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Final Report Davenport Newberry Volcano Passive Seismic Monitoring

December 13, 2012

APEX HiPoint

Fracture Mapping and 3D VSP

Now a *SIGMA*³ Company

SIGMA³

Project History

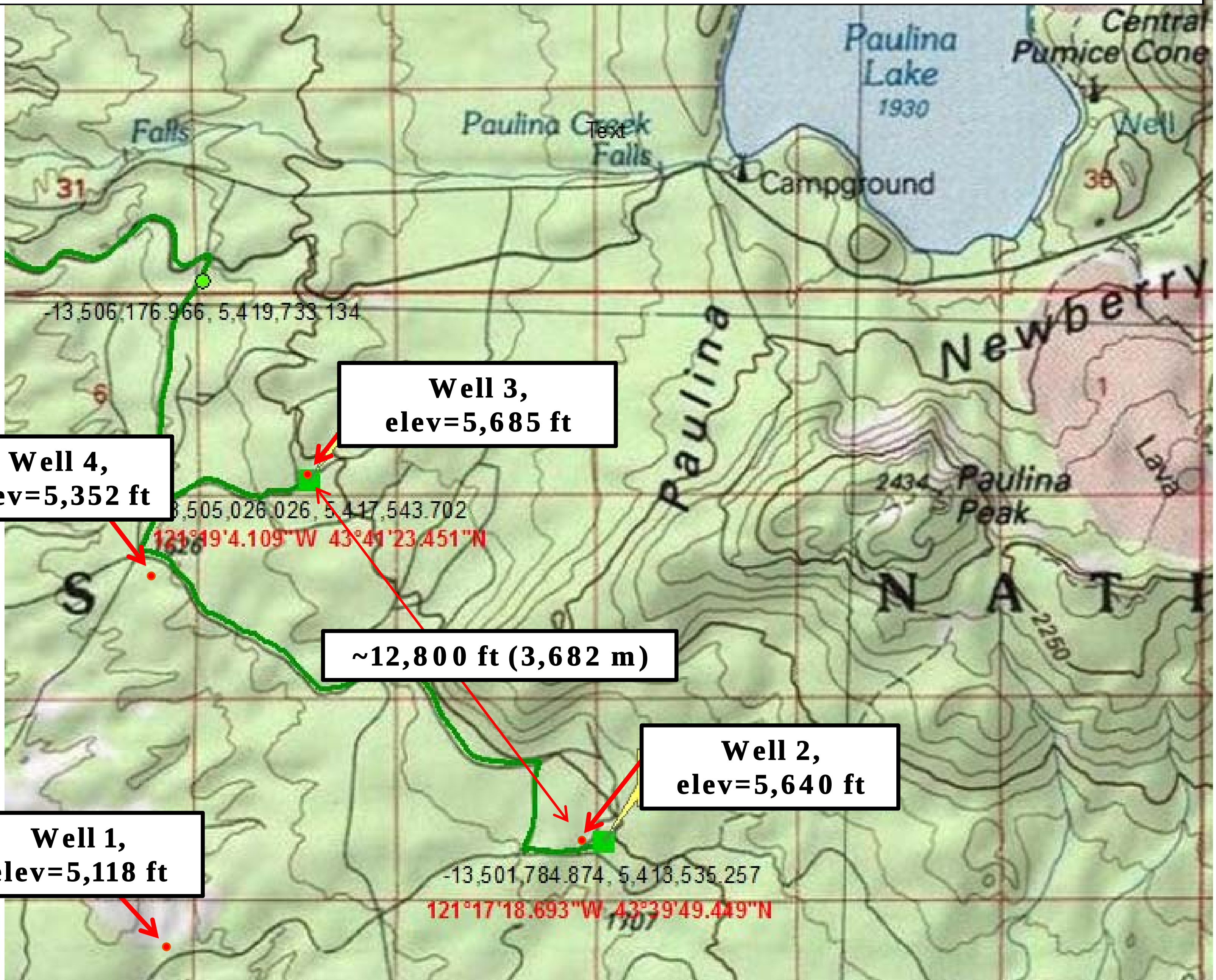
Davenport Newberry Holdings hired APEX HiPoint, LLC (now a *SIGMA³* company) to record and process passive seismic data at the Newberry Volcanic area near Bend, Oregon (central Oregon). Continuous seismic data was recorded in each of 4 instrumented observation wells for 6 days and 17 hours between December 23, 2011 and December 30, 2011. Maps of the well locations are shown on the following two slides. Each observation well contained 11, 12, or 13 3-component digital geophone sondes spaced at 50 ft. The geophones sondes were manufactured by GeoSpace of Houston, TX and are high-grade digital instruments used by the *APEX* group of SigmaCubed for passive microseismic work in the oil and gas industry. The purpose of recording the data was to determine 1) if areas of anomalously high levels of seismic energy could be detected and located and 2) if such areas could be detected, what would the characteristics of the anomaly be such as spatial extent, time variance of amplitude, and seismic frequency dependence.

APEX's data processing technology, including "Low Amplitude Seismic Emission Analysis" (LASEA) previously known as "Fluid Flow Analysis", was employed to achieve the goals of the survey. A basic assumption is that areas of anomalously high persistent seismic wave emission are probably associated with subsurface fluid movement or high variations in heat flow that cause stress changes in the rock mass and thus seismic emissions. The acronym "LASEA" was adopted as we recognized that Fluid Flow or fluid movement is probably not the only source of persistent low-amplitude seismic wavefields.

The first LASEA analysis was completed in April, 2011 with an initial grid volume from 5,000 ft depth to 11,000 ft depth. However, Davenport requested that the analysis volume be increased to include from 3,000 ft depth to 20,000 ft depth so the calculations were repeated with a larger volume. The second set of calculations include application of a new data filter that suppresses noise based on adaptive filtering between vertical and horizontal geophone components. The filter improved the clarity of the NW-SE energy trend that was evident in the first pass of data processing.

Satellite view with instrument well locations (Well 1,2,3&4).

Topographic map at approximate alignment with satellite view and well locations.



Basic Information About the Seismic Data

The survey data was continuously recorded but broken up into records of 10-seconds in length for convenience in handling the data. The last sample of one record is followed by the first sample of the next record and the sequential samples are recorded precisely 0.5 milliseconds apart. Each 10-second record contains a 10-second long data trace for EACH of the 141 geophones (47 3-component geophone sondes) that was deployed. The start time of each data trace is precisely synchronized to the same time. The record times are synchronized with a GPS satellite and is accurate to within a fraction of a microsecond.

Information for absolute comparisons of recorded data amplitudes

Seismic data amplitudes can carry important information. Data amplitudes as recorded by seismic instruments are a function of the instrument design and gain (amplitude multipliers) that are applied to data before being recorded. Specifications for the recording instruments used are given below with the information needed by seismologists to be able to directly compare amplitudes recorded by varying instruments.

Specifications

Frequency	**4.5 Hz**	**8 Hz**
Natural Frequency (Fn) ±.75 Hz	4.5 Hz	8 Hz
Fn tolerance at tilt	± 1.25 Hz	± 1.25 Hz
Tilt, vertical geophone	10°	20°
Tilt, horizontal geophone	±1.25°	±3.5°
Resistance		
Standard Coil Resistance	380 Ω ±5%	
Distortion		
Harmonic Distortion with coil to case	N.S.	<0.20%
velocity of 0.7 in/s (1.8 cm/s) p-p		@12 Hz
Sensitivity		
Intrinsic Voltage Sensitivity (G)	.81 V/in/s, (.32 V/cm/s) ± (10%)	
Normalized Transduction Constant	.0416 $\sqrt{DCR}$ V/in/s. (.0164 $\sqrt{DCR}$ V/cm/s)	
Damping		
Open Circuit Damping (Bo)	.34 ±20%	.39 ±10%
Damping Constant (B_cR_t)	762	602

Specifications at 25°C, Orientation is operating position (vertical or horizontal) unless otherwi

Internal to the sonde, there were actually two geophones for each component wired in parallel. The impedance is ½ of the value shown and sensitivity is 2 times the value shown. Voltage sensitivity is 1.62 V/in/s and Normalized Transduction Constant is 0.832 V/in/s.

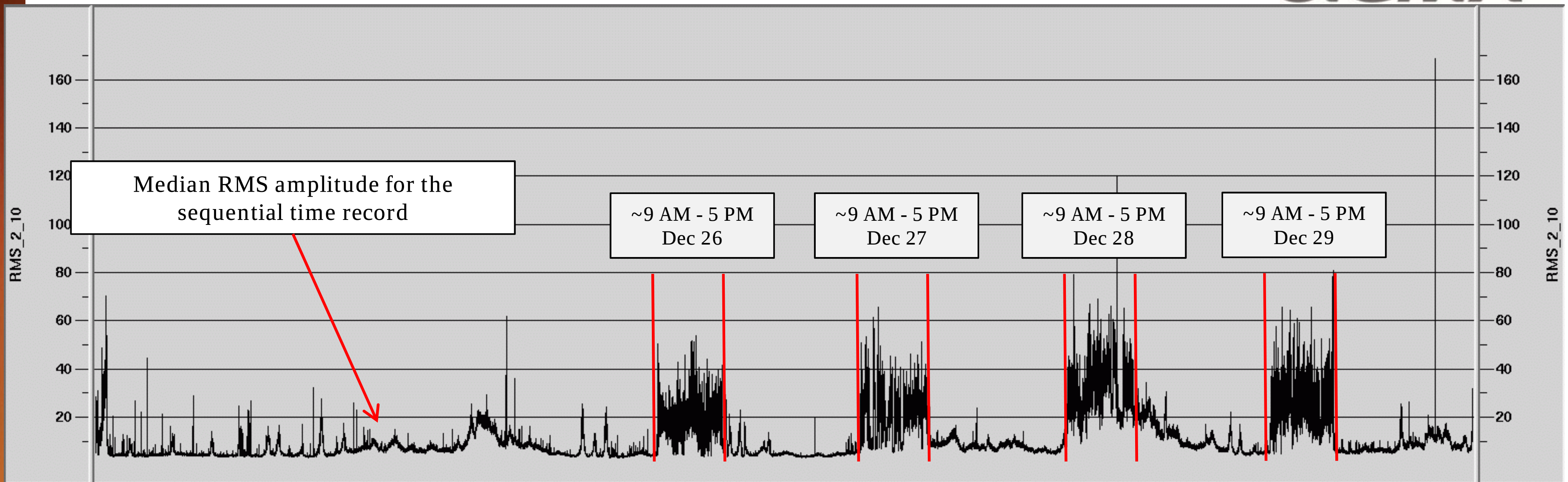
Ambient Seismic Measurements

Variations through time in ambient (background) seismic energy can be useful in understanding components of cultural and naturally-occurring seismic energy sources. The Root Mean Squared (RMS*) amplitude of the data was computed for the entire time length of the of the survey and plotted as one of the data attributes. The following slide shows the Median RMS amplitude computed at 10-second intervals for the entire 6 day, 17 hour survey. A bandpass filter of 2-10 Hz (this filter preserves frequencies in the band 2-10 Hz) was applied to the data before computation of the RMS amplitude. A second computation was also done for a higher frequency band and is discussed later.

*The Root Mean Squared (RMS) amplitude is computed at 10 second intervals for this dataset in the following way. First, the sum of squared data trace amplitudes was computed for each 10-second long data trace in a data record. The square root of the summed squared values was then computed. For example, for this dataset each 10-second data record contained 138 data traces (46 sondes times 3 data traces per sonde). Each of the data traces in a 10-second record contained 20,000 data samples. The RMS value (square root of the sum of squared amplitudes) was computed for each data trace in the 10-second record, thus this part of the operation resulted in 138 RMS values, one for each respective input data trace.

The second step in the operation was to compute the median RMS value from the 138 RMS values derived above. The median computation results in a single output value that represents the RMS amplitude of the 10-second data record from which the RMS value was derived. The median computation avoids having a small number of noise bursts dominate the amplitude measurement.

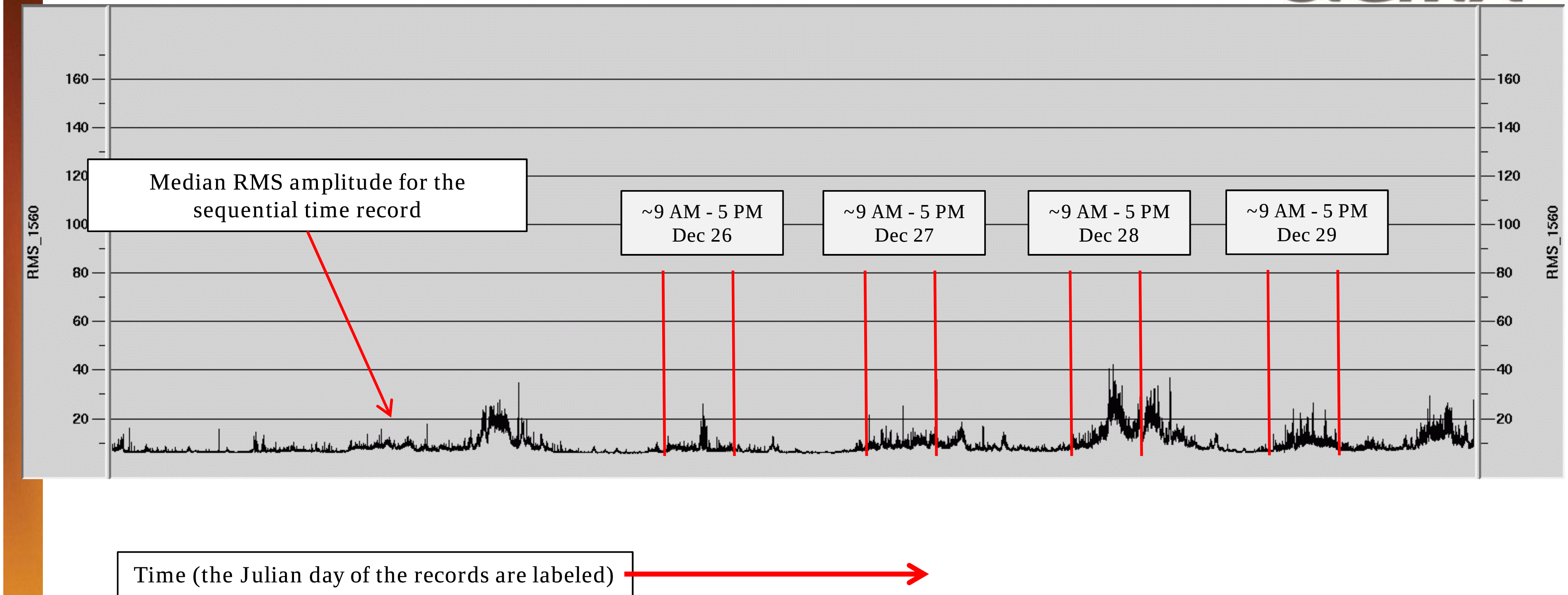
Root Mean Squared (RMS) amplitude 2-10 Hz for entire duration of survey



Julian day (GMT)

In the 2-10 Hz frequency bandwidth, there is a significant rise in ambient RMS amplitude that is in the 9:00 AM to 5:00 PM time frame which is clearly cultural. Interestingly, the nearest significant human population to the field site is La Pine, Oregon which is 12 miles away from the field site and with a population of only 1,700.

Root Mean Squared (RMS) amplitude 15-60 Hz for entire duration of survey

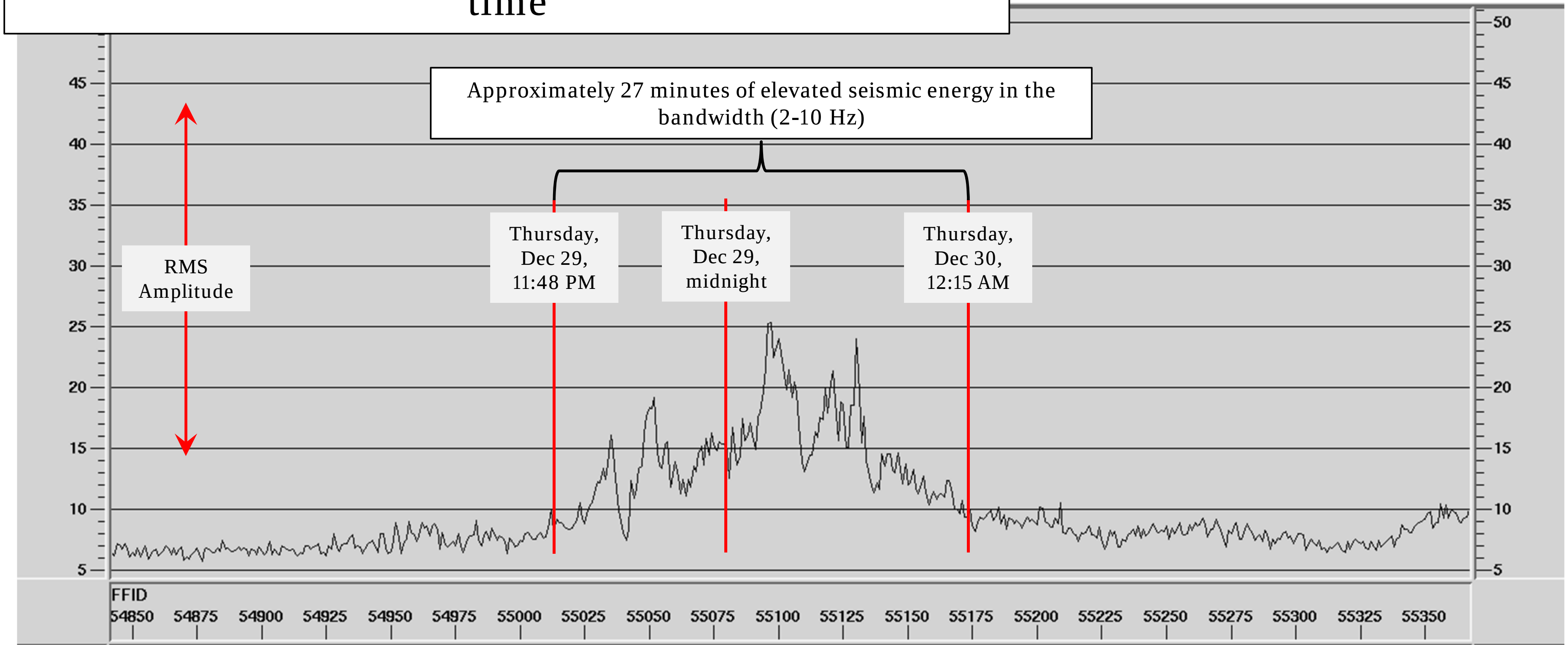


We repeated the calculations from the previous slide using data to which a bandpass filter that preserved frequencies between 15 and 60 Hz had been applied. The plot above is on the same scale as the previous slide (2-10 Hz preserved) from which we can see that there is a significant amount more energy in the 2-10 Hz bandwidth than the 15-60 Hz bandwidth during the high-amplitude periods. The rest of the time there is about the same amount of energy in these two bandwidths. The LASEA analysis of the data was conducted on the data with 15-60 Hz bandpass filter to avoid interference from low-frequency cultural noise in the 2-10 Hz bandwidth.

Note that even though this band includes 60 Hz signal it is not necessary to assume that the contribution at 60 Hz is due to 60 Hz electrical noise (the frequency at which US electrical power operates). The equipment used to record the data is nearly immune to 60-cycle electrical noise because digitization of the signal is done within the geophone sonde itself and the length of wire over which analog signal is carried within the geophone sonde is on the order of a few centimeters rather than a copper strand that carries signal to the surface along with picking up 60-cycle interference.

Root Mean Squared amplitude 2-10 Hz for limited time

SIGMA3

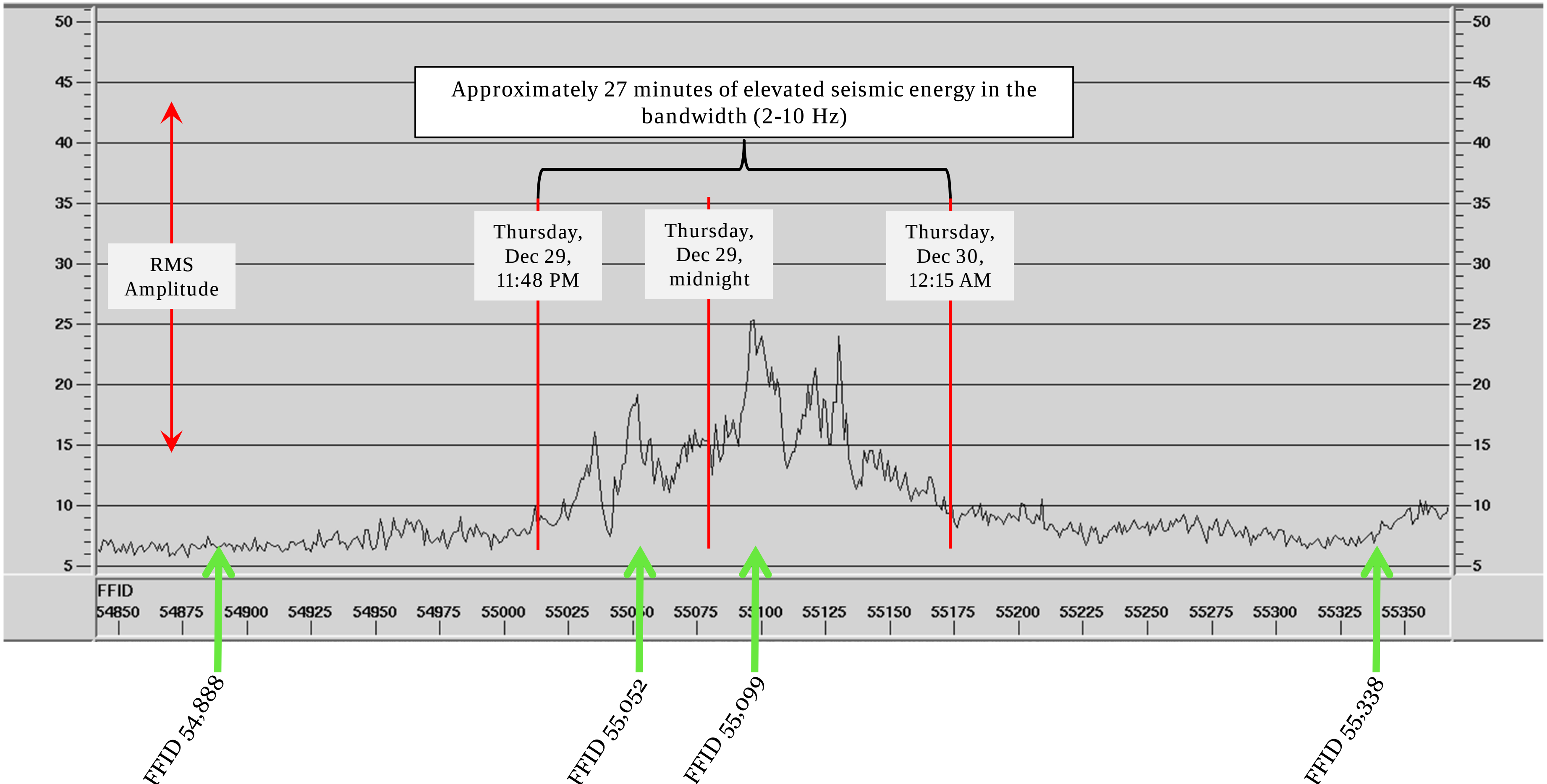


Plots in the previous slides show that the seismic frequency band 2-10 Hz contains more ambient seismic signal than the 15-60 Hz bandwidth. The 2-10 Hz bandwidth does not strictly contain cultural seismic signals however. The data above shows RMS amplitude in the 2-10 Hz bandwidth for a time period of approximately 1.5 hours centered around midnight, December 29, 2011. In the center of the time period shown there is a 27-minute time period in which there is an elevated RMS amplitude from 12 minutes before midnight until 15 minutes after midnight in which RMS amplitude increases by a factor of 2 to 4 over the time period before or after the 27-minute period.

There are multiple time periods such as the 27 minute time period shown that are unlikely to have a cultural source such as mining, gravel, or timbering operations because of the short time duration (industrial operations are sustained) and the time of day. Most outdoor industrial operations do not run at night due to safety restrictions and worker availability. See continued discussion on the next two slides.

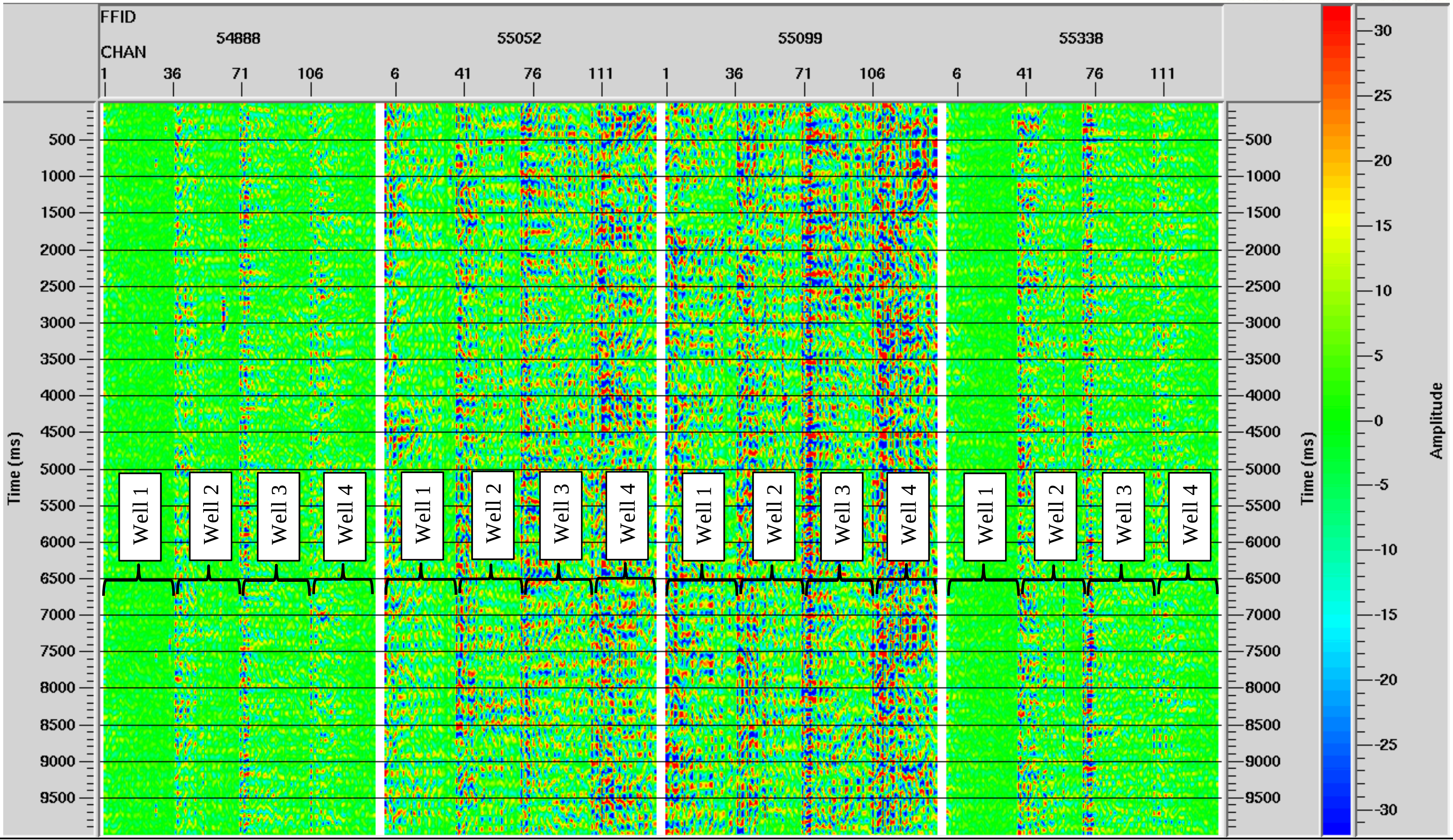
Note: the horizontal axis in this plot is labeled “FFID” which stands for “Field File Identification” and is a standard seismic terminology indicating a unique number that is assigned to each field record. For this dataset FFID values are sequential and incremented by 1 with each new 10-second record. See continued discussion on the next slide.

Green arrows point to records shown on the following slide



Seismic records at the times of the four green arrows shown above were extracted and plotted on the next slide to verify that the background amplitude increase was ubiquitous across all of the observation wells.

Seismic records showing amplitudes before, during, and after the 27 minute high amplitude period



The four seismic records annotated in the previous slide are shown here after bandpass filter of 2-10 Hz with entire-screen scaling, which means that amplitudes can be directly compared to one another. Red and blue colors indicate that the data trace has high amplitude and green means low amplitude. Thus, it is easy to see that the two center records (55,052 and 55,099) that were recorded during the high-amplitude midnight period on the previous slide do, in fact, have a larger amplitude than the two records recorded outside the 27 minute time period. The fact that all four wells see elevated amplitude indicate that the effect of the source is widespread throughout the area. There are numerous short time periods within the survey time period that likely have a naturally occurring source since they are in time periods unlikely to have a cultural/man-made origin such as industrial activity.

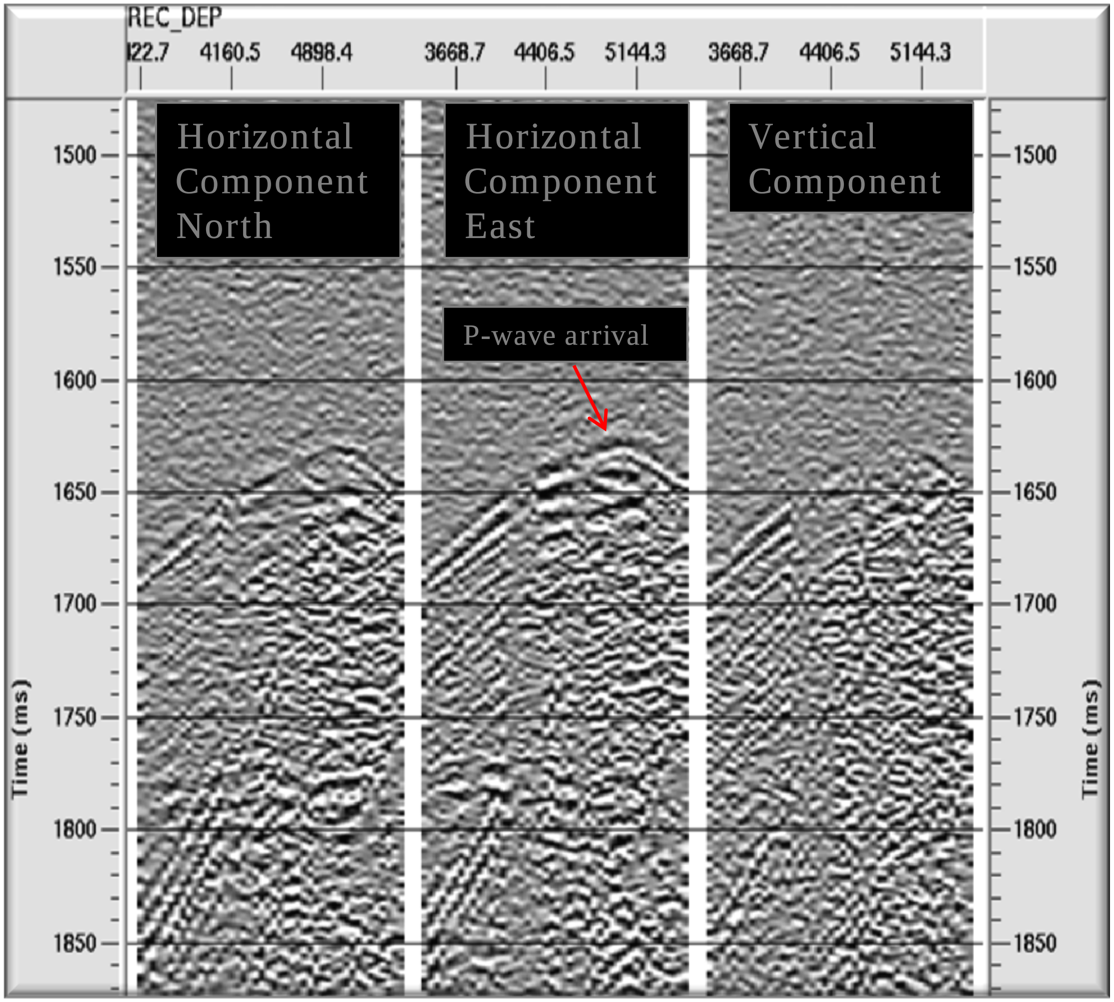
Overview of LASEA concept and data processing

Before proceeding into the next section that describes the major findings of this study, we discuss the fundamental calculations that are the basis of LASEA or Low Amplitude Seismic Emission Analysis. The following eight slides discuss the LASEA method and method of displaying the result. Results from the Newberry Volcano project then follow.

Use of P-waves

The data processing applied to the Davenport Newberry dataset is specifically for P-waves (compressional waves). Shear waves, or S-waves, were not considered for three reasons. First, we do not have S-wave velocity information for this location and velocity information is a critical element in LASEA calculations. Second, we have observed that S-waves in the seismic frequency band that we consider do not propagate through the upper few hundred meters of the earth as well as they do at depth. While our observations are for sedimentary formations, we have no evidence at this location to contradict our observation, hence S-waves many not even be present in the recorded data. Finally, we have never done LASEA analysis with S-waves due in part to the complexity in the polarity of S-waves and S-wave splitting. P-waves are much more predictable than S-waves and therefore more reliable for LASEA computations.

Explanation of Low Amplitude Seismic Emission Analysis (LASEA)

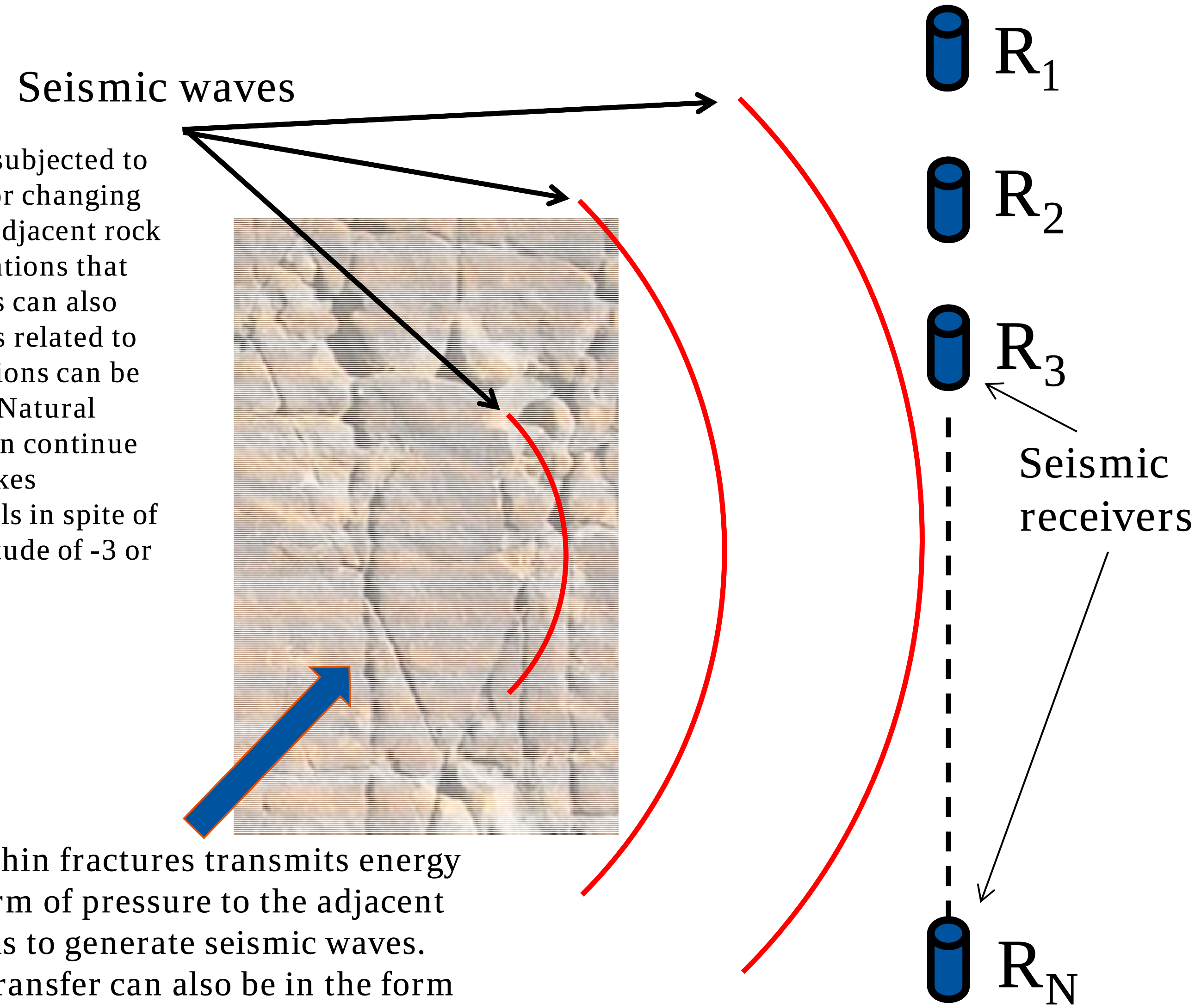


Conventional microseismic methods focus on analysis of relatively high-amplitude short duration seismic events like the one shown in the figure to the left. Events like this one originate when rocks break in response to injection of hydraulic stimulation fluids or changes in stress due to large temperature variations. They are generally very small earthquakes with magnitude on the order of -3 to -1.

In contrast to the large-amplitude short-duration events, there are also situations in which seismic energy is generated over long periods of time but with smaller amplitudes than the event shown in the figure to the left.

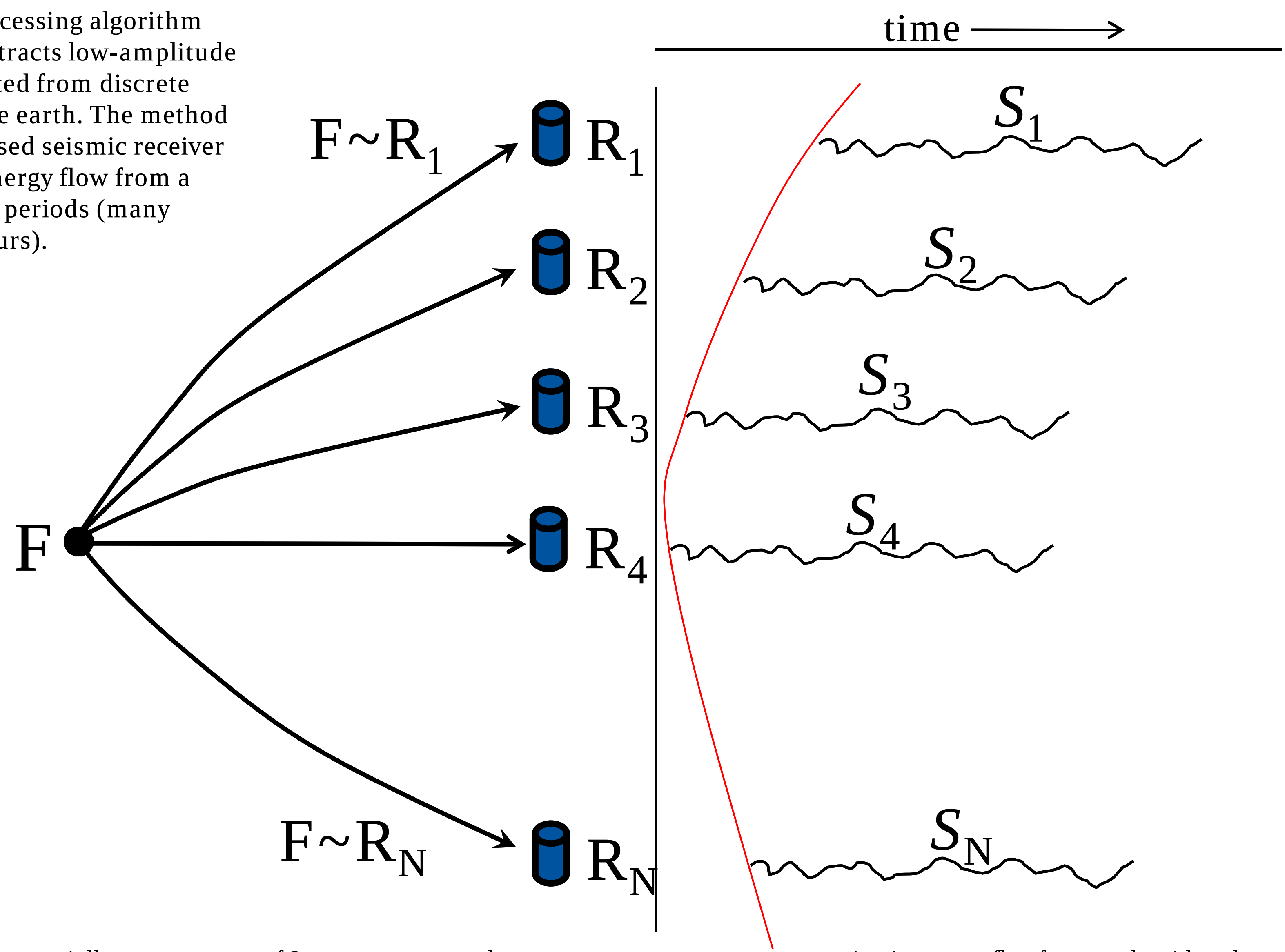
SigmaCubed has developed a method that we call LASEA (Low Amplitude Seismic Emission Analysis) that provides a direct measure of seismic energy output from points in a volume of earth over time. Anomalously large amplitude values may correspond to locations in the earth where fluids are moving, stress is changing due to temperature fluctuations, or the points are in direct connection with a source of variable pressure, even when rocks to not break in response to the pressure/stress changes.

When fluids in natural fractures are subjected to varying pressure from fluid sources or changing temperature, the fluids push on the adjacent rock walls generating low-amplitude vibrations that can be recorded by geophones. Rocks can also fracture in response to stress changes related to temperature variations. These vibrations can be persistent over long periods of time. Natural processes such as volcanic activity can continue for millennia. The LASEA method takes advantage of persistent seismic signals in spite of relatively small amplitudes of magnitude of -3 or smaller.



Fluid within fractures transmits energy in the form of pressure to the adjacent rock walls to generate seismic waves. Energy transfer can also be in the form of conductive heat transfer that could cause stress and rock fractures.

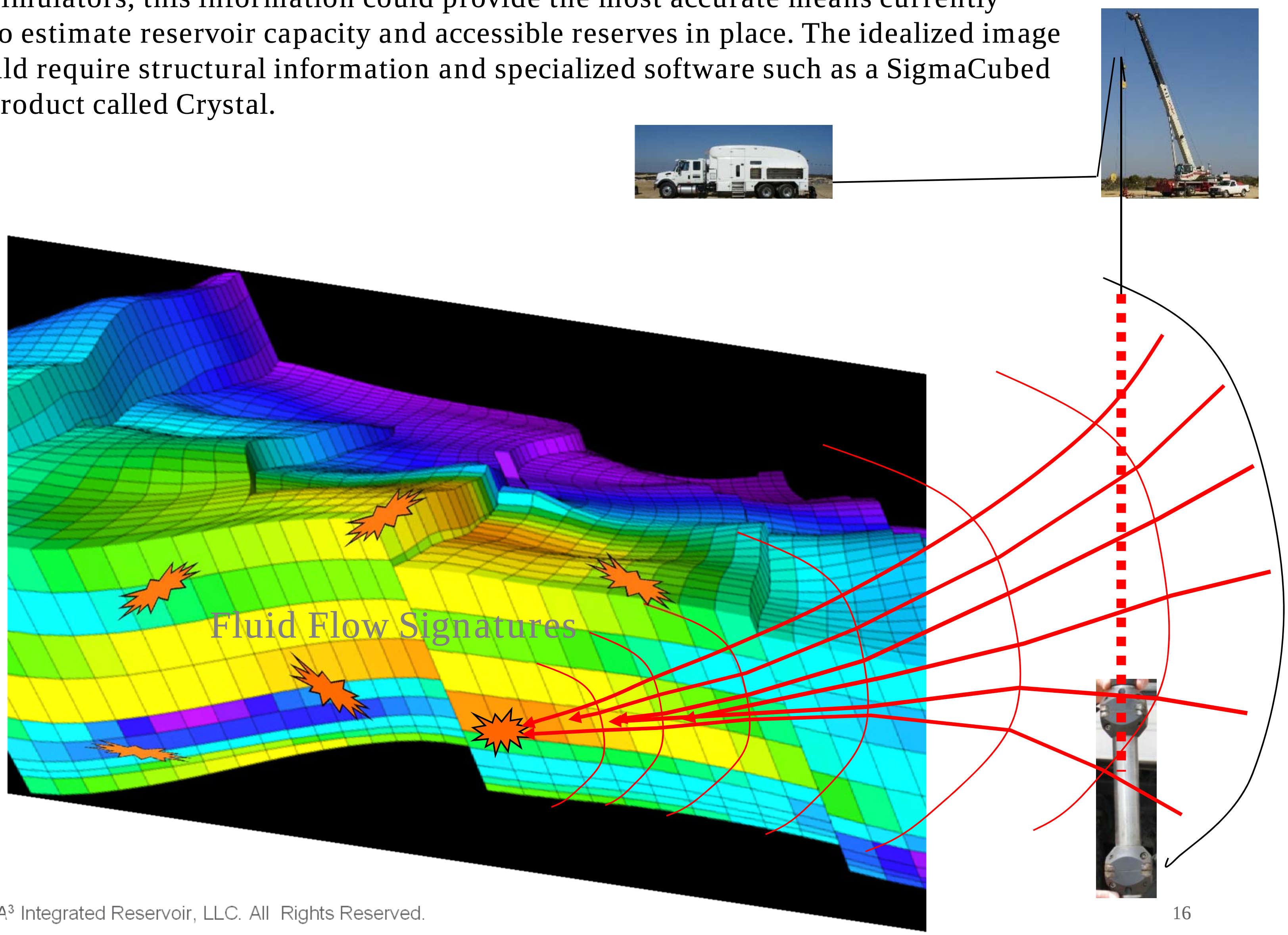
The LASEA data processing algorithm (patent pending) extracts low-amplitude seismic signals emitted from discrete grid nodes within the earth. The method essentially uses focused seismic receiver arrays to measure energy flow from a point over long time periods (many minutes to many hours).



The LASEA algorithm essentially uses an array of 3-component geophones as an antenna to measure seismic energy flux from each grid node in a 3D volume somewhere near the observation wells. The algorithm is much more focused and precise than a simple energy measurement as it employs elements of Kirchhoff Depth Migration, virtual source concepts, and other technologies. The algorithm is computationally intensive but computers with sufficient computational capacity can be employed to efficiently calculate results. The output from the algorithm is an estimate of energy output from each grid node in a volume defined by the user. Amplitudes of output sample <u>values are comparable to one another</u> but at this time the output is not computed or reported in standard energy or power output measures such as watts.

Reservoir Production Monitoring with LASEA

LASEA can be used to monitor production from producing fields to determine where fluids are being produced or for monitoring subsurface hydrothermal activity. Combined with reservoir simulators, this information could provide the most accurate means currently available to estimate reservoir capacity and accessible reserves in place. The idealized image below would require structural information and specialized software such as a SigmaCubed software product called Crystal.

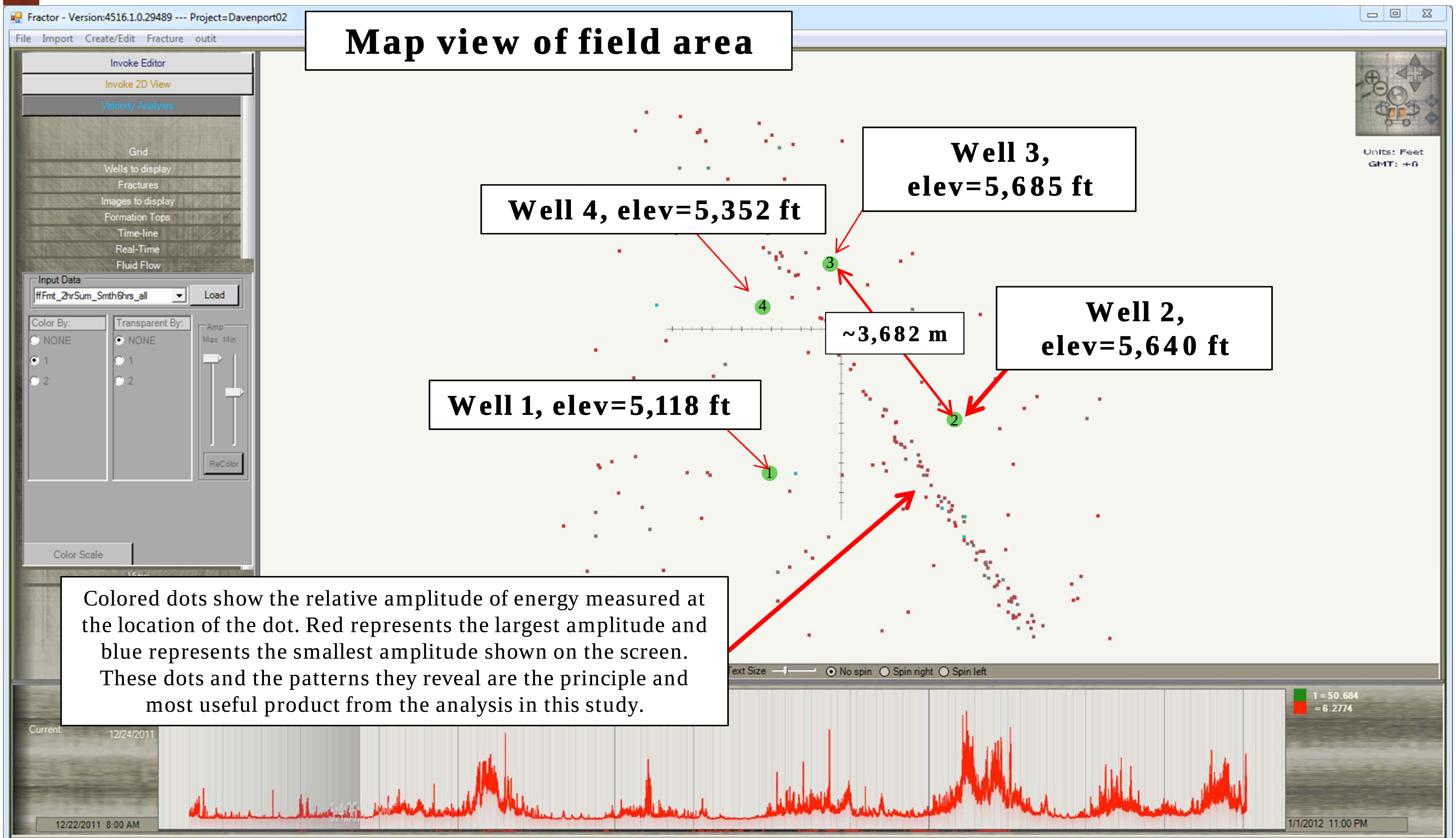


LASEA Output

LASEA scans a full 3D volume of the earth at a user-specified grid interval and computes the amount of seismic energy detected from that location over some time period, normally on the order of a few minutes to hours. LASEA then outputs a number corresponding to the energy measurement for that grid node and time. The grid node energy measurements can then be viewed in a 3D viewer to observe trends in the energy.

The following three slides show a view of the 3D seismic viewing package developed by APEX HiPoint called Fractor. The results are from the Davenport Newberry Volcano project.

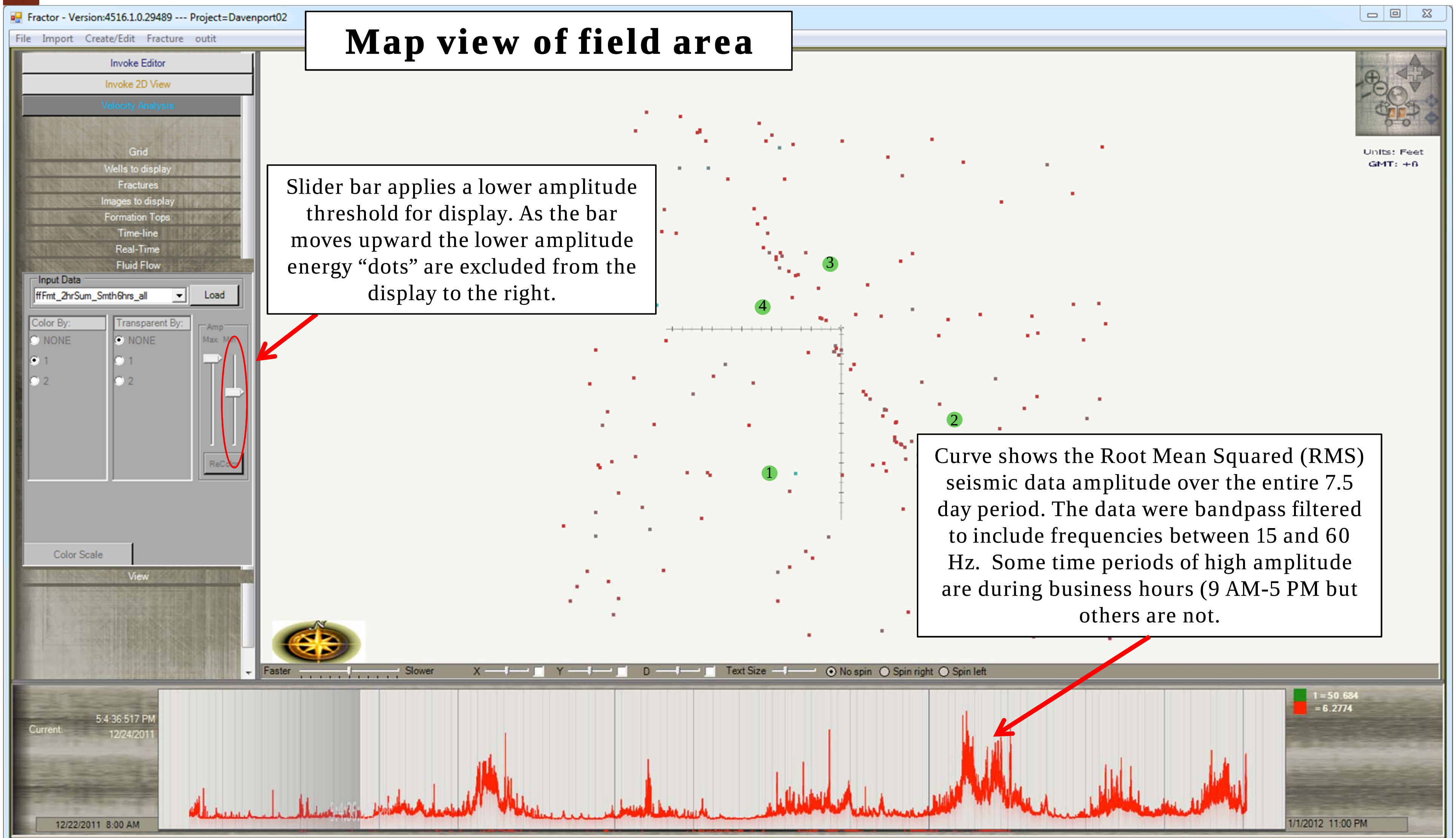
Viewing software features



Time scale – 8 days in length

Viewing software features continued

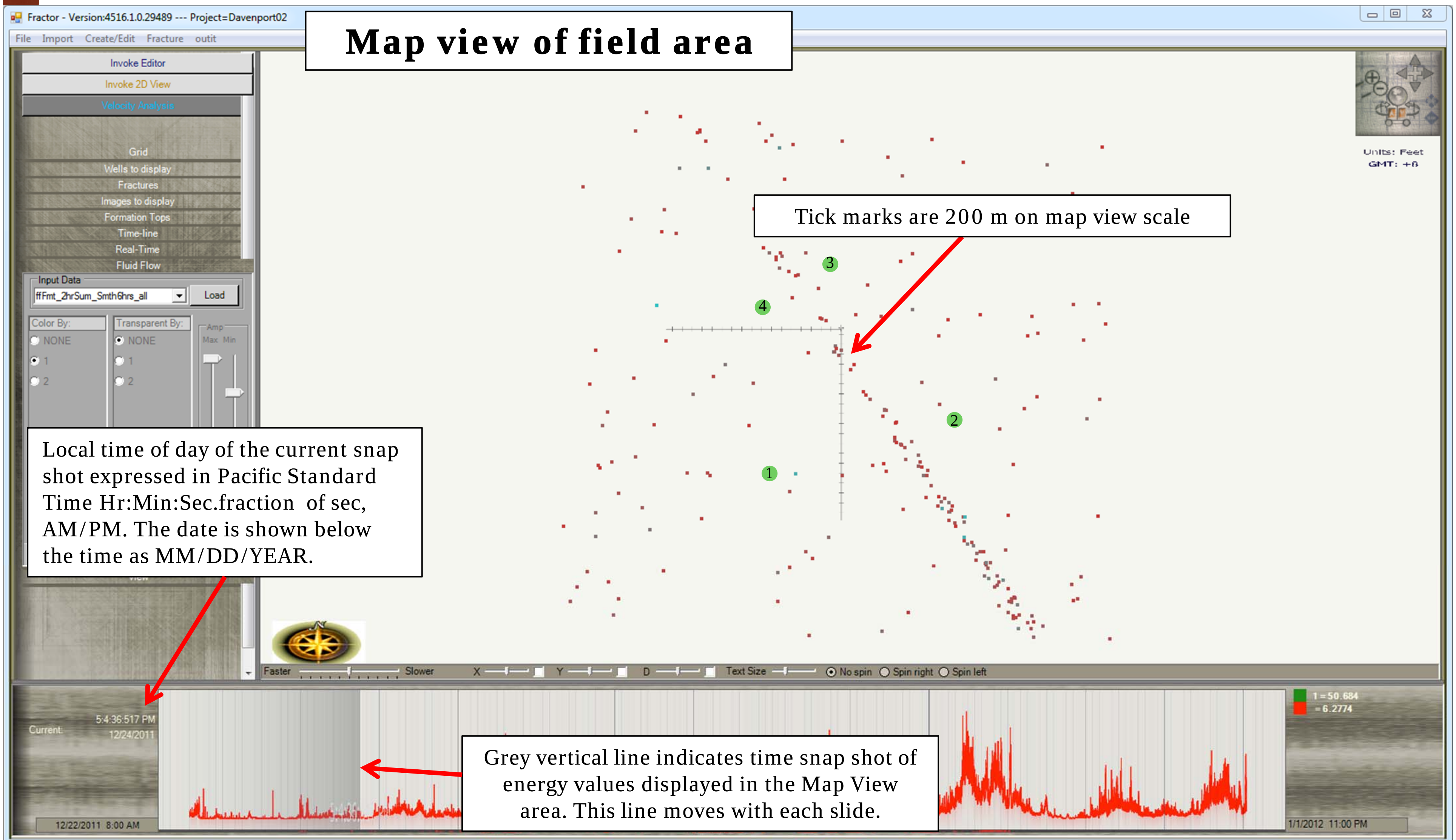
SIGMA³



Time scale – 8 days in length

Viewing software features continued

SIGMA[3]



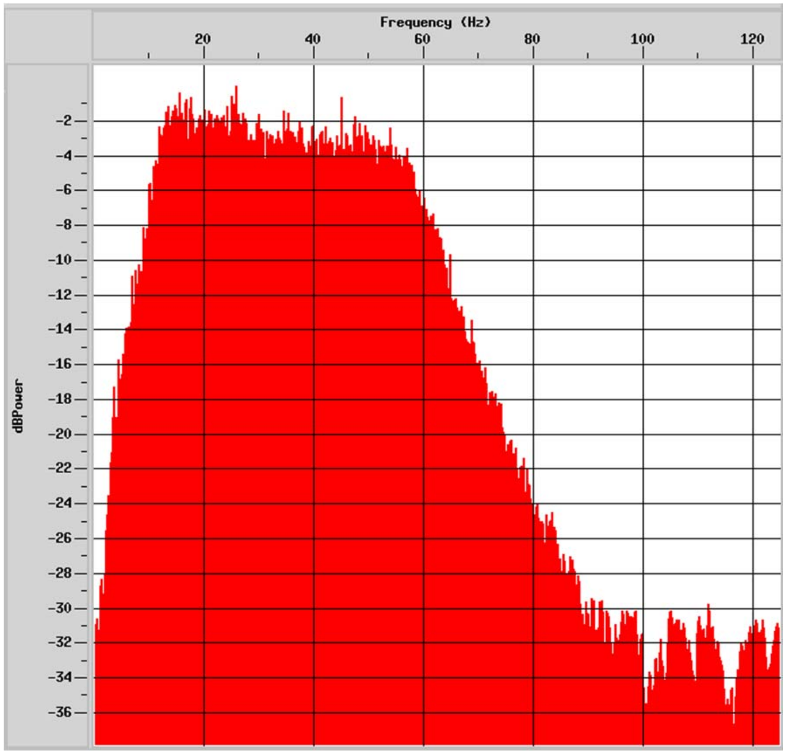
Data Processing Steps Applied Prior to LASEA

The data processing steps applied to the Davenport Newberry data prior to being input to the LASEA process are shown below:

1) Load data from field disks to ProMAX data format (ProMAX is a leading industry seismic data processing software package)
2) Apply geometry assignment to all data (receiver X, Y, and elevation)
3) Determine horizontal geophone component orientation and apply rotation to Vertical, North, and East directions
4) Bandpass filter (Butterworth bandpass 12 Hz, 18 dB/Oct, 60 Hz, 45 db/Oct - discussed below)
5) Noise suppression via 3-Component filter (discussed below)

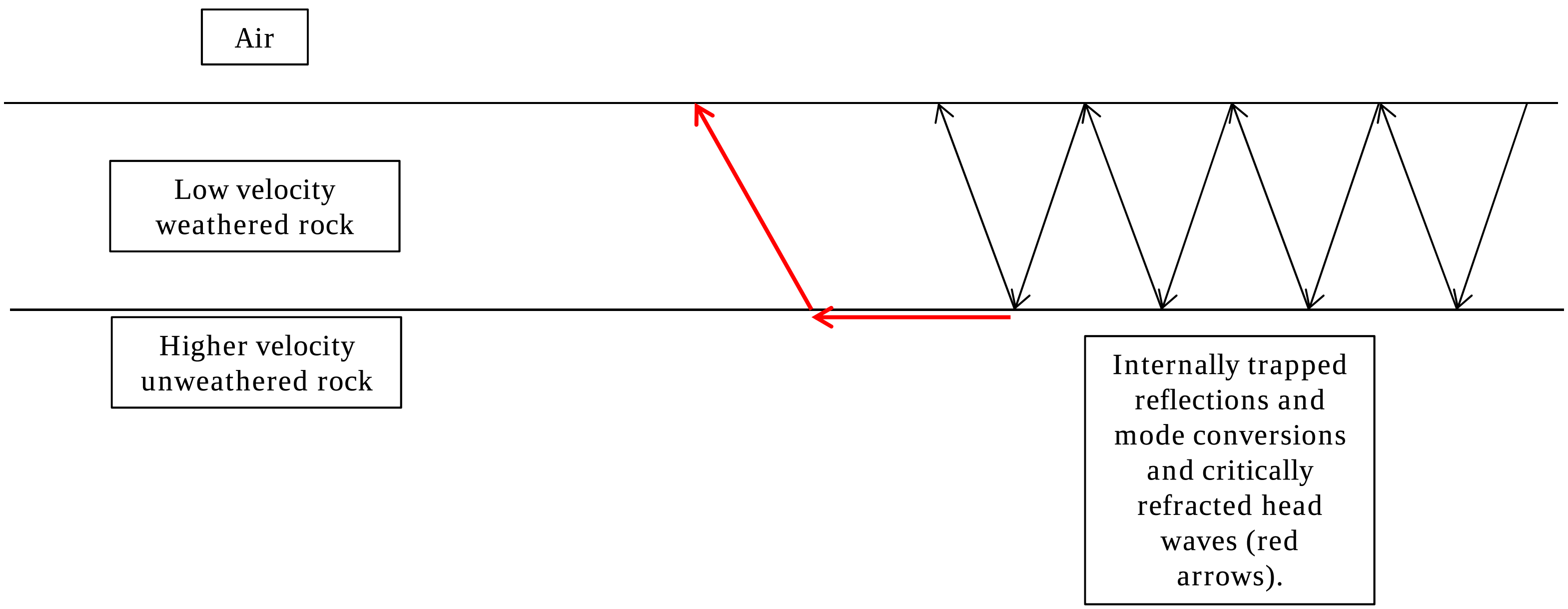
Steps 4 and 5 were done to maximize signal quality with respect to “noise” where “noise” is defined as seismic energy that is not of interest to this project and that may interfere with the signal quality of the desired data. Examples of seismic energy not of interest to this project are high frequency background noise and culturally generated noise.

The amplitude spectrum and filter panel displays of the data were analyzed and it was found that below 15 Hz there is a significant amount of coherent energy in the near-surface waveguide (more later on this subject) and a significant random noise component enters the data above 60 Hz. We therefore applied a Butterworth bandpass filter with the following parameters 12 Hz, 18 db/Octave slope, 60 Hz, 45 db/Octave slope. The spectrum of a typical record after the filter is shown to the right.



Data Processing Steps Applied Prior to LASEA (continued)

Step 5 in the data processing flow discussed above is titled “Noise suppression via 3-Component filter”. The filter applied was developed by SigmaCubed geophysicists after it was noticed that in nearly every location we have tested, it appears that the near-surface (approximately upper 1,000 ft of the earth) acts a waveguide. The waveguide effect occurs when there are large velocity variations in a vertical direction and wave modes become trapped as depicted in the sketch below. Near-surface velocity effects are well known in seismology and are related to weathering and compressional stress unloading of rocks and is what drives the need for refraction statics in reflection seismology.



Data Processing Steps Applied Prior to LASEA (continued)

The near-surface waveguide effects described above act as a source of seismic interference for our desired seismic signals from depth. The desired signals from depth arrive at the surface with a strong bias toward traveling vertically upward due to the wavefield being refracted toward the normal of the velocity gradient. Our 3-component noise filter takes advantage of the known wavefield characteristics of both the desired signals and the undesired signals and suppresses the undesired part of the observed wavefield.

LASEA Processing Specifics

The grid node spacing for computations was 100 m. The velocity field was taken from previous work in Table 19 of an unpublished report titled "Report to AltaRock Energy Inc. Newberry Calibration Shot Project" by Gillian R. Foulger, of Foulger Consulting, dated October 09, 2010. The table directly from the report is shown below:

Foulger Consulting 38

Table 19: Best final velocity model.

Depth interval (m)	Depth interval (feet)	Velocity (km/s)
0 - 150	0 - 492	2.0
150 - 300	492 - 984	2.0
300 - 450	984 - 1,476	3.4
450 - 600	1,476 - 1,969	3.5
600 - 750	1,969 - 2,461	3.7
750 - 900	2,461 - 2,953	3.8
> 900	> 2,953	unresolved

Depths greater than 900 m were unresolved in the Foulger report and for the LASEA analysis were assumed to be 3.8 km/s via extension of the deepest velocity determined in Table 19.

Further refinement of the velocity field may be possible with seismic sources that may be generated by upcoming fracture stimulation at the Newberry site.

Additional velocity information

A table of interval velocity as a function of depth derived from the shallow instrument wells is presented below. The measurements are taken from nearby source points shot with a small surface seismic source provided by APEX-HiPoint (now SIGMA^3). The table is for depths greater than 73 m. Depths shallower than 73 m exhibited highly variable velocities but are generally in the range of 1,800 m/s indicating a variable weathering layer. Wells 1, 2, and 3 had a consistent velocity at depths between 73 and 195 m and Well 4 had a lower velocity. All of the above variations are consistent with observed spatial variations that are well-documented and in commercial seismic data analyses such as surface seismic reflection imaging.

Well Number (see map in Slide 4 above)	Velocity in m/s in the interval 73-195 m depth
1	3,123
2	3,230
3	3,299
4	2,566

LASEA Processing Specifics continued

Depths greater than 900 m were unresolved in the Foulger report and for the LASEA analysis were assumed to be 3.8 km/s via extension of the deepest velocity determined in Table 19. Further refinement of the velocity field may be possible with seismic sources that may be generated by upcoming fracture stimulation at the Newberry site.

The dots shown on the LASEA display are effectively the result of a series of cross correlations and sums that include input from two hours of continuously recorded data (over 1.9 gigabytes of data). An additional data smoother was also applied such that for any given grid node in the volume, the data sample that is displayed is an average of the 2-hour LASEA value for that 2-hour time period AND the prior and subsequent two hour periods. The time smoothing provides way to diminish the effect of anomalous amplitudes, both large and small.

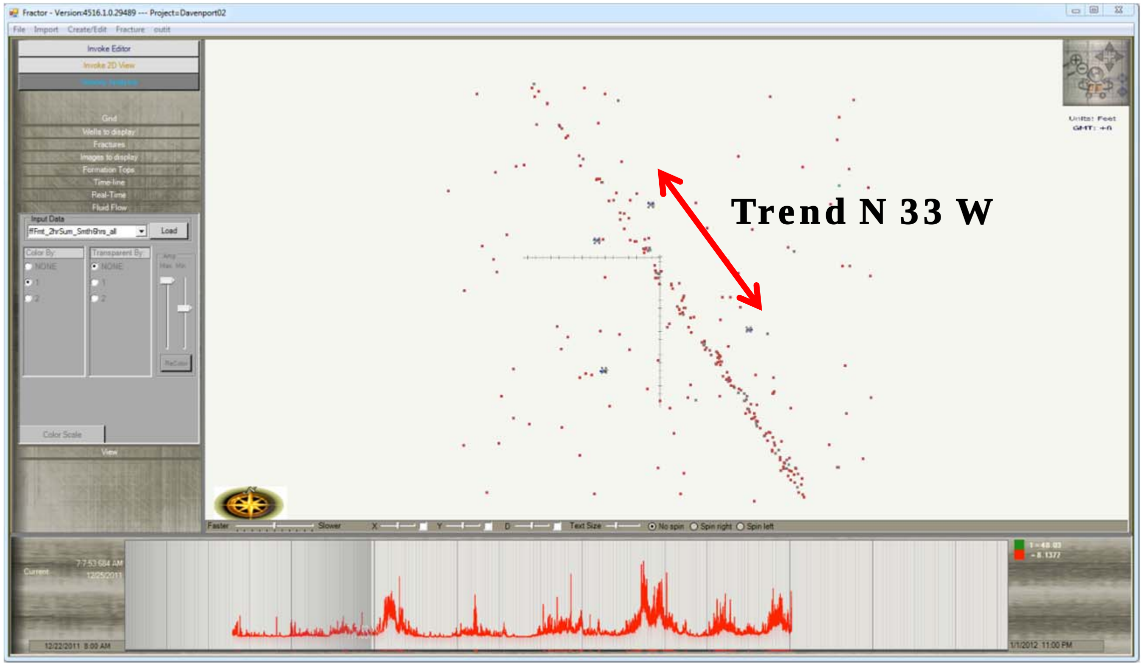
LASEA Results for Newberry Volcano Study

The following slides show highlights from the LASEA results for Newberry Volcanic Area.

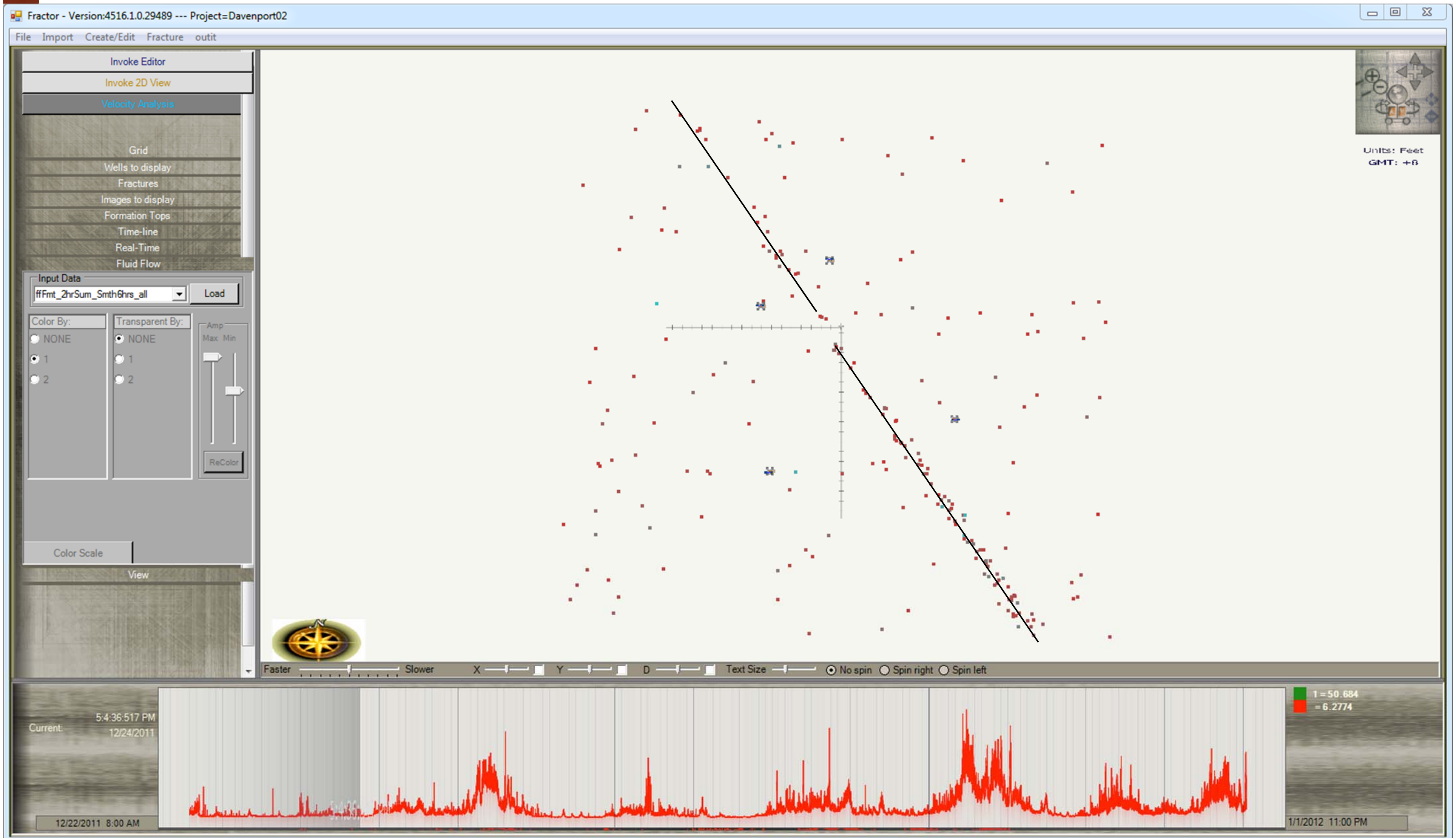
Linear Trend Activity – a principle discovery

Two separate time periods of seismic activity resulted in a strongly linear trend being illuminated. “Strongly linear” is a qualitative phrase but the NW-SE linear trend stands out against the background seismic activity as shown in the example below which was recorded during the first period of activity at 07:07 am, 12/25/2011. The begin and end times of the two time periods are in the table below. The second activity period followed the first by 3 days and 5 hours. The first period lasted ~22 hours and the second ~31 hours though the second may have lasted longer but recording ceased near the end of the second period. Both time periods show activity at the same locations.
The linear trend probably continues beyond the mapping area shown as the NW and SE ends of the trend are at the edges of the investigation area.

Begin	End	Comment
12/24 5:10 pm	12/25 7:00 pm	Consistently present
12/29 00:15 am	12/30 07:00 am	Intermittent, consistently present but variable in amplitude relative to ambient background levels



Linear Trend Activity – possible variation in direction



While further analysis is warranted, the linear trend appears to vary somewhat between the NW and SE segments of the trend. The difference is only a few degrees but is visually perceptible. The two line segments drawn above were fit by eye.

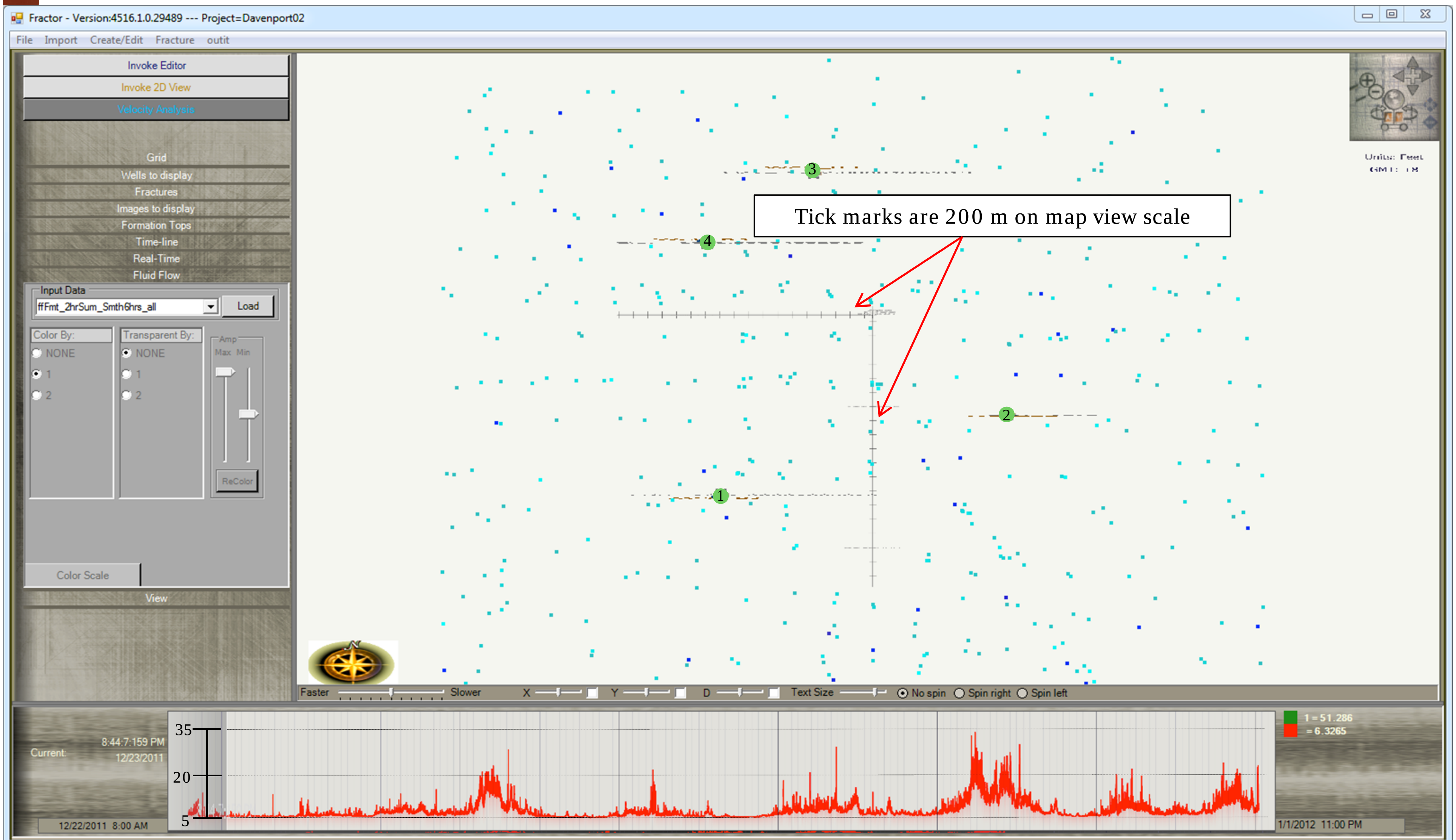
Important time intervals in the following slides

The following slides show the LASEA results at various sequential time steps throughout the 6 day-17 hour recording time period. These slides were selected and annotated to show typical results but also times of interest. The amplitude threshold slider bar was set in each display to optimize information that can be derived from each slide. Setting the slider bar is an interpretive process. Davenport and its agents may wish to set slider bars at different levels to discover other results.

The first slide shown is December 23 at 8:44 PM. The first approximately 27 hours of operation showed primarily indistinct energy patterns and was typified by generally low background (RMS) seismic amplitudes. The second slide shows the energy field December 24 at 5:04 PM when the first of two time periods displaying linear trends appears on the data.

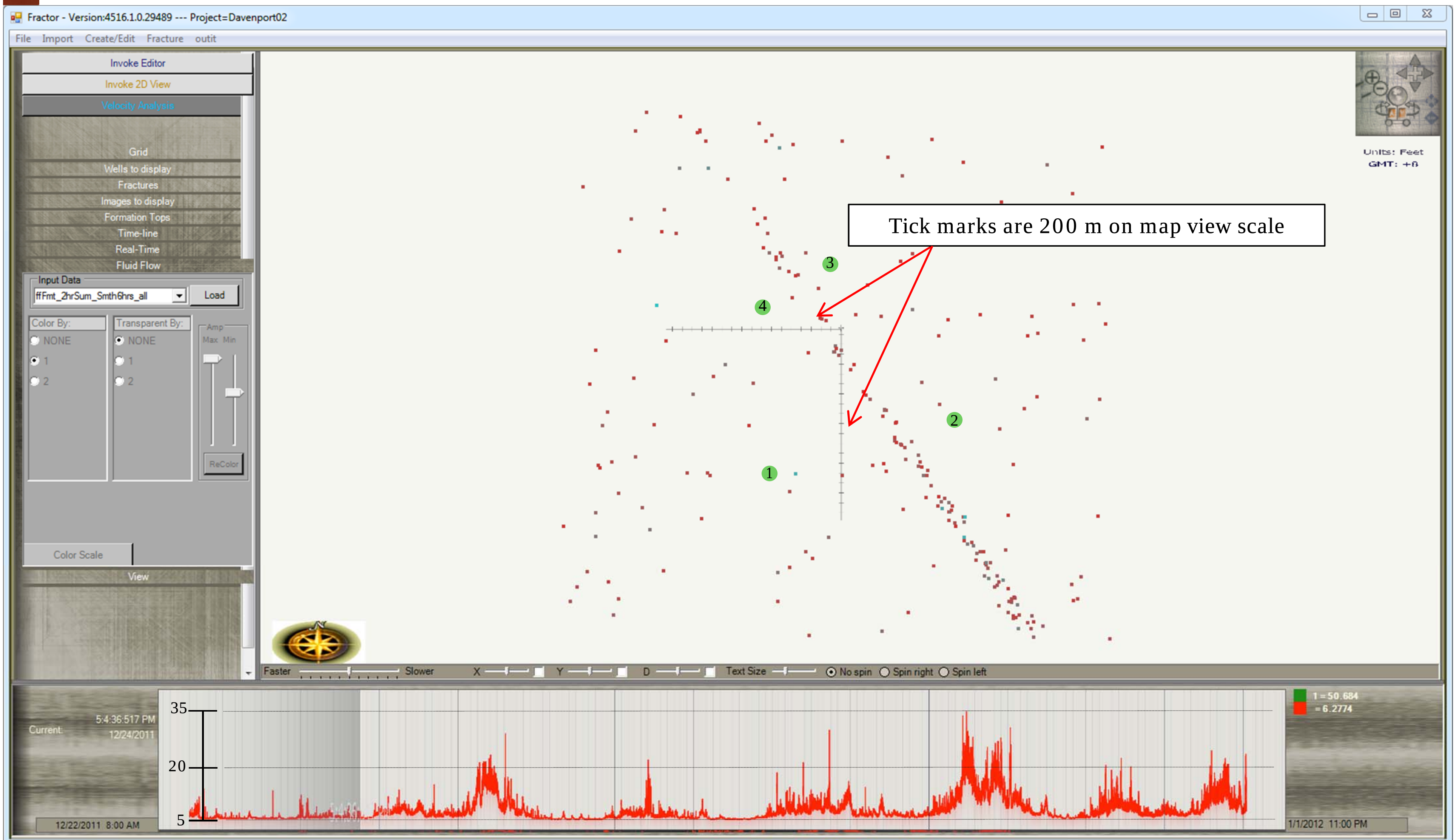
On the first two slides there is an annotation showing that there are 200 m between adjacent tick marks on a scale that is on the plot. The scale remains consistent at 200 m between tick marks for all *map view* slides shown henceforth.

Dec 23 – 8:44 PM



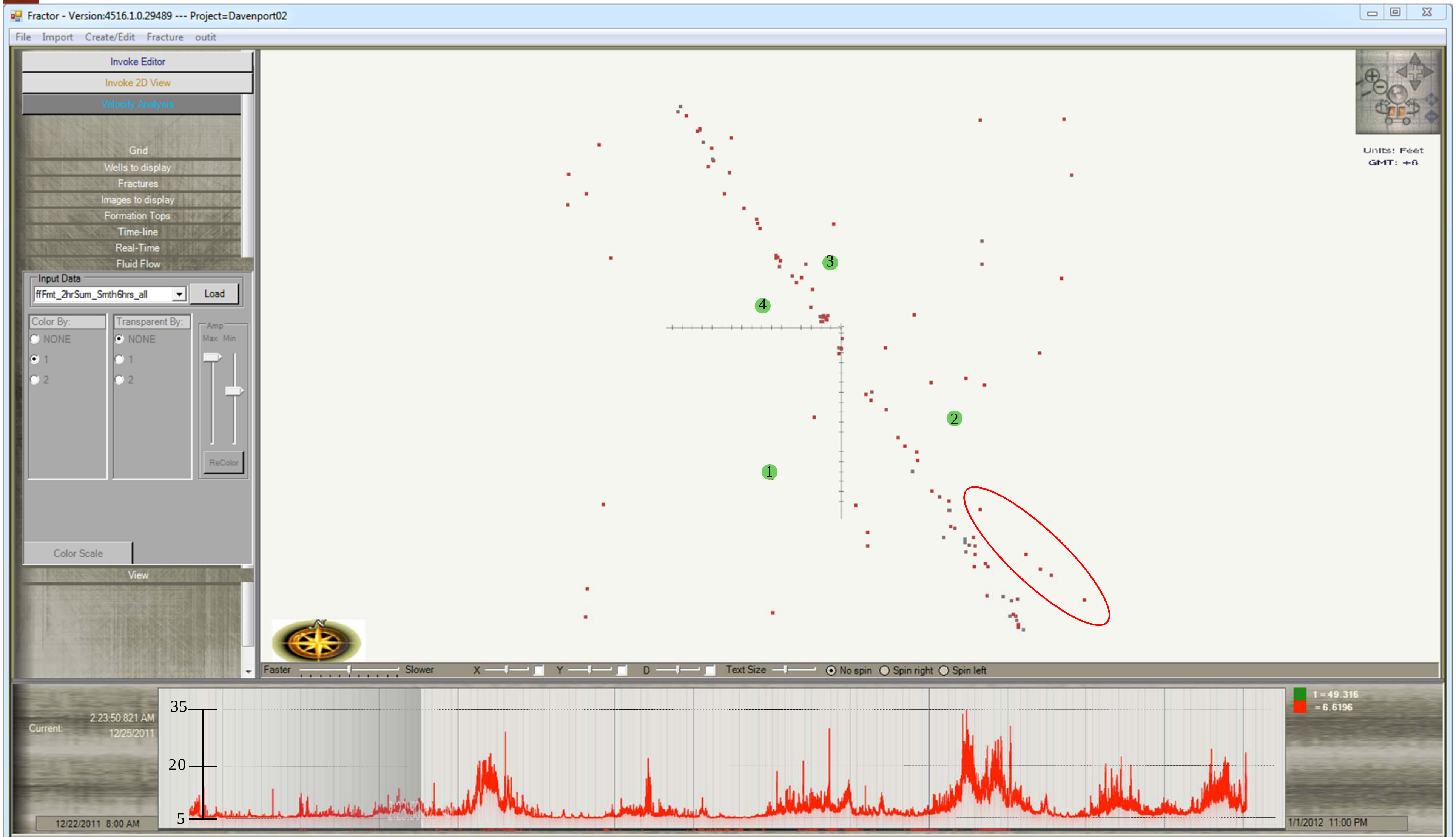
The first approximately 27 hours of operation is typified by relatively low background energy (RMS curve in red above) and indistinct energy patterns, though there is a hint of the linear trend even in this figure but it does not stand out against the general background amplitudes.

Dec 24 – 5:04 PM



The linear trend becomes apparent at this point in time standing out as a clear trend above the ambient seismic energy.

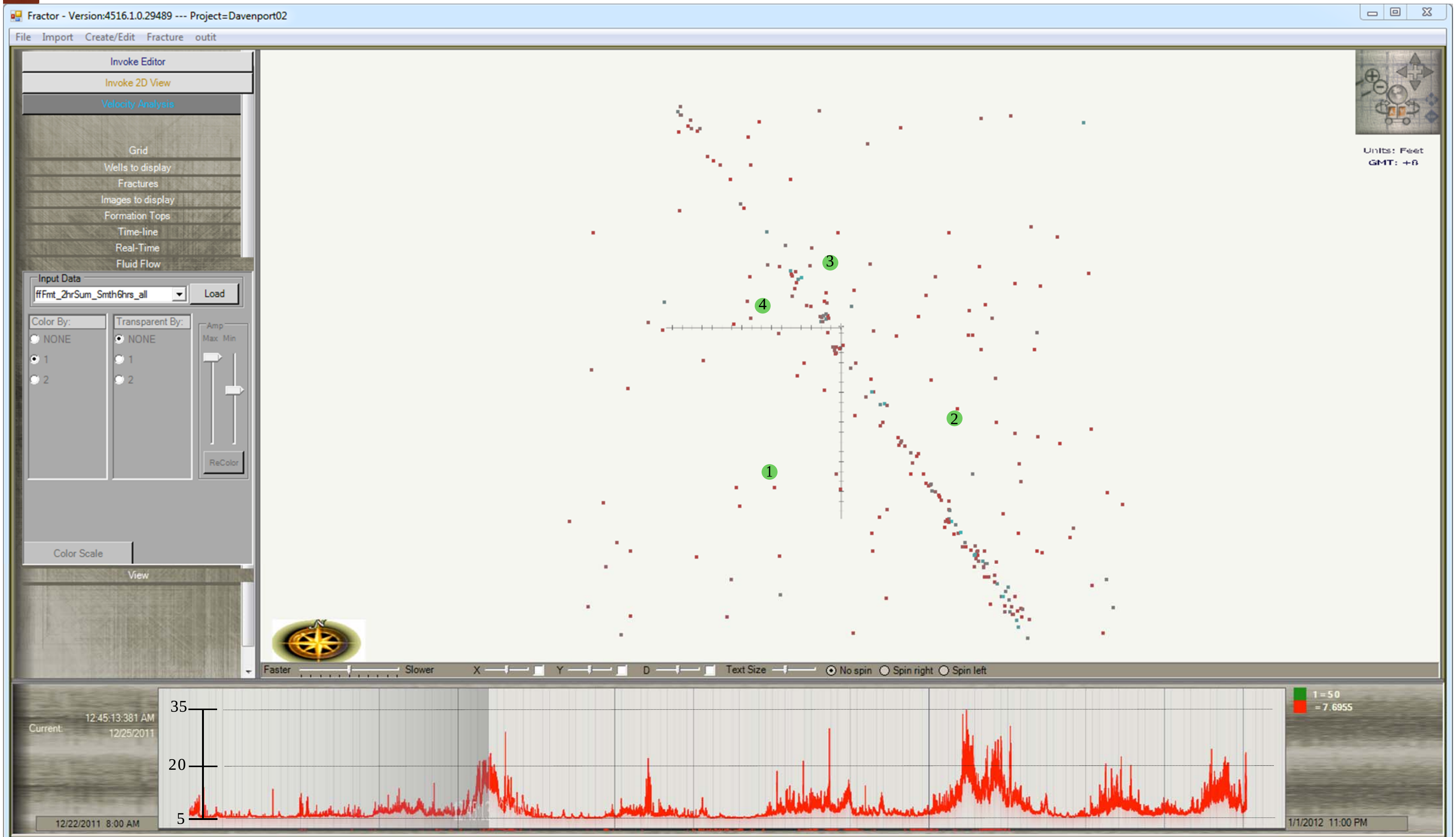
Dec 25 – 2:23 AM



The linear trend continues with an interesting "splay" to the SE which is visible from time to time. This trend has a slightly different orientation than the main trend in the SE part of the field area.

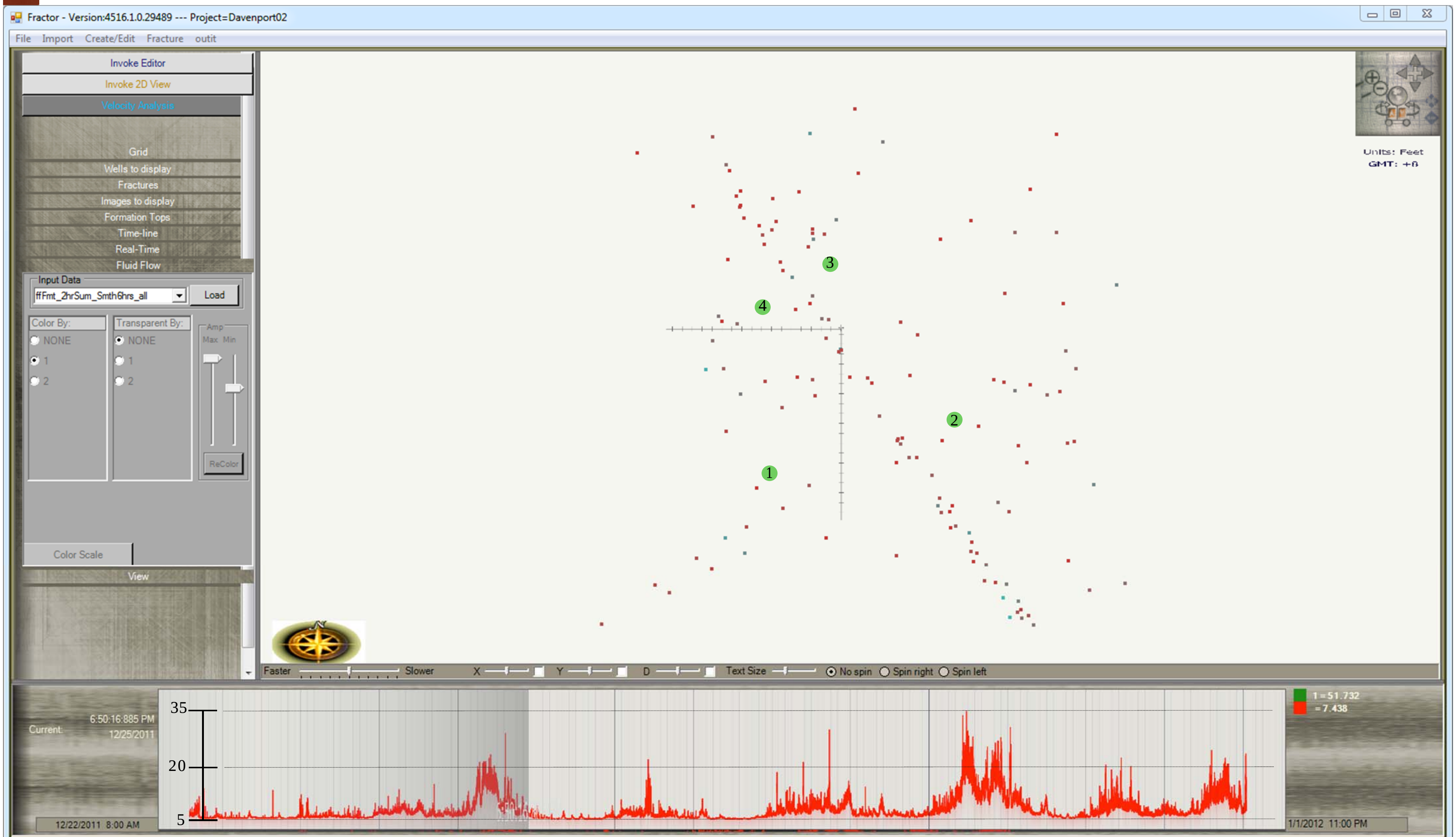
Dec 25 – 12:45 (afternoon)

SIGMA³



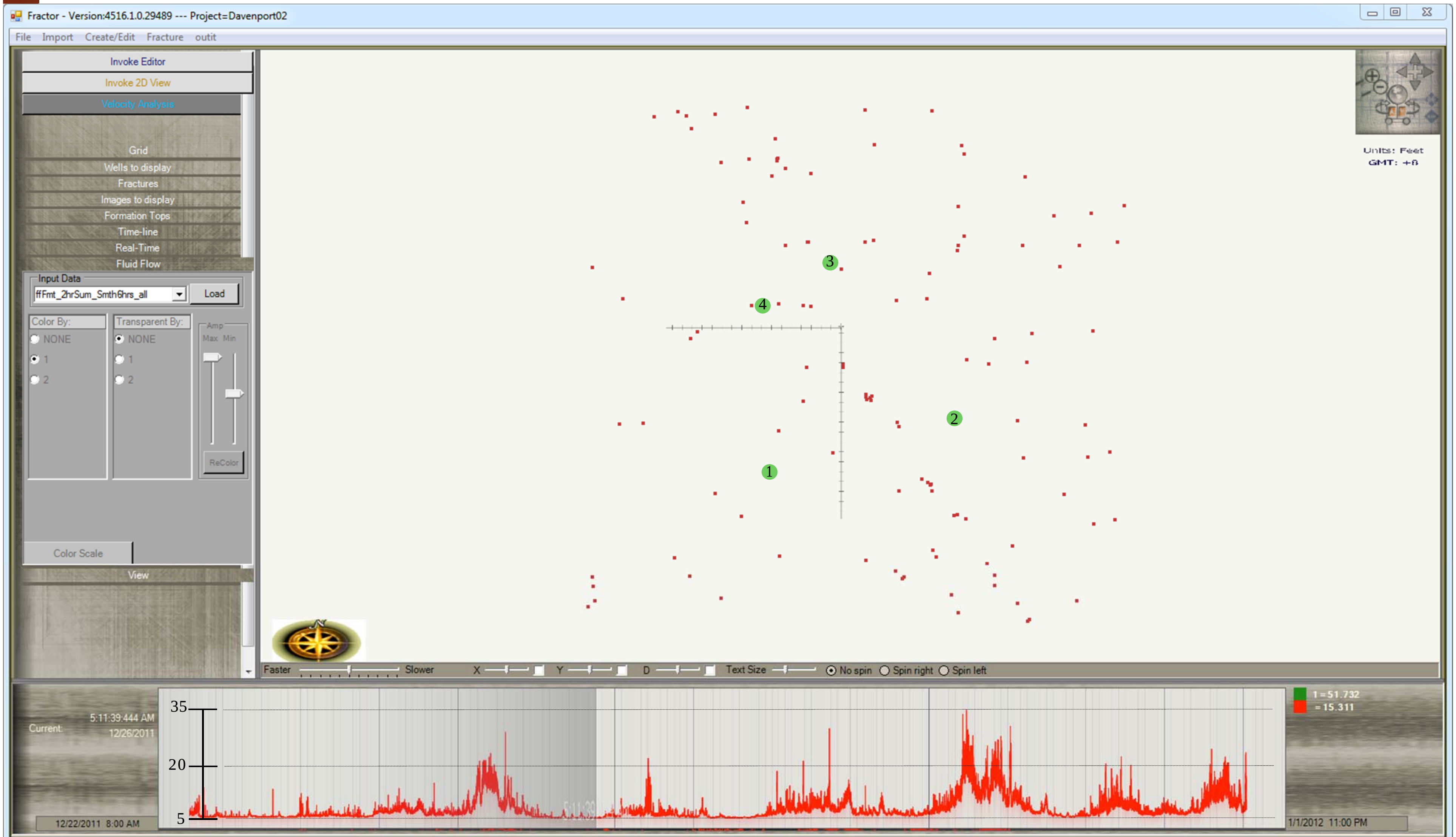
The linear trend continues. Note that the software displays the hour directly afternoon as "AM" but we know from the context of the display and from moving the pointer to before 12:00 and after 1:00 that this plot is 45 minutes after noon and should be considered "PM" rather than AM.

Dec 25 – 6:50 PM (end of linear trend)



The linear trend continues until this time then stops as the ambient RMS amplitude decays. Note that the time shown is a national holiday in the United States (Christmas day) and we do not expect industrial activity to have occurred anywhere within the region, thus the RMS amplitude decay at this point in time along with the cessation of the linear trend points to the linear trend and ambient noise levels being related to one another.

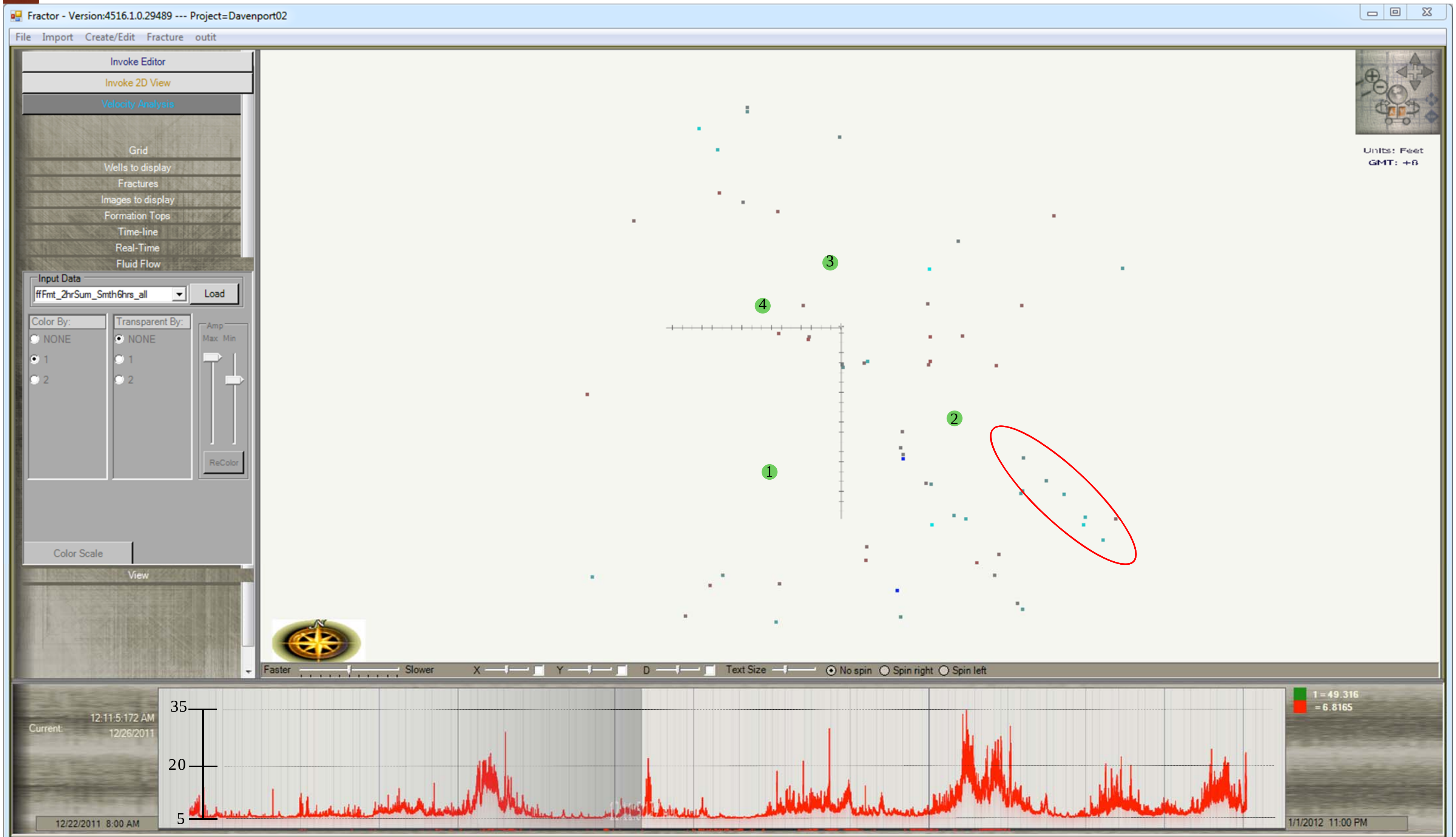
Dec 26 – 5:11 AM (quiet period)



During this quiet ambient background period, the linear trend is still somewhat present, but near the same amplitude of the largest ambient background.

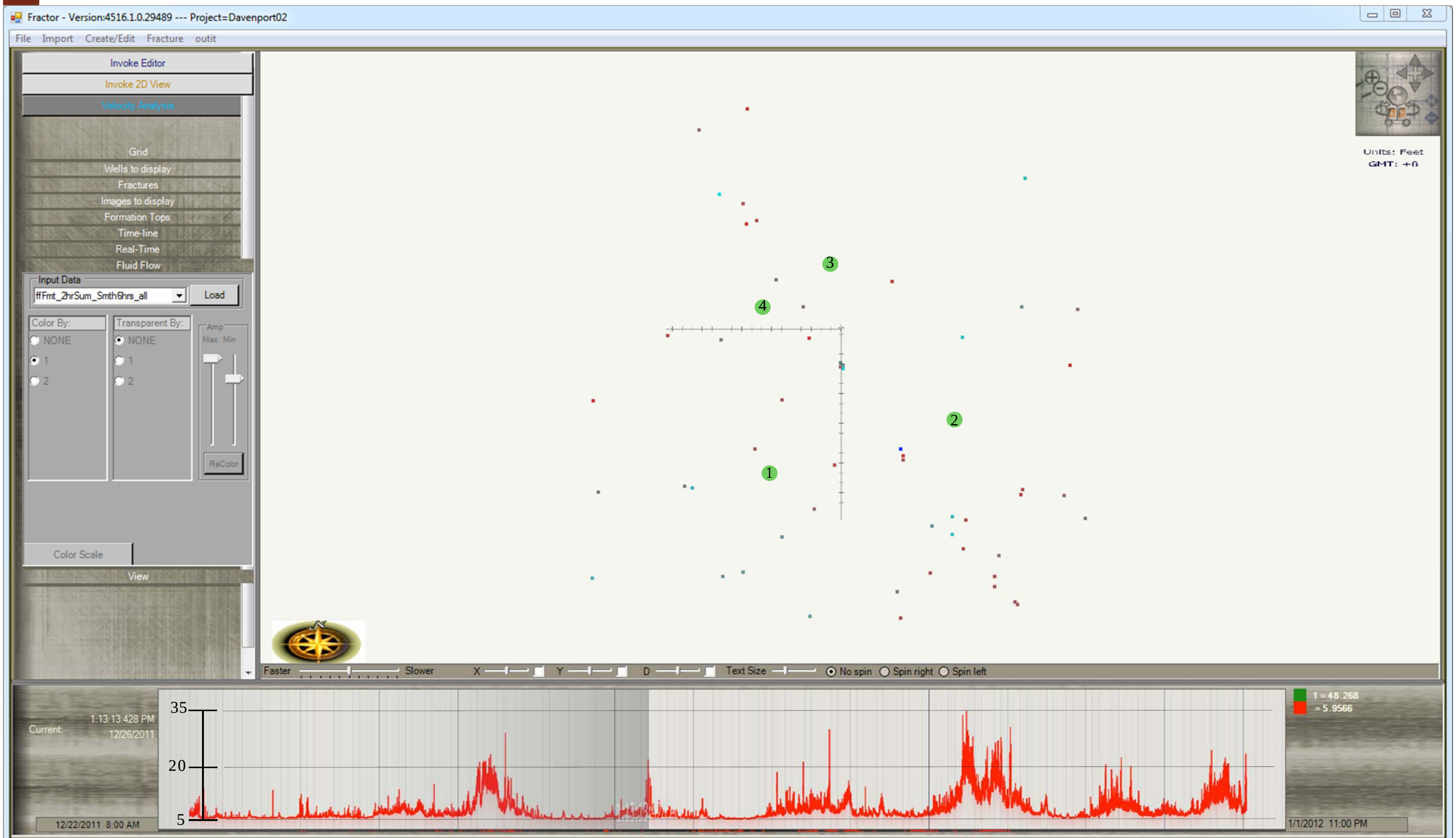
Dec 26 – 12:11 PM (afternoon)

SIGMA³



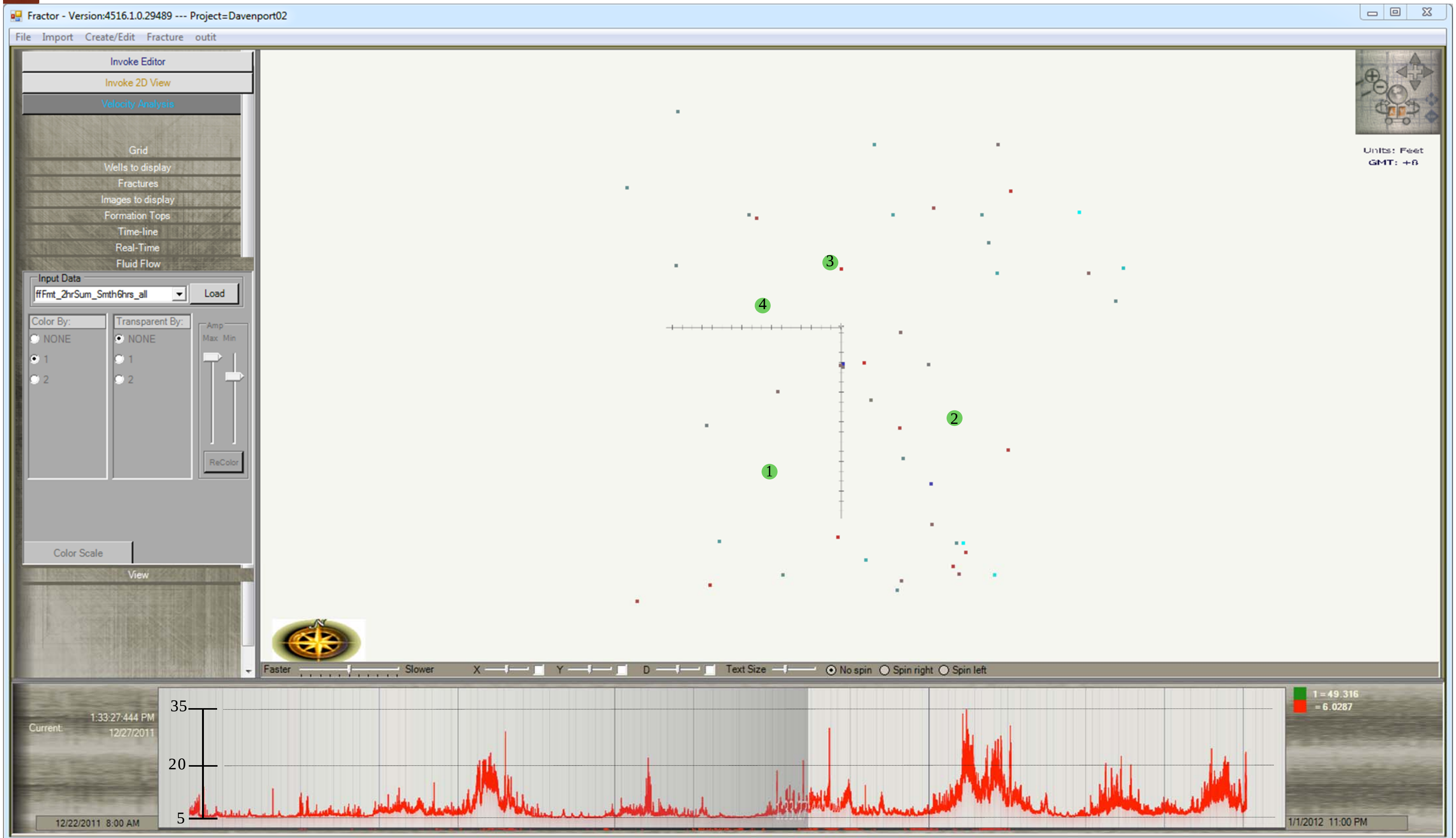
During this quiet ambient background period, the linear trend is still somewhat present, but near the same amplitude of the largest ambient background. During this time the "splay" area returns, though it is in a different position than in the previous slide on Dec 25 at 2:23 AM.

Dec 26 – 1:13 PM



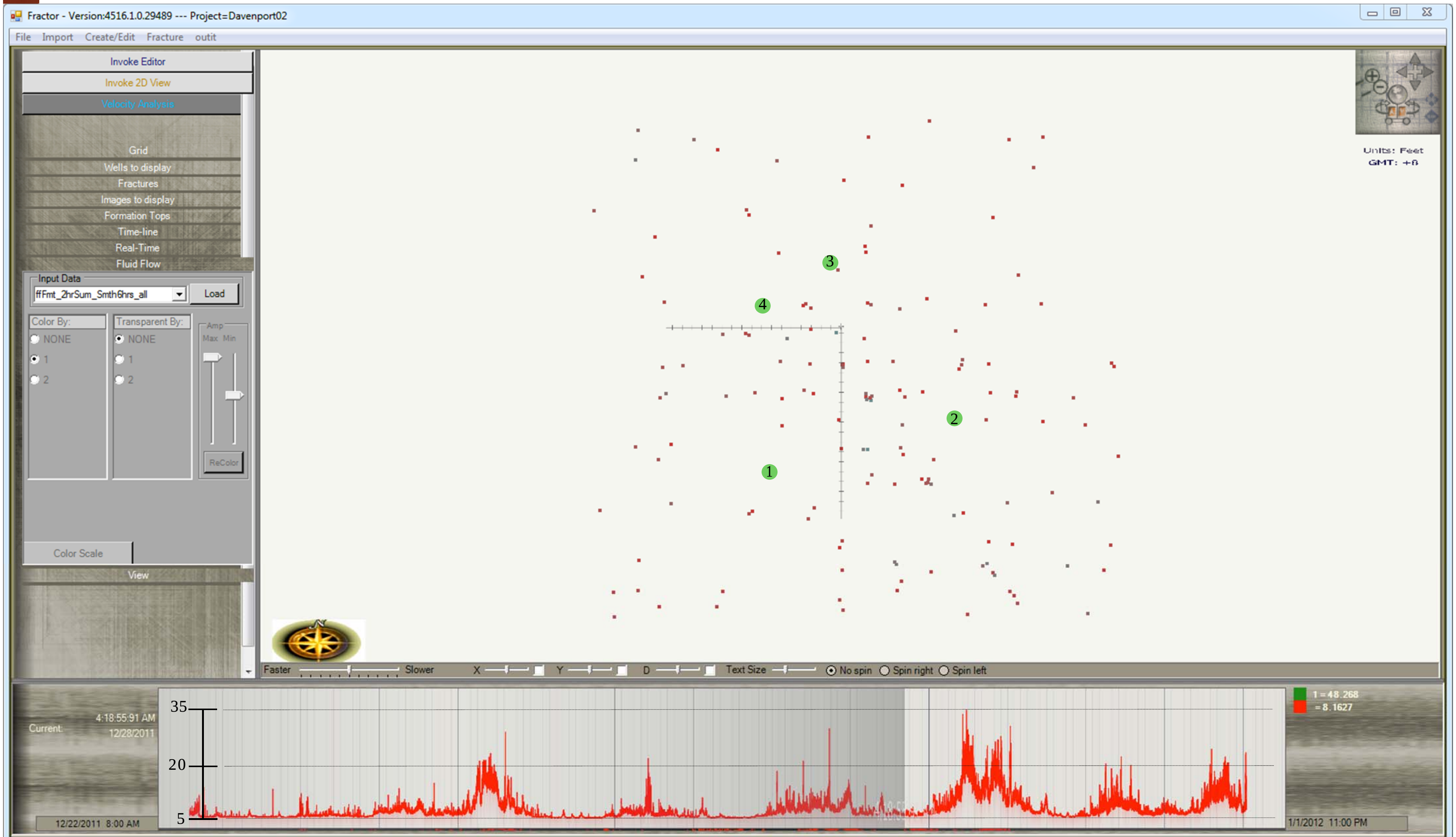
During this quiet ambient background period, the linear trend is still somewhat present, but near the same amplitude the largest ambient background.

Dec 27 – 1:33 PM



During this quiet ambient background period, the linear trend is still somewhat present, but near the same amplitude the largest ambient background.

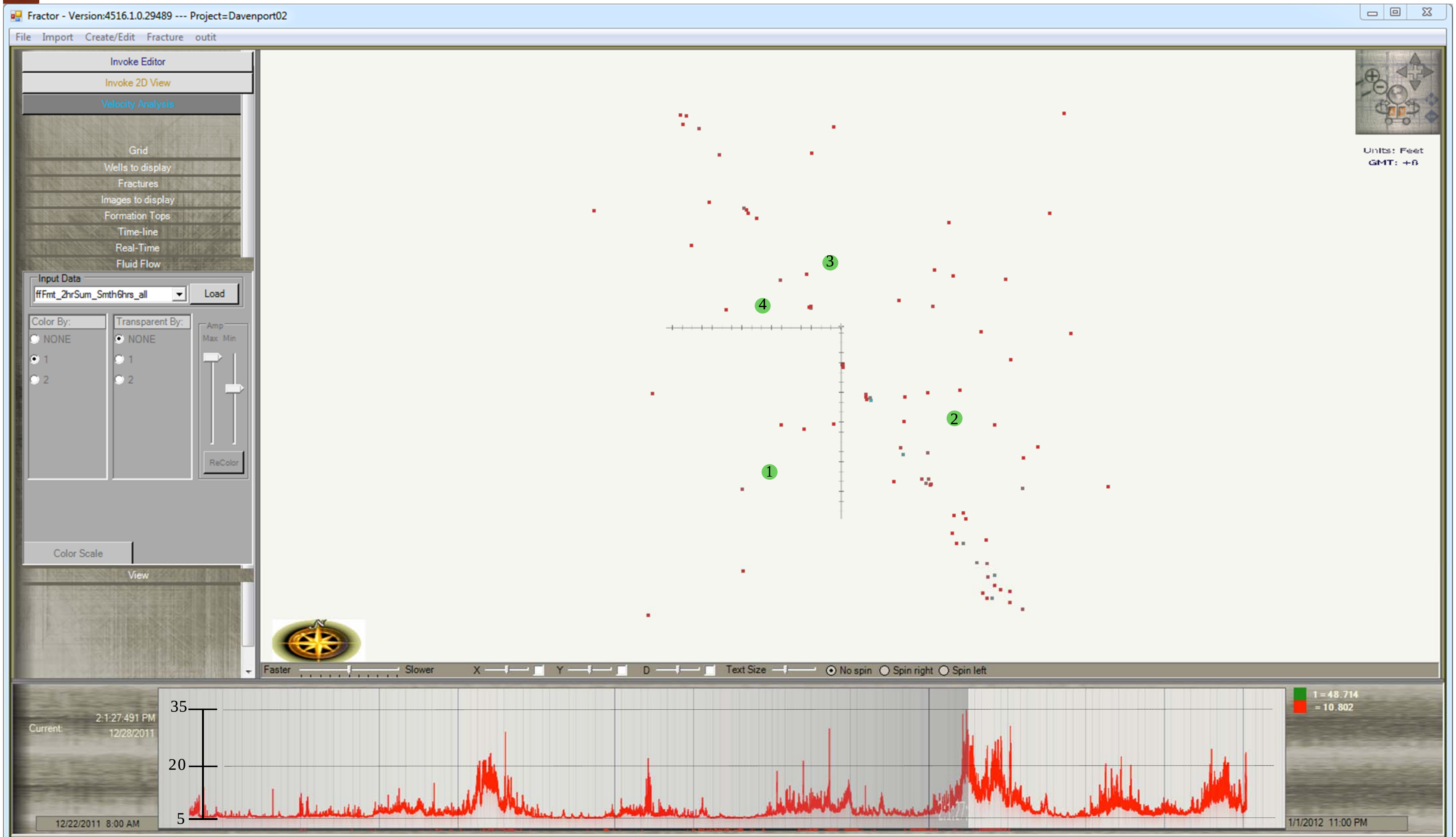
Dec 28 – 4:18 AM



During this quiet ambient background period, there is not an immediately discernible pattern to the energy.

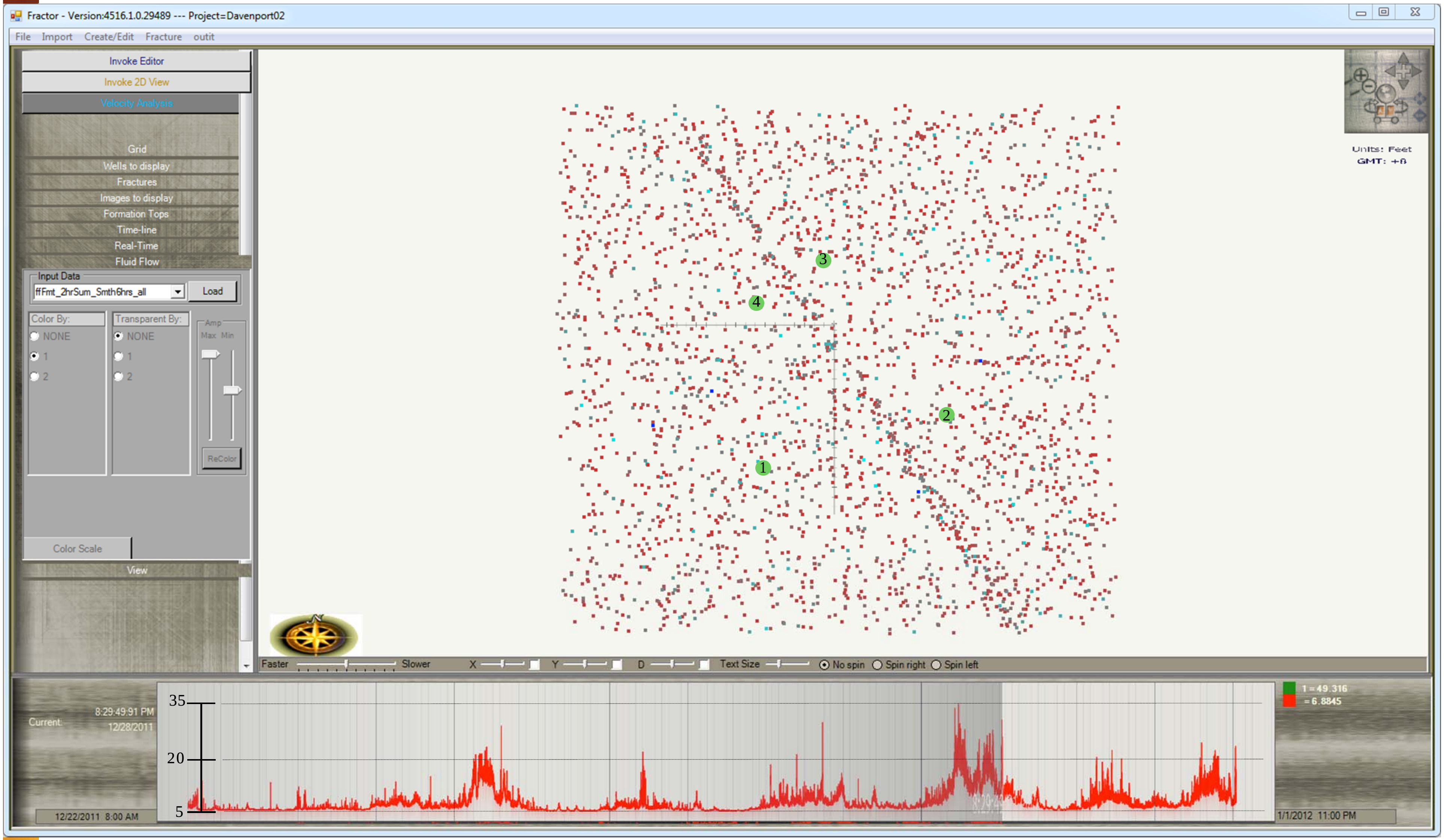
Dec 28 – 2:01 PM start linear trend

SIGMA³



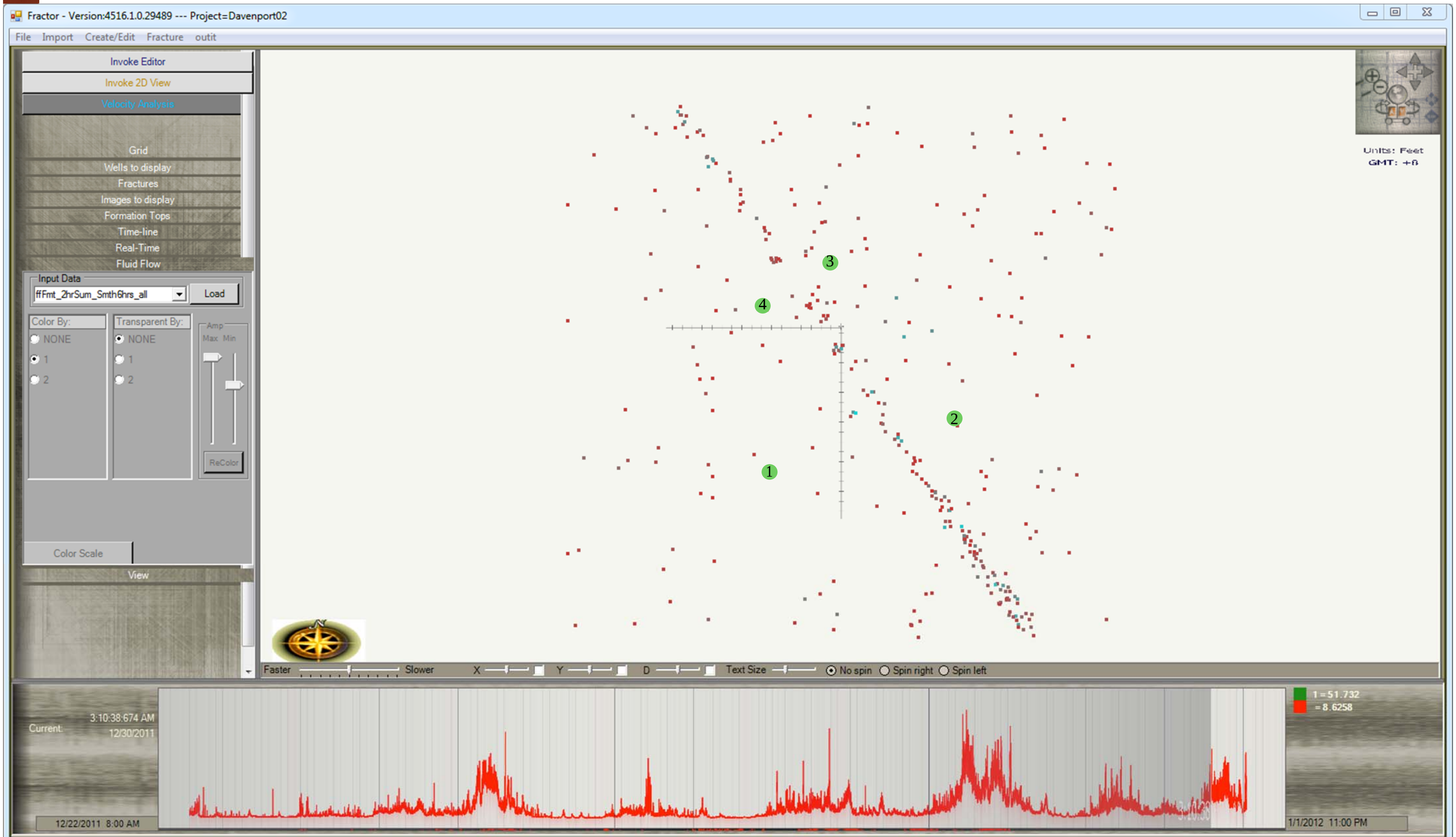
The linear trend restarts at this point during a high ambient background increase which is coincidental with mid-day, so part of the ambient energy is due to cultural sources.

Dec 28 – 8:29 PM trend continues but high background energy



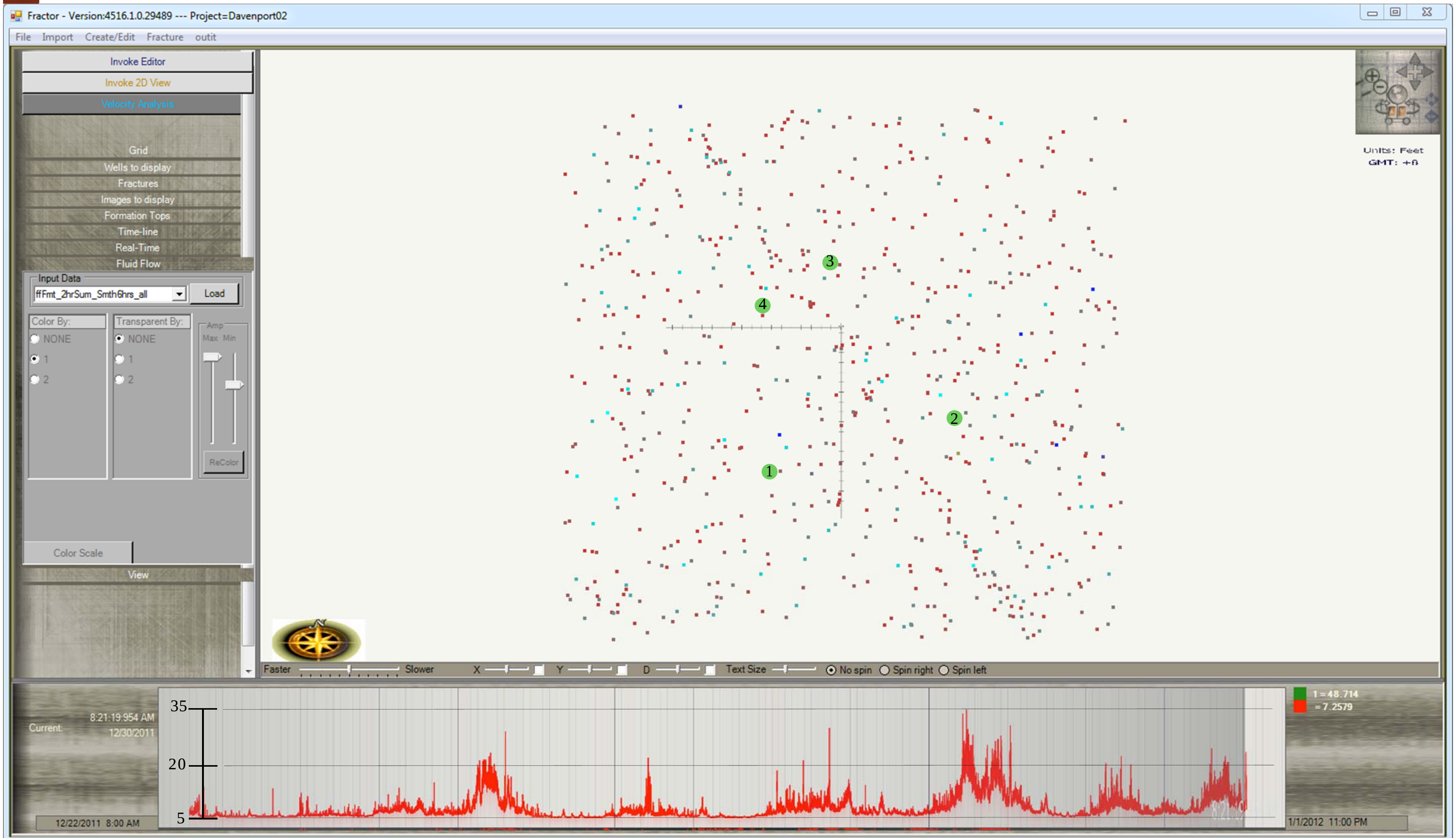
The linear trend continues but there is also relatively high ambient energy.

Dec 30 – 3:10 AM continue linear trend



The linear trend continues.

Dec 30 – 8:21 AM End of data, weak trend at this time



This frame is at the end of the recording period. The linear trend is still present at this time.

Depth of the high amplitude LASEA signal

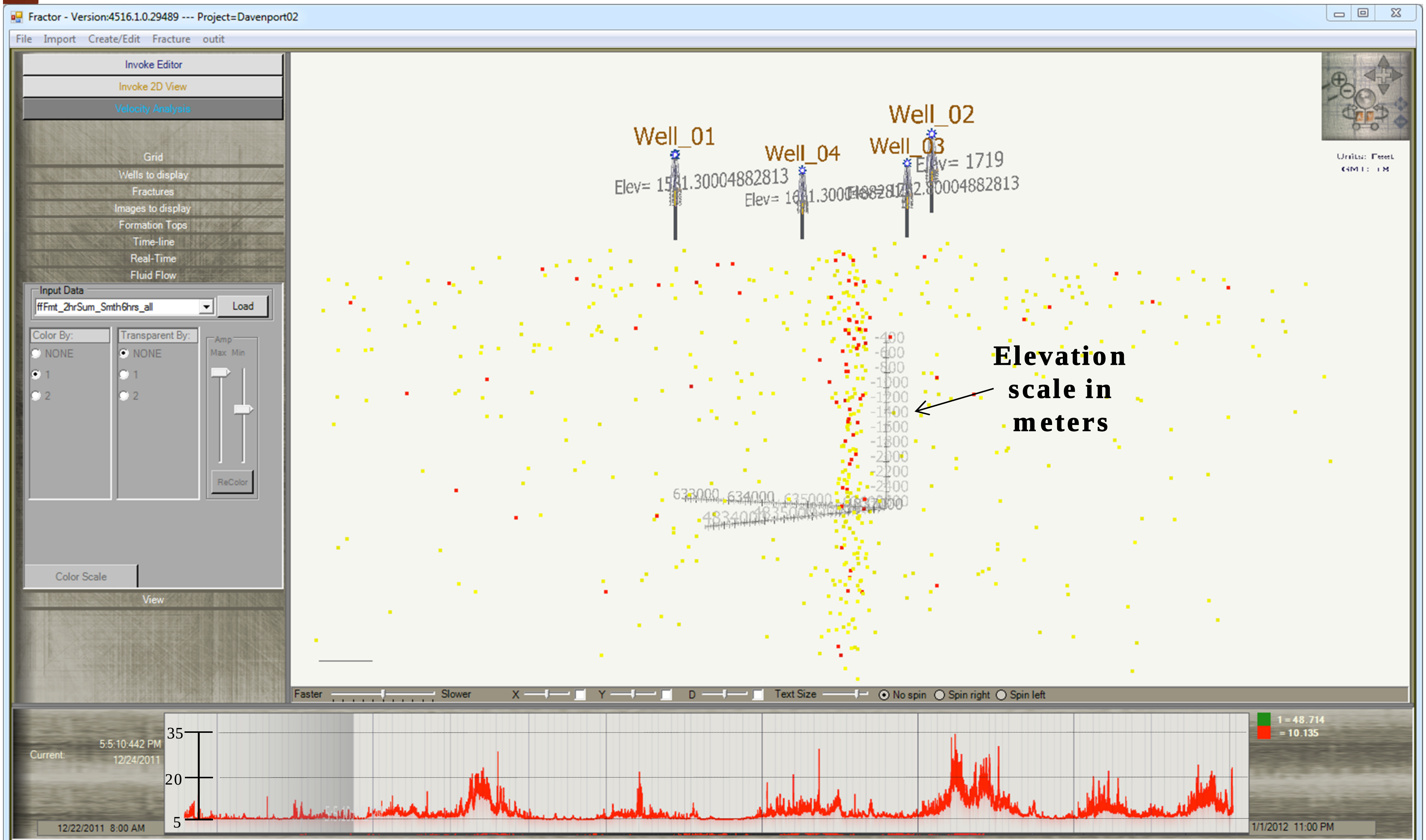
The following slides show the LASEA results as a side view from the southeast looking along the strong NW-SE lineation. The first slide shows the results with a low threshold amplitude set which reveals that the lineation extends above the expected depth of maximum activity (10,000 ft = ~3,050 m) and well into the shallow section.

The next slide however shows the same scene only with the low-amplitude threshold slider set to a higher level. The measurement tool in the figure shows elevation in meters. The highest-amplitude parts of the lineation are at an elevation of about -1,400 m or a depth of 3,100 m (~10,000 ft) relative to the surface of the earth. The well head elevations are also shown on the plot.

The presence of the lineation at shallower depths may or may not have geologic significance, but it is our opinion that they are an artifact of the actual signal coming from depth and being incorrectly imaged by the algorithm *because the geometry of the observation wells is not well suited to imaging shallow seismic activity in combination with the data processing algorithm.* We would need wells much closer together to image shallow seismic activity. The fact that the highest amplitude energy mapping comes from depth, where the recoding wells geometry *IS* favorable, is an indication that the energy from depth is real but that the shallower energy is an artifact. We do not see a way to draw an exact line separating artifact from real image data.

Dec 24 – 5:05 PM Side View from the Southeast – low threshold

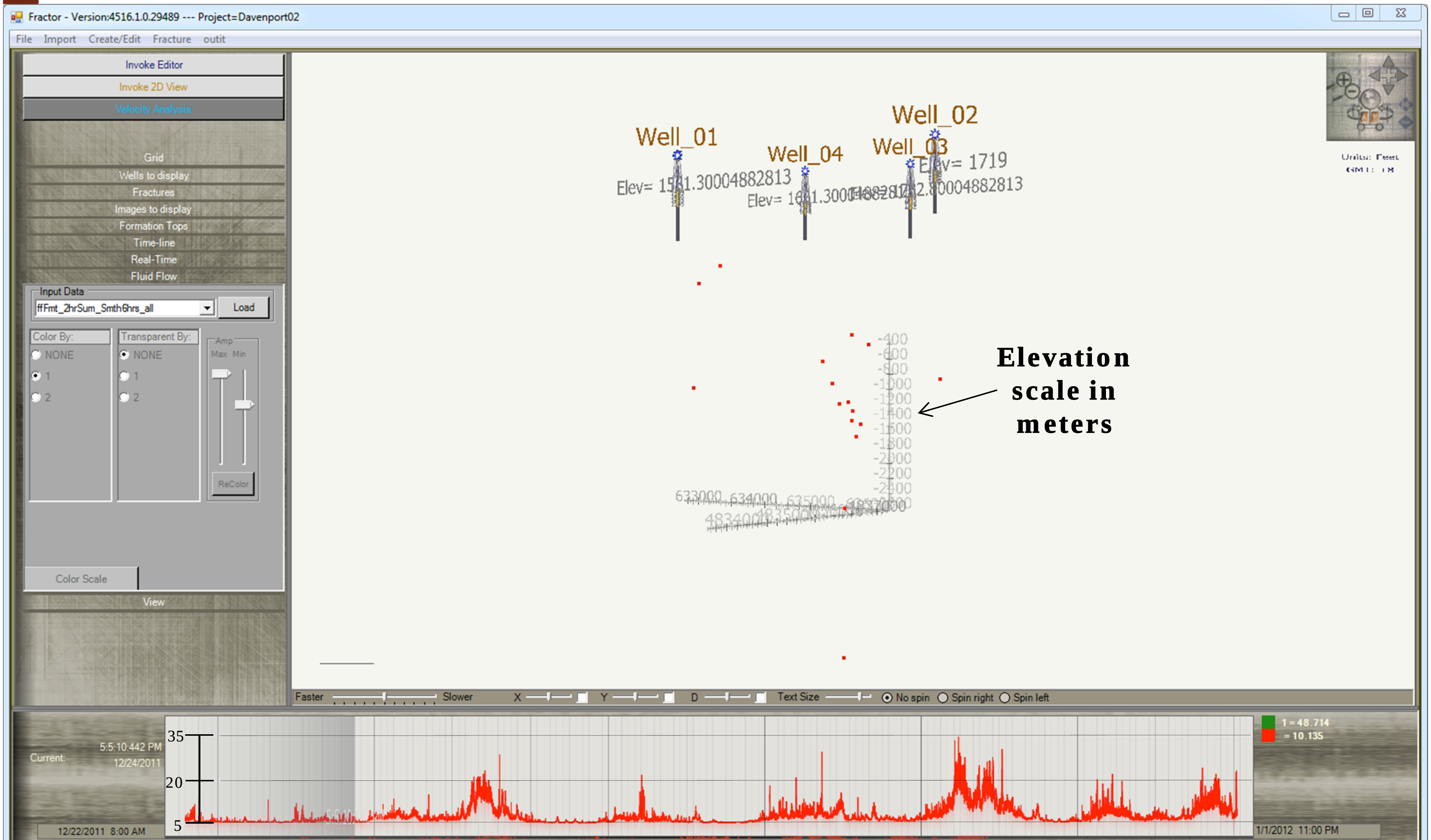
SIGMA³



A low threshold value is set for the energy and it can be seen that some energy is mapped for a large depth range for the linear feature. The next slide however shows a different story.

Dec 24 – 5:05 PM Side View – high threshold ~10,200 ft

SIGMA[3]



This slide is identical to the previous slide except that the display threshold has been raised showing that the predominant energy is mapped in the depth range of 3,000 m (elevation at the surface is ~1600-1700 m). Energy mapped at shallower depths is probably due to the receiver well geometry being unfavorable for shallow mapping and there for those shallow values are probably processing artifacts. The higher amplitude energy is concentrated at the SE end of the linear trend.