Addendum to Ground Penetrating Radar

Survey Report:

Tel Es-Safi, Israel

Data Acquired June 15-17, 2003

Report compiled August 4, 2003

Addendum compiled October 29, 2003

Addendum to Survey and Report Published by
Mnemotrix Systems, Inc.

Overview:

The purpose of this addendum is to provide additional detail and discussion towards the goal of a better understanding of the results given in the August 4th, 2003 GPR Survey report of the work done at Tel Es-safi.

This addendum includes 19 freeze-frames taken from the Study Area 1 Vertical Depth-Profile Animation available in the previous report, available for viewing on the Mnemotrix Website at: http://www.mnemotrix.com/geo/es_1b_z.gif.

The anomalies pointed out in that report are further explained here and have been outlined in each of the depth freeze-frames in an unchanging light blue color, according to their shape at first 0.59 meters depth. This was done so that one can trace the shape and presence of each anomaly as depth increases in addition to enhancing the understanding of the patterns seen in the data during lab post-processing.

Also included in this addendum is a further explanation of the results and recommendations of the survey done at Study Area 2.

Equipment used at both Study Areas included a 200 MHz and 400 MHz antenna manufactured by Geophysical Survey Systems, Inc. (GSSI). GSSI equipment is FCC-approved, and our equipment is FCC registered.

Data was acquired on very sunny days in hot summer temperatures around 90 degrees Fahrenheit with little wind. Mnemotrix Systems, Inc. survey team members were physically accompanied by Dr. Oren Ackerman of Bar-Ilan University and several other individuals for additional help. Local herdsmen, their flocks, and other members of the nearby village at times were also present throughout the three days at the site.

Study Area 1

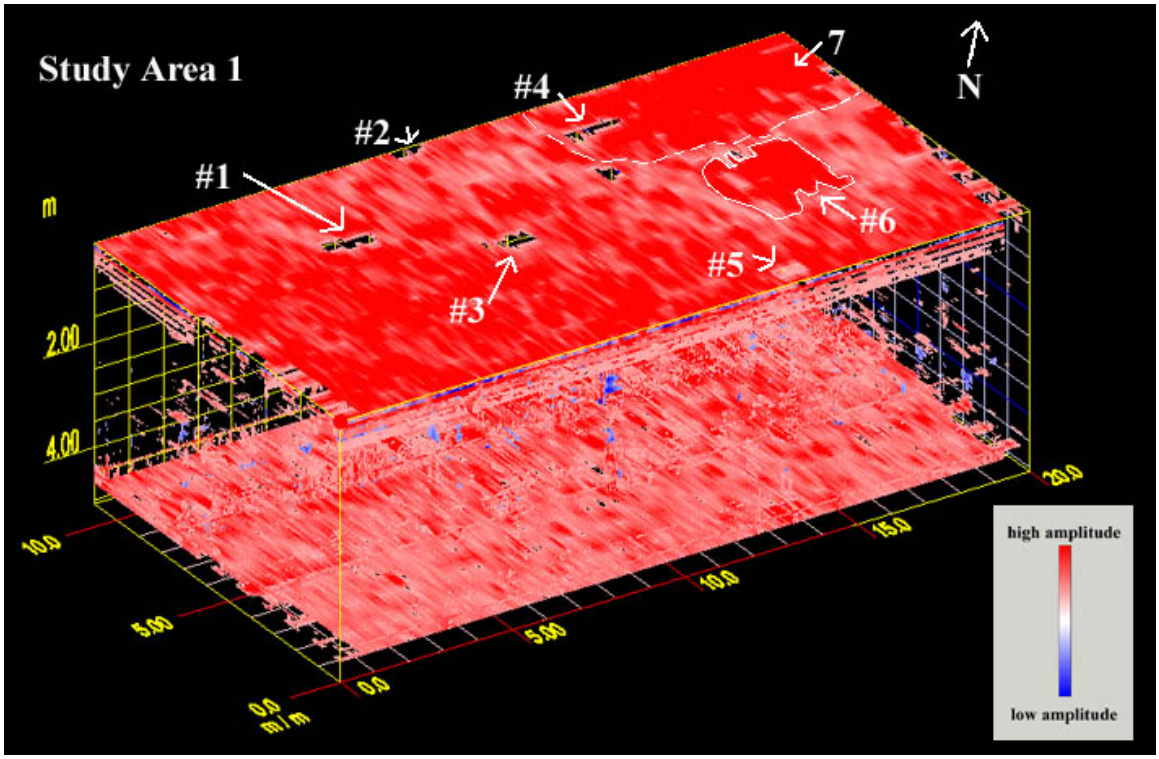

Figure 1

Figure 1 is the same image included on page 6 of the original report. As noted in that report, Anomalies 1-5 of Study Area 1 were interesting in that as each is seen in depth, they became distinct, vertically oriented lines. They stood out to us because their amplitude levels are very high. Again, using this color table, highest amplitudes will show in the reddest hue.

Anomalies 6 and 7 stood out because of their relatively large size (about 3-4 meters wide and about 10 meters long, respectively), and roughly rectangular shape. As referenced in the report, Oren Ackerman and Uri Reiss told us that many years ago a cattle feeder about 20 feet long (6-7 meters), went missing and may have been buried in this general area. Knowing this, when we were in the field we paid particular attention to anomalies 6 and 7, which were showing up on our scans the first day. It is one of the

reasons why we honed in on this area in Study Area 1 the second day for our more intensive grid. Again as mentioned in the report, because Anomaly 7 on the northwest corner seems to extend past the grid area shown, its complete dimensions are unknown. Therefore we surmise that this could be the buried cattle feeder.

Figure 2 below is the closest to the surface freeze-frame selected from the website animation. In this figure, light blue outlines have been drawn in to demarcate the anomalies and have been placed for emphasis to enhance understanding consistently as depth progresses throughout the freeze-frames. X and Y coordinates are shown for the purpose of locating and marking the anomalies at the site. Dimensions are given to help visualize the size of each anomaly.

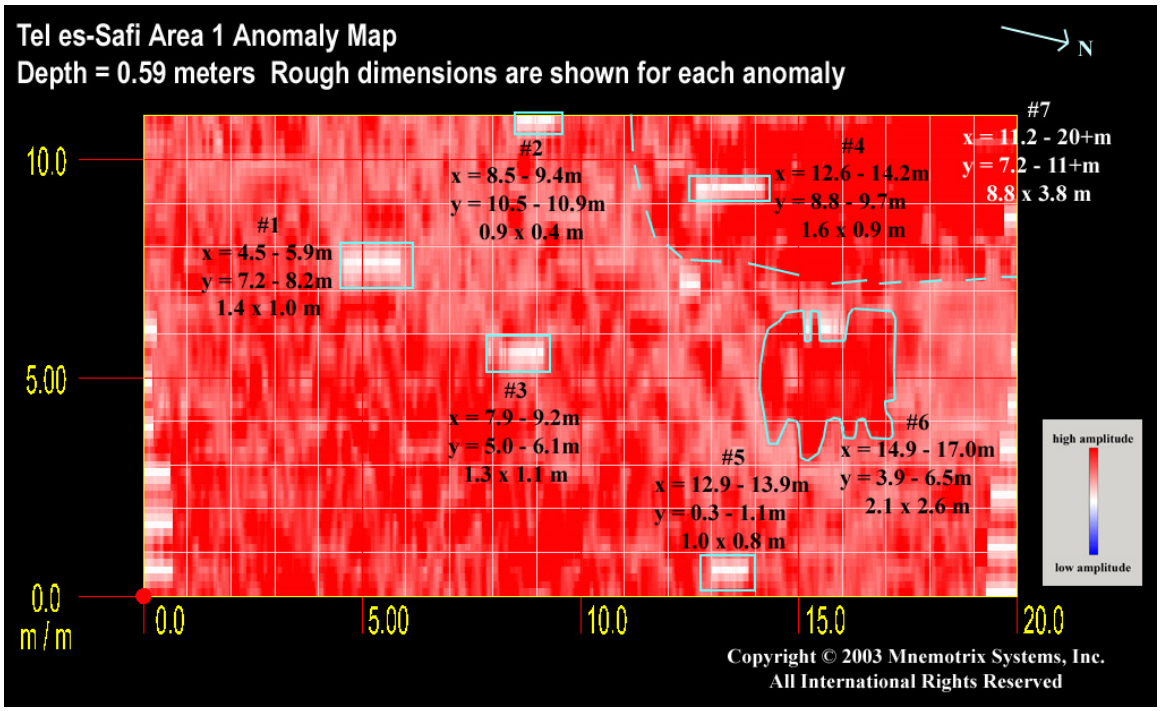

Figure 2

Summary of Dimensions for Each Anomaly (in meters)							
Anomaly	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#7**
Width	1.4	0.9	1.3	1.6	1.0	2.1	8.8
Length	1.0	0.4	1.1	0.9	0.8	2.6	3.8

Figure 2 is taken from the same depth as the one from the report (0.59 meters). The outlined anomalies are those that can be seen as the selected depth profiles progress. The estimated rough coordinates of the anomalies as they exist within the surveyed area are to assist in a descriptive visualization of the features they may denote. This image and the above table are provided to assist locating these anomalies in the field.

As depth increases, Anomaly 6 becomes smaller as we extend past the object/feature. Anomaly 7 disappears around 0.7 meters. Anomalies 1-5 seem to stay relatively distinct as particular "signal interrupts" until ˜0.8 meters. As depth increases they are evidenced as distinct vertical lines that clump together. It is possible that this is the depth at which the object is actually located because the vertical lines have high-amplitude signals.

When the GPR comes to something that is *significantly different* from whatever it was previously traveling through, it registers it as a high amplitude or low amplitude reflection. High amplitude reflections are when the radar wave comes to a material in which it can travel fast or faster than it was previously, and vice versa for low amplitude reflections. According to this color table then, at the depths at which you see these anomalies that have previously been only white (neither positive nor negative amplitude), and now are red or blue, a change has occurred.

To refer back to the complete depth-profile animations on the website, see this URL: http://www.mnemotrix.com/geo/movie.html#essafi.

Scrolling through these next freeze-frames from **Figure 3** forward, the patterns discussed in the report can be viewed, at successively lower depths.

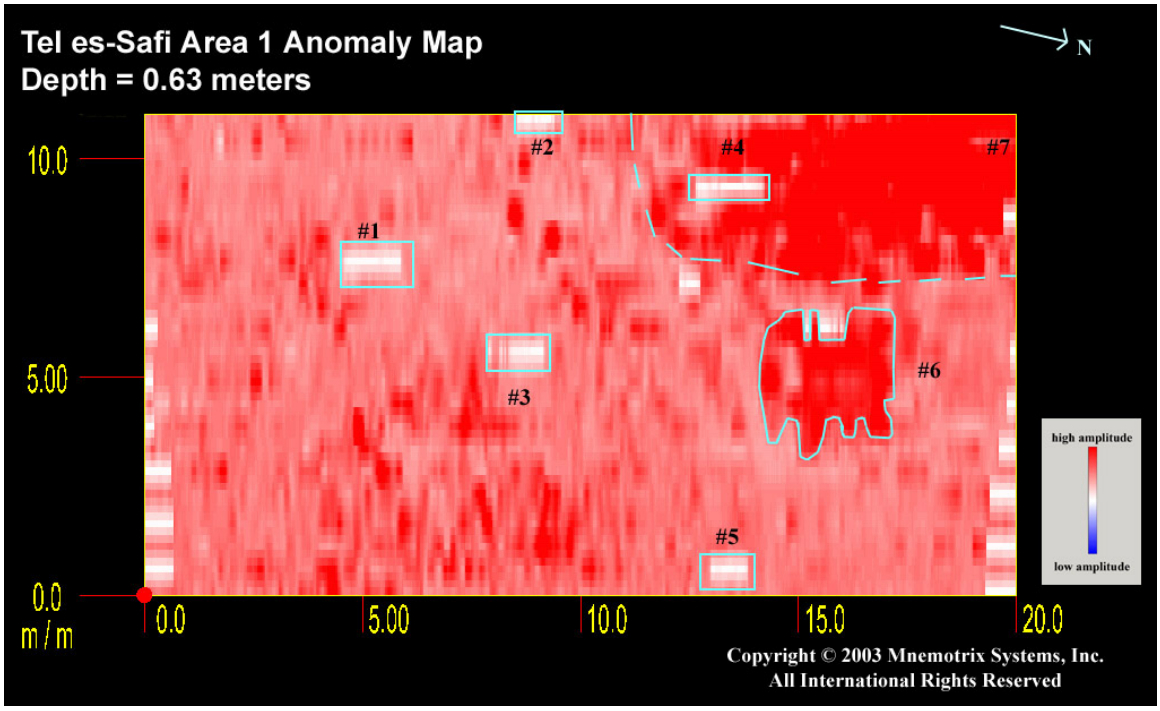

Figure 3

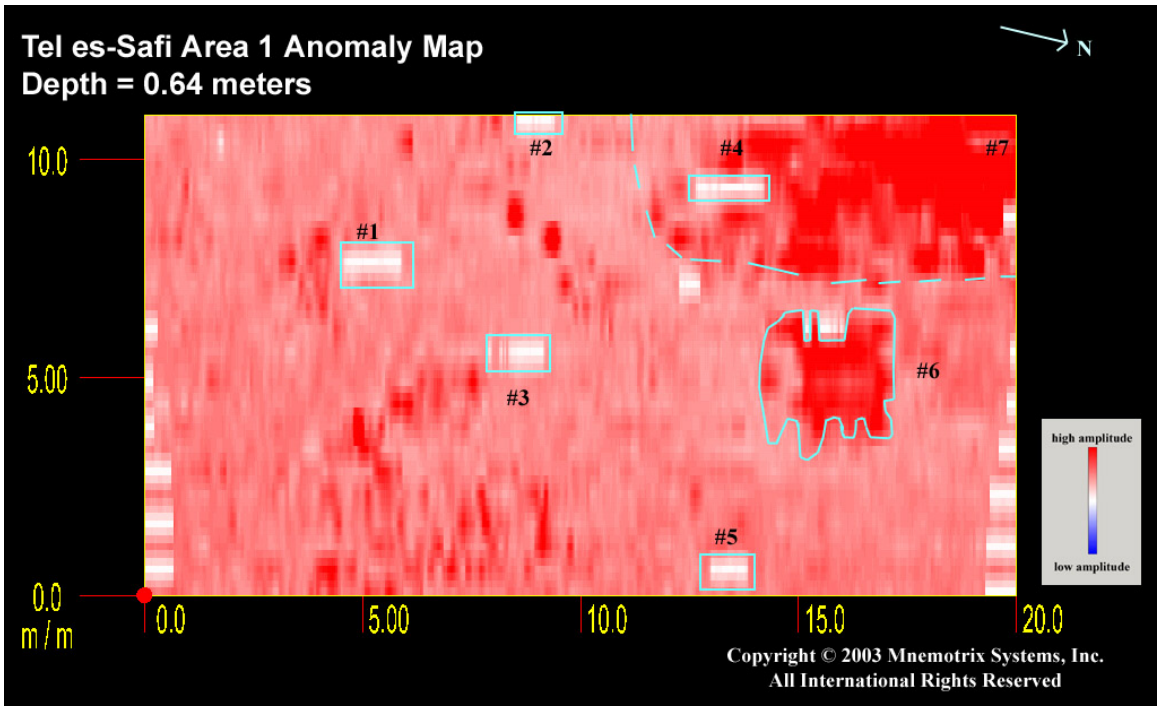

Figure 4

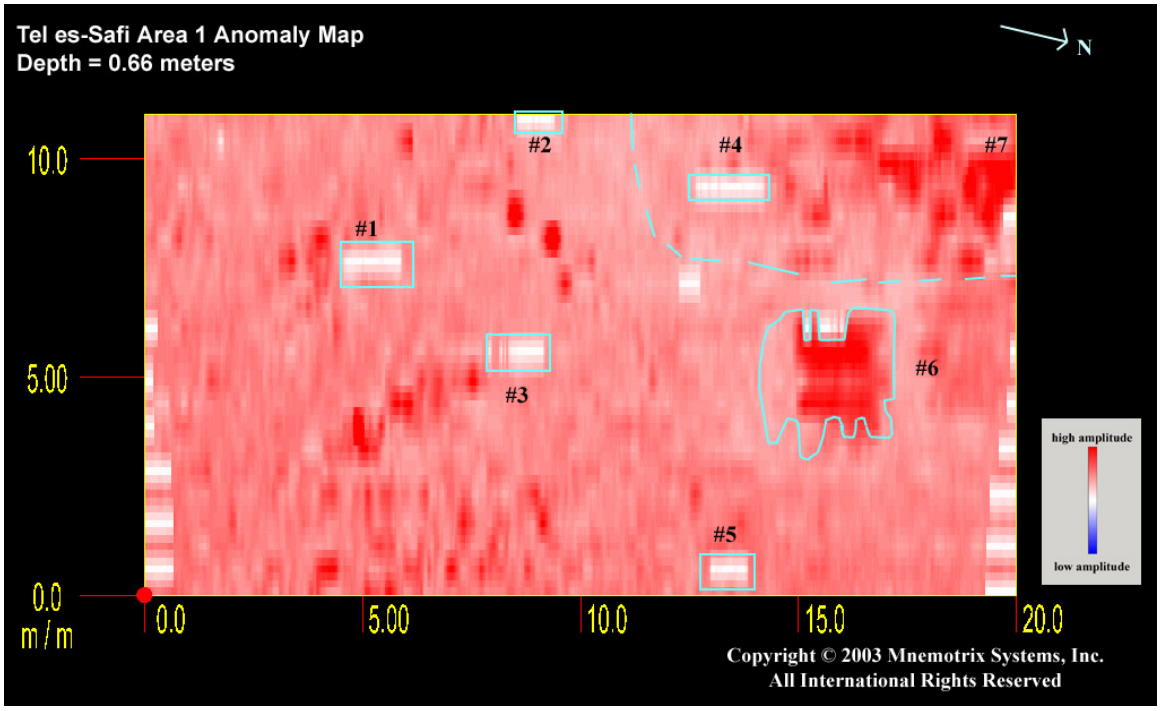

Figure 5

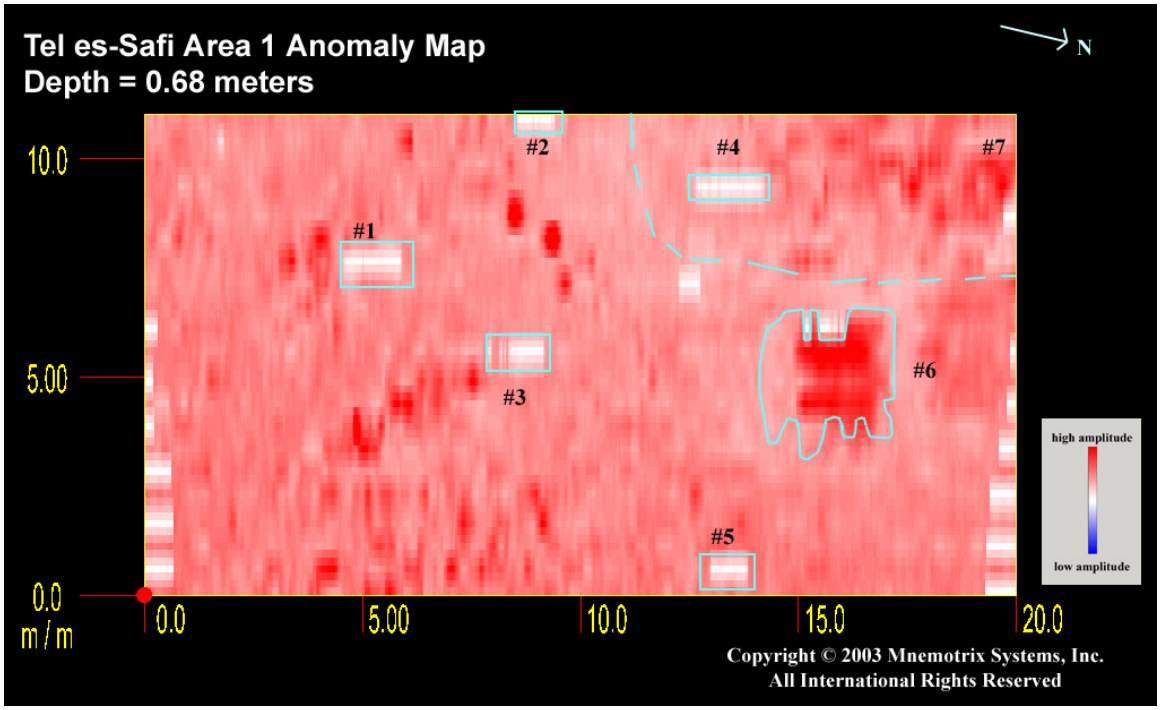

Figure 6

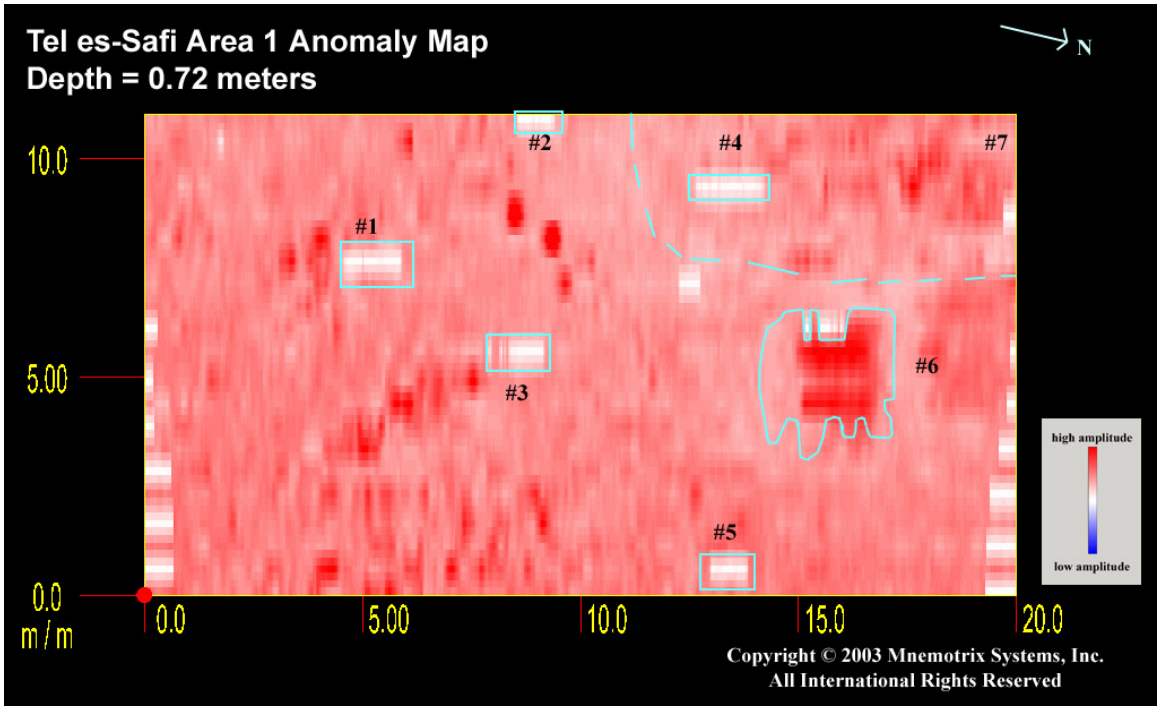

Figure 7

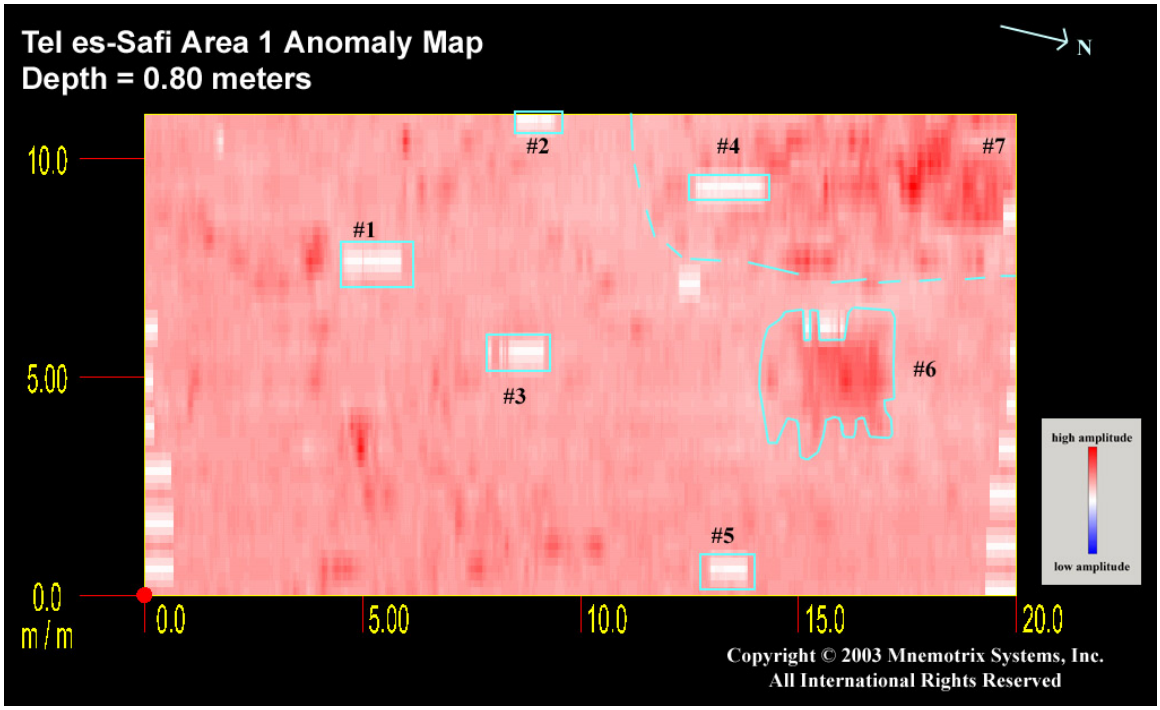

Figure 8

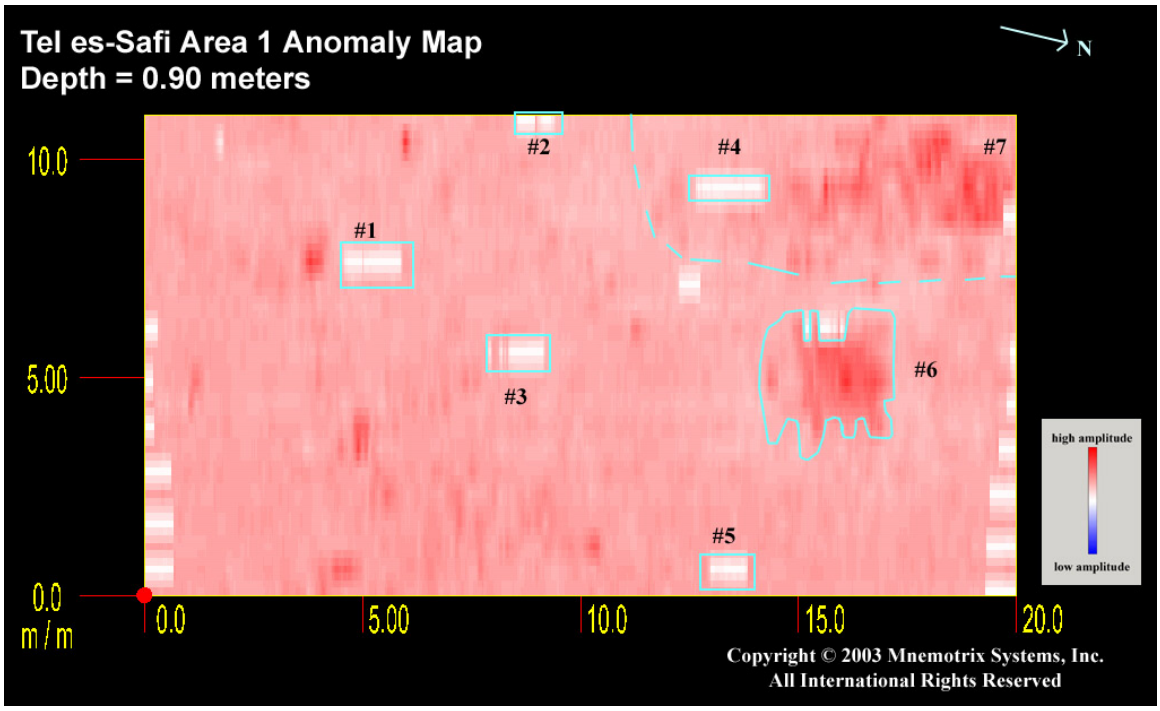

Figure 9

Looking at Anomaly 2 (**Figure 9** above), one can begin to see the clumping mentioned earlier, as vertical lines that begin to appear inside Anomalies 1-5. At the same time, #6 and #7 are almost unseen as the radar signal moves past them going further into the sub-surface.

Notice that Anomalies 1-5 average about 1.2 meters wide. These are the features that we thought may be graves due to their rectangular shape and orientation.

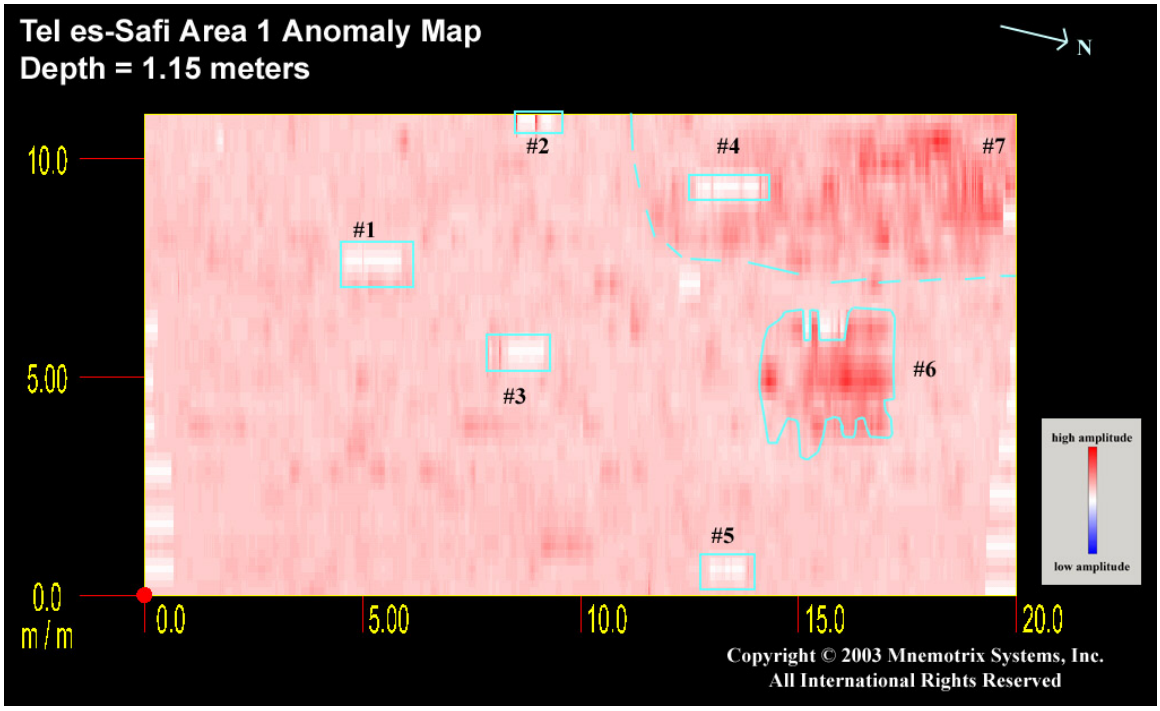

Figure 10

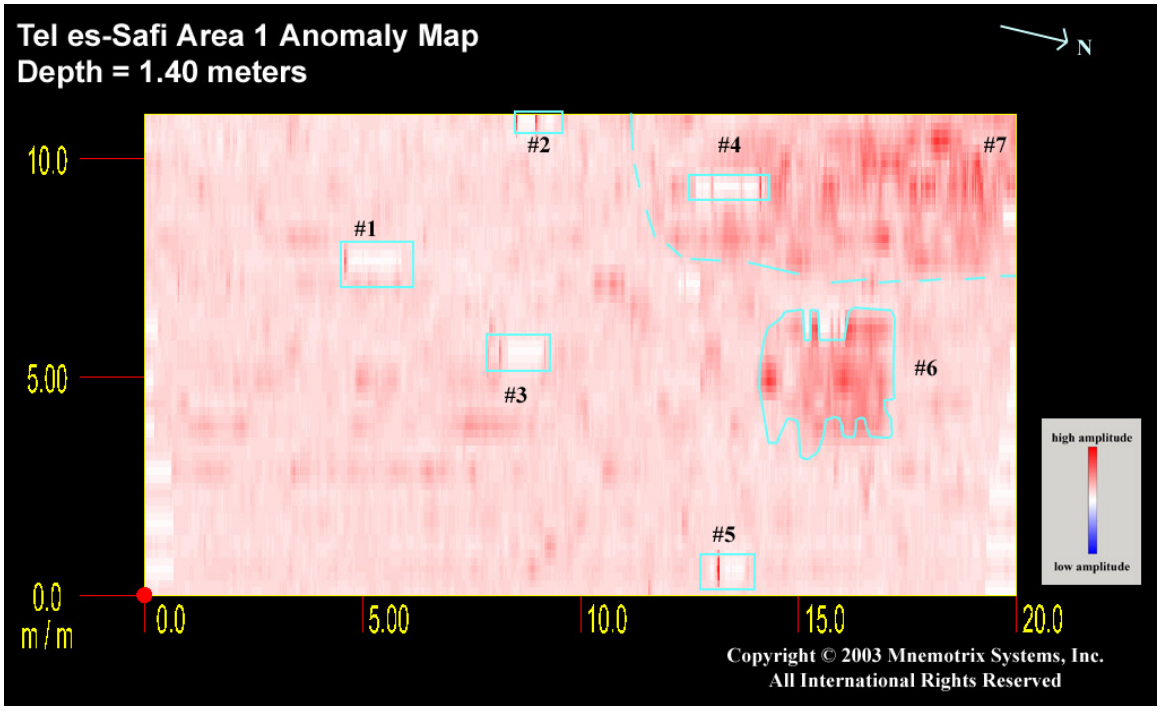

Figure 11

In **Figure 11** Anomalies 1-5 all now show vertically oriented lines.

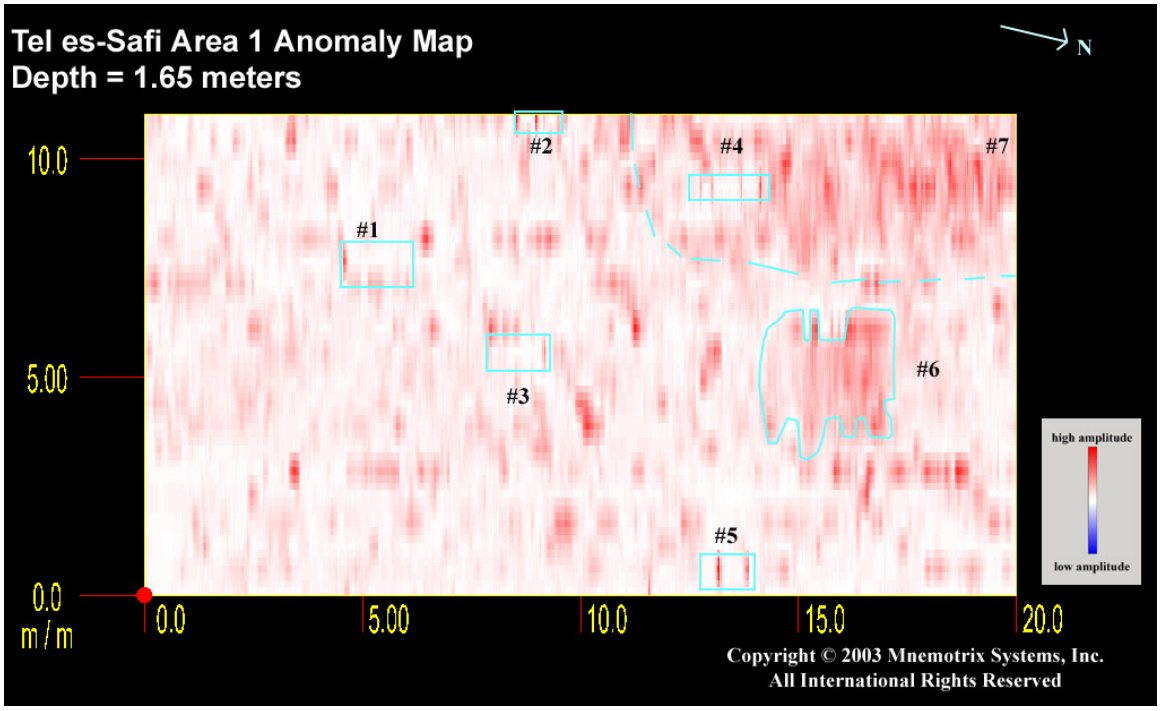

Figure 12

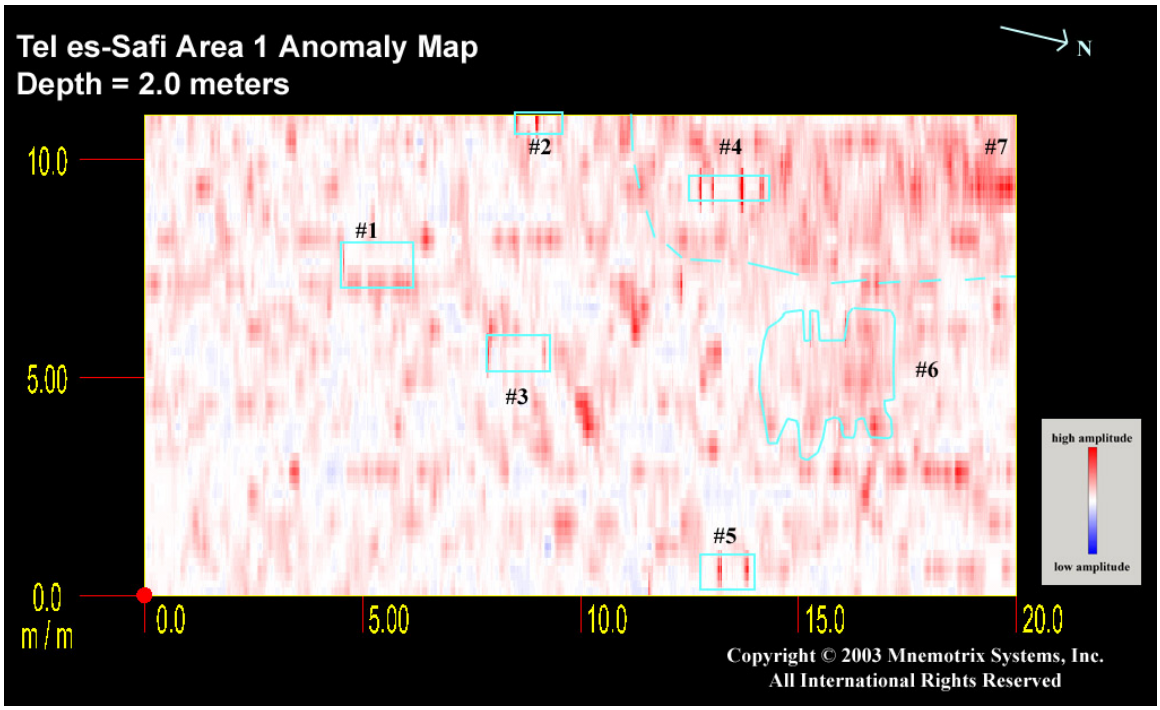

Figure 13

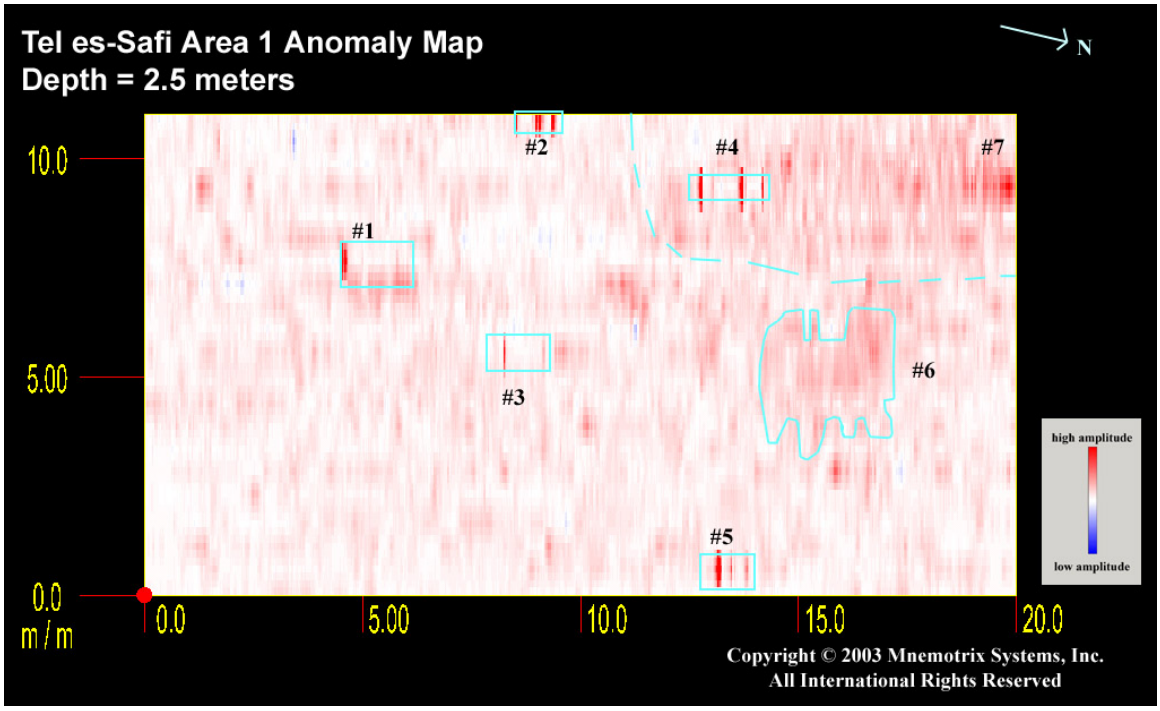

Figure 14

Anomalies 6 and 7 have basically disappeared by 2.5 meters, as shown in **Figure 14**. The overall amplitude/color is neutral/white. But at a depth of 3.0 meters, as shown in **Figure 15**, the signal speeds up with higher amplitudes/red hues.

Due to the extent of these higher amplitudes/redder hues occurring consistently along a particular depth, as seen in **Figure 15,** we believe this could possibly signify a habitation layer or horizon that we were coming upon. It may also simply be a geologically different layer. While not included in this summary, the grayscale view of this habitation layer confirms this point of view.

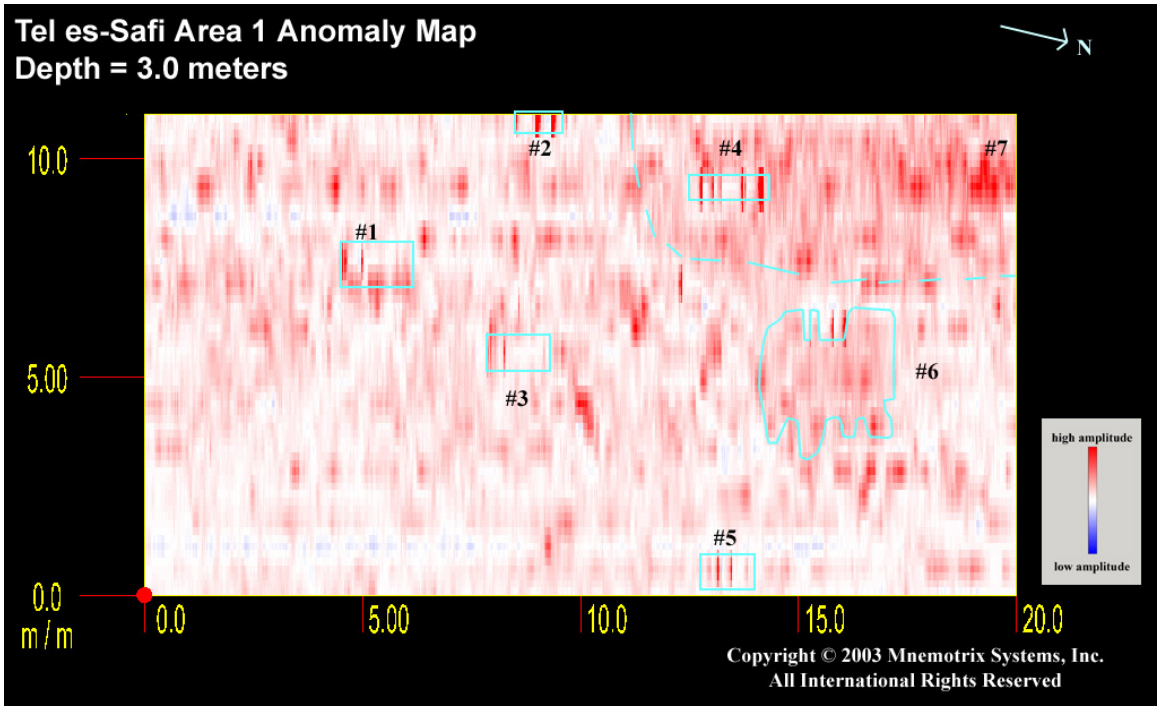

Figure 15

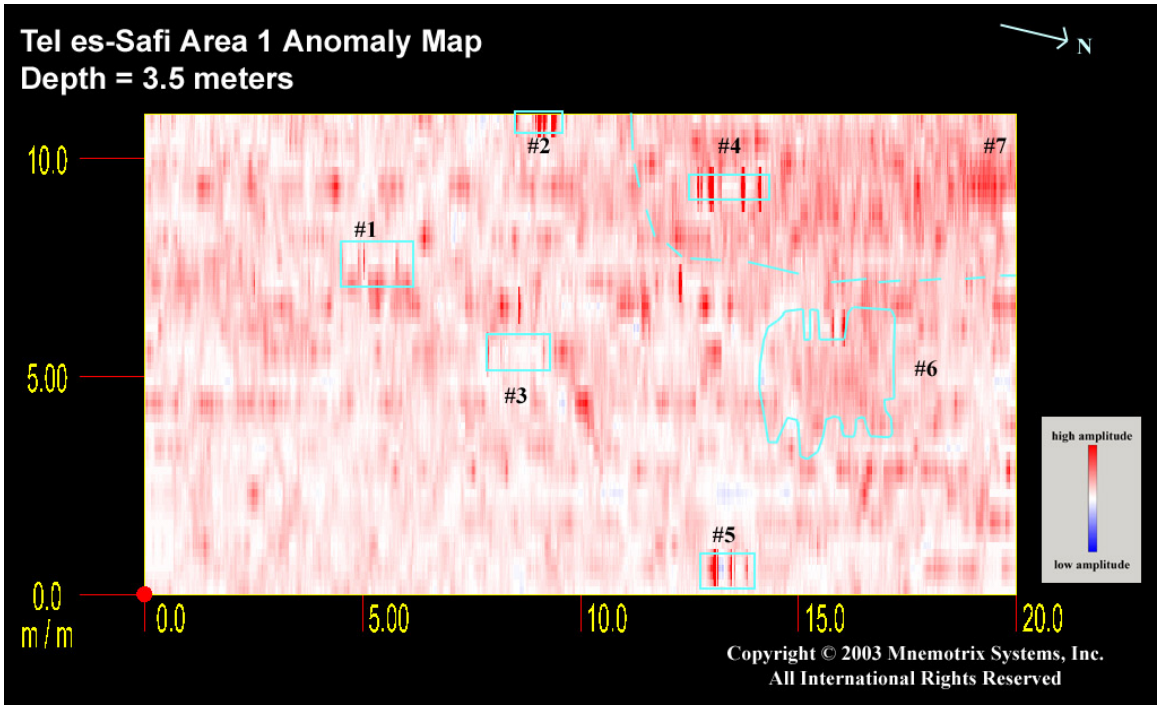

Figure 16

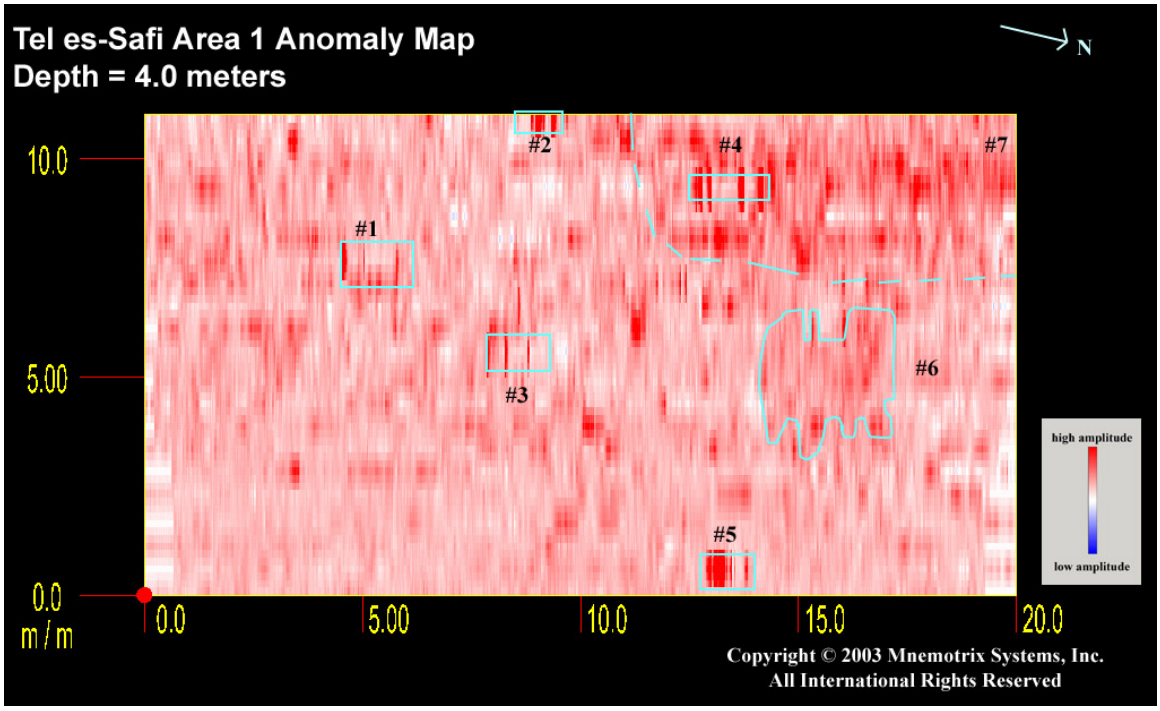

Figure 17

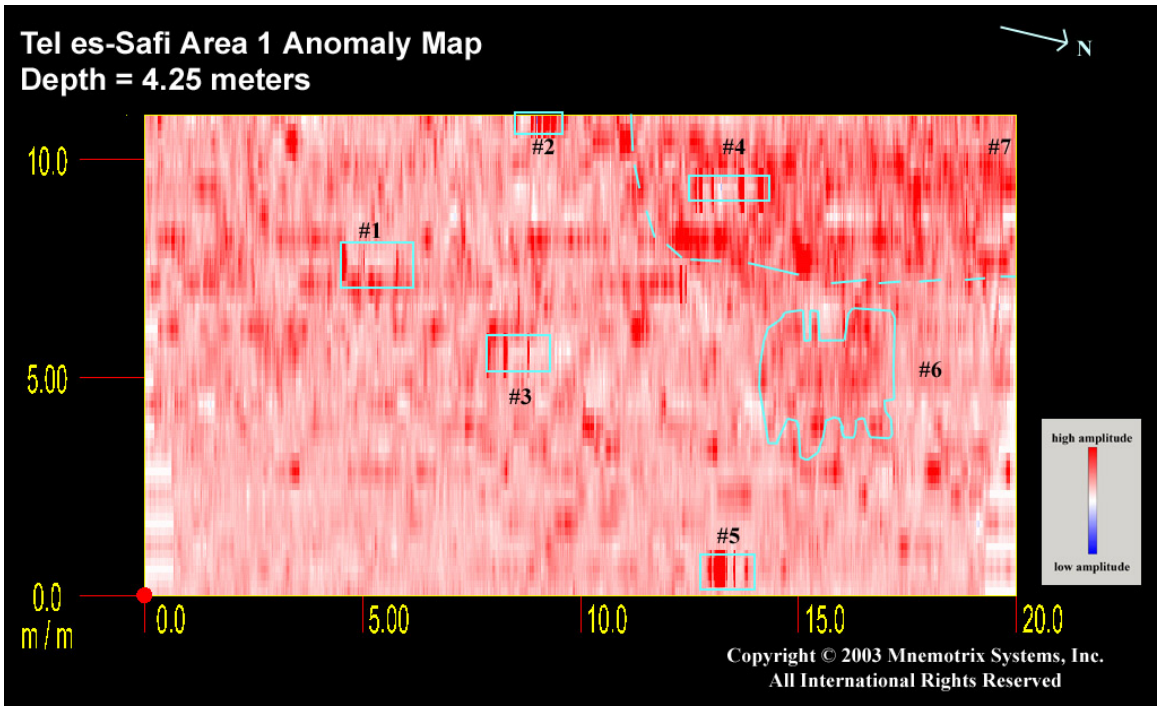

Figure 18

In **Figure 18** Anomalies 2 and 5 are almost completely filled with the vertically oriented high amplitude lines and only become more filled as depth increases to 4.5 meters (**Figure 19**).

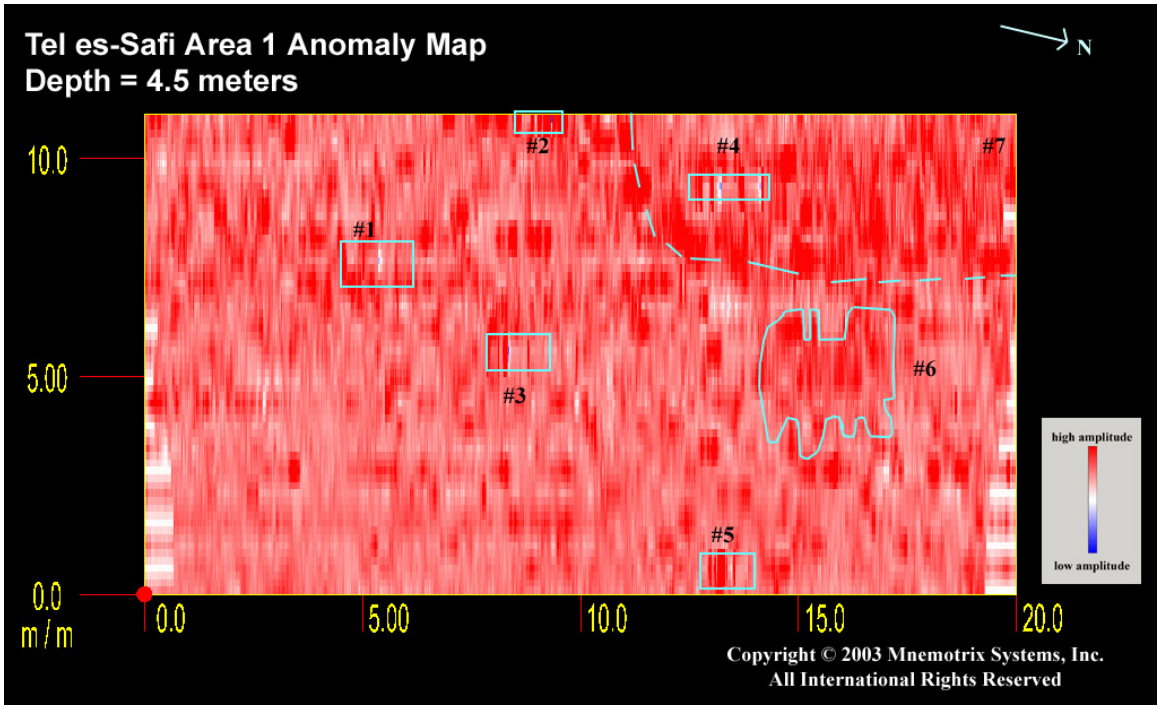

Figure 19

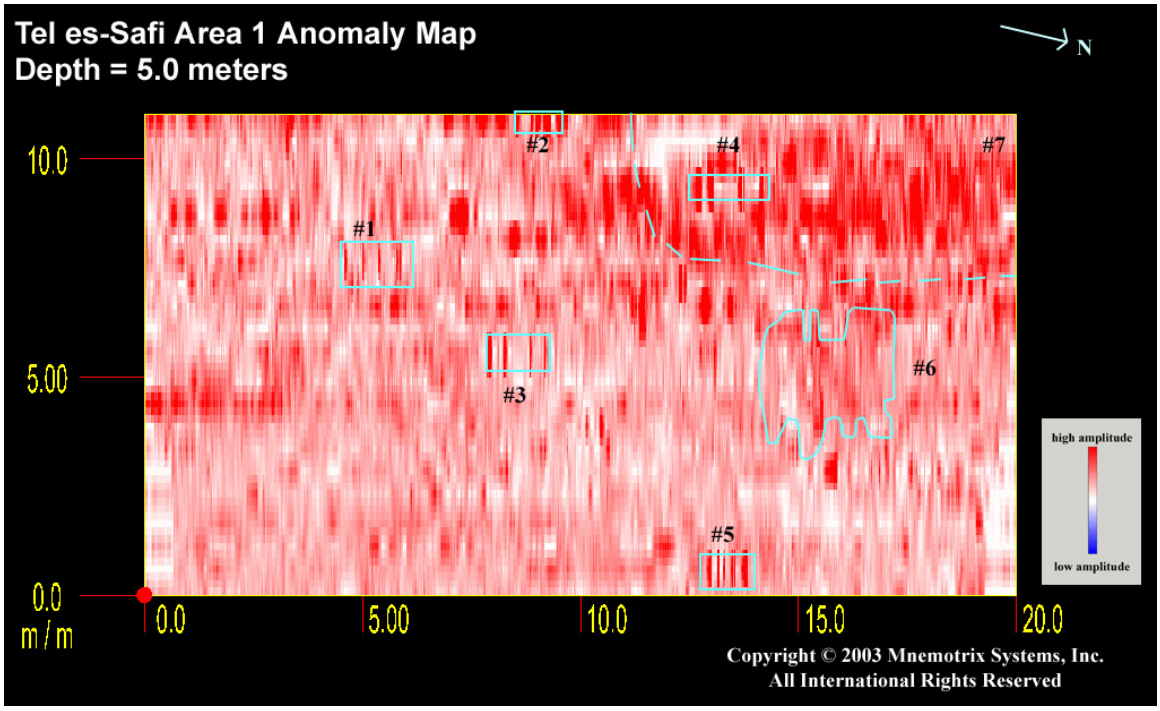

Figure 20

At 4.5 meters deep, the lowest depth of the GPR survey (**Figure 20**), all possible "graves" (Anomalies 1-5) are filled with vertically oriented lines. Note that these anomalies began to really be prevalent around 2 meters depth (Figure 13) and continued until 5 meters depth (Figure 20). Spatially speaking, the features are about 1.2 meters wide and potentially are "seen" for about 3 meters. However, because we have such a limited understanding of how the Tel es-Safi sub-surface looks with GPR, and the issues of interference at the site, it is hard to tell what the "average" is.

This is why doing more follow-up surveys are recommended, as they can only help to increase our understanding and thus our certainty as to what these features actually are and what they consist of.

Study Area 2

Our strategy for this area was to see if we could intersect the siege moat somewhere along the road. Our hypothesis rested on the fact that the siege moat would look significantly different from the surrounding matrix in *structure*. Therefore, we should have been able to have a reflection that would signal its location beneath the surface.

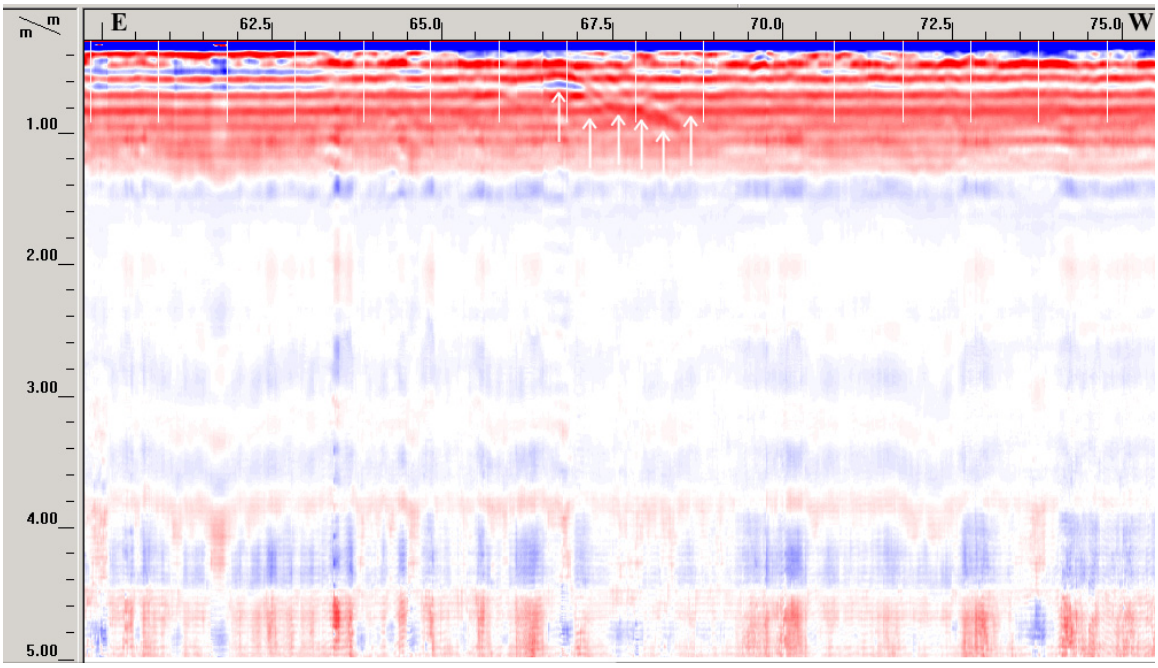

Figure 21

As mentioned in the report, we were having problems with interference and physical problems with the equipment and the heat. Nevertheless, we were able to find some very subtle, but *present*, reflections at 26 meters and 67.5 meters (shown in **Figure 21** above) from the eastern starting point. (Refer to pg. 9 of the report for more explanation).

Although we cannot be 100% sure that these indeed are locations of the siege moat, they certainly are good starting points for a more focused and intensive GPR survey in those two areas.

Considering that the test drags along the road were over 100 meters long, and we were successful in finding two locations, we see it as a success in that we could potentially not have to excavate that entire 100 meters looking for the moat. Our best suggestion then, as stated in the report, is to do more surveys in those locations on the road to become more certain of what we're looking at. In so doing, obviously, we then gain a much better feel for what the sub-surface along the road looks like in GPR and can get even more specific regarding the moat reflections which will be helpful to all (i.e. time and energy saved).