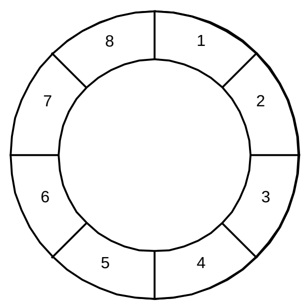
The Cement Map Explained

A. Introduction

The heart of the Radial Bond Tool is the segmented crystal found two feet below the transmitter. This crystal is cylindrical in shape, 2-1/2" in diameter, and 2" long. It is divided into 8 segments, each of which covers 45° of the well bore. (Note: In actuality, there are 16 crystal segments, each paired electrically with an adjacent crystal segment to form each crystal sector.) The crystal assembly is rigidly affixed within the crystal can, and the orientation of crystal segment #1 is marked on the outside of the can.



B. The Calibration Procedure

When the Radial Bond Tool is calibrated, the sonde section is rigidly centralized in a 5-1/2" calibration chamber and the chamber is pressured up to 500 lbs of water pressure. The tool is powered up and the calibration signal is set to 1.5 Volts, using pots within the electronics section of the tool. Gates are then set over E_1 of the 3ft, 5ft, Sum, and each of the 8 segmented crystals. Each of these signals is then set to 1 Volt, again using pots within the electronics section.

Using the SCBL Shop/Free Pipe Calibration routine, the tool is then calibrated so that the 3ft, 5ft, Sum, and each of the 8 segmented crystals reads 100 millivolts within the test chamber. Then, the test chamber is depressurized, and the tool is rotated 180 degrees. The test chamber is again pressurized and the calibrations are checked again to assure that the tool was properly centralized during the calibration procedure.

NOTE: While it is true that the expected amplitude reading for the 3ft receiver in 5-1/2" casing is 72 millivolts, that is the expected reading with pressurized water on the backside of the casing. The presence of air on the backside allows the test chamber to vibrate more freely than 5-1/2" casing. The expected readings of the 3ft in various sizes of pipe, as found in your RBT procedure and within the Warrior Logging System are based upon a tool calibrated to 100 millivolts in a 5-1/2" test chamber with air on the backside.

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C. The Radial Readings

With the Shop Calibration recorded in the Tools.ini file, all that is left for the Engineer to do at the well site, is to perform the SCBL Wellsite Internal Reference Cal and the SCBL Air Zero Cal. These calibrations generate a secondary Gain and Offset that are applied to readings from the SCBL outputs before they are plotted and recorded. These secondary calibrations are identified by WS_ and are listed directly under the curve to which they are applied.

Edit Calibrations

Edit Select

Name	Type	Gain	Hi Read	Hi Ref	Lo Read	Lo Ref	Offset
AMP3FT	Lin2Pt	97.649	1.009	100.000	-0.015	0.000	3.004
WS_3FT	Lin2Pt	1.008	0.000	0.000	0.005	0.000	-0.021
AMPCAL	Lin2Pt	66.102	1.503	100.000	-0.009	0.000	0.625
WS_CAL	Lin2Pt	1.008	1.493	1.503	-0.008	-0.009	-0.001
AMP5FT	Lin2Pt	98.521	1.000	100.000	-0.015	0.000	1.491
WS_5FT	Lin2Pt	1.008	0.000	0.000	-0.006	0.000	-0.009
AMPSUM	Lin2Pt	99.273	0.993	100.000	-0.014	0.000	1.403
WS_SUM	Lin2Pt	1.008	0.000	0.000	-0.008	0.000	-0.006
AMPS1	Lin2Pt	97.452	1.011	100.000	-0.015	0.000	1.482
WS_S1	Lin2Pt	1.008	0.000	0.000	-0.008	0.000	-0.007
AMPS2	Lin2Pt	98.770	0.997	100.000	-0.015	0.000	1.505
WS_S2	Lin2Pt	1.008	0.000	0.000	-0.006	0.000	-0.009
AMPS3	Lin2Pt	98.485	1.002	100.000	-0.014	0.000	1.366
WS_S3	Lin2Pt	1.008	0.000	0.000	-0.008	0.000	-0.006
AMPS4	Lin2Pt	97.953	1.008	100.000	-0.013	0.000	1.296
WS_S4	Lin2Pt	1.008	0.000	0.000	-0.007	0.000	-0.006
AMPS5	Lin2Pt	97.091	1.016	100.000	-0.014	0.000	1.337
WS_S5	Lin2Pt	1.008	0.000	0.000	-0.003	0.000	-0.011
AMPS6	Lin2Pt	98.266	1.004	100.000	-0.014	0.000	1.346
WS_S6	Lin2Pt	1.008	0.000	0.000	-0.008	0.000	-0.006
AMPS7	Lin2Pt	99.237	0.994	100.000	-0.013	0.000	1.325
WS_S7	Lin2Pt	1.008	0.000	0.000	-0.008	0.000	-0.006
AMPS8	Lin2Pt	99.230	0.995	100.000	-0.013	0.000	1.308
WS_S8	Lin2Pt	1.008	0.000	0.000	-0.007	0.000	-0.006

When the SCBL Internal Reference Calibration is performed, the High and Lo Read of the AMPCAL from the Shop Calibration are used as the Hi and Lo Ref for the WS_CAL and the Calibration Signal is calibrated back to the readings taken during the Shop Calibration. The Gain derived from this calibration is then applied to ALL of the Bond curves. This calibration adjusts the Warrior Logging System for differences in line length and variations in Sync Levels.

When the SCBL Air Zero Cal is performed, the gates of all the bond signals are set to their approximate values for the casing size anticipated by choosing the appropriate Setup (under *Load Setup*), while to tool is in air. This calibration generates the secondary calibration offset, which is applied to each of the Bond curves individually. This adjusts for variations with in the different Warrior Logging Systems.

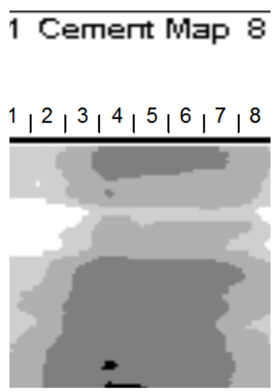
When using Shop Calibrations for logging, both of these calibrations must be done before going in the hole. If, for some reason a Wellsite Calibration is performed, there is no need to perform these two additional calibrations. Wellsite calibrations are not recommended except under unusual situations.

The responses of the individual sector measurements are plotted out under the SCBL06.prs presentation, which together with SCBL05.prs are the new log presentations under the new release.

D. The Cement Map

The Cement Map is a graphical representation of the response of the sector measurements. The shading of the cement map is purely representative of the recorded amplitude readings from the various sectors. Look back to the representation of the segmented crystal shown at the beginning of this bulletin, and visualize the sectors laid out horizontally.

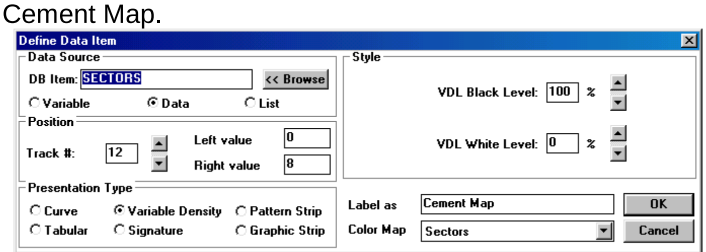
Each of the individual sectors is represented by a section of the cement map, as shown below. The shade applied to each section of the map is a function of the amplitude of that sector as recorded.



The Warrior Logging System uses an algorithm to determine the shading associated with the amplitude recorded, based on several factors. These factors include:

1. The number of grayscales and the density of the grayscales in the Cement Map, as applied in the screen and printer setup within the Warrior.ini file.
2. The Filter level associated with each of the Sector Curves.
3. The amplitude reading of adjacent sectors.
4. The High Reference recorded in the Shop Calibration associated with each Sector Curve.
5. The Black and White values set in the presentation file.

The only factor under control of the engineer is the Black and White values within the presentation file. The purpose of the Cement Map is to graphically illustrate small channels that may pose a problem. With that end in mind, the following is the proscribed setup for the Cement Map.



With the Black and White Levels set as above, the grays scales of the Cement Map will change as follows:

1. Amplitudes less than 10mv — Black
2. Amplitudes greater than 10mv and less than 20mv — Dark Gray
3. Amplitudes greater than 20mv and less than 30mv — Medium Gray
4. Amplitudes greater than 30mv and less than 40mv — Light Gray
5. Amplitudes greater than 40mv — White

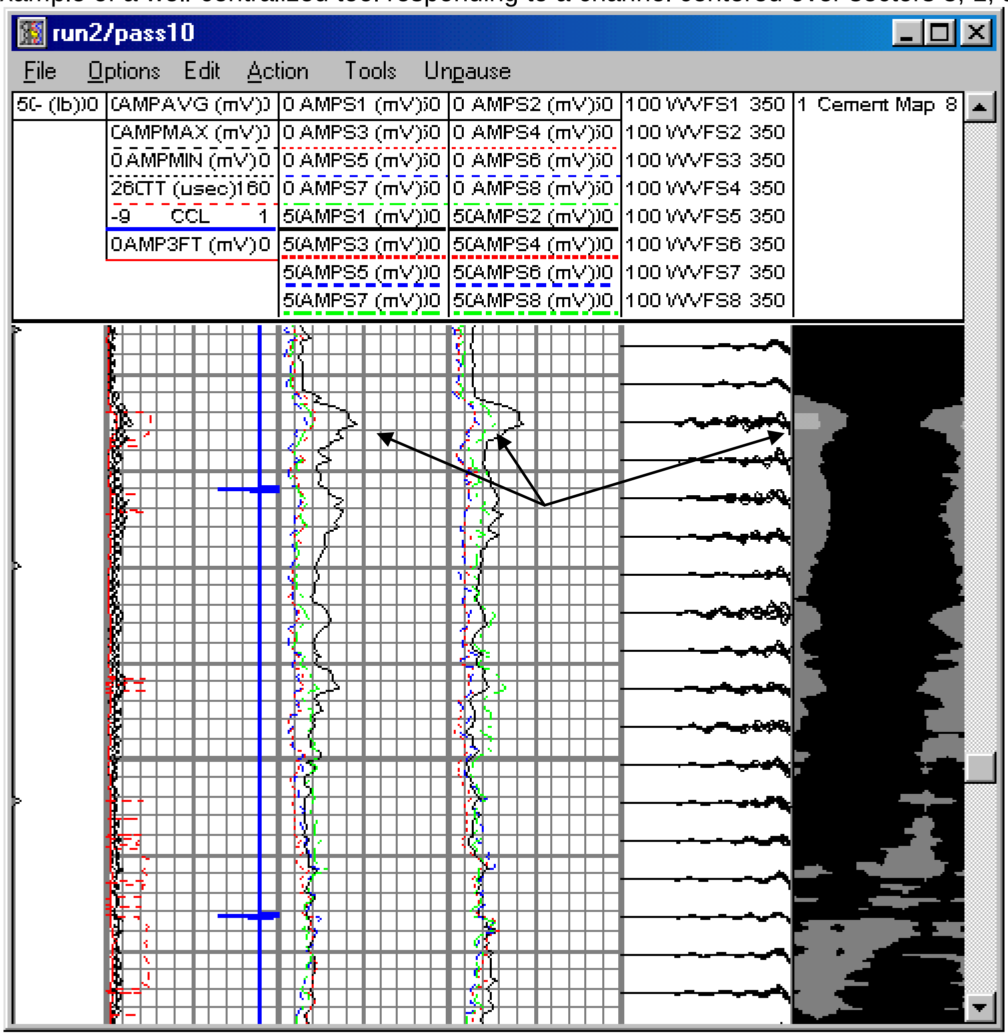
If different gray scales are needed for a particular application, contact Technical Support.

E. Logging Conditions

The Cement Map is a visual representation of the cement conditions behind the pipe. The Sector Crystal is not free to rotate within the tool, and the cement and casing are not free to rotate. However, the tool itself is free to rotate with the well, and it is expected that it will. For this reason, apparent "channels" may rotate within the cement map while running repeats, and that the Cement Map may not repeat exactly.

The Cement Map also becomes an important aid to quickly identify problems in tool setup or logging procedures.

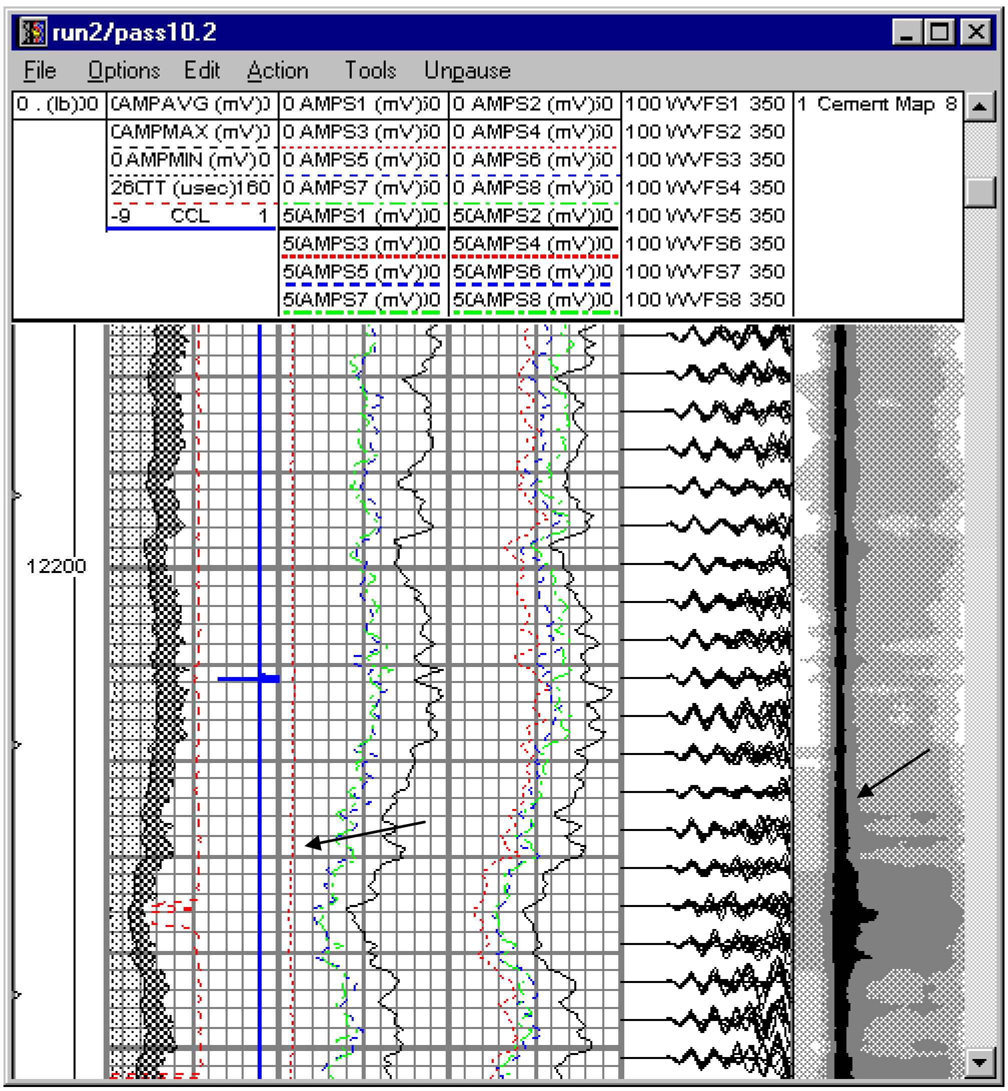
Below is a good example of a well-centralized tool responding to a channel centered over sectors 8, 1, and 2.



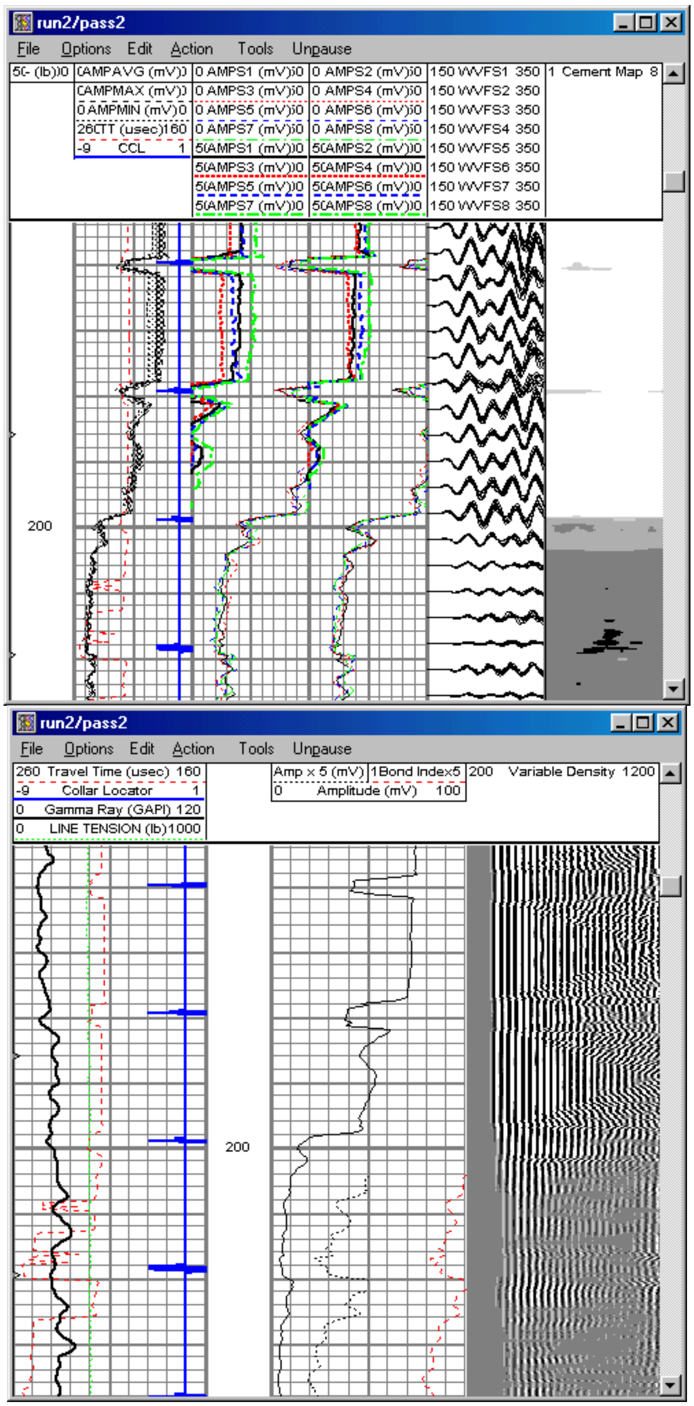
Note the shading changes as individual sectors go above 10mv and 20mv.

Below is an example log with <u>two</u> distinct problems.

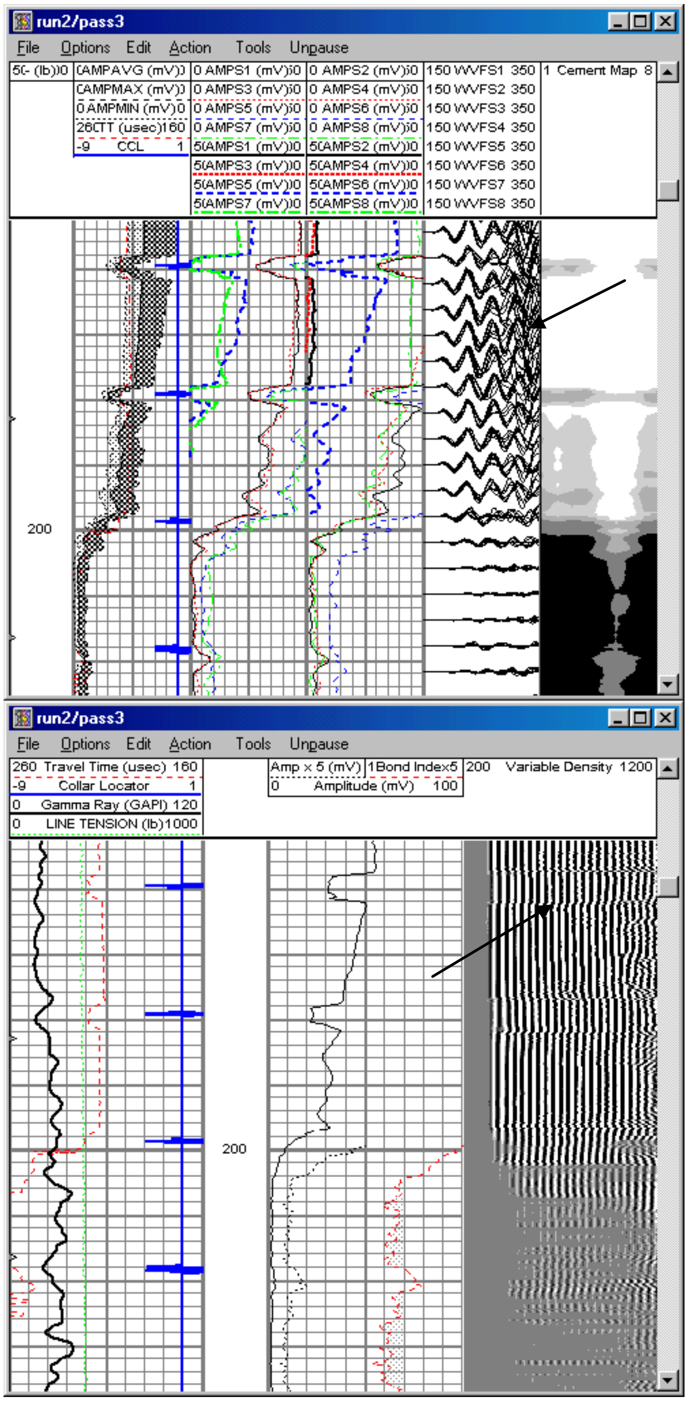
1. First, the calibration of sector 3 was incorrect. The gate was over E_1 during the Wellsite Freepipe Calibration, but was not moved off of E_1, when the zero reading was taken. This problem could be fixed using Recalculation and Edit Calibrations. Notice that there is a consistent, not rotating black line down sector 1 of the Cement Map, and that the AMPS3 curve is very non responsive.
2. In addition, this log was <u>not well centralized</u> when the Wellsite Calibration was done. Notice how Sector 1 remains consistently high through out the logged interval. Sector 1 was slightly further away from the casing, when the calibration was performed in a lighter weight pipe. Over the logged interval, in higher weight pipe, the centralizers brought the tool into the center of the pipe, but the higher gain needed to bring Sector 1 to 100mv previously, is now driving the AMPS1 curve and the Cement Map high in Sector 1.



Below is an example of a Test Well log, done with Shop Calibrations and proper Centralization.



Compare these presentations with the presentations on the following page of the same interval, same tool, same calibrations, but this log run without roller centralizers.



Note that there is significant difference in amplitude readings in all of the sectors, the cement map, and even the characteristic “W” chevron in the collar at 179’. Also compare the signature plots of the individual sectors over this interval. The variation of the signal arrivals after 250 μseconds is significant and indicates decentralization.