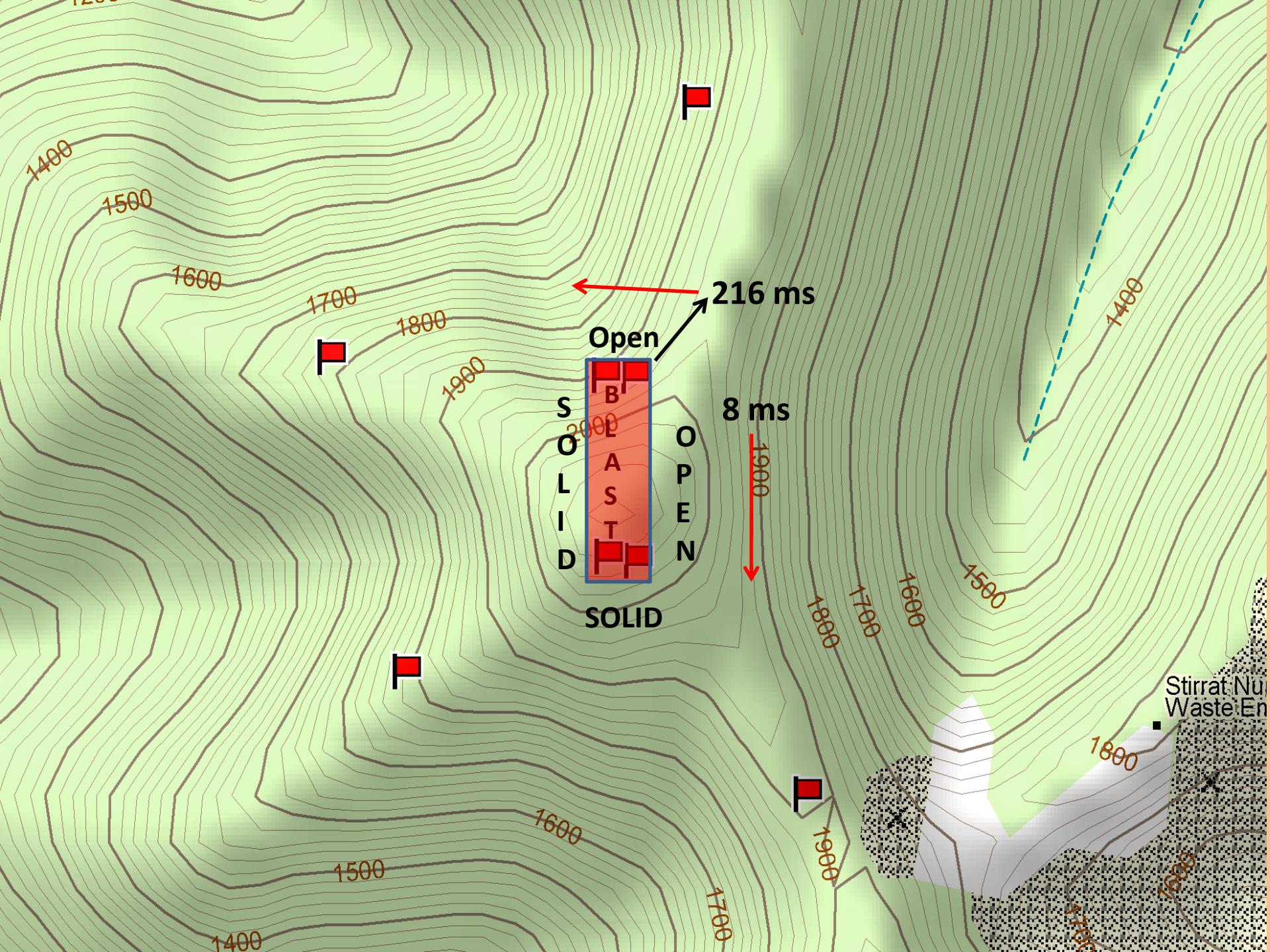
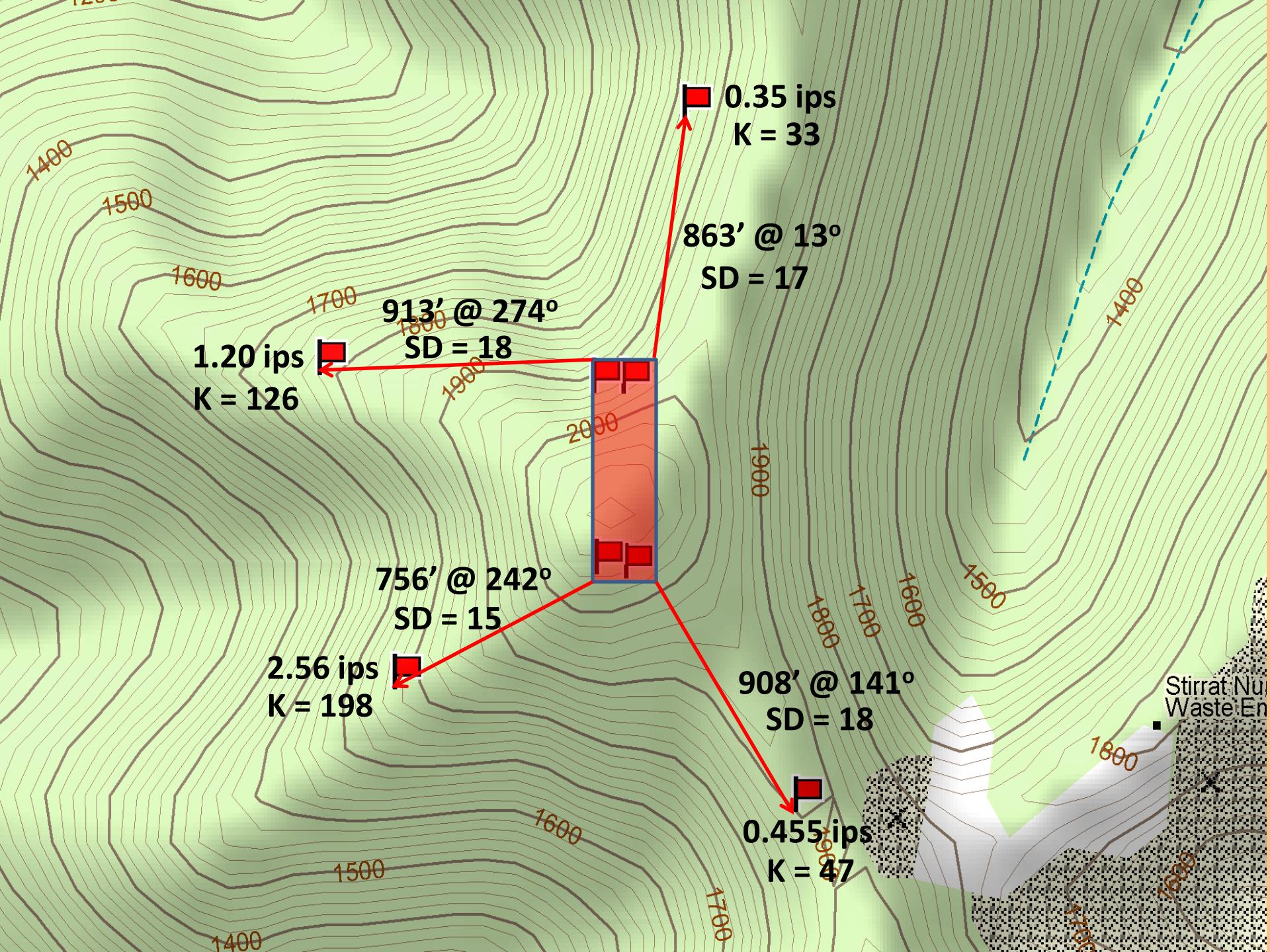


# Linear and Circular Seismic Arrays to Measure Surface Coal Blast Wave Propagations



# DIRECTIONAL EFFECTS





# SEISMIC ANOMALIES

**0.60 ips – 5.19 Hz – 125 dB**  **2,228' @ 6°**  
**1,916' Elev.**

**0.35 ips – 4.94 Hz – 123 dB**  **1,980' @ 14°**  
**1,828' Elev.**

**0.96 ips – 4.81 Hz – 127 dB**  **1,389' @ 9°**  
**1,834' Elev.**

**1.04 ips – 5.2 Hz - 130 dB**  **645' @ 2°**  
**1,774' Elev.**

**8,608 lbs/del**   
**1,900' Elev.**

A topographic map showing contour lines and blast locations. The map includes elevation values such as 1,300, 1,400, 1,500, 1,600, 1,700, 1,800, 1,900, and 1,700'. A dashed blue line marks a boundary or path. Several red flag icons indicate blast points with specific parameters and elevations:

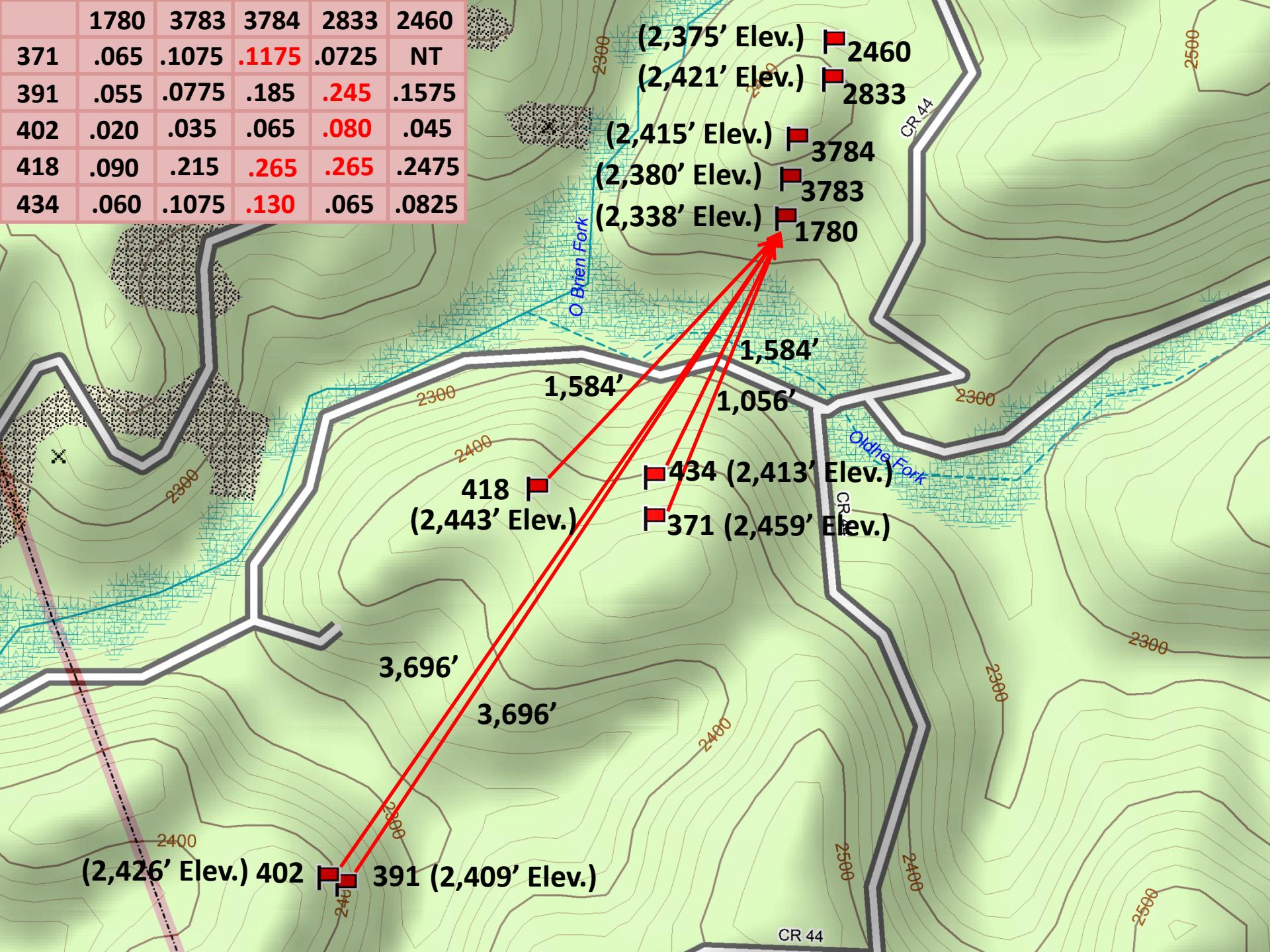
- 0.70 ips – 5.19 Hz - 128 dB      1,915' Elev. (red flag at 1,915')
- 0.50 ips – 5.13 Hz - 130 dB      2,086' @ 6° (red flag at 2,086')
- 0.50 ips – 5.13 Hz - 130 dB      1,991' @ 8° (red flag at 1,991')
- 0.335 ips – 4.56 Hz - 127 dB      1,924' Elev. (red flag at 1,924')
- 0.335 ips – 4.56 Hz - 127 dB      1,816' @ 14° (red flag at 1,816')
- 0.43 ips – 4.75 Hz - 128 dB      1,838' Elev. (red flag at 1,838')
- 0.43 ips – 4.75 Hz - 128 dB      1,626' @ 14° (red flag at 1,626')
- 0.43 ips – 4.75 Hz - 128 dB      1,866' Elev. (red flag at 1,866')
- 1.28 ips – 10.0 Hz - 133 dB      535' @ 358° (red flag at 535')

7,483 lbs/del

BLAST

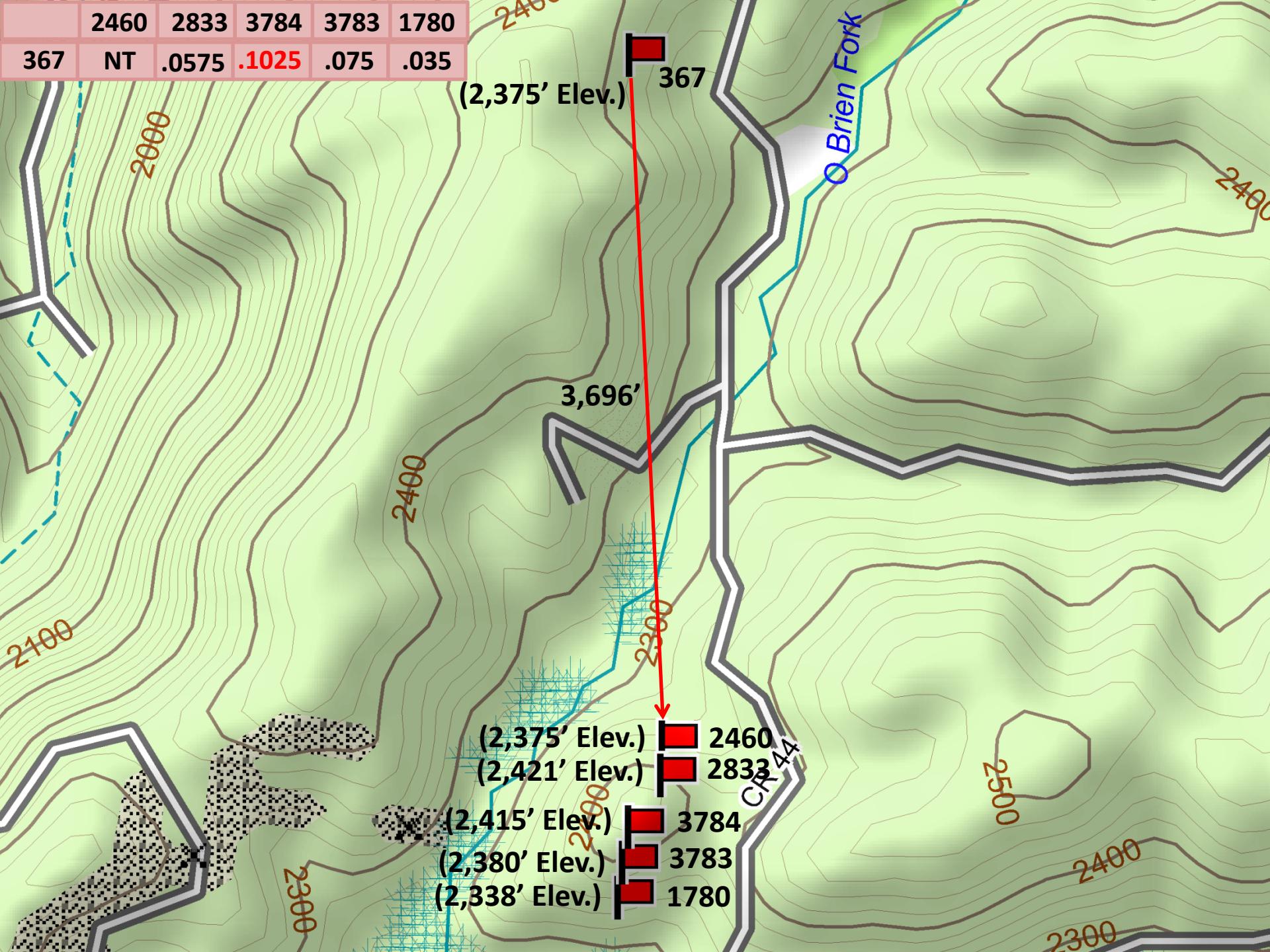
1,900' Elev.

	1780	3783	3784	2833	2460	
371	.065	.1075	<b>.1175</b>	.0725	NT	
391	.055	.0775	.185	<b>.245</b>	.1575	
402	.020	.035	.065	<b>.080</b>	.045	
418	.090	.215	<b>.265</b>	<b>.265</b>	.2475	
434	.060	.1075	<b>.130</b>	.065	.0825	



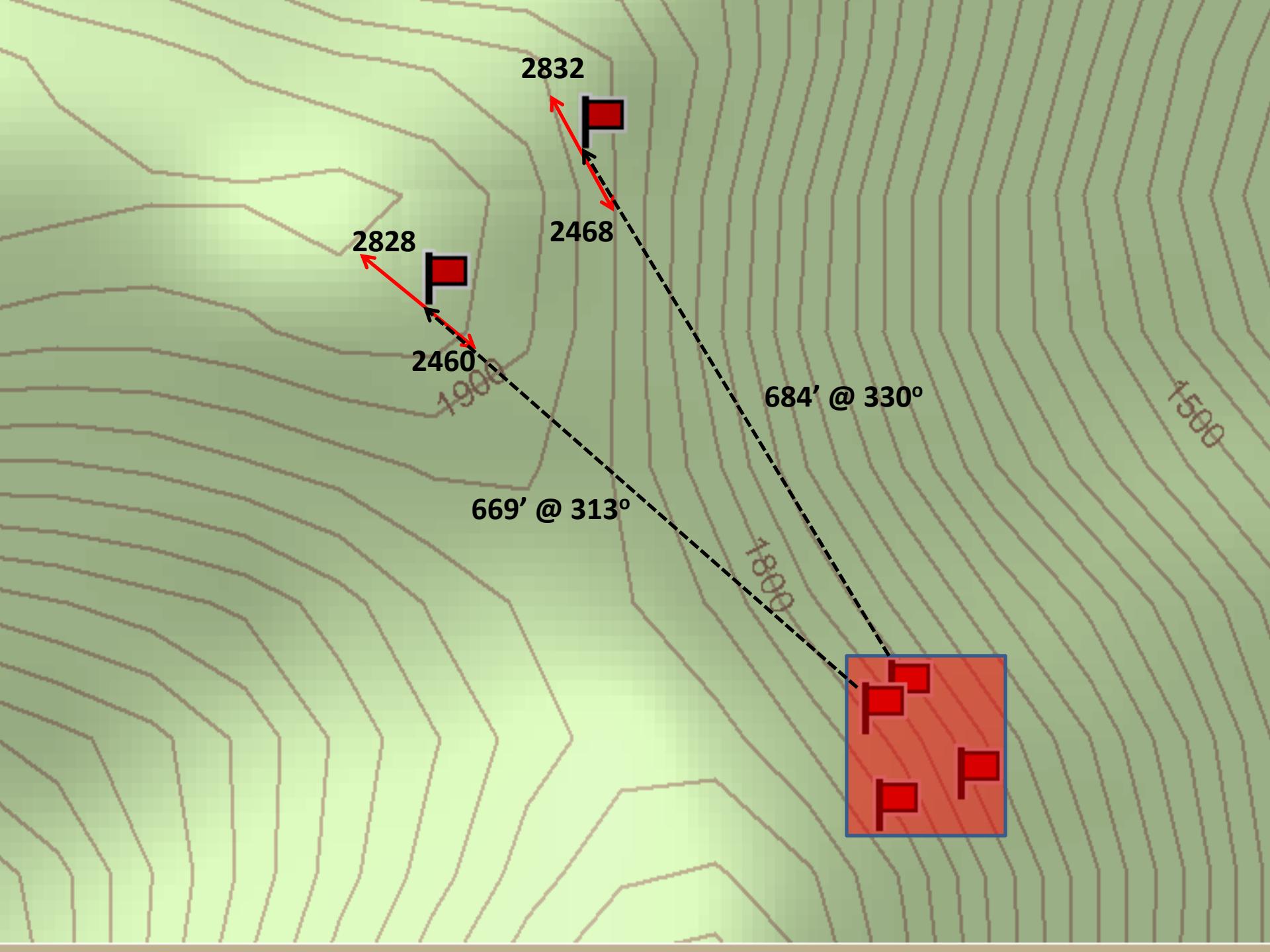
**2460** **2833** **3784** **3783** **1780**

**367**    NT    **.0575**    **.1025**    **.075**    **.035**

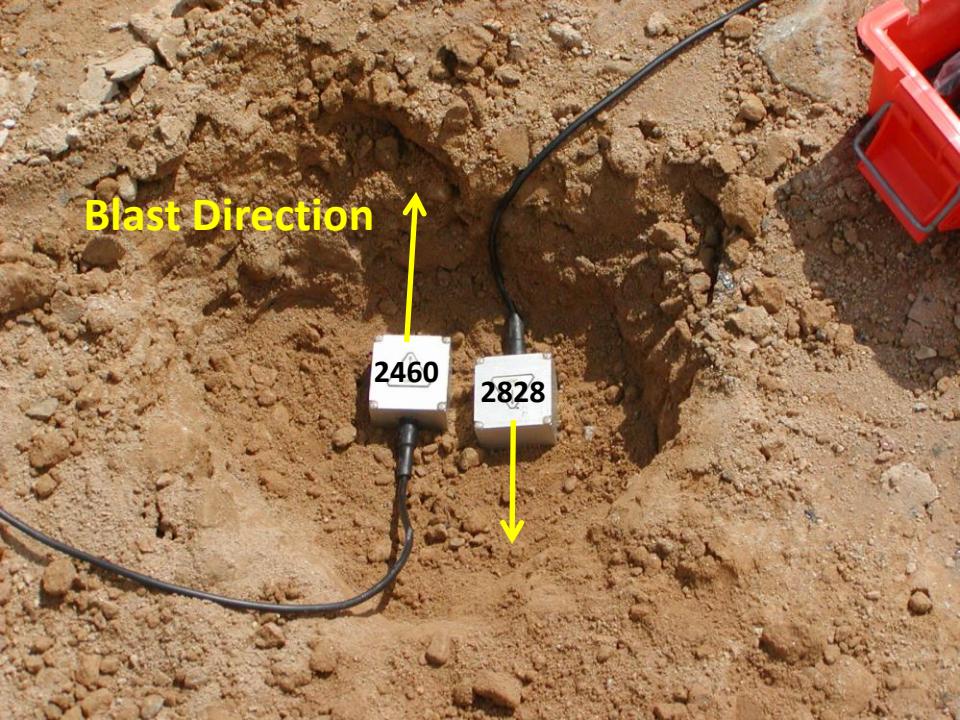
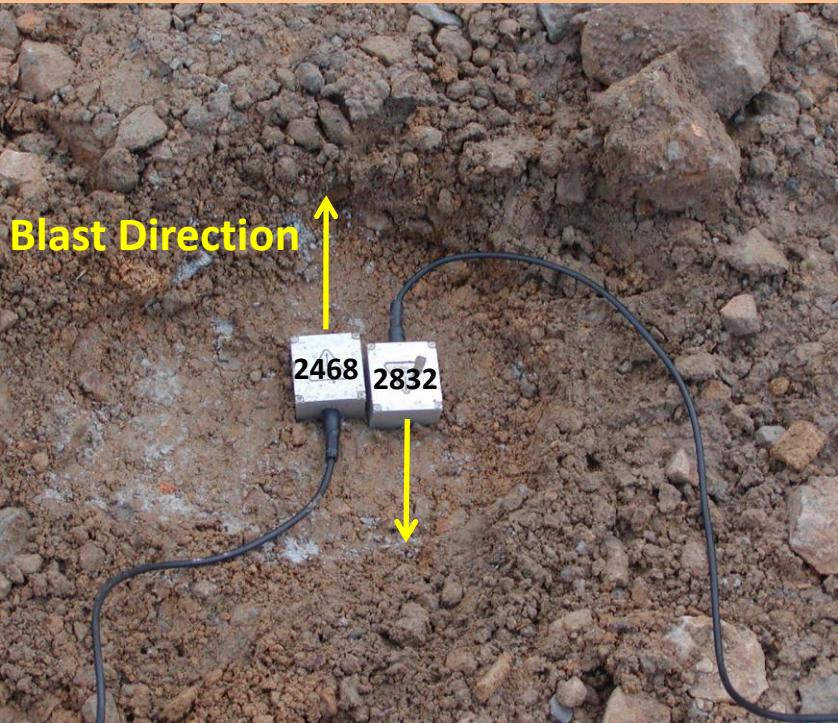


# **GEOPHONE ORIENTATION**

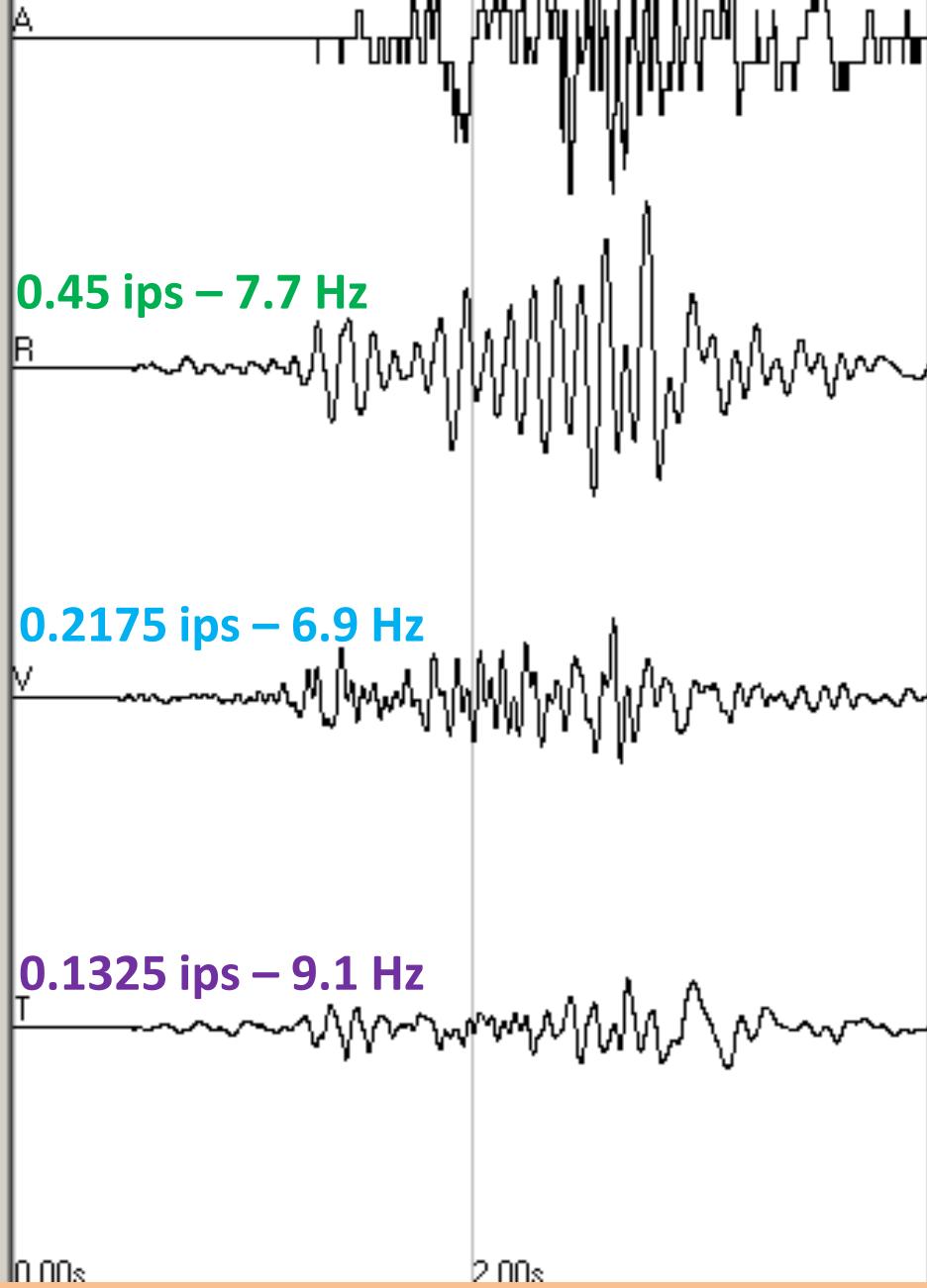
## **CASE 1**



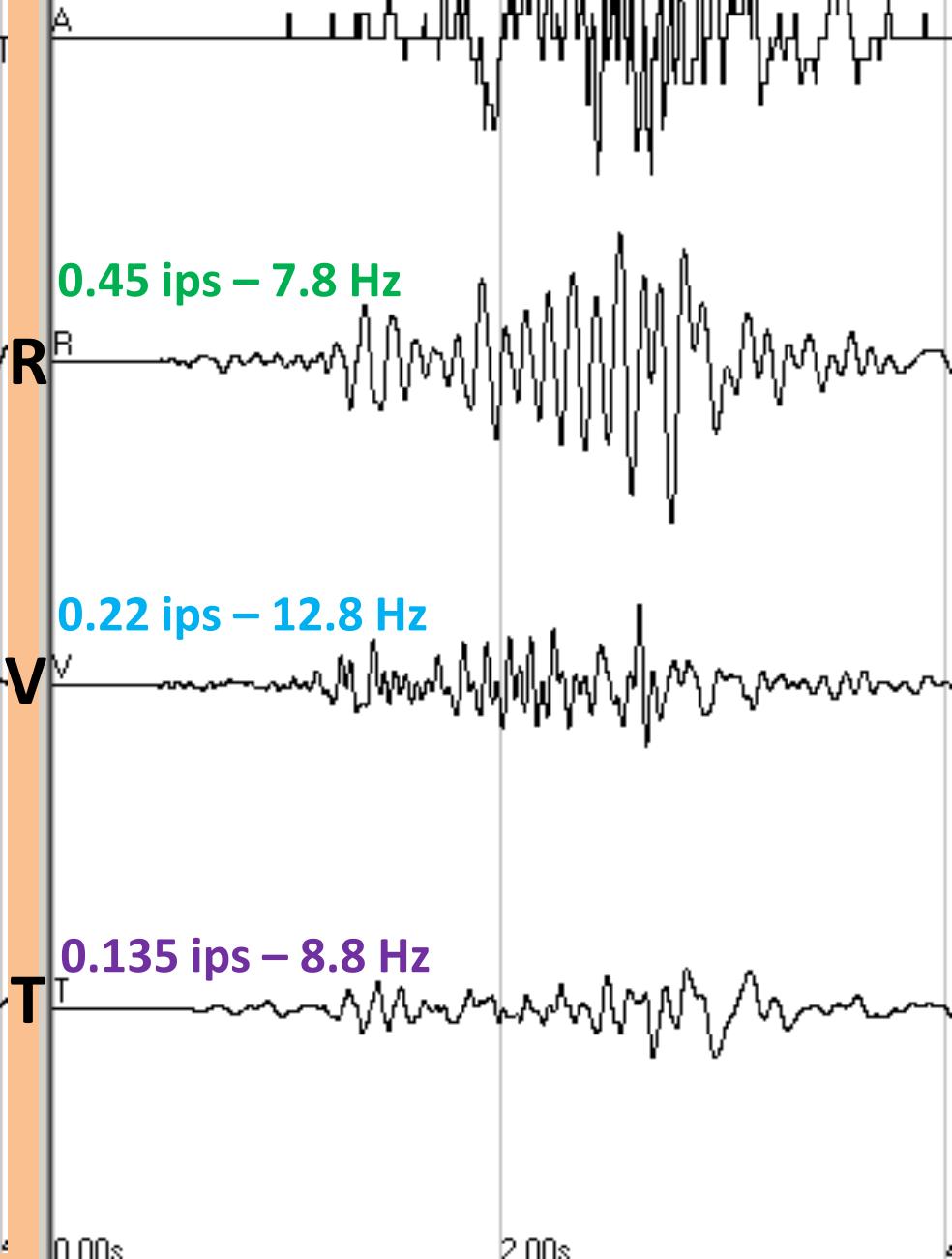
3/29/06



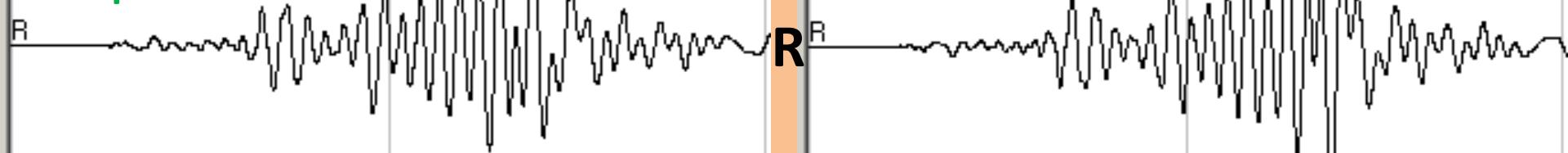
2460 – Radial Towards Blast



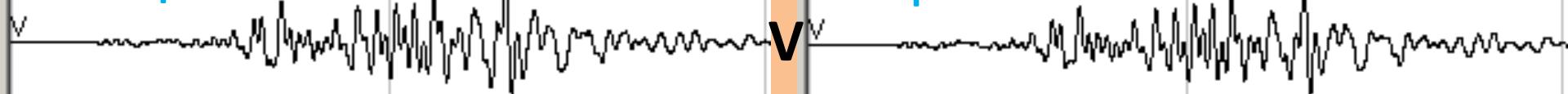
2828 – Radial 180° From Blast



0.45 ips – 7.7 Hz

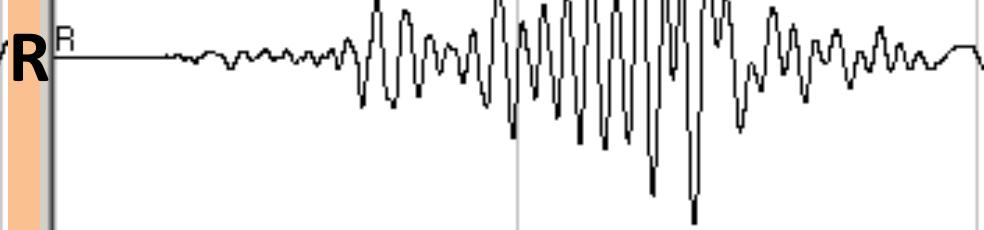


0.2175 ips – 6.9 Hz



0.1325 ips – 9.1 Hz

0.45 ips – 7.8 Hz



0.22 ips – 12.8 Hz



0.135 ips – 8.8 Hz

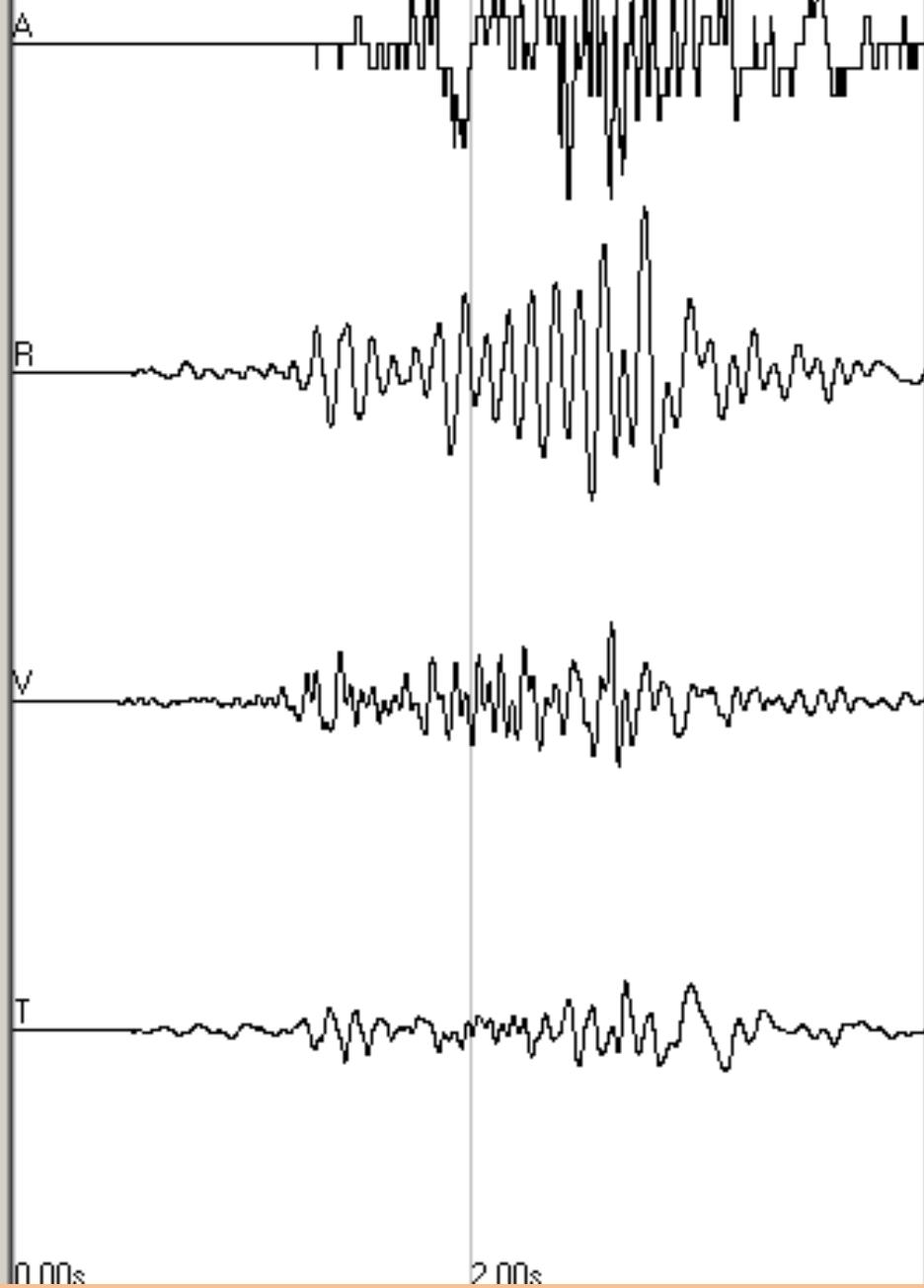
0.00s

2.00s

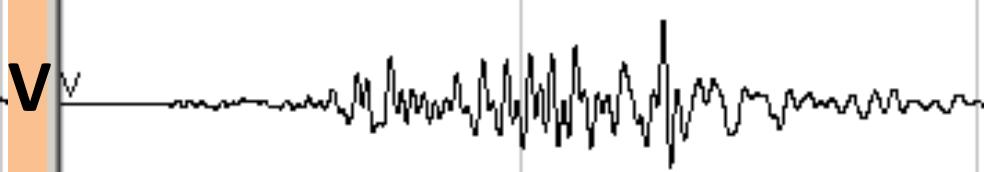
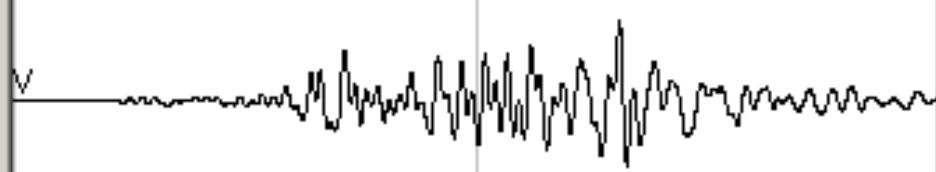
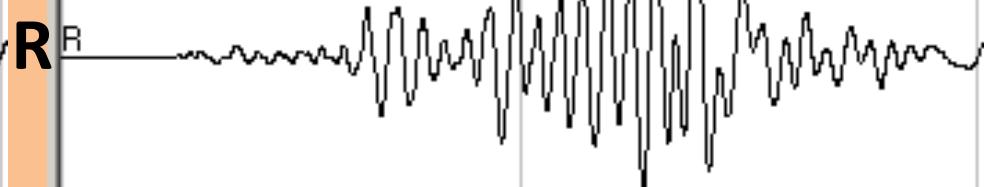
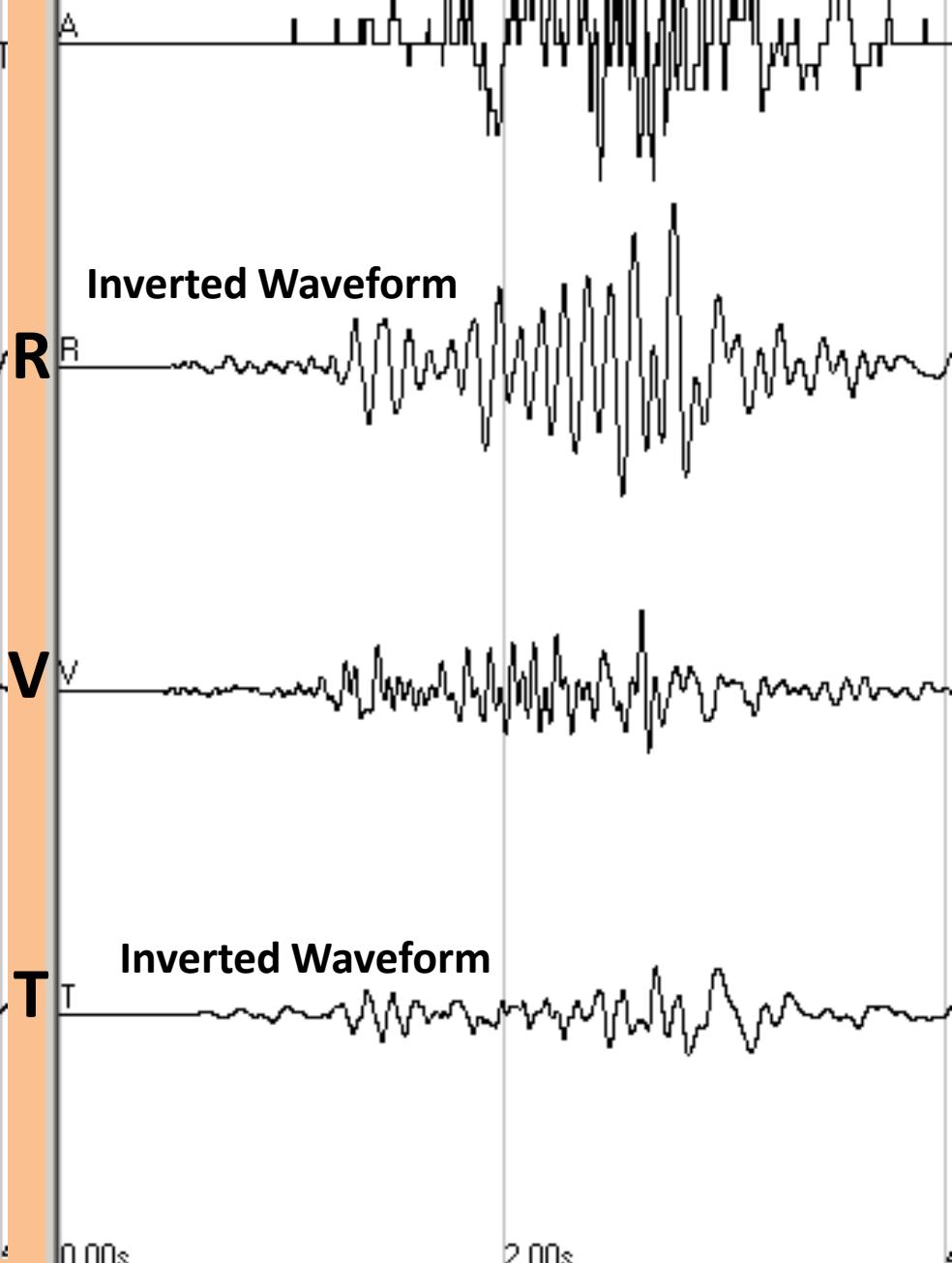
0.00s

2.00s

**2460 – Radial Towards Blast**

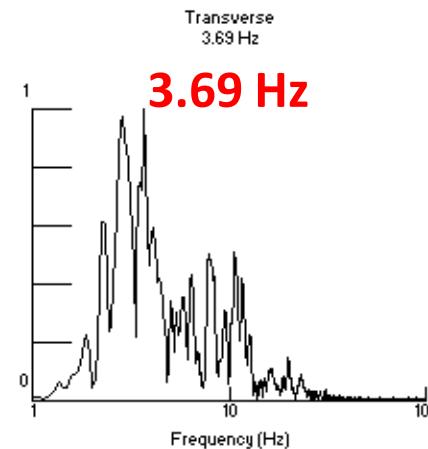
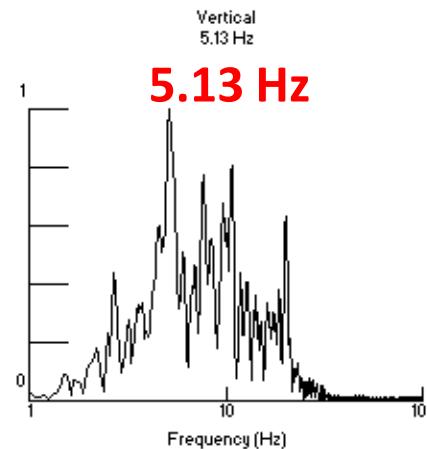
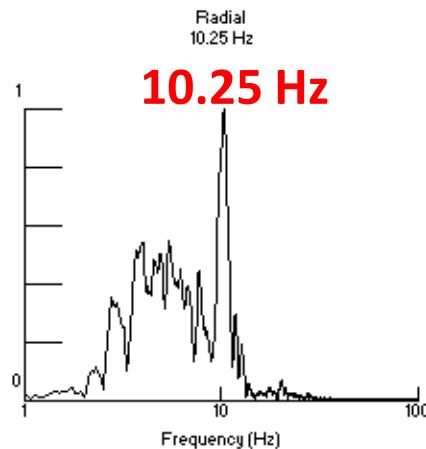
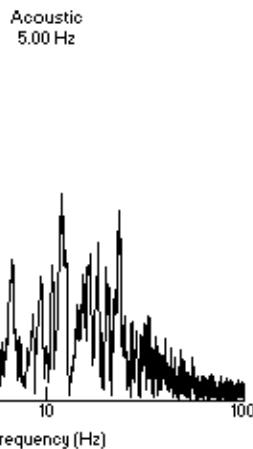


**2828 – Radial 180° From Blast**

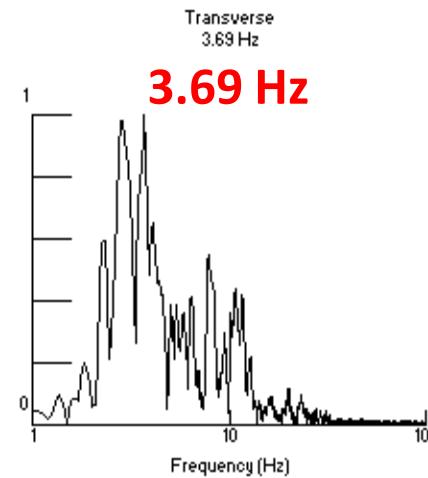
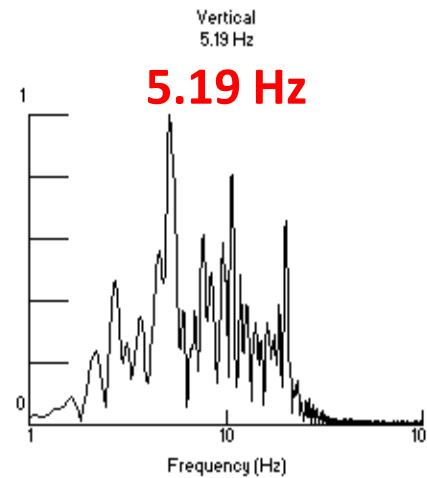
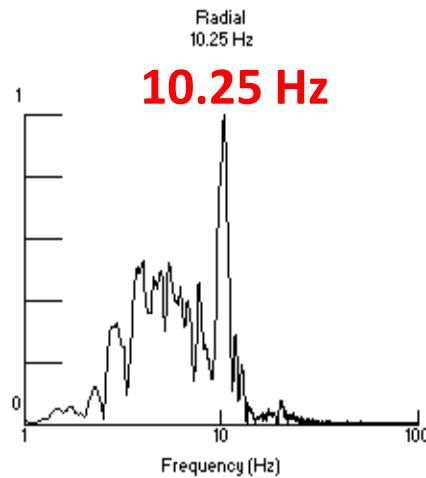
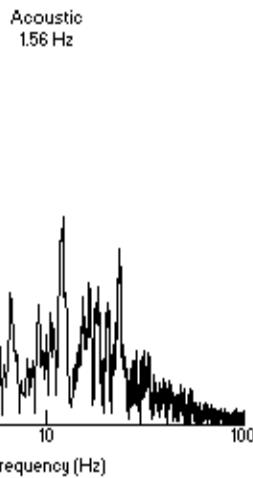


# Fast Fourier Transform (FFT) Comparison

2460



2828



**2468 – Radial Towards Blast**



**0.66 ips – 6.4 Hz**



**0.245 ips – 13.1 Hz**



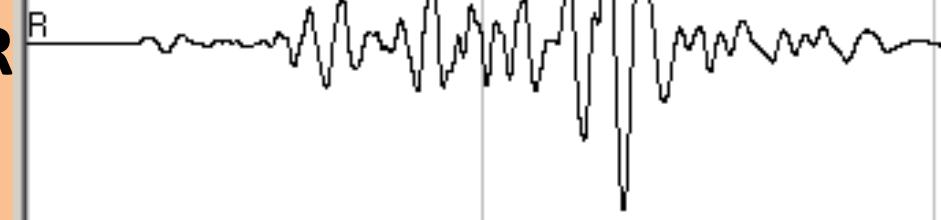
**0.32 ips – 7.7 Hz**



**2832 – Radial 180° From Blast**



**0.65 ips – 6.4 Hz**



**0.248 ips – 5.9 Hz**



**0.33 ips – 7.8 Hz**



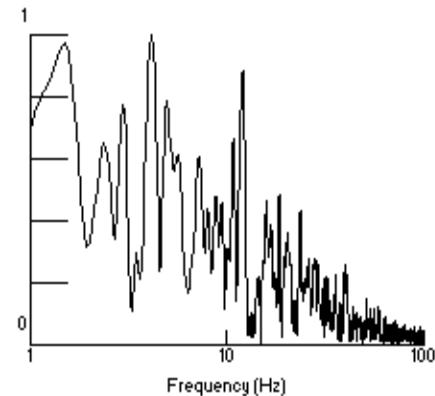
0.00s

2.00s

# Fast Fourier Transform (FFT) Comparison

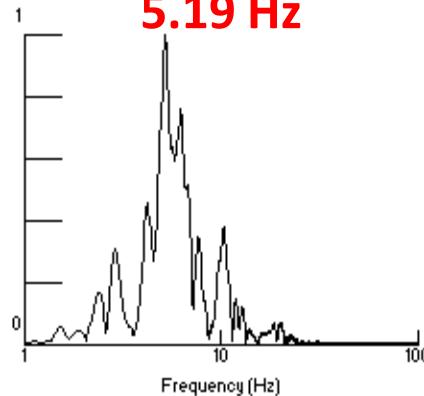
2468

Acoustic  
4.19 Hz



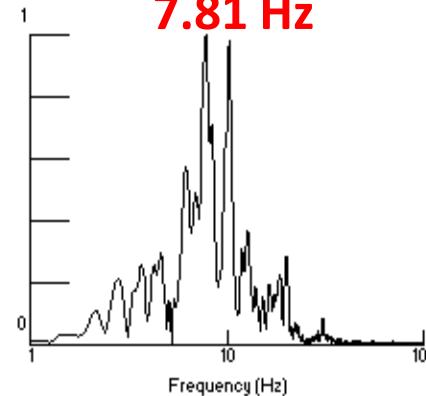
Radial  
5.19 Hz

5.19 Hz



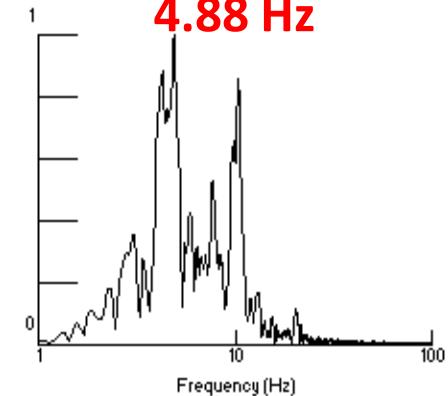
Vertical  
7.81 Hz

7.81 Hz



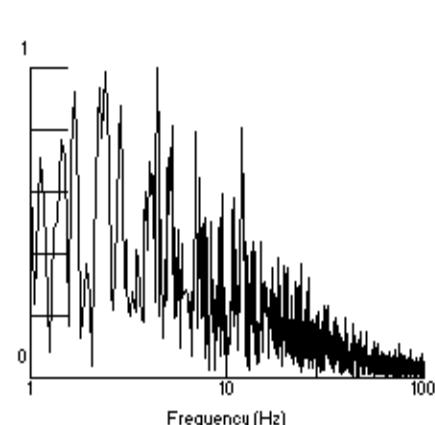
Transverse  
4.88 Hz

4.88 Hz



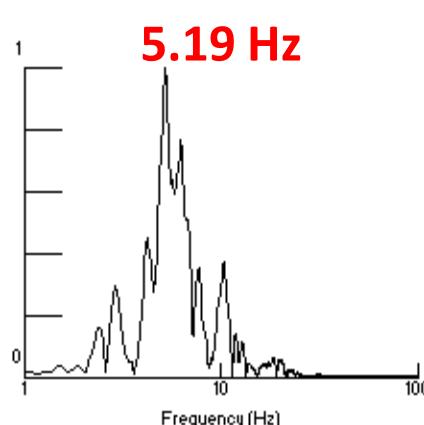
2832

Acoustic  
4.44 Hz



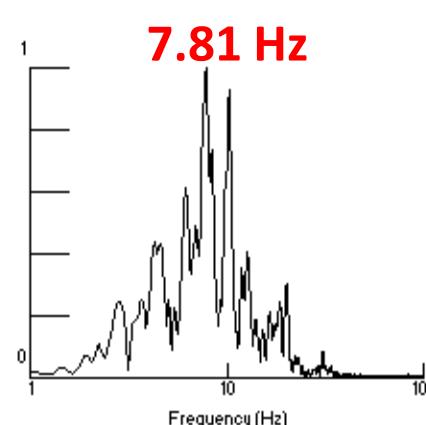
Radial  
5.19 Hz

5.19 Hz



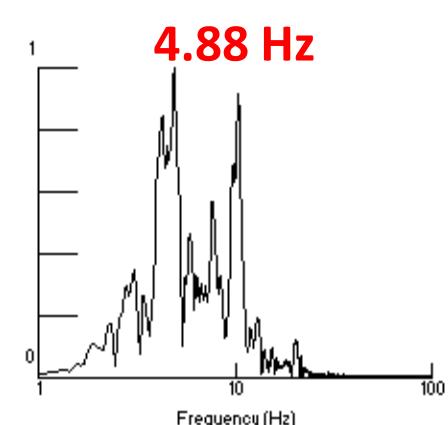
Vertical  
7.81 Hz

7.81 Hz



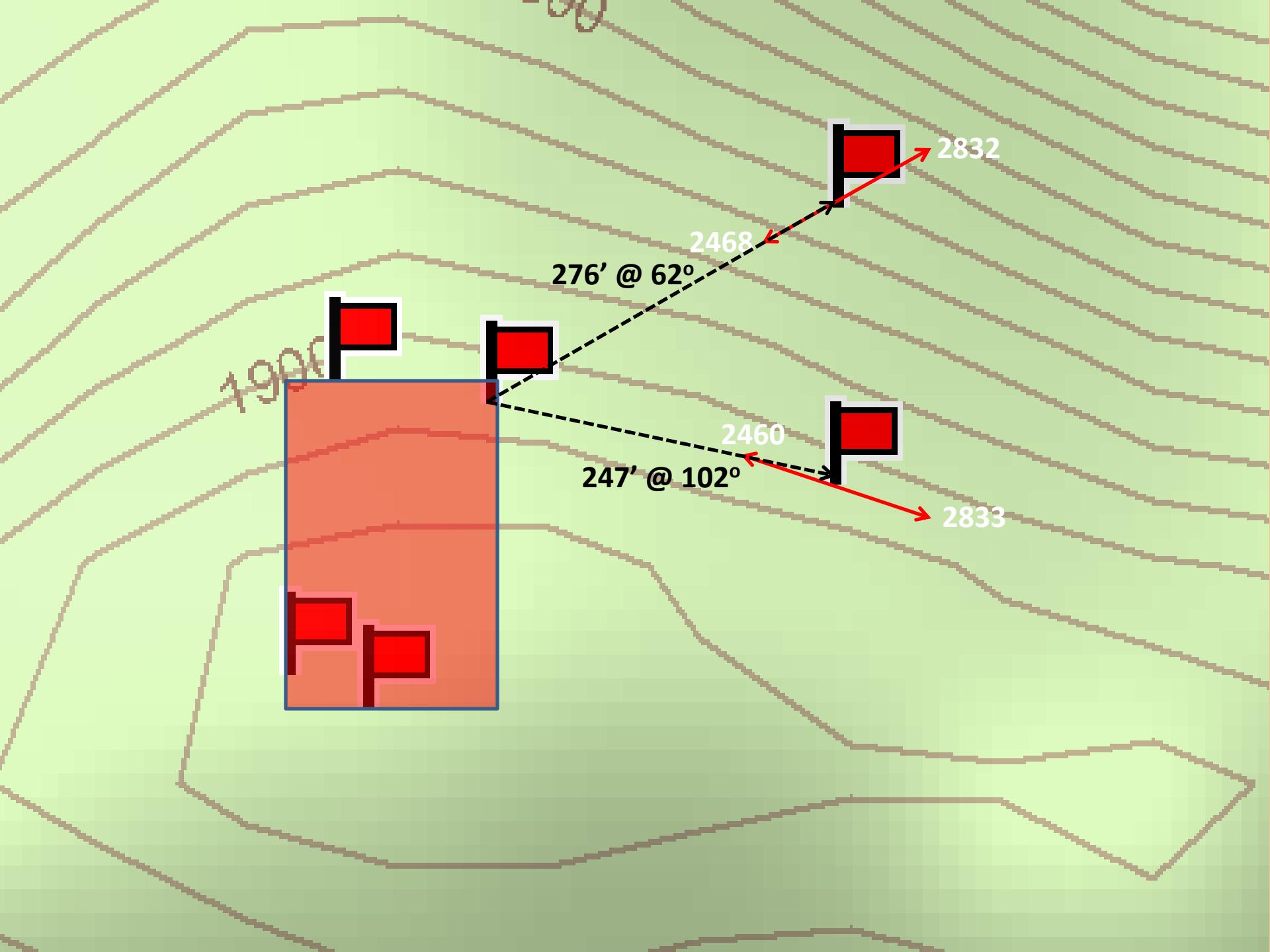
Transverse  
4.88 Hz

4.88 Hz

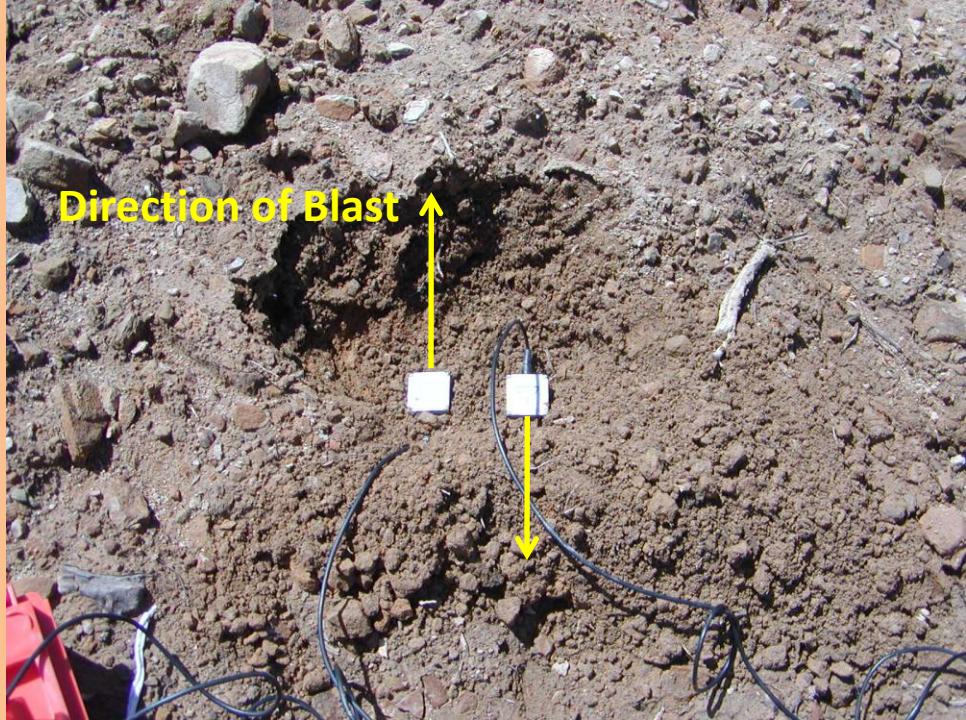
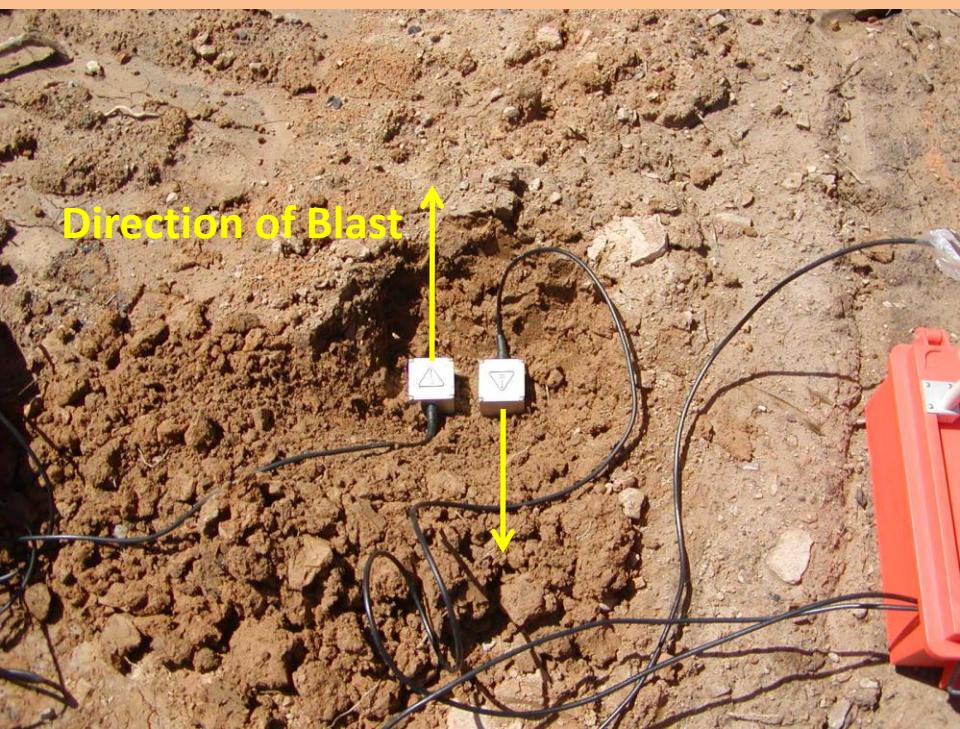


# **GEOPHONE ORIENTATION**

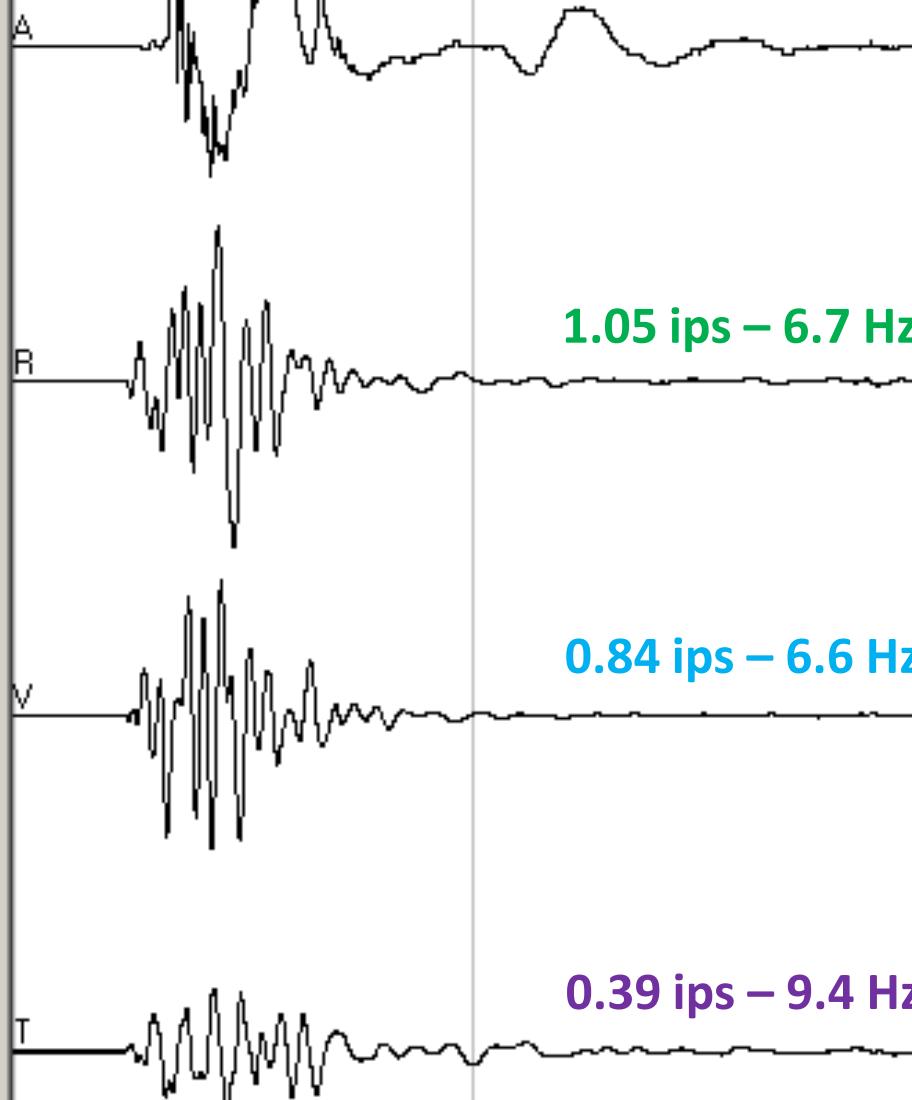
## **CASE 2**



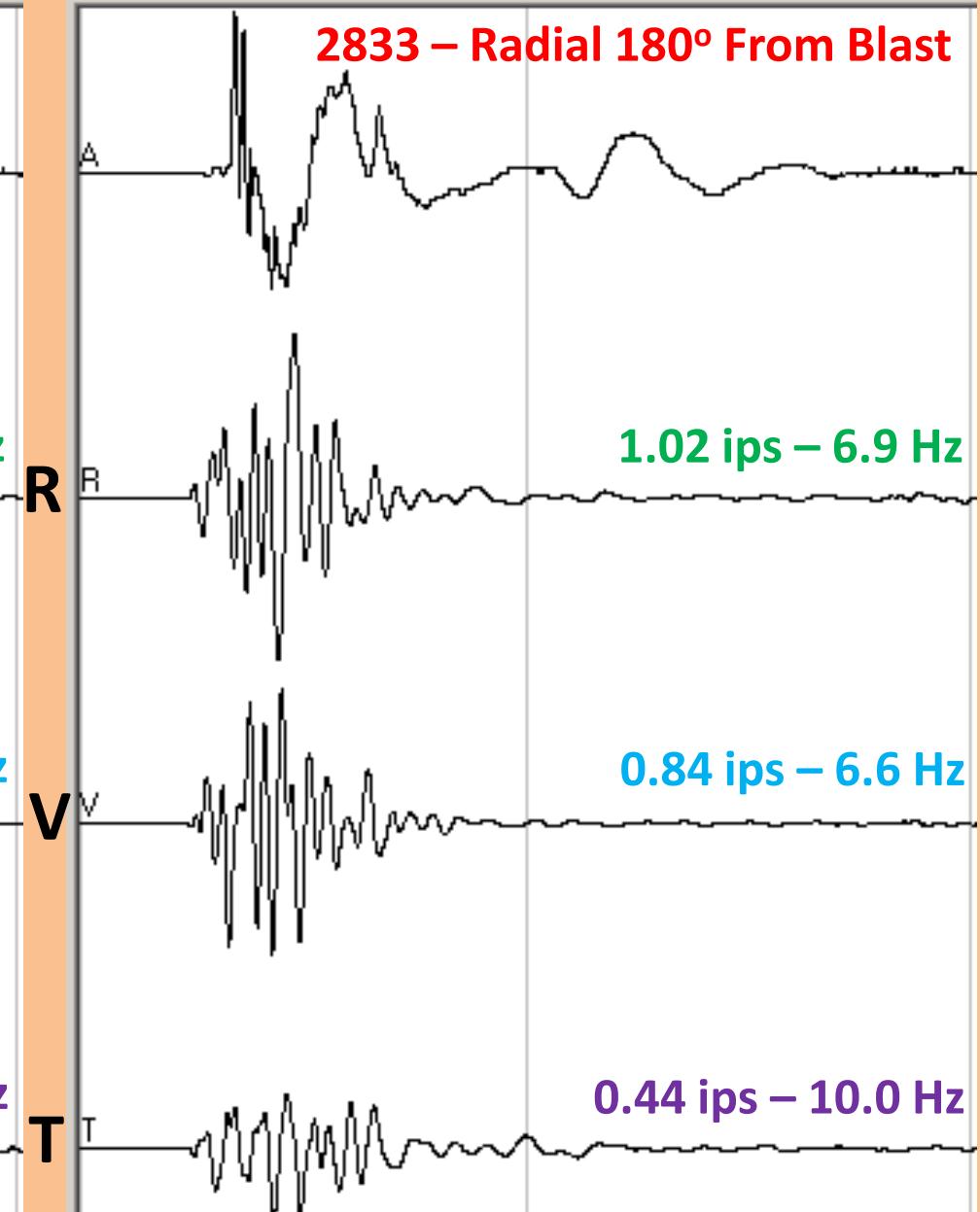
4/10/06



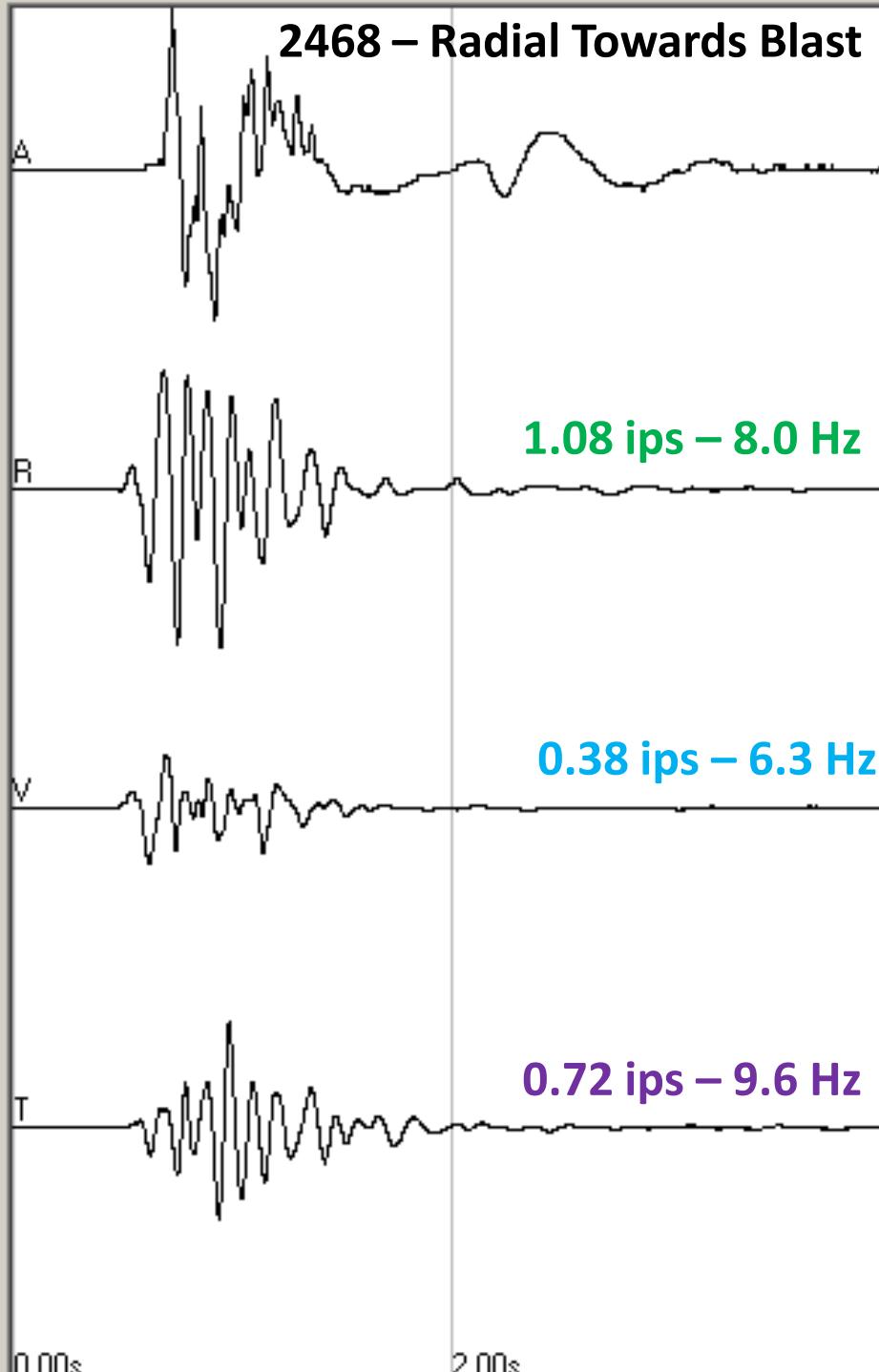
**2460 – Radial Towards Blast**



**2833 – Radial 180° From Blast**



**2468 – Radial Towards Blast**

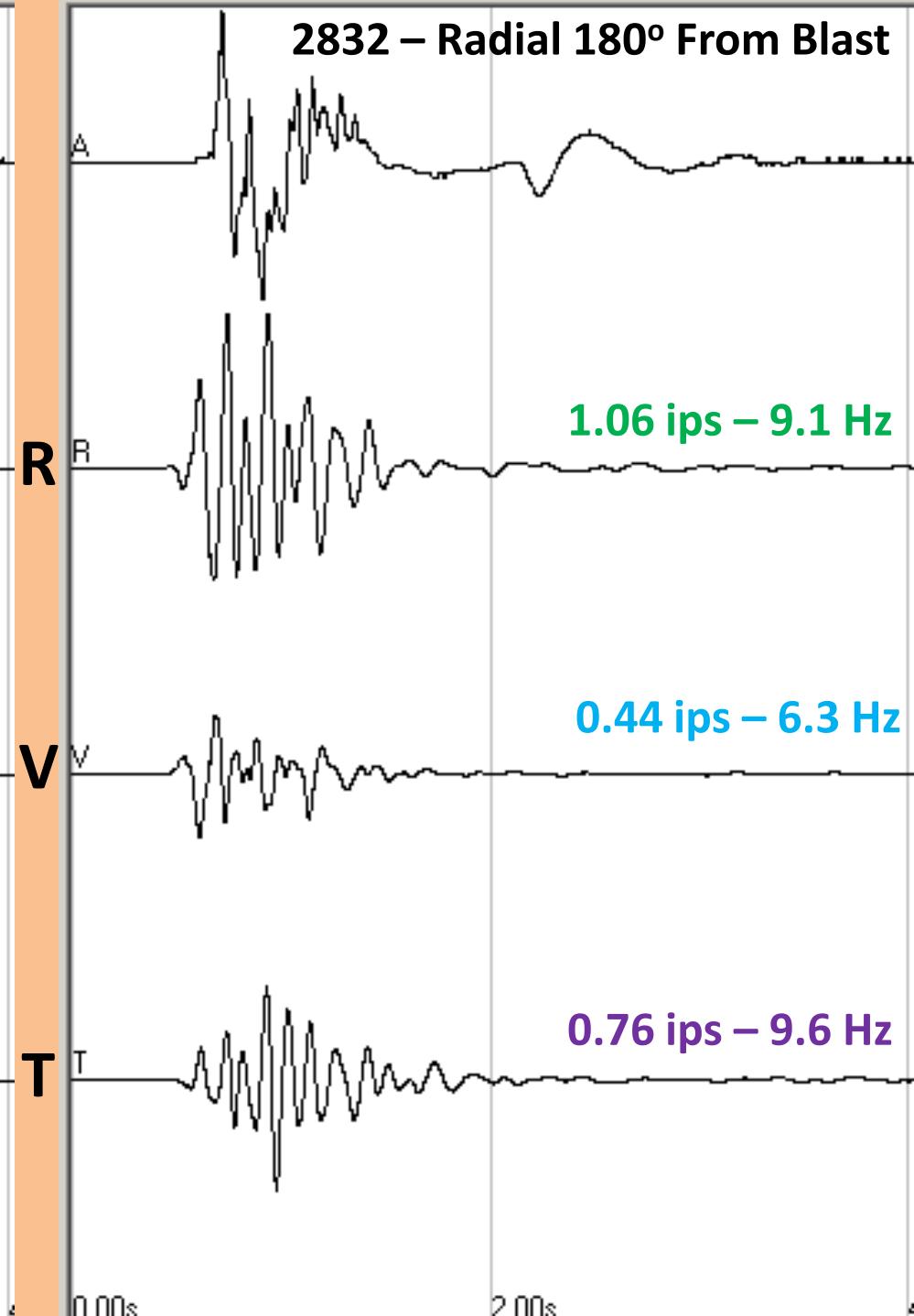


**1.08 ips – 8.0 Hz**

**0.38 ips – 6.3 Hz**

**0.72 ips – 9.6 Hz**

**2832 – Radial 180° From Blast**



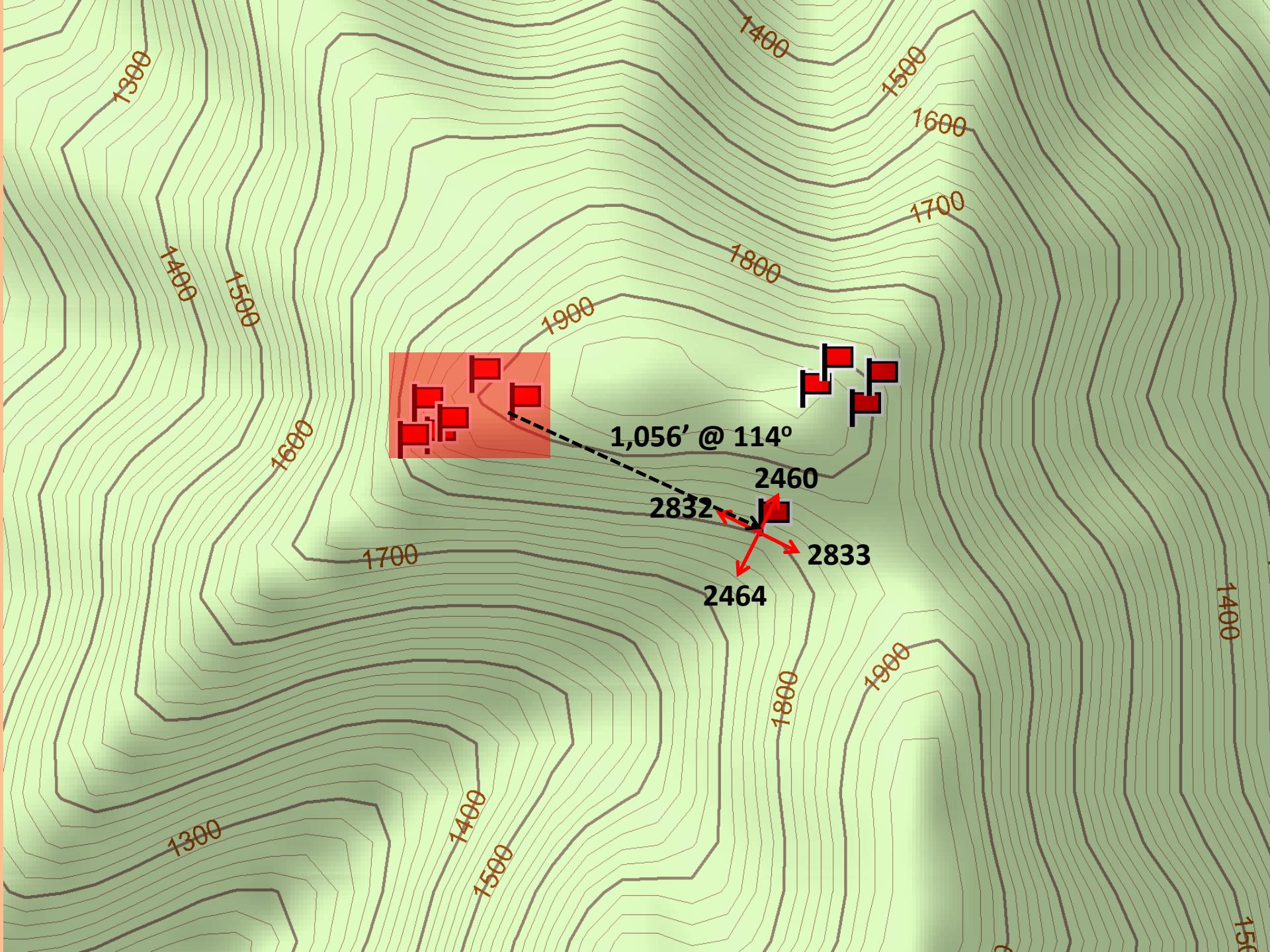
**1.06 ips – 9.1 Hz**

**0.44 ips – 6.3 Hz**

**0.76 ips – 9.6 Hz**

# **GEOPHONE ORIENTATION**

## **CASE 3**



2/24/06

Direction of Blast

2832

2464

2460

2833

**2832 – Radial  
Towards Blast**

**0.0475 ips – 11.6 Hz**

**0.055 ips – 11.3 Hz**

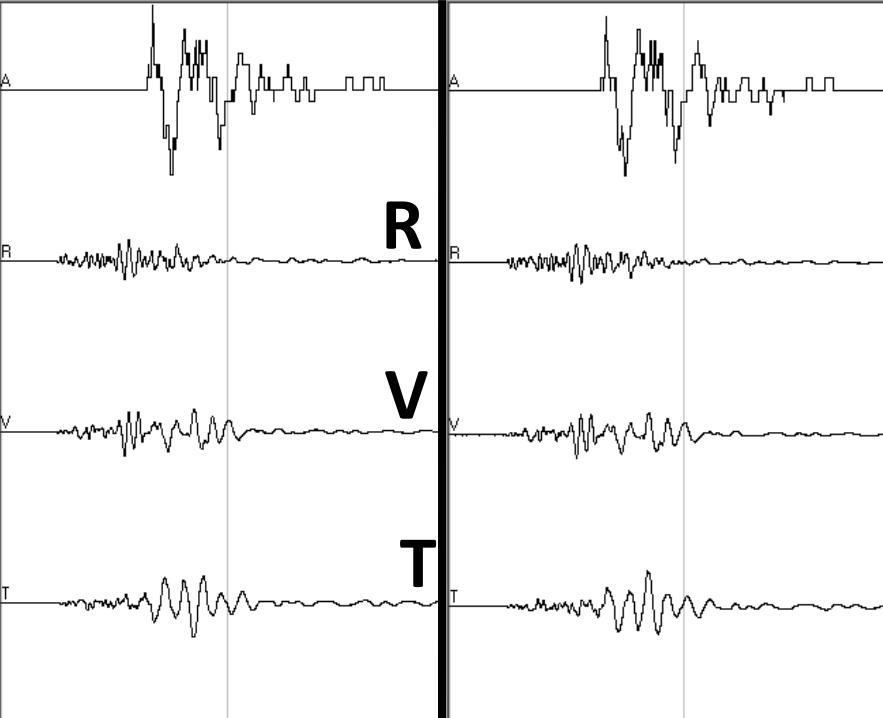
**0.08 ips – 6.0 Hz**

**2464 – Radial  
270° From Blast**

**0.0875 ips – 6.1 Hz**

**0.055 ips – 11.6 Hz**

**0.0475 ips – 11.3 Hz**

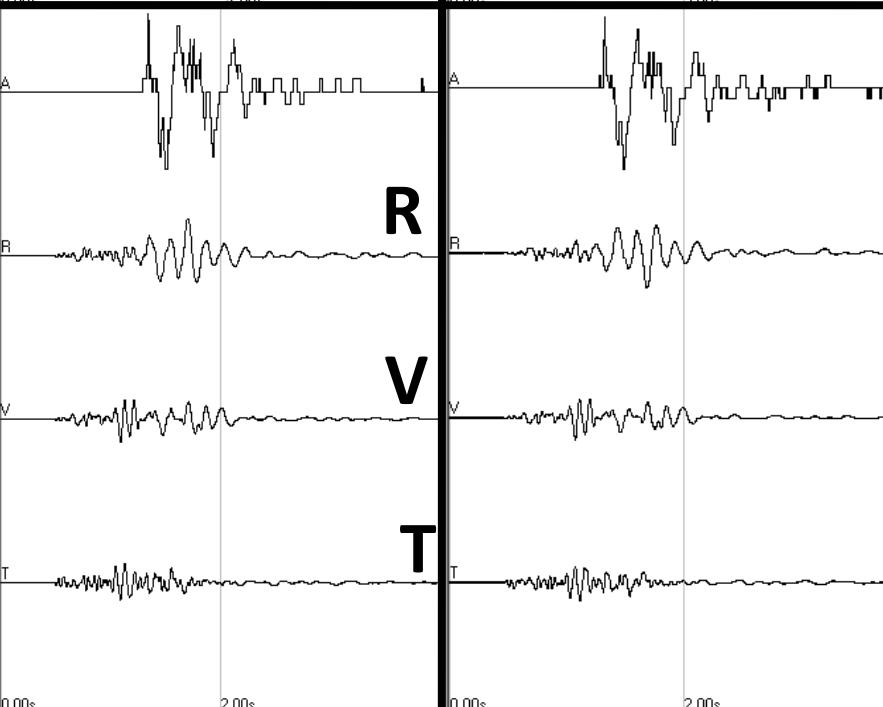


**2833 – Radial  
180° From Blast**

**0.05 ips – 11.3 Hz**

**0.055 ips – 11.3 Hz**

**0.0825 ips – 6.0 Hz**

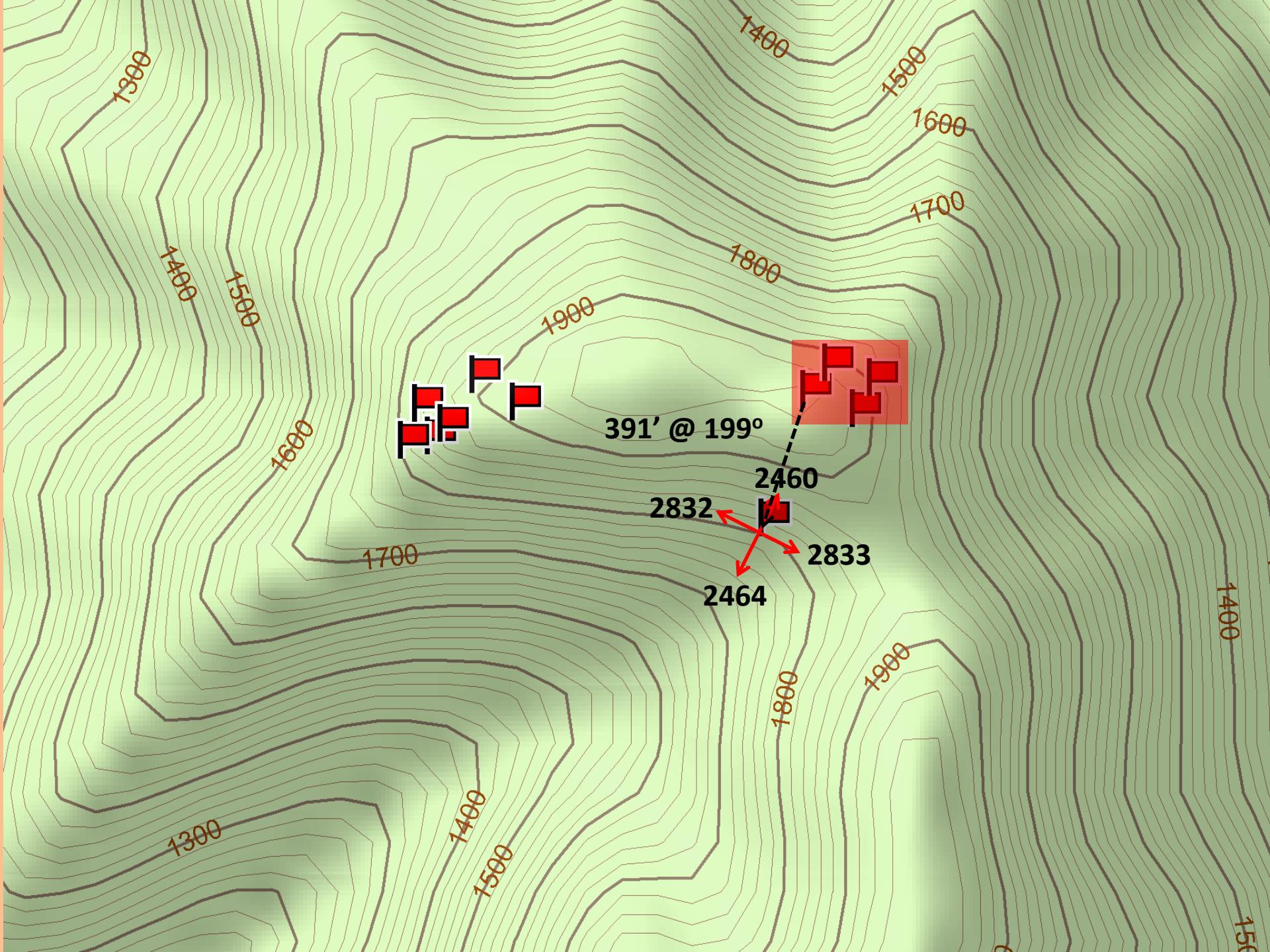


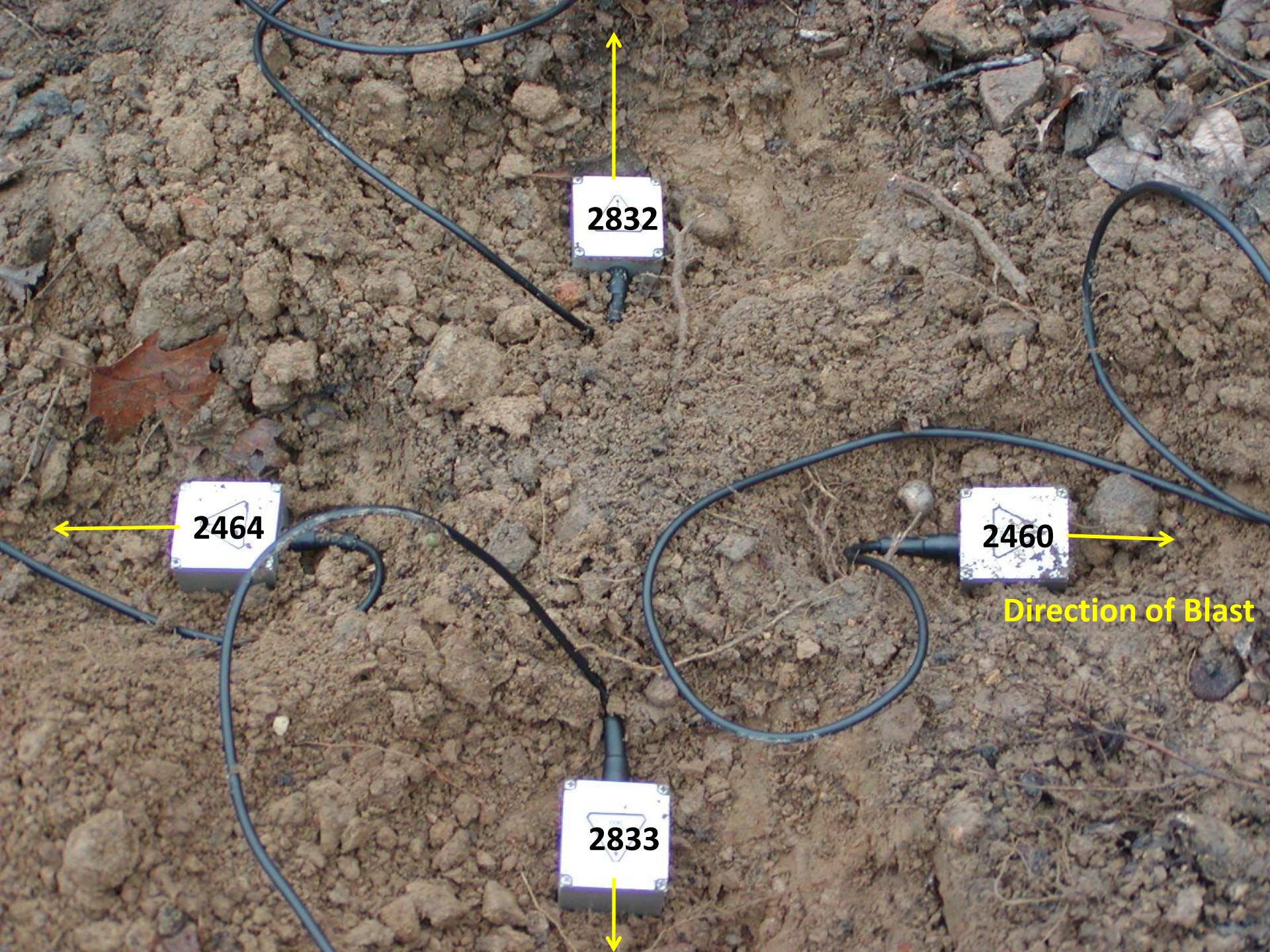
**2460 – Radial  
90° From Blast**

**0.0875 ips – 6.1 Hz**

**0.055 ips – 11.6 Hz**

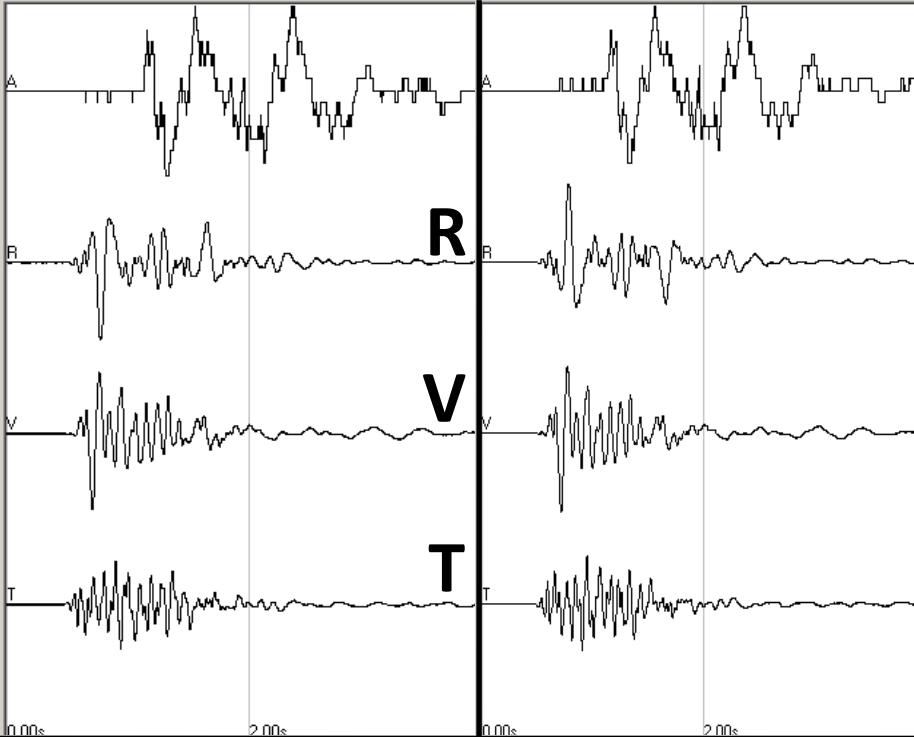
**0.045 ips – 10.8 Hz**





## **2460 – Radial Towards Blast**

**0.1825 ips – 6.6 Hz**



## **2464 – Radial 180° From Blast**

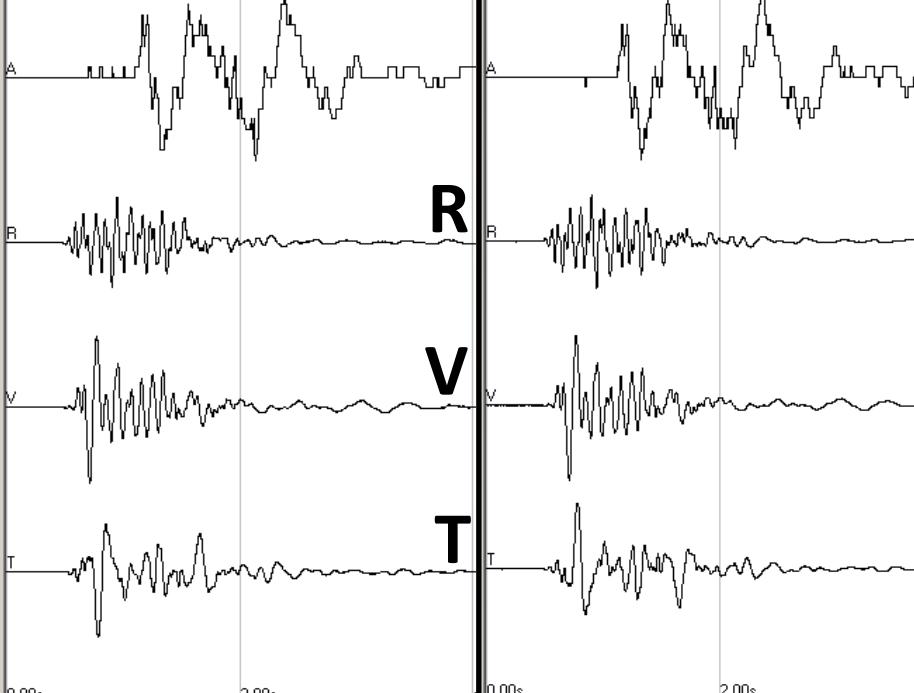
**0.18 ips – 6.7 Hz**

**0.185 ips – 8.0 Hz**

**0.1125 ips – 12.1 Hz**

## **2832 – Radial 270° From Blast**

**0.11 ips – 13.4 Hz**



## **2833 – Radial 90° From Blast**

**0.1175 ips – 11.9 Hz**

**0.185 ips – 8.1 Hz**

**0.1575 ips – 6.7 Hz**

# Geophone Orientation & Waveform Analysis

- 1) Vertical waveforms are similar independent of geophone orientation
- 2) Radial & Tangential waveforms are inverted when geophones orientated 180°
- 3) Radial waveforms at 0° are similar to tangential waveform at 270°
- 4) Tangential waveforms at 0° are similar to radial waveform at 90°

# Geophone Orientation & Waveform Analysis

- 5) Radial waveforms at 180° are similar to tangential waveform at 90°
- 6) Tangential waveforms at 180° are similar to radial waveform at 270°
- 7) R,T, and V particle velocities show minor differences independent of geophone orientation
- 8) Variance in Zero-Crossing frequencies are not as apparent in FFT frequencies

# THANK YOU

