Advanced Structural Geology, Fall 2022

Course Introduction

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School of Earth and Space Exploration

Arizona State University

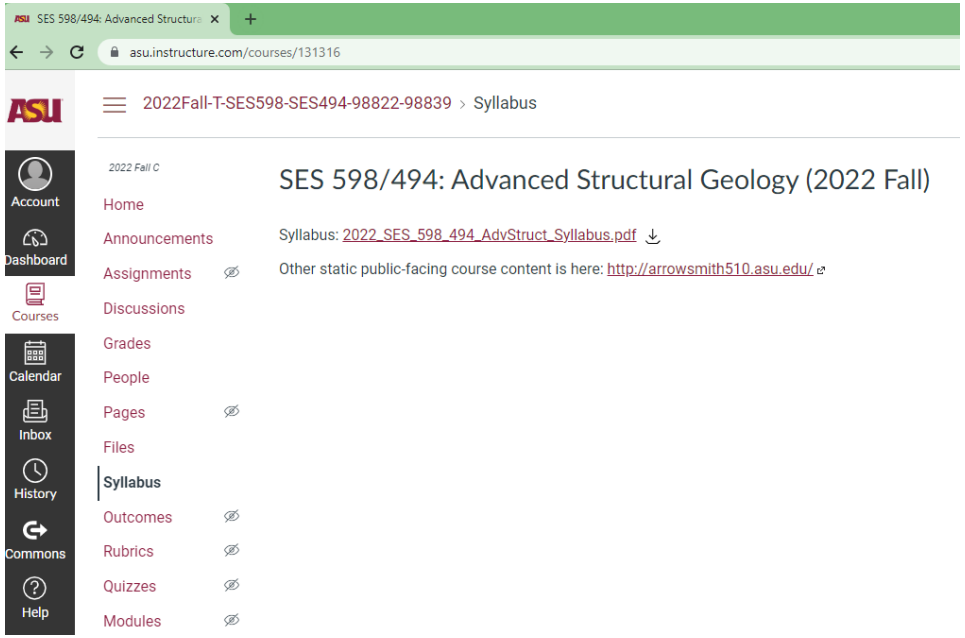
Agenda

- Introductions
- Syllabus review
- Schedule review
- Assignments for next week
- Motivations for the course
- Mountain building and the Alps lecture

Introductions—short go around

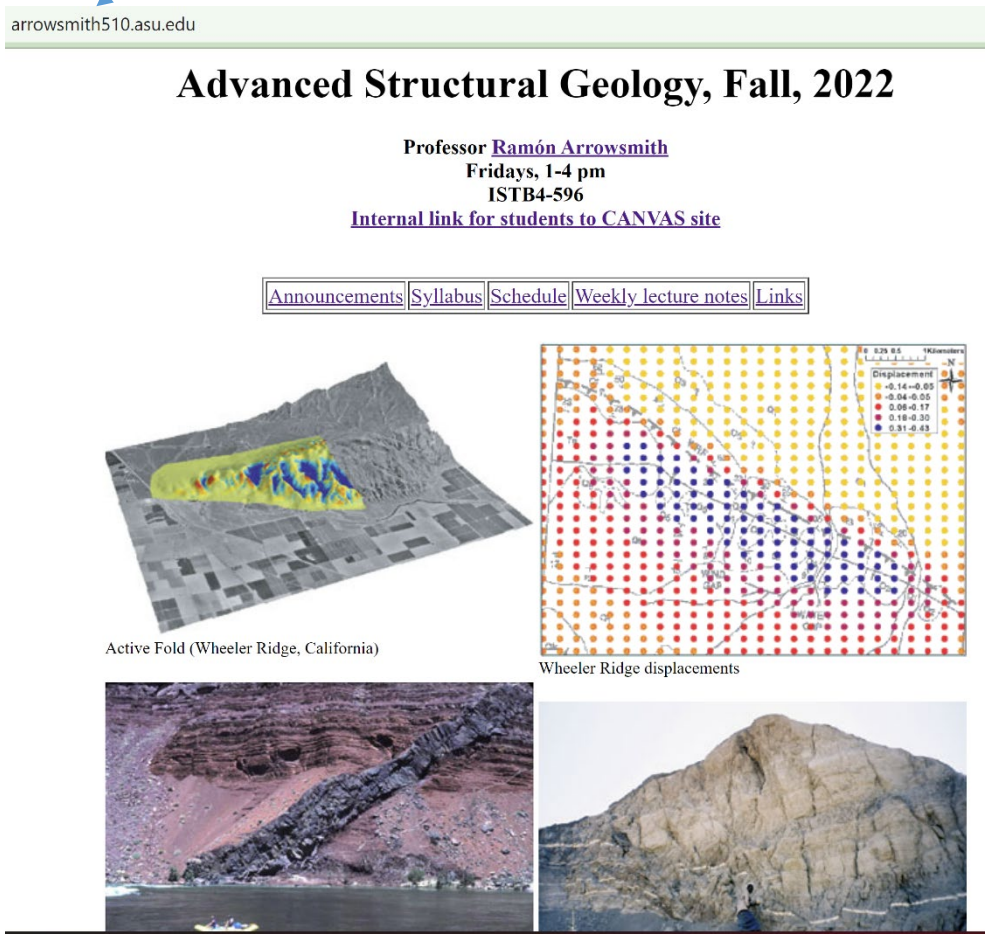
- Name, major/degree goal
- Experience in structural geology and tectonics (course work, projects, etc.)
- Interests for this class

Course access



- Course administration
- Assignments turned in and graded here
- Grade book
- Other content that needs to be behind student authentication

Old course number; still using the same web site



- Open access to lectures, assignments, schedule

Syllabus highlights--I

Course Description: Advanced topics in structural geology and tectonics. This course should build a deeper understanding of the geometry, motions, and processes associated with deformation of the earth's crust (or that of other rocky planets). Topics include:

- Global and regional tectonics and mountain building
- Geometric techniques in structural geology
- Basic continuum mechanics (stress, strain, and rheology)
- Description and analysis of geologic structures (i.e., faults and folds)
- Deformation over different time-scales

Credits: 3

Course Learning Outcomes

At the completion of this course, students will be able to:

- Explain the geologic history and processes in mountain belts with emphasis on the north American Cordillera.
- Describe the types of faulting in different tectonic regimes, as well as understand how vectors, stress, and traction apply to faults.
- Understand crustal stress and the processes associated with faulting and magmatic intrusions in the crust.
- Understand the basic concepts of continuum mechanics (stress, strain, and rheology)
- Apply concepts from linear algebra and computer coding to solve problems in structural geology.

Syllabus highlights--II

This is an in-person class

If you are not able to physically attend class, I need to know in advance. I will do my best to accommodate but I hope the in person experience will be worthwhile.

We will have a few virtual class meetings out of necessity and I will let the class know in advance when those will be and how they will work.

Plus some field trips:

What can we do on a Friday afternoon?

Full day local trips:
Nov 6 and 13???

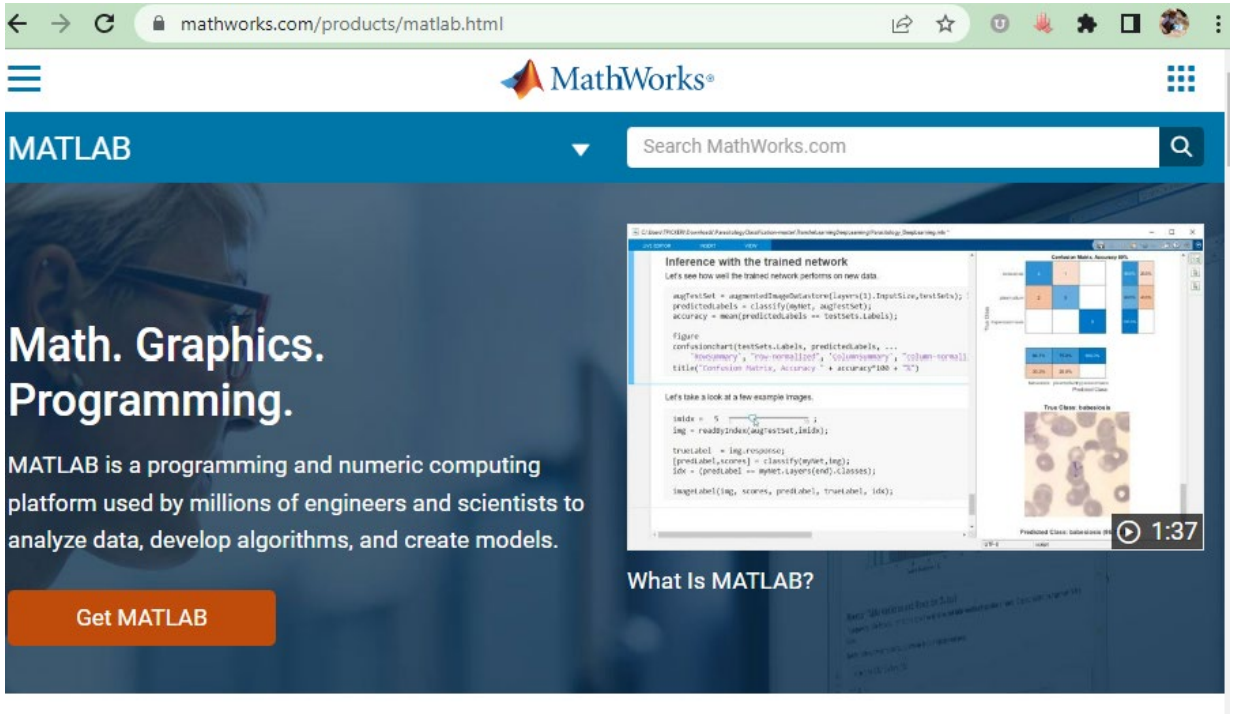
Three hour long class??
Really 3 x 50 minute periods:
I—Review and discuss
II—Lecture
III—Demos and exercises

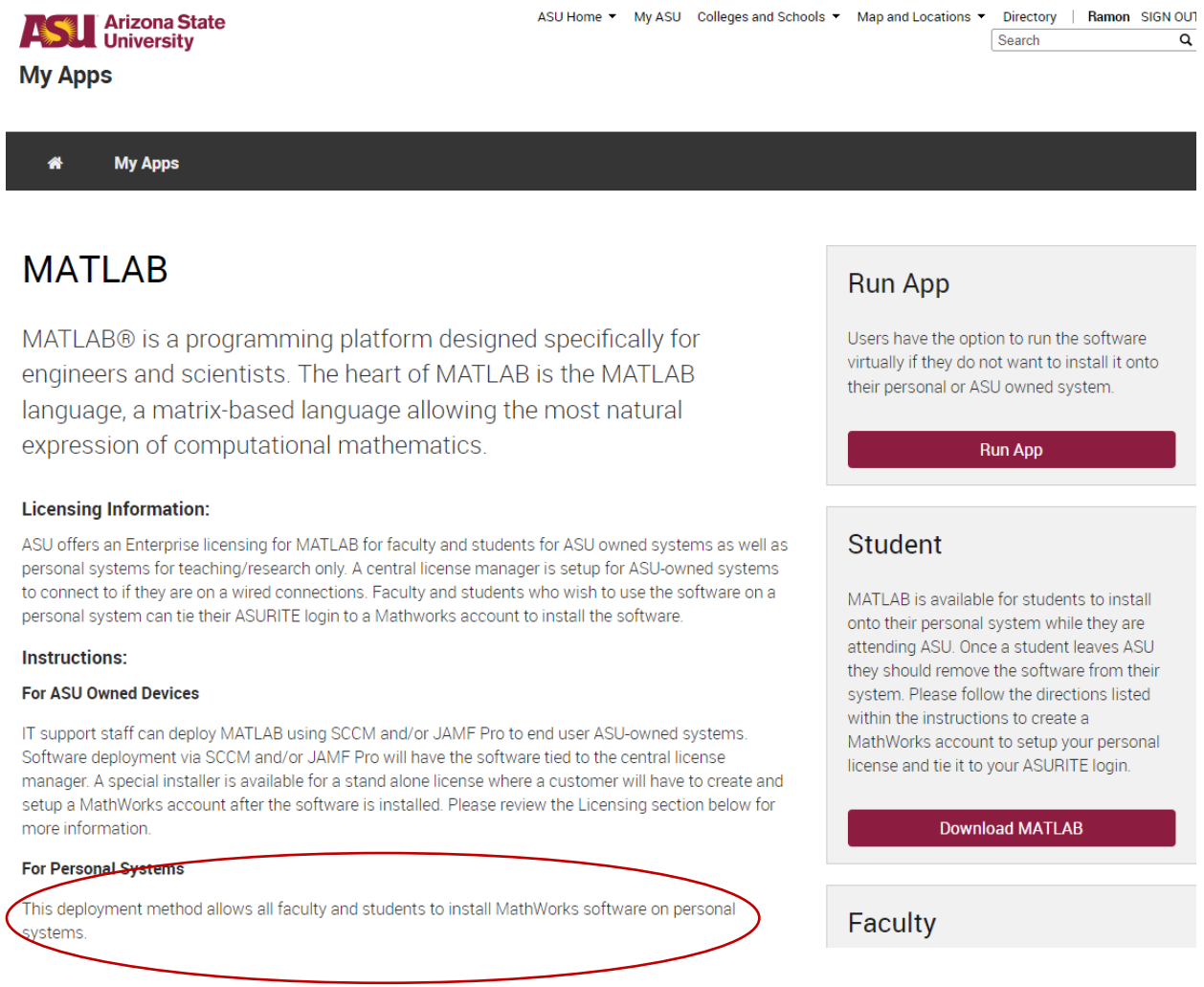
Course Schedule
Subject to Change!!!

Date	Mode
August 19	In person
August 26	In person
September 2	Virtual
September 9	In person
September 16	In person
September 23	In person
September 30	Virtual
October 7	Virtual
October 14	In person
October 21	Virtual
October 28	?
November 4	In person
November 11	In person
November 18	In person
December 2	In person

http://arrowsmith510.asu.edu/GLG510--Schedule.html

Syllabus highlights--III





We are using **Matlab**

I will teach you what you need

If you can do it in Python, I would love to see it and will consider some extra credit for the effort

Syllabus highlights--IV

Assignment Schedule

- **Weekly reading and discussion assignments.**
- **In class activities will be turned in for credit.**
- **A couple of larger homework assignments**
- **Final project and presentation**

Submitting Assignments

All assignments, unless otherwise announced, MUST be submitted to the designated area of Canvas. Do not submit an assignment via email.

Late or Missed Assignments

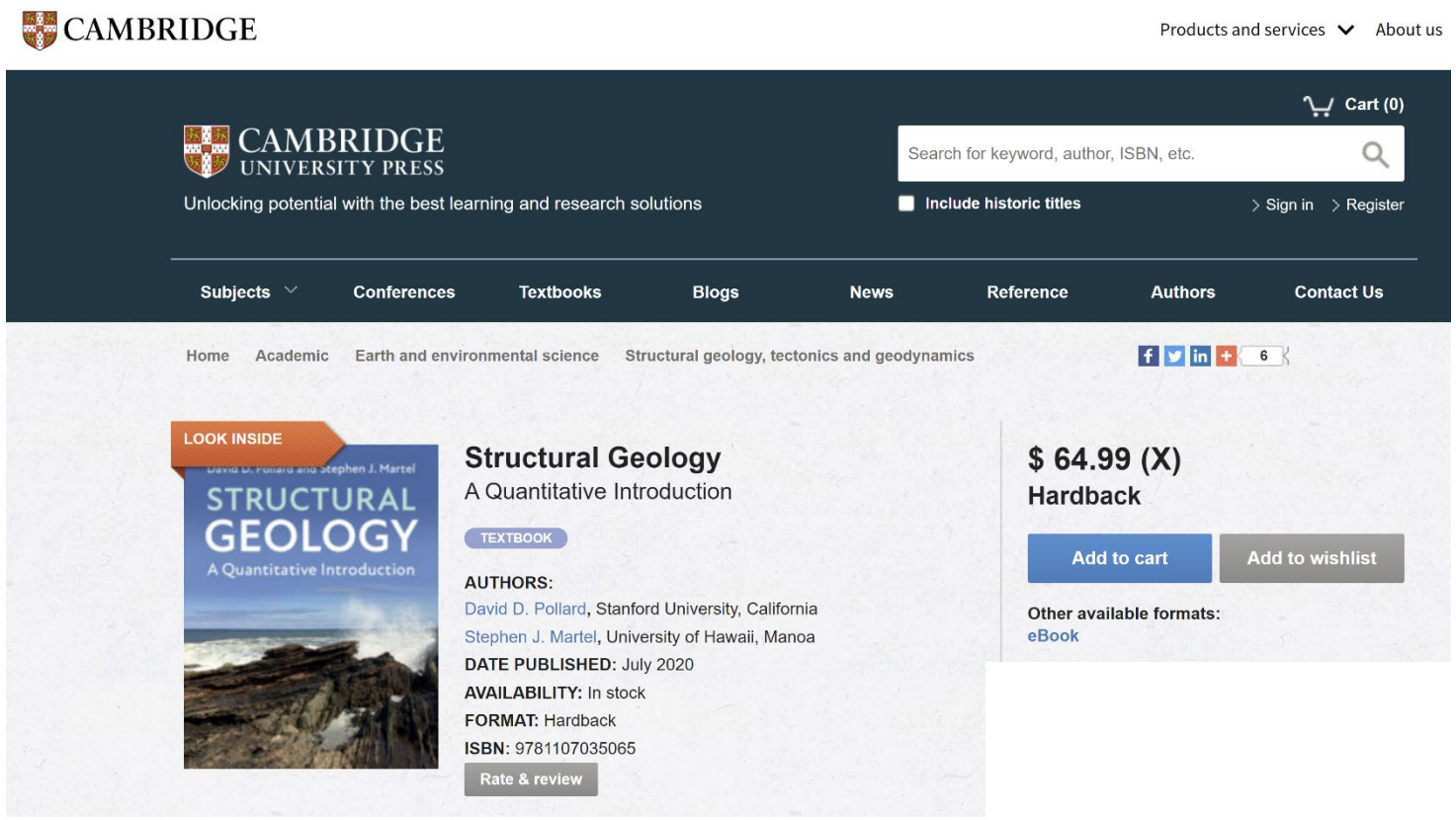
Notify the instructor **BEFORE** an assignment is due if an urgent situation arises and you are unable to submit the assignment on time. Unexcused LATE assignments will be assessed a cumulative 10% per day penalty.

Syllabus highlights--V

Recommended textbook:

Structural Geology: A Quantitative Introduction by Pollard and Martel

I will provide other handouts/pdfs for reading



Assignment for Friday August 26, 2022

- Overview of the North American Cordilleran Tectonic belt
- Read (CANVAS site->Files->Papers):
  - Dickinson, Evolution of the North American Cordillera, Annu. Rev. Earth Planet. Sci. 2004. 32:13–45; doi: 10.1146/annurev.earth.32.101802.120257
  - McQuarrie and Wernicke, An animated tectonic reconstruction of southwestern North America since 36 Ma, Geosphere; December 2005; v. 1; no. 3; p. 147–172; doi: 10.1130/GES00016.1
- One page (single spaced 12 point font) summary of each submitted to CANVAS in advance:
  - How do they motivate their work? Why is it important?
  - How did they do it (methods)?
  - General result (bullet list of main outcomes)
  - Questions you have

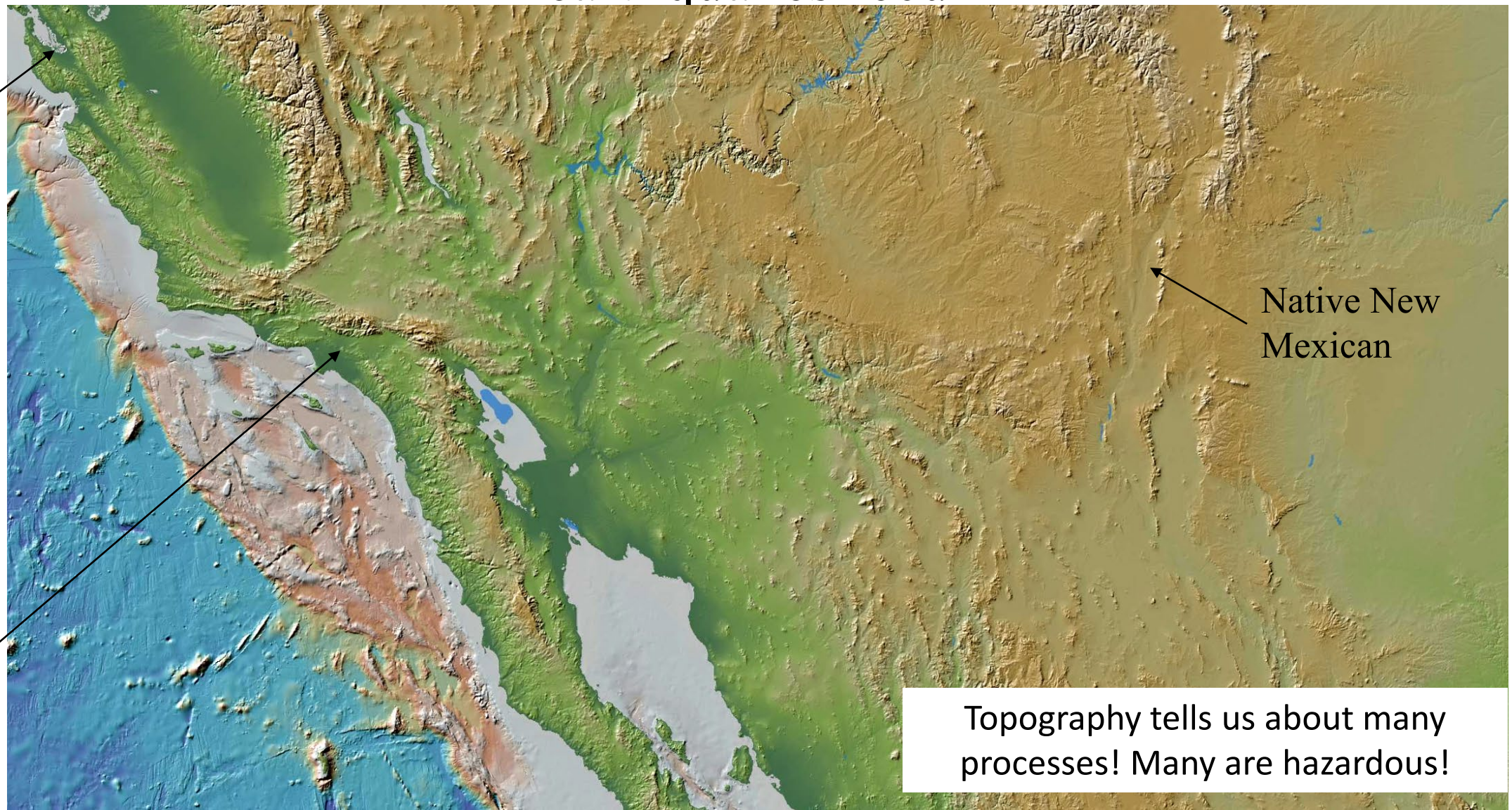
Some background

Background: Ramón Arrowsmith

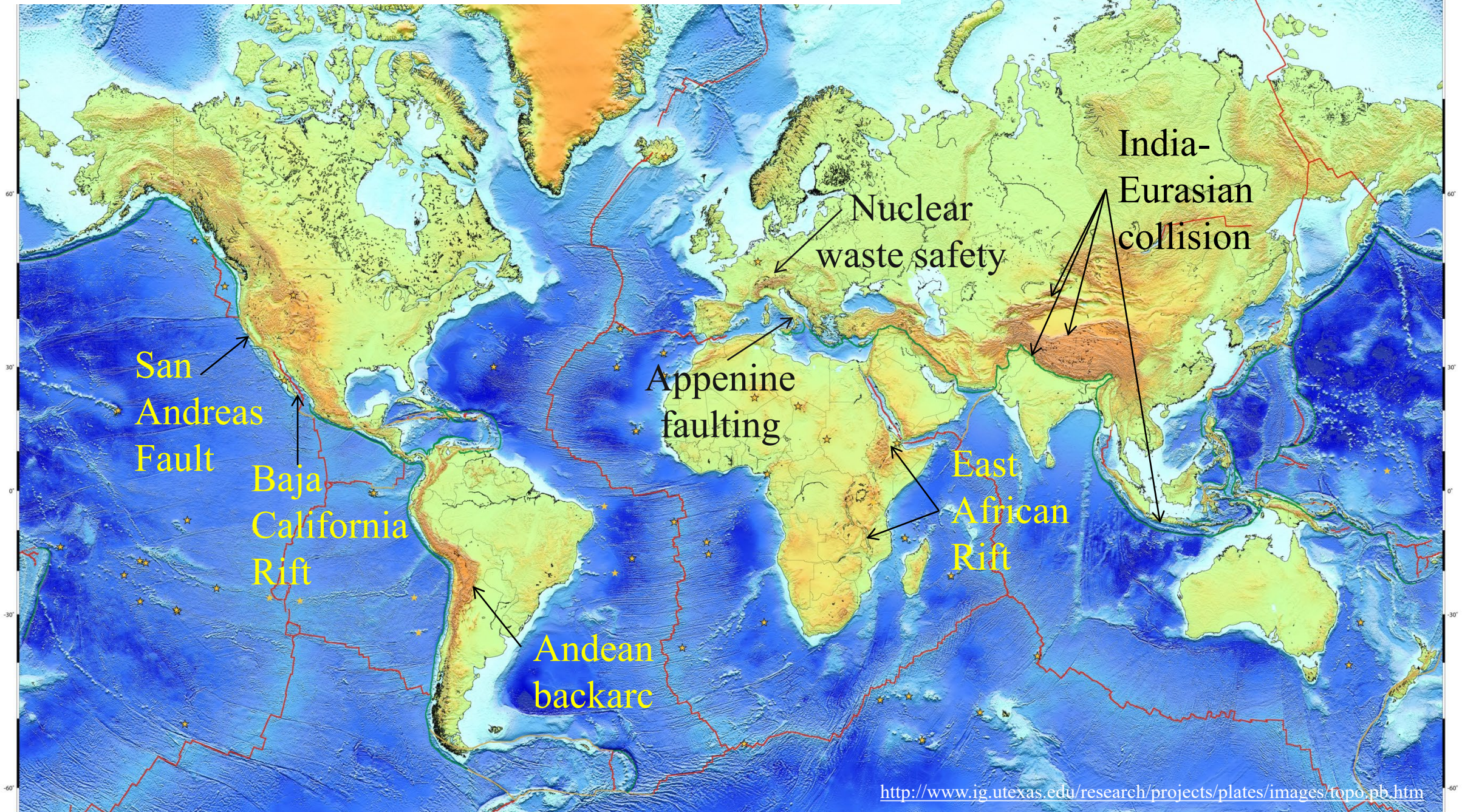
Studying geology and the landscape to understand how faults work and earthquakes recur

PhD in Geol. & Env. Sciences-Stanford

BA in Geology and Spanish from Whittier College

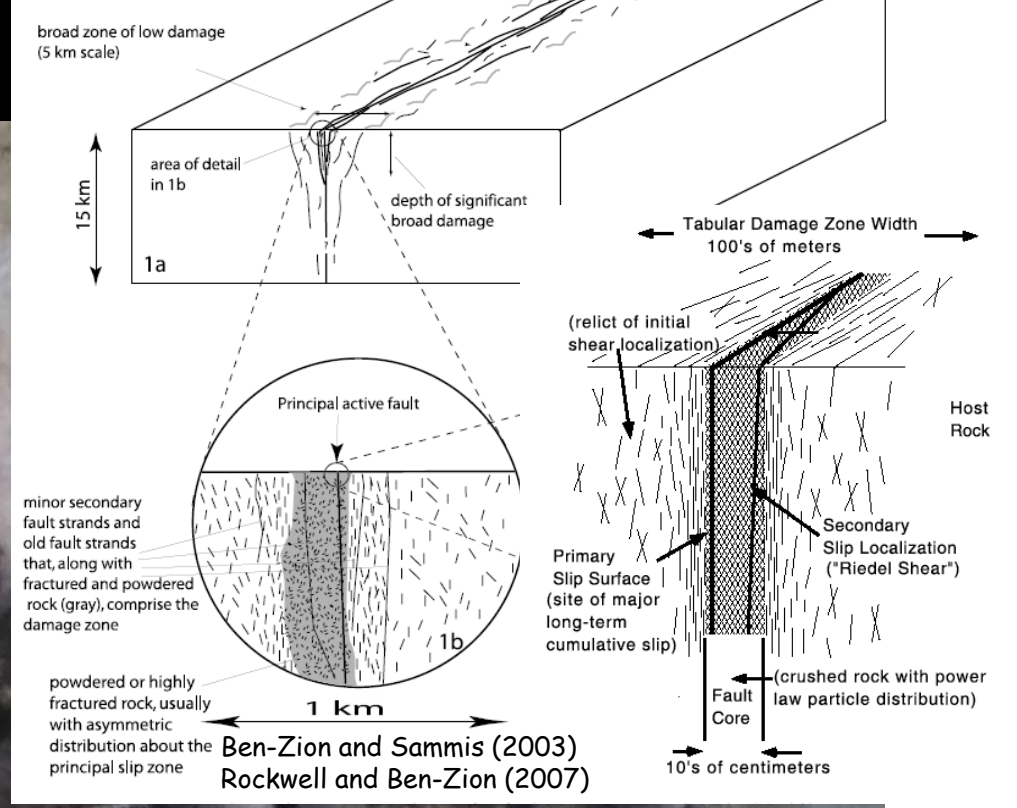


Drawing observations and motivations globally



Zooming into faults

-Fault trace mapping
-Reconstructing slip histories
-Understanding geomorphic response to uplift
-3D topographic differencing



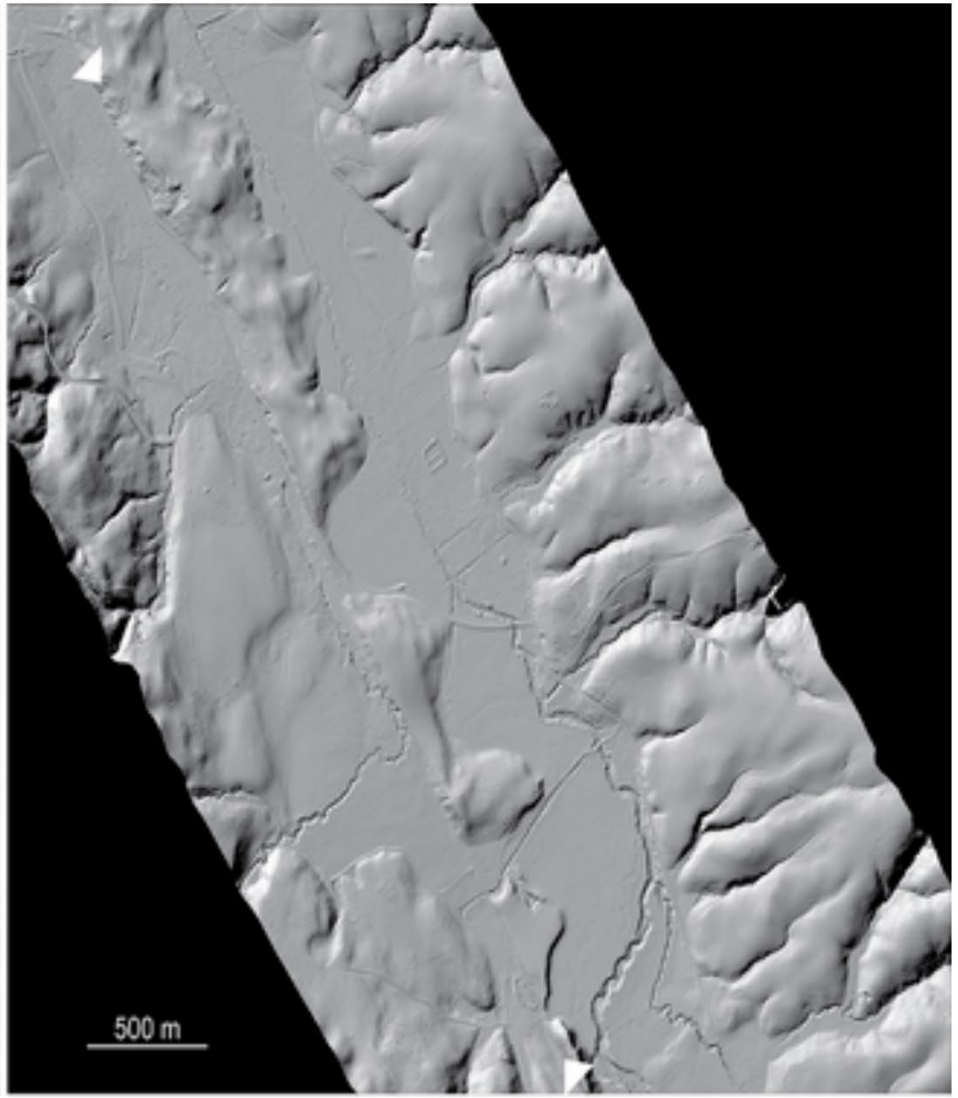
Ben-Zion and Sammis (2003)
Rockwell and Ben-Zion (2007)

Salisbury, et al., 2018

SCEC
AN NSF+USGS CENTER

Southern California Earthquake Center

Studying earthquakes and their effects in California and beyond



https://fromtheprow.agu.org/remembering-the-great-1906-san-francisco-earthquake/

Remembering the Great 1906 San Francisco Earthquake

Earthquake forecasting as a large scale community activity; we contribute simulation and field constraints

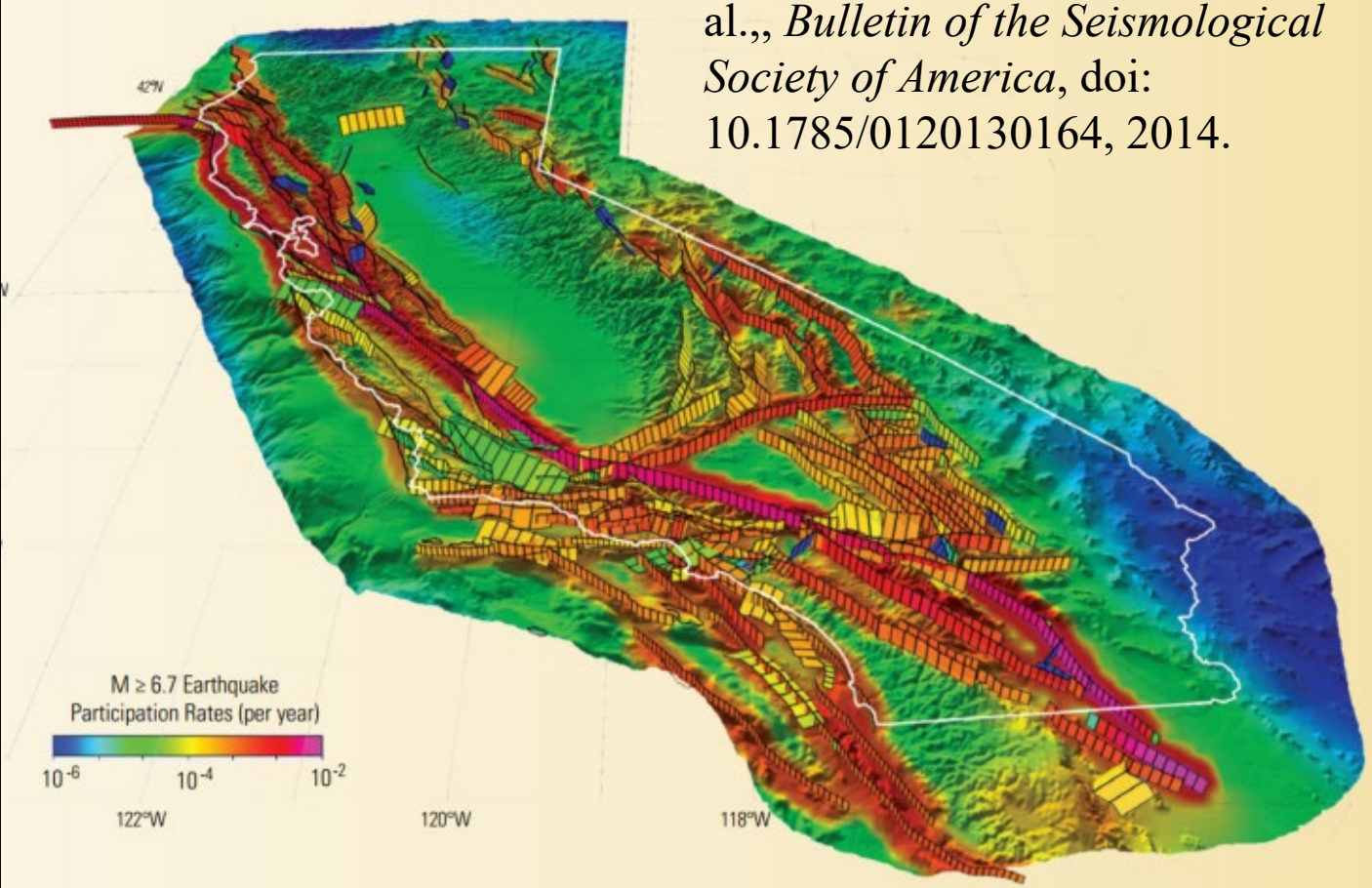
USGS science for a changing world

SCEC an NSF+USGS center

CGS CALIFORNIA GEOLOGICAL SURVEY

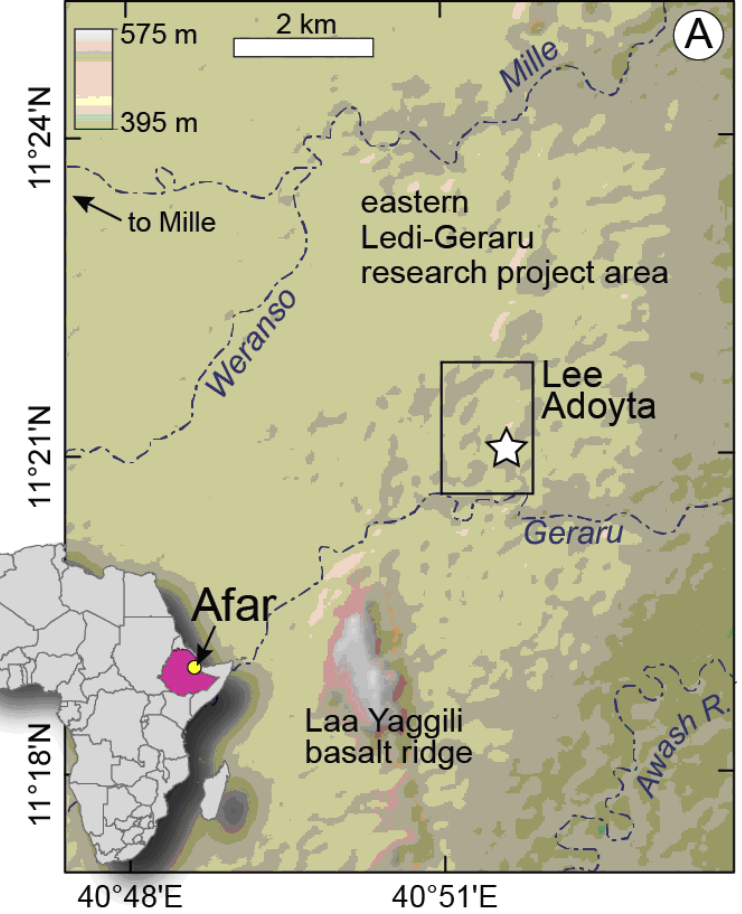
The Uniform California Earthquake Rupture Forecast, Version 3 (UCERF3)—The Time-Independent Model

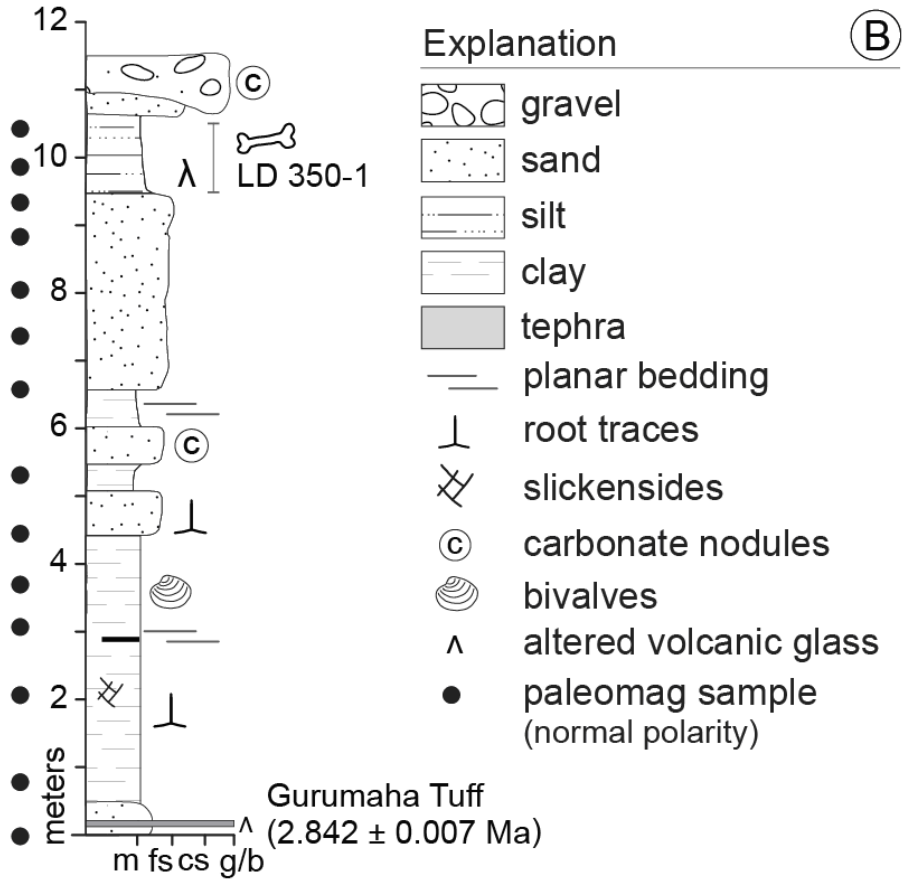
Field, E. H., Arrowsmith, J R., et al.,, *Bulletin of the Seismological Society of America*, doi: 10.1785/0120130164, 2014.

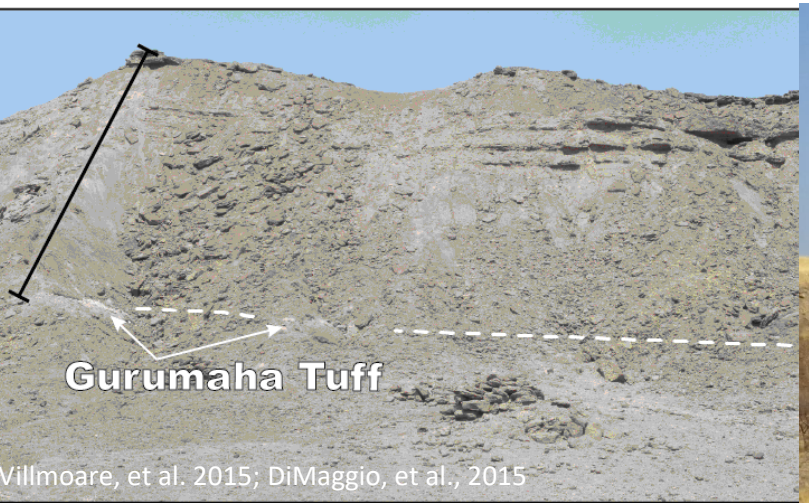


Geologic context of human origins


Faulted layers





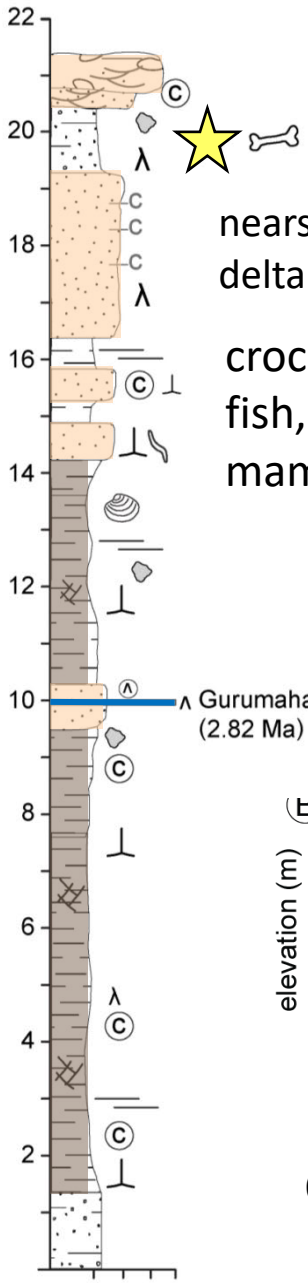


Geologic context of human origins: major interdisciplinary collaboration with ASU's Institute of Human Origins and the School of Human Evolution and Social Change

2015: checking the “Hom” site

Campisano, DiMaggio, Villmoare,
Kimbel, Afar colleagues + Dupont-Nivet + A. Deino

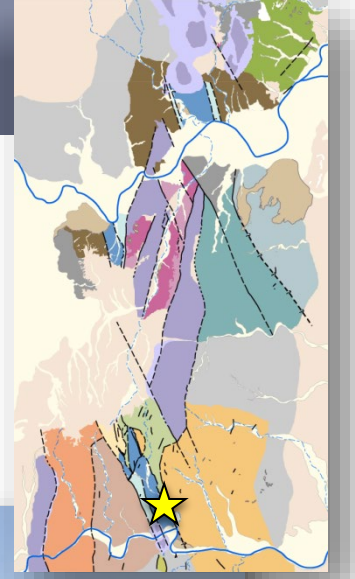
context of hominin mandible

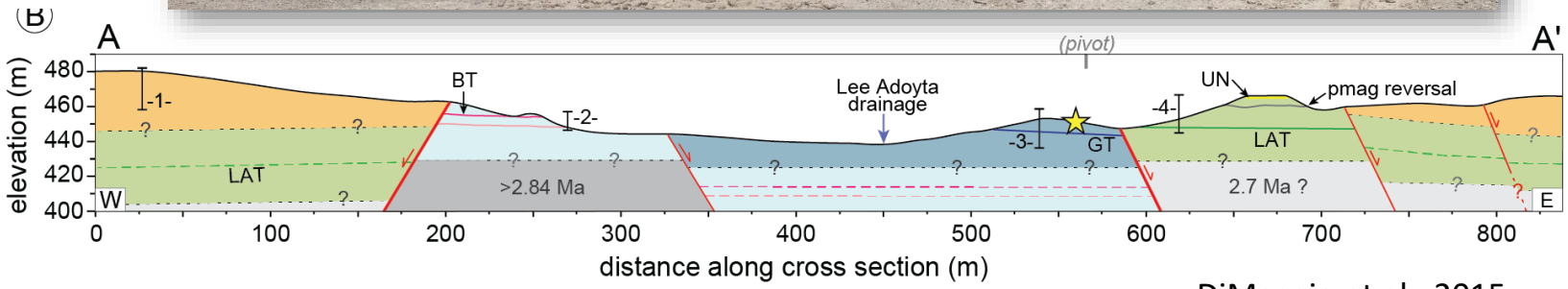


nearshore
delta plain

crocs,
fish, &
mammals

credit: K. Reed



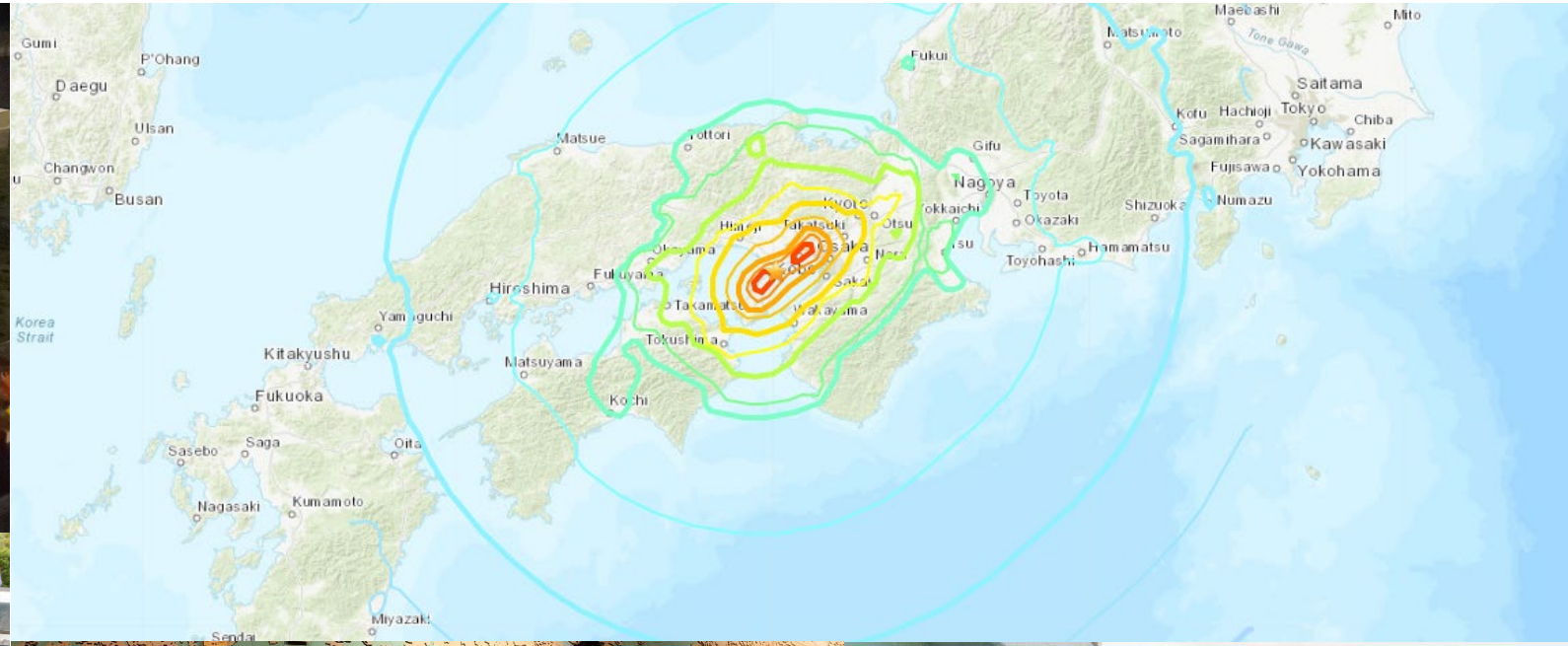


DiMaggio et al., 2015

Open Habitat - mixed grasslands/shrublands w/ gallery forest; lakes/rivers

Great Hanshin earthquake（阪神・淡路大震災, Hanshin Awaji daishinsai), or **Kobe earthquake**, occurred on January 17, 1995 at 05:46:53 JST – magnitude 6.9, more than 6,000 people died; it was strongly felt across **Japan**. Economic losses were >$200 Billion. Major memorial and societal response.


Arrowsmith photo



https://earthquake.usgs.gov/earthquakes/eventpage/usp0006rew/map

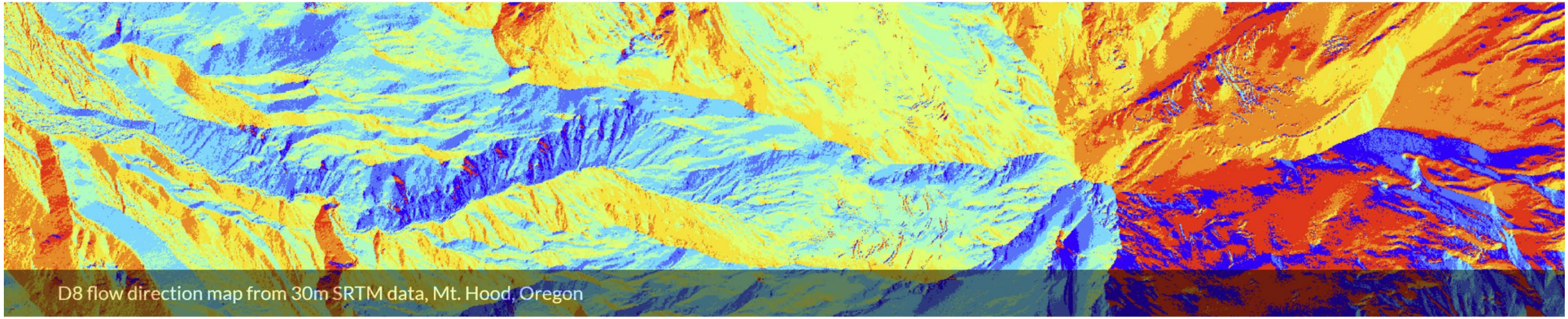
Arrowsmith photo


Arrowsmith photo


By 神戸市, CC BY 2.1 jp, https://commons.wikimedia.org/w/index.php?curid=37241600

OpenTopography

High-Resolution Topography Data and Tools



D8 flow direction map from 30m SRTM data, Mt. Hood, Oregon

Latest News

OpenTopography computes first map of topographic change at the statewide scale

Feb 15, 2022

The OpenTopography team is pleased to announce the publication of our new open-access article in the journal *Remote Sensing*: "Statewide USGS 3DEP Lidar Topographic...

New NCALM dataset over the Wax Lake Delta, LA available

Request an API Key

Latest Datasets:

- Sediment Accretion Rates and Spatial Patterns in the Wax Lake Delta, LA 2020
- Structure from Motion data along the sSAF, Salt Creek, CA 2021
- Coastal Catchments, Otago, New

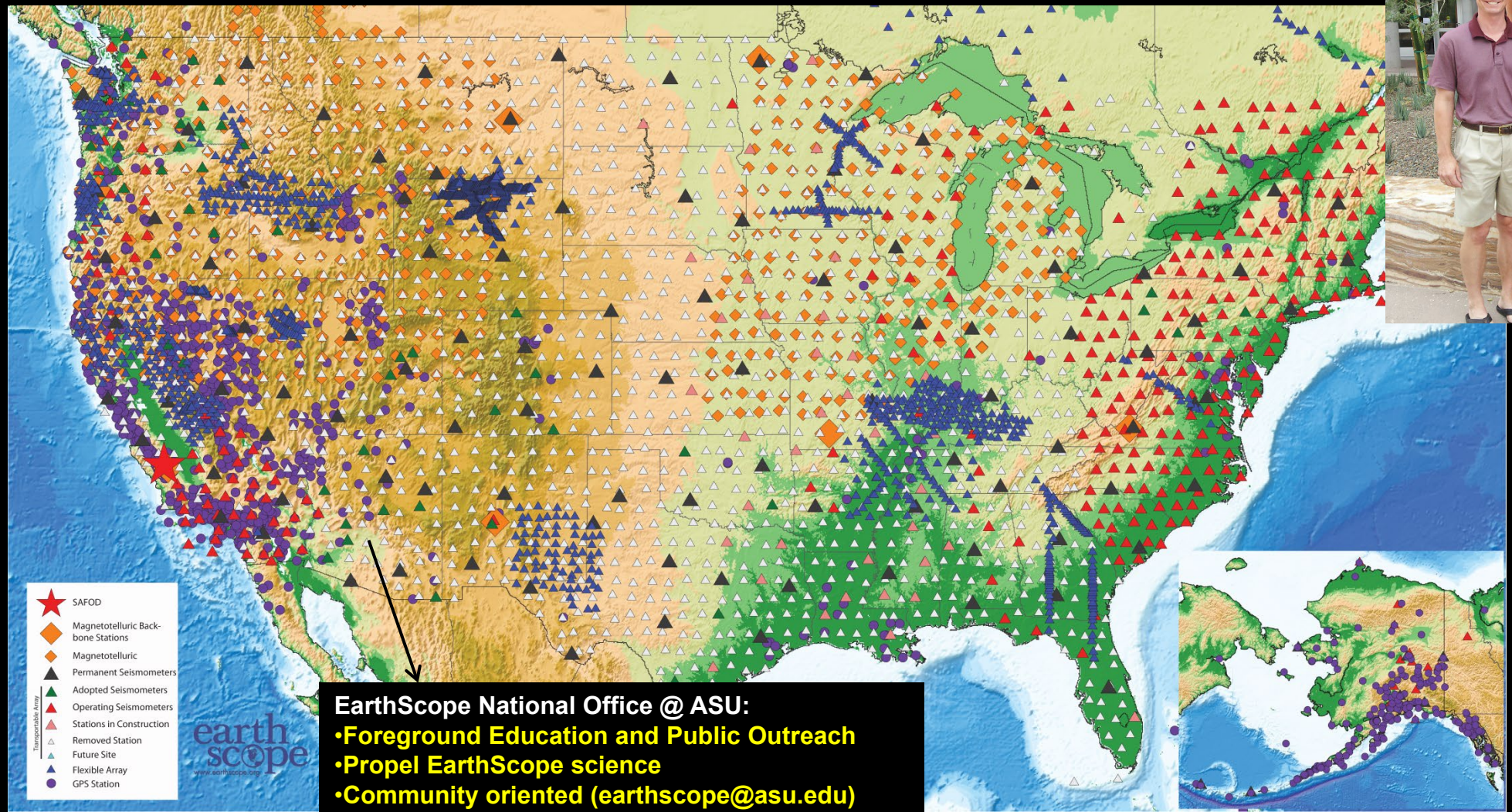
Exploring the Structure and Evolution of the North American Continent

Earth Sciences version of Hubble Space Telescope

Enables "survey mode" of continent

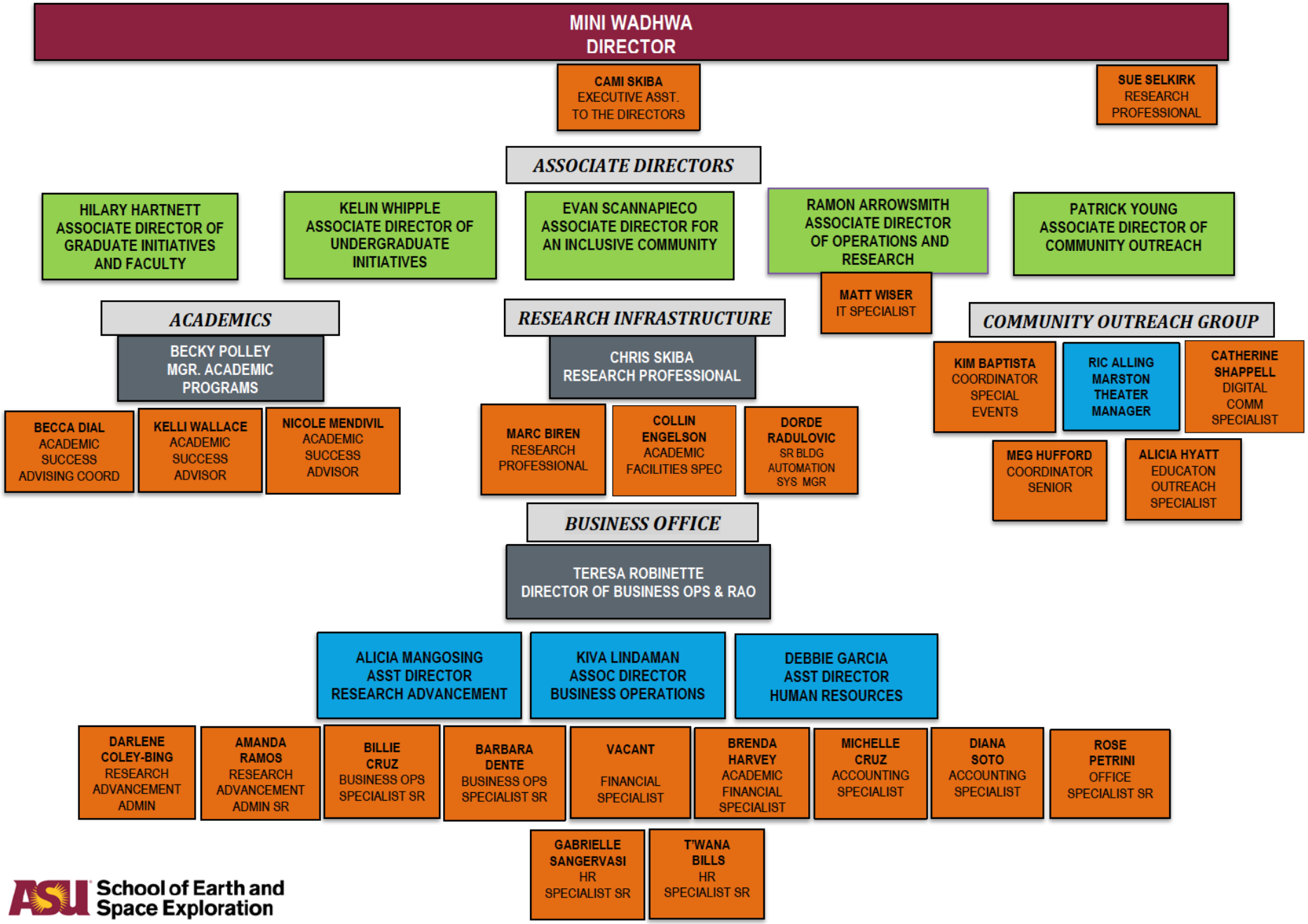
Named the #1 "Epic Project" by Popular Science in 2011

EarthScope National Office @ ASU 2011-2015



EarthScope National Office @ ASU:

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



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Updated: August 3, 2022