

Advanced Structural Geology, Fall 2022

Course Introduction

Ramón Arrowsmith

ramon.arrowsmith@asu.edu



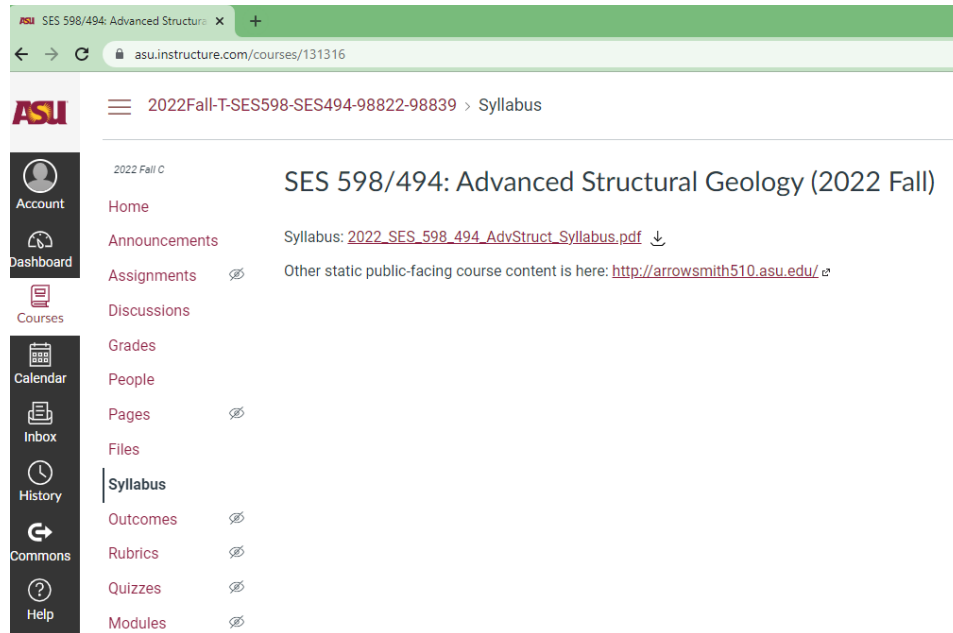
Agenda

- 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

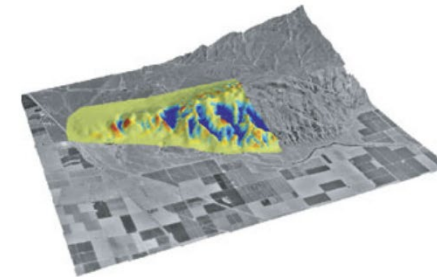
arrowsmith510.asu.edu

Advanced Structural Geology, Fall, 2022

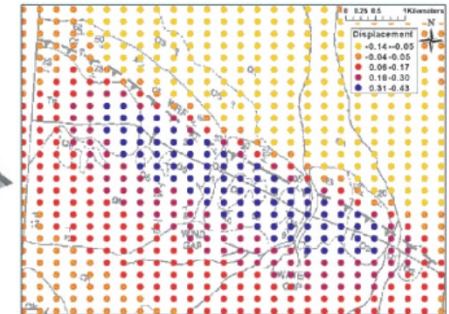
Professor [Ramón Arrowsmith](#)
Fridays, 1-4 pm
ISTB4-596

[Internal link for students to CANVAS site](#)

[Announcements](#) | [Syllabus](#) | [Schedule](#) | [Weekly lecture notes](#) | [Links](#)



Active Fold (Wheeler Ridge, California)



Wheeler Ridge displacements



- 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

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

Syllabus highlights--III

Math. Graphics. Programming.

MATLAB is a programming and numeric computing platform used by millions of engineers and scientists to analyze data, develop algorithms, and create models.

[Get MATLAB](#)

What Is MATLAB?

```
inferWithTrainedNetwork
Let's see how well the trained network performs on new data.
imgTestSet = imageDatastore('layers(1).InputDir', testSet);
predictedLabels = classify(imgTestSet, net);
accuracy = mean(predictedLabels == testSet.Labels);

figure
confusionchart(testSet.Labels, predictedLabels, ...
    'Accuracy', True-normalize, 'Column-normal', ...
    'title','Confusion Matrix, Accuracy ' + accuracy*100 + '%');

Let's take a look at a few example images.
idx = 5;
img = readImage(imgTestSet, idx);
trueLabel = img.Response;
[predictLabel, scores] = classify(imgTestSet, img);
idx = (predicted == imgTestSet.classes);
imgTable(img, scores, predictLabel, trueLabel, idx);
```

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

MATLAB

MATLAB® is a programming platform designed specifically for engineers and scientists. The heart of MATLAB is the MATLAB language, a matrix-based language allowing the most natural expression of computational mathematics.

Licensing Information:

ASU offers an Enterprise licensing for MATLAB for faculty and students for ASU owned systems as well as personal systems for teaching/research only. A central license manager is setup for ASU-owned systems to connect to if they are on a wired connections. Faculty and students who wish to use the software on a personal system can tie their ASURITE login to a Mathworks account to install the software.

Instructions:

For ASU Owned Devices

IT support staff can deploy MATLAB using SCCM and/or JAMF Pro to end user ASU-owned systems. Software deployment via SCCM and/or JAMF Pro will have the software tied to the central license manager. A special installer is available for a stand alone license where a customer will have to create and setup a MathWorks account after the software is installed. Please review the Licensing section below for more information.

For Personal Systems

This deployment method allows all faculty and students to install MathWorks software on personal systems.

Run App

Users have the option to run the software virtually if they do not want to install it onto their personal or ASU owned system.

[Run App](#)

Student

MATLAB is available for students to install onto their personal system while they are attending ASU. Once a student leaves ASU they should remove the software from their system. Please follow the directions listed within the instructions to create a MathWorks account to setup your personal license and tie it to your ASURITE login.

[Download MATLAB](#)

Faculty

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

The screenshot shows the Cambridge University Press website. At the top, the Cambridge logo and name are visible, along with navigation links for 'Products and services' and 'About us'. A search bar is present with the text 'Search for keyword, author, ISBN, etc.' and a search icon. Below the search bar, there are links for 'Sign in' and 'Register'. A navigation menu includes 'Subjects', 'Conferences', 'Textbooks', 'Blogs', 'News', 'Reference', 'Authors', and 'Contact Us'. The main content area features a book cover for 'Structural Geology: A Quantitative Introduction' by David D. Pollard and Stephen J. Martel. The cover has a 'LOOK INSIDE' banner and shows a landscape with a body of water and a rocky shore. To the right of the cover, the book title and authors are listed. The price is shown as '\$ 64.99 (X) Hardback'. There are buttons for 'Add to cart' and 'Add to wishlist'. Below the price, it says 'Other available formats: eBook'. At the bottom of the product information, there is a 'Rate & review' button.

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LOOK INSIDE

David D. Pollard and Stephen J. Martel

STRUCTURAL GEOLOGY
A Quantitative Introduction

TEXTBOOK

Structural Geology
A Quantitative Introduction

\$ 64.99 (X)
Hardback

Add to cart Add to wishlist

Other available formats:
eBook

AUTHORS:
David D. Pollard, Stanford University, California
Stephen J. Martel, University of Hawaii, Manoa

DATE PUBLISHED: July 2020

AVAILABILITY: In stock

FORMAT: Hardback

ISBN: 9781107035065

Rate & review

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

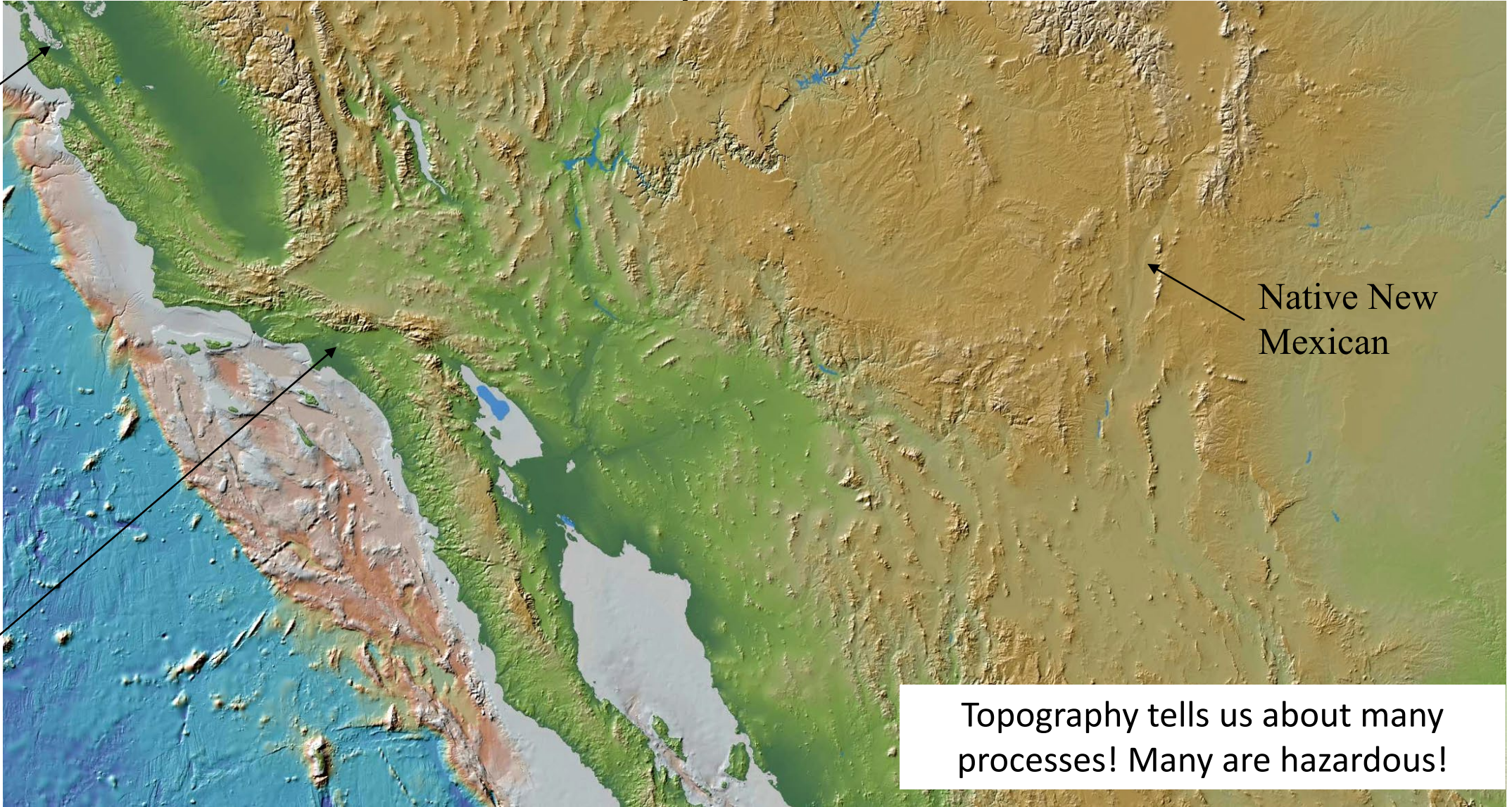
Studying geology and the landscape to understand how faults work and earthquakes recur

PhD in
Geol. &
Env.
Sciences-
Stanford

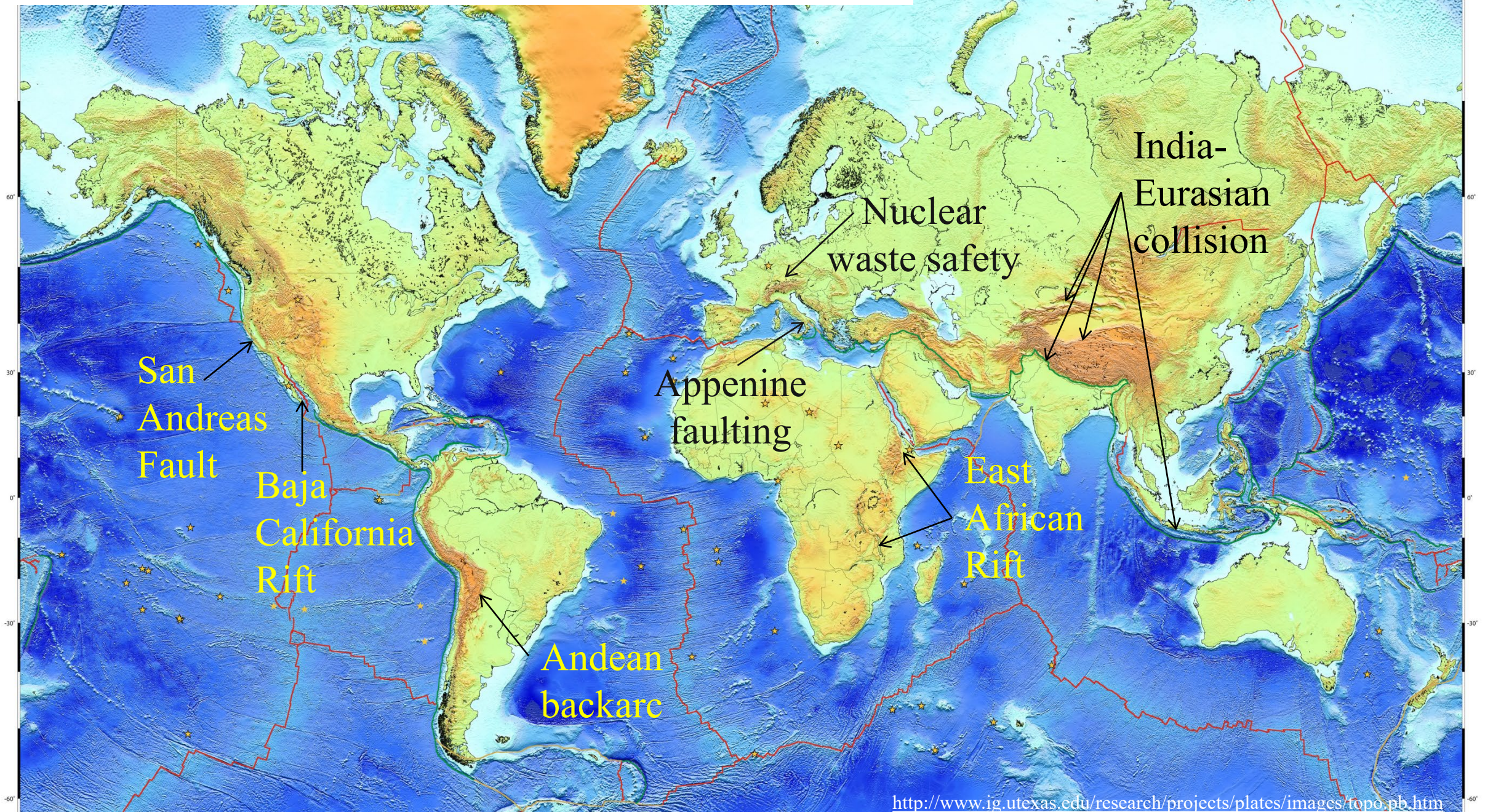
BA in
Geology
and
Spanish
from
Whittier
College

Native New
Mexican

Topography tells us about many
processes! Many are hazardous!

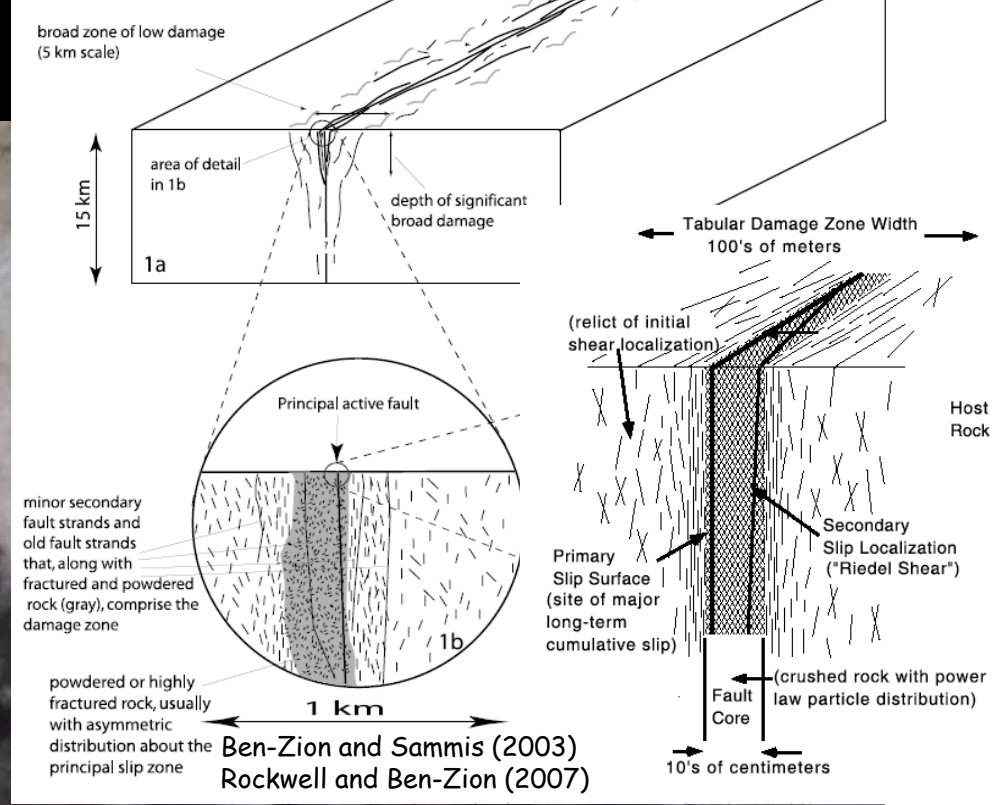


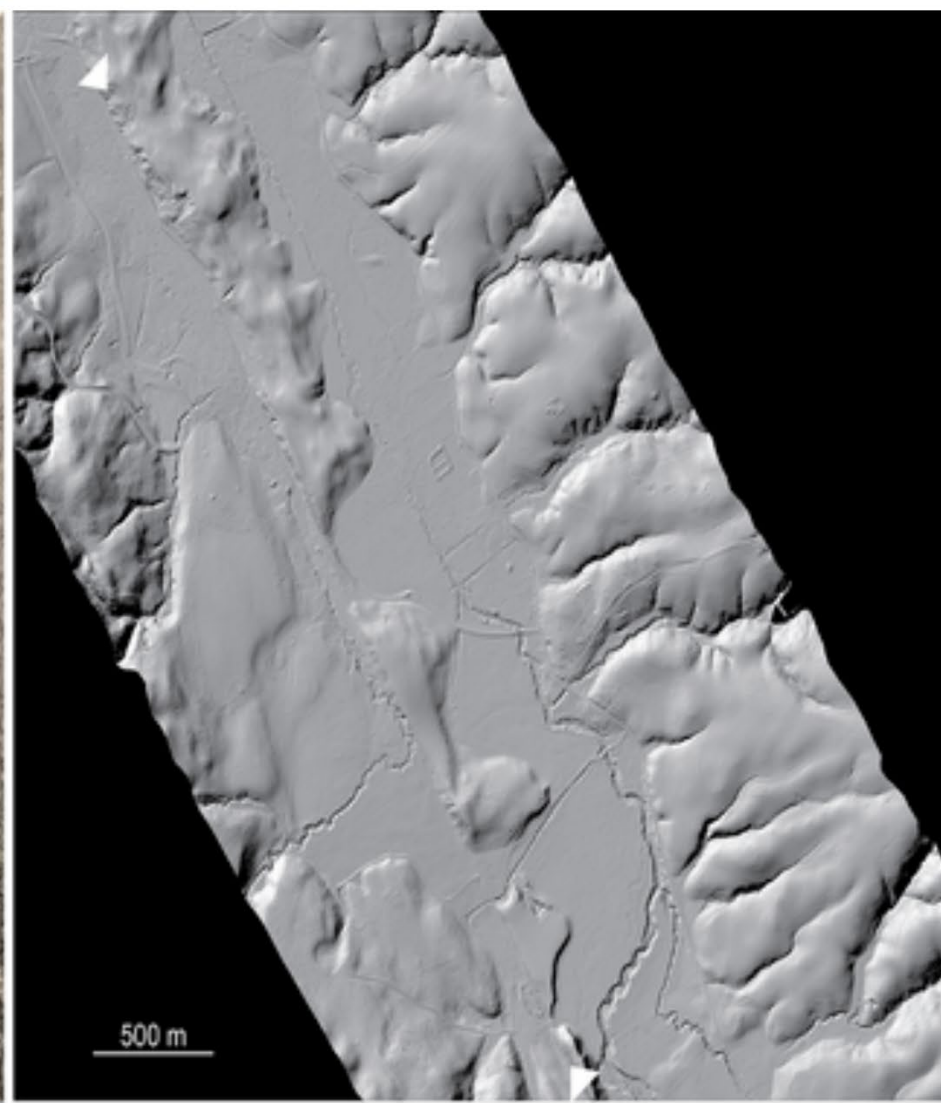
Drawing observations and motivations globally



Zooming into faults

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





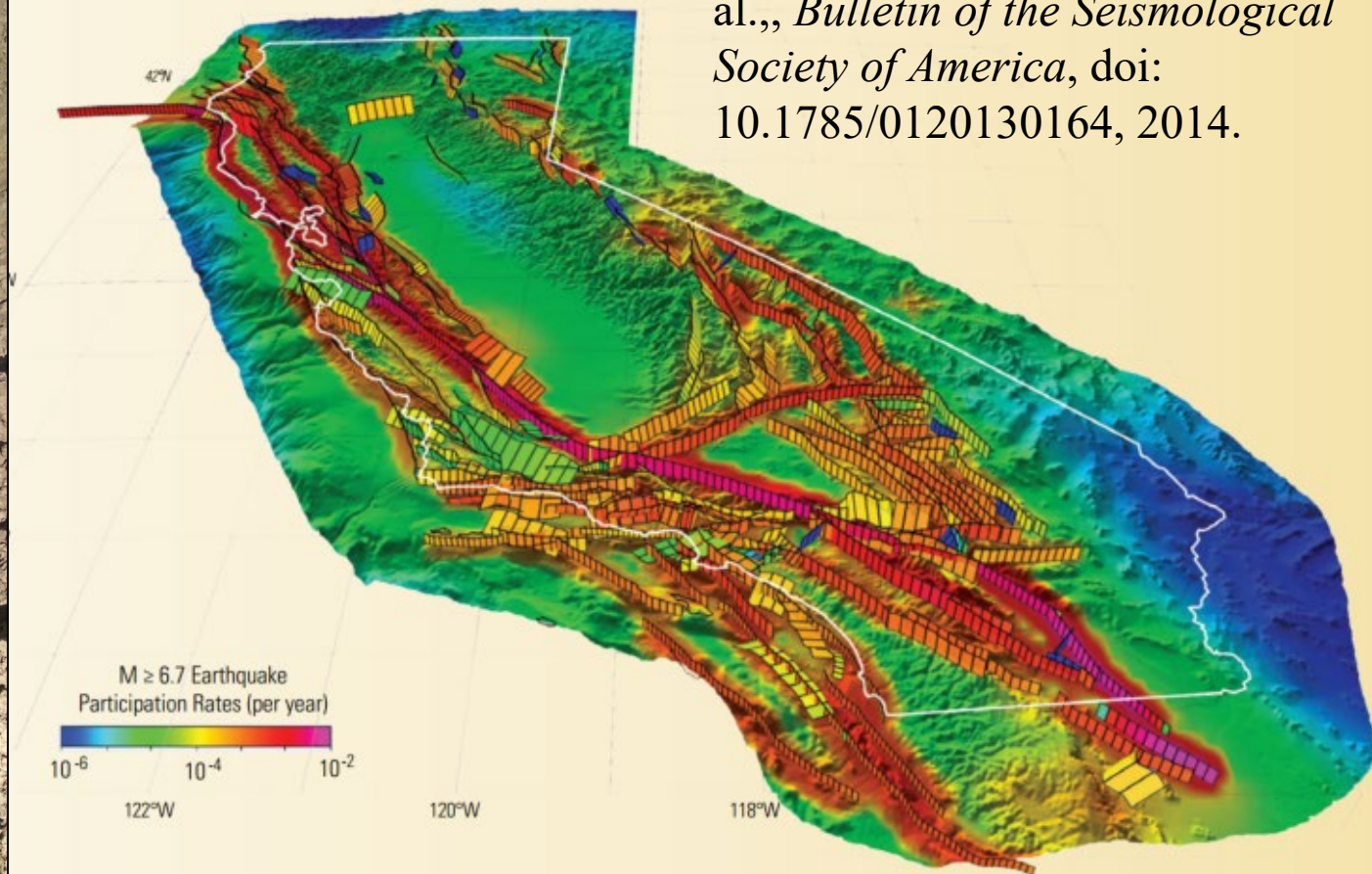
<https://fromtheprow.agu.org/remembering-the-great-1906-san-francisco-earthquake/>

Remembering the Great 1906 San Francisco Earthquake

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

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.

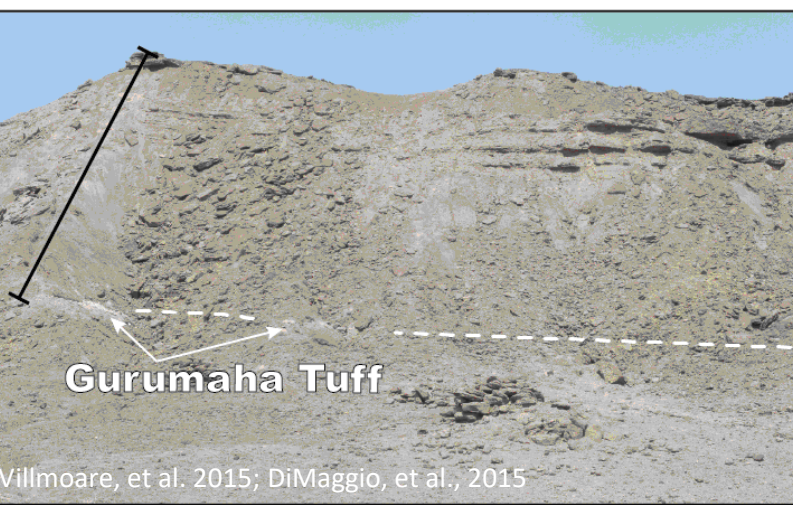
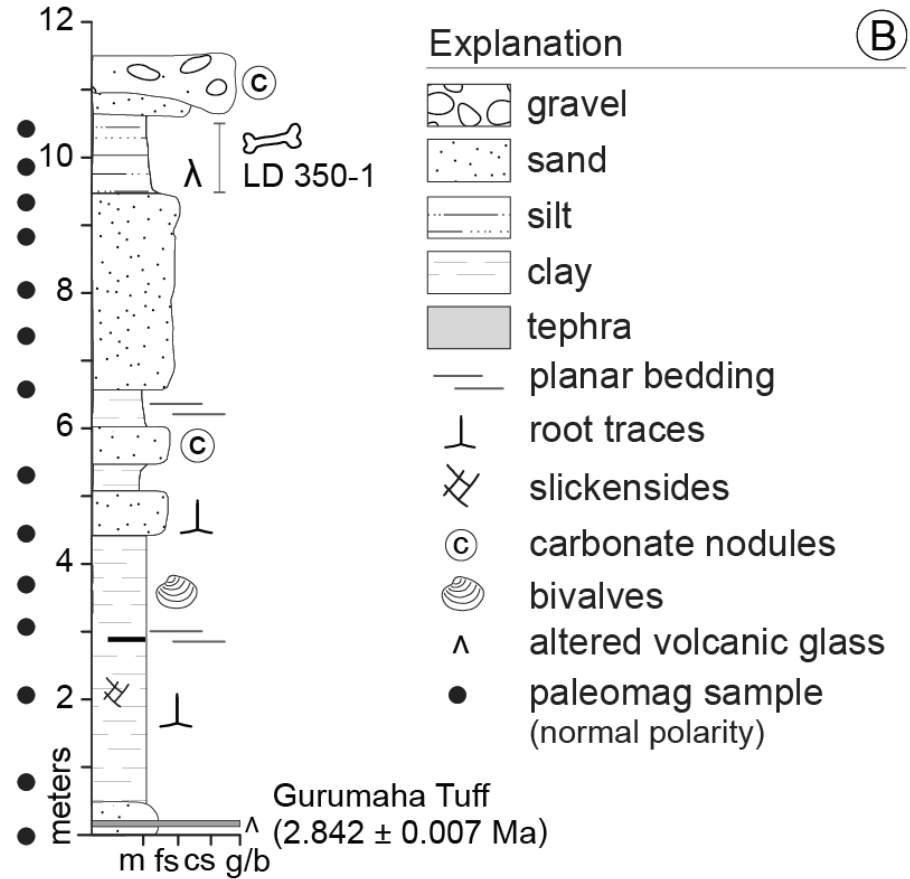
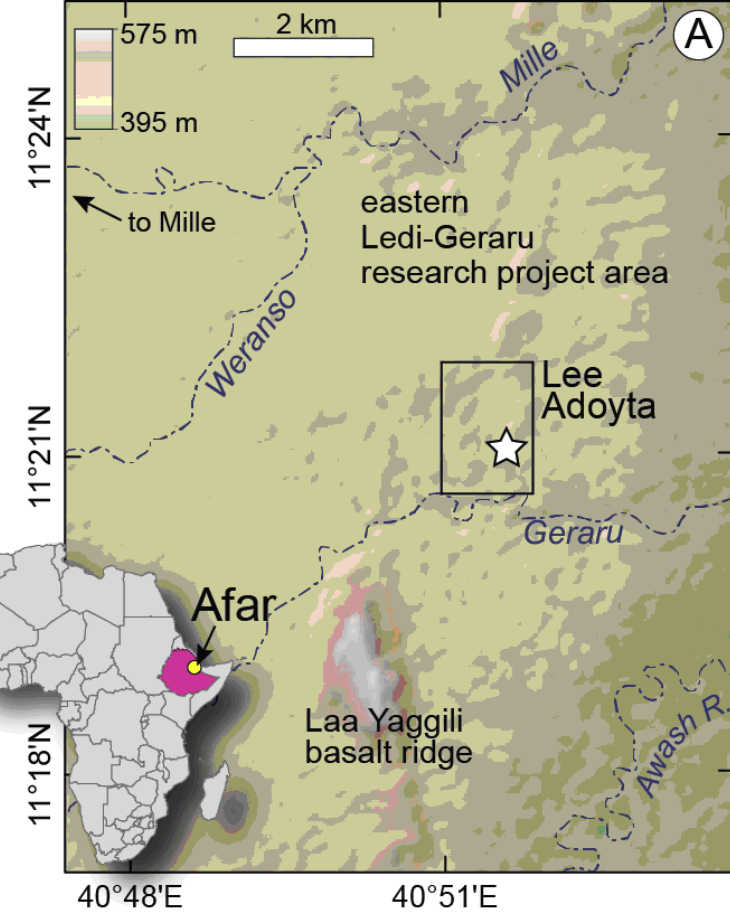


Geologic context of human origins



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

Villmoare, et al. 2015; DiMaggio, et al., 2015

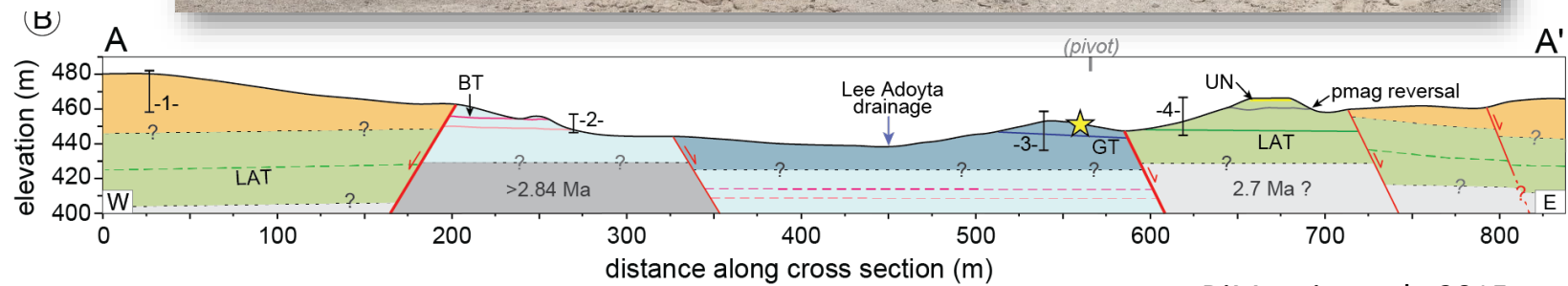
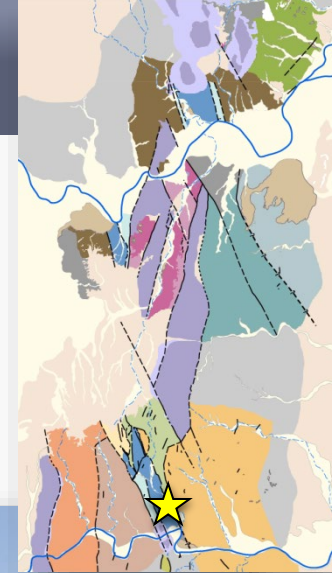
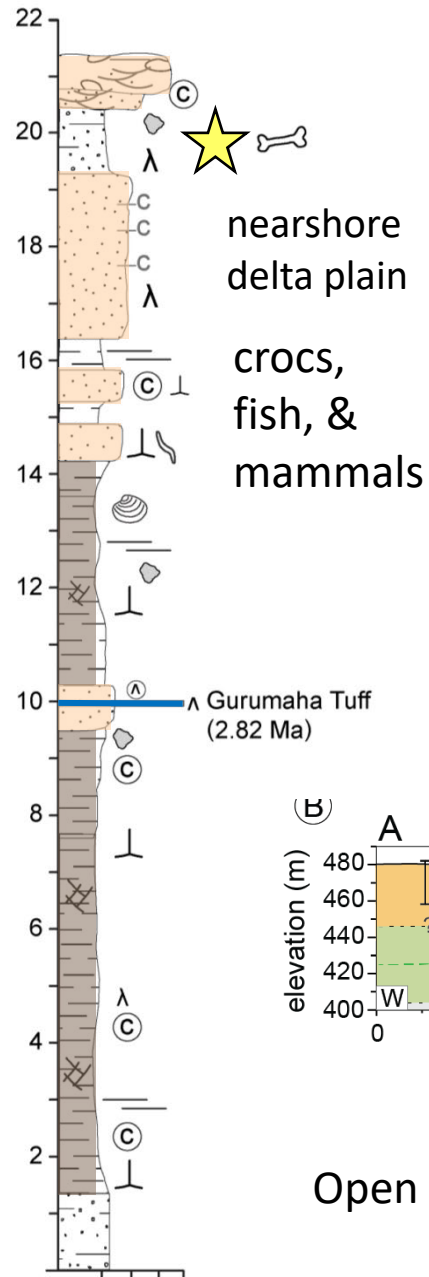


2015: checking the “Hom” site

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



context of hominin mandible



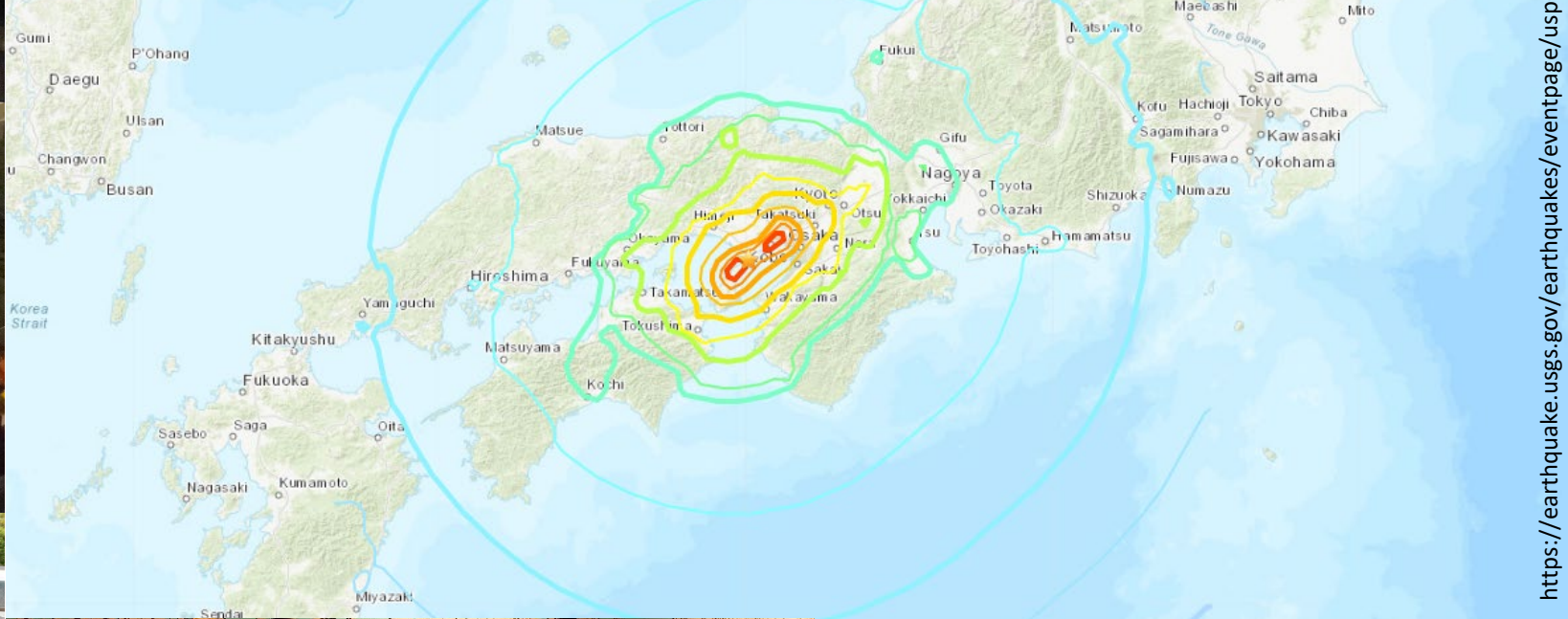
DiMaggio et al., 2015

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



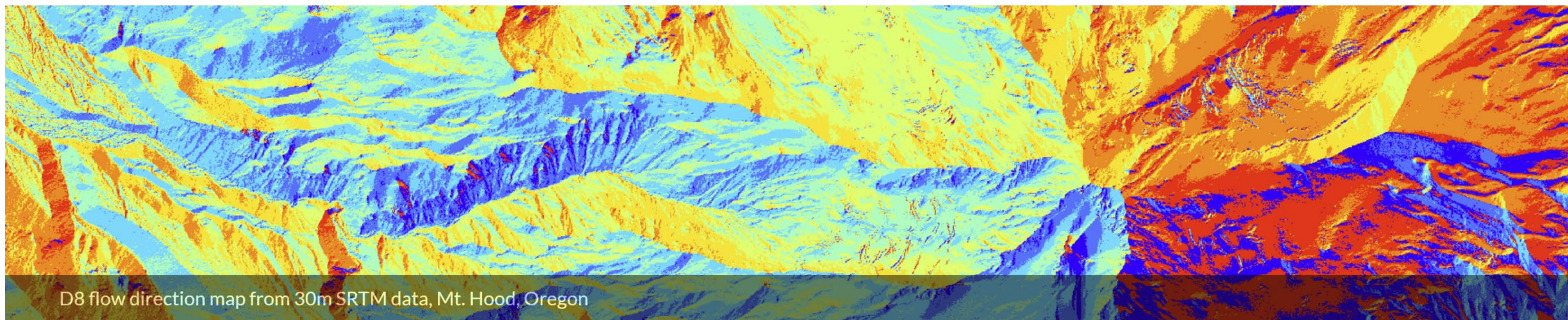
Arrowsmith photo



Arrowsmith photo



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



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

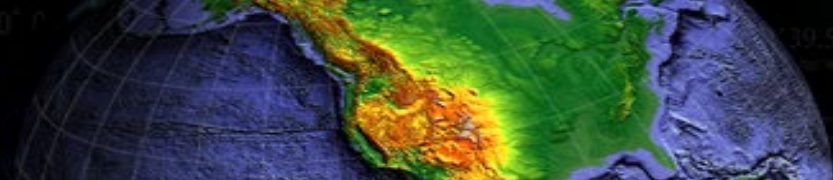
The OpenTopography team is pleased to announce the publication of our new open-access article in the journal *Remote Sensing*:
“Statewide USGS 3DEP Lidar Topographic...”

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 Zealand 2021

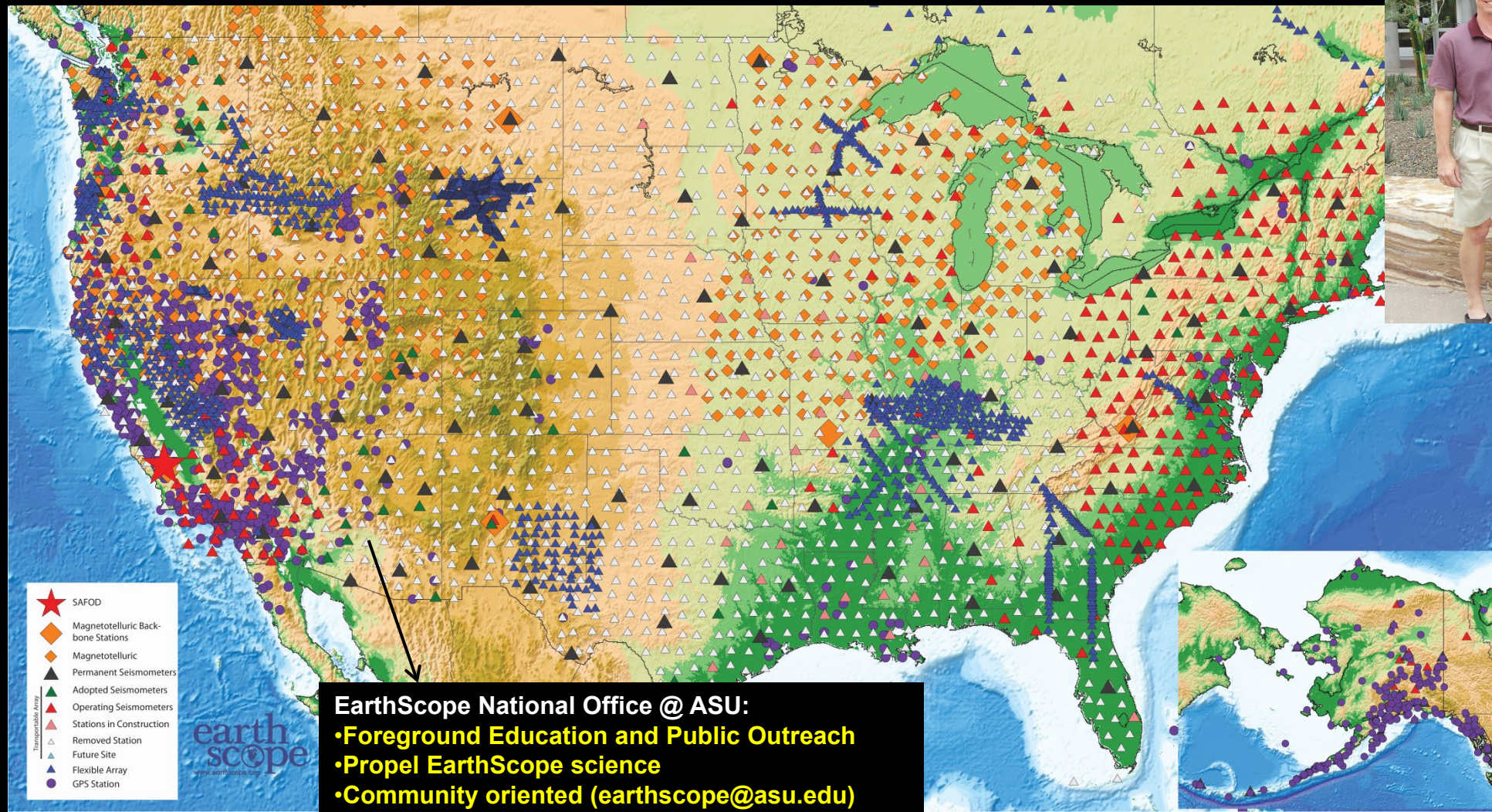


Exploring the Structure and Evolution of the North American Continent

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)

