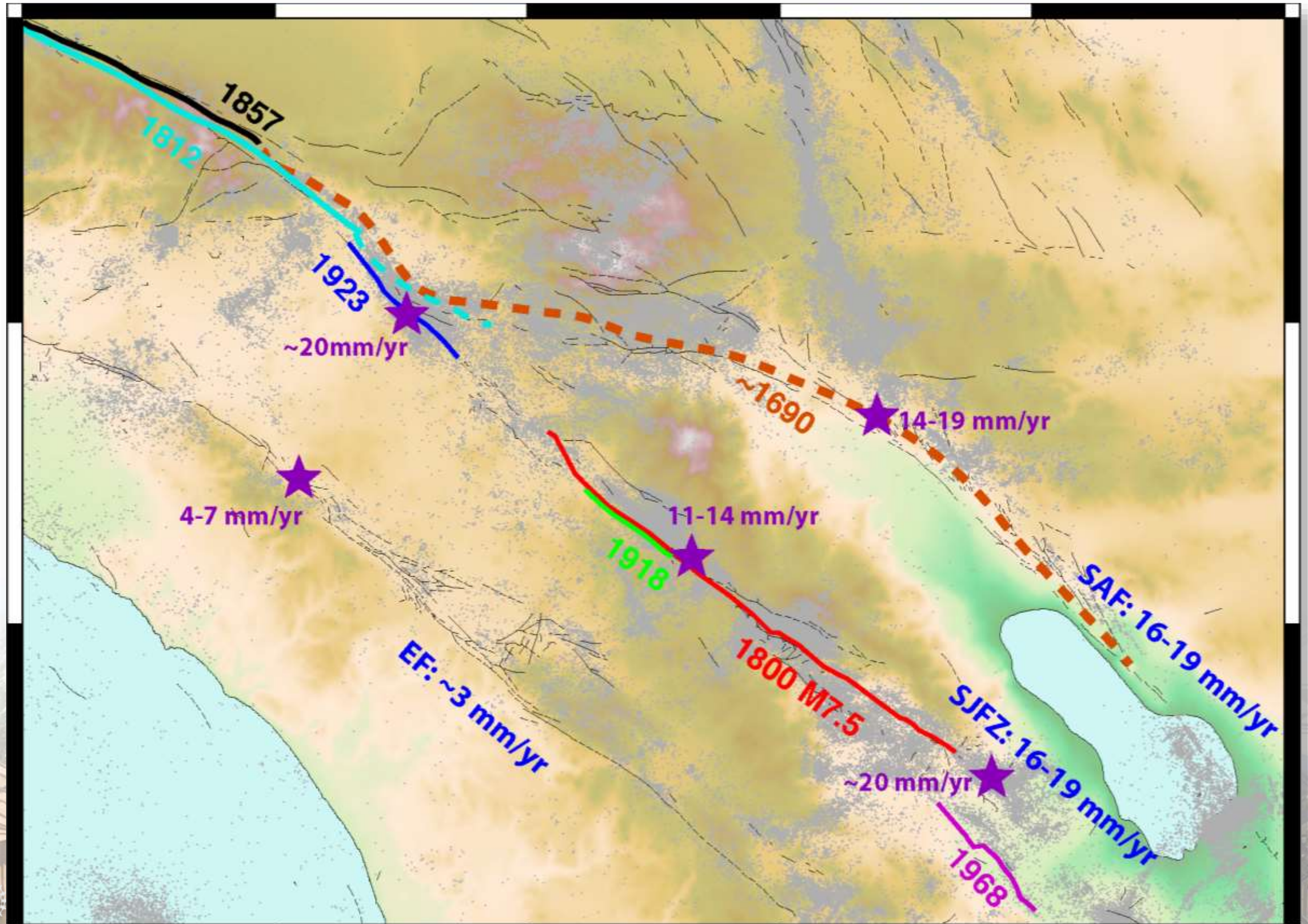
ANZA
SEISMIC NETWORK

Frank Vernon
Institute of Geophysics and Planetary Physics

ANZA Seismic Network

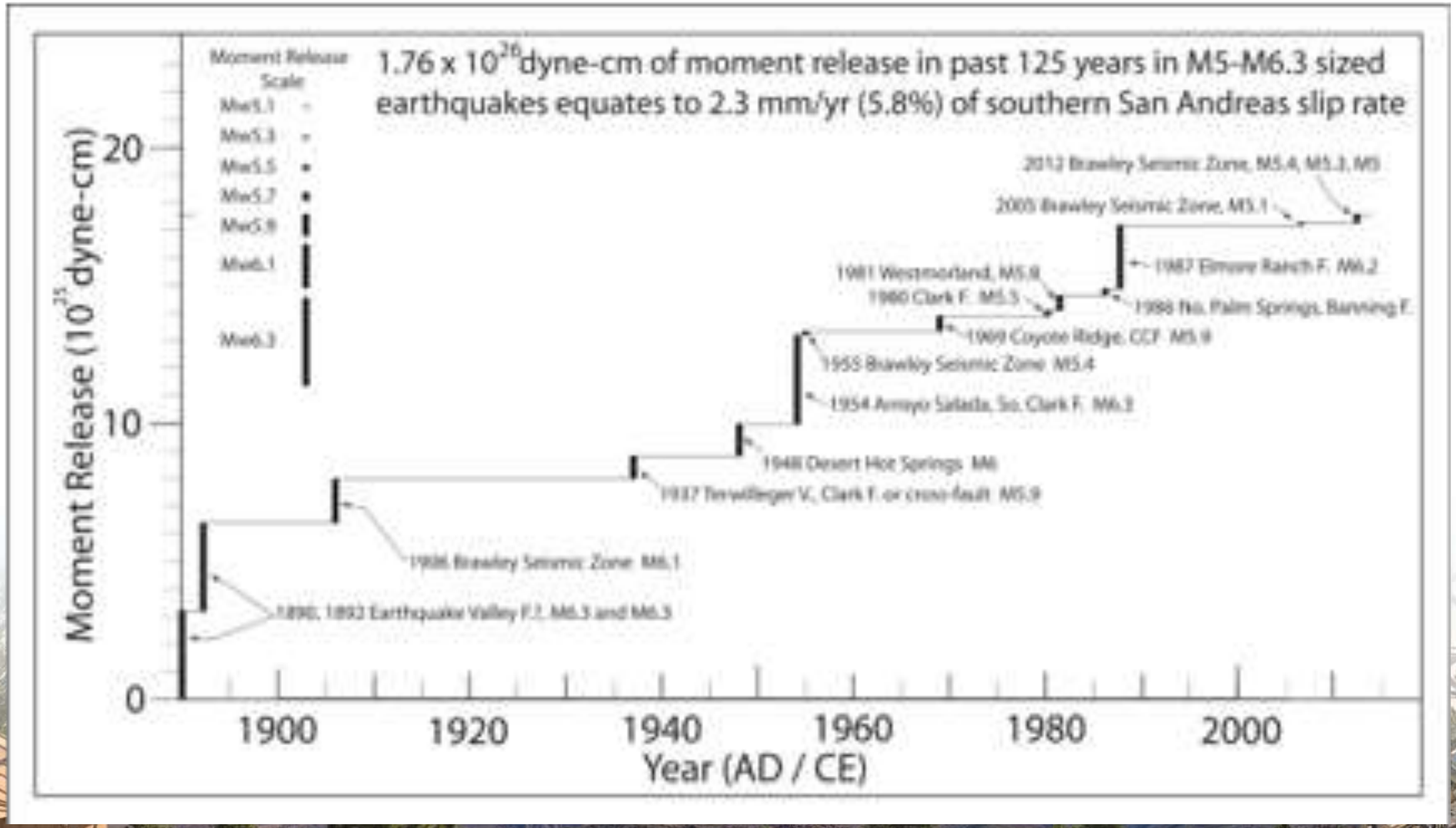
- Utilizes state-of-the-art broadband and strong motion sensors with real-time telemetry to monitor local and regional seismicity in southern California.
- Provides real-time data to the Advanced National Seismic System (ANSS), the California Integrated Seismic Network (CISN), and the greater San Diego community.
- Currently consists of twenty-nine operational stations.
- Provides extensive real time coverage of the San Jacinto Fault Zone, augmenting the regional coverage provided by the Southern California Seismic Network.
- Well positioned for Earthquake Early Warning with 20 stations positioned close to the fault between the town of Hemet and southeast to below Ocotillo Wells covering the highest risk segment of the fault for more than 120 km.

Southern California Major Ruptures

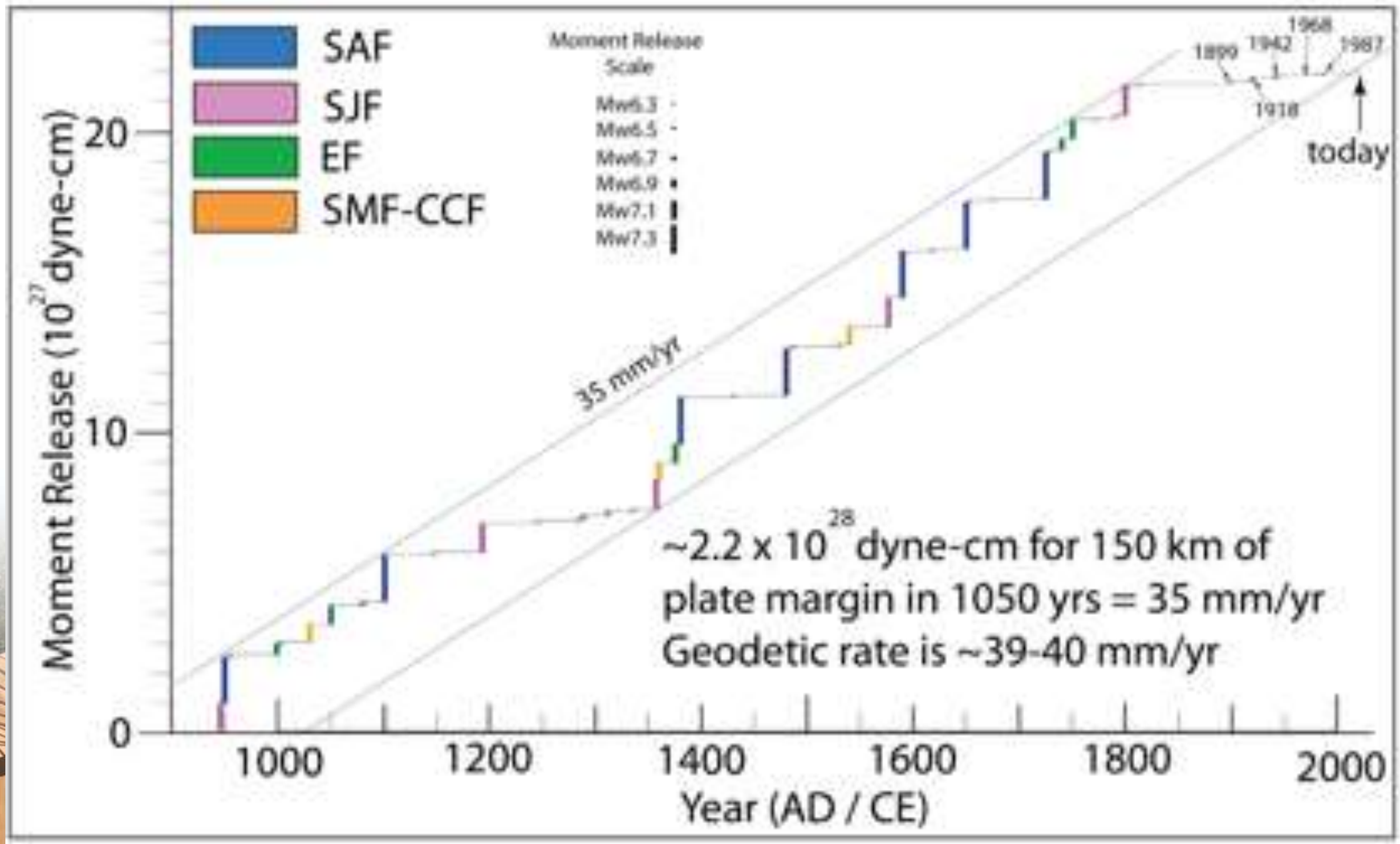


Southern California Paleoseismic Sites - Rockwell 2015

Southern California Historical Moment Release - Rockwell 2015

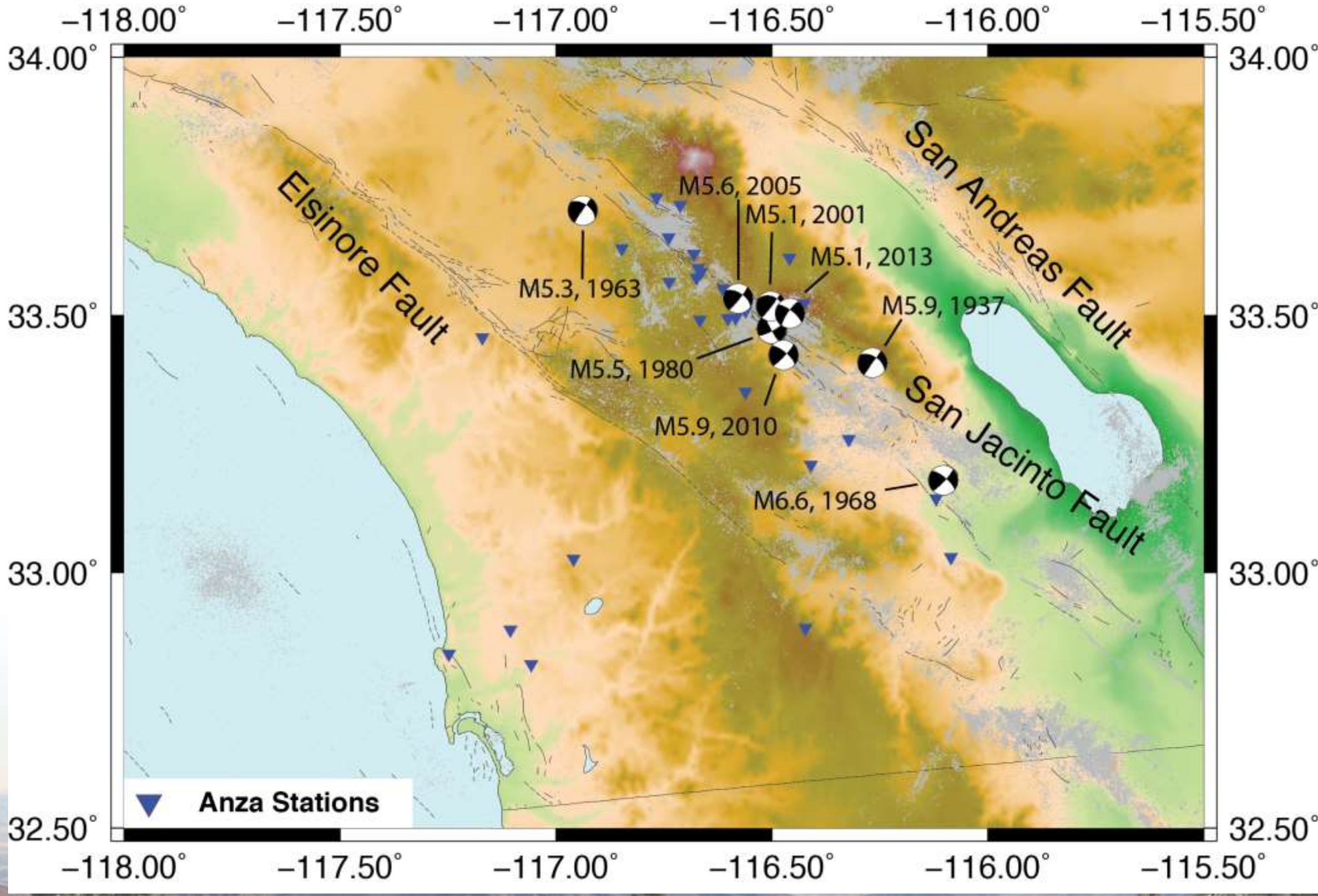


Southern California Pre-Historical Moment Release - Rockwell 2015



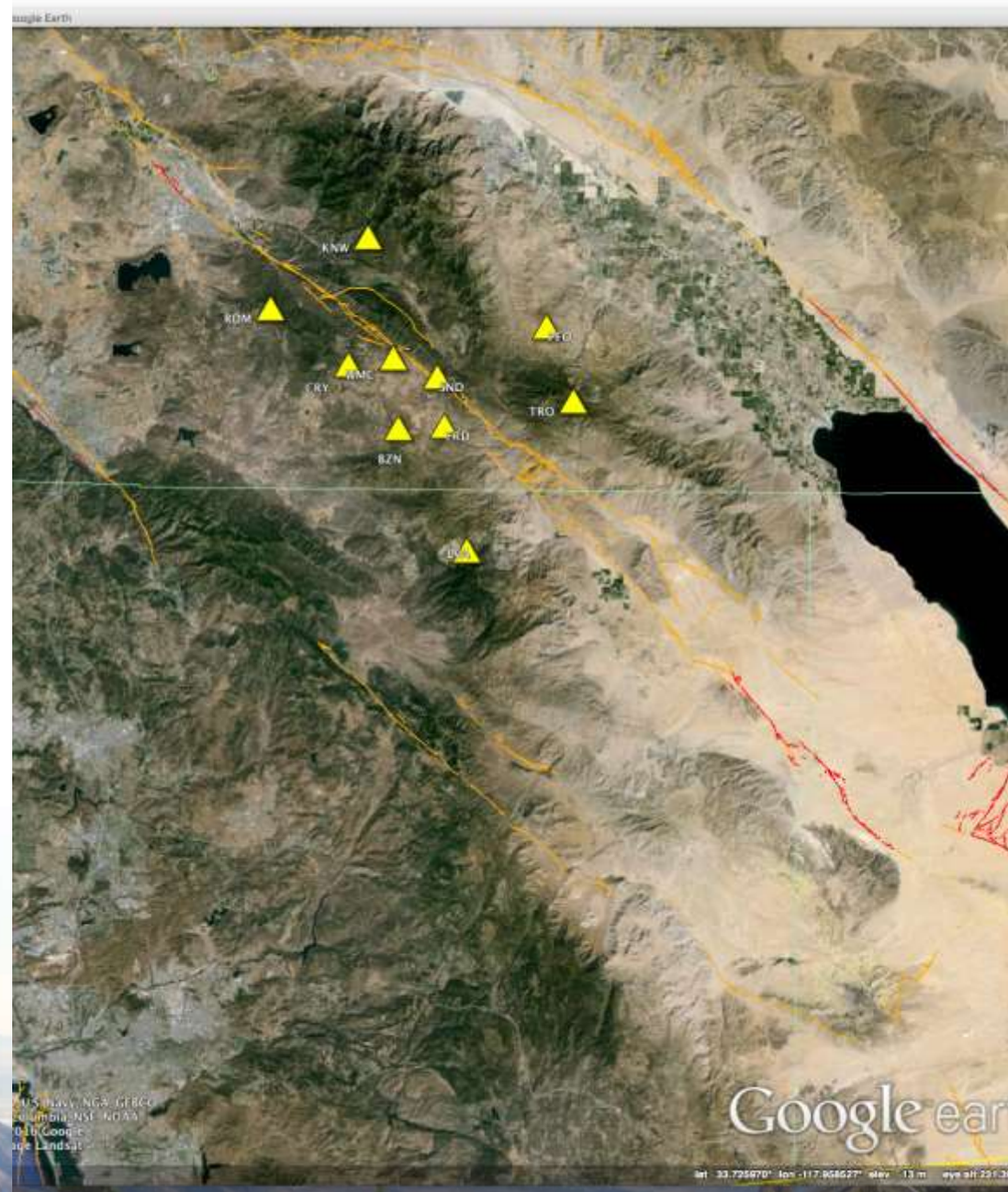
San Jacinto Fault M > 5

- 1937-1980
  4 events
- 1981-2000
  0 events
- 2001-present 4 events

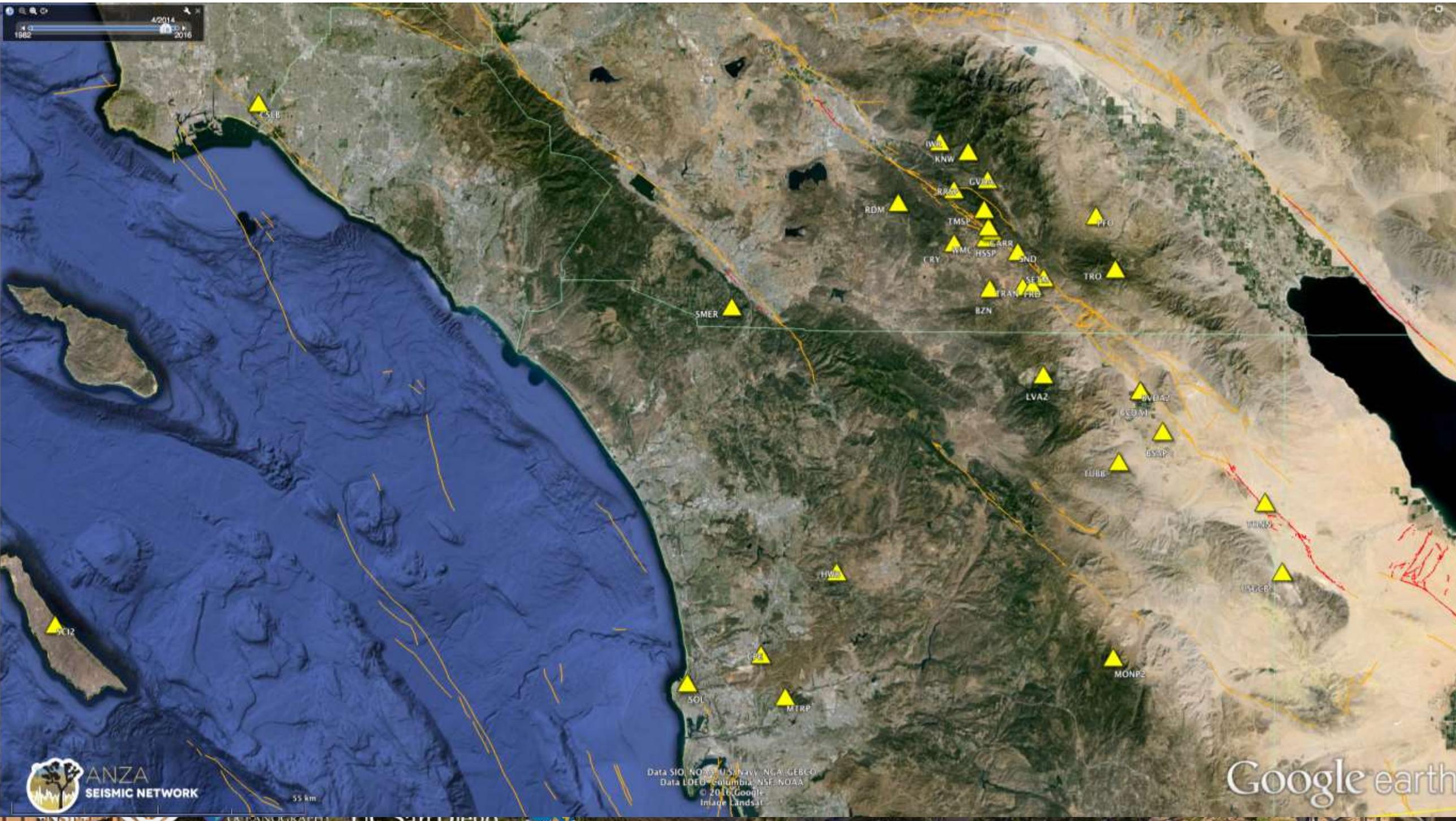


1982-1990 ANZA Phase 1

- Operational in 1982
- First real time digital telemetry seismic network
- 10 short period three-component stations
- 16 bit resolution
- Event triggered



2010-present ANZA Phase 6



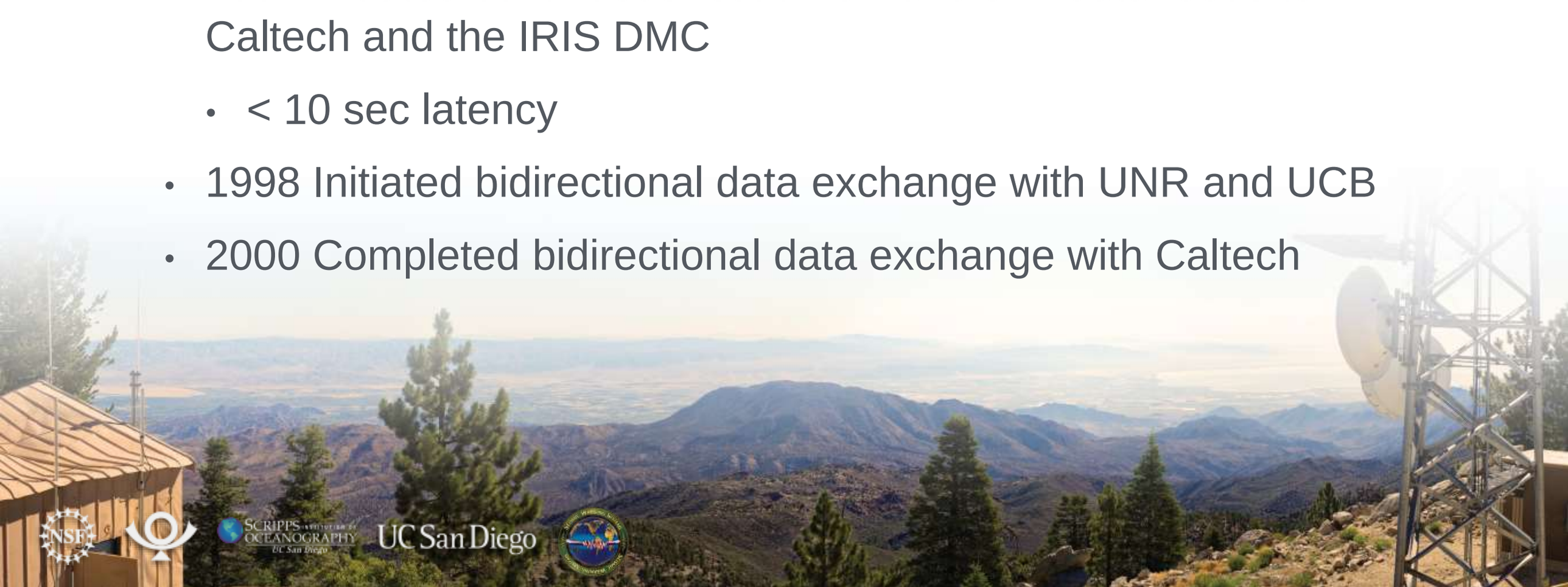
ANZA Current Configuration

- 29 stations in network in remote locations
  - wireless telemetry
  - solar powered, battery backup
  - low power equipment
  - onsite storage
- 22 stations within 15 km of San Jacinto Fault
  - 14 Broadband Sensors
  - 21 with Strong Motion Sensors
    - 10 Free Field Surface Stations
    - 11 Shallow Borehole Episensors (~ 5 meters)
  - 5 Strong Motion Stations within 1 km of fault

ANZA Real Time Data Exchange

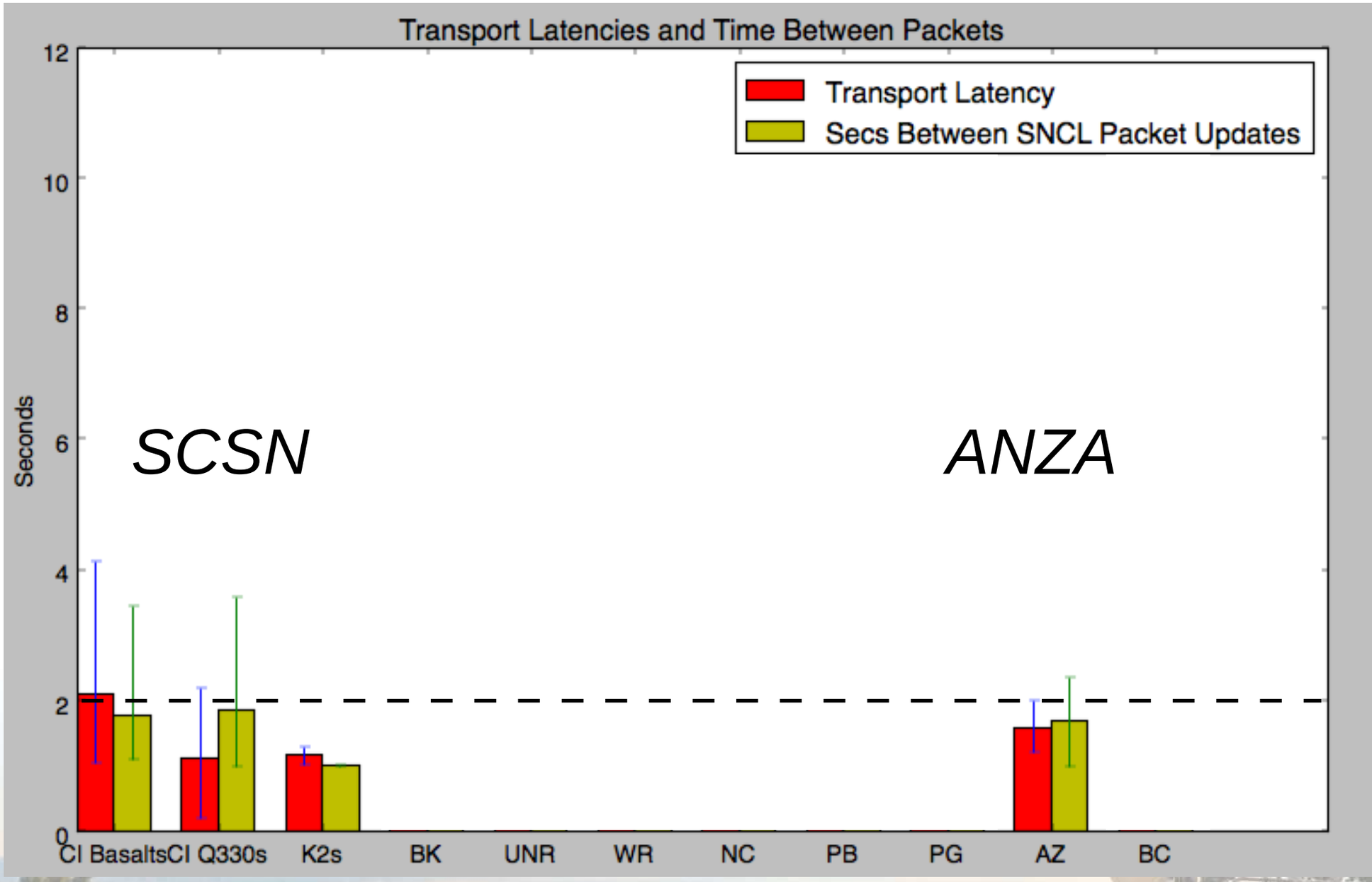
Real Time Data Delivery

- 1995 initiated sending phase picks and event waveforms to Caltech
- 1996 installed BRTT Antelope data acquisition software (also used for the Nevada and the Alaska seismic networks)
- 1997 initiated continuous real time waveform data feeds to Caltech and the IRIS DMC
  - < 10 sec latency
- 1998 Initiated bidirectional data exchange with UNR and UCB
- 2000 Completed bidirectional data exchange with Caltech



Earthquake Early Warning Latency

- Data latency by seismic network observed by Caltech in 2015
- ANZA data has similar latency to Caltech data



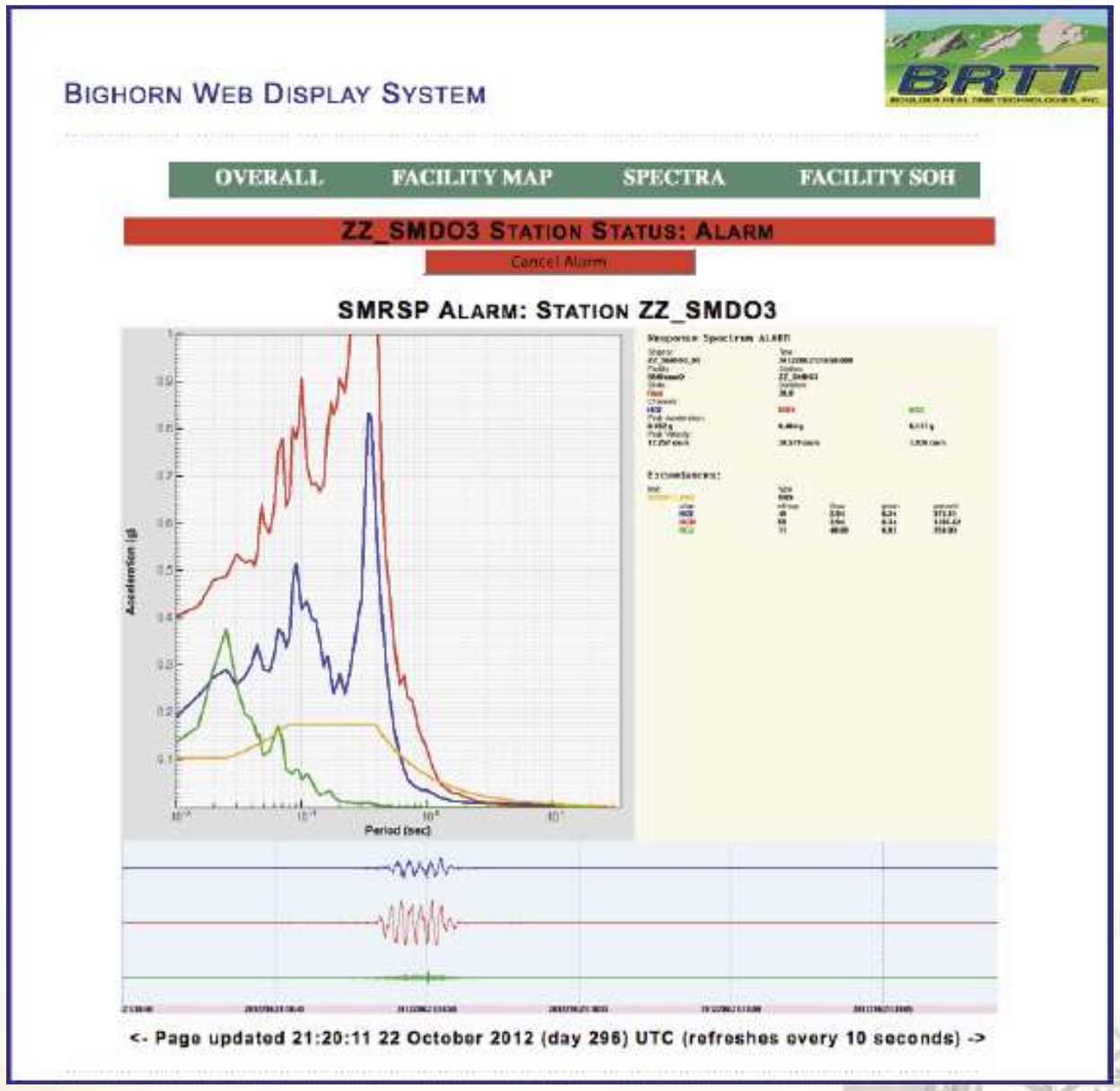
ANZA

Bighorn - Near Real Time Response Spectra

SEISMIC NETWORK

Main Features

- Now-casting of wavefield spectral content
- Real-time, continuous response spectra exceedence
- Automatic alarms against engineered criteria (Structural Health Monitoring)
- Independent of Earthquake Location
  - No need to wait for location
  - Applicable for non-earthquake sources
  - Real time hazard assessment
- Quantitative, critical decision support



Data Policy

- All data are openly available without restriction in real time
- Real time data delivered to
  - SCSN/CISN
  - University of Nevada, Reno
  - IRIS Data Management Center
- Permanent archive of data at IRIS DMC

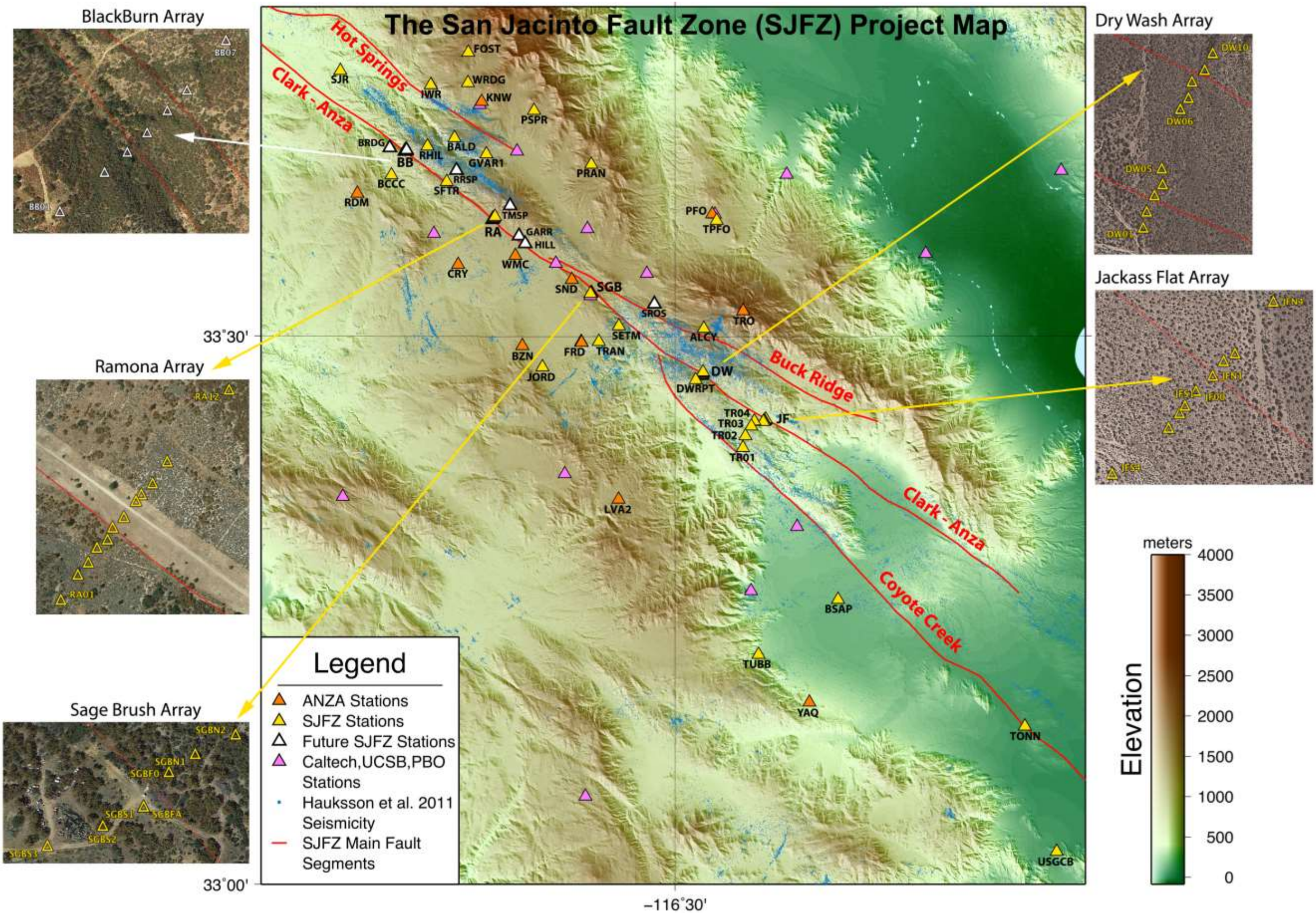
ANZA Seismic Network

- High Quality Data
  - Ground Motion Studies
  - Seismic Structure
  - Earthquake Source
  - Scaling $0 \leq M \leq 5.6$
  - High Seismicity
- Science Results
  - 18 PhD Thesis from 6 Universities
  - 105 Refereed Journal Articles

ANZA

The SJFZ Project Deployment Map

SEISMIC NETWORK

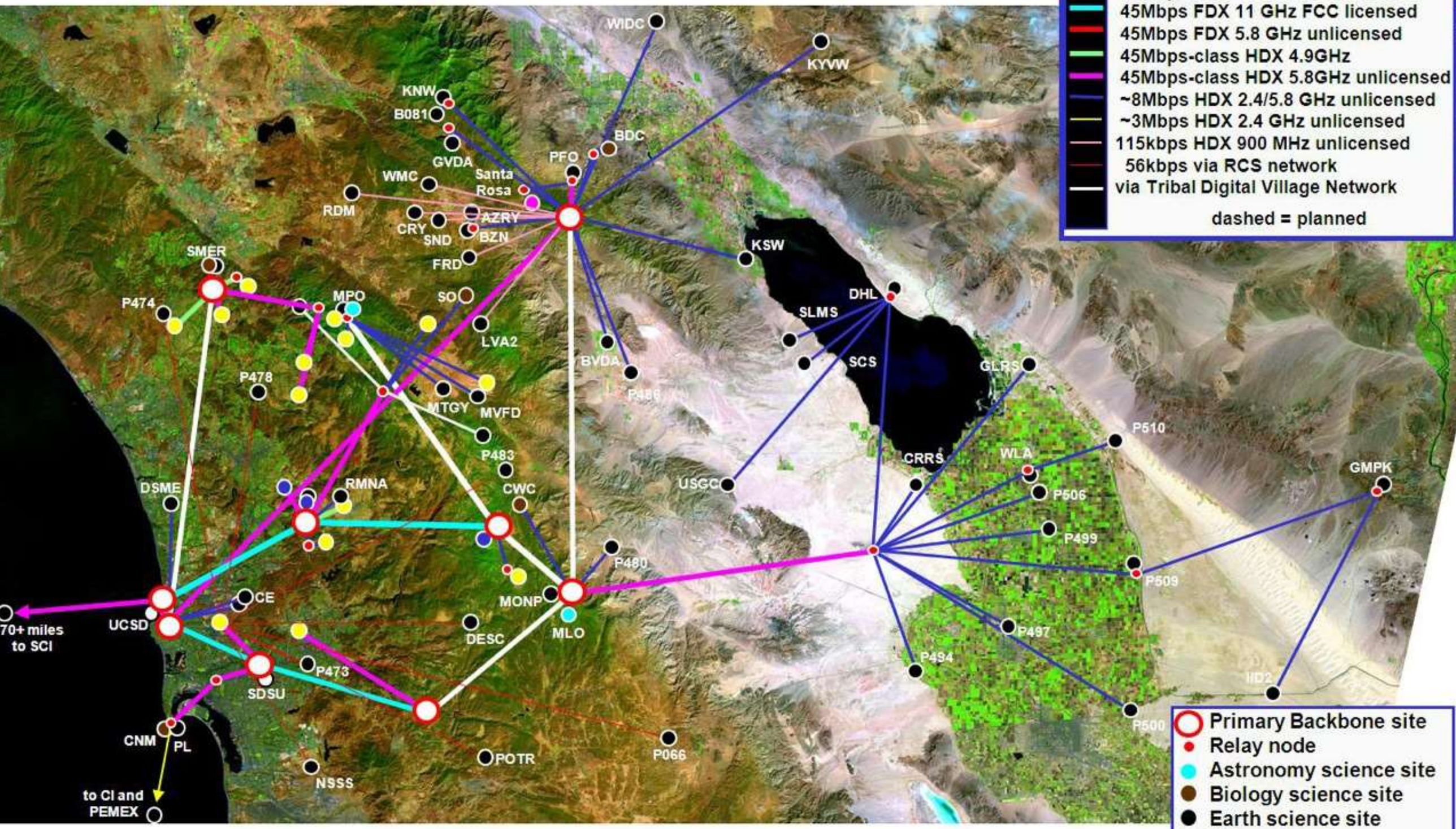


ANZA

SEISMIC NETWORK

Portable Realtime Telemetry Station Deployed in Damage Zone on the Clark Strand of the San Jacinto Fault Zone

HPWREN topology – January 2015

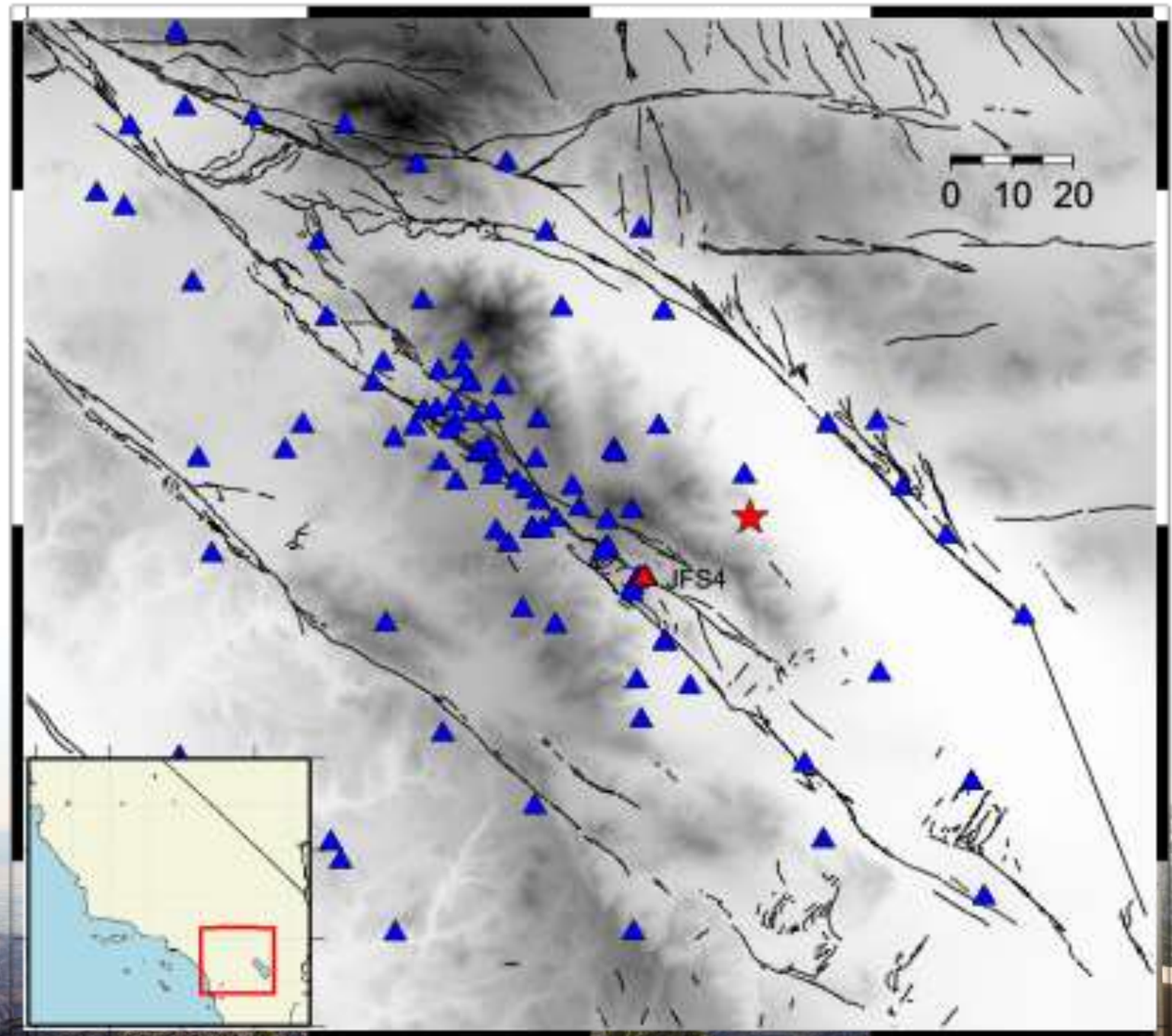


Applied Network Research

http://anr.ucsd.edu

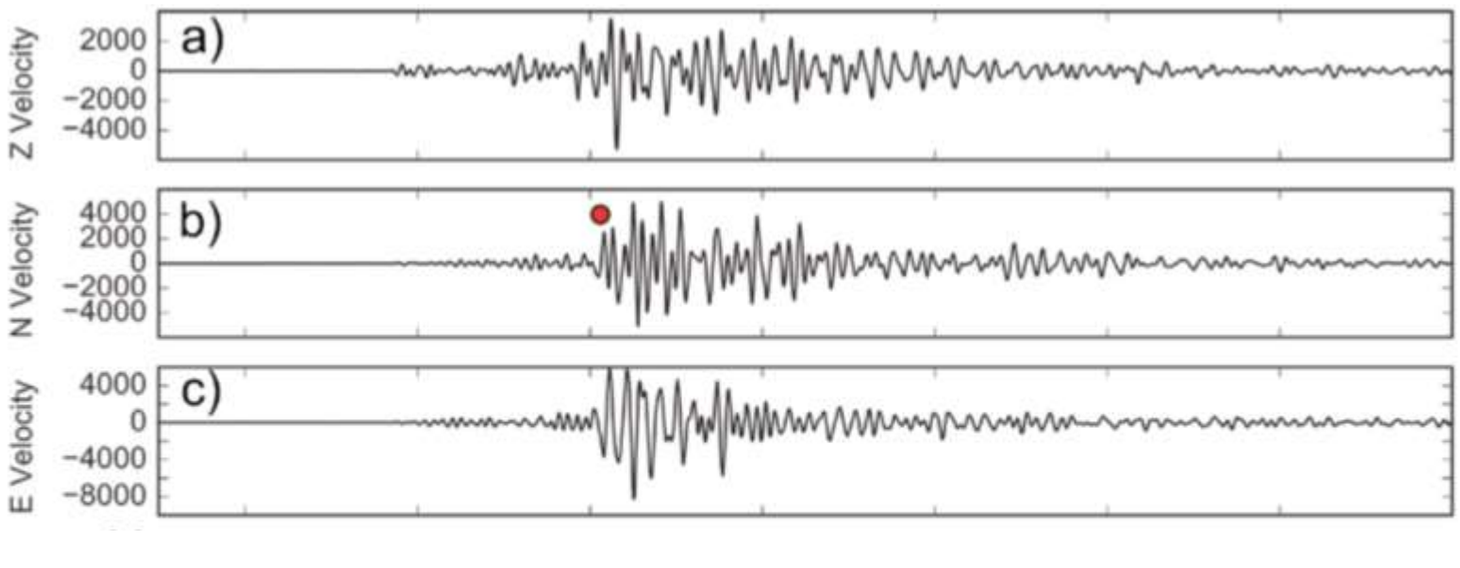
SJFZ Virtual Network

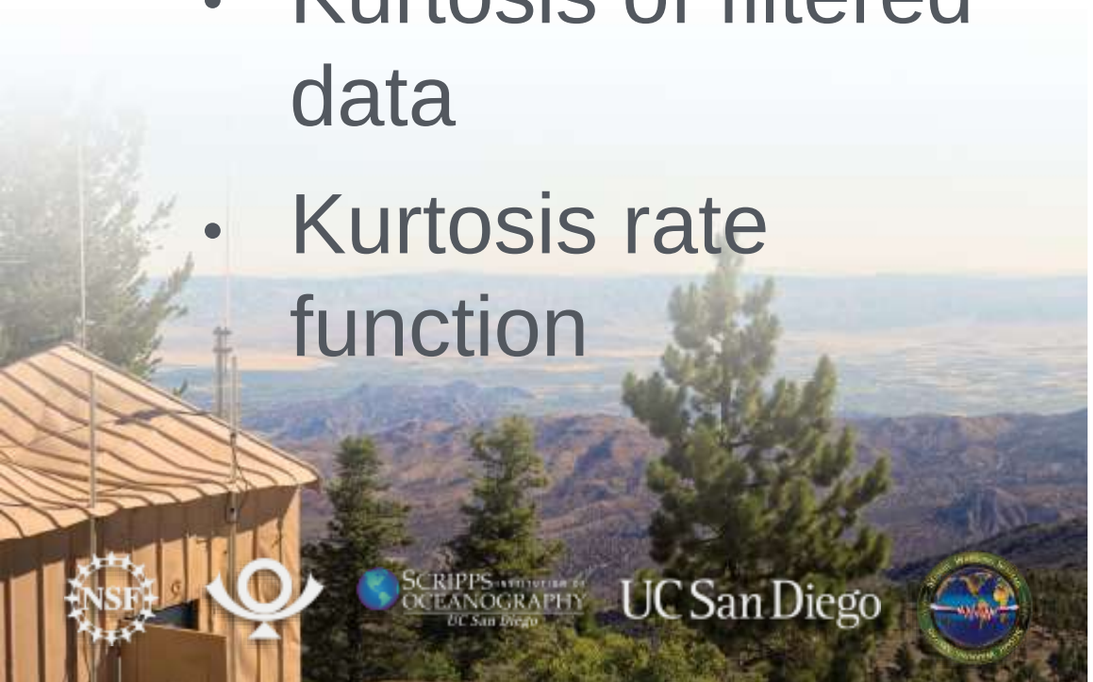
- 123 stations
- AZ, CI, PB, SB, YN networks



S-Wave detector

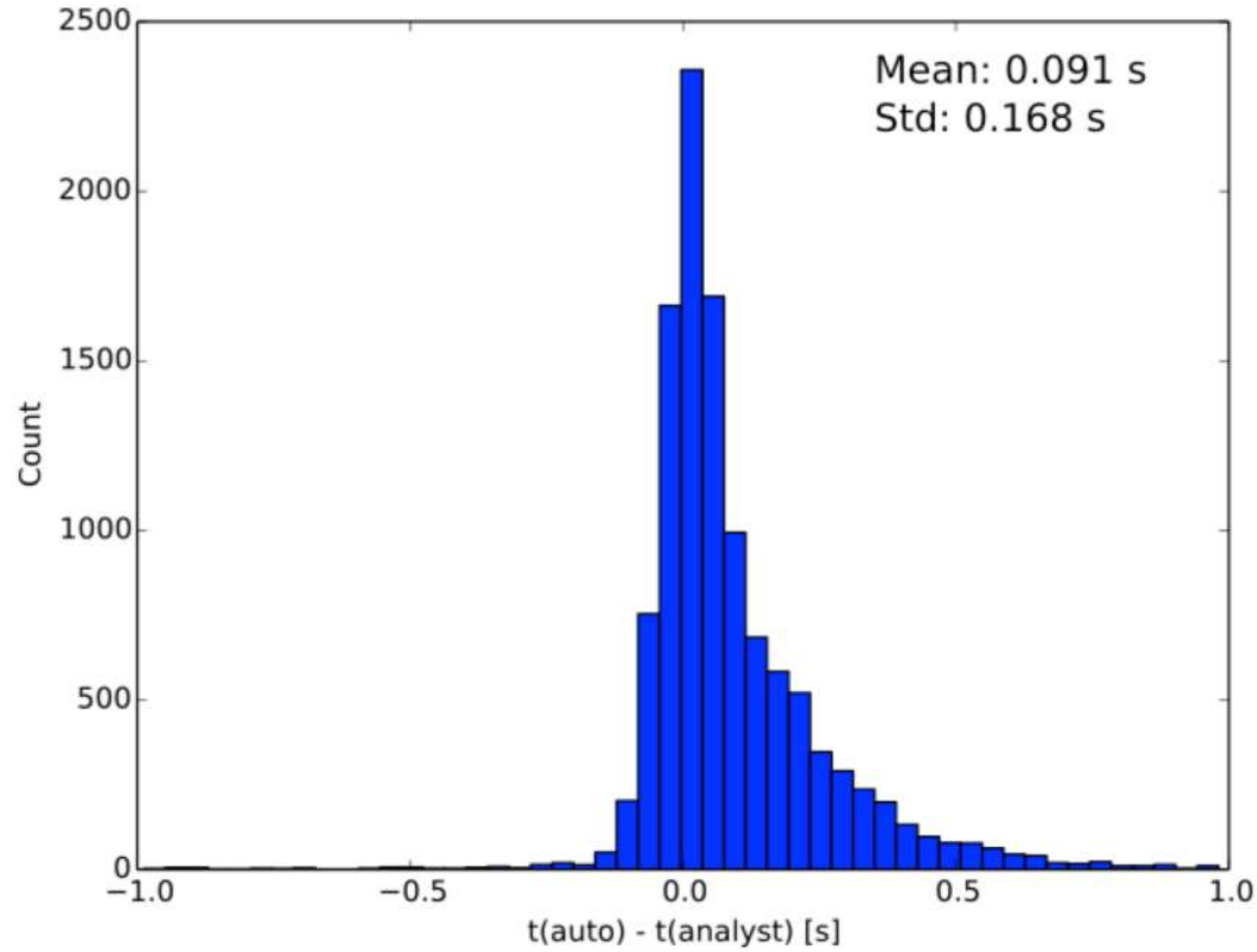
- 3 component seismic data
- S polarization filter
- S filtered N-S channel
- smoothed STA/LTA
- Kurtosis of filtered data
- Kurtosis rate function





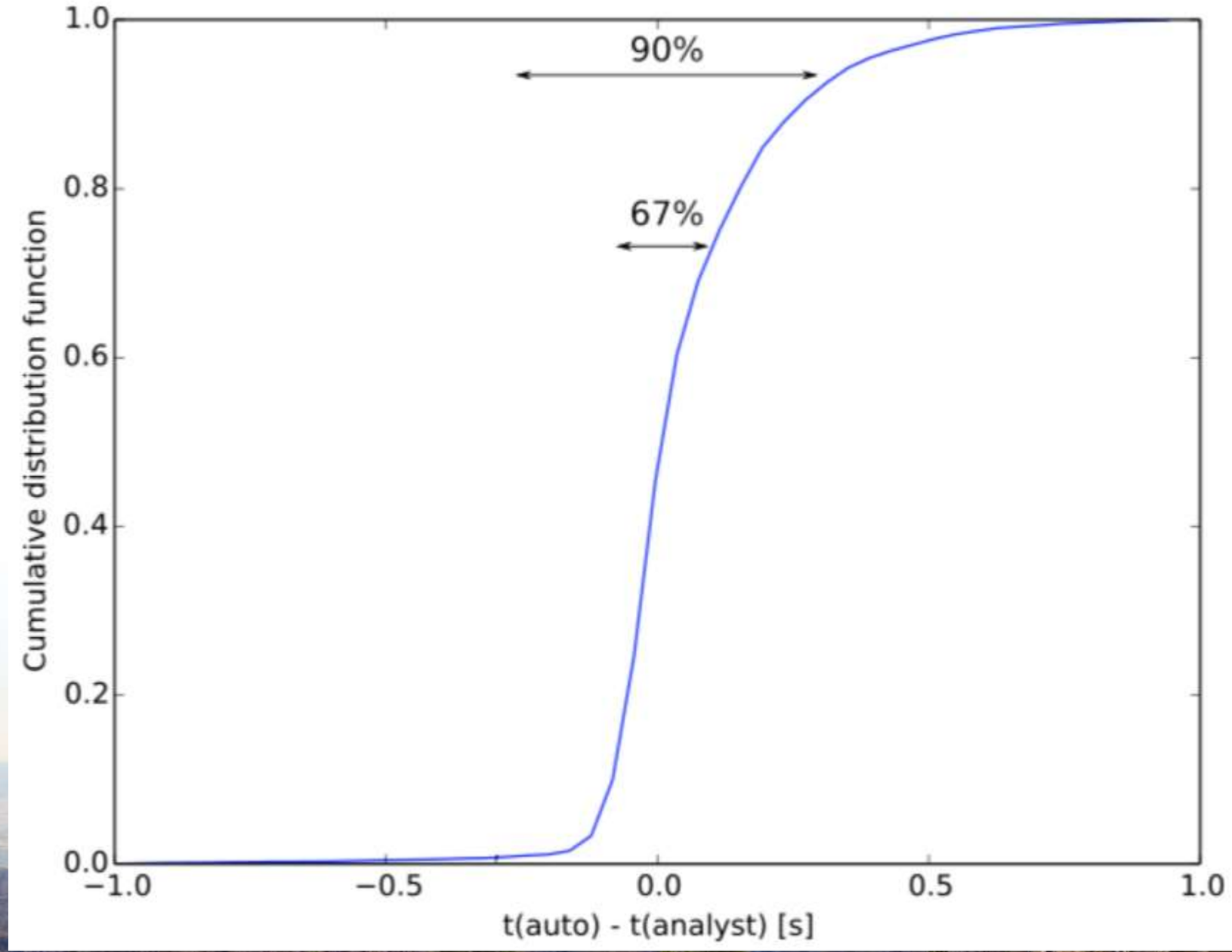
Comparing Analyst - Automatic S Picks

- 123 Stations
- One month data
- 11,353 S wave picks
- 0.09 ± 0.168 s
  - slightly biased
  - skewed distribution



Empirical Cumulative Distribution Function

- 123 Stations
- 11,353 picks
- < 0.06 sec 50%
- < 0.11 sec 67%
- < 0.31 sec 90%



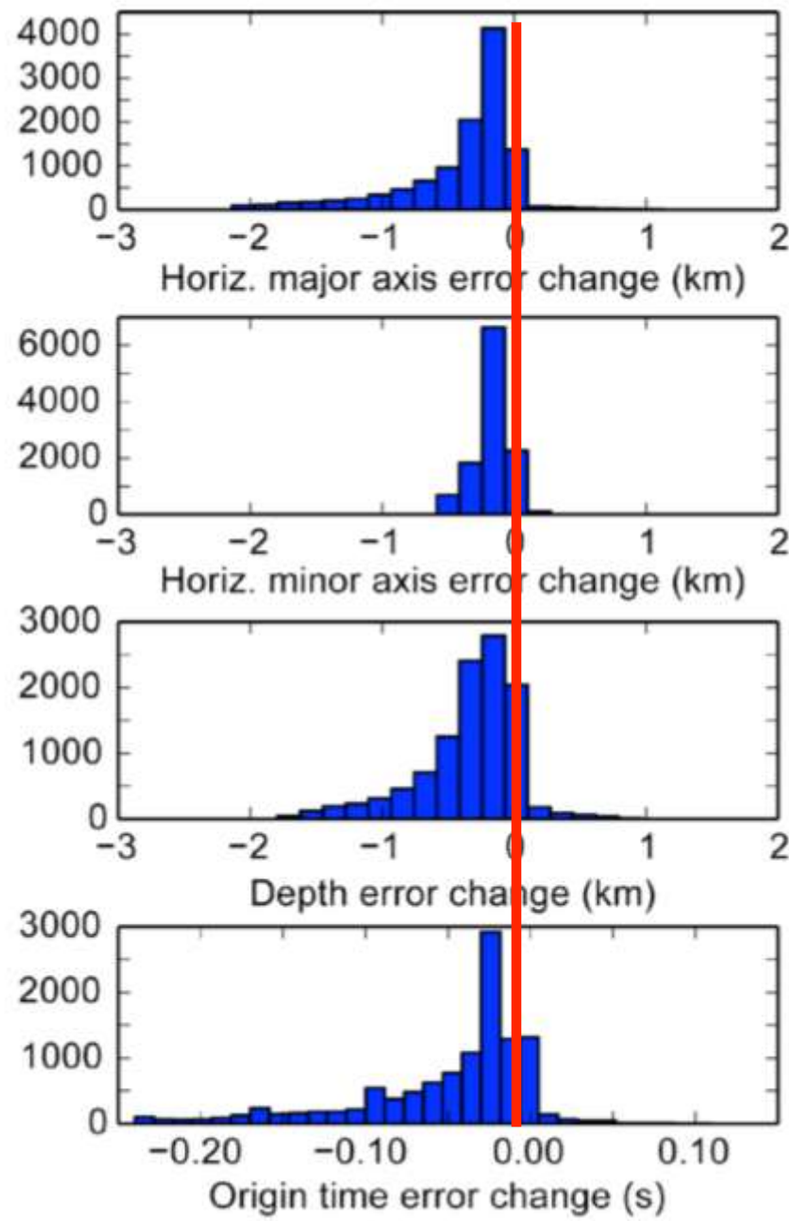
2013 SJFZ Processing

- Processed with dbdetect
  - 38k S picks
  - P/S = 7.53
- Processed with dbdetect + dbshear
  - 267k S picks
  - ~600% increase
  - P/S = 1.08

Uncertainty Statistics

- 11,197 event locations calculated with dbgenloc
- Uncertainty generally decreased
- No systematic bias in location

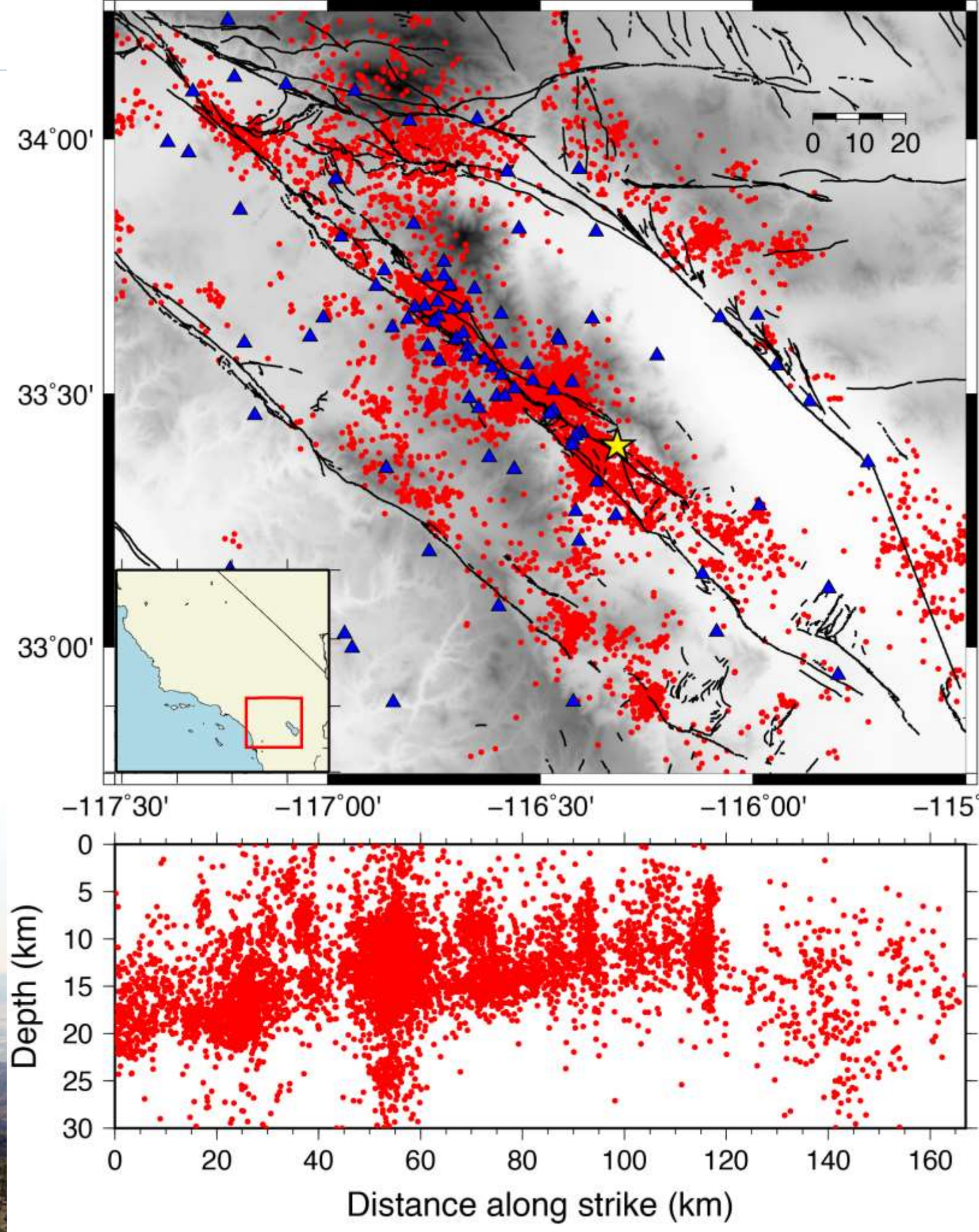
Uncertainty Change



ANZA

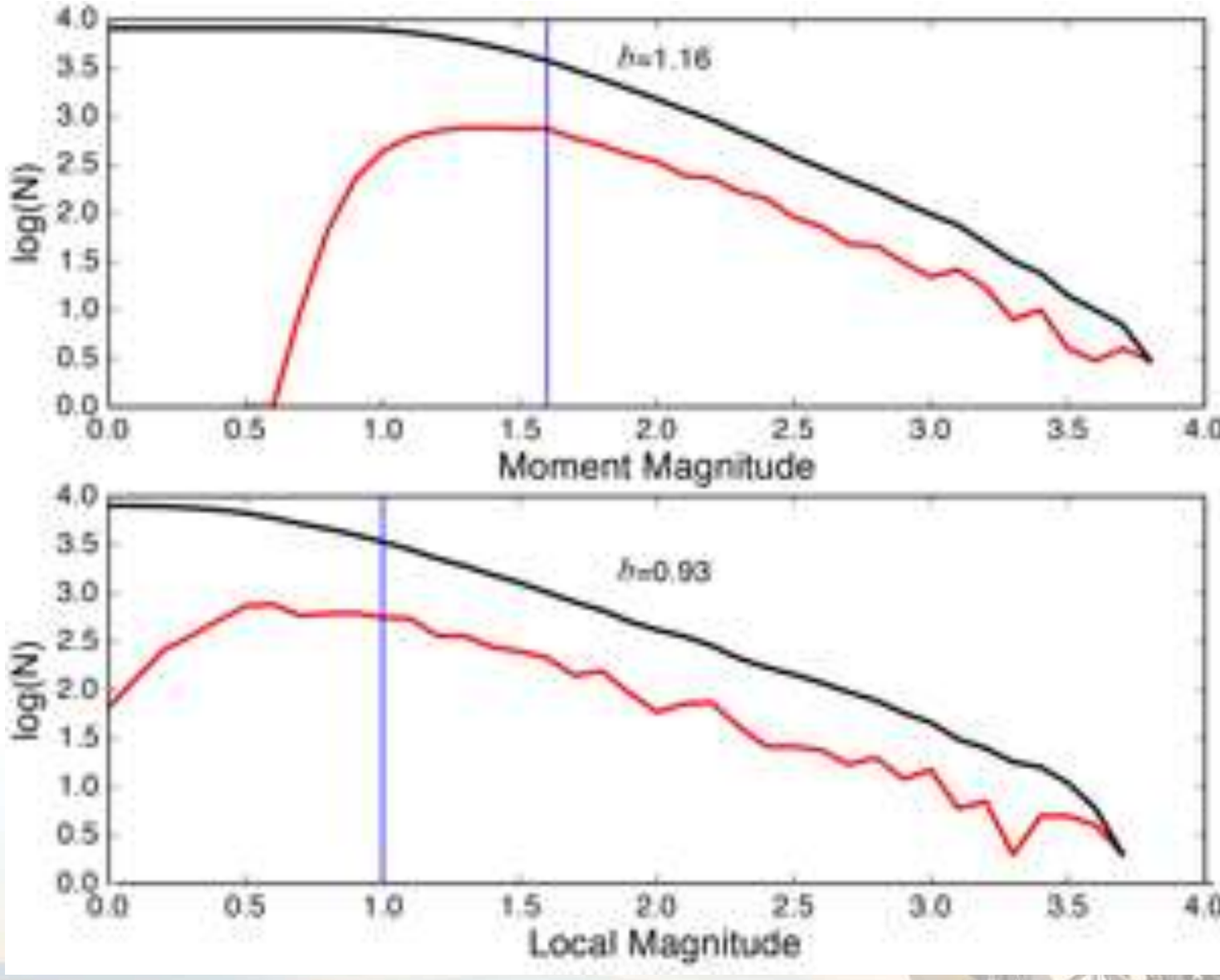
SJFZ Mw Events

- 2013 data
- >13,000 event locations



b values

- M_w 1.16



- M_l 0.93

SJFZ Scaling Relationships