Nankai 3D Seismic Processing Summary Part 2

Summarized by Sean Gulick, December 4, 2002

Introduction

This document serves as an update to *Nankai 3D Seismic Processing Summary* compiled by Zhiyong Zhao on January 30, 2001. Key additions to the processing history of the Nankai 3D data following the summary by Zhao include a decision regarding the 12.5x25 m binning and a fundamental change in binning strategy that ultimately resulted in bins that contain an constant number and distribution of shot-receiver offsets. In this document we conclude with the post-stack time migrated interpolated volume, which is the final post-stack 3-D volume. Processing that followed was in the pre-stack realm ultimately leading up to a pre-stack time migrated volume considered to be primary product from the Nankai 3-D seismic experiment. There last section of this document highlights the additional processing done for prestack time migration.

Binning Strategy

Early in 2001 two versions of 3-D bins existed for the Nankai 3-D data: 50x25m and 12.5x25m. The reason for the second binning (as it was referred to in the previous processing summary) was to attempt to reduce the spurious returns at the basement reflection that when migrated obscured the overlying reflectors (Figure 1). The 12.5x25m data showed some improvement but ultimately was not worth the processing cost as the total stacked data volume was 4x that of the 25x50m binned data. In the end the ultimate problem for the stack that resulted in both the spurious returns from the basement and in a significant acquisition footprint observed in the seafloor amplitude map is uneven offset distribution within the bins. This uneven offset distribution stems from the acquisition of the 3-D data with a single streamer in waters of varying current. The Kurishio current in the northwestern portion of the 3-D survey area off Japan was frequently between 2 and 4 knots to the northeast during our 2 month cruise in 1999. In contrast the southeastern end of our survey area had currents ranging from 0 to 1 knot on average. This problem was compounded by the higher speed current shifting in position somewhat throughout the 2 month cruise. The result of this variable current on our acquisition was an uneven distribution of offsets within the bins.

The solution to this problem is to generate even offset distribution in every bin while not smearing the resolution of the data or generating amplitude anomalies. Shot gathers within the 3-D survey frequently exhibit higher amplitude in the near offsets relative to the far offsets. Therefore simply interpolating and/or extrapolating traces within a normally moved out shot gather would result in higher amplitude stacked traces in bins that had a higher percentage of near traces. The potential for smearing the final image and ultimately lowering the data quality through interpolating within a bin is also high. The processing scheme worked out by Nathan Bangs and Sean Gulick was to instead re-sort the 25x50m binned data into gathers consisting of a single offset from each bin across the survey in the crossline direction. For example, a single common offset crossline gather might be offset 1500 from sail lines 180 to 360 at crossline 1000 making a gather that if complete would be 181 traces wide. All traces with duplicate offsets were removed from the bins previously so there will be many bins with large numbers of missing traces. The strategy is then to interpolate within these common offset crossline gathers such that any gather with less than 181 traces be interpolated laterally so that every common offset crossline gather had the same number of traces (each inline gets a trace for each offset). When the data is then re-sorted back into the standard 25x50 m bins every bin would have the full range of offsets.

Once these interpolated 25x50m bins were created through this common offset crossline interpolation, the data could be deconvolved, moved out, muted, and stacked as in conventional 3-D processing. The jobs that accomplish this sorting, interpolating, resorting, deconvolving, NMO, muting, and stacking are listed in Table 1. Other than this interpolation scheme the rest of the processing before stacking was the same as described in *Nankai 3D Processing Summary*. The stacked volume was then time migrated in Geodepth as described in *Nankai 3D Processing Summary*. The resulting migrated stack (see example in Figure 2) was free of these spurious basement returns and a seafloor amplitude map (Figure 3) shows the acquisition footprint to be greatly reduced. A final post-stack product produced was a 3-D depth conversion of the 3-D post-stack time migrated volume.

<u>Data Backups</u>

In addition to the file and data backups that were described in *Nankai 3D Processing Summary*, another set of DLT tapes were made containing the interpolated gathers sorted as common offset crossline gathers. Finally the post-stacked time migrated volume was also backed up to tape. The list of tapes and backed up files are in Table 2. As of December, 2002, the interpolated stack with mutes exists on disk in SEGY and LOD formats at:

/disk/utig3_d1/Nankai3D_processing_during_interp_phase/interpmutestack.segy and
/disk/utig3_d1/Nankai3D_processing_during_interp_phase/interpmutestack.lod,

the post-stack time migrated volume is being kept on disk at:

/disk/utig3_d1/sean/3Dtimemigall.sgy,

and a depth converted version is being kept in the folder:

/disk/utig3_d1/sean/.

Both the time migrated and depth converted volumes have been loaded into Geoframe for interpretation.

<u>Prestack Processing</u>

Summarized by Steffen Saustrup, December 4, 2002

In July of 2001 another version of the 50x25 binned data was generated using largely the same processing scheme. As before, individual offsets were interpolated in the crossline direction to ensure a regular distribution of offsets throughout the grid. However, in this case the binned data were saved in addition to the stacks. Both pre-

stack and post-stack time migrations were generated for these data. During this processing the binning scripts were updated for increased efficiency and to include the following changes in
processing:

-header words were updated for prestack migration
-3D horizons for seafloor and basement time were generated and stored
in the database for use with mutes and decons.
-The surgical mute at the multiple was improved.
-The stretch mute at the seafloor was improved.
-A prestack deconvolution was added.

The sort, interpolation, and stack (without pstm) scripts and jobs are all found in:

/d1/Nankai3D_processing_during_interp_phase/steffen.

Scripts and jobs for horizon picking and 3D surface generation:

/d1/pstm/focus_jobs/horizonpick.dat
/d1/pstm/focus_jobs/3d_hc3d.dat

PSTM stack job script:

/d1/pstm/focus_jobs/pstm_stackall.csh

Table 1 **Processing flows and scripts to generate crossline interpolated post-stack migrated version of the Nankai 3-D volume**

Type	Directory	File Names	Purpose
Horizon	d5/sean	seafloornewbin.txt	Seafloor picks
Horizon	d5/sean	basementnewbin.txt	Basement picks
Script	d5/sean	cdplblxload#.csh	Reads crossline stacks, reorders to inlines, writes out volumes
Script	d5/sean2	cdplblxload#.csh	Reads crossline stacks, reorders to inlines, writes out volumes
Focus	d5/sean	cdplblxload#.dat	Focus flows from cdplblxload scripts
Focus	d5/sean2	cdplblxload#.dat	Focus flows from cdplblxload scripts
Focus	d5/sean	cdplblxsort.dat	Focus flow that completes 1st part of crossline offset sort
Script	d5/sean	Ninterp(all)#.csh	Completes 2nd part of sort, decon, nmo, mutes, resorts, and stacks
Focus	d5/sean	Nsort#.dat	Focus flows from Ninterp(all) scripts that do the sort
Focus	d5/sean	Ninterp(olate)#.dat	Focus flows from Ninterp(all) scripts that do the decon, nmo, mutes, resorts, and stack
Script	d5/sean2	Ninterpall#.csh	Completes 2nd part of sort, decon, nmo, mutes, resorts, and stacks
Focus	d5/sean2	Nsort#.dat	Focus flows from Ninterpall scripts that do the sort
Focus	d5/sean2	Ninterpolate#.dat	Focus flows from Ninterp(all) scripts that do the decon, nmo, mutes, resorts, and stack

Note: # stand for run number while N is a letter representing different portions of the 3-D volume, words in ( )'s are sometimes present

Table 2 **Backup Data Tapes (all tapes created with tar command)**

Tape	Name	File Name Format	Files Included
1	Nankai 3D Interpolated Gathers	INTERP#.focus	1, 21, 41, 61, 81, 101, 121, 141, 161, 181, 201, 221, 241, 261, 281
2	Nankai 3D Interpolated Gathers	INTERP#.focus	301, 321, 341, 361, 381, 401, 411, 431, 451, 471, 491, 511
3	Nankai 3D Interpolated Gathers	INTERP#.focus	531, 571, 591, 611, 631, 651, 671, 691, 711, 731, 751
4	Nankai 3D Interpolated Gathers	INTERP#.focus	771, 791, 811, 831, 851, 871, 891, 911, 931, 951, 971, 991
5	Nankai 3D Interpolated Gathers	INTERP#.focus	1011, 1031, 1051, 1071, 1081, 1101, 1121, 1141, 1161, 1181, 1201, 1221
6	Nankai 3D Interpolated Gathers	INTERP#.focus	1241, 1261, 1281, 1301, 1321, 1341, 1361, 1381, 1401, 1421, 1441, 1461
7	Nankai 3D Interpolated Gathers	INTERP#.focus	1481, 1501, 1521, 1541, 1561, 1581, 1591, 1611, 1631, 1651, 1671, 1691
8	Nankai 3D Interpolated Gathers	INTERP#.focus	1701, 1721, 1741, 1761, 1781, 1801, 1821, 1841, 1861, 1881, 1901, 1921
9	Nankai 3D Interpolated Gathers	INTERP#.focus	1941, 1961, 1981, 2001, 2021, 2041, 2061, 2081, 2091, 2101, 2121, 2141, 2161
10	Nankai 3D Interpolated Gathers	INTERP#.focus	2181, 2201, 2221, 2241, 2251, 2271, 2291, 2311, 2331, 2351, 2371, 2391
11	Nankai 3D Interpolated Gathers	INTERP#.focus	2411, 2431, 2451, 2471, 2491, 2511, 2531, 2551, 2571, 2591, 2611, 2631
12	Nankai 3D Interpolated Gathers	INTERP#.focus	2651, 2671, 2691, 2711, 2731, 2751, 2771, 2781, 2801, 2821, 2841, 2861
13	Nankai 3D Interpolated Gathers	INTERP#.focus	2881, 2901, 2921, 2941, 2961, 2981, 3001, 3021, 3041, 3061, 3081, 3101
14	Nankai 3D Interpolated Gathers	INTERP#.focus	3121, 3141, 3161, 3181, 3201, 3221, 3241, 3261, 3281, 3301, 3321, 3341
15	Nankai 3D Interpolated Gathers	INTERP#.focus	3361, 3381, 3401, 3421, 3441, 3461, 3481, 3501, 3521, 3541, 3561, 3581
16	Nankai 3D Interpolated Gathers	INTERP#.focus	3601, 3621, 3641, 3661, 3681, 3701
	NANKAI 3D 12.5x25m Stack	stack4.lod	stack4.lod

Note1: Example of naming convention INTERP1.focus where this file contains the crossline interpolated gathers from crosslines 1-20.

Note2: stack4.lod is a backup of the 12.5x25m stacked volume which was deleted from disk prior to doing crossline interpolation processing.

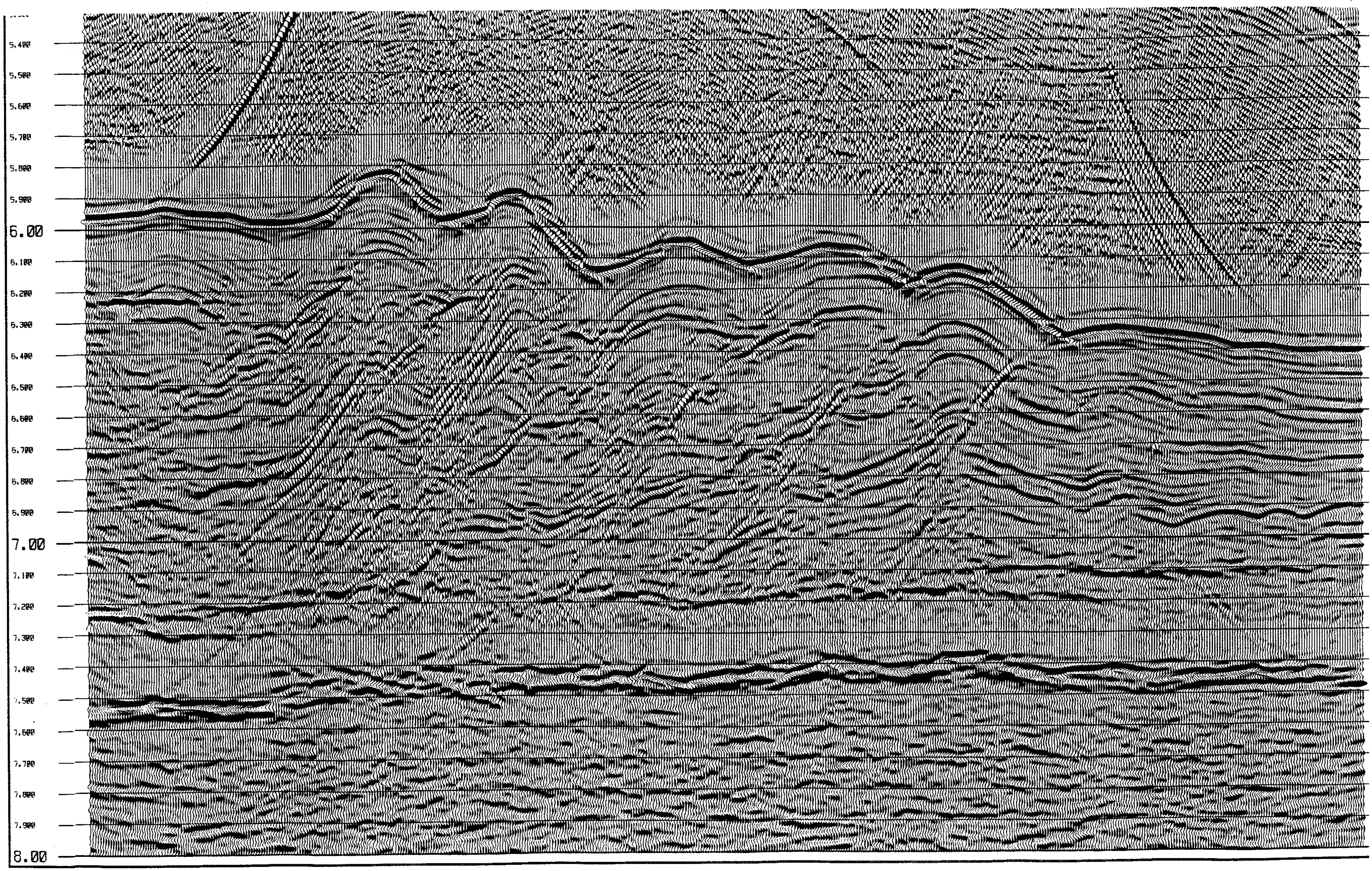

Figure 1: Example from Line 250 of basement noise generated by incomplete offset distribution. Notice how migration generates "smiles" that obscure the overlying data when the basement reflections in the incomplete bins are attempted to be placed in their true subsurface locations. These "smiles" do not go away by reducing the migration velocity.

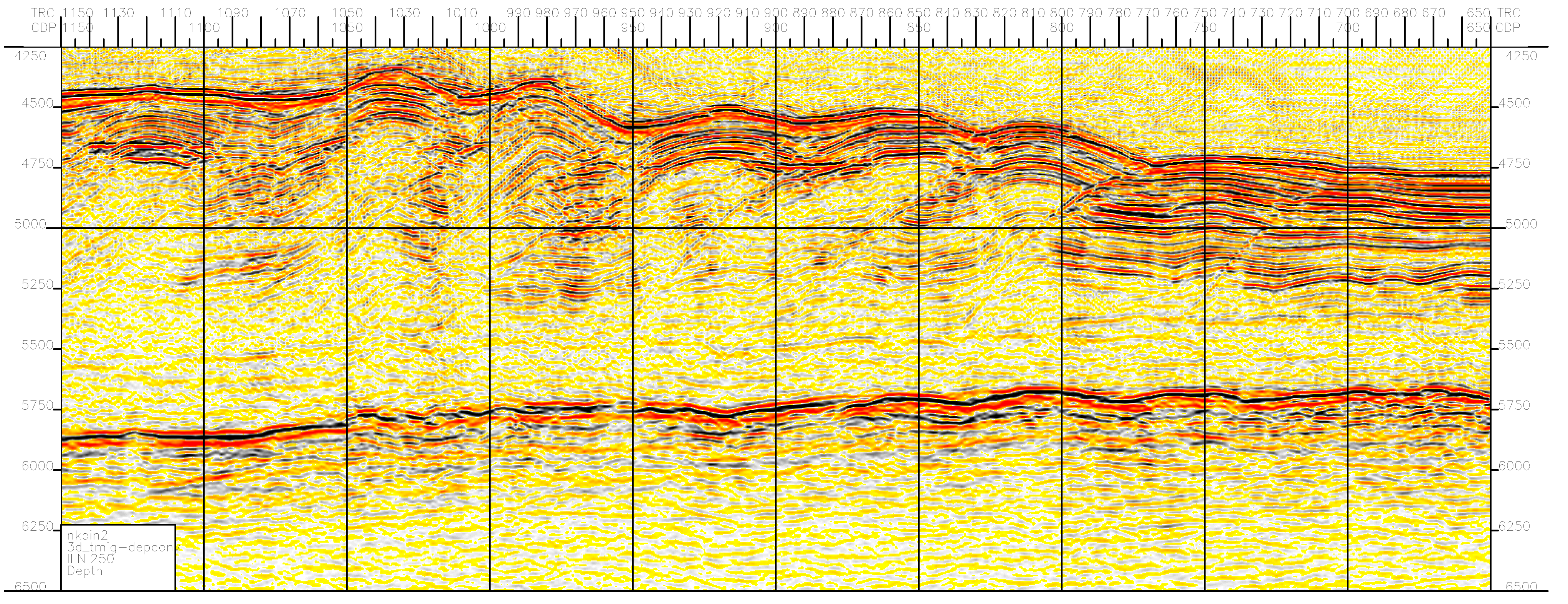

Figure 2. Line 250 from current time-migrated and depth-converted volume showing lack of basement noise.

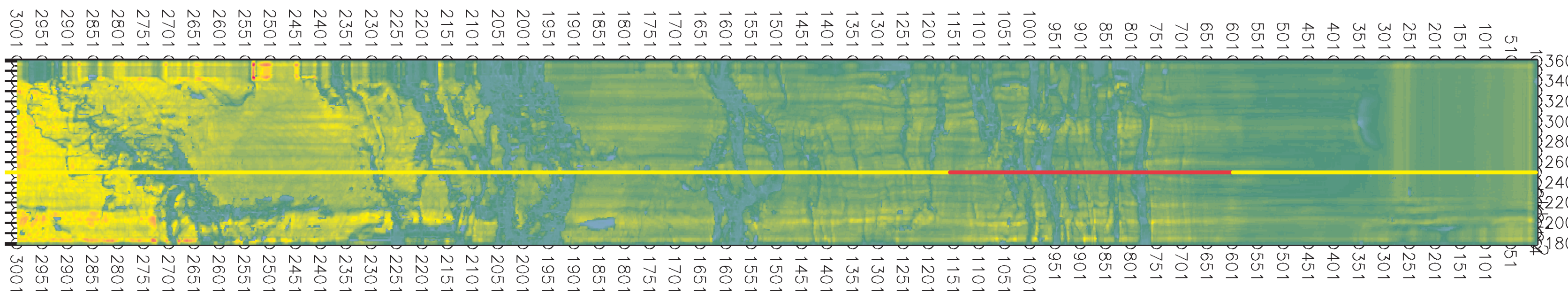

Figure 3: Seafloor amplitudes from depth converted time migrated version of the interpolated volume. Relative amplitudes are preserved and increase towards the warmer colors.