Popeye G-Sand Log Responses and Synthetic Seismogram Ties v 1.0

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OVERVIEW

This document is a compilation of log responses, time-depth relationships, and seismograms at each of the wells in the Popeye field that penetrate the G-Sand package. Figure 1 is a basemap of the G-Sand penetration location at each well. Table 1 lists the data that were used for the well time-depth tie and synthetic seismogram generation for each well. Table 2 lists the magnitude and sign of the static time shift applied to align the synthetic and extracted seismograms for each 3D survey. Each well has up to three documents: Log Response, Time-Depth Tie, and Seismic Tie. Each document is discussed in detail below.

Log Response

This document focuses on the log response of the G-Sand. The linear reference scale for the wireline logs in this document is TVDSS (feet). A nonlinear MD (feet) scale is also included. Most wells contain at least a gamma ray and resistivity log. Some wells do not have a sonic or density log. For these wells, a derived log using Gardner's relationship is shown. The wireline log scales are not consistent from one well to another; they are optimized to appropriately show the data in each well. The grey baseline is the baseline for the G-Sand only.

Well Tie

Before synthetic seismograms can be generated, a well tie must be performed. The well tie process is a domain translation from depth to time. This process generates a non-linear two-way-time reference in depth that is used to convert linear depth logs to a linear time domain. Since our wells are deviated, linear MD logs must first be converted to linear TVD logs so that the domain translation is actually from TVD to TWTime. The Adjusted Sonic Method is used because it honors each checkshot data point as an exact time-depth tie and smoothly transitions between checkshot data points by integrating the DT log to fill in time-depth pairs.

The linear reference scale for this document is TVD on the left. On the right is the non-linear TWTime scale. The first column shows interval velocities from the checkshot time-depth pairs and equivalent interval velocities from the DT log. The difference between these two interval velocities is shaded blue where the DT interval velocities are greater than the checkshot interval

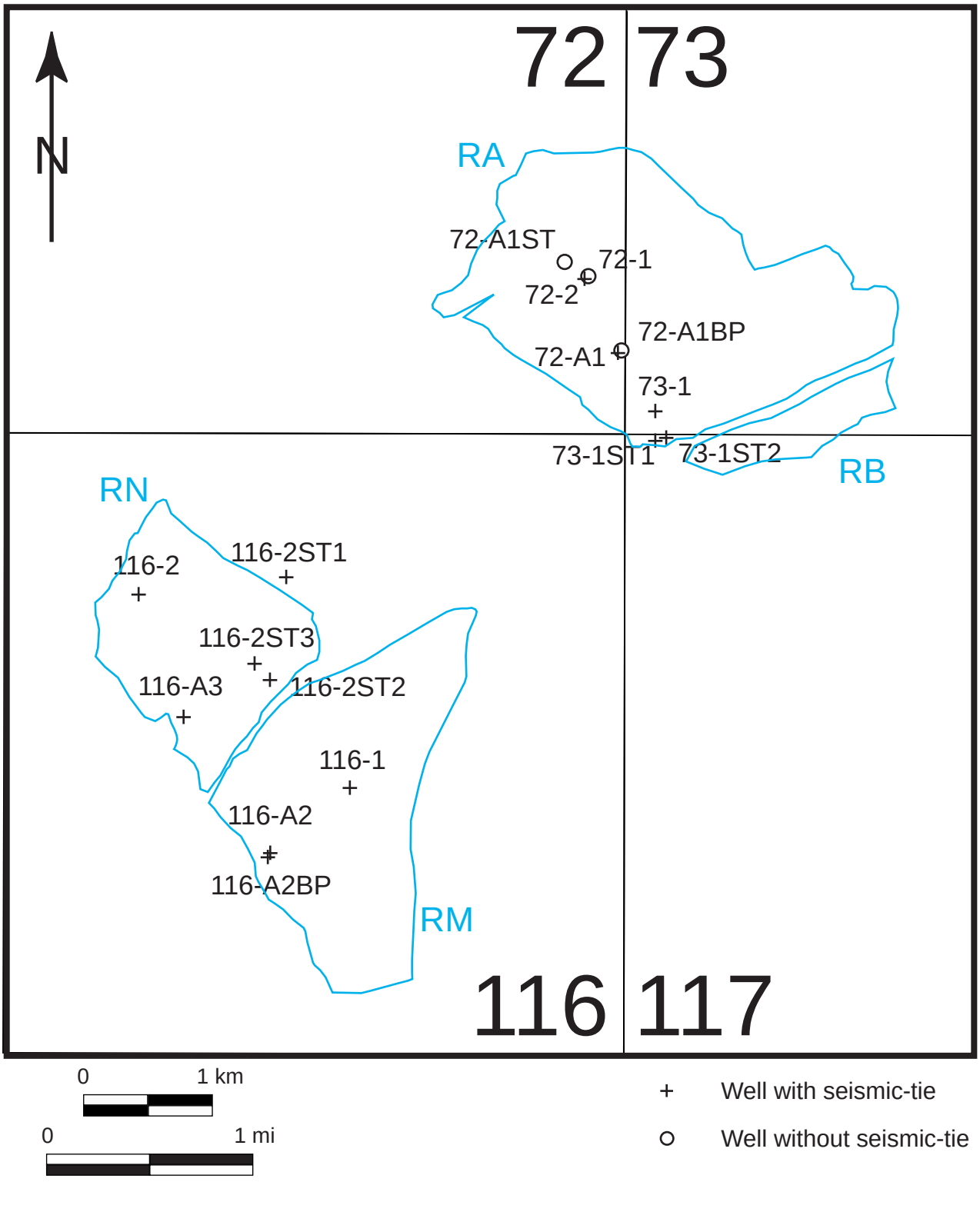
velocities. It is shaded green where the checkshot interval velocities are greater than the DT interval velocities. The second column shows both the input DT log in black and the adjusted DT log in red. The adjusted DT log is the reconciled DT log that incorporates the checkshot drift. The middle column shows checkshot drift in ms. Checkshot drift is the difference in TWTime between the integrated sonic and the checkshot survey. Checkshot drift is set to zero at the first checkshot datapoint below the start of the DT and RHOB logs, and should smoothly increase with depth. Any kinks may represent a bad checkshot data point or a true distinct velocity due to lithology or overpressure. Checkshot surveys with closely spaced datapoints are more likely to have kinks. The last column shows the resulting time-depth relationship with the checkshot data points lying exactly on it.

Seismic Tie

After the well tie, depth-referenced logs are transformed to time and with a sampling rate of 3 ms. The TWTime-referenced DT and RHOB logs are used to calculated an RFC at each sample. This RFC spike log is then accumulated and detrended. A Butterworth band-pass filter is applied to the accumulated and detrended RFC log to produce a RUNSUM synthetic. A suite of RUNSUM synthetics are created with corner frequencies of 5-20, 5-22, 5-24, 5-26, 5-28, and 5-30 Hz. The one that matches the extracted trace is the one shown. RFC synthetics are created by convolving a Ricker wavelet with the RFC spike log. A suite of RFC synthetics are created with central Ricker frequencies of 10, 12, and 14 Hz.

The linear reference scale for all wireline logs and seismograms in this document is TWTime (seconds). The sampling rate is 3 ms. Nonlinear TVDSS and MD scales are also included. A seismic trace is extracted from each 3D survey at the G-Sand penetration and compared to the appropriate synthetic seismogram. The 1984 survey is 90-degrees phase rotated and has a sampling rate of 3 ms. The 1997 survey is zero-phase and has a sampling rate of 4 ms. The grey baseline is the baseline for the G-Sand only since logs have DC (a low frequency trend).

Basemap


72
73
N
RA
72-A1ST
72-1
72-2
72-A1BP
72-A1
73-1
73-1ST1
73-1ST2
RB
RN
116-2
116-2ST1
116-2ST3
116-A3
116-2ST2
116-1
116-A2
116-A2BP
RM
116
117
0
1 km
0
1 mi
Well with seismic-tie
Well without seismic-tie

DATA USED

Table 1 summarizes the data used for the time-depth tie and synthetic seismogram creation.

Table 1: Data Used

Well	Checkshot	DT	RHOB
116-1	✓	✓	✓
116-2	✓	✓	✓
116-2ST1	✓	✓	✓
116-2ST2	✓	✓	✓
116-2ST3	116-2ST2	✓	✓
116-A2	116-1	✓	✓
116-A2BP	116-1	✓	✓
116-A3	116-2	Gardner	✓
72-1	--	--	--
72-2	✓	✓	✓
72-A1	72-2	✓	✓
72-A1BP	--	--	--
72-A1ST	--	--	--
73-1	✓	✓	✓
73-1ST1	✓	✓	✓
73-1ST2	73-1ST1	✓	Gardner

A check indicates that the well uses its own data. If a well does not have its own checkshot survey, an edited checkshot survey from a nearby well is used. This editing process assumes that the geology is the same between the location of the checkshot survey and the location of the well without a checkshot survey. It only compensates for the difference in KB and WD between the two locations in both the depths and times so that interval velocities remain the same. If a well does not have a DT or a RHOB log, then one is derived from the other using Gardner's relationship as follows:

$$\rho = 0.23 \cdot v^{0.25}$$

$$RHOB = 0.23 \cdot \left(\frac{10^6}{DT} \right)^{0.25}$$

$$DT = \frac{10^6}{\left(\frac{RHOB}{0.23} \right)^4}$$

If a well does not have both DT and RHOB logs nor a checkshot survey, then neither a time-depth tie nor a seismic tie is performed for the well. This is the case for wells 72-1, 72-A1PB, and 72-A1ST.

SEISMOGRAM SHIFT

Table 2 summarizes the amount of static time shift in seconds that is necessary to align the extracted seismogram of both surveys to the synthetic seismogram at each well. The amount of shift is defined as:

Shift = TWTime (synthetic) – TWTime (extracted)

Therefore a negative shift indicates that the extracted trace was deeper than the synthetic trace and a positive shift indicates that the extracted trace was shallower than the synthetic trace.

Table 2: Static Shift to Align Extracted and Synthetic Seismograms

Well	1997 Shift (s)	1984 Shift (s)
116-1	-0.048	-0.024
116-2	-0.046	-0.033
116-2ST1	-0.072	-0.066
116-2ST2	-0.082	-0.066
116-2ST3	-0.075	-0.066
116-A2	-0.116	-0.096
116-A2BP	-0.125	-0.108
116-A3	-0.063	-0.054
72-1	--	--
72-2	-0.054	-0.021
72-A1	-0.056	-0.027
72-A1BP	--	--
72-A1ST	--	--
73-1	-0.039	0.003
73-1ST1	-0.078	-0.018
73-1ST2	-0.084	-0.030

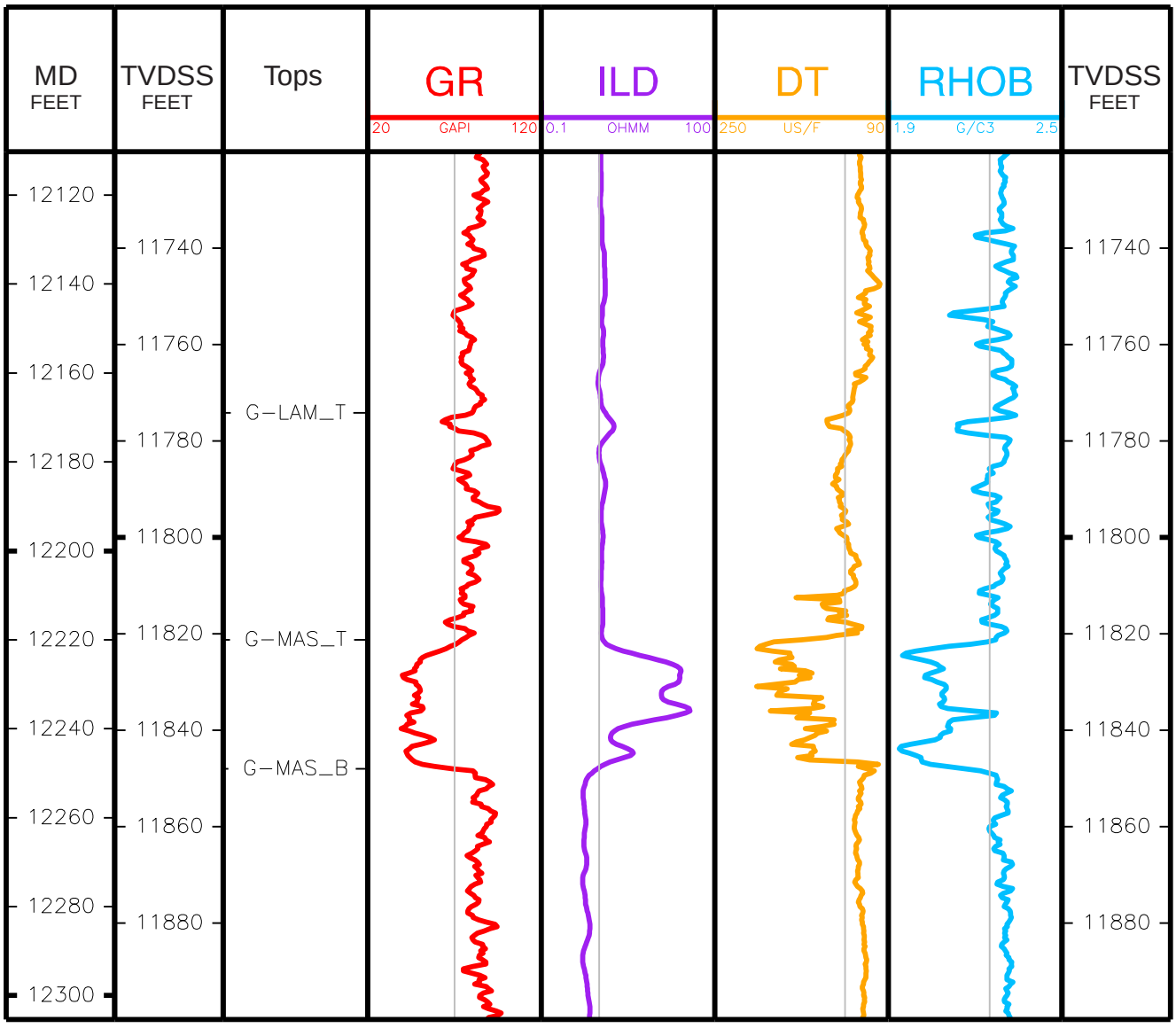
The amount of shift is usually calculated on the time-depth pair of the trough minima that represents the top of the G-Sand in zero-phase data and the middle of the G-Sand in RUNSUM

data. Where it is difficult or impossible to identify the G-Sand trough minima, the amount of shift is calculated on the time-depth pair of either the peak maxima below the G-Sand trough minima or the trough minima of another sand. This was necessary for the wet well (116-2ST1), the well with only 6 ft of G-Sand (73-1), and also 116-A2 and 116-A2BP.

Both RFC and RUNSUM synthetics were created with a sampling rate of 3 ms, which is the same sampling rate as the 1984 dataset. Therefore the shift for the 1984 dataset is an integer multiple of 3 ms. Since the sampling rate of the 1997 dataset is 4 ms, the shift is a multiple of 1 ms.

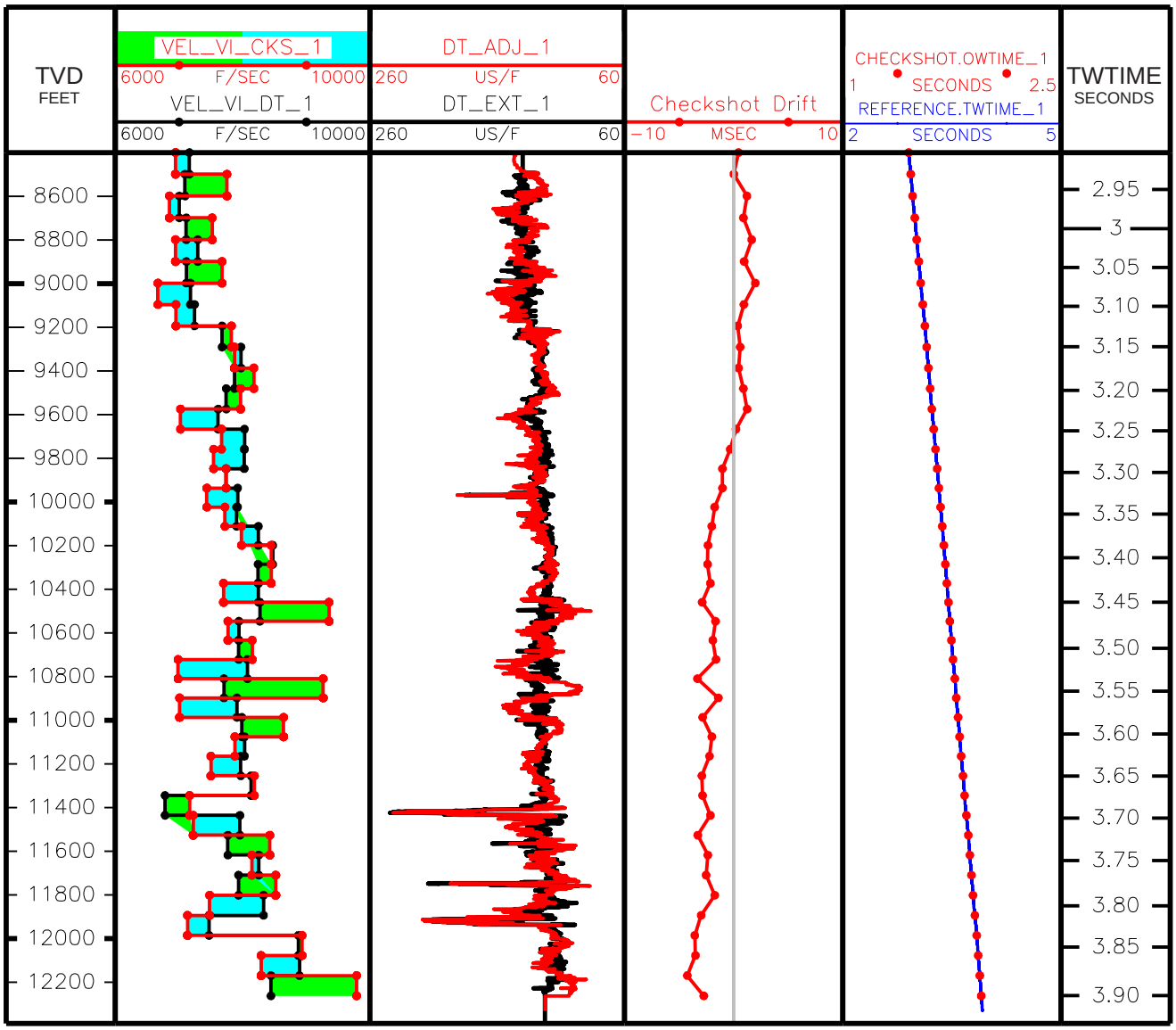
116-2 Log Response

RN



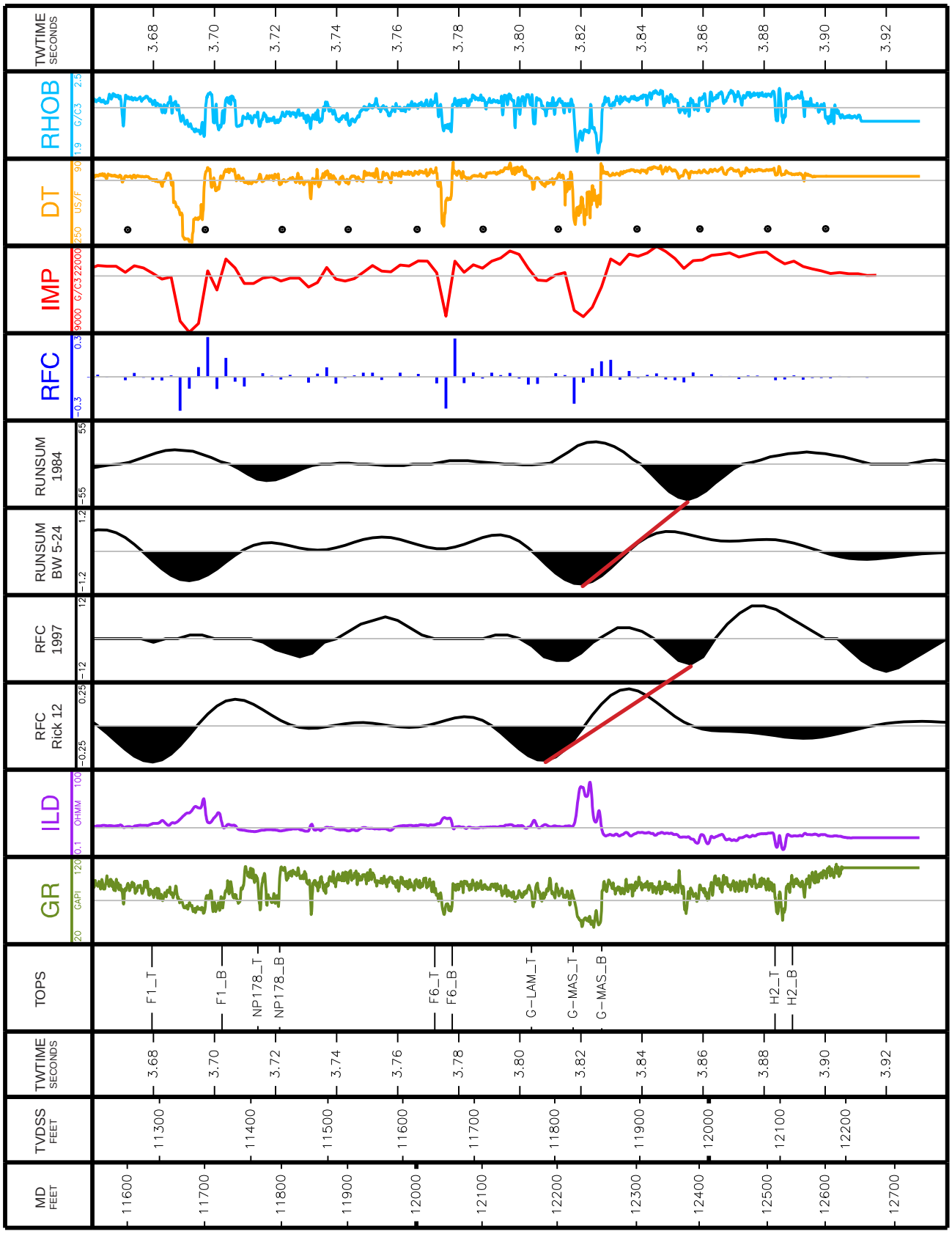
116-2 Time-Depth Tie

RN



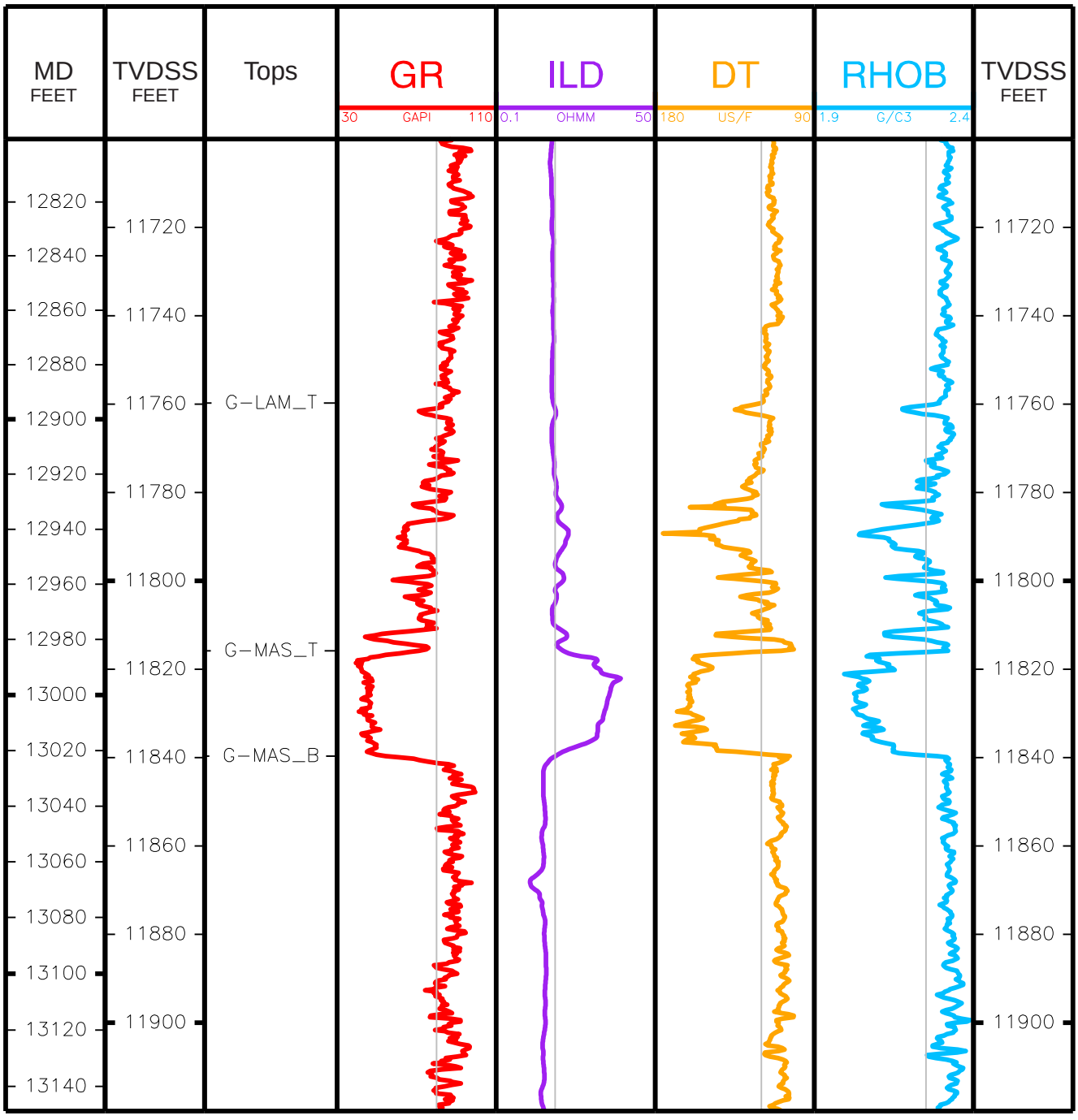
116-2 Seismic Tie

RN



116-2ST2 Log Response

RN



116-2ST2 Time-Depth Tie

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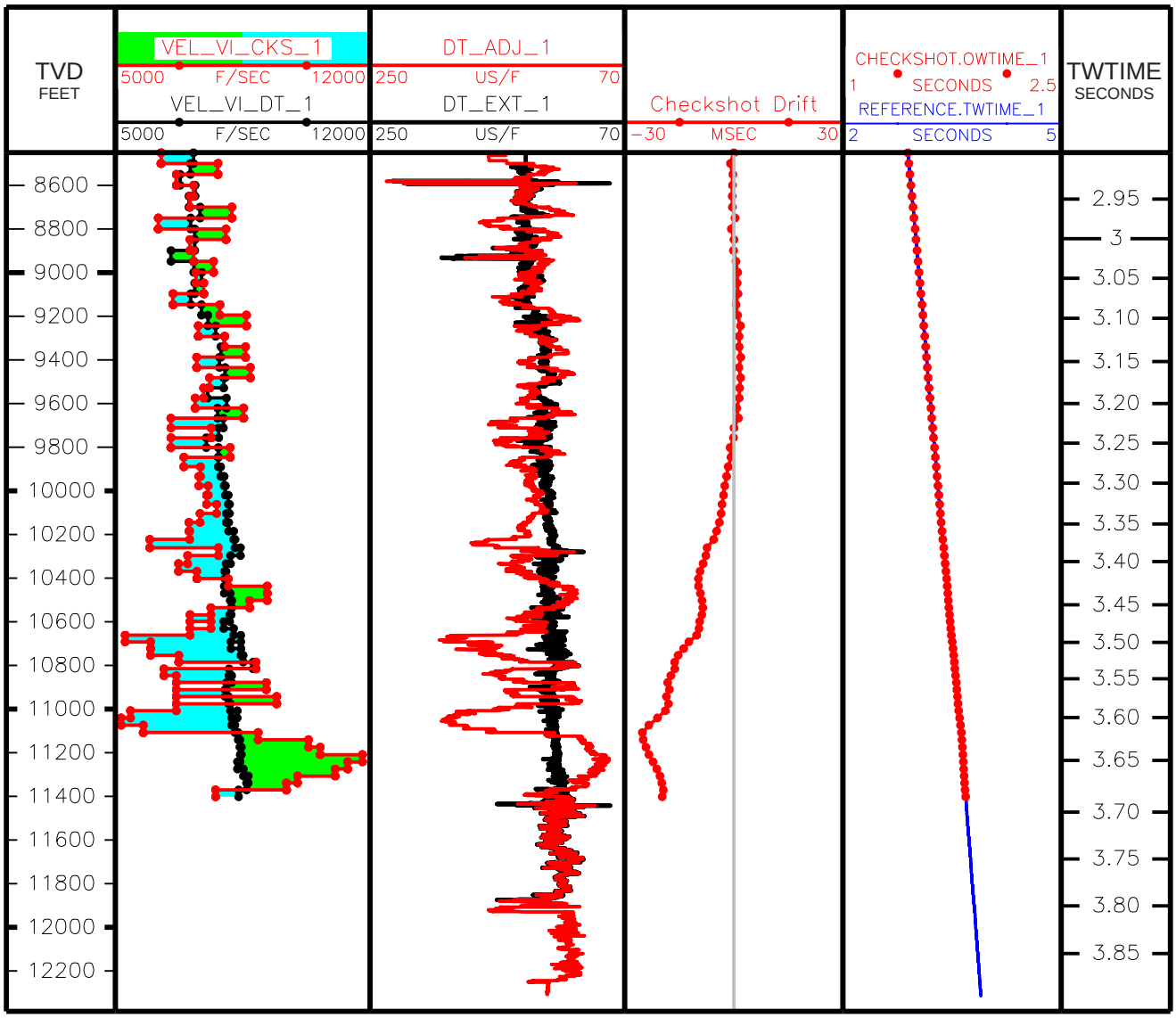
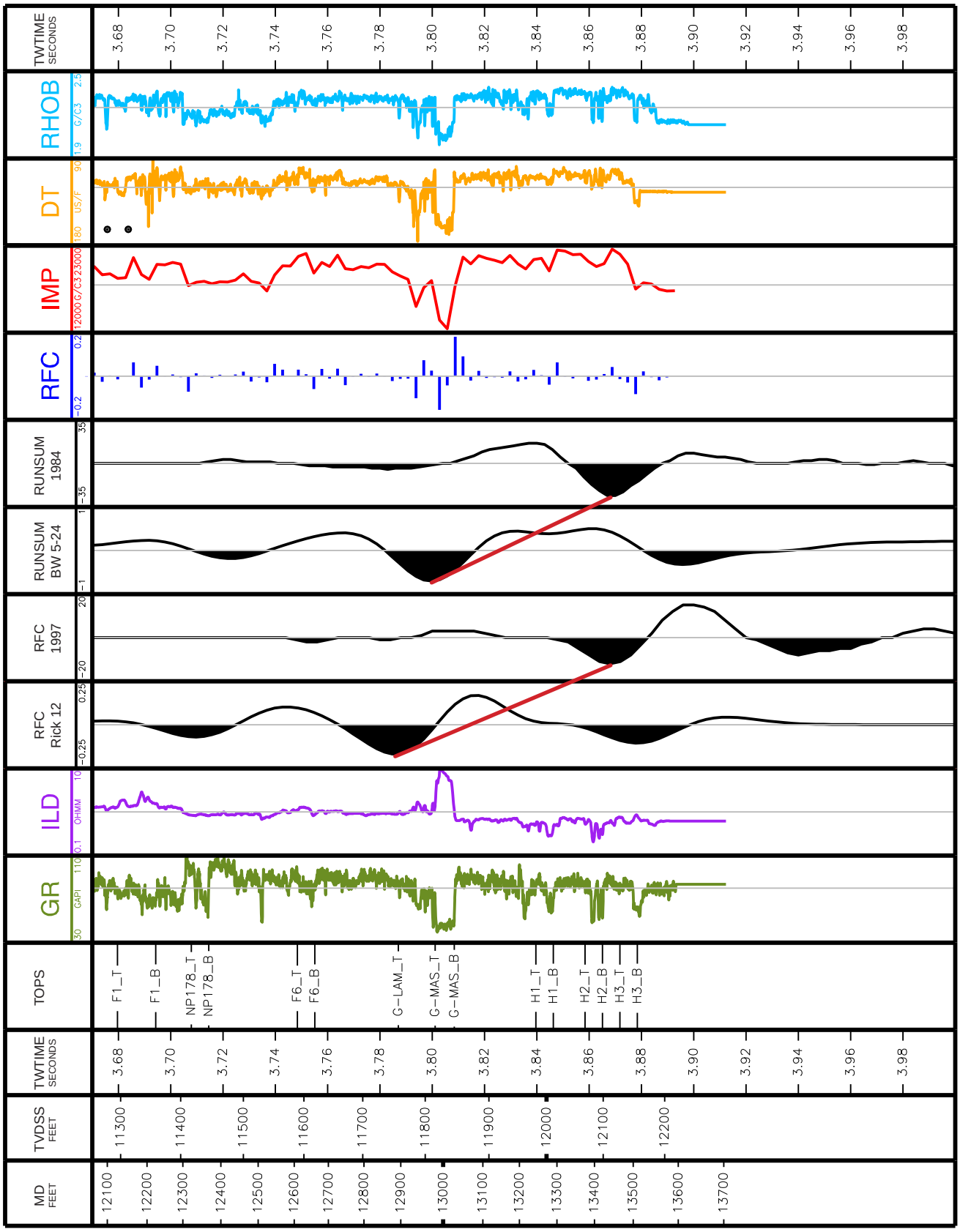


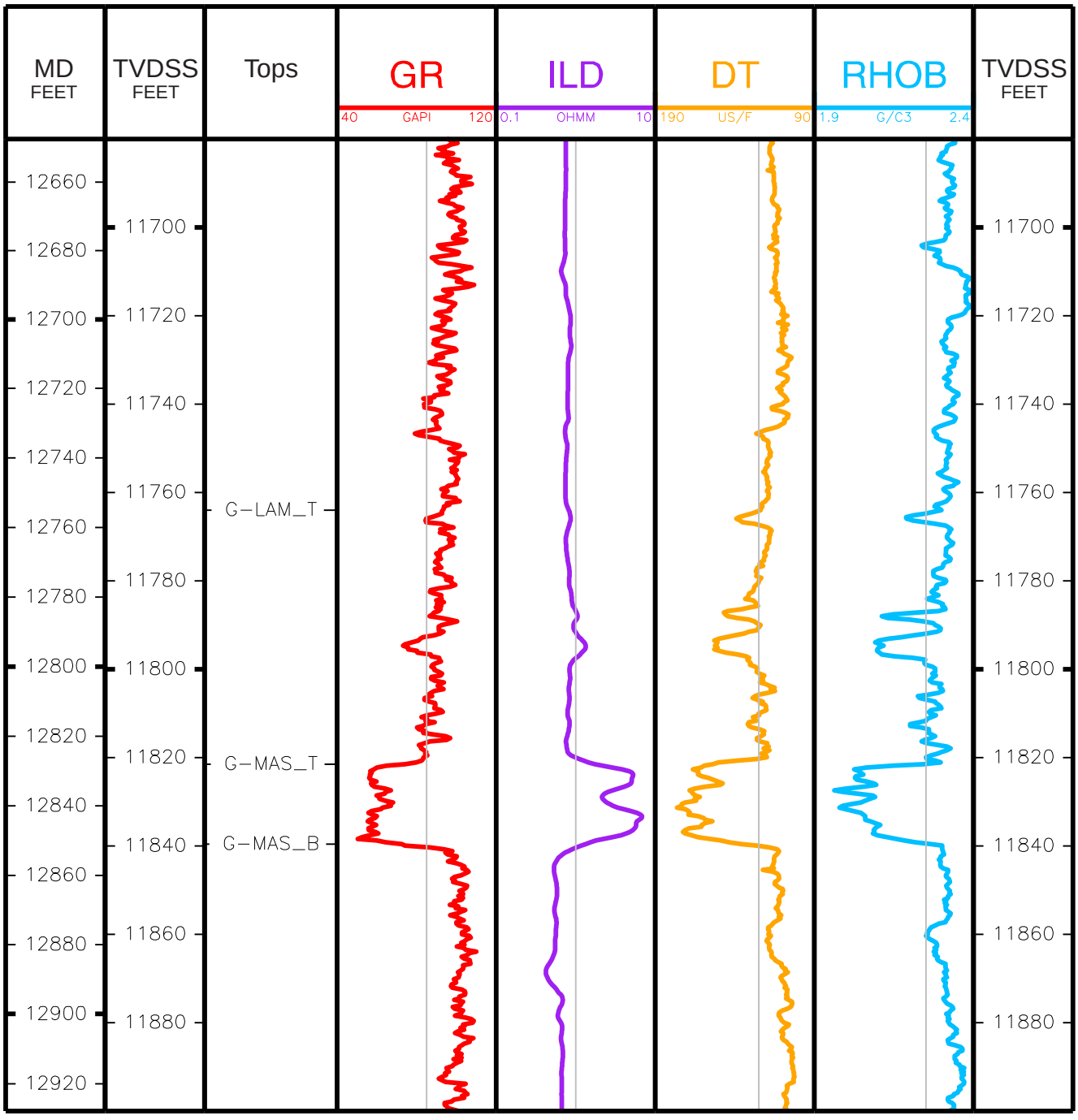
116-2ST2 Seismic Tie

RN



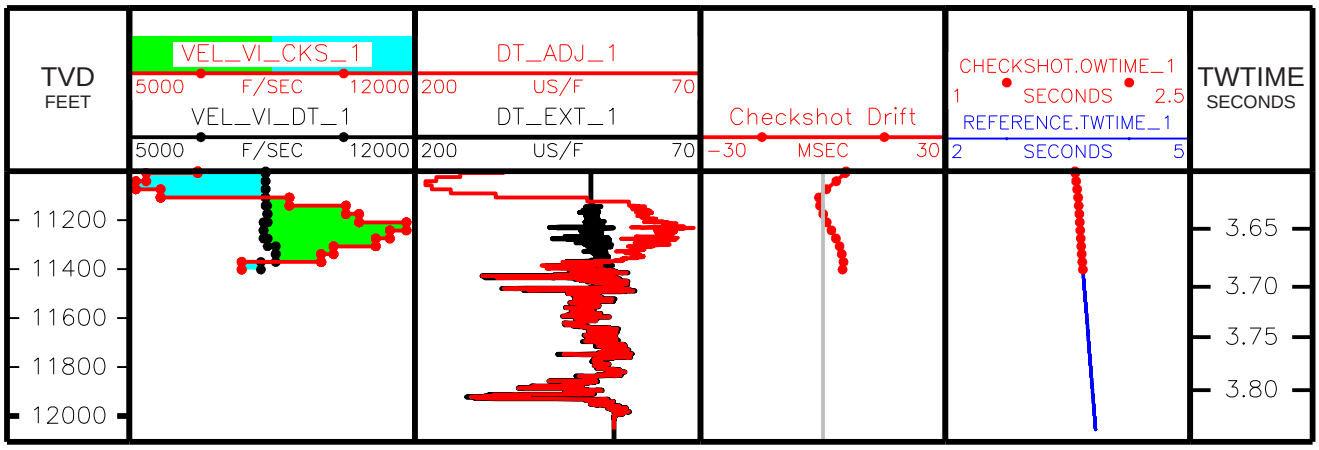
116-2ST3 Log Response

RN



116-2ST3 Time-Depth Tie

RN



116-2ST3 Seismic Tie

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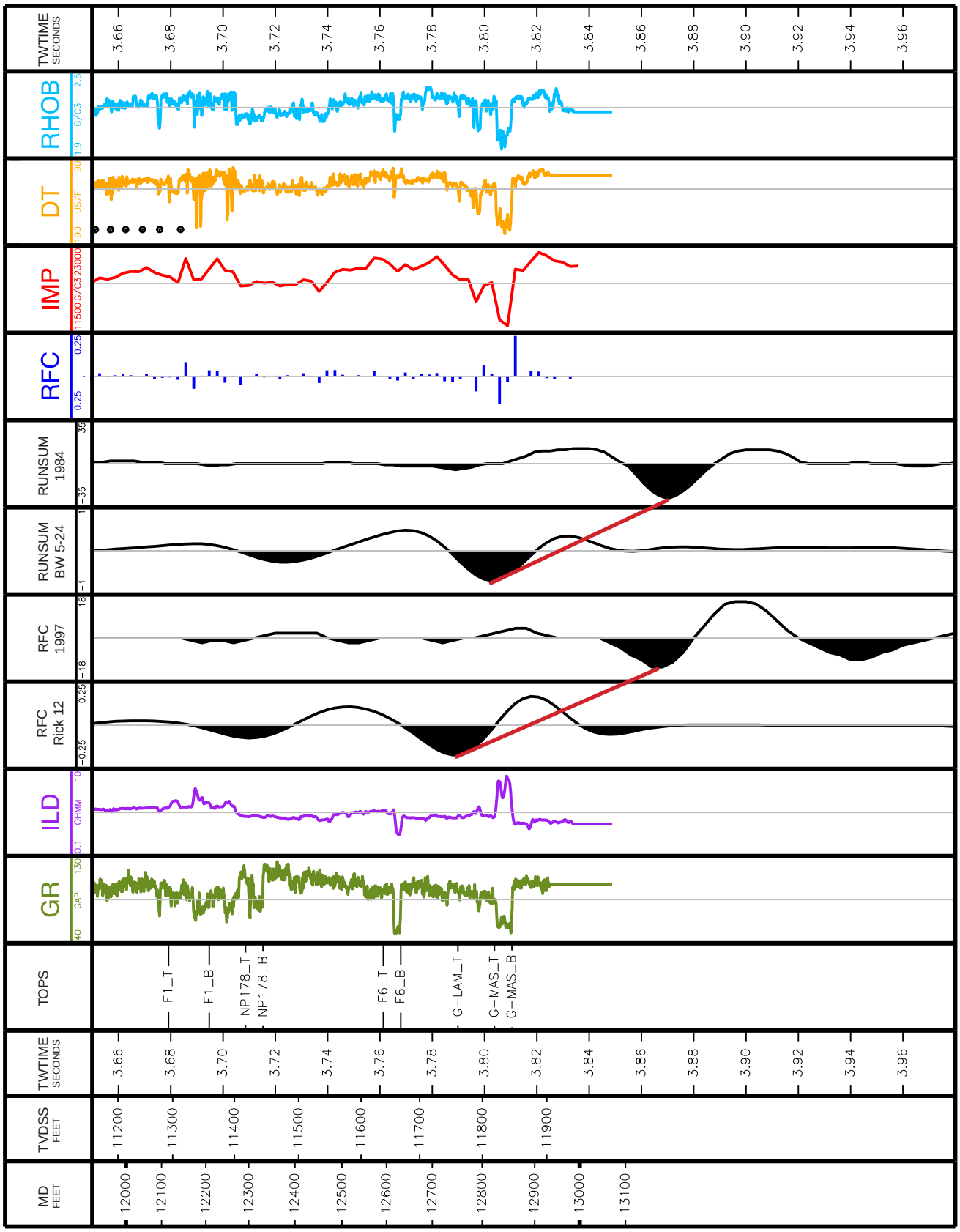
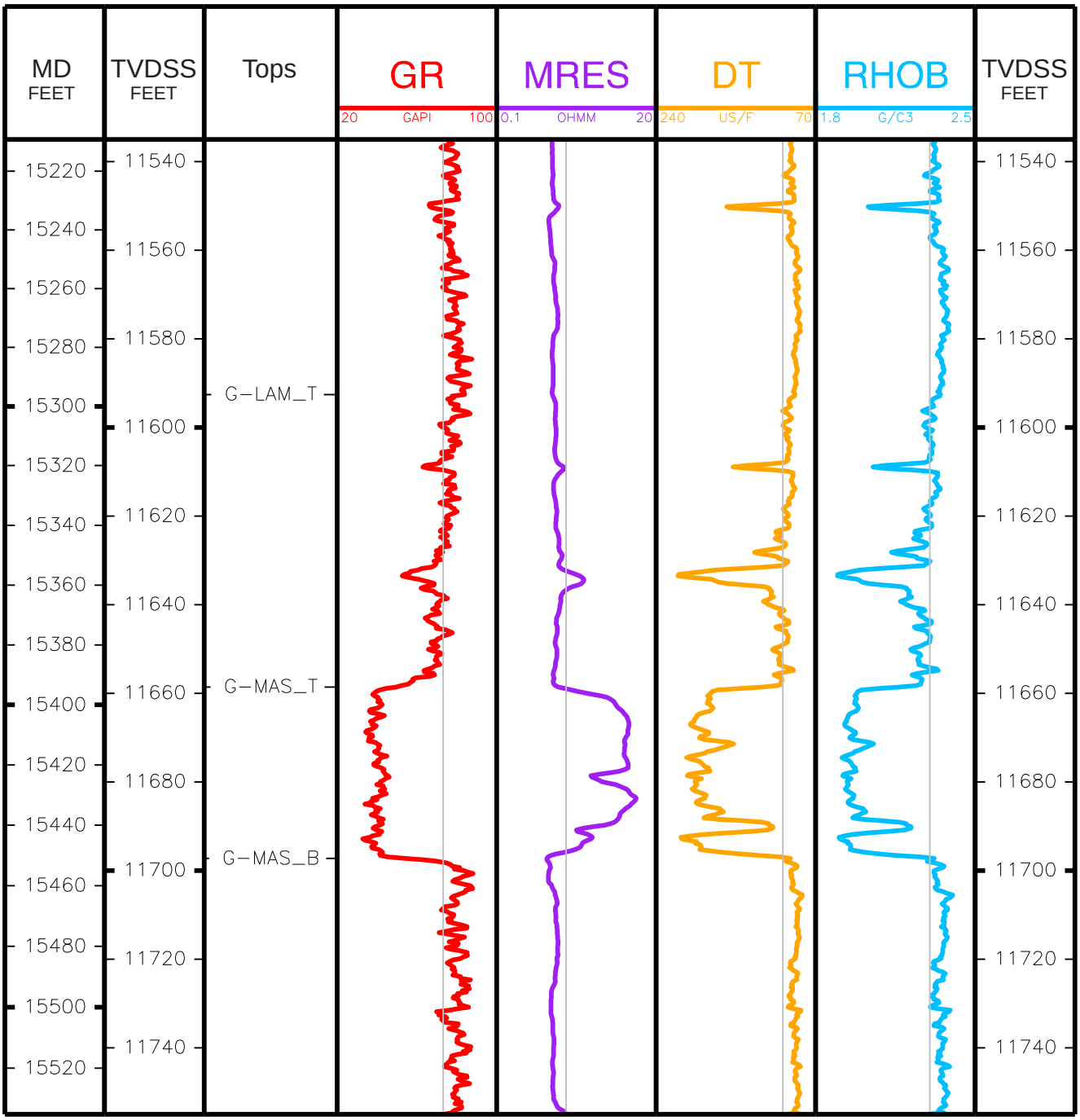


116-A3 Log Response

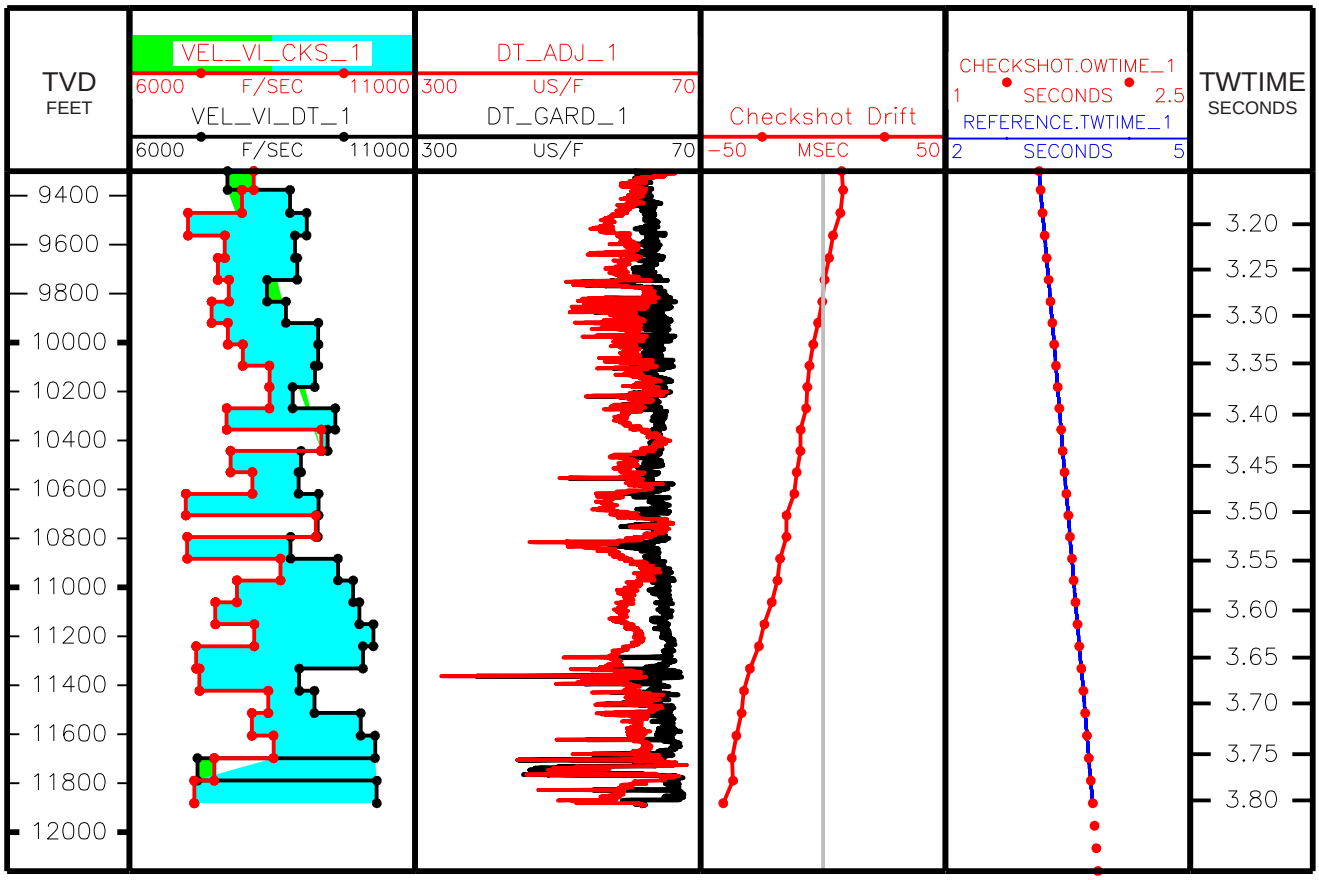
RN



The sonic log is derived from the density log using Gardner's relationship.

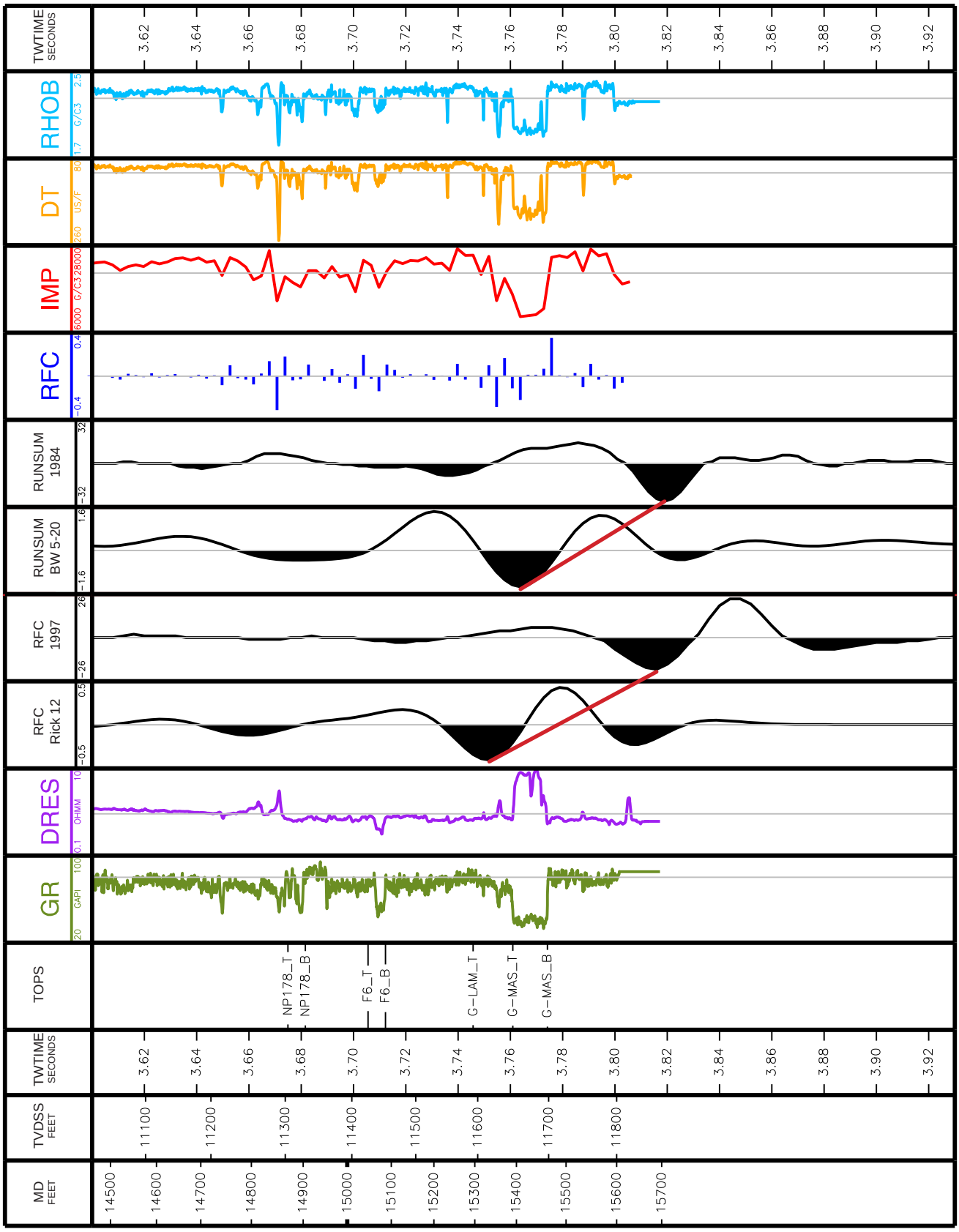
116-A3 Time-Depth Tie

RN



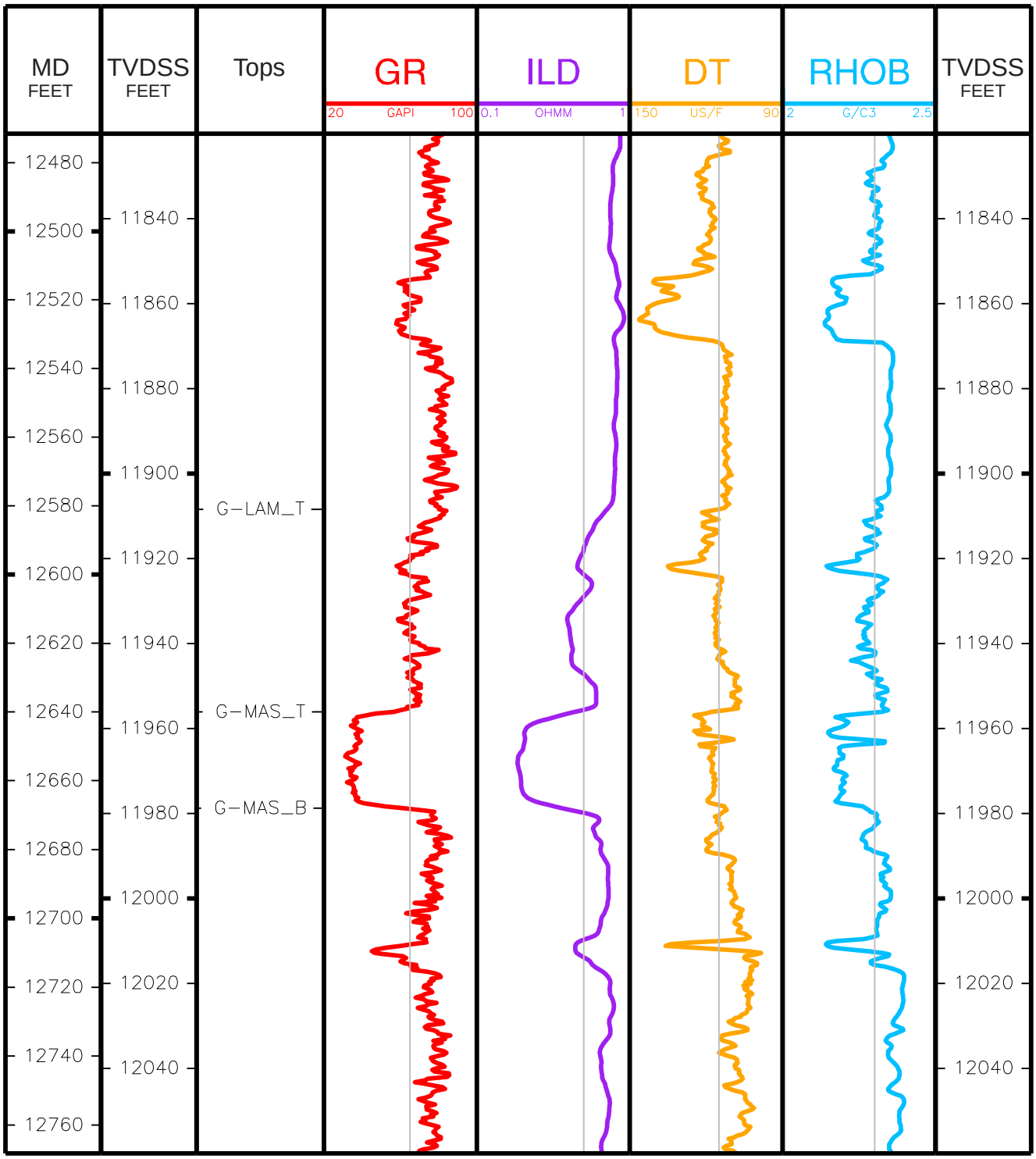
116-A3 Seismic Tie

RN



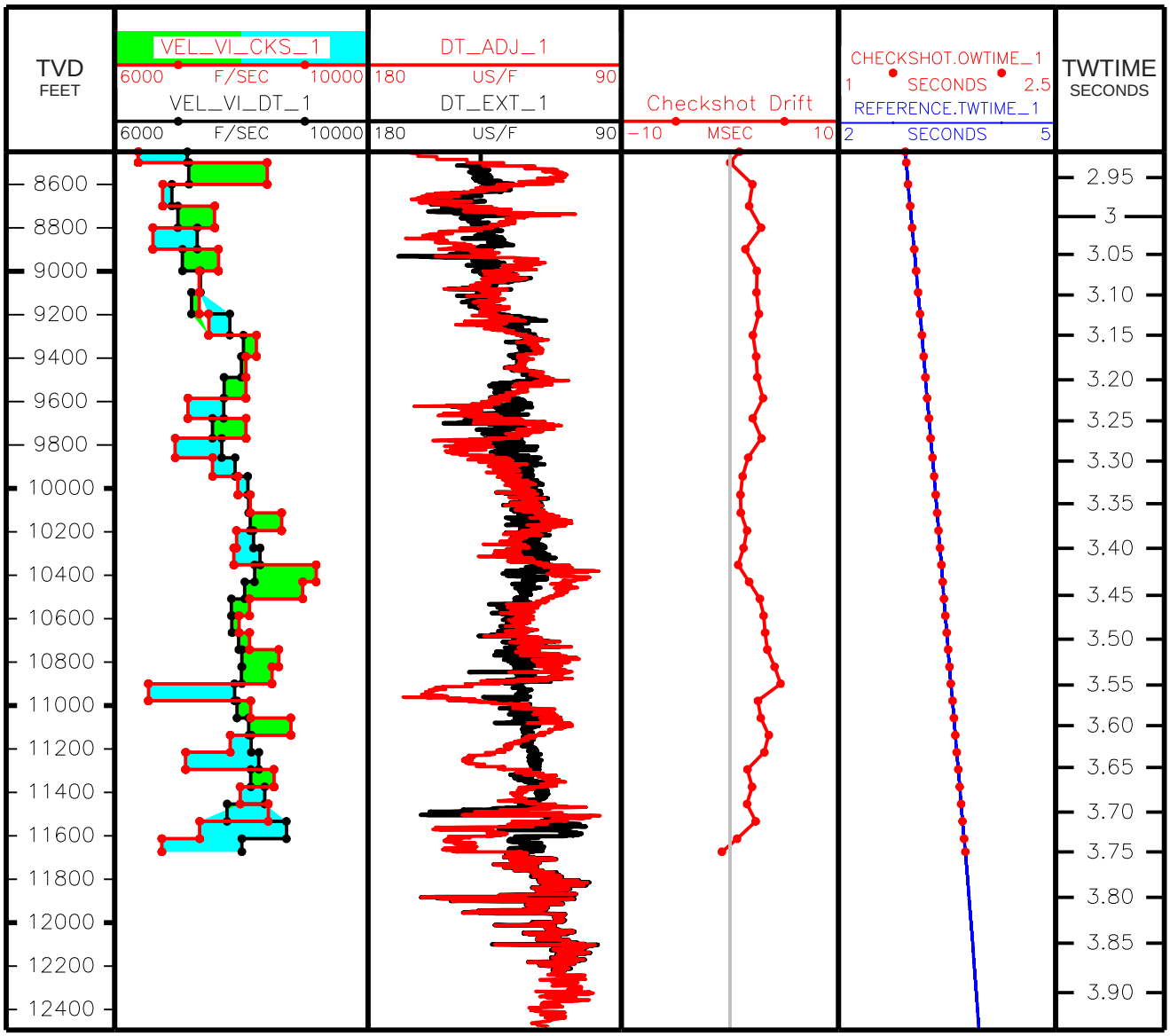
116-2ST1 Log Response

Aquifer



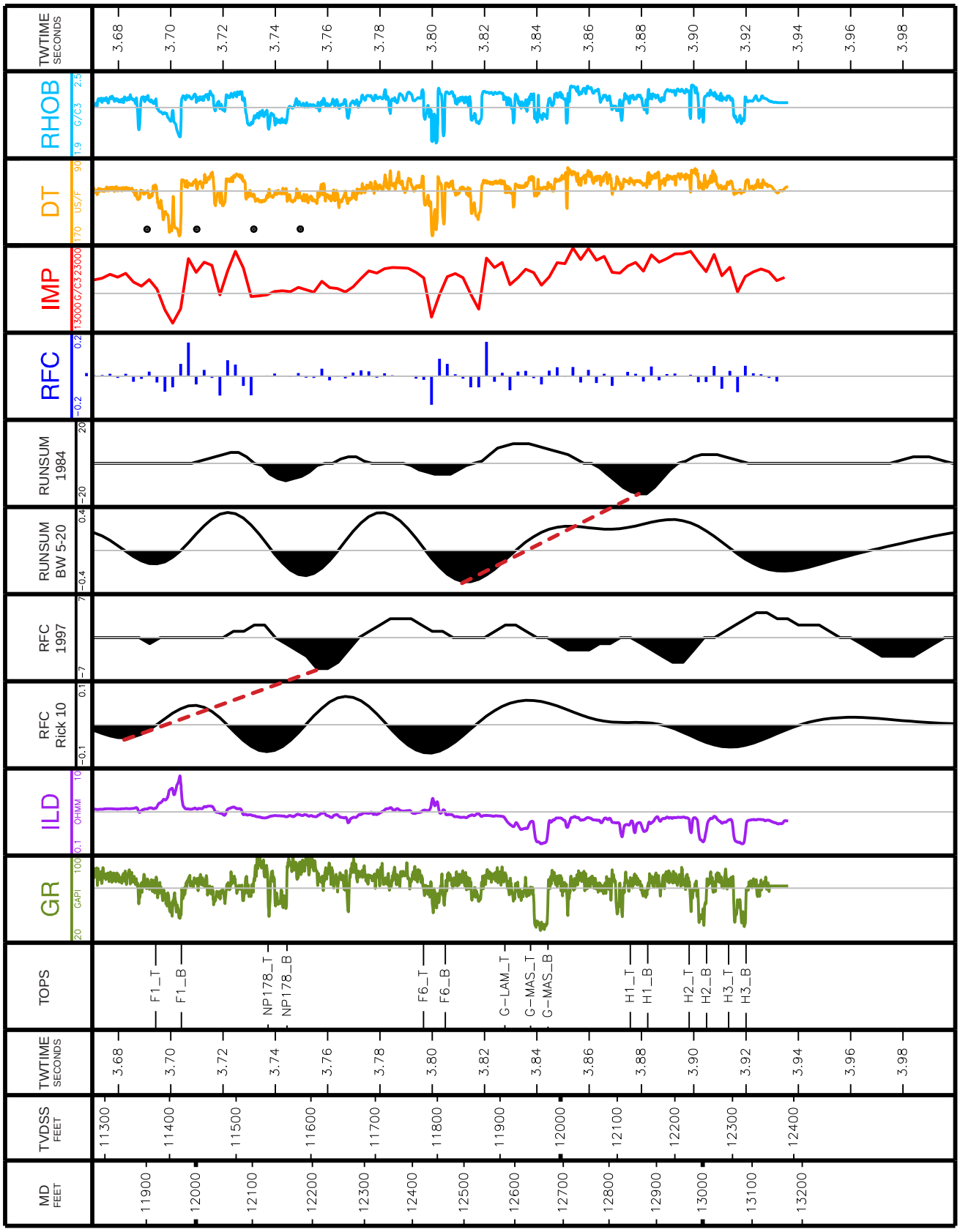
116-2 ST1 Time-Depth Tie

Aquifer



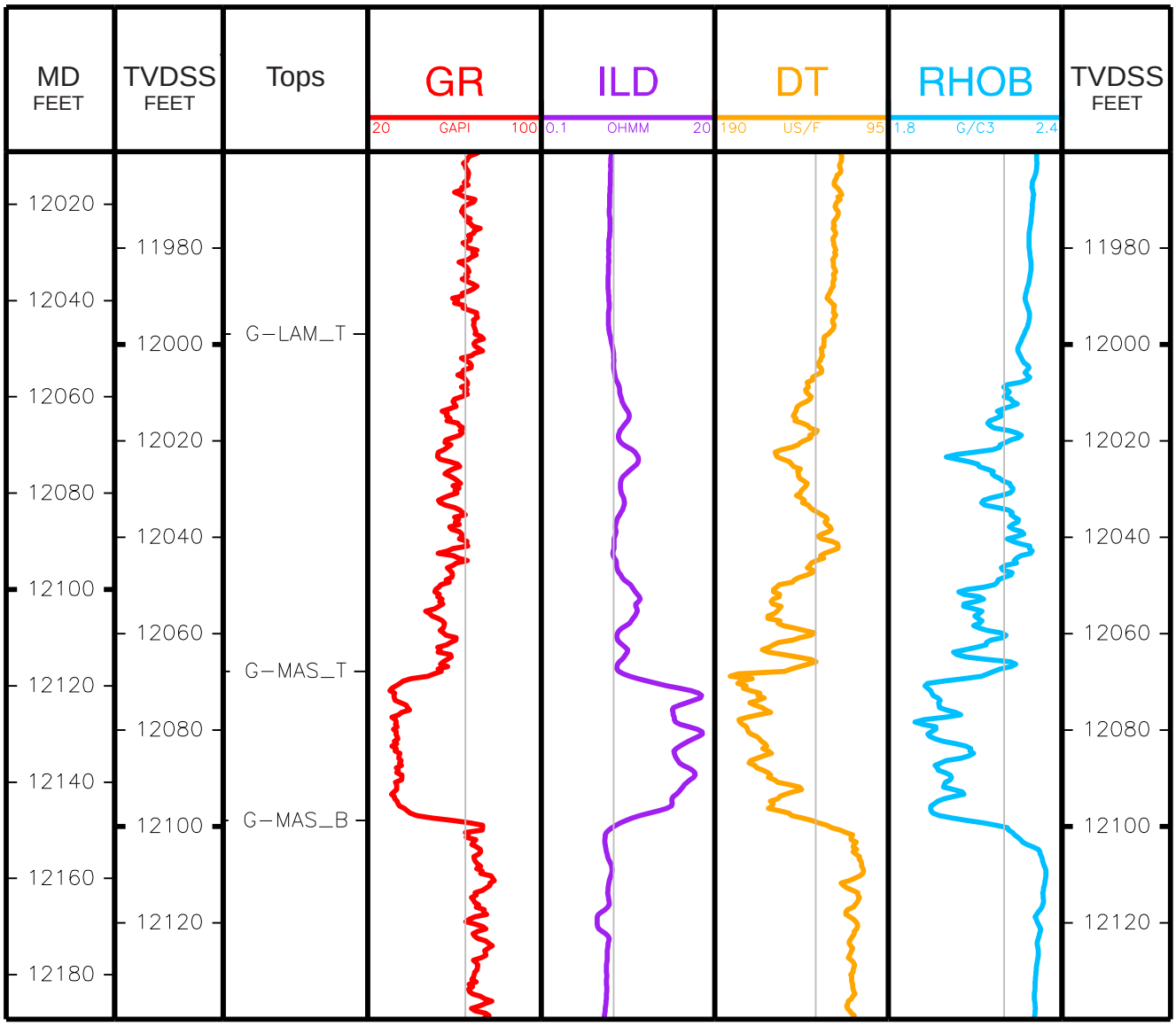
116-2ST1 Seismic Tie

Aquifer



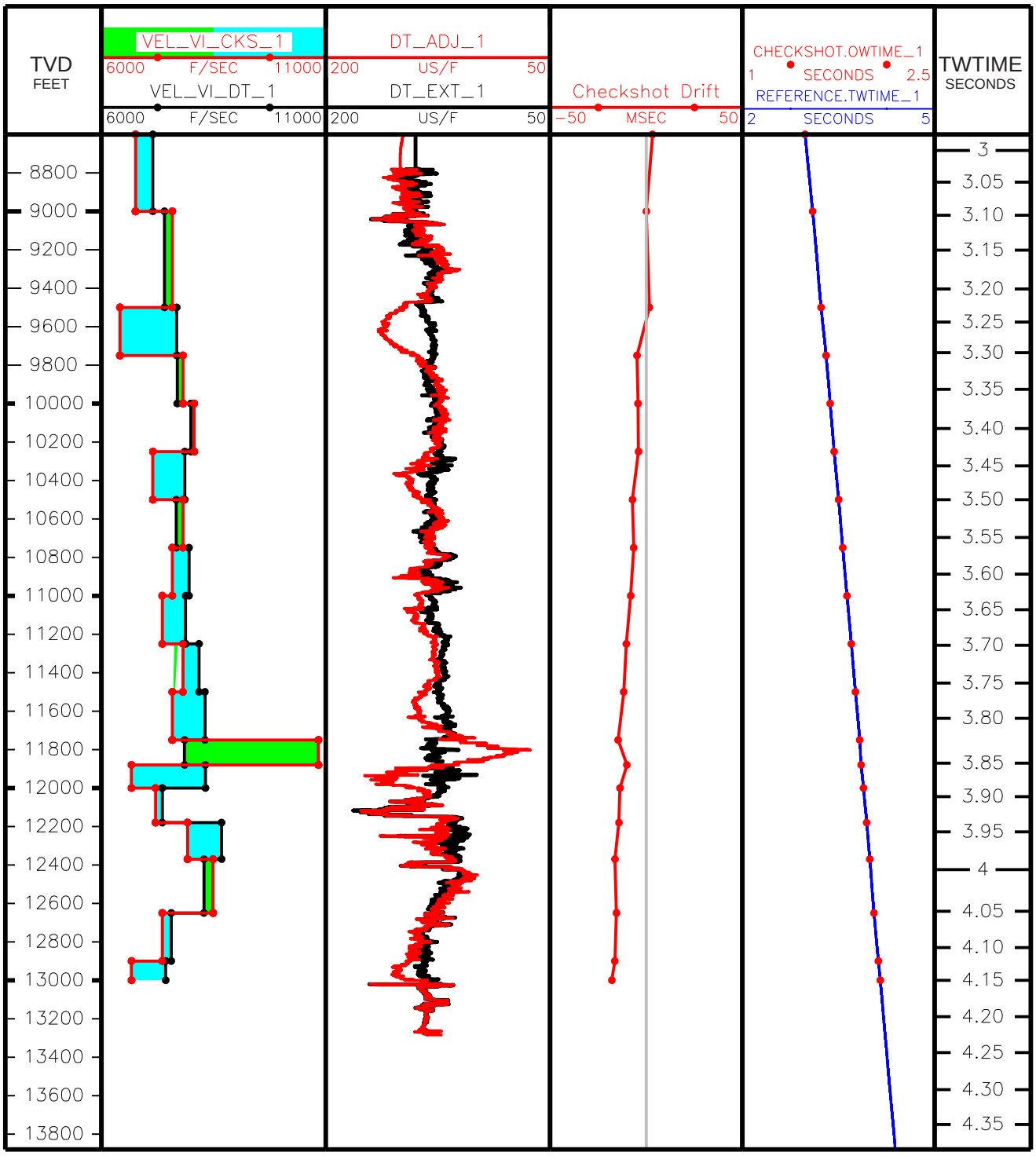
116-1 Log Response

RM



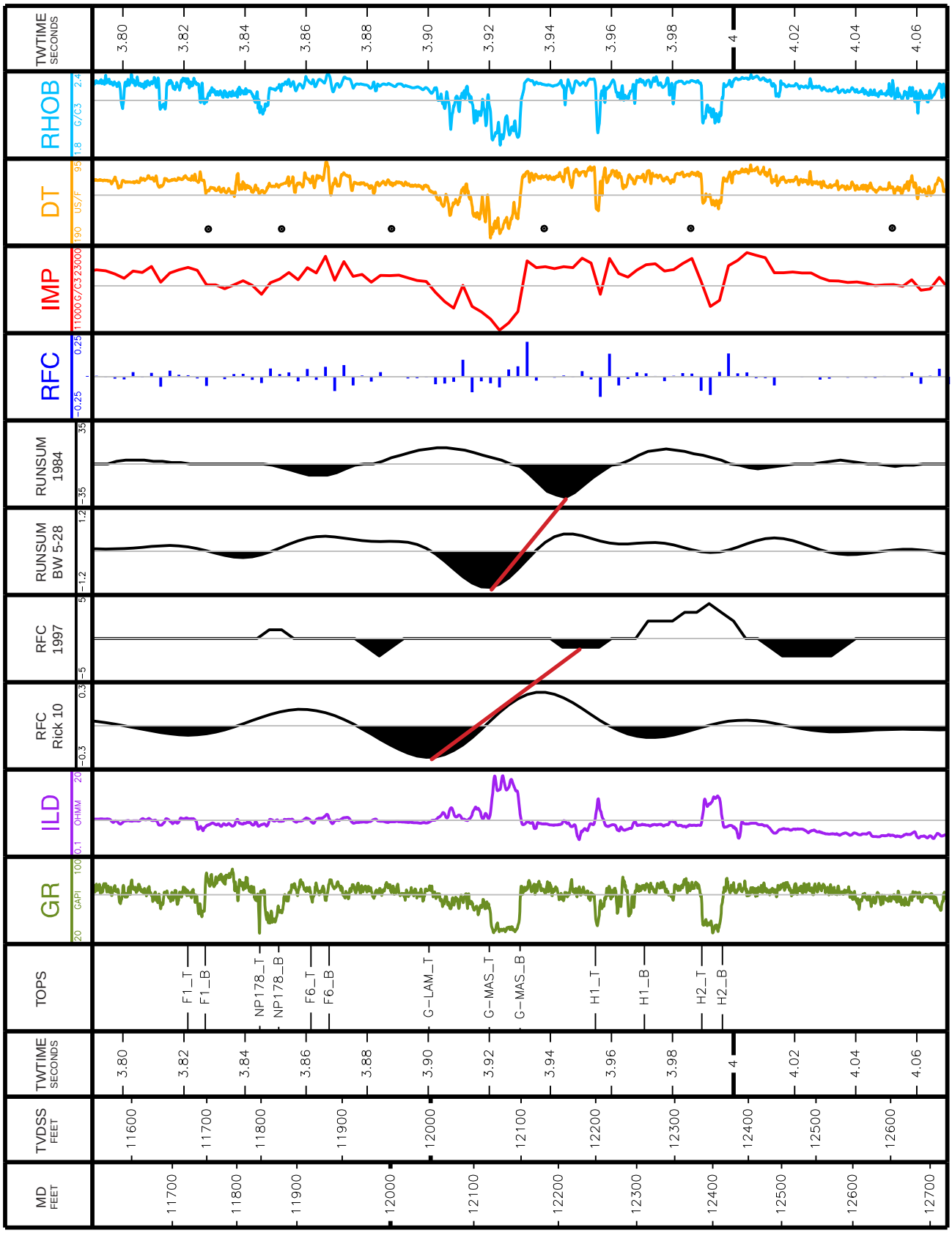
116-1 Time-Depth Tie

RM



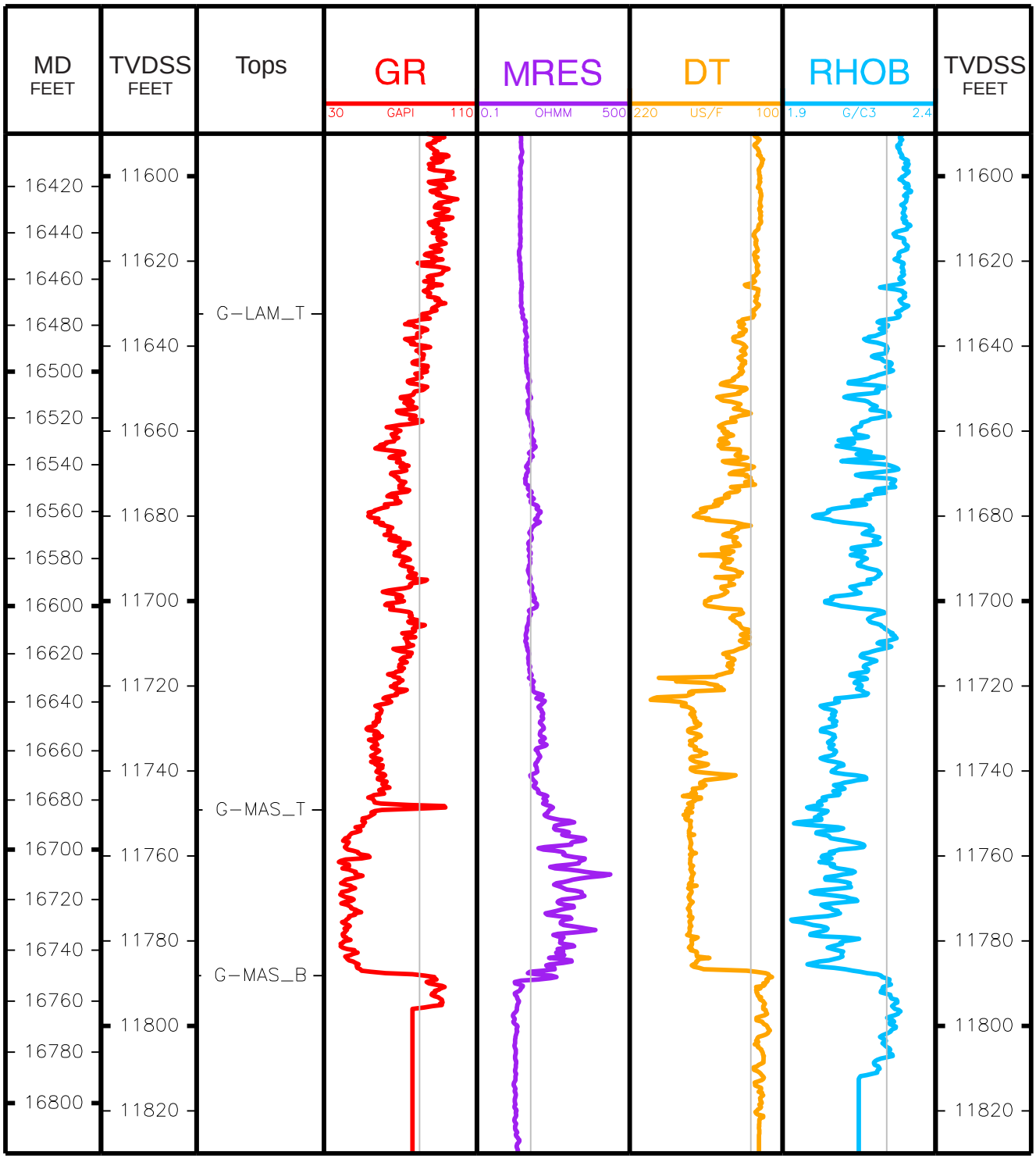
116-1 Seismic Tie

RM



116-A2 Log Response

RM



116-A2 Time-Depth Tie

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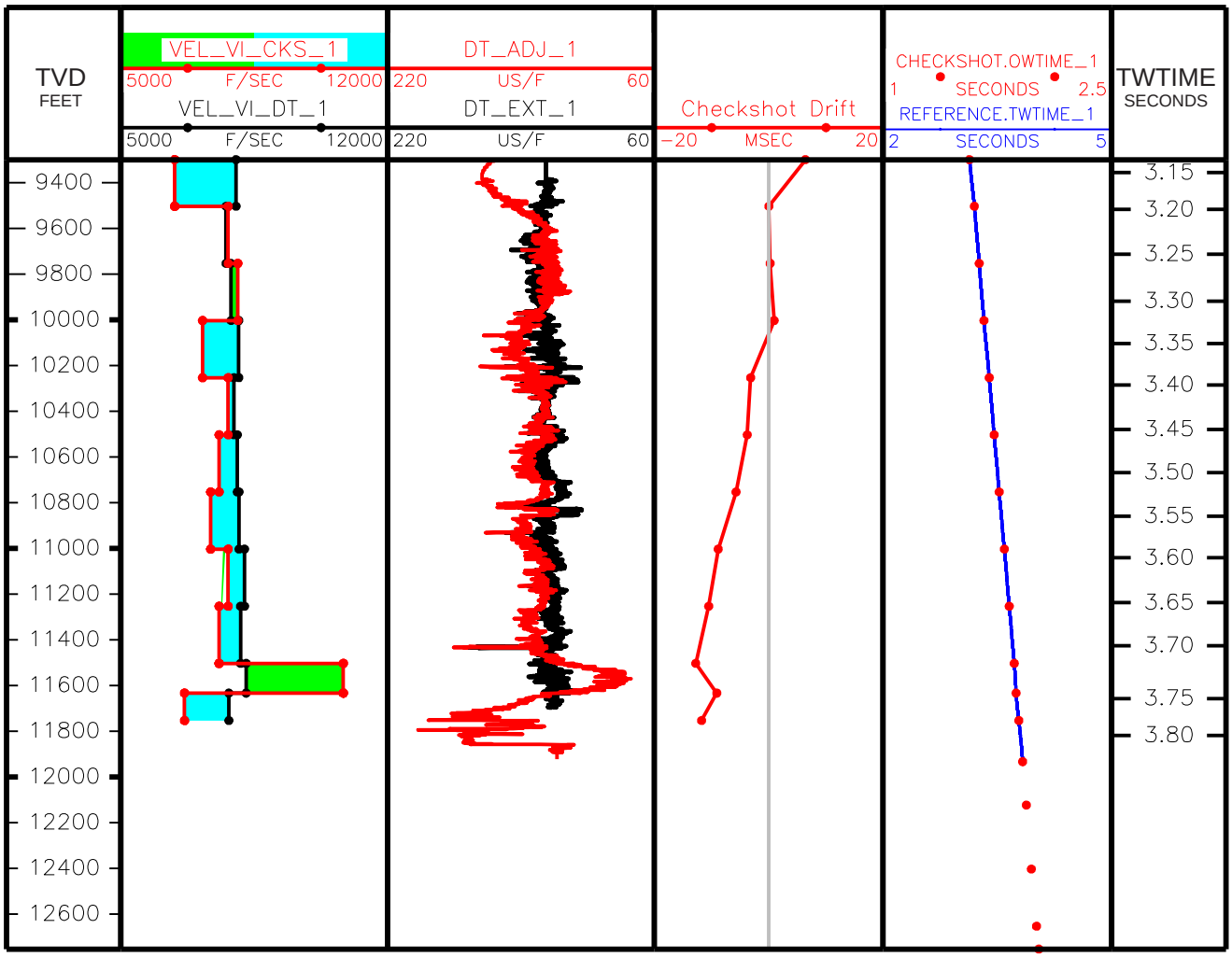

116-A2 Seismic Tie

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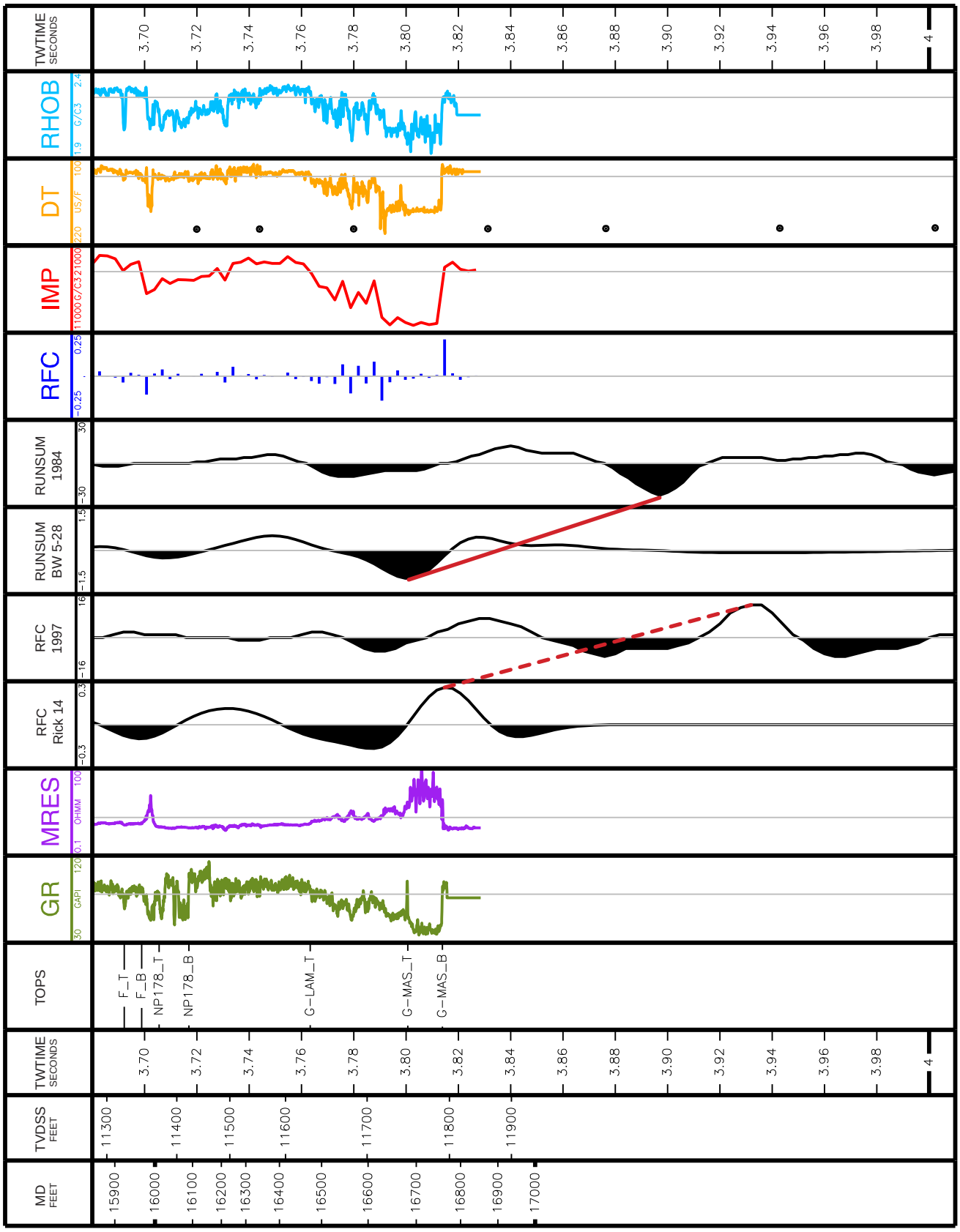
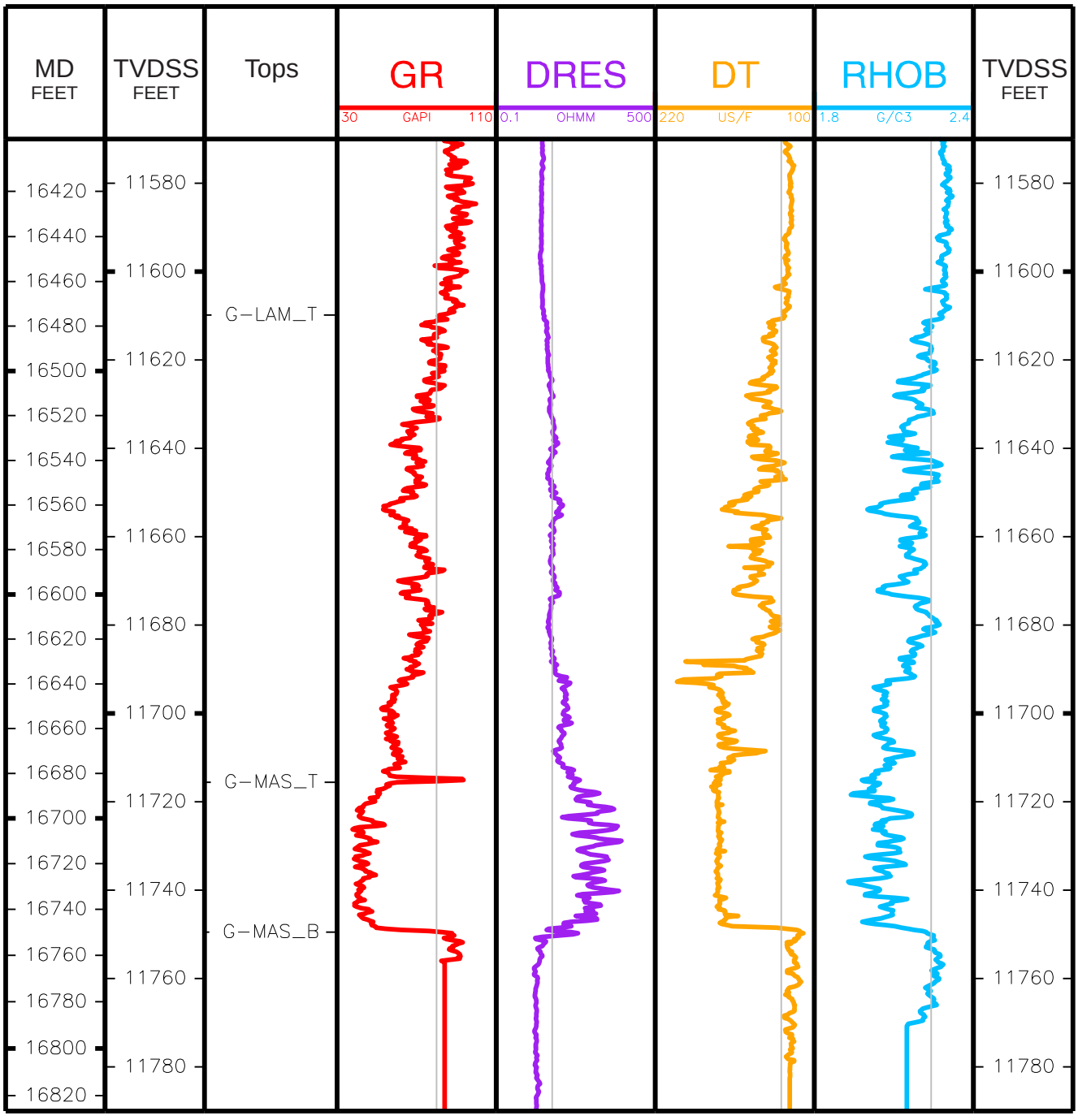


116-A2BP Log Response

RM



116-A2BP Time-Depth Tie

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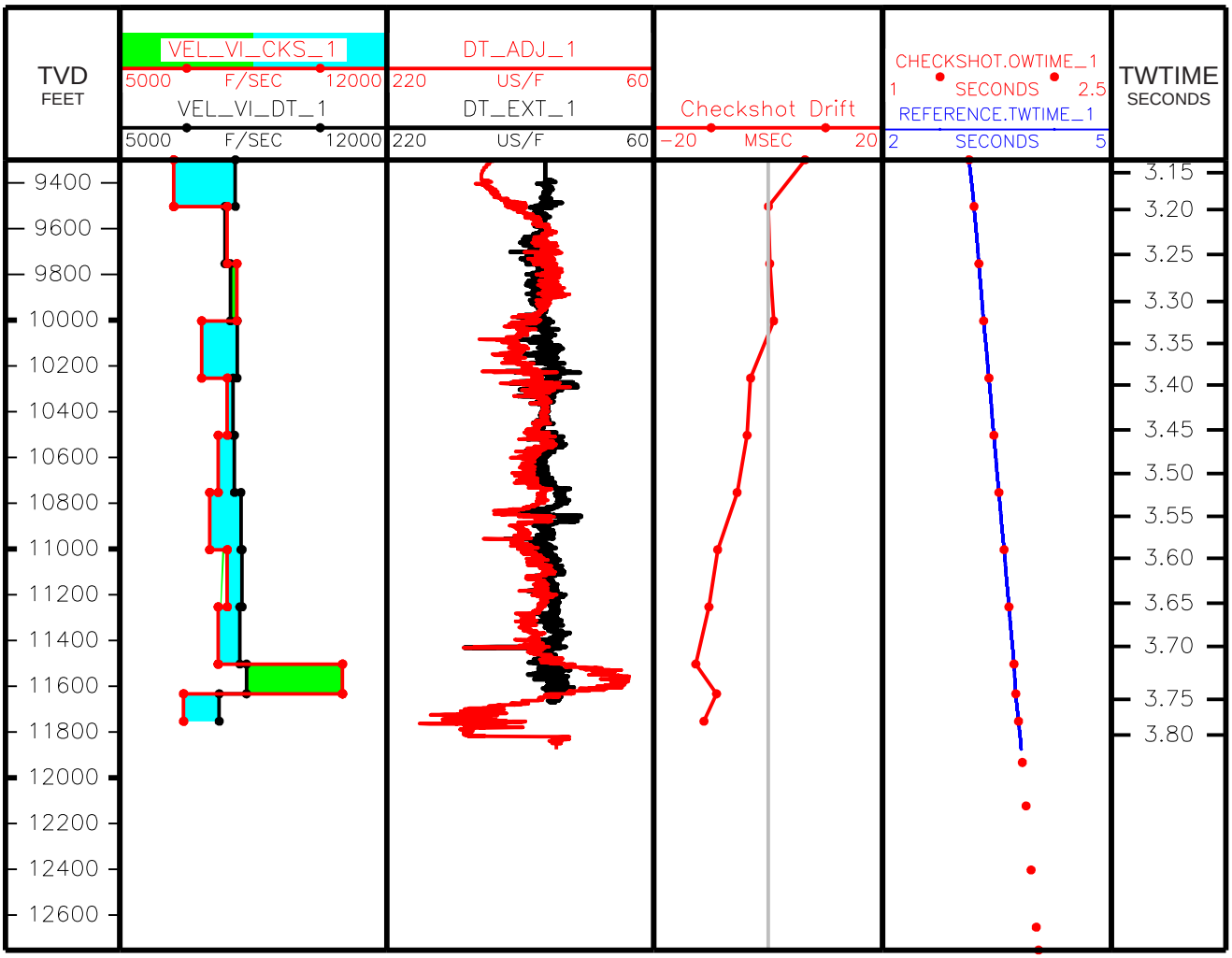
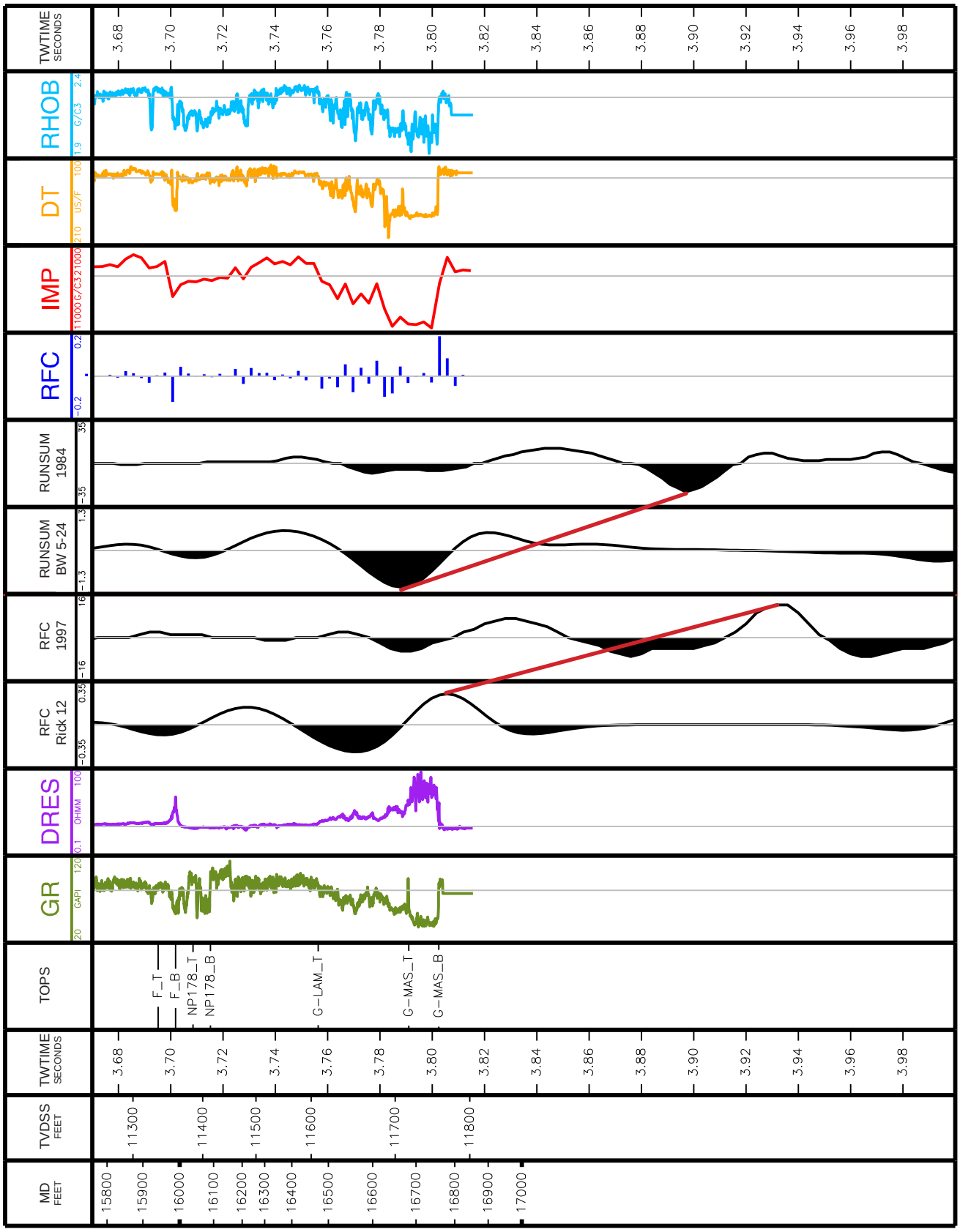


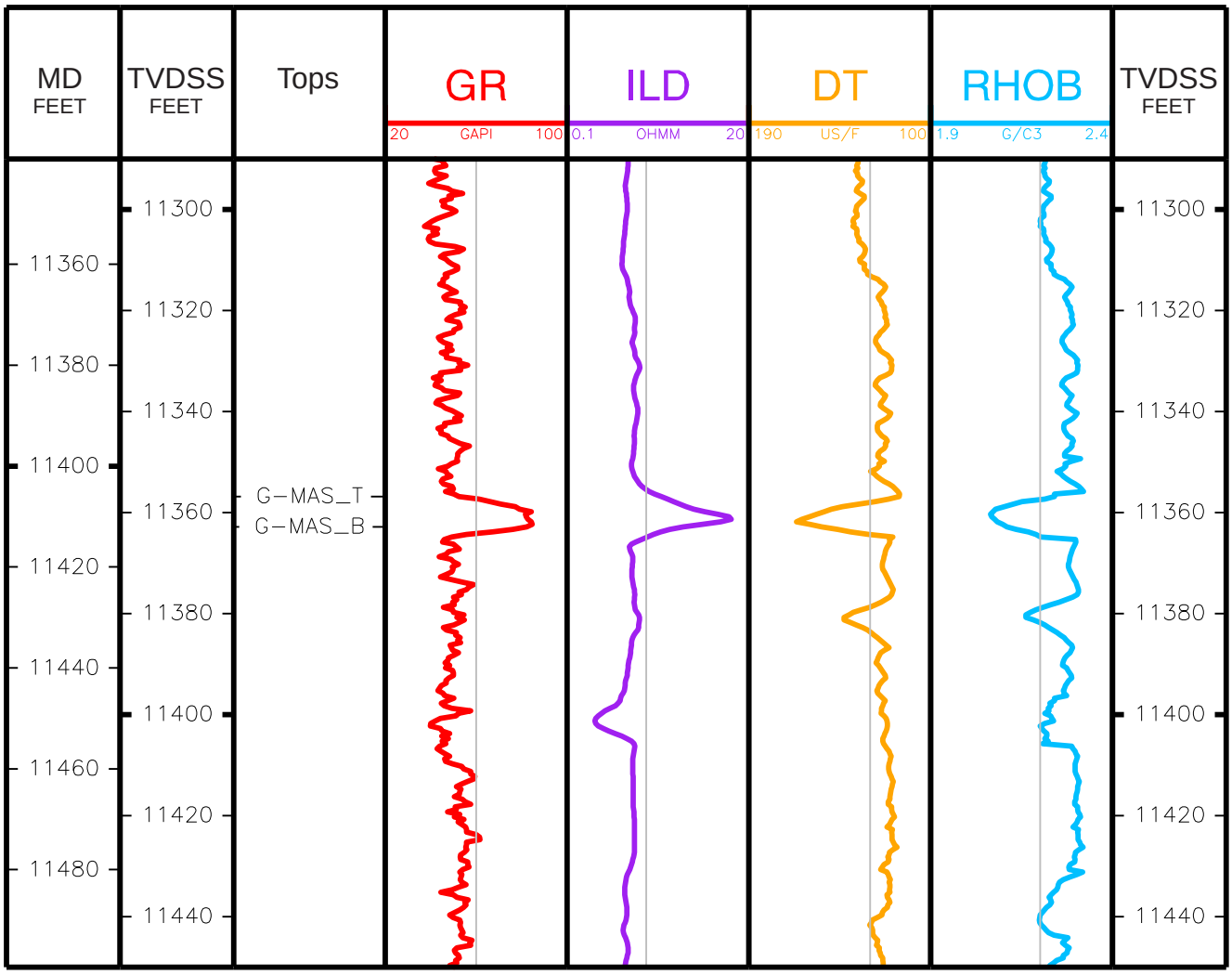
116-A2BP Seismic Tie

RM



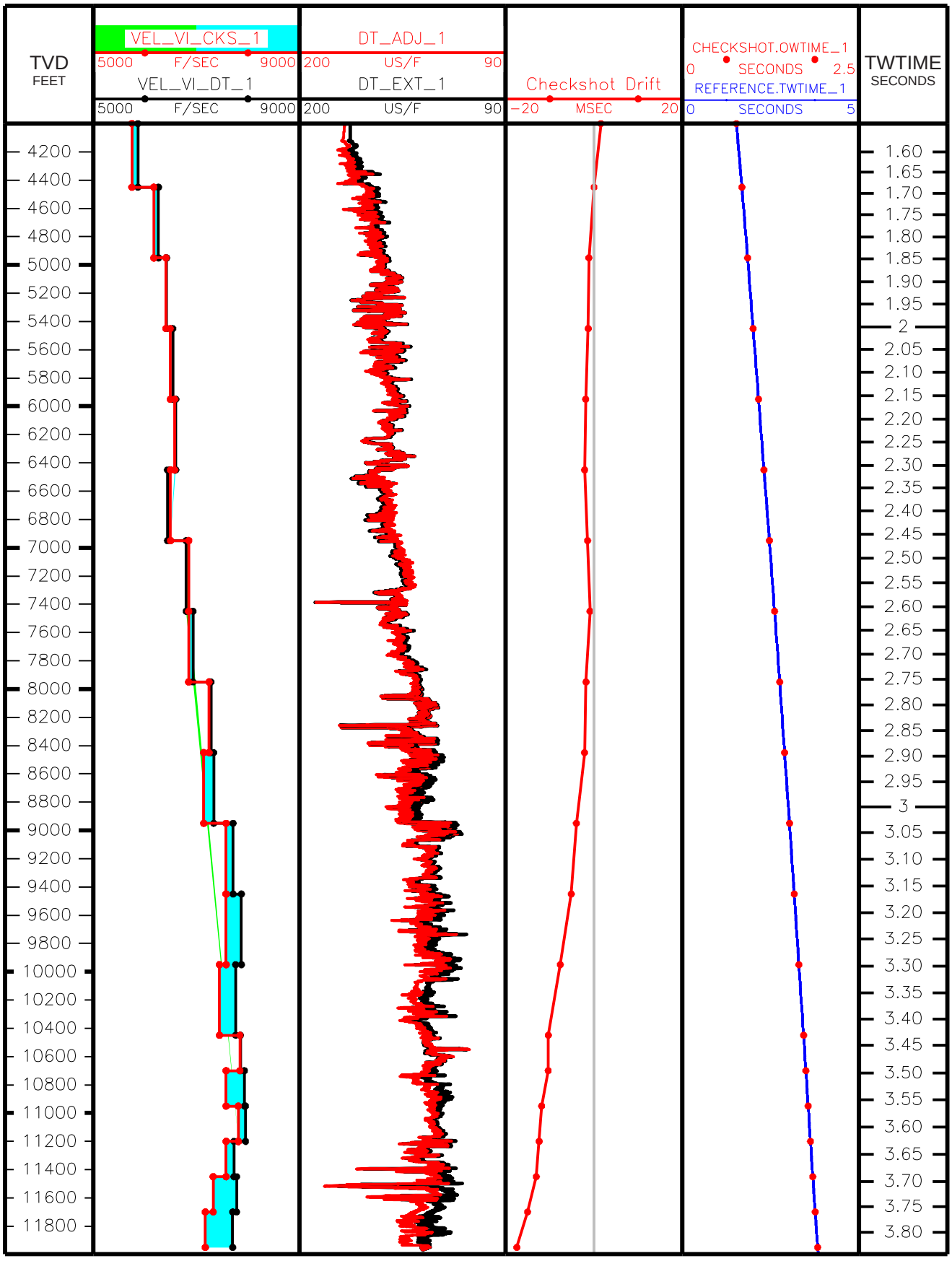
73-1 Log Response

RA



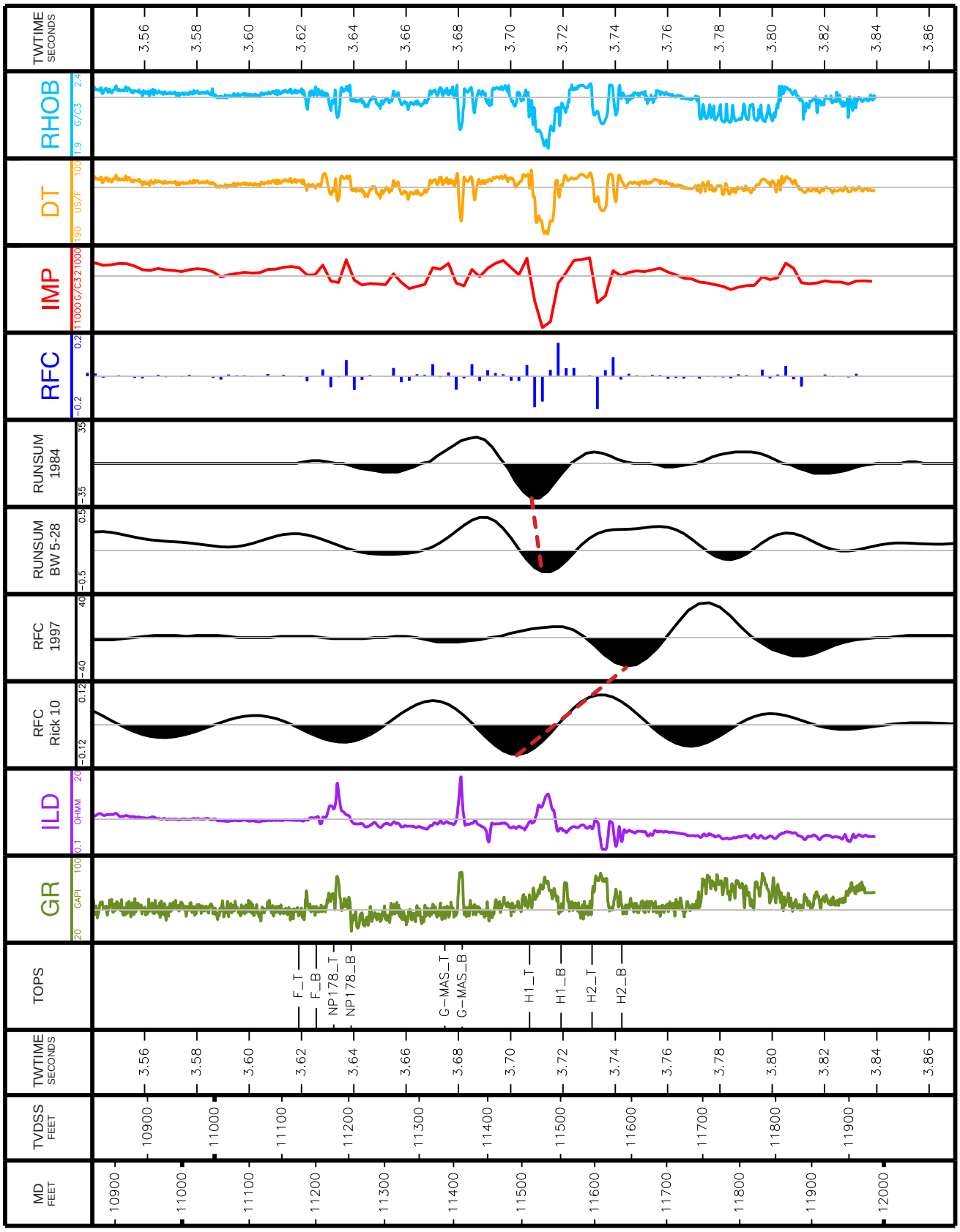
73-1 Time-Depth Tie

RA



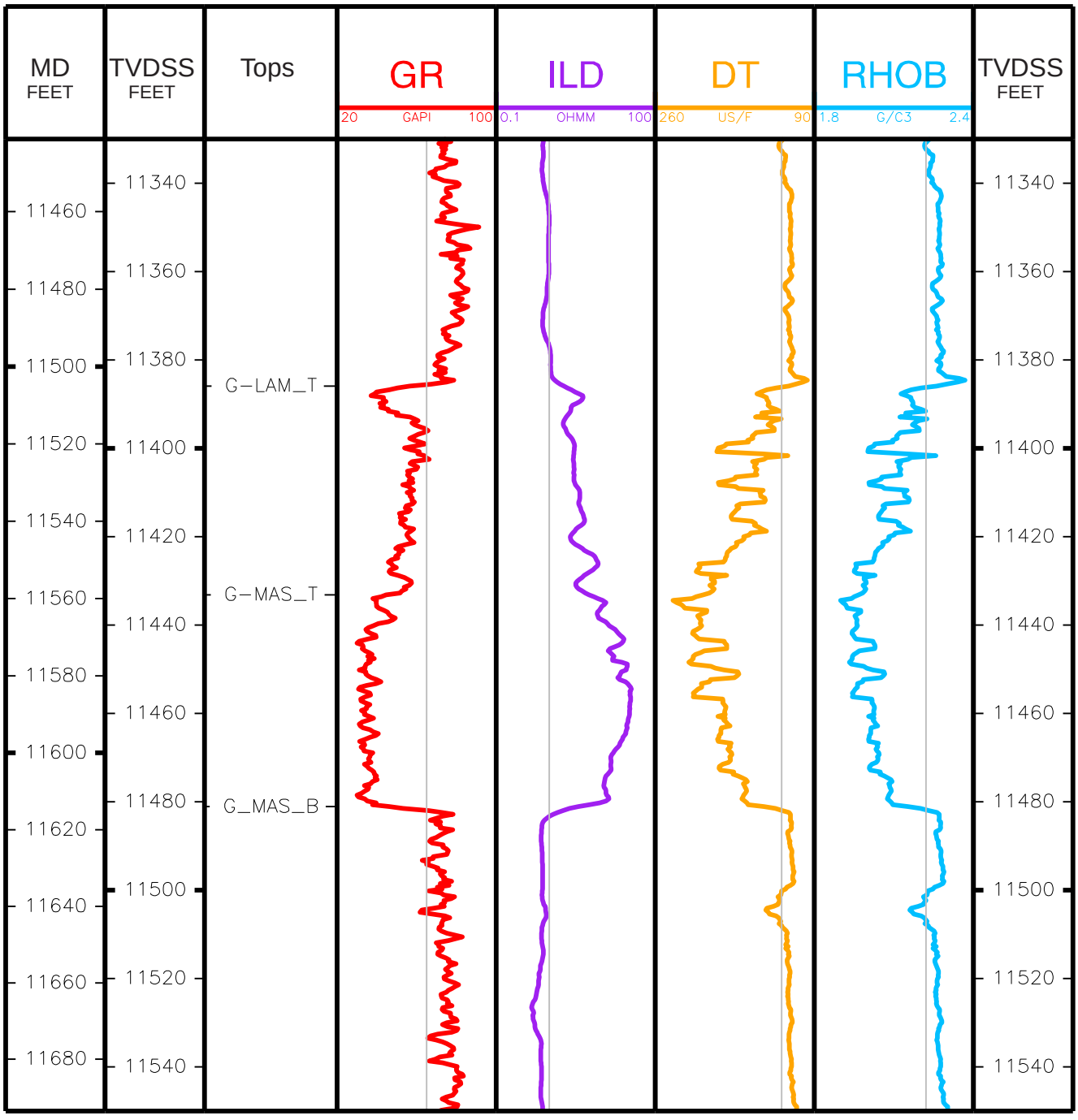
73-1 Seismic Tie

RA



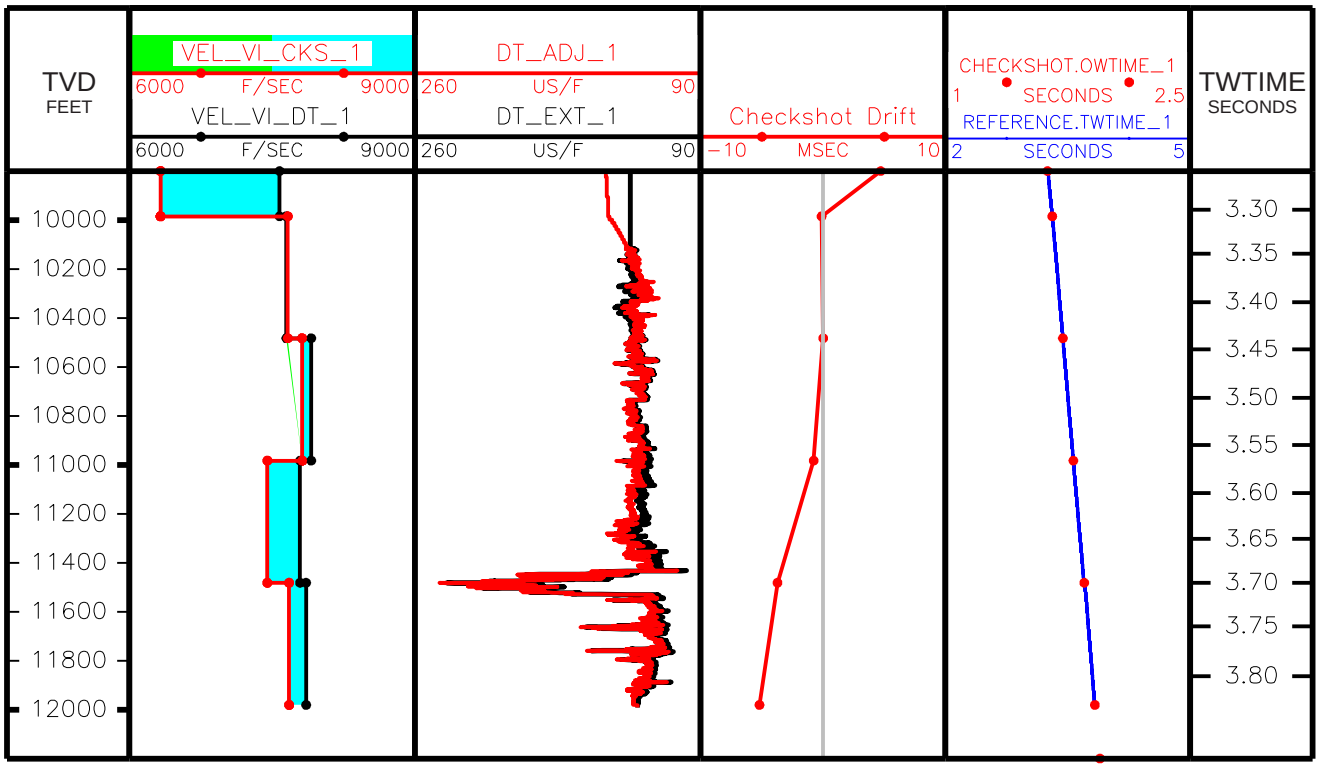
73-1ST1 Log Response

RA



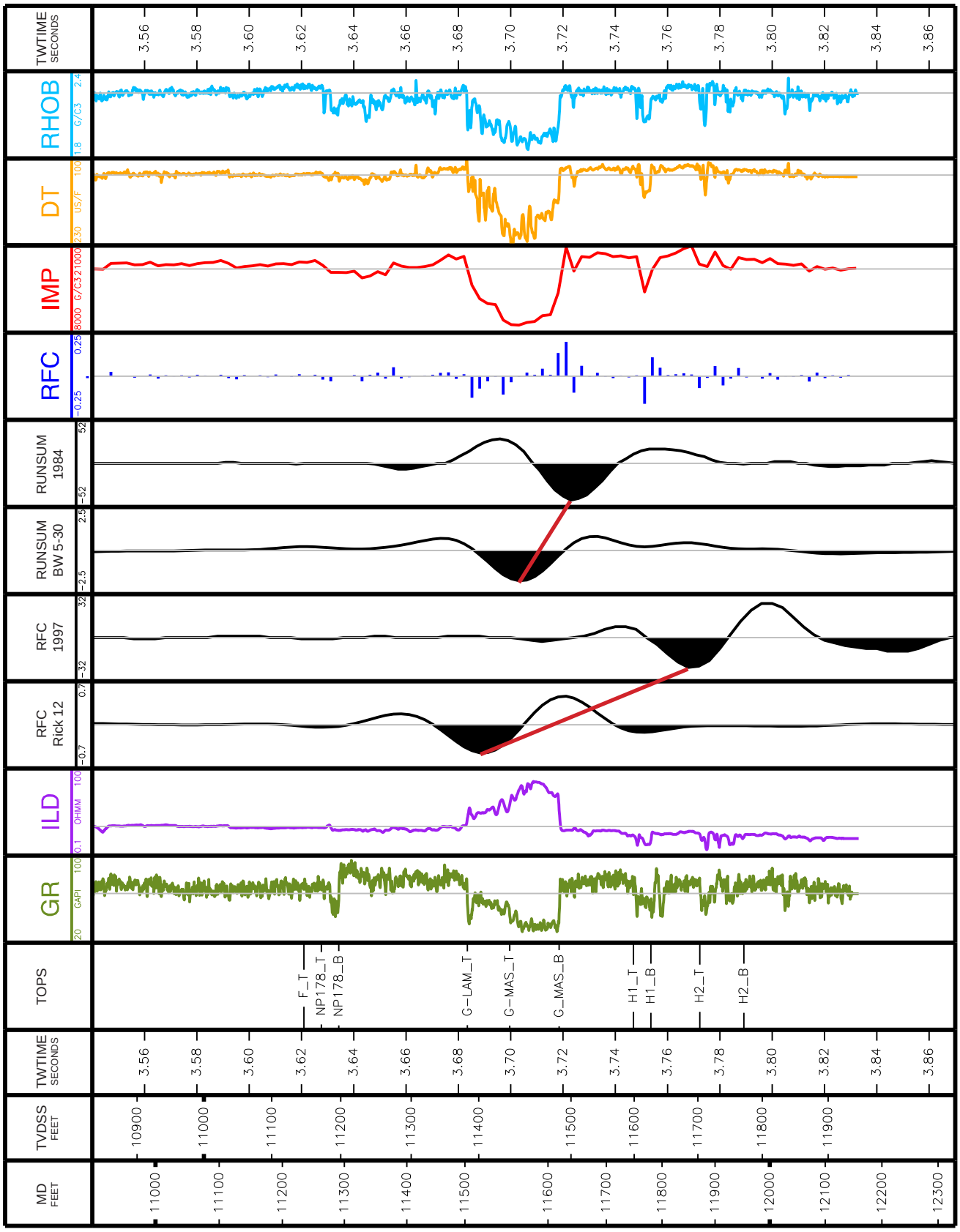
73-1ST1 Time-Depth Tie

RA



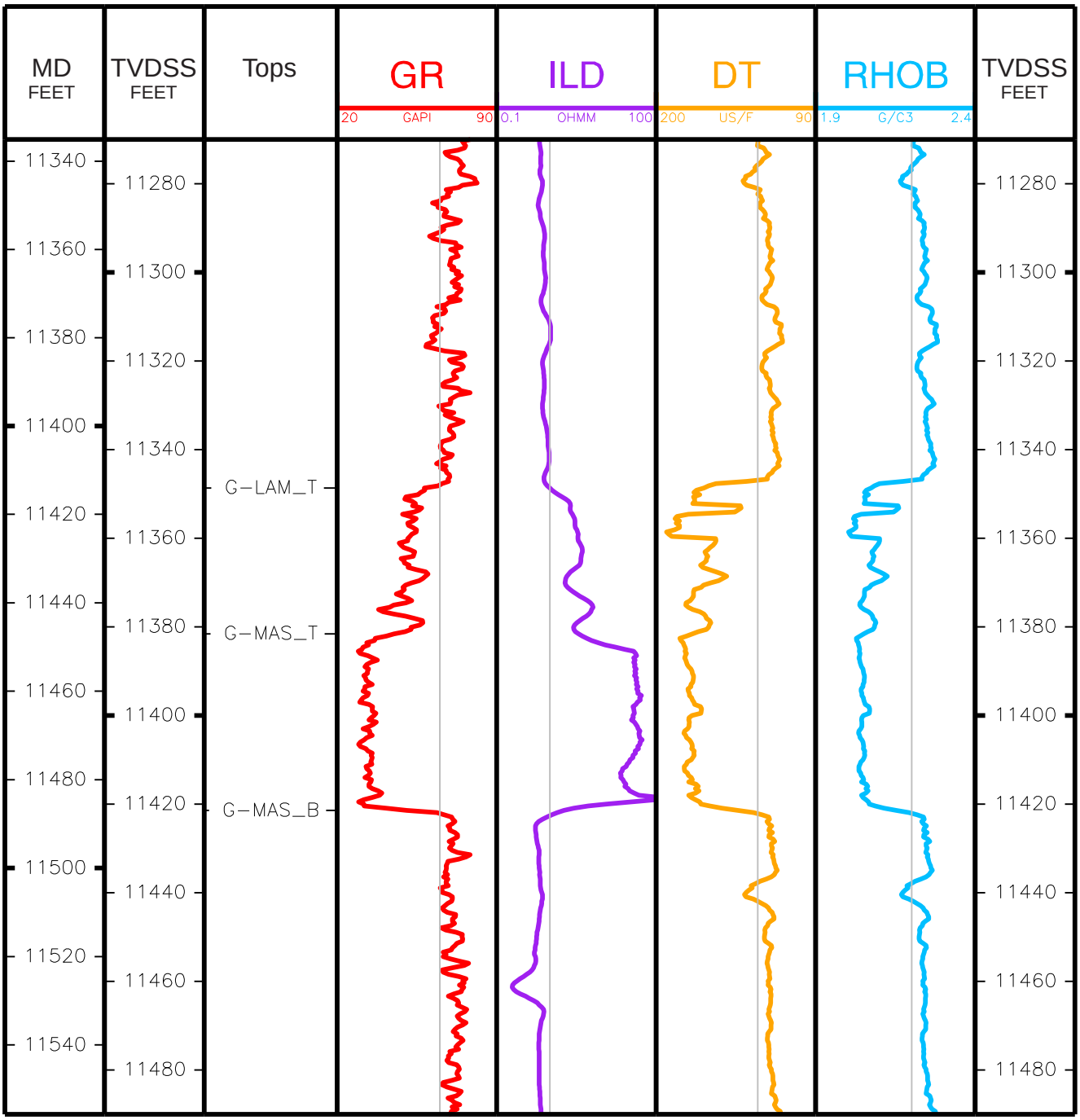
73-1ST1 Seismic Tie

RA



73-1ST2 Log Response

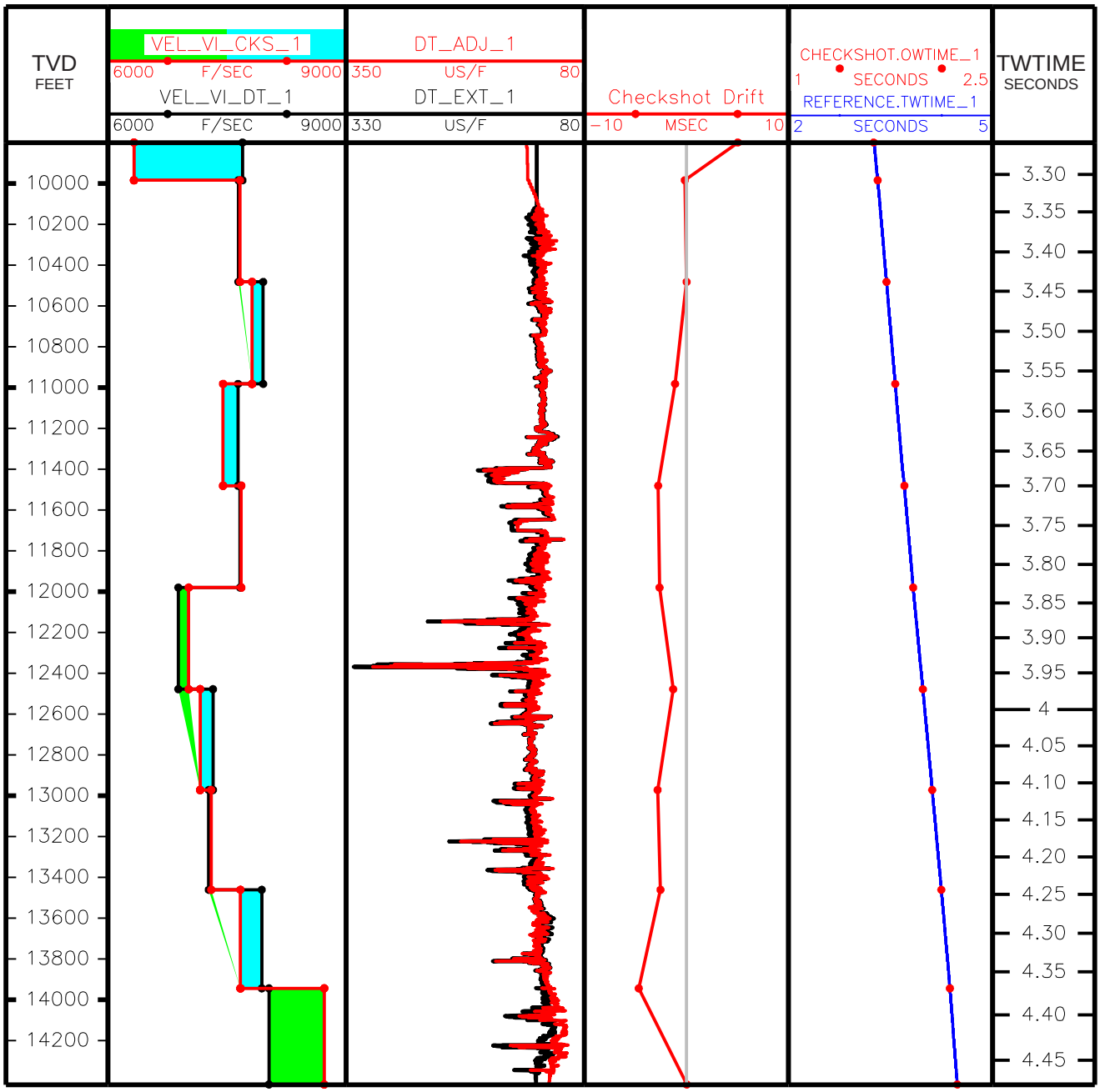
RA



The density log is derived from the sonic log using Gardner's relationship.

73-1ST2 Time-Depth Tie

RA



73-1ST2 Seismic Tie

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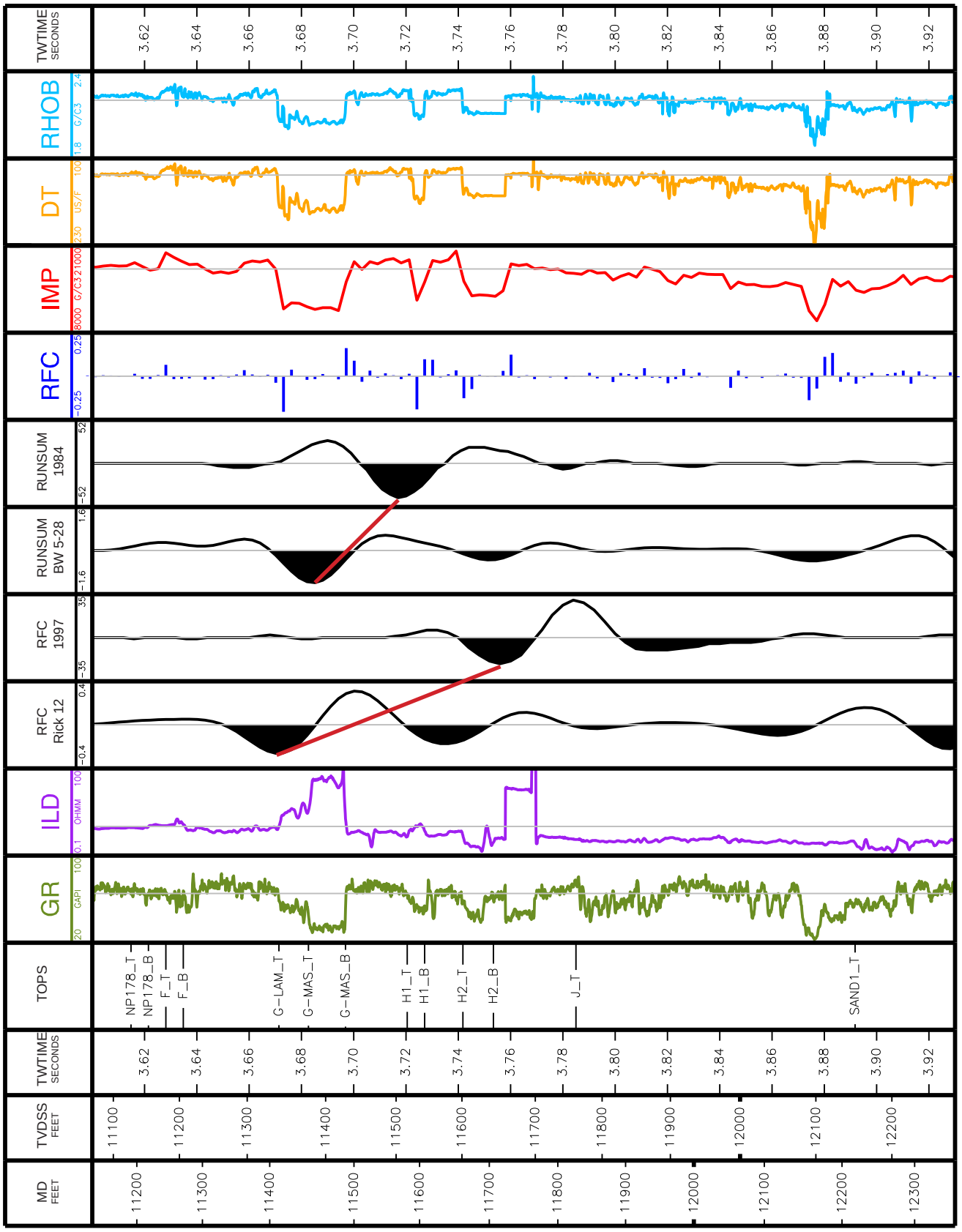
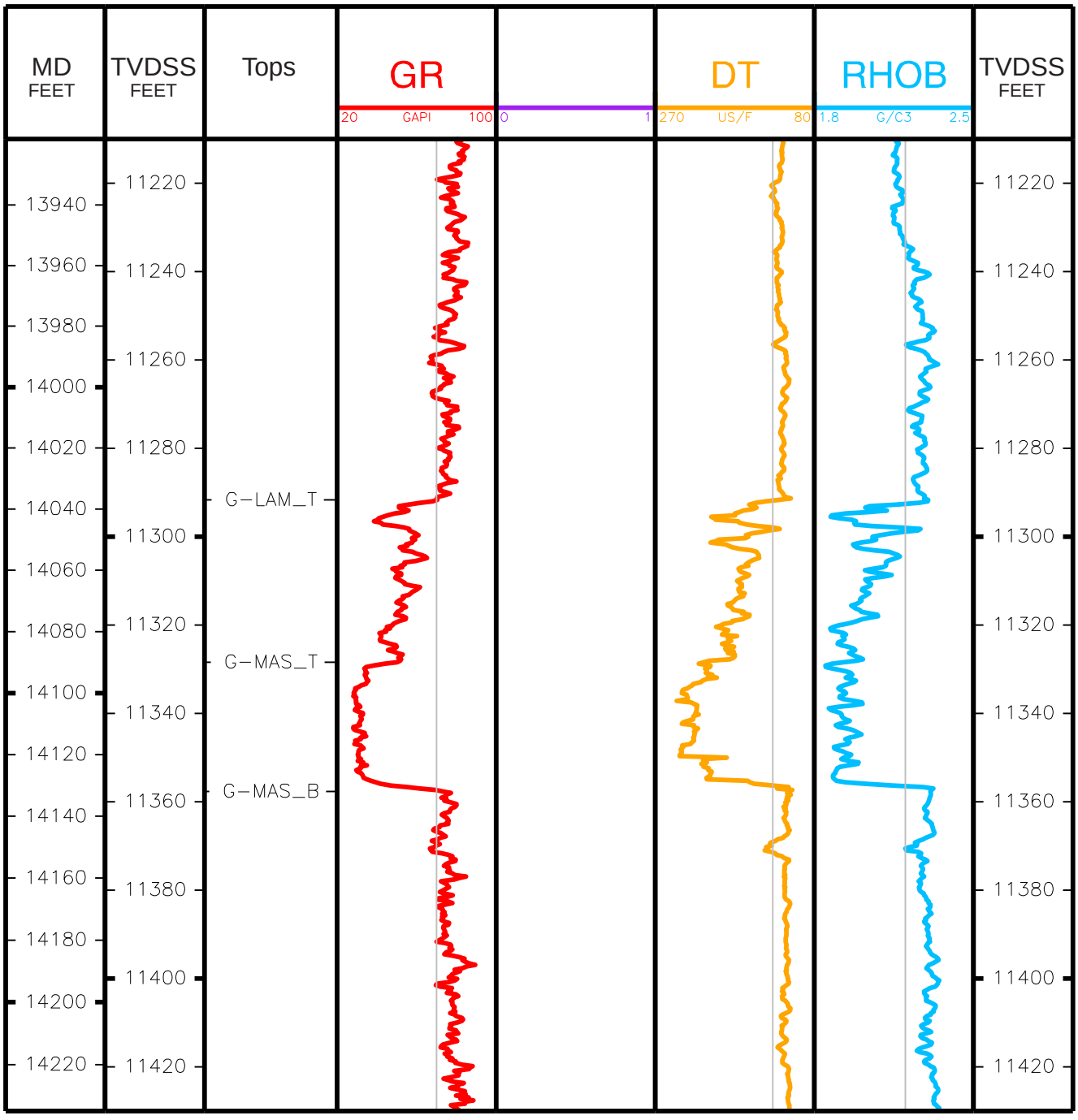


72-A1 Log Response

RA



72-A1 Time-Depth Tie

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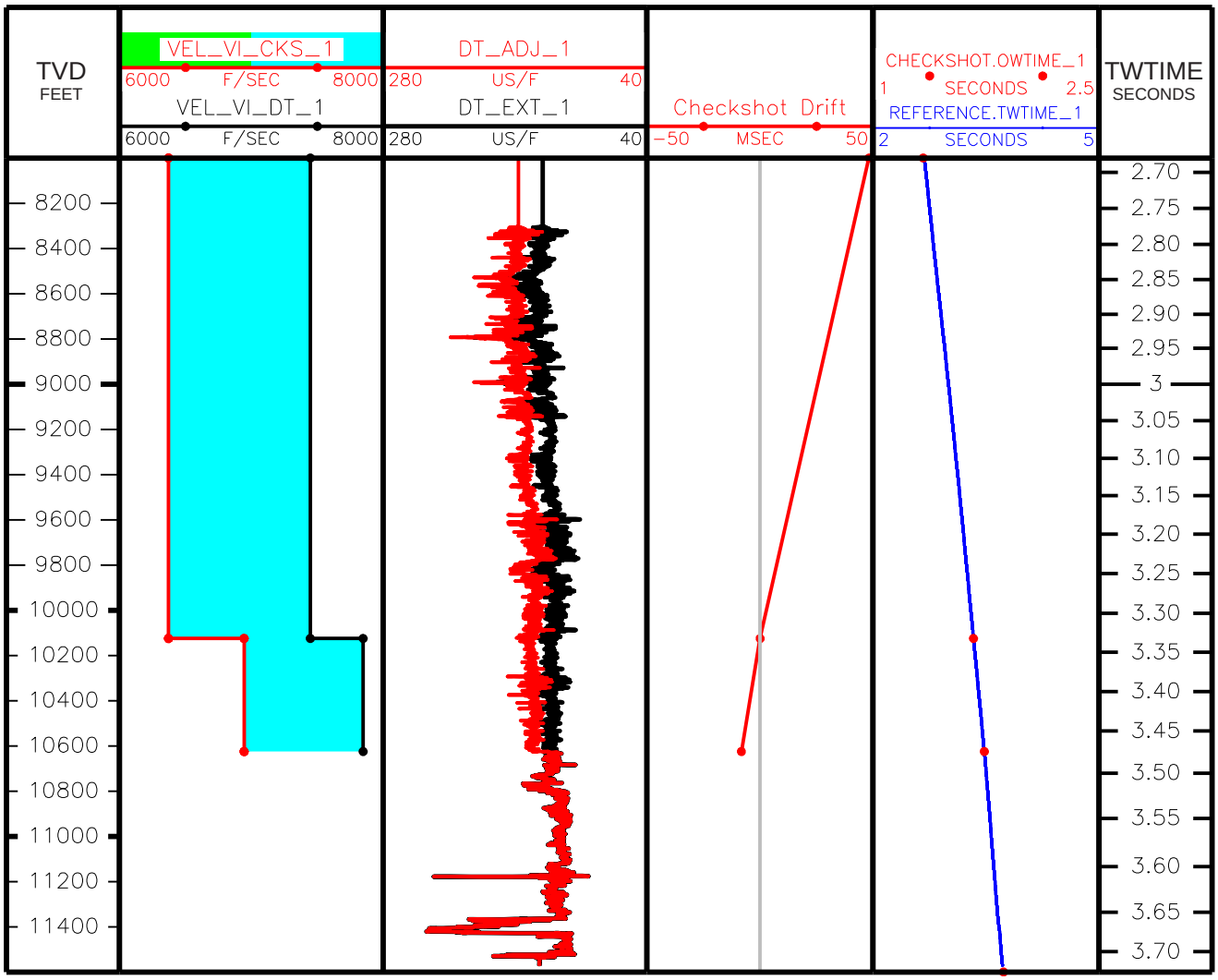

72-A1 Seismic Tie

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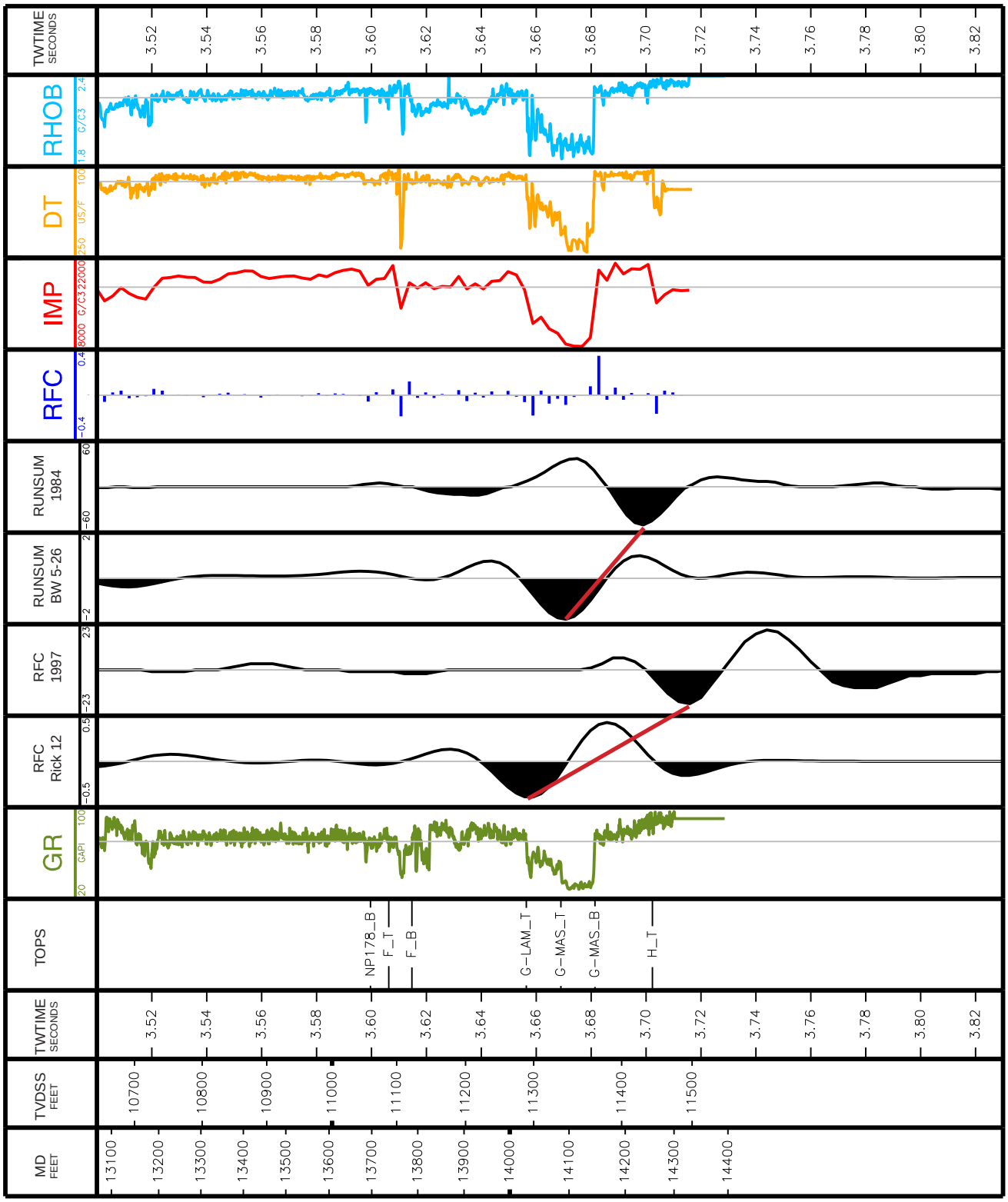

72-A1ST Log Response

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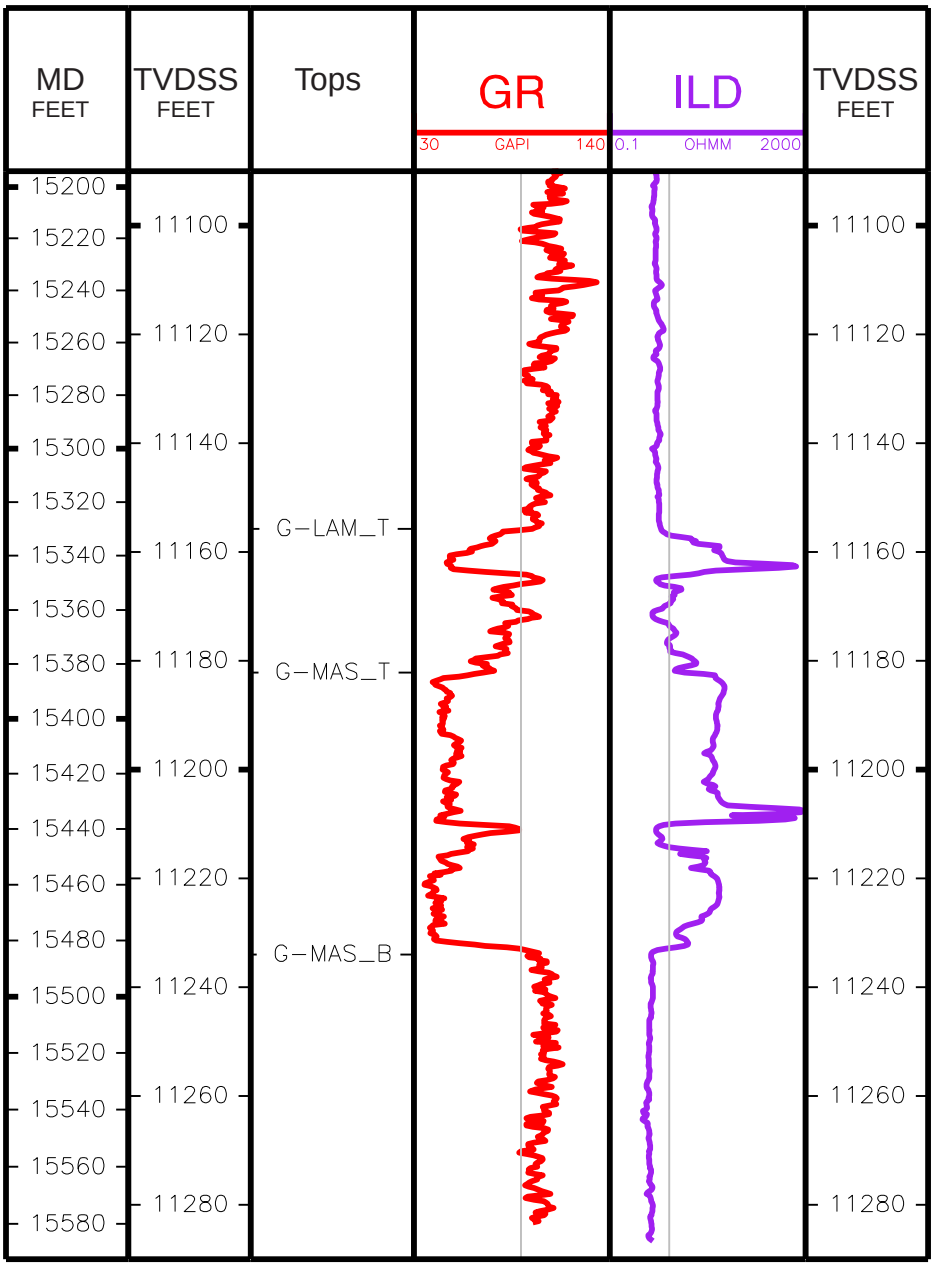

72-A1BP Log Response

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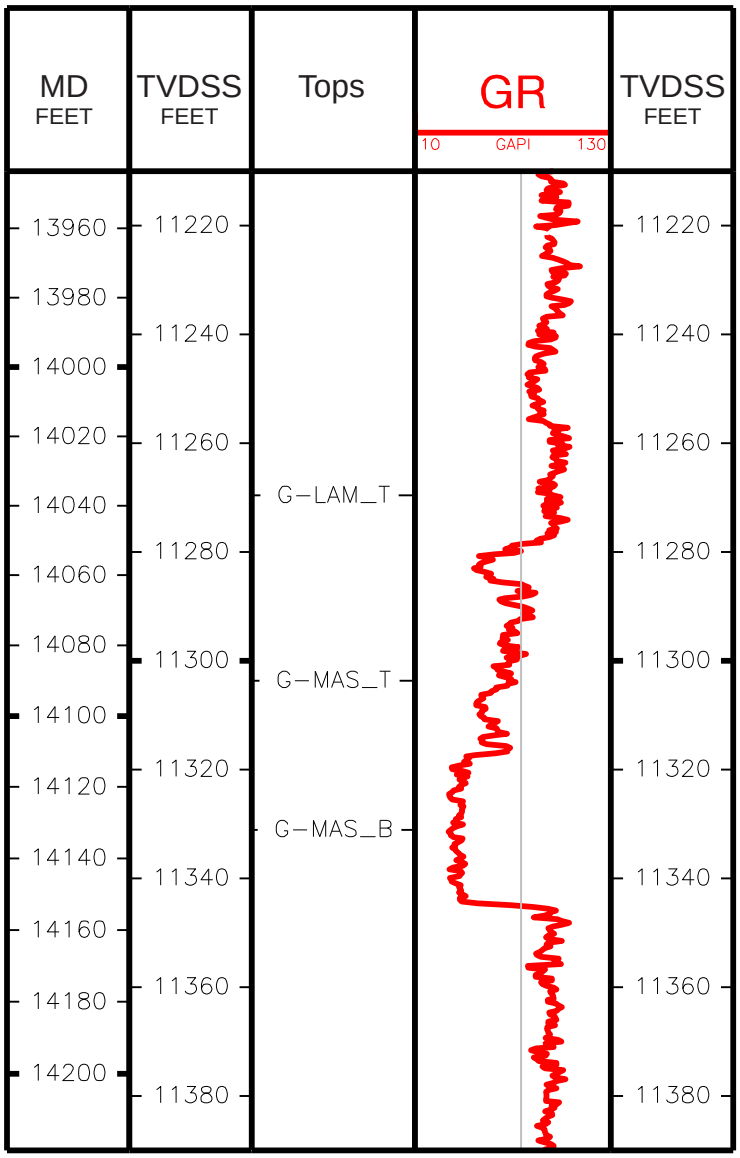
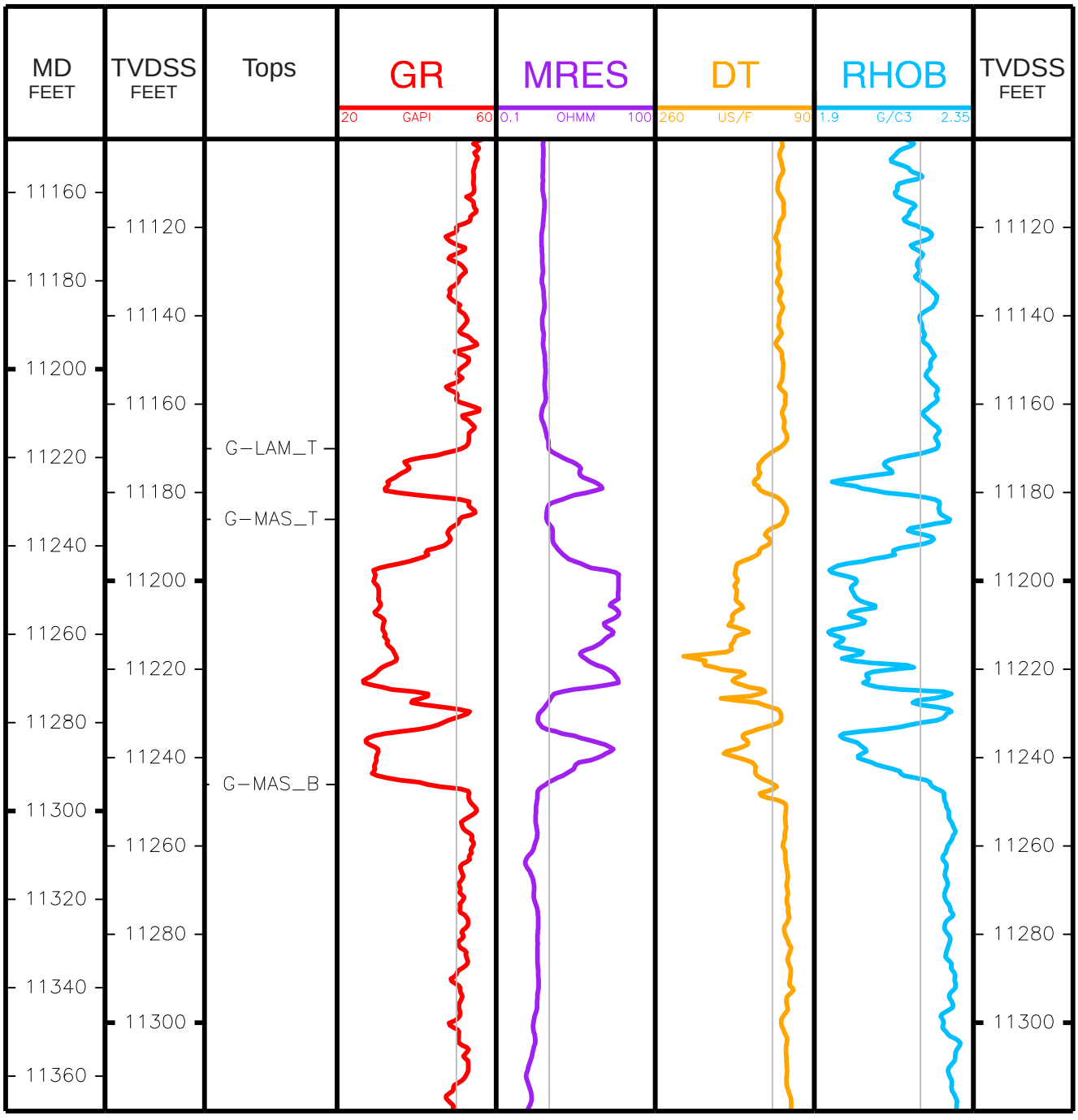


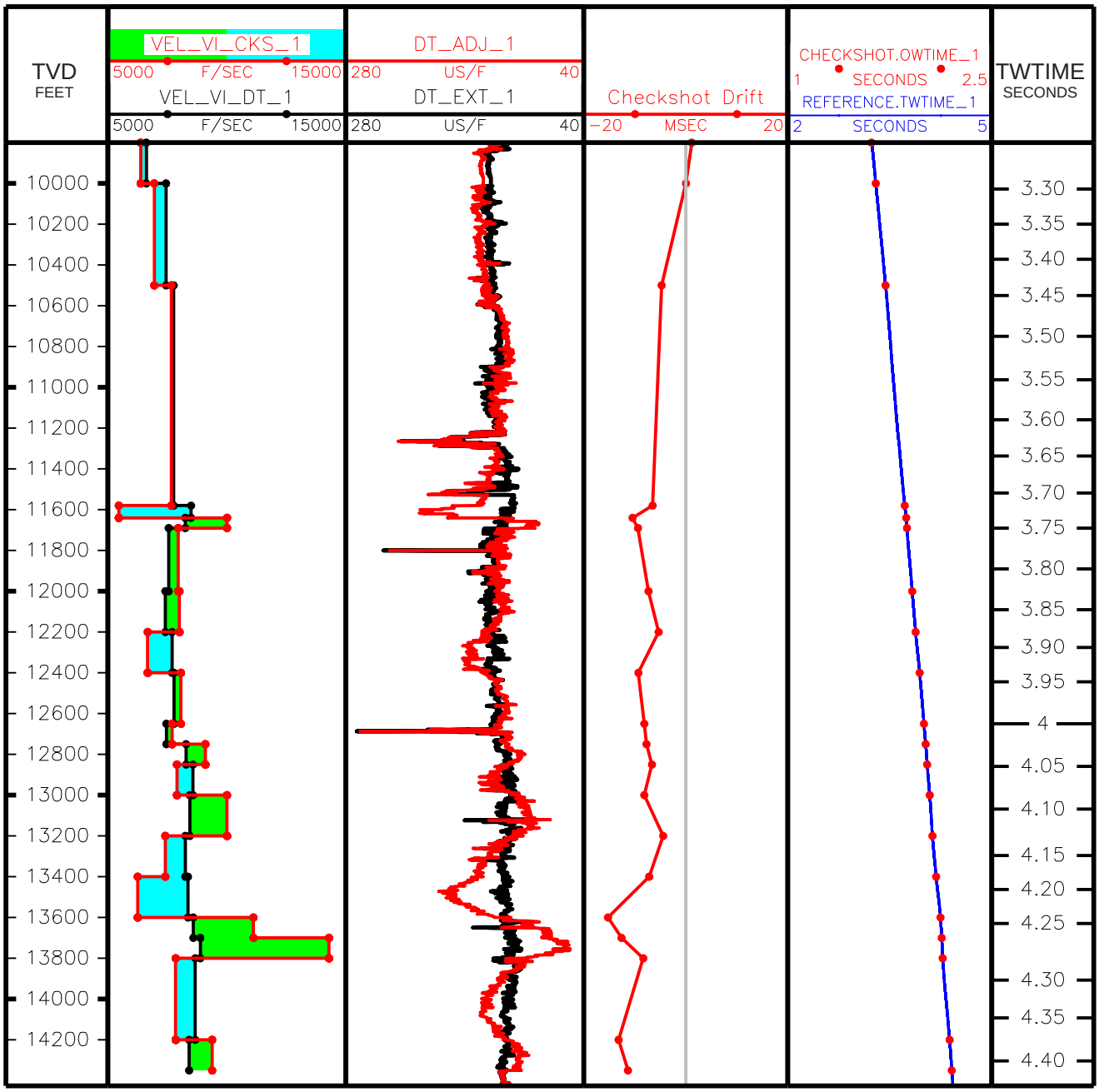
72-2 Log Response

RA



72-2 Time-Depth Tie

RA



72-2 Seismic Tie

RA