = gamma ray log (GVR memory data), Cxy = ADN ultrasonic calipers (C15, C26, C37, and C48), TAB_DEN = TAB of ADN density measurement, IDRO = image-derived density, IDDR image-derived density correction (for stand-off), TAB_RAB_BD = TAB of GVR deep button resistivity, TAB_RAB_BIT = TAB of GVR bit resistivity, RES_BD = deep button resistivity, RES_BM = medium button resistivity, RES_BS = shallow button resistivity, V_P = sonic compressional velocity, DTCO = ⊗t compressional transit time measurement, sonic processing and quality color-coded indicators and geoVISION resistivity image quality.

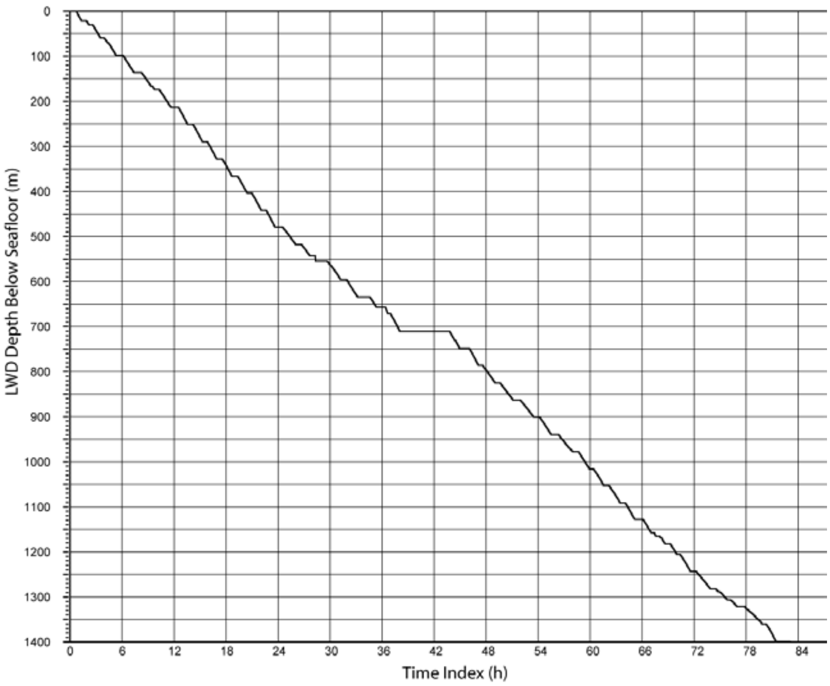

Figure 5. Time-depth relationship in Hole C0002A. LSF = LWD depth below seafloor.

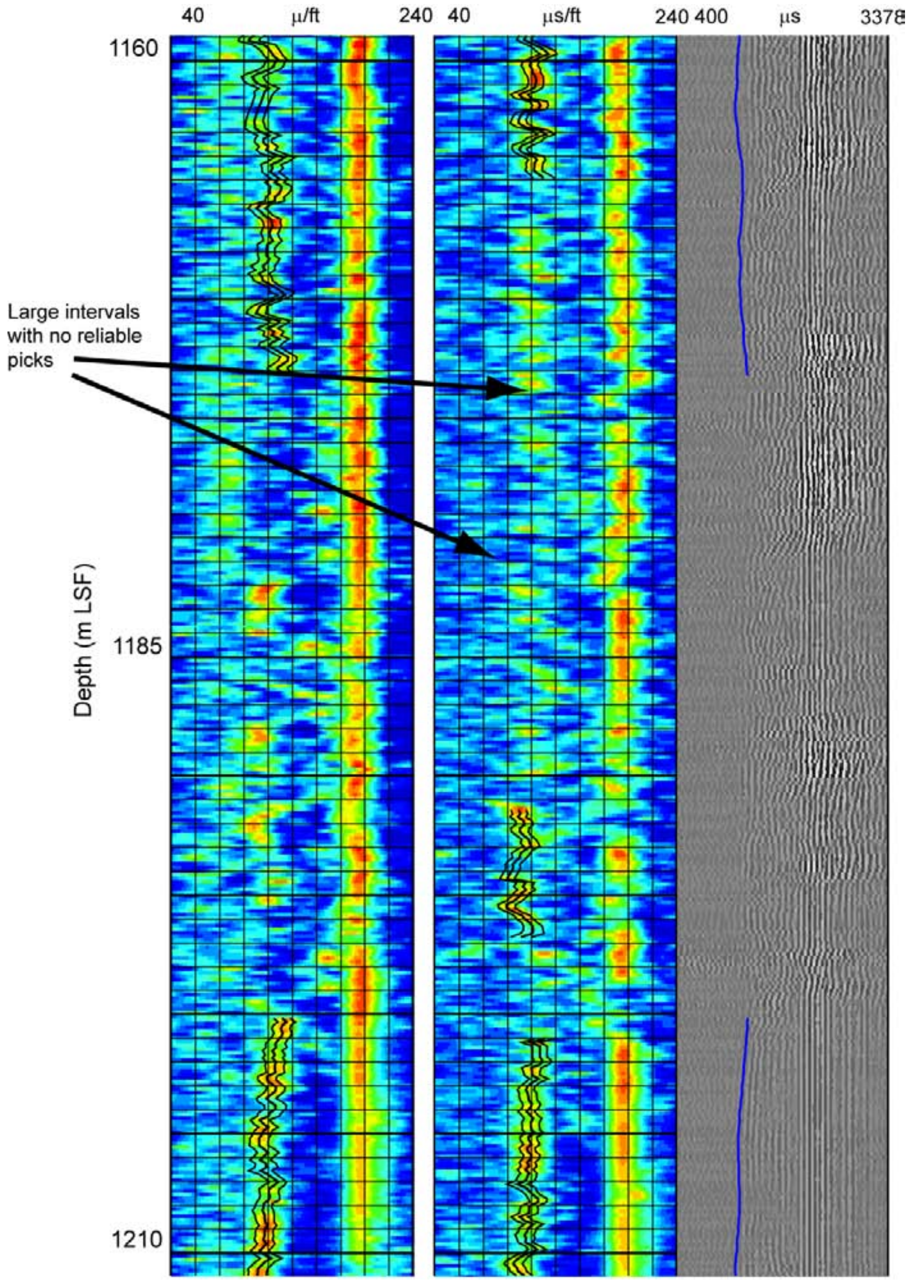

Figure 6. Example of wide quality control log prepared for the sonic log from the sonicVISION tool. Color panels are slowness coherence plots for the common source (left) and common receiver (middle) configurations of the tool. Horizontal axis is slowness, with higher slowness (lower velocity) to the right. Warm colors = high signal strength at a particular slowness. Black vertical lines = manual picks. Gray-scale plot shows seismograms with time increasing to the right. Blue line = arrival pick associated with slowness identified in the picks. Final slowness value at depth is given by the mean of the slownesses picked in the common source and common receiver configurations. This serves to compensate for tool position in the hole. This plot illustrates an interval in which few if any reliable velocity picks are possible. LSF = LWD depth below seafloor.

Table 1. Quality Control Characteristics of the sonic log data as a function of depth

Intervals (m LSF)				
Top	Base	Zone	Quality	Comments
-6	107	2	0	Difficult to distigush from mud arrival.
107	634	2	2	Fairly intermittent arrivals with zones of clear arrivals and zones hard to pick on MP Wide. While in general worse, there are patches where MP Wide-Fast (pulling out) returns improved signal over MP Wide (ex: 327-347 m LSF). Leaky-P gives a more continuous, but less trustworthy coherence. Separation from mud arrival improves with depth. Note: processing parameter change at 546 m LSF but no obvious change in coherence.
634	760	1	1	Fairly strong arrivals on MP Wide clearly distinguished from mud velocity.
760	813	1	2	Intermittent arrivals with some gaps in MP Wide. 2 m scale oscillation in values that may be noise related.
813	934	1	1	Excellent arrivals; significant jumps appear to be trustworthy.
934	978	1	3	Very few reliable looking coherency patches. Base is location of parameter change from "very slow" to "slow" parameters.
978	1075	1	2	Reliable patches with small gaps that are unpickable in between.
1075	1099	1	3	Large unpickable gap.
1099	1118	1	2	Pickable section.
1118	1150	1	3	Unpickable.
1150	1165	1	2	Pickable but not as clear as some of the patches.
1165	1191	1	3	Unpickable.
1191	1282	1	2	Pickable with some clear patches and some mediocre patches.
1282	1293	1	3	Unpickable.
1293	1391	1	2	Mix of pickable coherent packages and small unpickable gaps.

Table 2. Quality Control Characteristics of Hole C0002A resistivity image data as a function of depth.

Depth Interval (m LSF)		
top	bottom	Comments
	129	Start GVR rotation: Beginning of image log
129	197	Very good
197	201	Excellent
201	202	Poor
202	218	Excellent
218	219	Poor
219	323	Excellent
323	324	Poor
324	1353	Excellent
1353	1355	Good (data drop-outs)
1355	1398	Excellent
	1398	End of GVR image log