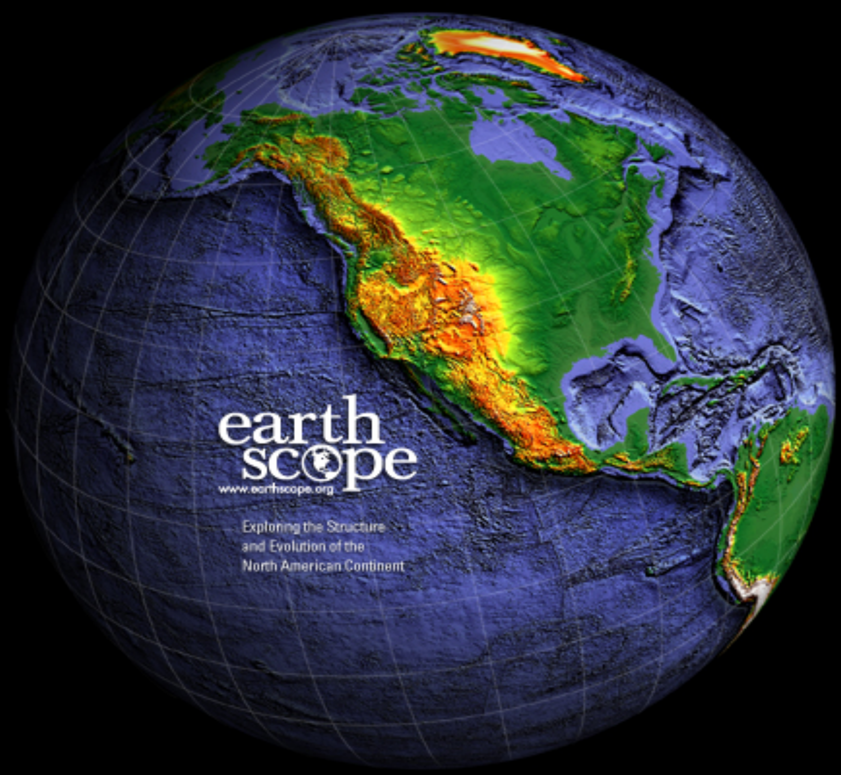
Earthscope Institute: Geochronology and the Earth Sciences

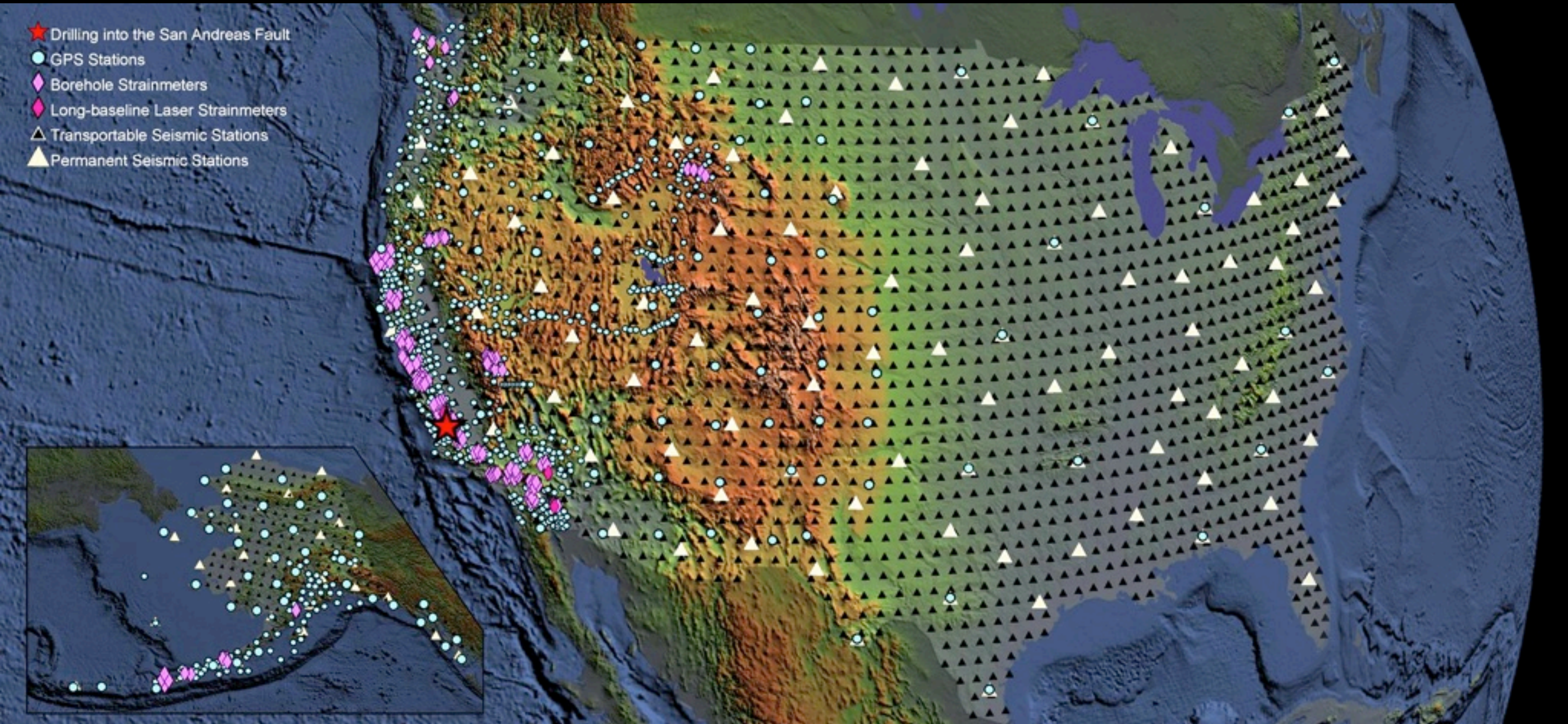
Becky Flowers, James Metcalf, Tammy Rittenour, Blair Shoene, Ramon Arrowsmith



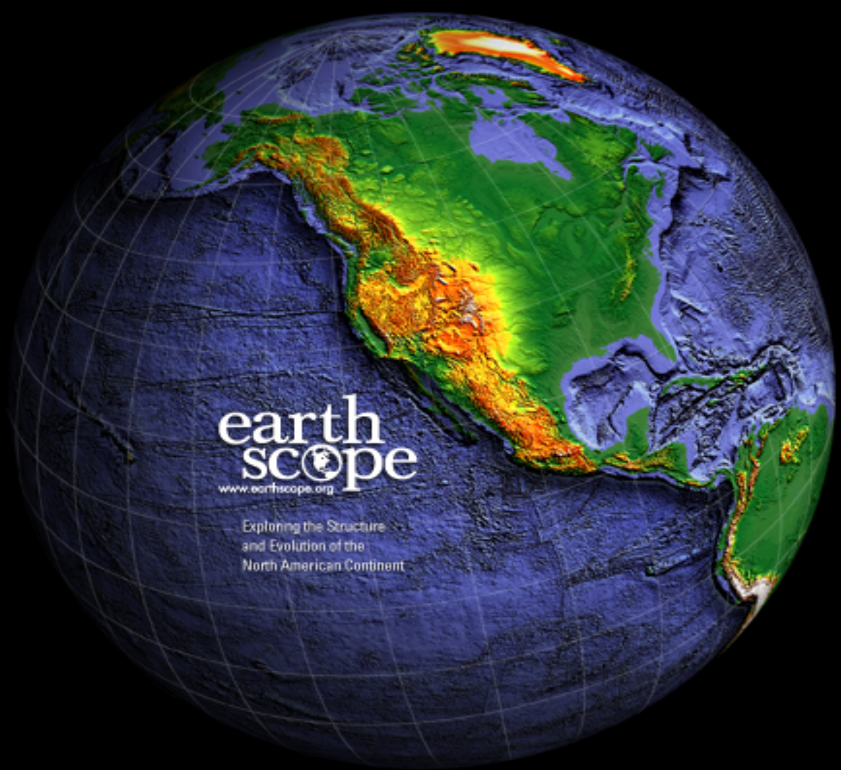
- theory and application of geochronologic methods
- highlight examples of how different geochronology methods have been *and can be* used to explore the temporal evolution of the North American continent

EarthScope: Enabling New Science

- **Earth Sciences version of Hubble Space Telescope**
- **Enables "survey mode" of continent**
- **Named the #1 "Epic Project" by Popular Science in 2011**



Its 15 year mission (2003-2018) to boldly explore the structure and evolution of the North American continent



http://onceuponageek.com/2009/09/30/star-trek-enterprise-wallpapers/

Observatories, Science Program, Investigator and educator community

- Synoptic perspective
- Community data and facilities
- Hierarchical nesting of focused projects within broad coverage
- Integrative and multidisciplinary

earth scope

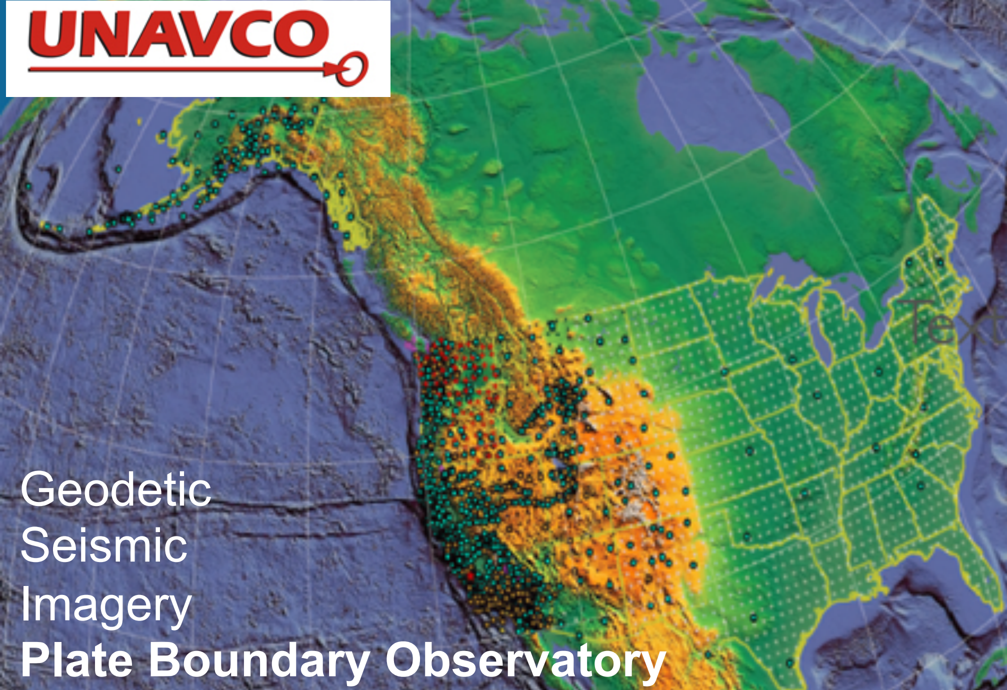
Unlocking the Secrets of the North American Continent

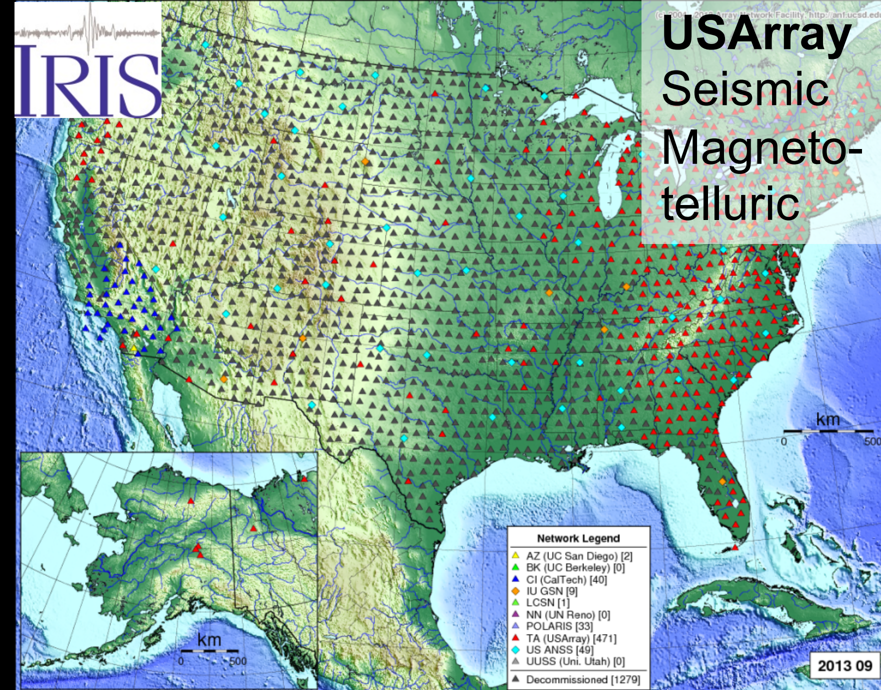
An EarthScope Science Plan for 2010–2020

www.earthscope.org

EarthScope Science Targets (*http://www.earthscope.org/information/publications/science_plan/*)

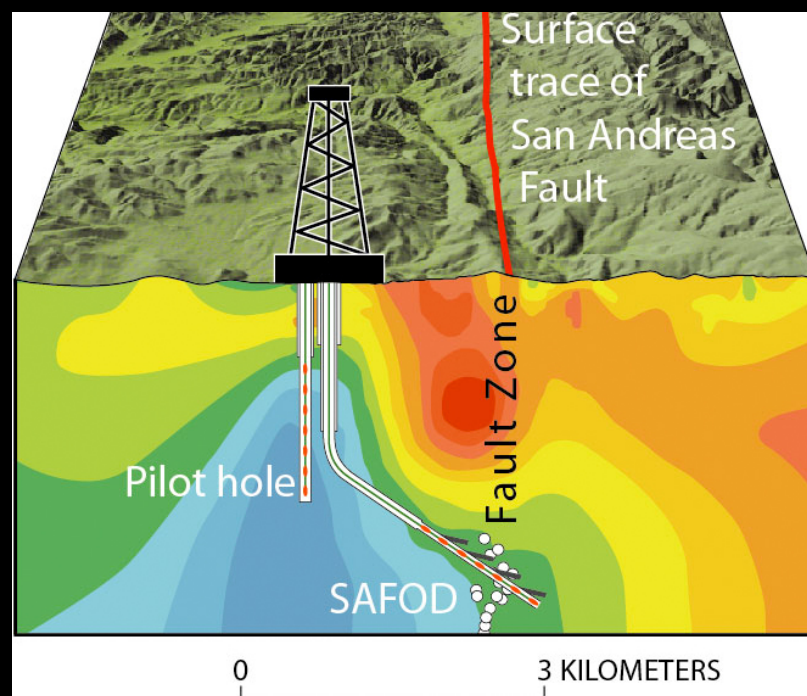
- Imaging the Crust and Lithosphere Beneath North America
- Active Deformation of the North American Continent
- Continental Evolution Through Geologic Time
- Deep Earth Structure and Dynamics
- Earthquakes, Faults, and the Rheology of the Lithosphere
- Magmas and Volatiles in the Crust and Mantle
- Topography and Tectonics: Elucidating Time-Space Patterns of Lithospheric Deformation
- EarthScope Contributions to Understanding Earthquake, Tsunami, Volcano, and Landslide Hazards
- Expanding EarthScope's Reach (E+O)
- EarthScope Data in the Service of EarthScope Science



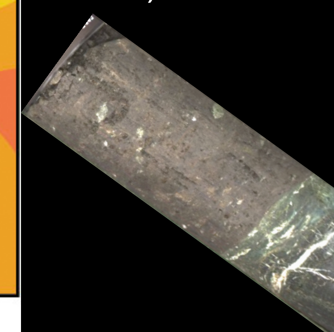


The three observatories of the EarthScope

Facilities for EarthScope have successfully built a powerful apparatus for doing science

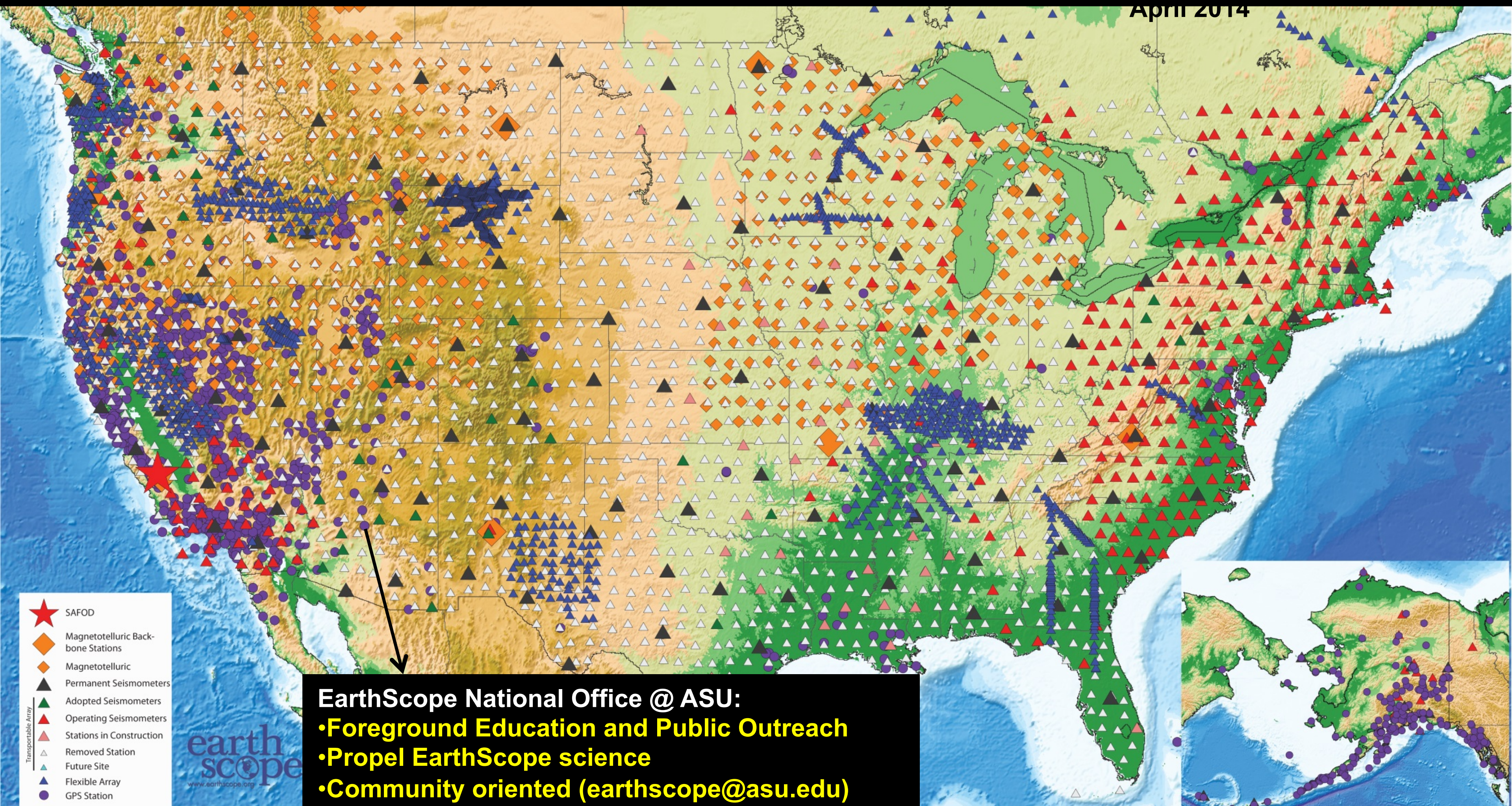


San Andreas Fault Observatory at Depth (built by Stanford/ USGS)



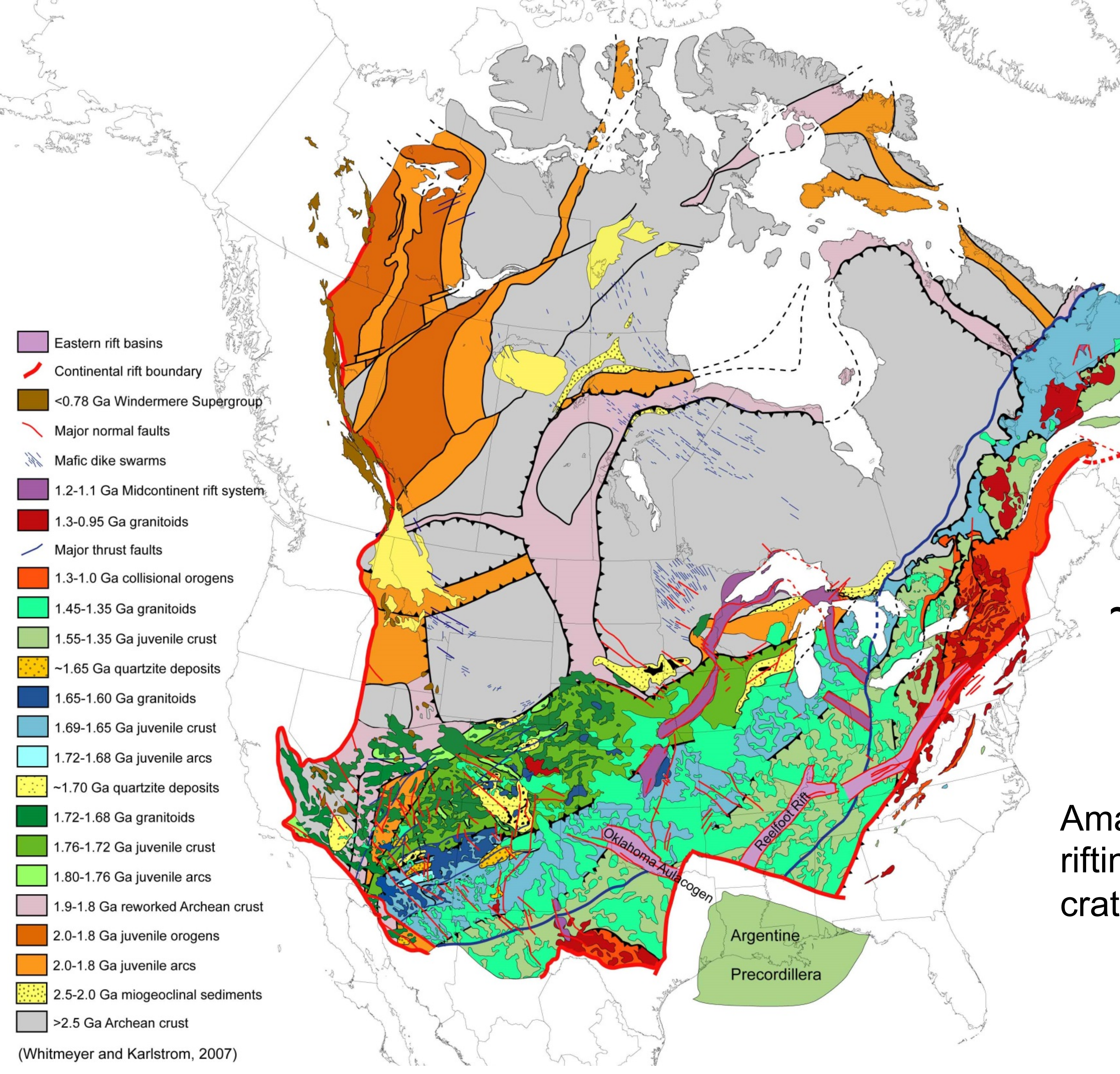
Exploring the Structure and Evolution of the North American Continent

The EarthScope scientific community conducts multidisciplinary research across the Earth sciences utilizing freely available data from instruments that measure motions of the Earth's surface, record seismic waves, and recover rock samples from depths at which earthquakes originate.



EarthScope National Office @ ASU:

- **Foreground Education and Public Outreach**
- **Propel EarthScope science**
- **Community oriented (earthscope@asu.edu)**



Exploring the Structure and Evolution of the North American Continent:

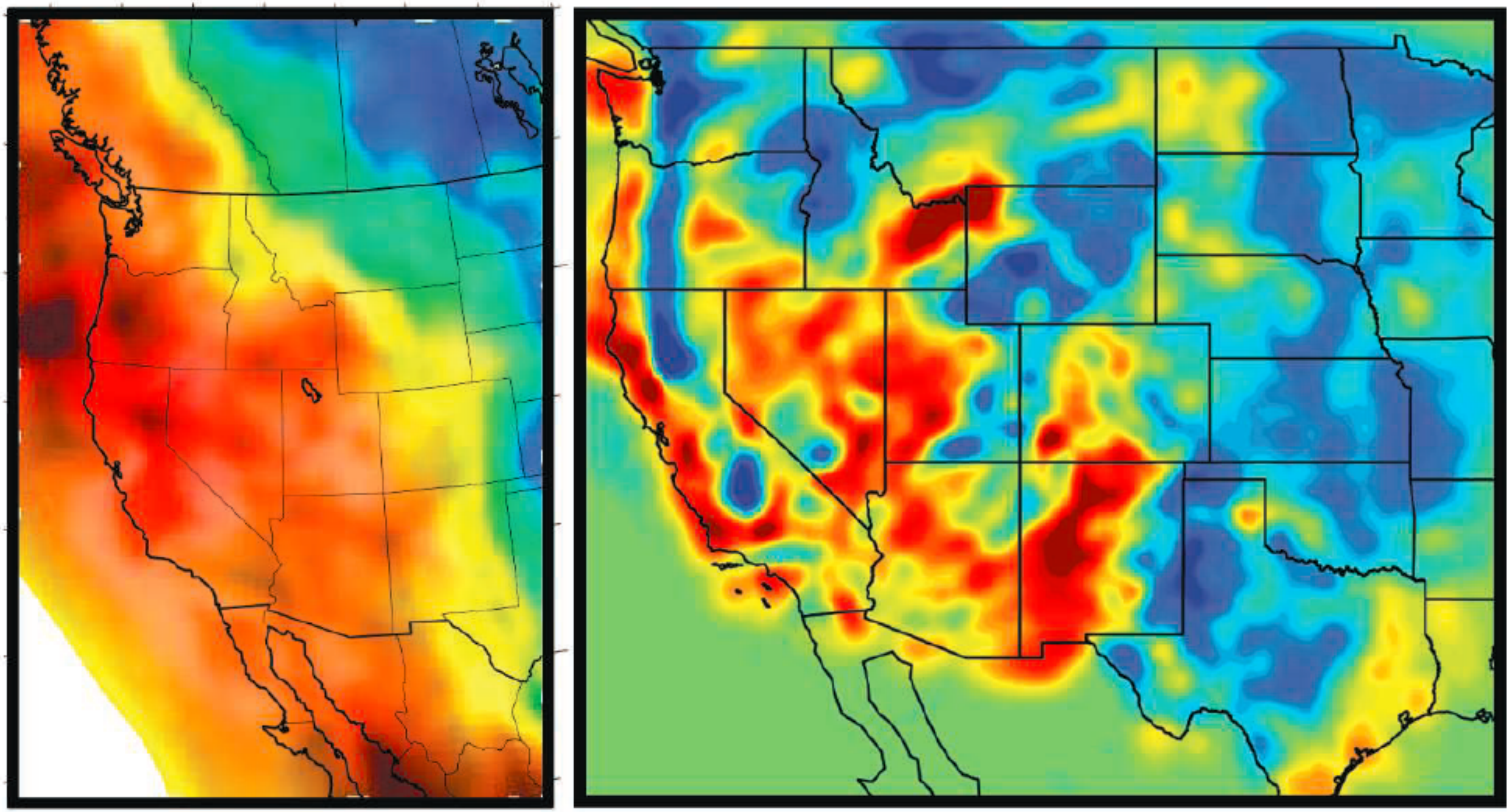
Measuring the motions and the properties that constrain the processes

~ 0.535 Ga

Amalgamation and rifting manifest in cratonic interior

-Whitmeyer and Karlstrom, 2007

Western United States at a Depth of 90 Kilometers



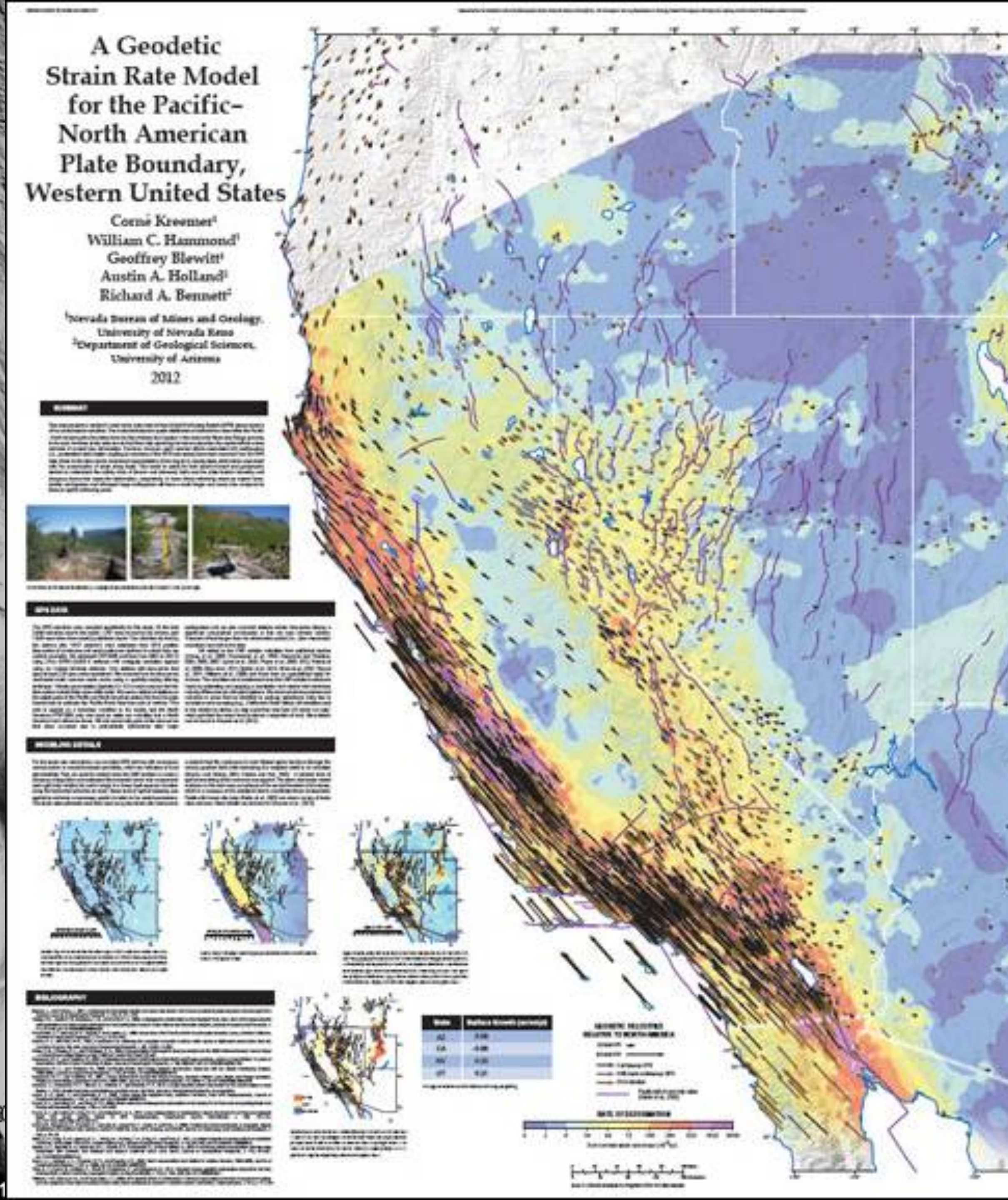
That's better. Seismic data from EarthScope's Transportable Array sharpened existing imaging (*left*) so that colder (blue) and hotter (red) features in the mantle stand out (*right*). **Kerr, 2013**

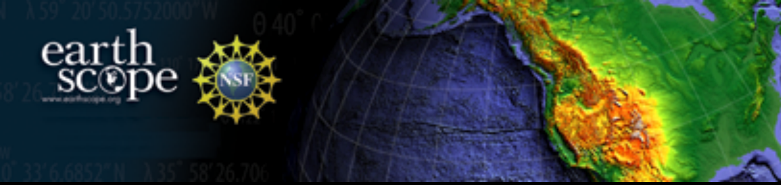
High-quality, freely available data + new analysis methods

Transformative insights into Earth structure

Deformation & Surface Change

- Measure earth deformation at multiple scales
- Free and open data products

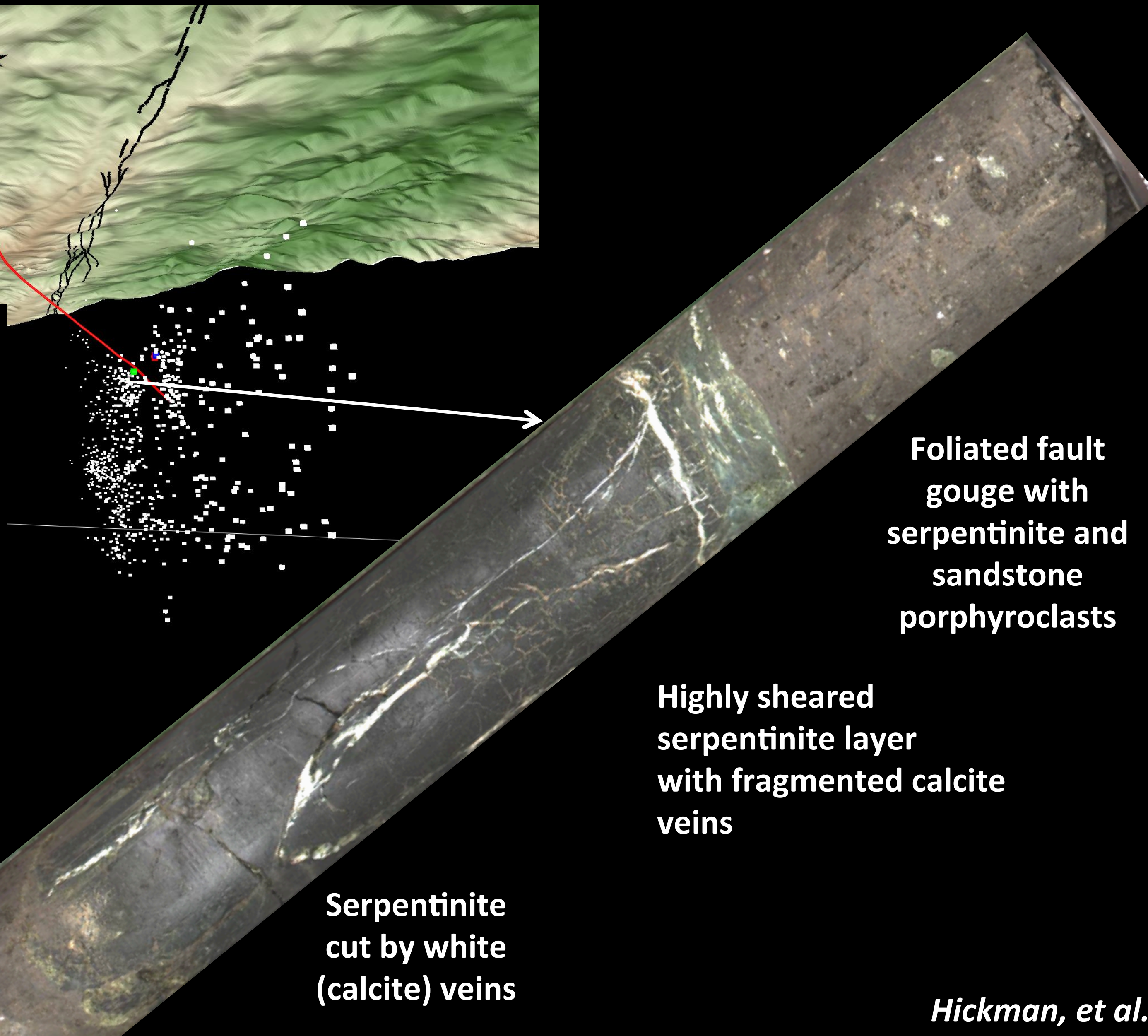




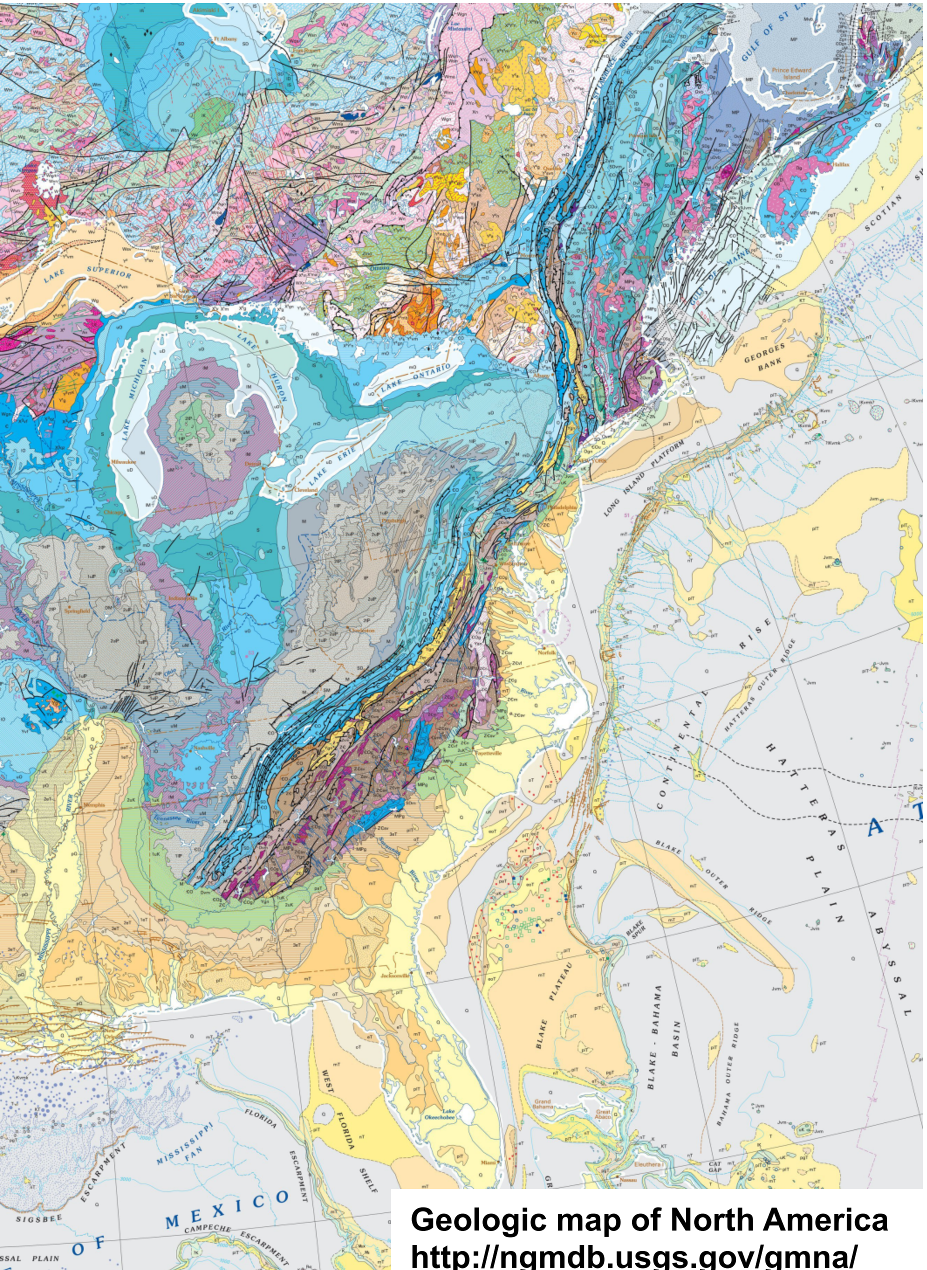
San Andreas Fault Observatory at Depth:

Test fundamental theories of earthquake mechanics
Establish a long-term observatory in the fault zone

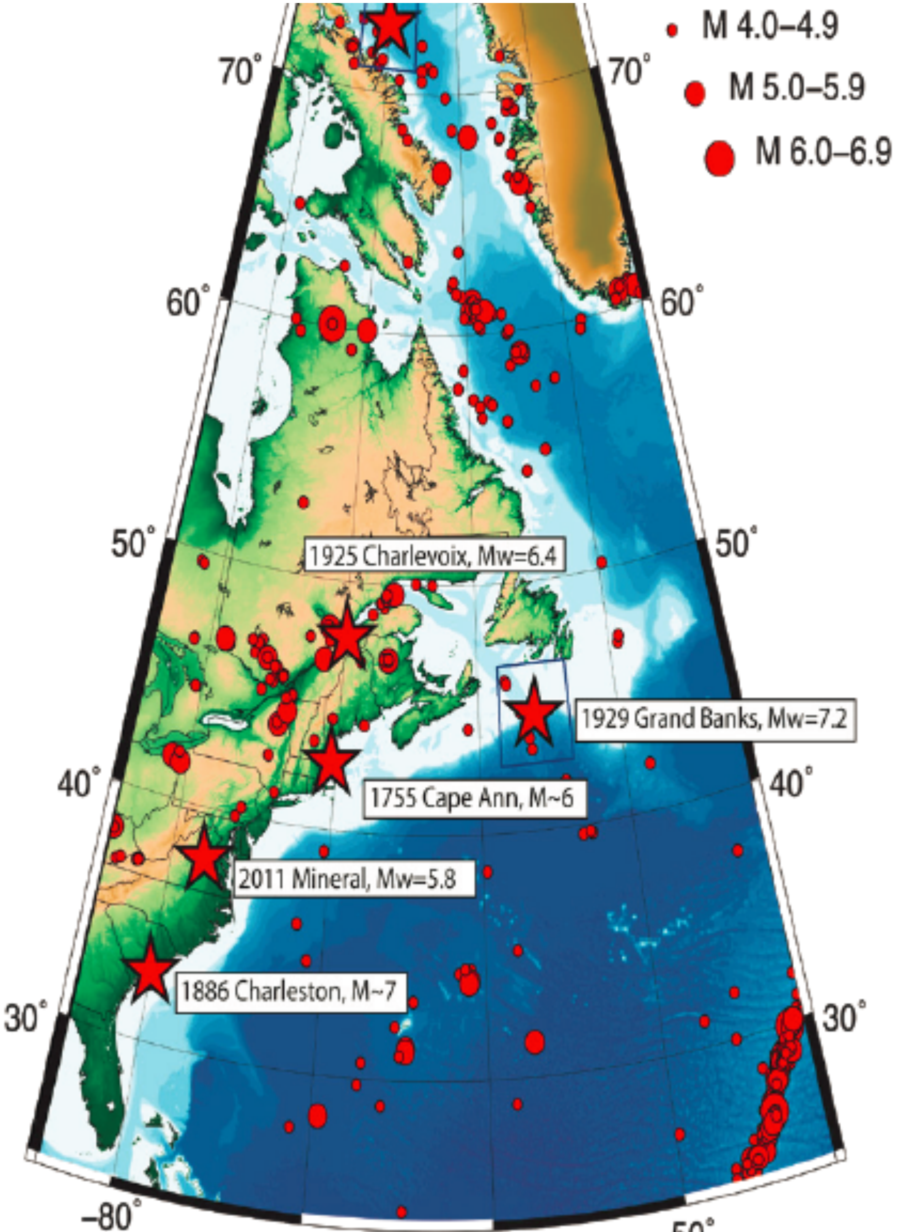
San Andreas Fault Observatory at Depth is an indispensable element of the core EarthScope Facilities. Its continued operation and management as a community resource continues to be an essential and integral part of EarthScope science.



EarthScope is transforming our thinking about the tectonic history and active processes in eastern North America



Geologic map of North America
http://ngmdb.usgs.gov/gmna/



Wolin et al. [2012]

EarthScope Meetings

- EarthScope Institute on the Spectrum of Fault Slip Behaviors (2010)
- EarthScope Institute on the Lithosphere-Asthenosphere Boundary (2011)
- EarthScope-GeoPrisms Alaska Planning Workshop (2011)
- GeoPRISMS - EarthScope Planning Workshop for the Cascadia Primary Site (2012)
- EarthScope Workshop: Four-Dimensional Evolution of the Conterminous U.S.; Pre-GSA meeting (2013)
- CIG-EarthScope Institute for Lithospheric Modeling (2014)
- Earthscope Institute: Geochronology and the Earth Sciences (2014)

- +IRIS and UNAVCO biennal science workshops
- +EarthScope biennal national meetings

- 2015 EarthScope National Meeting (Stowe, Vermont June 15-18, 2015)

2001 EarthScope Planning documents

"Systematic geochronology is required to understand the key concept of time, captured by the slogan 'no dates, no rates.'"

Recognition of the value of a wide range of geochronometry applied to basement geology to earthquake timescales.

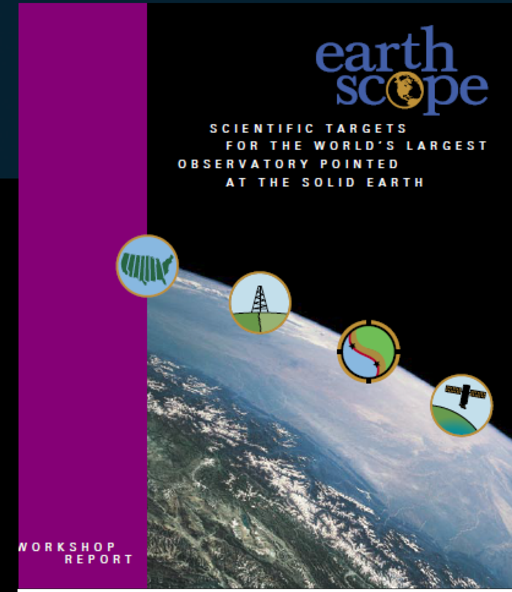
While no large scale renewal of geochronology facilities was achieved, numerous dates were made possible for EarthScope science.

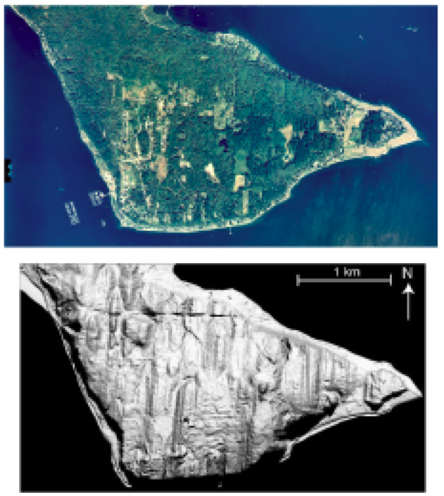
Fast forward to:

"share some geochronology love"—Chris Andronicos

And then…

Earthscope Institute: Geochronology and the Earth Sciences (2014)




The Plate Boundary Observatory

Results of the First Workshop on Geological Researc

Held at Pasadena, California
May 22-25, 2001

Submitted by PBO Geology Committee

EarthScope Community

EarthScope is a community effort.

We need you:

Let us know your successes
Be vocal
Tell us what is needed
Participate

earthscope@asu.edu
ramon.arrowsmith@asu.edu

EarthScope Geochronology Graduate Student Award Program

PIs: Becky Flowers (CU), Ramon Arrowsmith (ASU), Jim Metcalf (CU), Blair Schoene (Princeton), Tammy Rittenour (USU)

Funded by NSF EarthScope Award EAR-1358514

Motivations

1) Promote interdisciplinary and innovative science by fostering new relationships between graduate students, scientists, and geochronology labs at different institutions.

2) Equip the next generation of geoscientists with an understanding of modern geochronology tools that are profoundly important for conducting modern geoscience research.

Basic structure

1) Grad students can apply for up to $10k – typical award $8.5k.

Award will cover analytical costs, sample prep, and travel costs to visiting a host lab for a week or more to gain experience in acquiring and interpreting geochronology data for a project that advances some aspect of EarthScope science goals.

More information at: **http://www.earthscope.org/science/geochronology**

Basic structure

3) Any lab can participate

- The lab need only submit a 1-2 pg summary describing the research and learning experiences a student will have during a visit

- The program website maintains a current list of node labs and contact info to help students connect with potential host facilities

More information at: **http://www.earthscope.org/science/geochronology**

Basic structure

5) How does one apply?

- Applications must include a project description, detailed budget and budget justification
- Letters of support from the project advisor from the home institution and from the lab where the work will be carried out
- Copy of the lab's summary

First application deadline is March 16, 2015

More information at: **http://www.earthscope.org/science/geochronology**

Basic structure

6) What is the review process?

- Proposals will be reviewed by a panel of 4-5 geoscientists with a broad range of backgrounds.

- Nominations will be sought from the ESSC.

More information at: **http://www.earthscope.org/science/geochronology**

Potentially transformative outcomes

1) **Foster new relationships** between researchers and labs at different institutions and thereby promote multidisciplinary research efforts that lead to great science.

EarthScope Geochronology and the Earth Sciences

GSA short course, Fri-Sat, Oct 17-18, 2014

Kicks off the EarthScope Geochronology award program

Representatives from a variety of labs are available in an informal setting and provide an avenue for participants to connect with labs and discuss potential projects

Introduce participants to the fundamentals of geochronology relevant to EarthScope science

- Introductory seminars from geochronology experts on the basic theory and application of geochronology methods (including U-Pb, Ar, FT, He, luminescence, cosmogenics)
- Highlight examples of geochronology datasets that have helped answer significant geocscience questions
- Emphasis on practical considerations and tactical strategies for designing studies using different geochronology tools

Some Logistics

Pre- and post- short course surveys for participants, ~5 min each

- **NSF requires that you complete both surveys** so we can evaluate the success of the short course.

Reimbursement

- First 60 registered student participants can receive up to $200 of support if you:
  - Are a graduate student
  - Attend both days of the short course
- **All attendees and speakers must sign in each day in order to be reimbursed.** This is required by ASU for reimbursement purposes.
- Reimbursement will occur through the ASU ESNO

Some Logistics

Invited speakers

- Please upload your talk at the break before your presentation

- We would like to videotape your presentation and subsequently post it on the EarthScope website. If you are comfortable with this, we need you to sign a permission form.

- We would like to post a pdf of your presentation on the website. Please let us know if you aren't comfortable with this, or if you would like to post a modified version of your talk.

Talk length

- We will strictly limit you to your allotted time! We need to have time available for questions and participant interaction.

Breaks

- Morning and afternoon coffee breaks
- Early morning coffee and lunch also provided

Earthscope Institute : Geochronology in the Earth Sciences

Geological Society of America
Annual Meeting 2014
Vancouver, Canada

Ramon Arrowsmith (ASU)
Becky Flowers (CU)
Blair Schoene (Princeton)
Tammy Rittenour (Utah State U)
Jim Metcalf (CU)

Day 1 – Friday, October 17th, 2014

8:00 – 8:15 AM	Coffee
	Friday Morning Session Chair : Blair Schoene (Princeton)
8:15 – 8:45 AM	Introductory Remarks and Overview of Award Program **Speakers:** Ramon Arrowsmith (ASU), Becky Flowers (CU), and Jim Metcalf (CU)
8:45 – 9:45 AM	Introduction to Geochronology – Overview **Speaker:** Sam Bowring (MIT)
9:45 – 10:15 AM	Motivations and Applications Talk #1 **Speaker:** Mike Williams (UMass)
10:15 – 10:45 AM	Coffee Break
10:45 – 11:30 AM	Sm-Nd and Lu-Hf Geochronology **Speaker:** Ethan Baxter (BU)
11:30 – 12:15 PM	U-Pb Geochronology 1: Fundamentals of High Precision Dating **Speaker:** Blair Schoene (Princeton)
12:15 – 1:15 PM	Lunch

Day 1 – Friday, October 17th, 2014

Friday Afternoon Session Chair : Jim Metcalf (CU)

1:15 – 2:00 PM	U-Pb Geochronology 2: High Resolution Dating (SIMS) **Speaker:** Mark Harrison (UCLA)
2:00 – 2:30 PM	Motivations and Applications Talk #2 **Speaker:** John Cottle (UCSB)
2:30 – 3:00 PM	Coffee Break
3:00 – 3:45 PM	$^{40}Ar/^{39}Ar$ Geochronology **Speaker:** Kip Hodges (ASU)
3:45 – 4:15 PM	Motivations and Applications Talk #3 **Speaker:** Laura Webb (UVM)
4:15 – 5:00 PM	Opportunity for Discussion and Interaction Between Speakers and Participants

Day 2 – Saturday, October 18th, 2014

8:00 – 8:30 AM	Coffee
	Saturday Morning Session Chair : Becky Flowers (CU)
8:30 – 9:00 AM	Motivations and Applications Talk #4 **Speaker:** Ramon Arrowsmith (ASU)
9:00 – 9:45 AM	(U-Th)/He Geochronology **Speaker:** James Metcalf (CU)
9:45 – 10:15 AM	Coffee Break
10:15 – 11:00 AM	Fission-Track Geochronology **Speaker:** John Garver (Union College)
11:00 – 11:45 AM	U-series Geochronology **Speaker:** Kari Cooper (UC Davis)
11:45 – 12:45 PM	Lunch

Day 2 – Saturday, October 18th, 2014

Saturday Afternoon Session Chair : Tammy Rittenour (USU)

12:45 – 1:15 PM	Motivations and Applications Talk #5 **Speaker:** Becky Flowers (CU)
1:15 – 2:00 PM	Luminescence Geochronology **Speaker:** Tammy Rittenour (USU)
2:00 – 2:45 PM	Cosmogenic Nuclide Geochronology **Speaker:** Greg Balco (UC-Berkeley)
2:45 – 3:15 PM	Coffee Break
3:15 – 4:00 PM	14C Geochronology **Speaker:** Kate Scharer (USGS)
4:00 – 4:30 PM	Motivations and Applications Talk #6 **Speaker:** Jane Willenbring (U Penn)
4:30 – 5:00 PM	Opportunity for Discussion and Interaction Between Speakers and Participants