The EarthScope
Geophysical Observatories

Slides courtesy Bob Woodward, Incorporated Research Institutions for Seismology (IRIS)
EarthScope Project

Study the four dimensional structure and evolution of the North American Continent

- 3.2 km borehole into the San Andreas Fault
- 1099 permanent GPS stations
- 74 borehole strainmeters
- 5 laser strainmeters
- 100 Permanent seismic stations

- 400 transportable seismic stations occupying 2000 sites
- 30 magnetotelluric systems
- 100 campaign GPS stations
- 2146 campaign seismic stations
EarthScope Project

EarthScope Components

Plate Boundary Observatory
SAFOD
USArray

USArray Observatory Components

Transportable Array — 400 seismic stations, 70km grid
Flexible Array — 2146 portable seismic instruments for PI driven experiments
Reference Network — about 100 permanent seismic stations
Magnetotelluric — 7 backbone stations and 20 portable instruments
• Drilling through the San Andreas Fault
  • Collecting core samples
  • Installing long-term instrumentation
• Core retrieved - Summer, 2007!
Fault Gouge Layer
(1.5 m thick)

Highly sheared serpentine layer with fragmented calcite veins

Foliated fault gouge with serpentine and sandstone porphyroclasts

Serpentine cut by white (calcite) veins

Foliated gouge with serpentine and sandstone porphyroclasts

Serpentine Porphyroclast
Permanent GPS Stations
GPS Station

- Internet Uplink
- GPS receiver & Satellite modem
- GPS Signals
- GPS Antenna
- Deep Drill Braced Monument
- Cable runs
- Legs extend to 10-15m depth
GPS Installation
Some GPS Sites

Los Osos, CA

Seal Rock, AK

Rainy Pass, AK
Long Baseline Strainmeter

[Diagram of a Long Baseline Strainmeter with labeled parts: Laser, Mirror, Reference Beam, Beam Splitter, Photodetector, Optical Anchors, and a map showing a 400-600 meter baseline location.]
Long-baseline Laser Strainmeters
LiDAR
• Observatory components of USArray

  • Transportable Array
    • 400 seismic stations, 70km grid
    • Rolling across the country, west to east

  • Flexible Array
    • 2146 portable seismic instruments
    • Used by individual experiment teams

• Reference Network
  • ~100 permanent seismic stations
  • A “fixed” background network

• Magnetotelluric
  • 7 backbone stations providing a fixed background network
  • 20 portable instruments deployed each summer
Flexible Array

- A pool of high quality instrumentation used by teams for experiments lasting 1 day to two years

- Provide complete station sets to teams
  - Solar panels, power systems, cables, enclosures, . . .

- Provide training and assistance

Guralp Broadbands - 326
RefTek Texan with geophones - 1700
Guralp short period - 100
Kinematics EpiSensor - 20
Flexible Array

- Seven FA experiments currently in the field
- High data return
  - E.g., 94.5% for CAFÉ
- Includes near-real-time comms

Equipment:
- 326 broadband
- 120 short period
- 1700 active source
Reference Network

- ~ 100 stations in contiguous US
  - ANSS stations
  - Regional network stations
  - USArray Permanent Array

• 7 backbone sites

• All data at IRIS DMC

Station has already withstood 60-85 mph winds and golfball-sized hail!
MT Summer Campaign

Some field photos from the first site of Summer 2008 - Bear Lake, Idaho

- Taking care of details . . .
- MT TA vehicles on site for installation :)
- Connecting cables . . .
- Magnetometer before burying
MT Permanent Sites

determine the structure of the crust and mantle beneath the continental USA. The equipment is sensitive to you, your vehicle and any metal objects. Please stand back at least 200 yards. The site is monitored 24/7.
Transportable Array Installation Plan

2004 - 2013
As of September 30, 2008
- 650 commissioned
- 448 operating
- 200 removed

Rolling eastward at a rate of about 400 km per year

Stations going in . . .
. . . and coming out
TA Progress

- Rolling from west to east
- ~18 stations installed / month
- ~18 stations removed per month
• 400 broadband seismic stations
  • ~70 km spacing
  • ~1500 x 1500 km “footprint”
  • ~2 year deployments at each site
  • 10 years and 1623 sites to roll across the country

• Goals
  • High-quality broadband data
  • Maximize data return (>85%)
  • Data in near real time
    • 40 and 1 sps continuous
Construction
Installation
Just some plants in the way . . .

Or maybe some cold temperatures . . .

. . . or some snow
Servicing

Or maybe quite a bit of snow . . .
Servicing

... or a *lot* of snow
Servicing
Servicing
Siting Outreach

- Site reconnaissance by student teams
- 32 students in the field right now
- >100 students and 20 universities already involved

- Active Earth Displays at museums and interpretive centers
• TA stations can be “adopted” for the cost of the instrumentation
  • 25 stations adopted so far, numerous others in planning stages
  • WA, OR, ID, AZ, UT, . . .

• The TA is leaving a “wake” of permanent stations

• TA site reconnaissance
  • Use university students in summer
  • >70 students and 20 universities already involved
EarthScope is funded by the National Science Foundation.

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Want More Info?

- All EarthScope observatories are fully operational
- All data are completely open
- Data are rolling in and some very exciting science is underway
- Stay tuned . . .

On the Web

- EarthScope
  www.earthscope.org
- USArray
  www.iris.edu/usarray
- National Science Foundation
  www.nsf.gov