Seismic Refraction

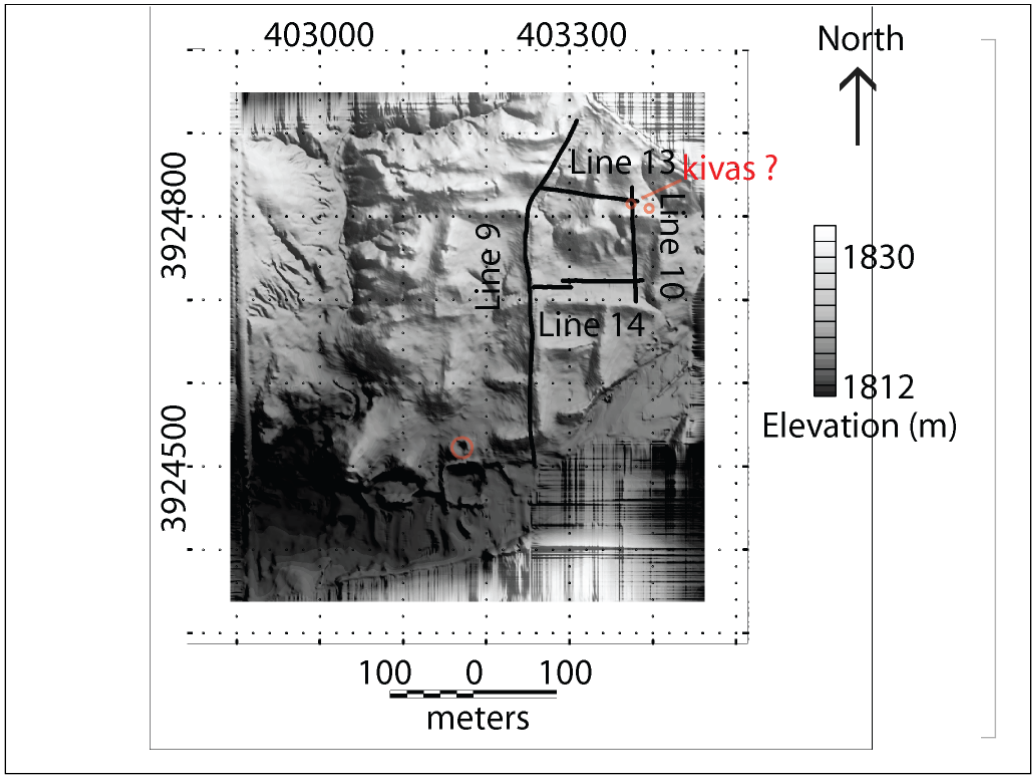
Matt Beachly

Archeological Targets

- Excavations
  - Kivas
  - Room-blocks
  - Trenches (Nels Nelson)

Survey Design

- Line 10 extension 50 m
- Line 13 120 m
- Line 14 100 m


403000
403300
North
3924800
3924500
Line 13
kivas ?
Line 9
Line 10
Line 14
1830
1812
Elevation (m)
100
0
100
meters

Survey Parameters

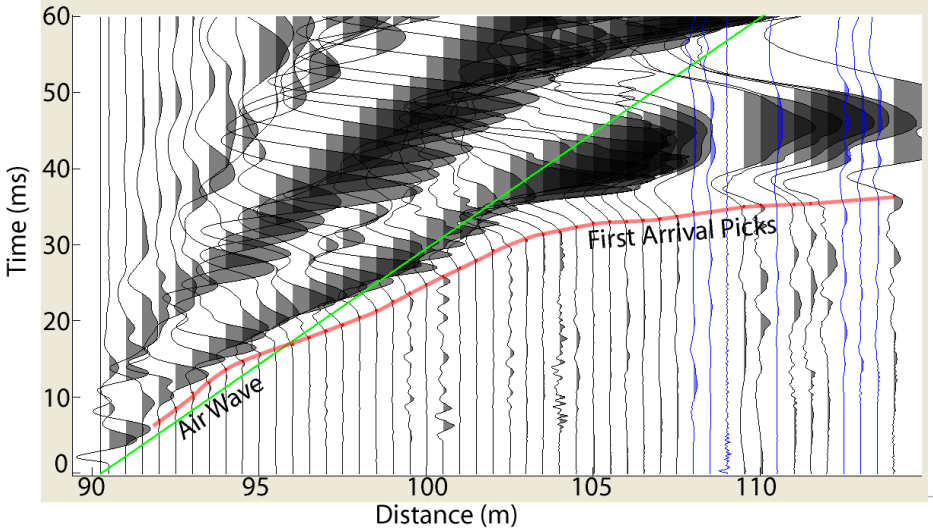
- 30 Hz vertical component geophones
- Hammer Source
- 48 geophones in the spread
- 0.5m geophone spacing
- 3m hammer station spacing
- 6 shot stacking
- Bison Seismic System

Data Processing

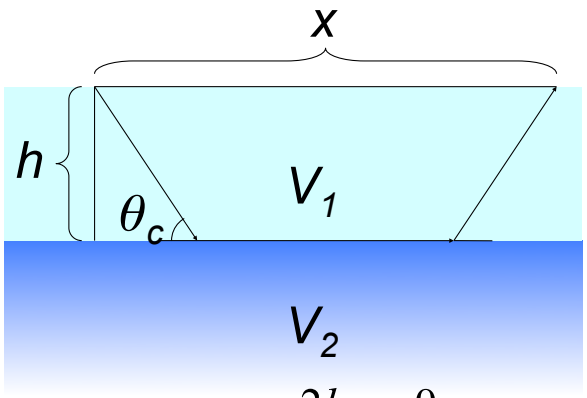
- Pick First Arrivals
- Design Forward Models
- Build Fence Diagram

- Software: MATLAB – geomod

Picking First Arrivals

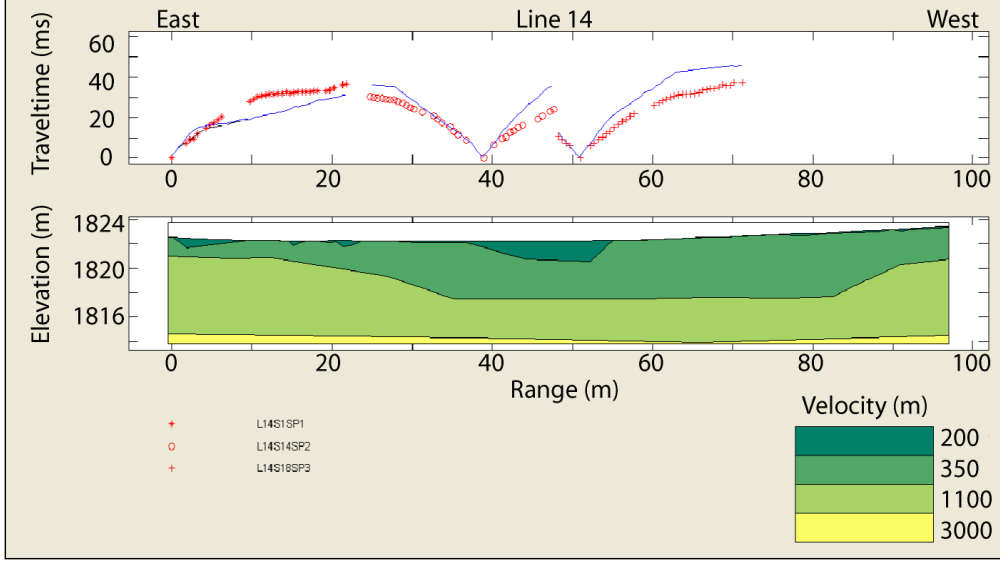


Refraction Geometry



$$t = \frac{x}{V_2} + \frac{2h\cos\theta_c}{V_1}$$

Forward Modeling

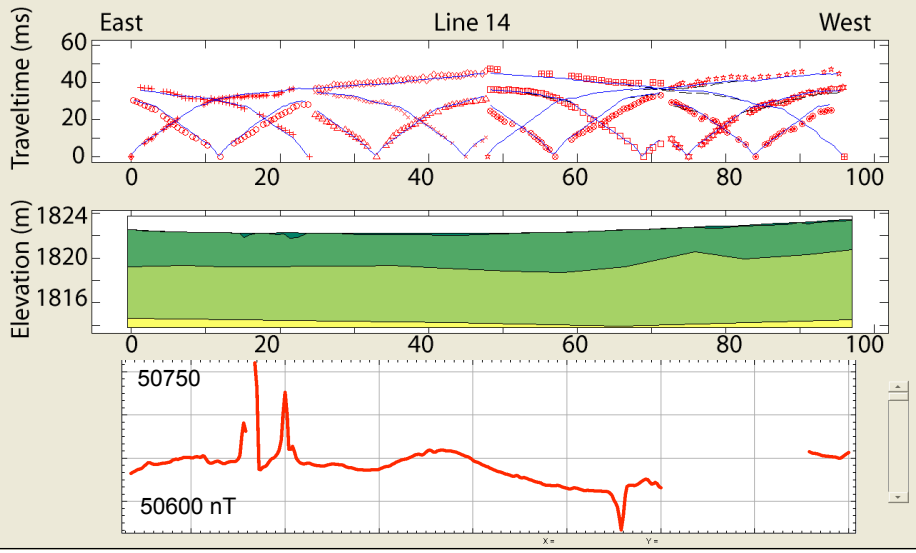


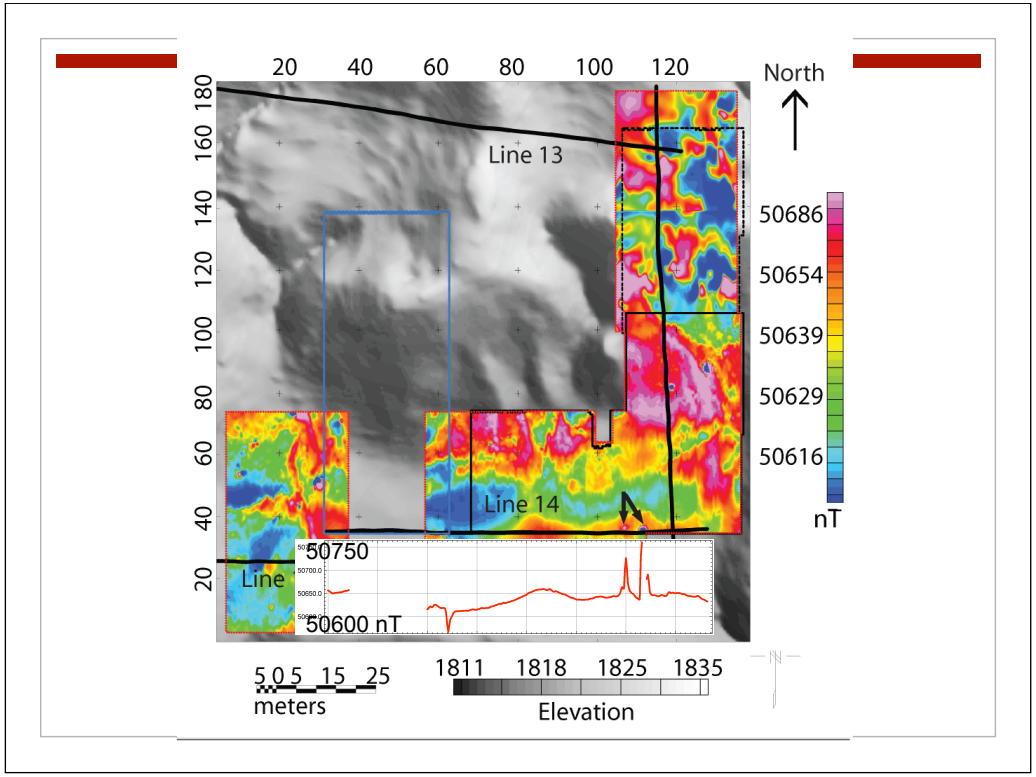
Velocities

- Soil: **200** m/s
- Fill: **300** m/s
- Terrace: **350** m/s
- Ancha Formation: **700-1100** m/s
- Galisteo Formation:

  m/s

Line 14


East
Line 14
West
Traveltime (ms)
60
40
20
0
0
20
40
60
80
100
Elevation (m)
1824
1820
1816
0
20
40
60
80
100
50750
50600 nT


20
40
60
80
100
120
North
180
160
140
120
100
80
60
40
20
Line 13
Line 14
Line
50686
50654
50639
50629
50616
nT
50750
50600 nT
5 0 5 15 25
meters
1811 1818 1825 1835
Elevation

Summary

- Processing
  - Geomod (Matlab)
  - First picks
  - Forward Model
- 2 fire pits on Line 14

Archeological Interpretations for Seismic Data

Shaun Finn

NEW MEXICO TECH
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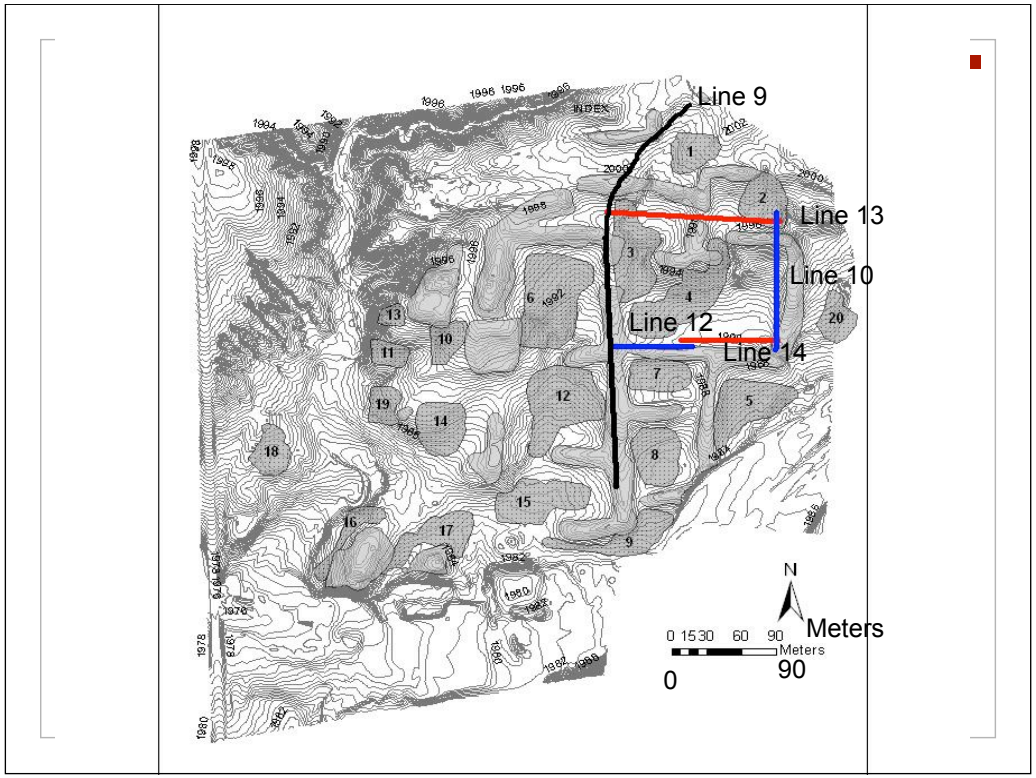
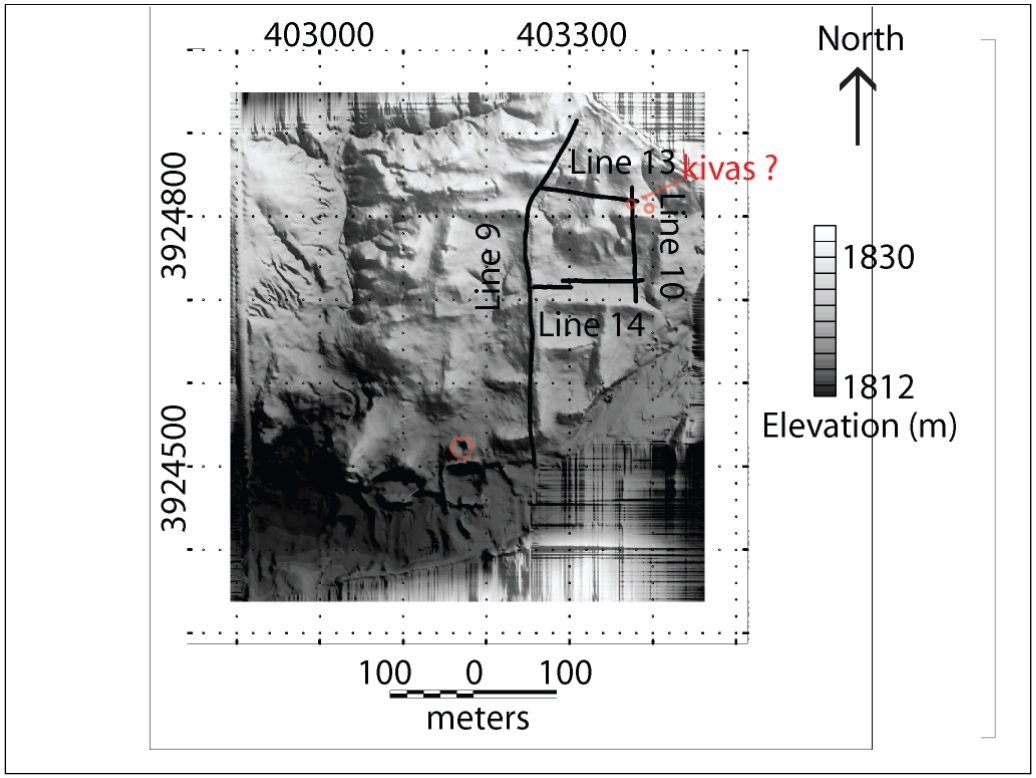

Line 9
Line 13
Line 10
Line 12
Line 14
N
Meters
0 15 30 60 90
Meters
0
90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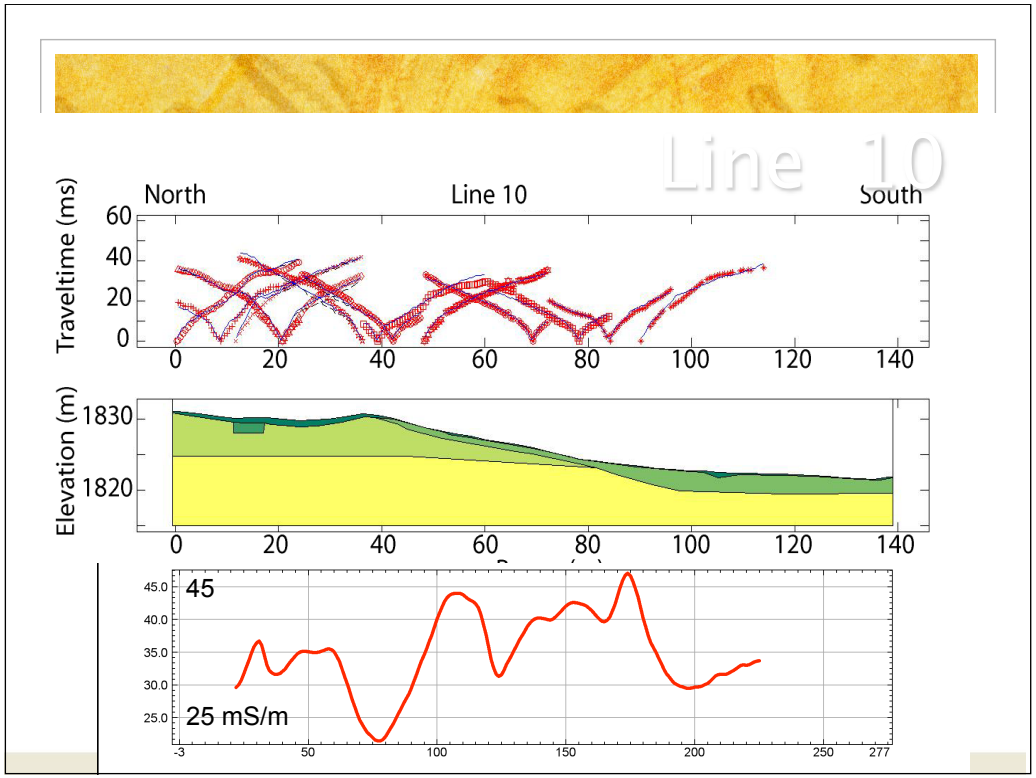
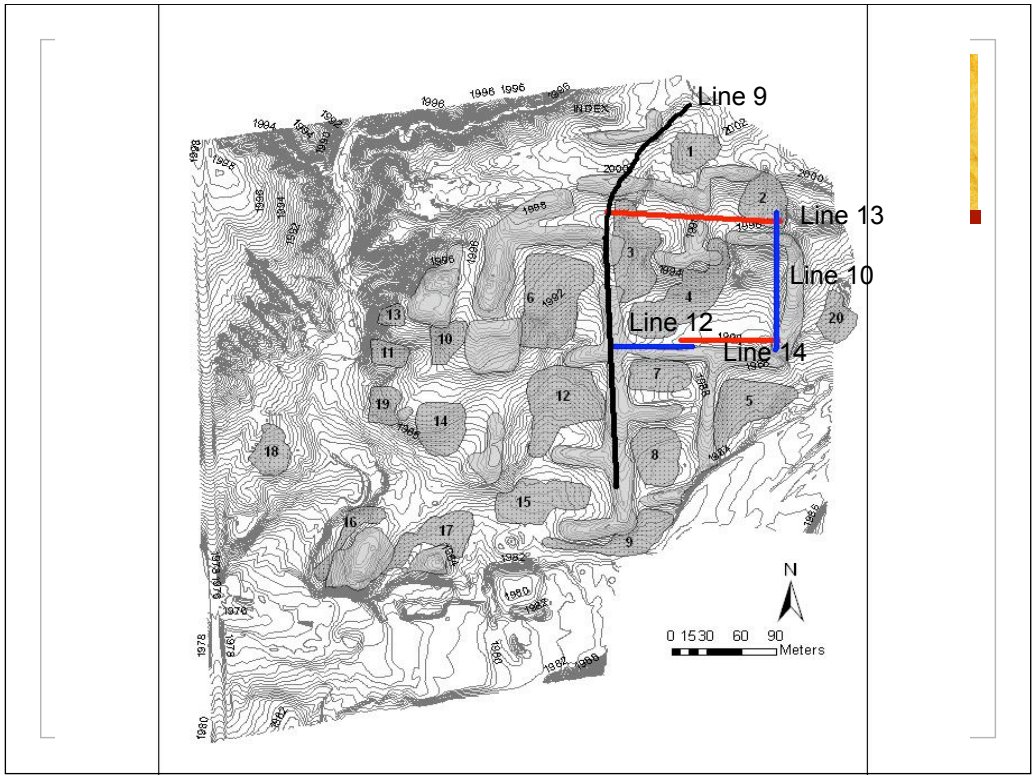
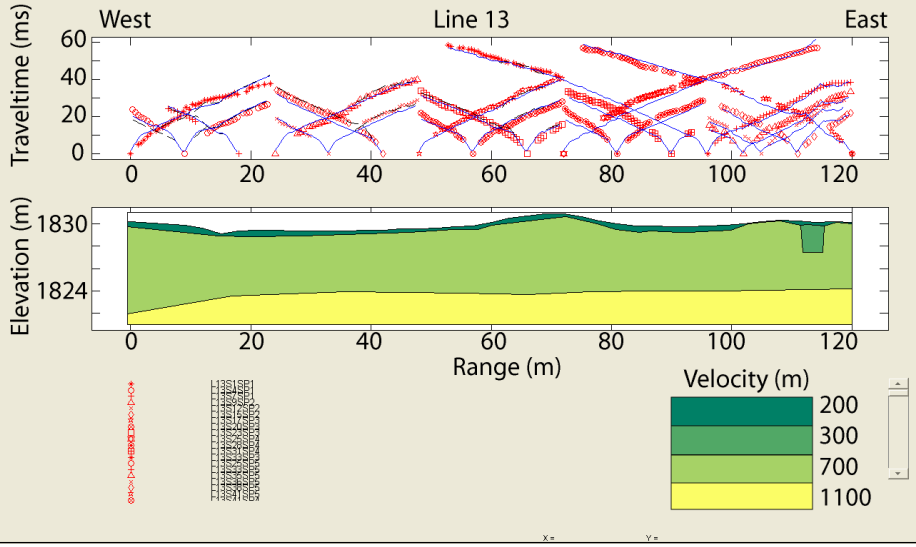
kivas ?
Line 9
Line 10
Line 14
1830
1812
Elevation (m)
100
0
100
meters

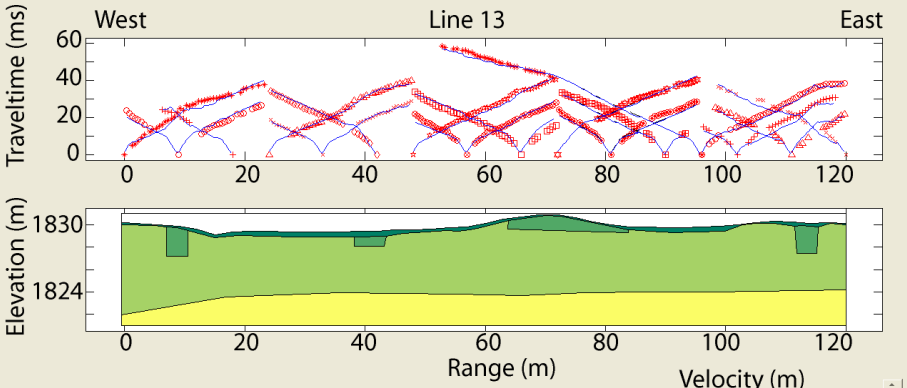

Line 10
North
Line 10
South
Traveltime (ms)
60
40
20
0
0
20
40
60
80
100
120
140
Elevation (m)
1830
1820
0
20
40
60
80
100
120
140
45
45.0
40.0
35.0
30.0
25.0
25 mS/m
-3
50
100
150
200
250
277


Line 9
Line 13
Line 10
Line 12
Line 14
N
0 15 30 60 90
Meters

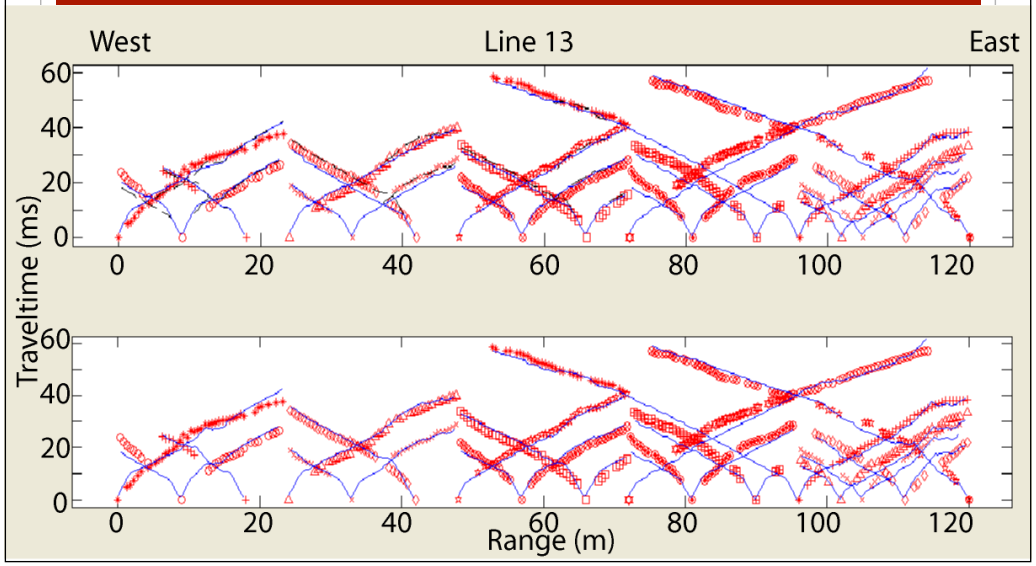
Line 13 Before



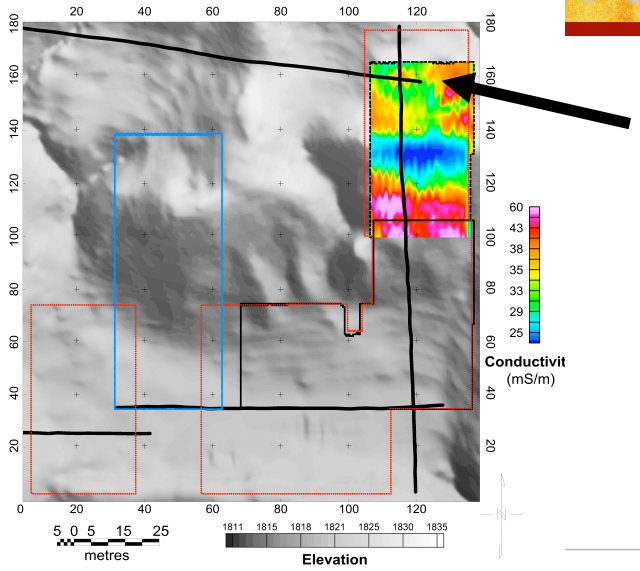
Line 13 After



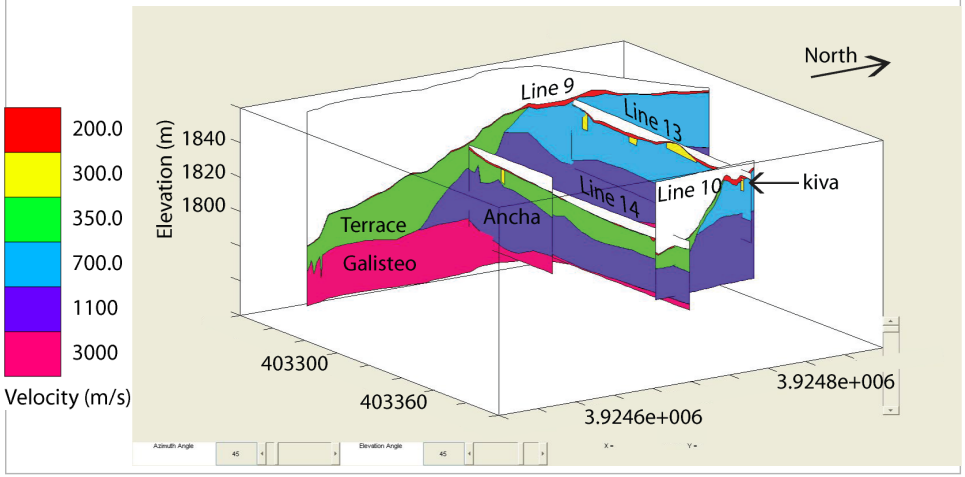
Line 13 Comparison



Comparison to 2006 EM Data

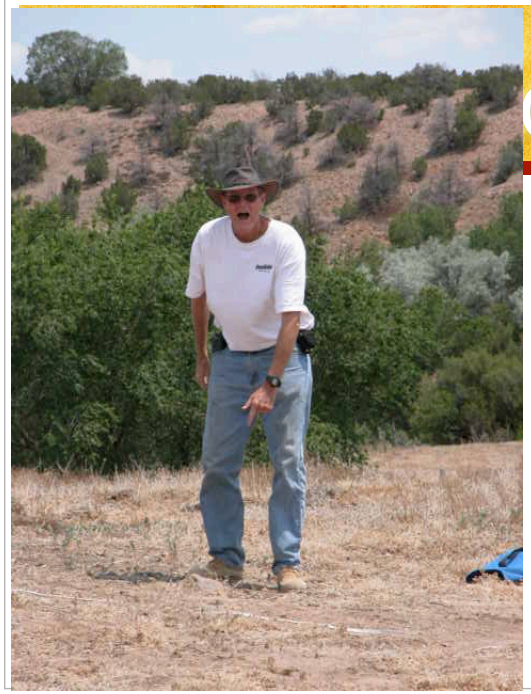


Fence Diagram



Conclusions

- Line 13 + Line 10 Intersection
  - Verified Kiva using multiple methods
  - Fence Diagram
- Some uncertainty



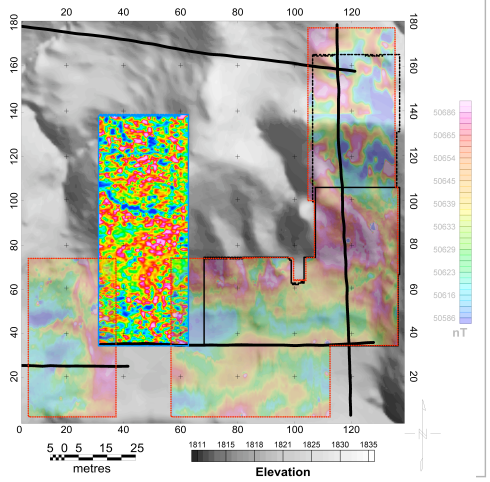
Questions?

Conclusion

San Marcos Archaeological Site

Summary

- Successful integration of four geophysical data sets:
  - Kivas!
  - Fire pits
  - Visible wall structures
- Building on the story of San Marcos…



Future work

- EM
  - Comparative measurements at a nearby non-archaeological site
  - Filter mag. suscept. data
- Seismic
  - Analyse mag data for Line 13
- EM/Mag/GPR
  - Extend overlap of data sets

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