

The 2008 Wells Earthquake Sequence

**Utah and Nevada
Earthquake Safety Council(s) Joint Meeting**

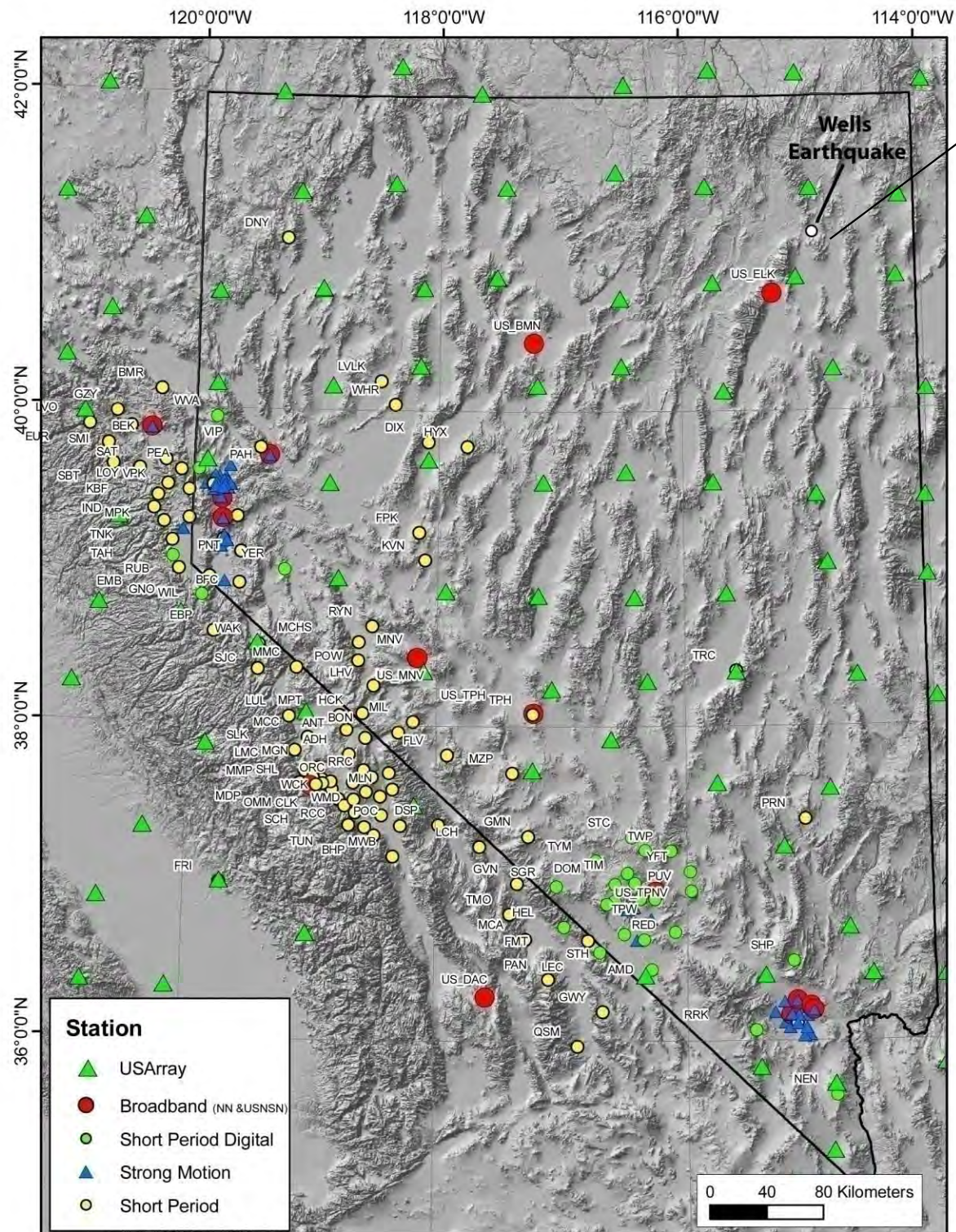
**Wells, Nevada
May 20, 2008**

**By: Seismic Network Staffs of UNR and Utah and
the USGS Golden Operations Group**



Wells Earthquake



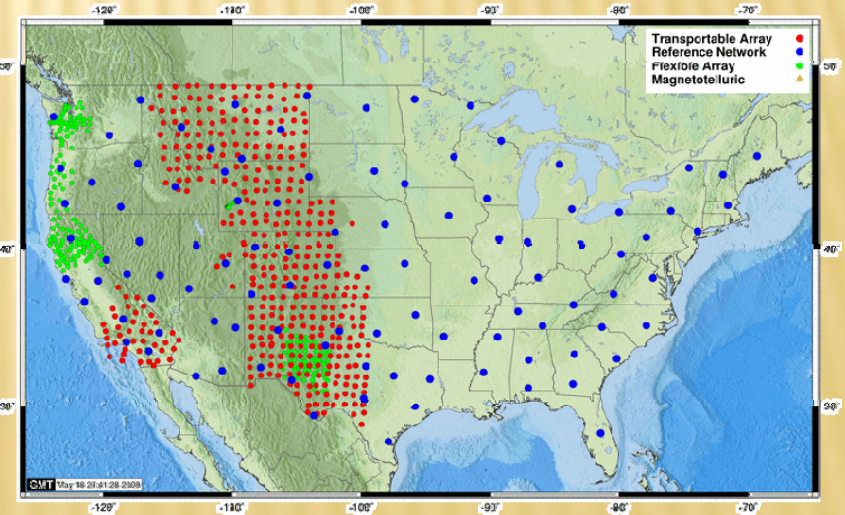


Wells Earthquake

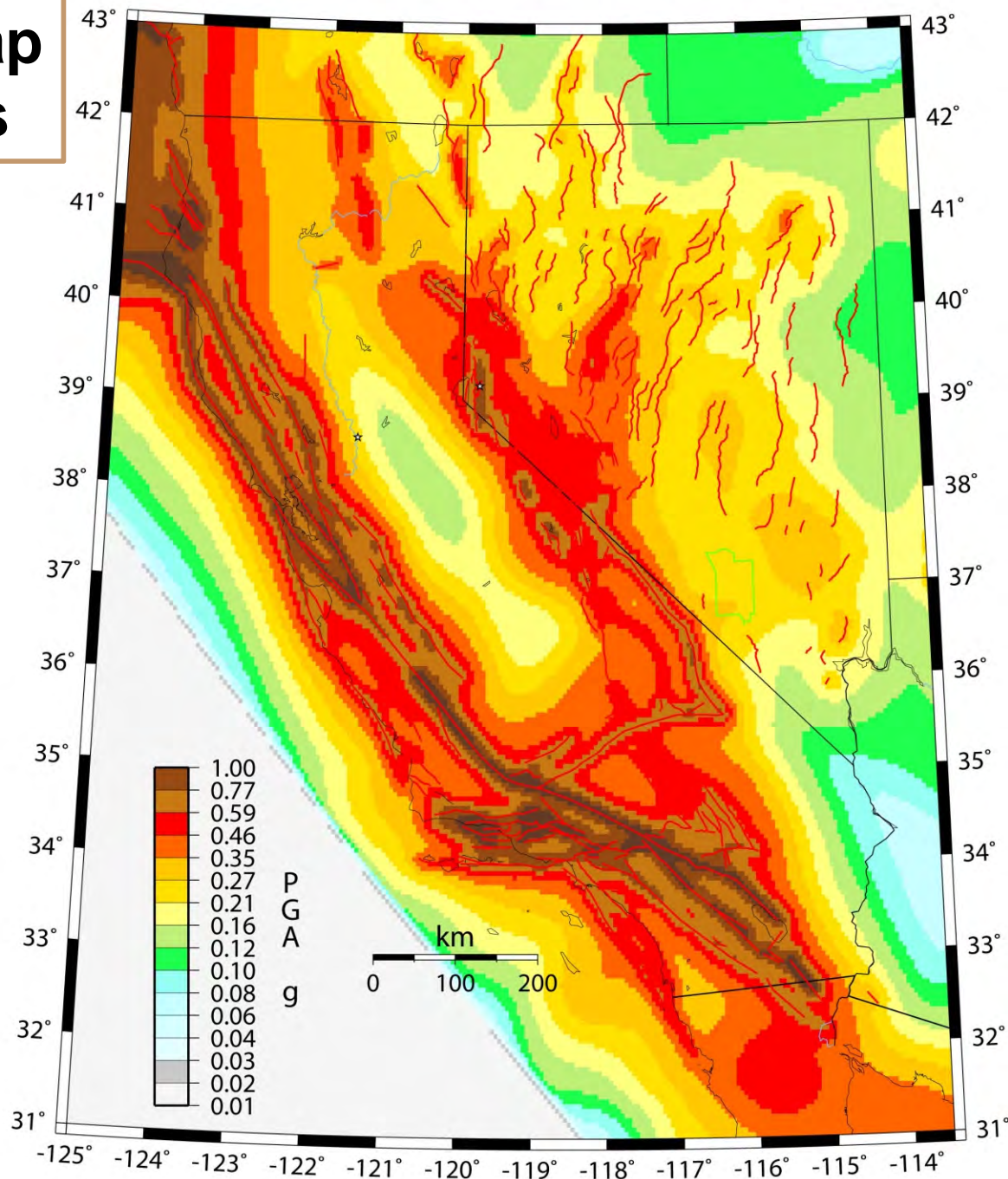
Regional Seismic Network
With EarthScope USArray

Regional Network Operations
2006-2008

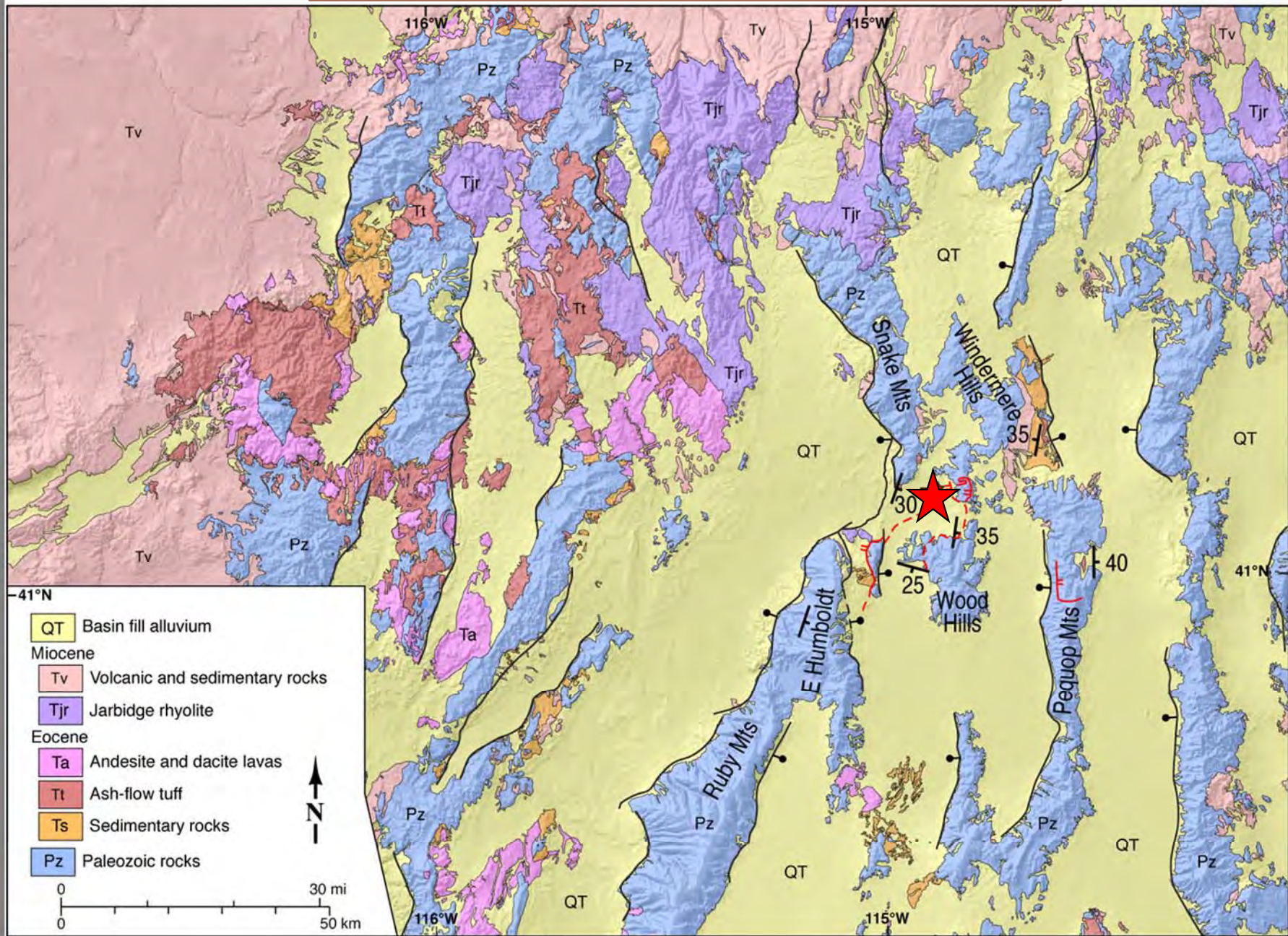
USArray Current Configuration



2008 USGS PGA Hazard Map 2% in 50 Years



Regional Geology Wells – N. Eastern Nevada



Slide from Chris Henry NBMG

Aftershock Sequence Response

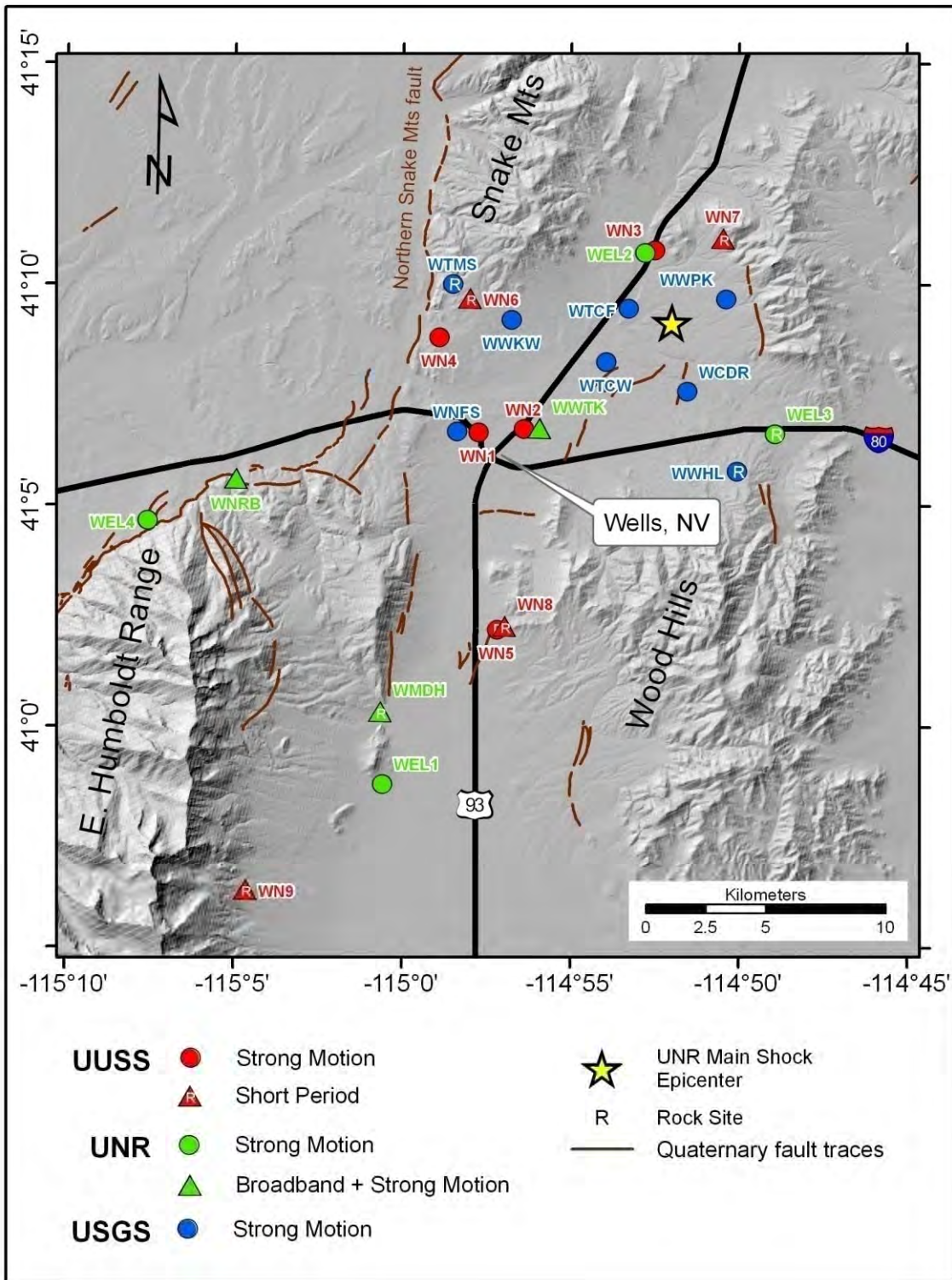


Aftershock Sequence Response



Aftershock Sequence Response





Portable Instrument Deployment

University of Utah
USGS
UNR

Enormous Support from the
Local Community

Local Real-Time Communications for Portable Seismic Stations



Real-time Seismic Monitoring

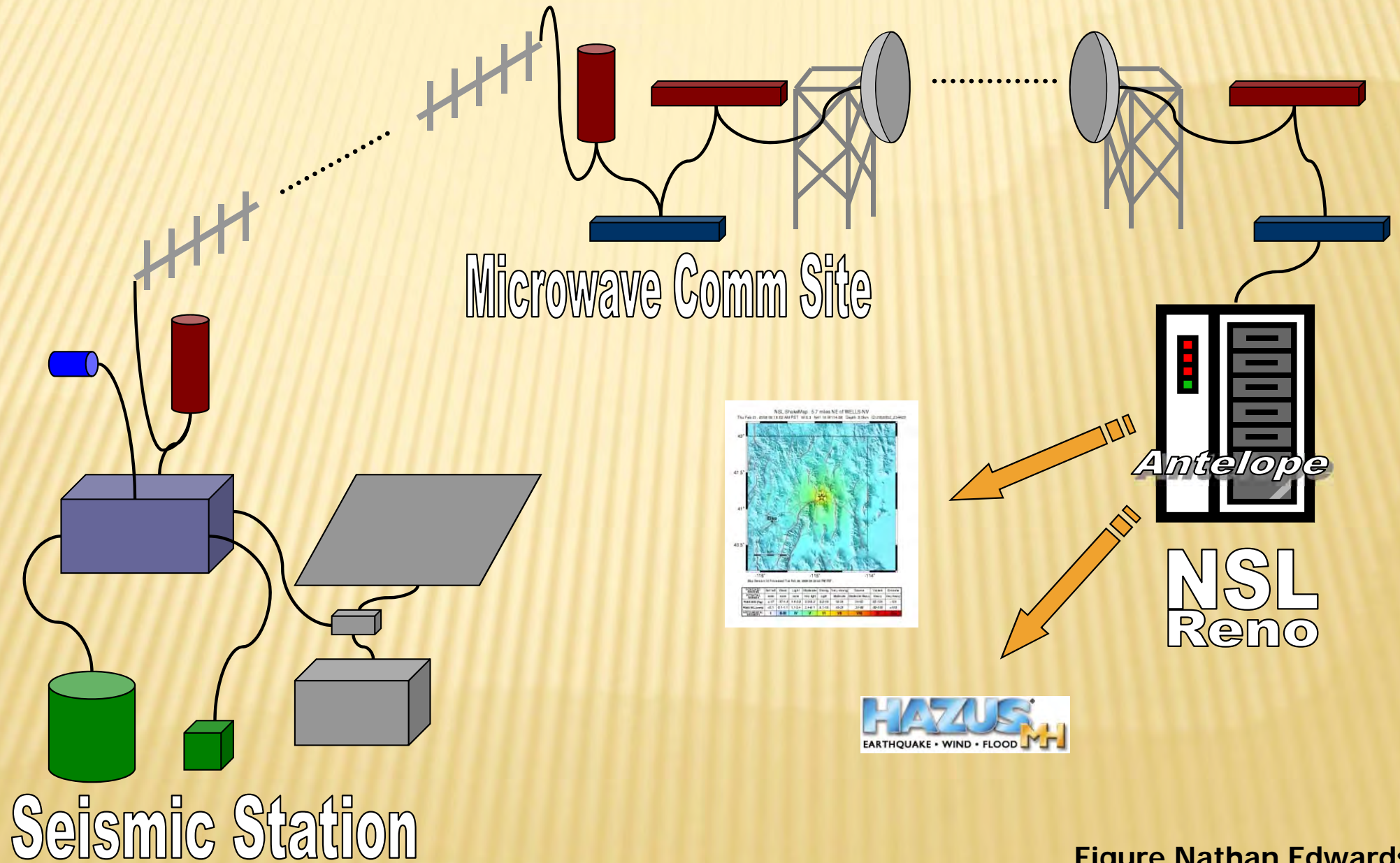
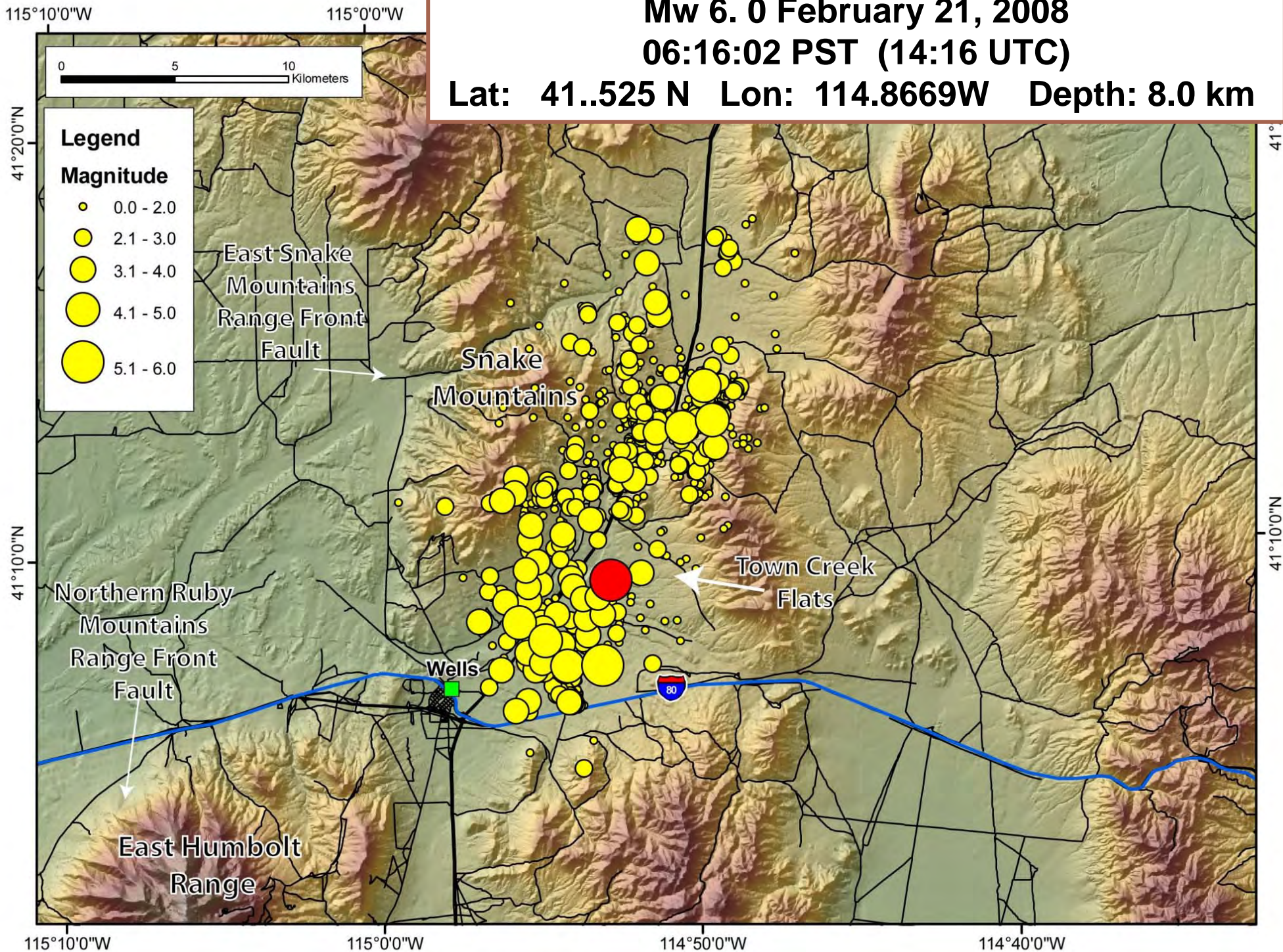


Figure Nathan Edwards

Mw 6.0 February 21, 2008

06:16:02 PST (14:16 UTC)

Lat: 41.525 N Lon: 114.8669W Depth: 8.0 km



Best Fitting Double Couple

Mo = 8.32e+24 dyne-cm

Mw = 5.88

Z_{hypocenter} = 11 km

| Plane | Strike | Dip | Rake |
|-------|--------|-----|------|
| NP1 | 205 | 50 | -90 |
| NP2 | 25 | 40 | -90 |

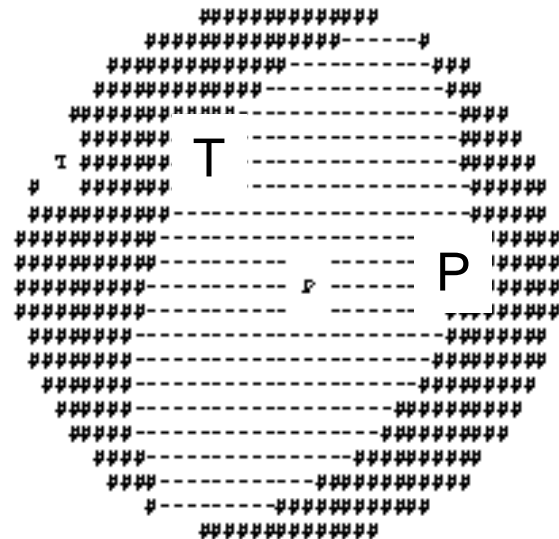
Principal Axes:

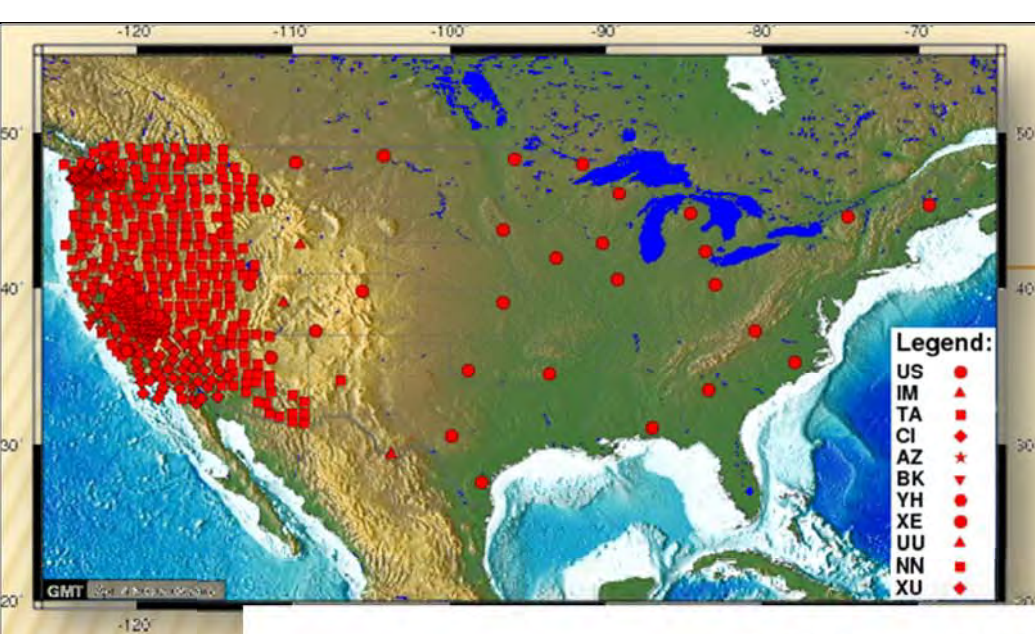
| Axis | Value | Plunge | Azimuth |
|------|-----------|--------|---------|
| T | 8.32e+24 | 5 | 295 |
| N | 0.00e+00 | -0 | 205 |
| P | -8.32e+24 | 85 | 115 |

Moment Tensor: (dyne-cm)

| Component | Value |
|-----------|-----------|
| Mxx | 1.46e+24 |
| Mxy | -3.14e+24 |
| Mxz | 6.10e+23 |
| Myy | 6.73e+24 |
| Myz | -1.31e+24 |
| Mzz | -8.19e+24 |

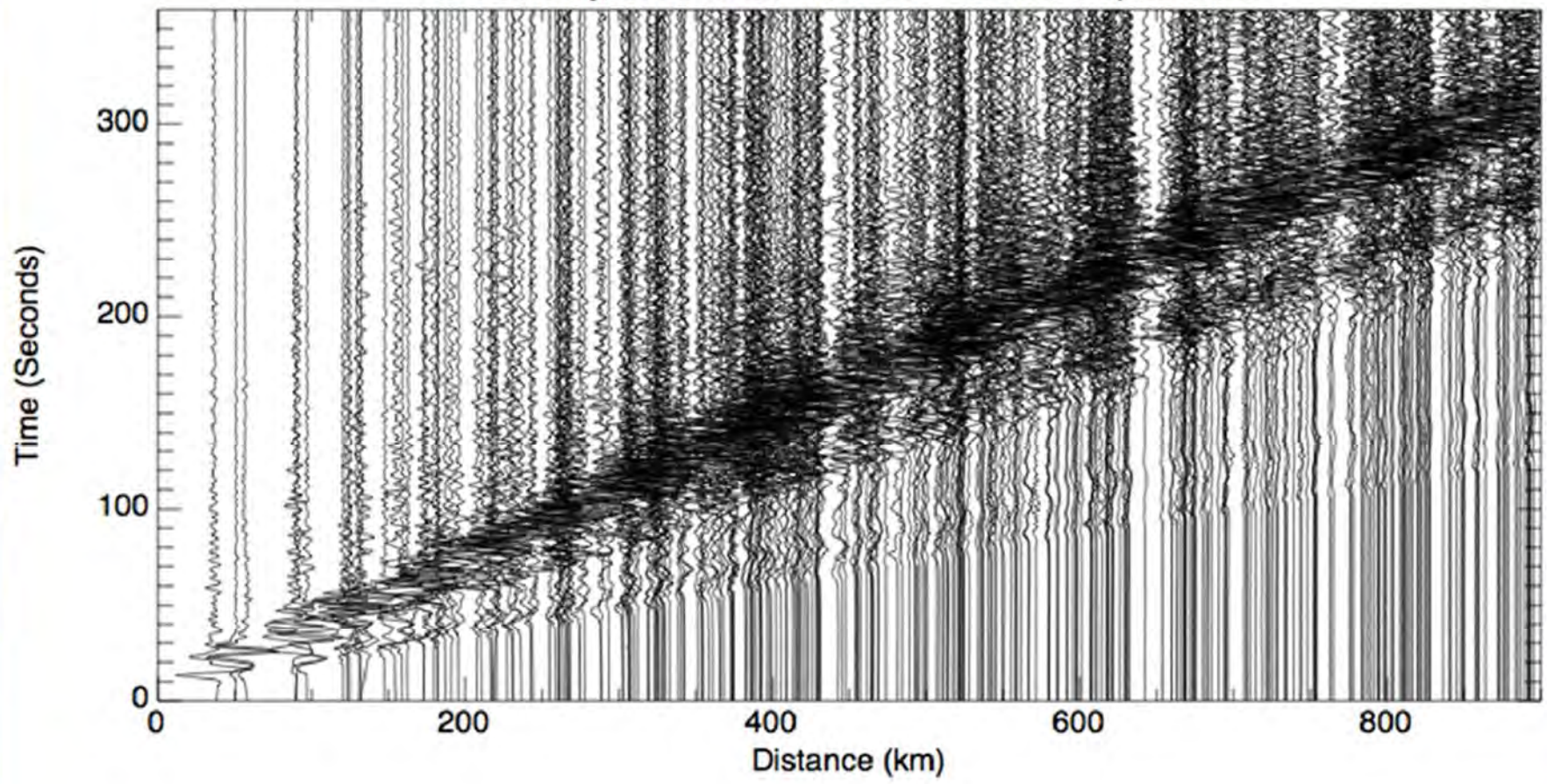
Mainshock
Moment Tensor Solution
SLU



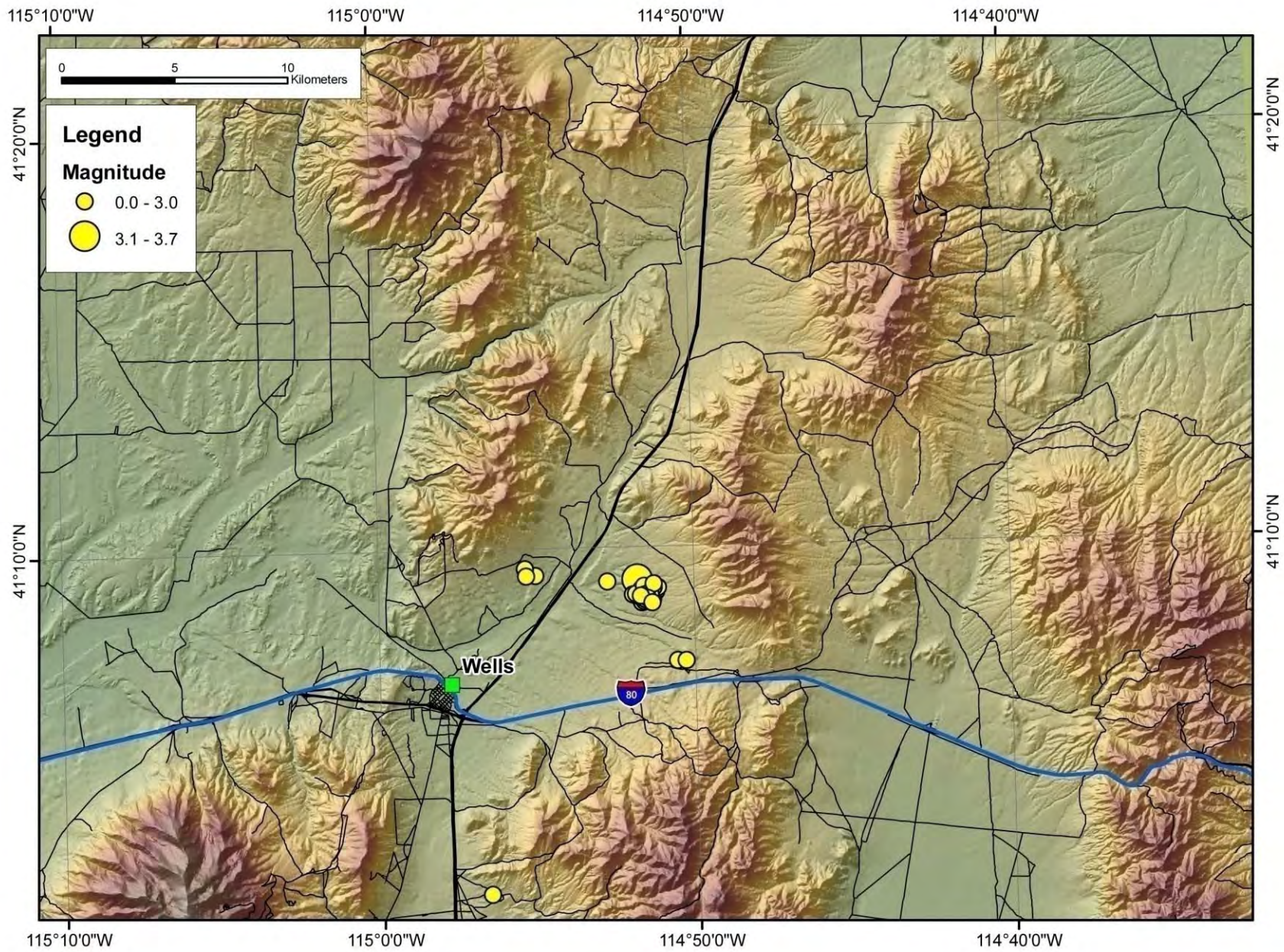


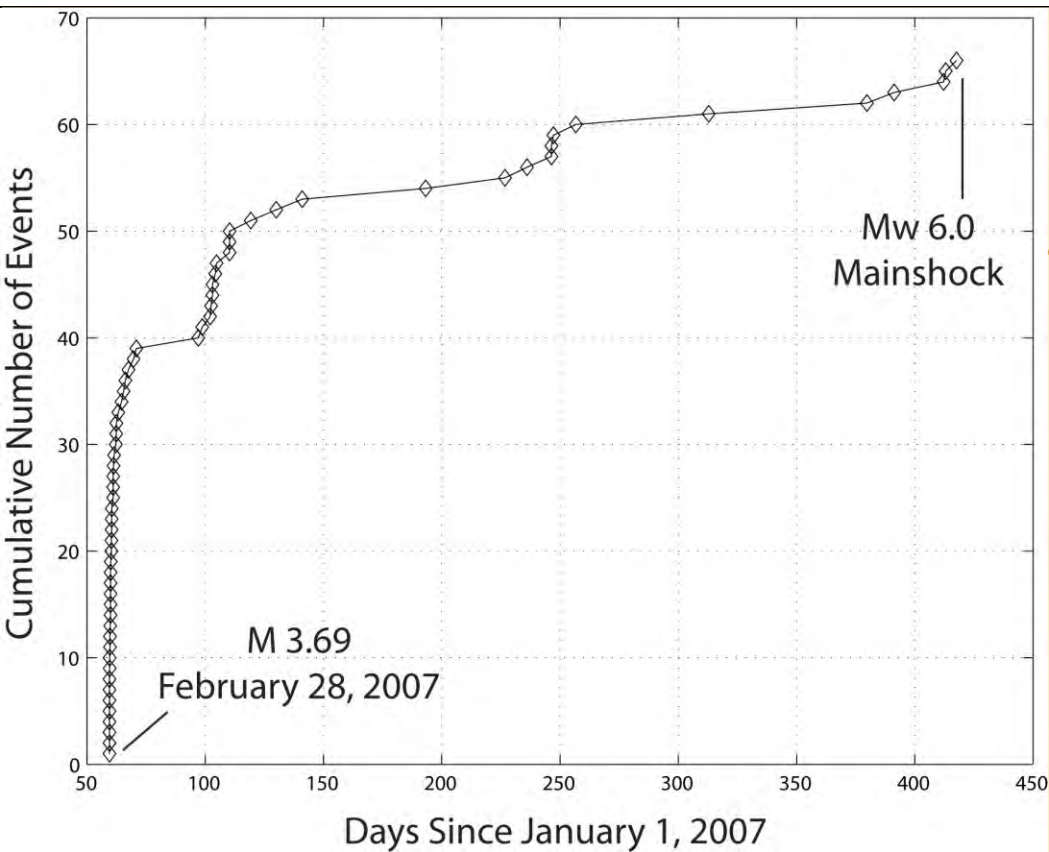
EarthScope USArray Network Wells Earthquake Records

21 February, 2008 - Near Wells, NV - Vertical Displacement



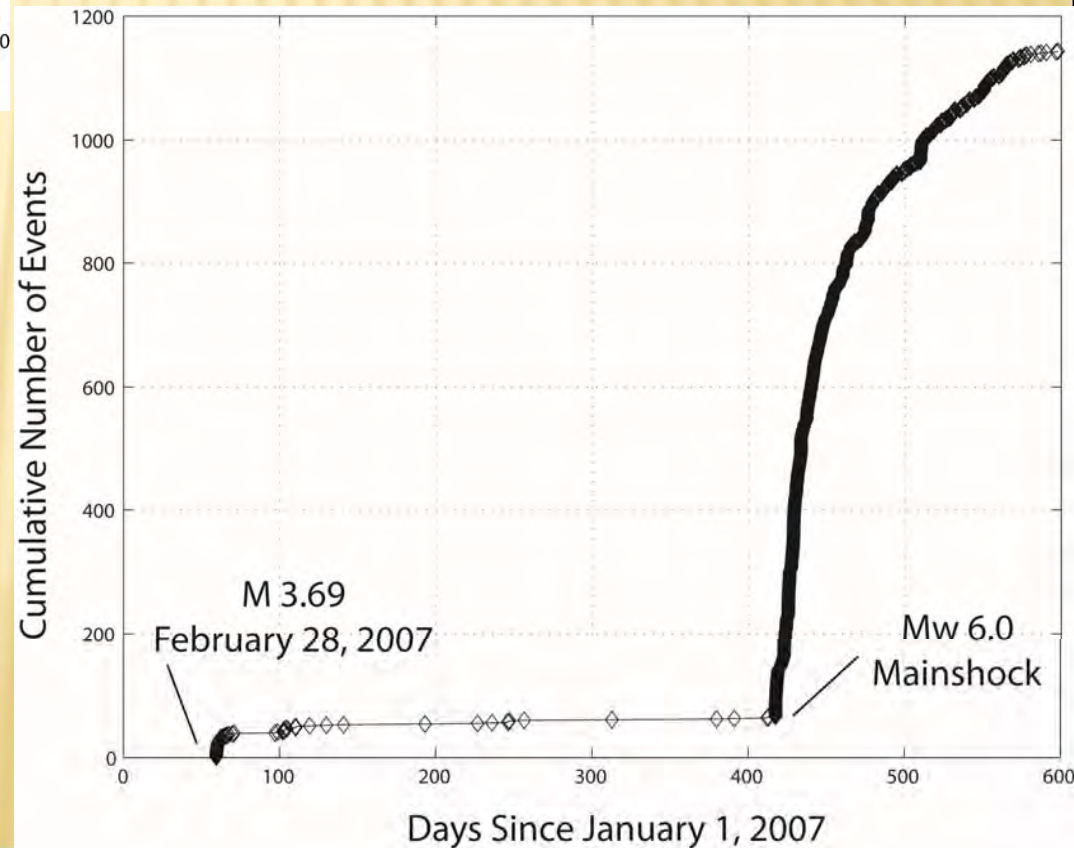
Earthquakes in TCF February 2007 through 2008 Mainshock

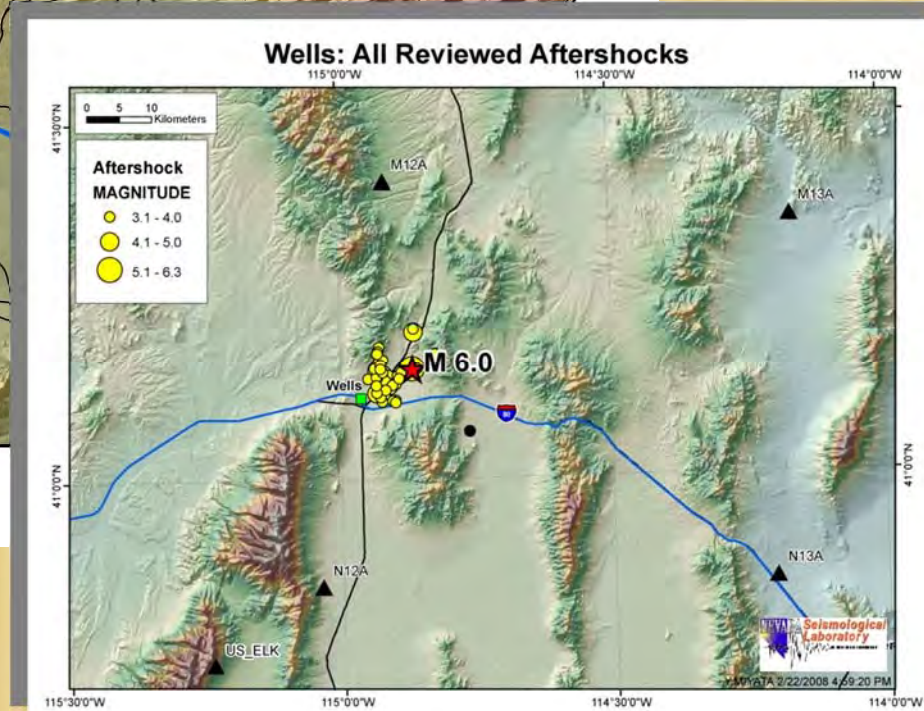
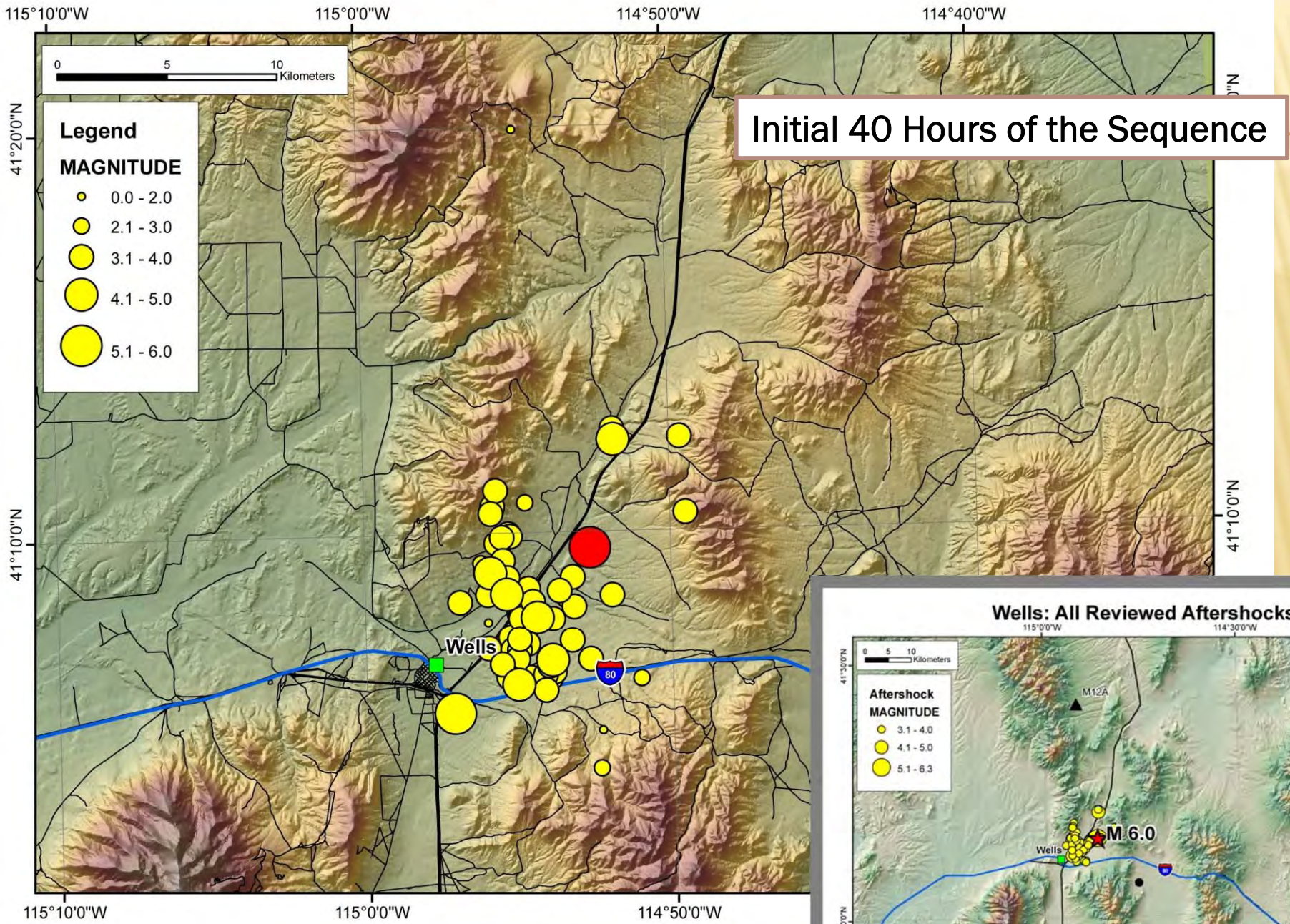


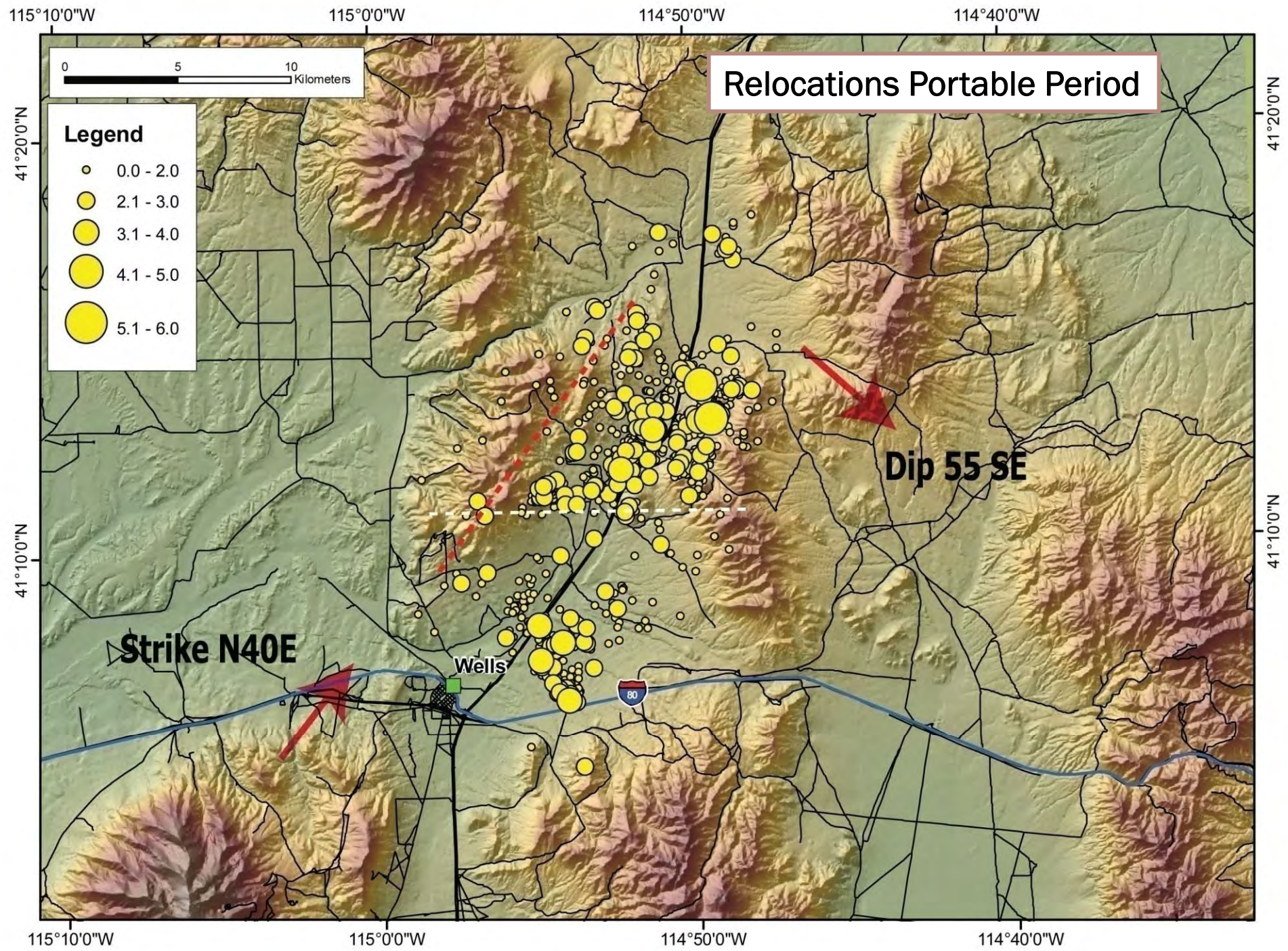


Wells Foreshock Activity Began Almost Exactly One Year Before the Mw 6.0 Mainshock

Time Progression of Activity



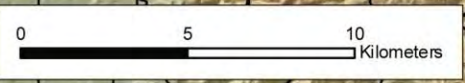




Relocations Portable Period

Legend

- 0.0 - 2.0
- 2.1 - 3.0
- 3.1 - 4.0
- 4.1 - 5.0
- 5.1 - 6.0

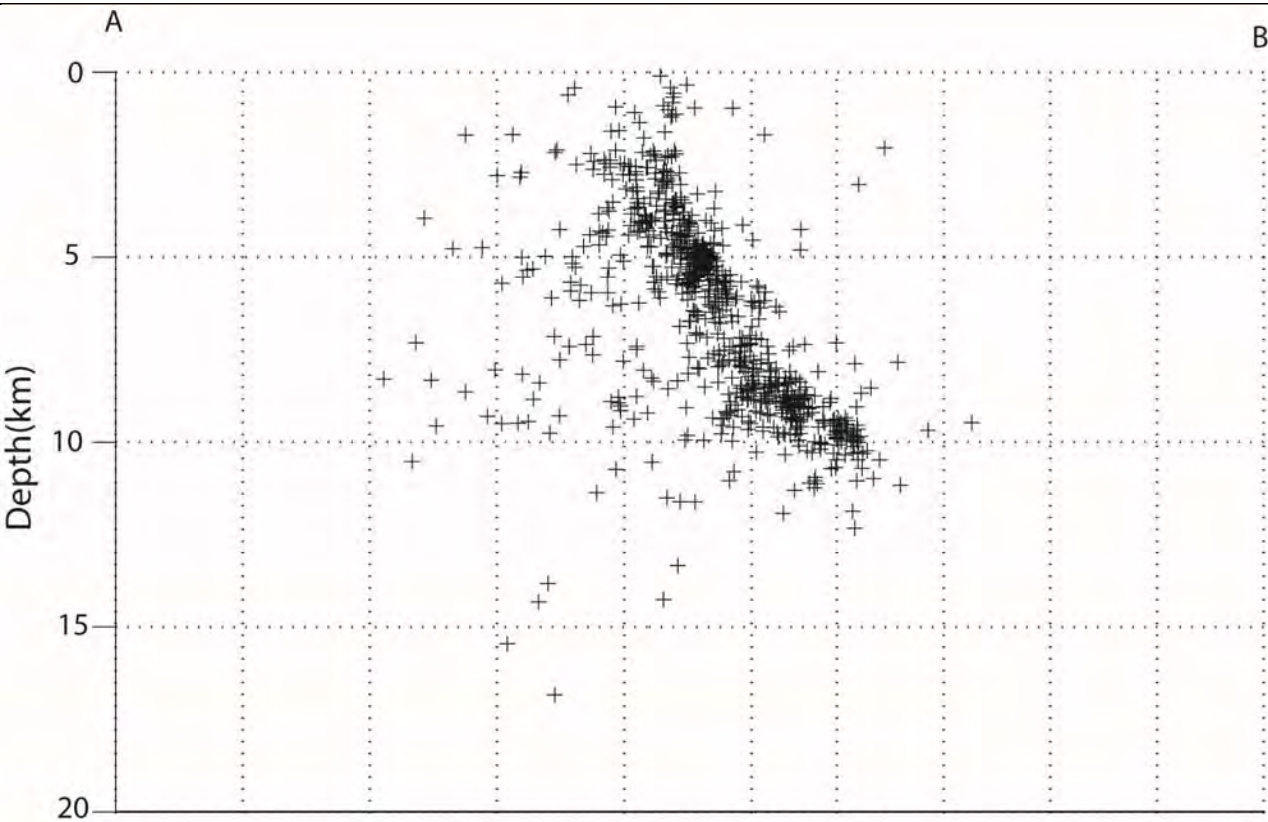


Strike N40E

Wells

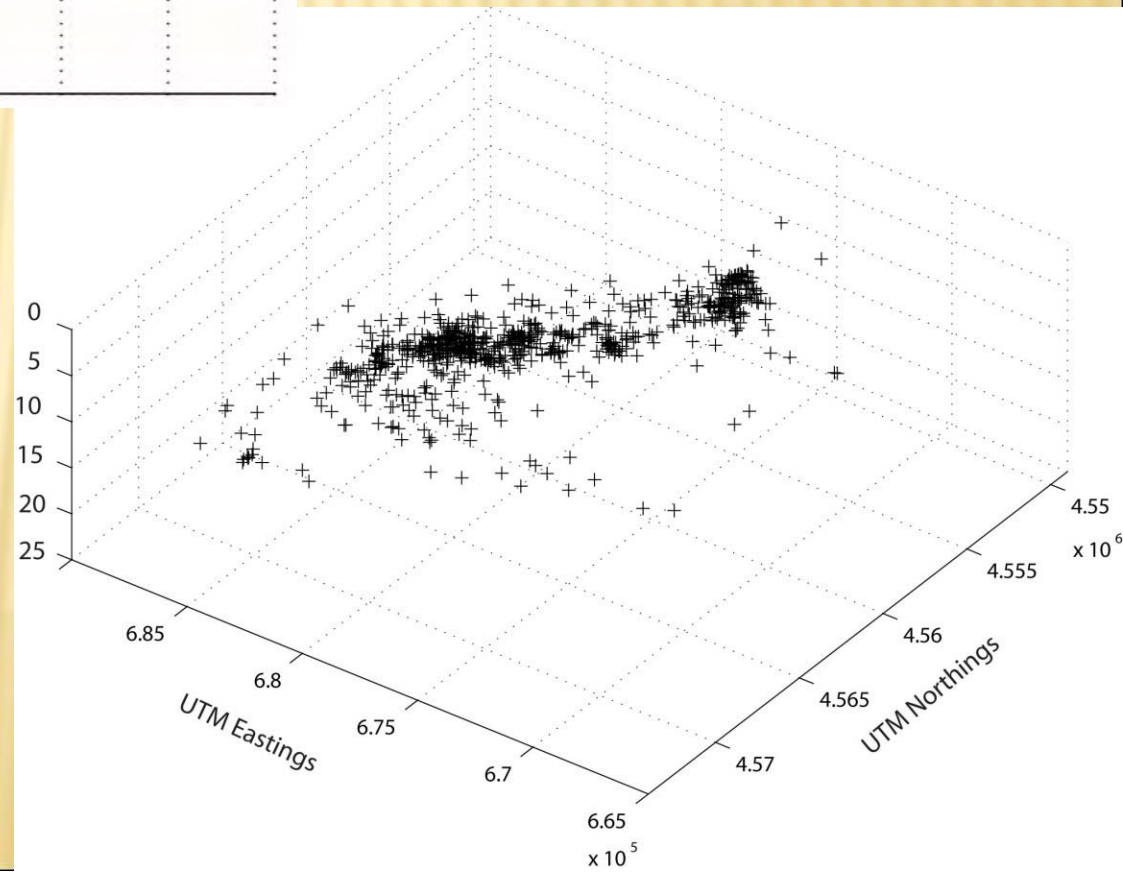
Dip 55 SE



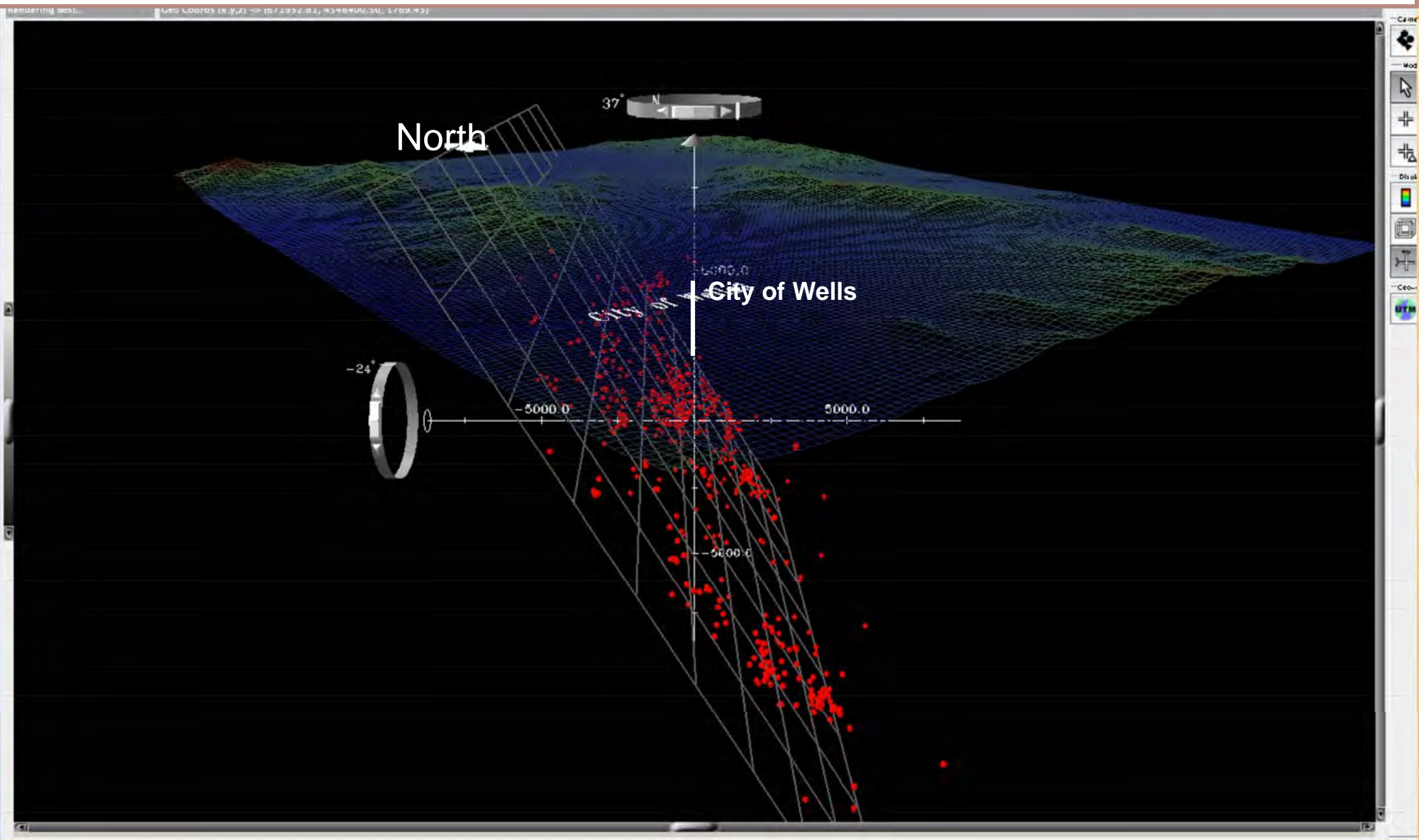


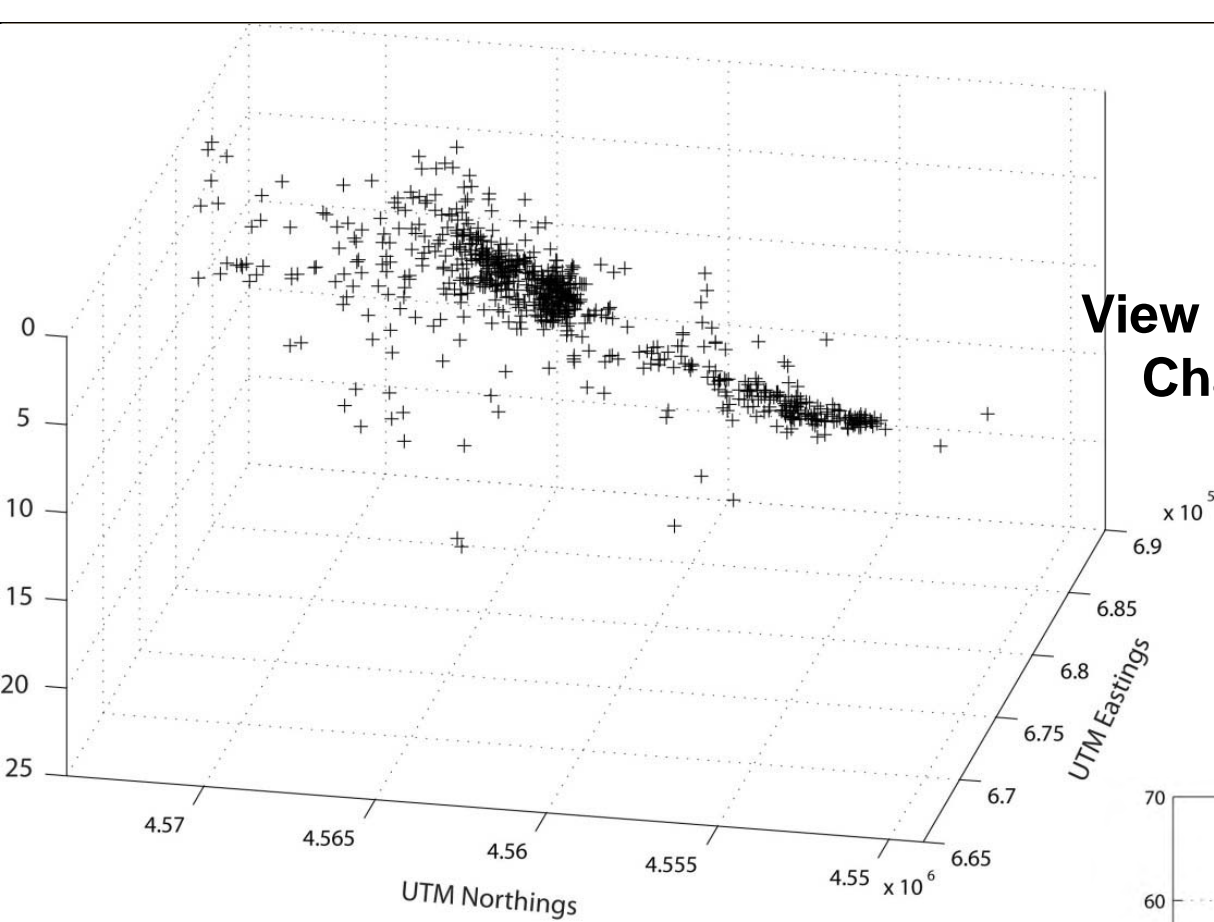
Cross-Section N40E

Down-Dip 55SE

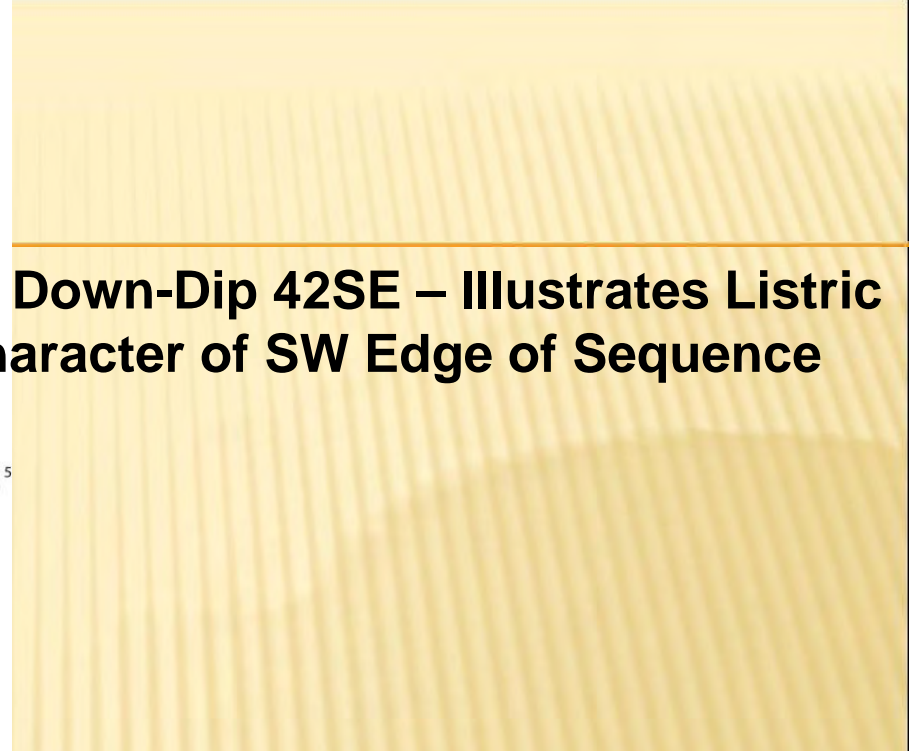


Perspective View Looking NE Along Mainshock Fault Plane

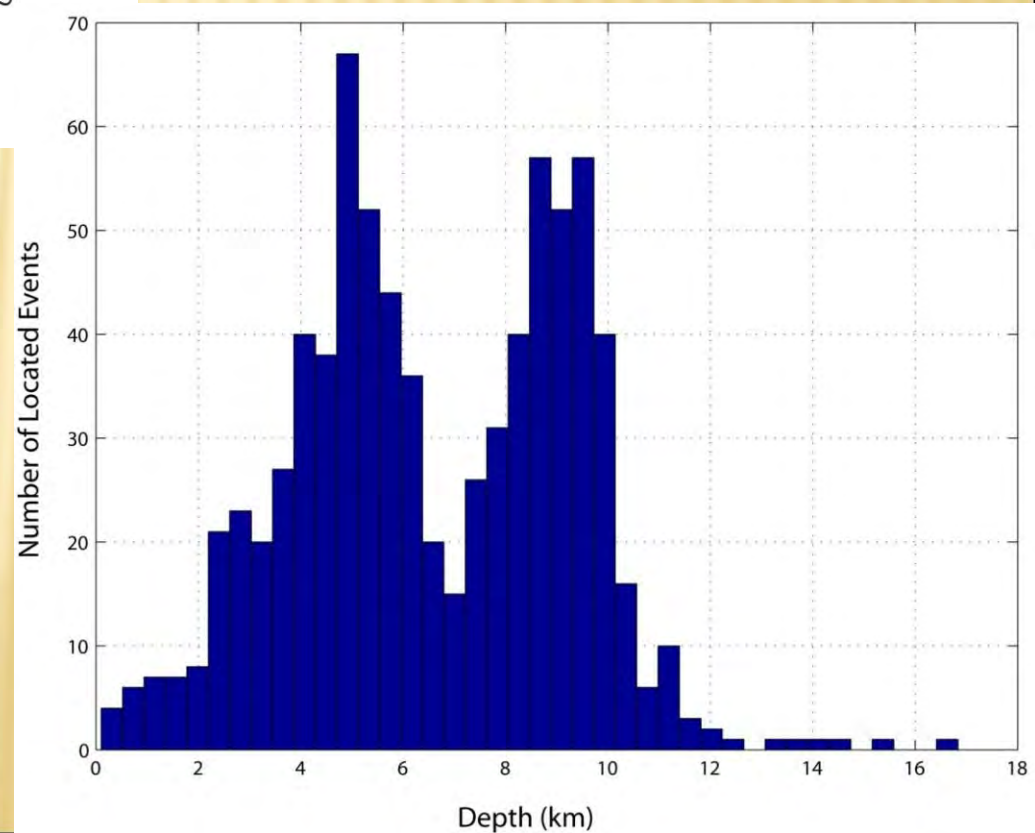




View Down-Dip 42SE – Illustrates Listric Character of SW Edge of Sequence



Depth Distribution of Relocations



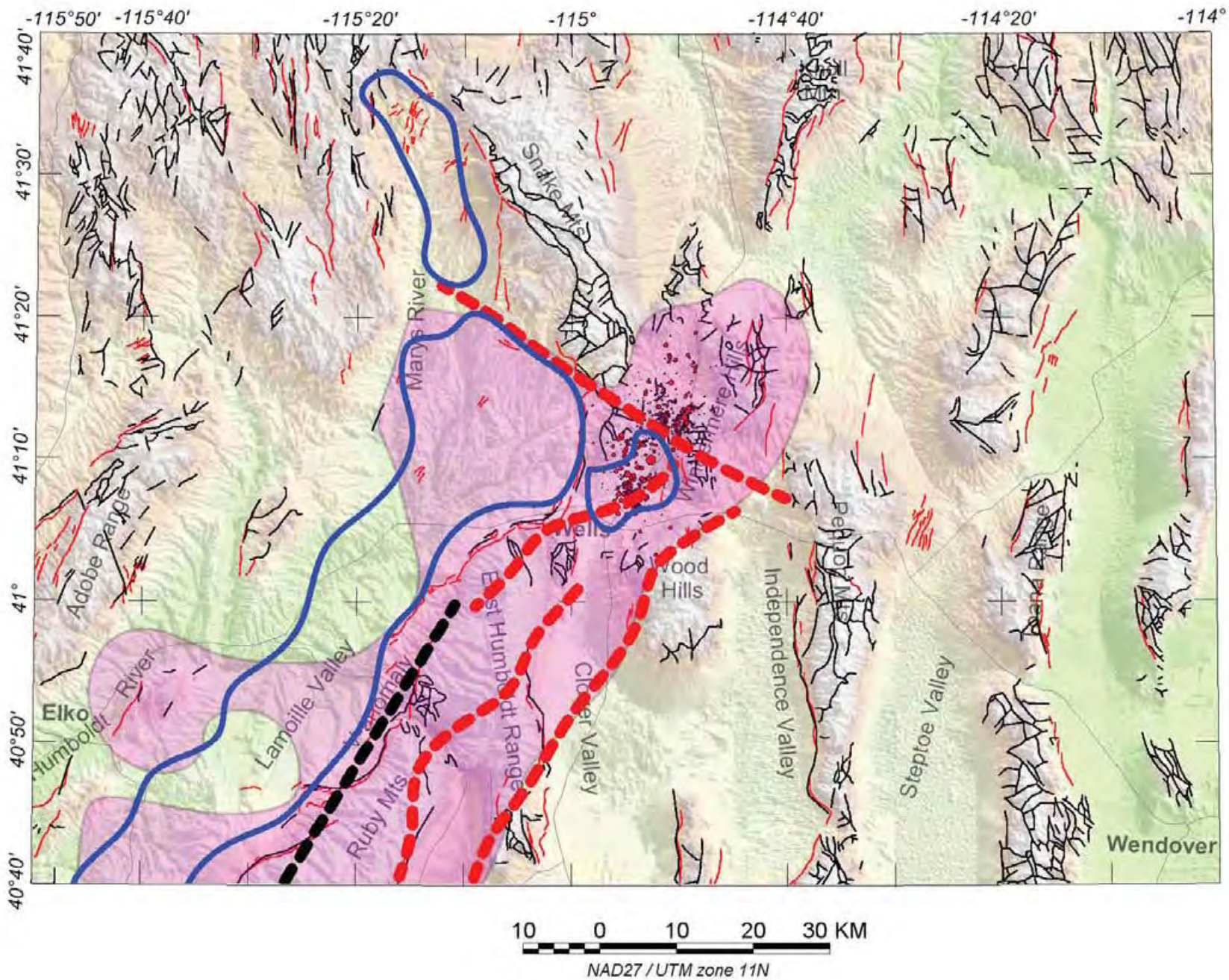
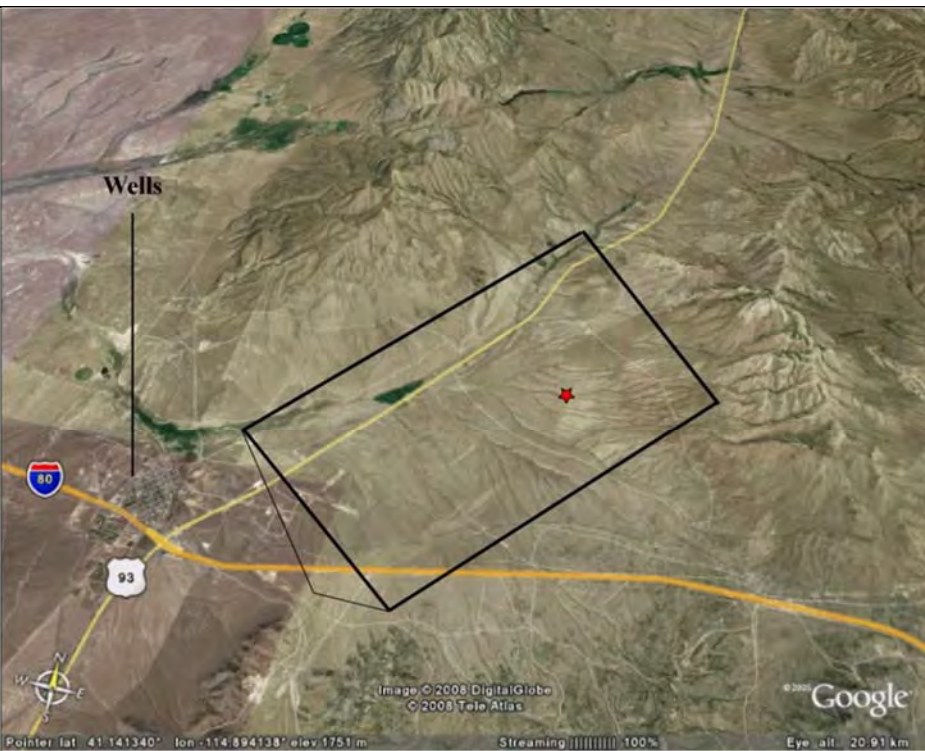
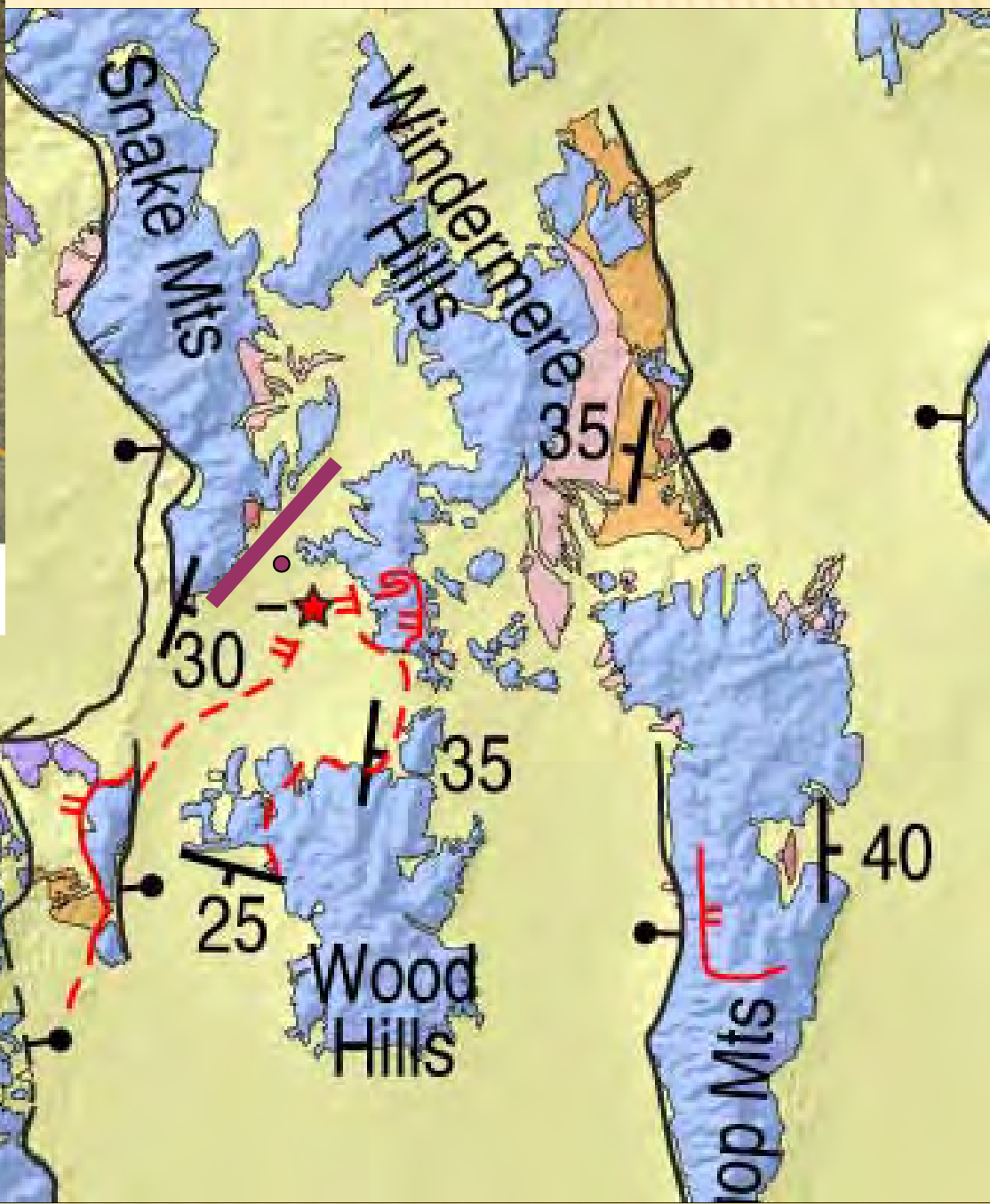
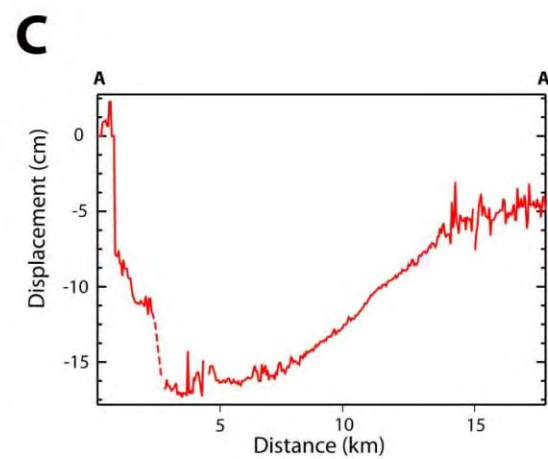
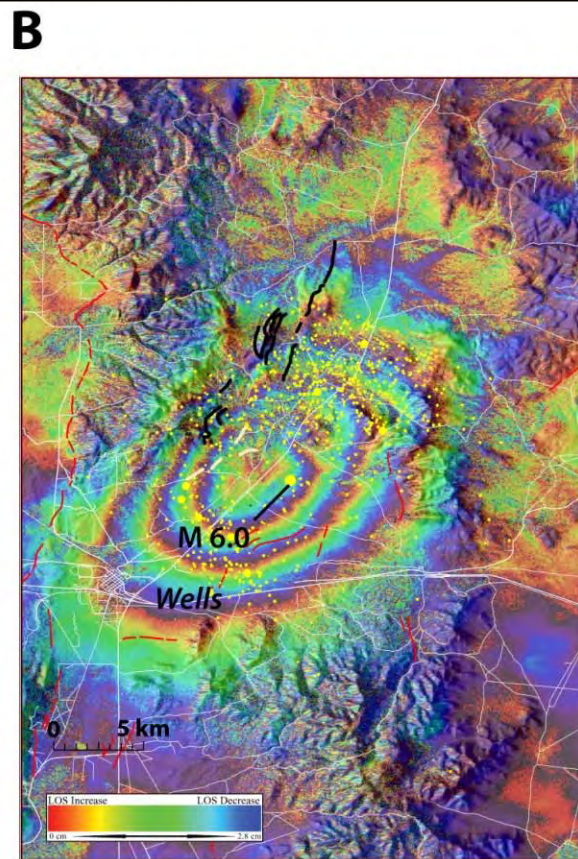
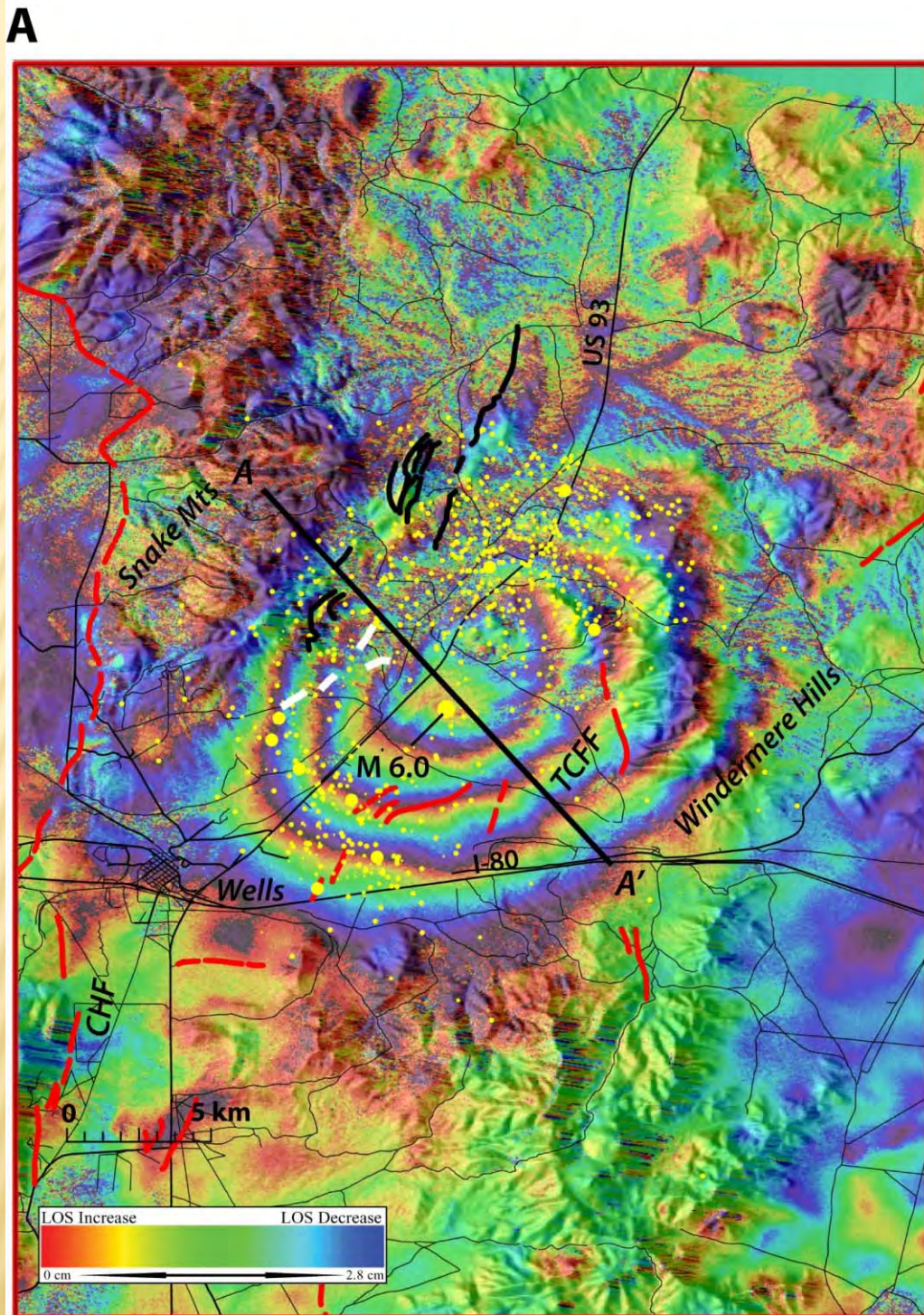


Figure 7 (Ponce et al., 2009). Geophysically defined lineaments and structures possibly associated with the February 21, 2008 Wells Mw 6 earthquake.



Faulting Geometry for Wells





**InSAR Image:
John Bell NBMG**

Fig. 2

Strike N40E

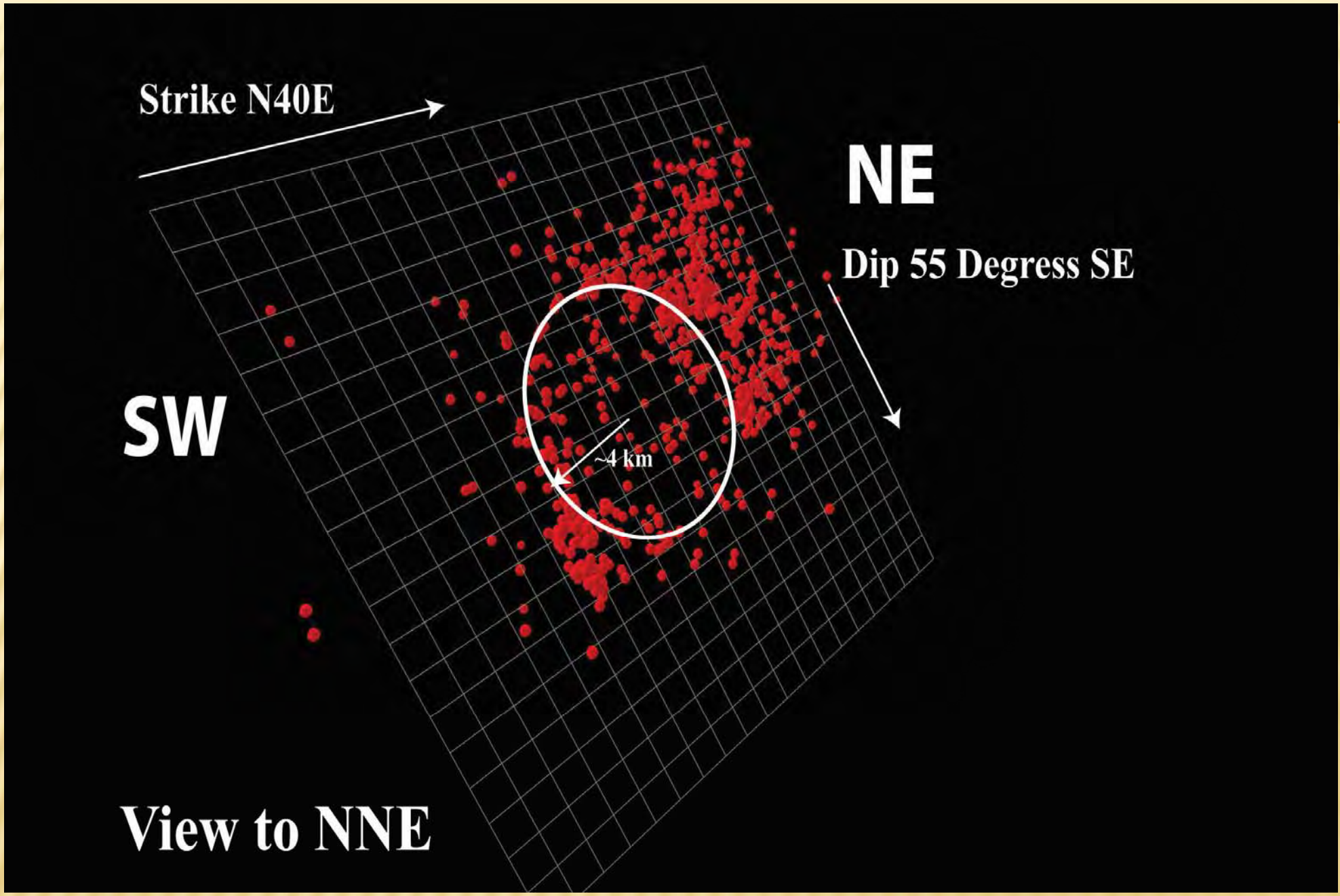
SW

NE

Dip 55 Degrees SE

~4 km

View to NNE



Wells Source Estimates

Radius of Fault Rupture from Aftershock Relocations: 4 km
Approximately Radial Rupture

| Source | Mo (dyne-cm) | Mw | Slip (cm) | Stress Drop (bars) |
|-------------|--------------|------|-----------|--------------------|
| USGS | 1.24e+25 | 6.00 | 83 | 86 |
| St. Louis | 8.31e+24 | 5.88 | 55 | 56 |
| UC Berkeley | 1.05e+25 | 5.95 | 70 | 72 |

$$\text{Stress Drop} = \frac{7}{16} \frac{M_o}{r^3}$$

$$\text{slip} = \frac{M_o}{\mu A}$$

Mo = seismic moment, r = source radius, A = fault area, u = rigidity

Speculation on Development of Town Creek Flats Basin

Assume: Extension began around 9 Ma (Henry et al., Wells Volume)

Depth of TCF ~1.75 km (Ponce et al., Wells Volume)

Elevation of Snake Mtn. to NW 0.25 km

Total subsidence of TCF 2 km relative to Snake Mtns.

Average TCF basin subsidence in 2008 Wells event, **10 cm**
(2/3 of InSAR estimates from Wells earthquake)

Requires 20,000 Wells earthquakes since 9 Ma to account for
2 km of subsidence

Return Period of Wells Events: 450 yrs

Mw Equivalent: 8.9

Number of Mw 7.0 Earthquakes: 632 events

Return Period of Mw 7.0: 14 Ka

Vertical Slip Rate: 0.2 mm/yr, consistent with the Ruby Mountains FZ

Implications: Formation of local basins without surface faulting required



A Special 'Thanks' to the Town of Wells and the Local Community