GETSI Module: GPS, Strain, and Earthquakes

https://serc.carleton.edu/getsi/teaching_materials/gps_strain/index.html

Other relevant information is posted at

http://CroninProjects.org/GETSI-EER2018/

and will be posted at the SERC site associated with this workshop

UNAVCO

NAGT

NSF

Vince Cronin

Phil Resor

Bill Hammond

Nancy West

Shelly Olds

Corné Kreemer

Beth Pratt-Sitaula

acknowledgments

NAGT

UNAVCO

NSF

GETSI Module: GPS, Strain, and Earthquakes

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The Plan*

*to the limited extent that I plan anything…

GETSI Module: GPS, Strain, and Earthquakes

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The Plan*

Accessing module documents today

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Some background context for this resource

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Overview of the module

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The GPS horizontal-strain analysis

- explanation
- demonstration

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A simple and inexpensive physical model

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Your turn to do an analysis

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Your turn to do an analysis

Back to the module

*to the limited extent that I plan anything…

Geoscience motivations for students to learn how to use these tools

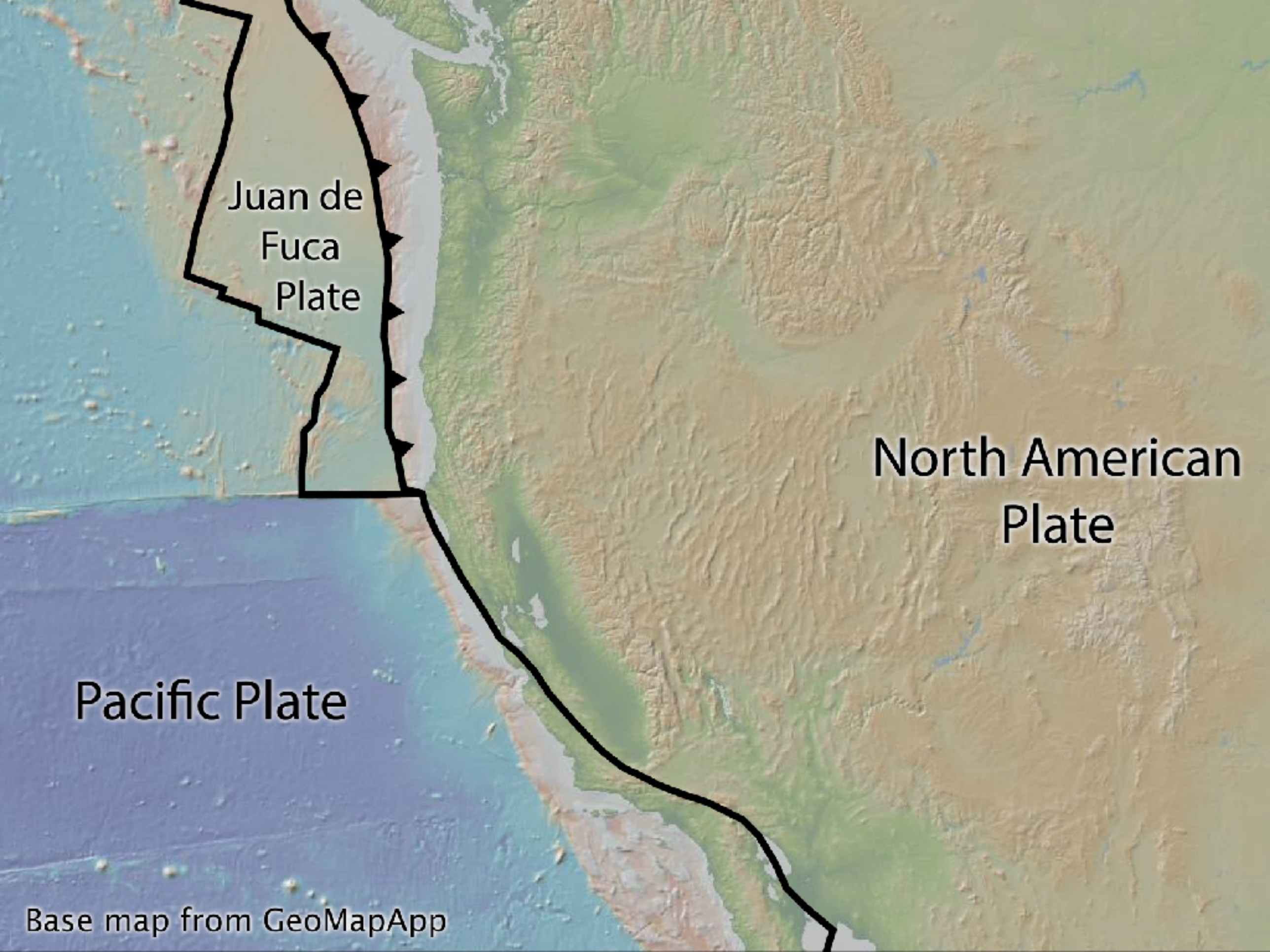
Base map from GeoMapApp

Juan de
Fuca
Plate

North American
Plate

Pacific Plate

Base map from GeoMapApp


Juan de
Fuca
Plate
North American
Plate
Pacific Plate
Base map from GeoMapApp

GSRM model velocities, after
UNAVCO GPS Velocity Viewer

Juan de
Fuca
Plate

North American
Plate

Pacific Plate

Instantaneous velocity
vectors in a reference
frame fixed to the stable
North American craton

Base map from GeoMapApp

GSRM model velocities, after
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M≥4.5 earthquakes,
1960-2018,
USGS-ANSS catalog

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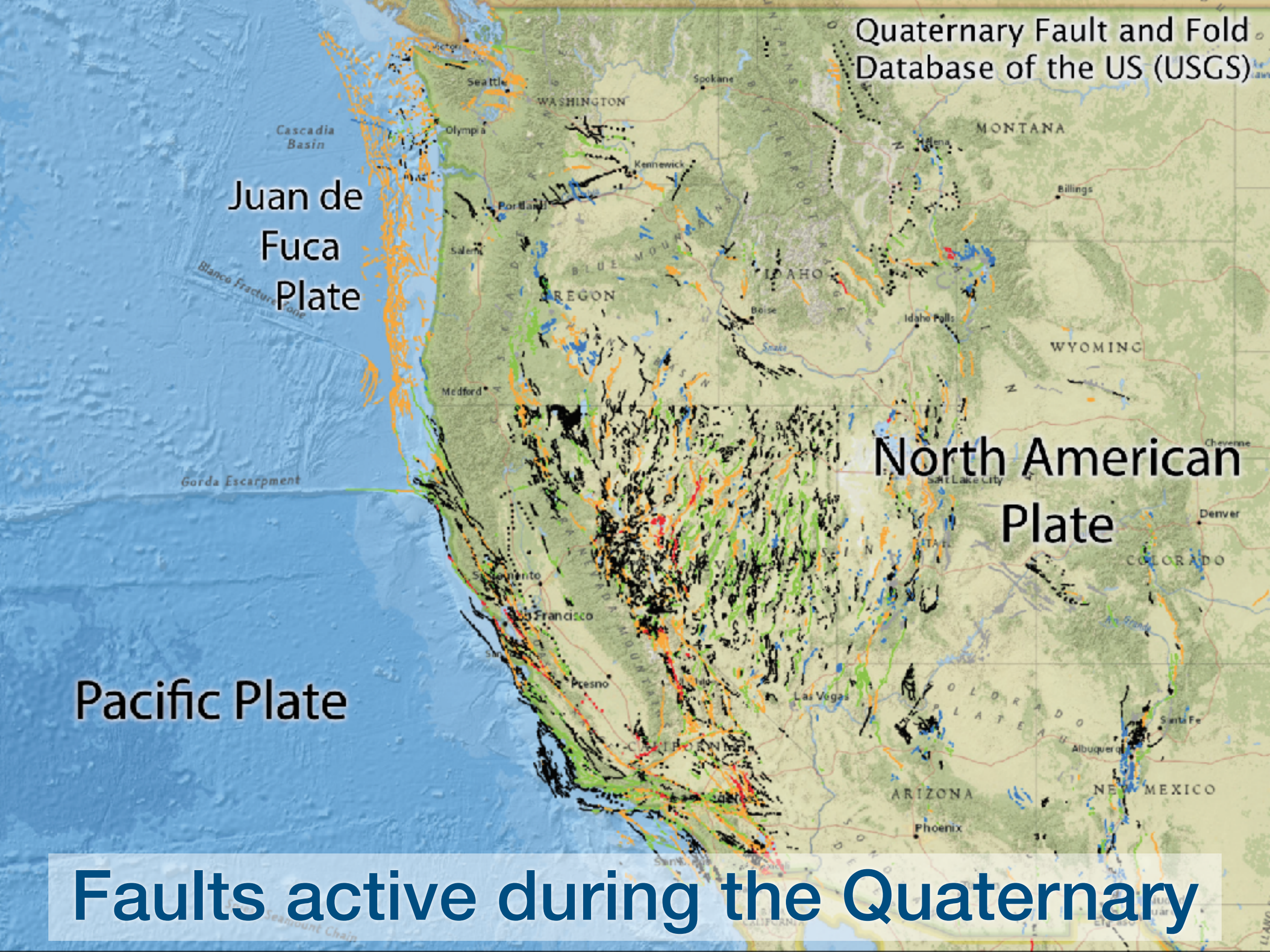
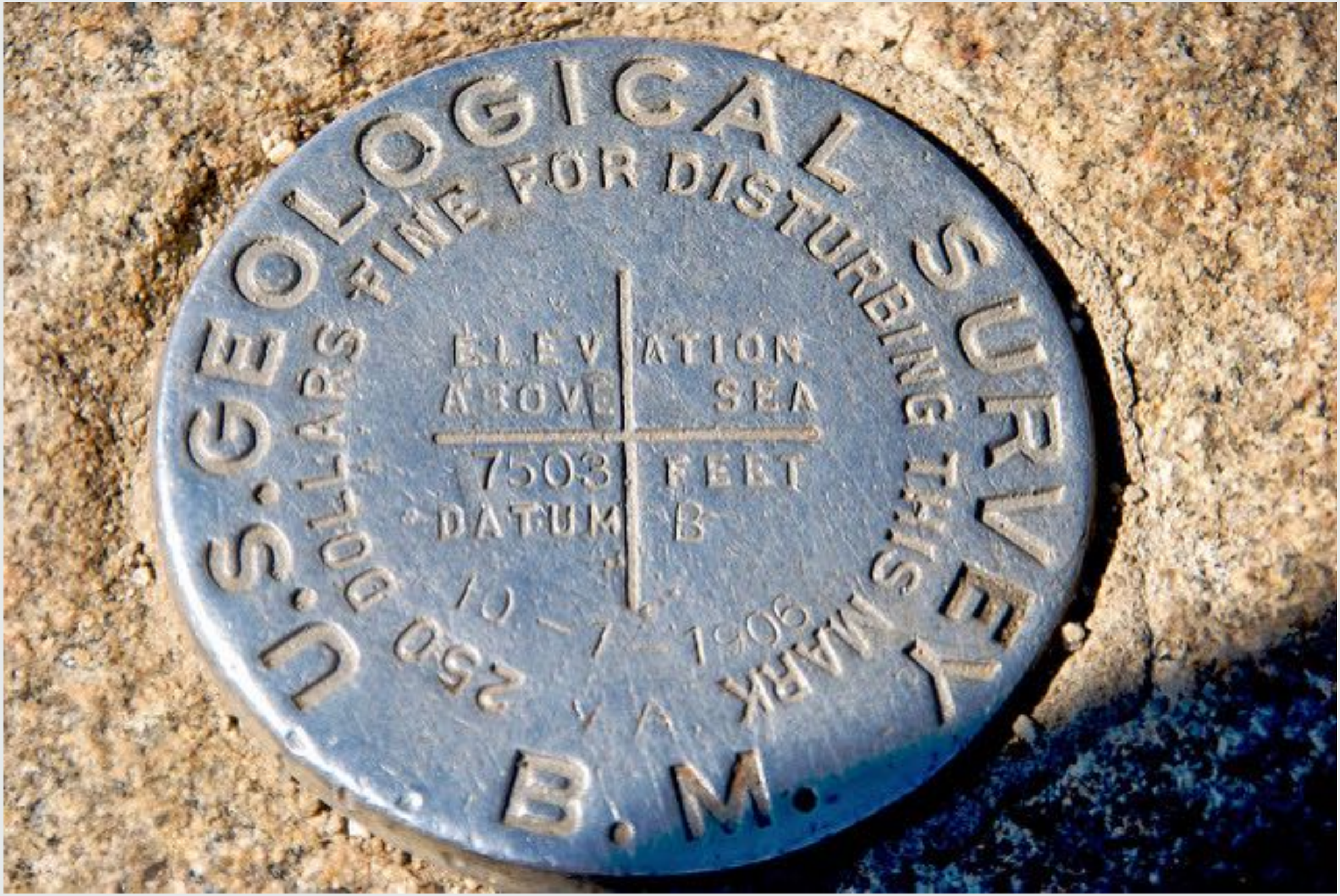
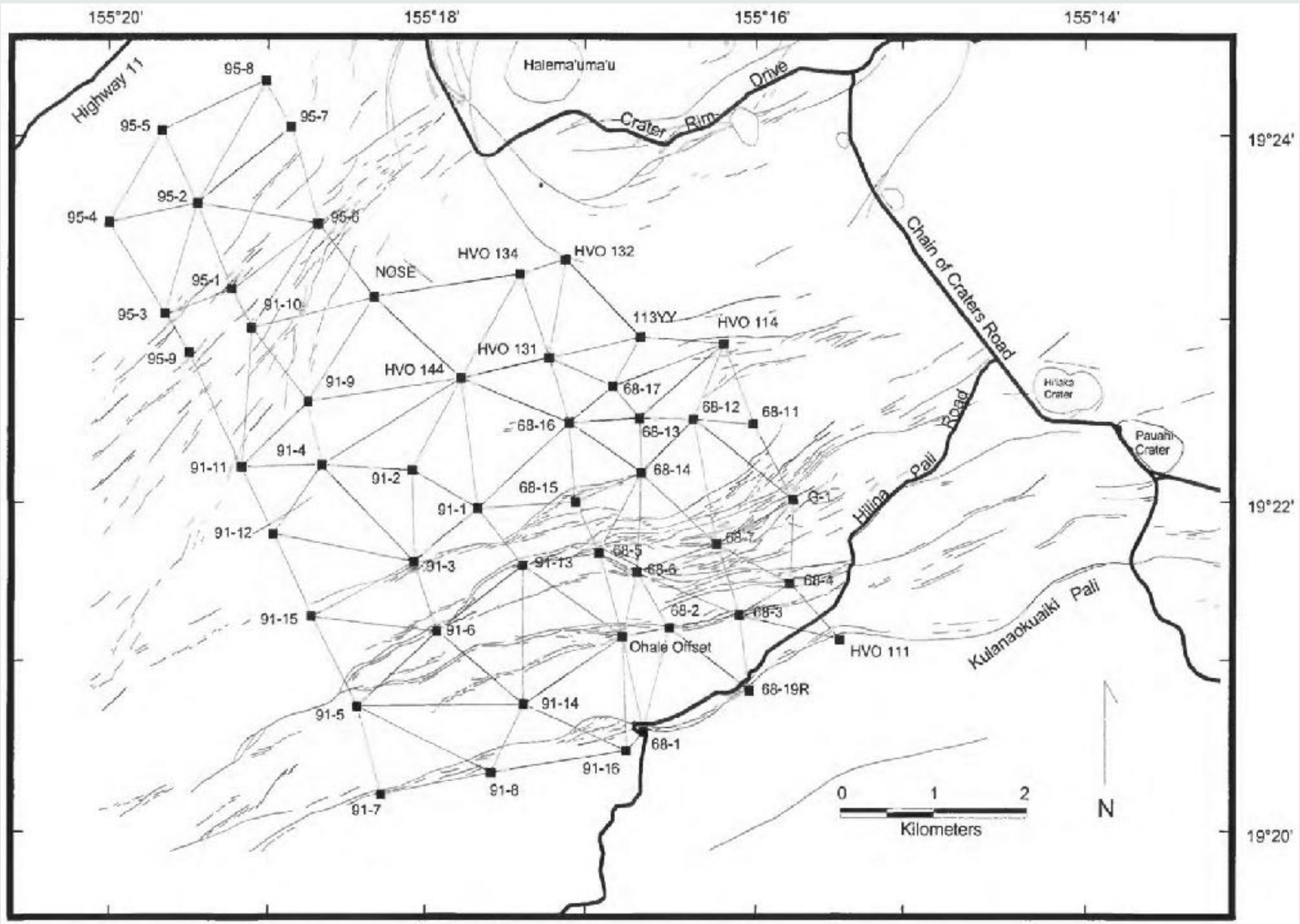


Faults active during the Quaternary

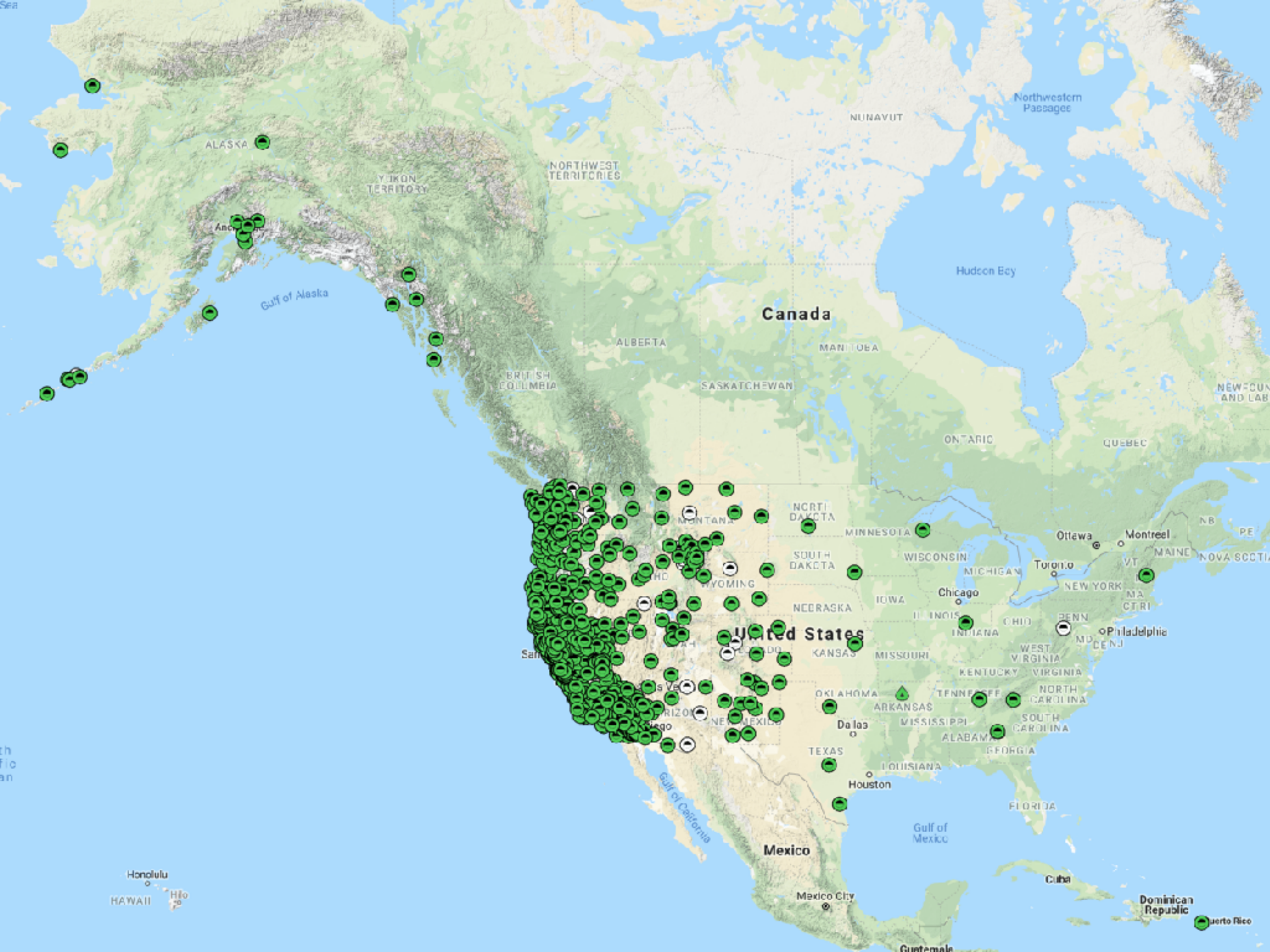


US Geological Survey benchmark, installed October 1, 1906

Using a geodimeter for repeat geodetic surveys of Mt. St. Helens, circa 1970s



EDM trilateration array, Kilauea, Hawaii, from Avery et al., 2002


ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
NUNAVUT
Northwestern Passage
Hudson Bay
Gulf of Alaska
Canada
ALBERTA
BRITISH COLUMBIA
SASKATCHEWAN
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND AND LABRADOR
United States
MONTANA
NORTH DAKOTA
MINNESOTA
SOUTH DAKOTA
WISCONSIN
MICHIGAN
WYOMING
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
NEW YORK
MAINE
VERMONT
NOVA SCOTIA
NEW BRUNSWICK
PEI
KANSAS
MISSOURI
WEST VIRGINIA
KENTUCKY
VIRGINIA
NORTH CAROLINA
SOUTH CAROLINA
OKLAHOMA
ARKANSAS
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
TEXAS
LOUISIANA
FLORIDA
Ottawa
Montreal
Toronto
Chicago
Philadelphia
Dallas
Houston
Gulf of California
Gulf of Mexico
Mexico
Mexico City
Cuba
Dominican Republic
Puerto Rico
Honolulu
HAWAII
Hilo

GSRM model velocities, after
UNAVCO GPS Velocity Viewer

Juan de
Fuca
Plate

North American
Plate

Pacific Plate

Instantaneous velocity
vectors in a reference
frame fixed to the stable
North American craton

Base map from GeoMapApp

PBO GPS site velocities and
GSRM model velocities, after
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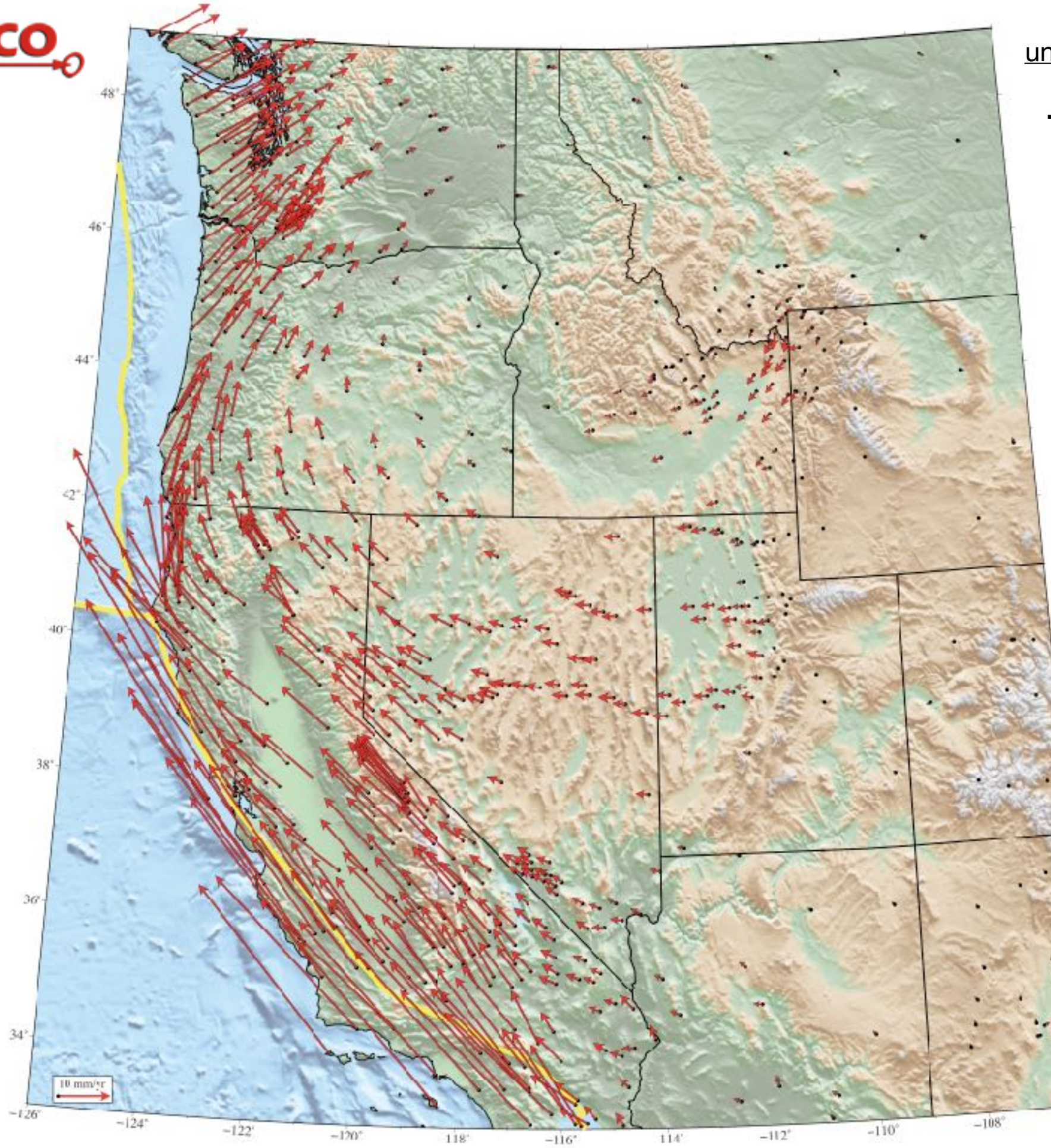
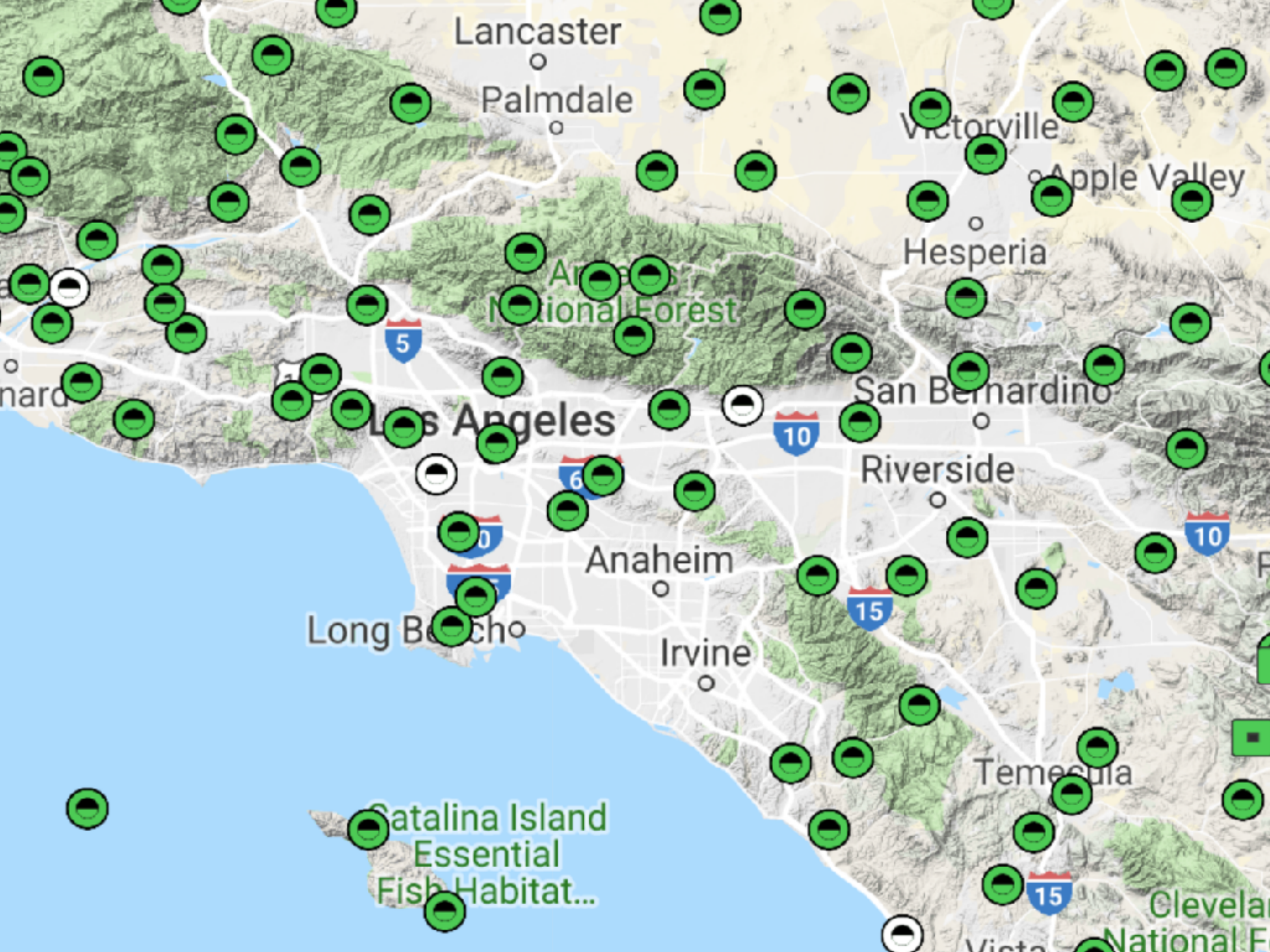
UNAVCO

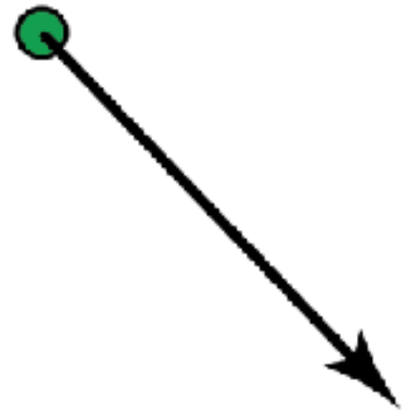
unavco.org/velocity-maps

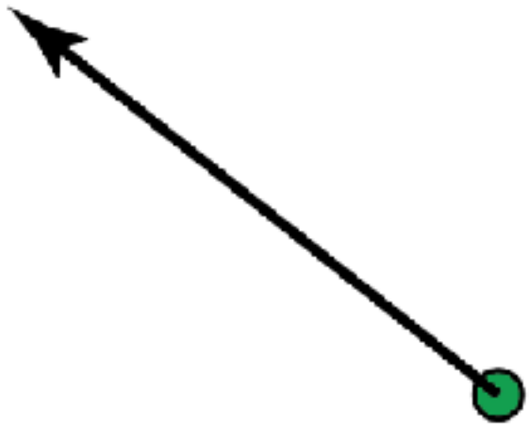
Tectonic Motion of the Western United States

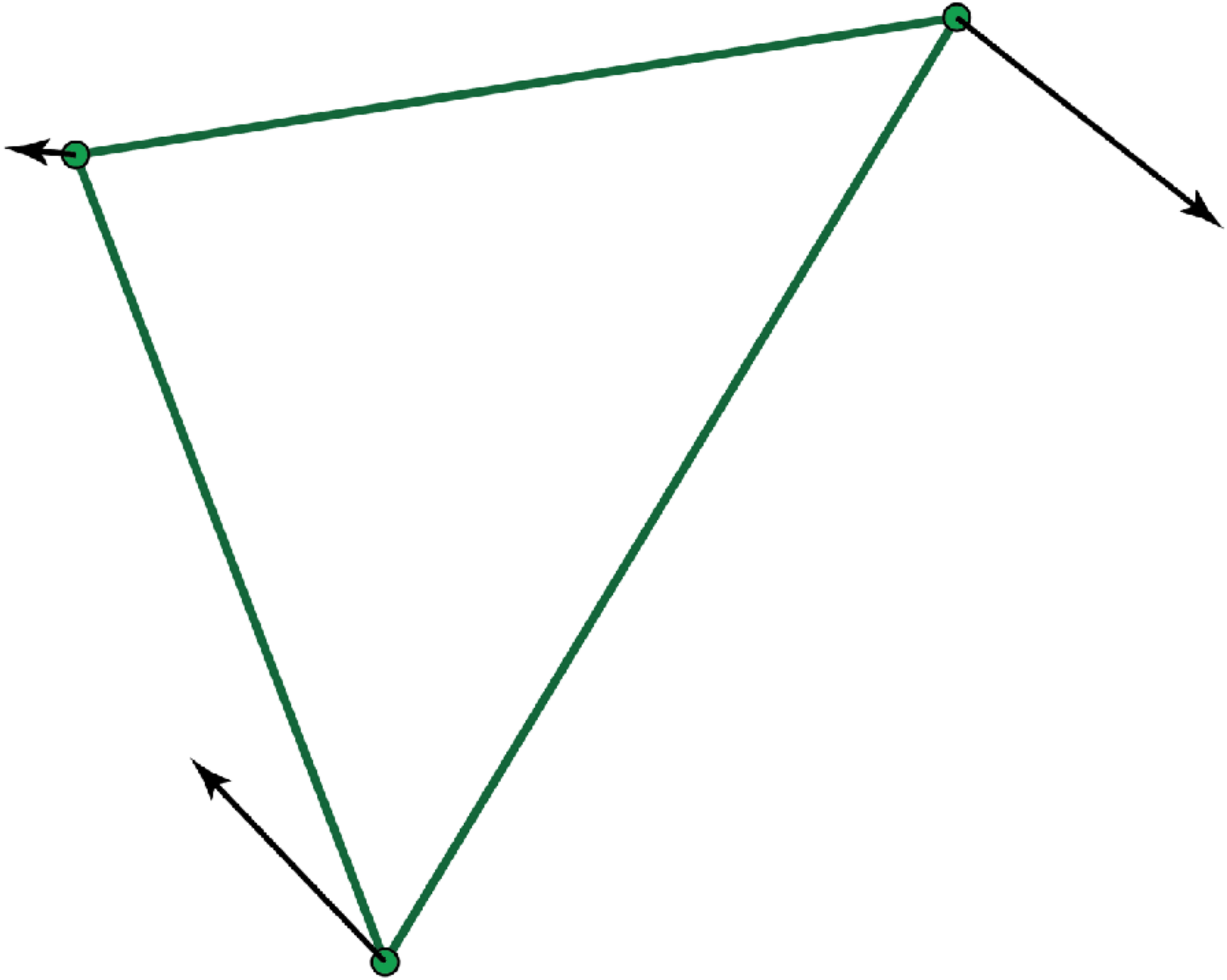


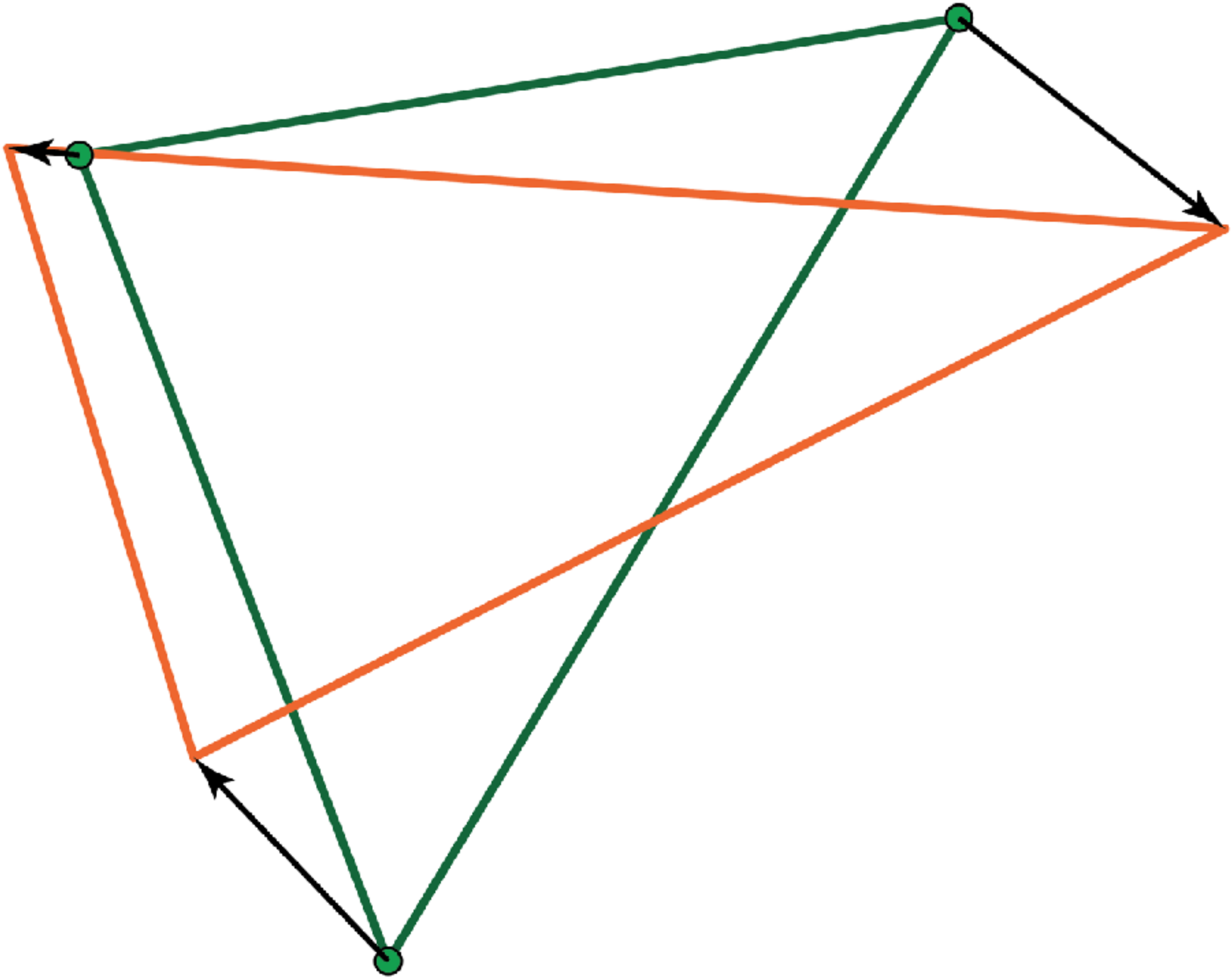
Velocities relative to the stable cratonic interior of the North American plate, as defined by NAM08


Lancaster
Palmdale
Victorville
Apple Valley
Hesperia
National Forest
5
San Bernardino
Los Angeles
10
Riverside
6
Anaheim
15
Long Beach
Irvine
Temecula
Catalina Island
Essential
Fish Habitat...









Play Time!

Fun with a triangle of stretchy cloth

Components of deformation

Components of deformation

Translation (change of position)

Components of deformation

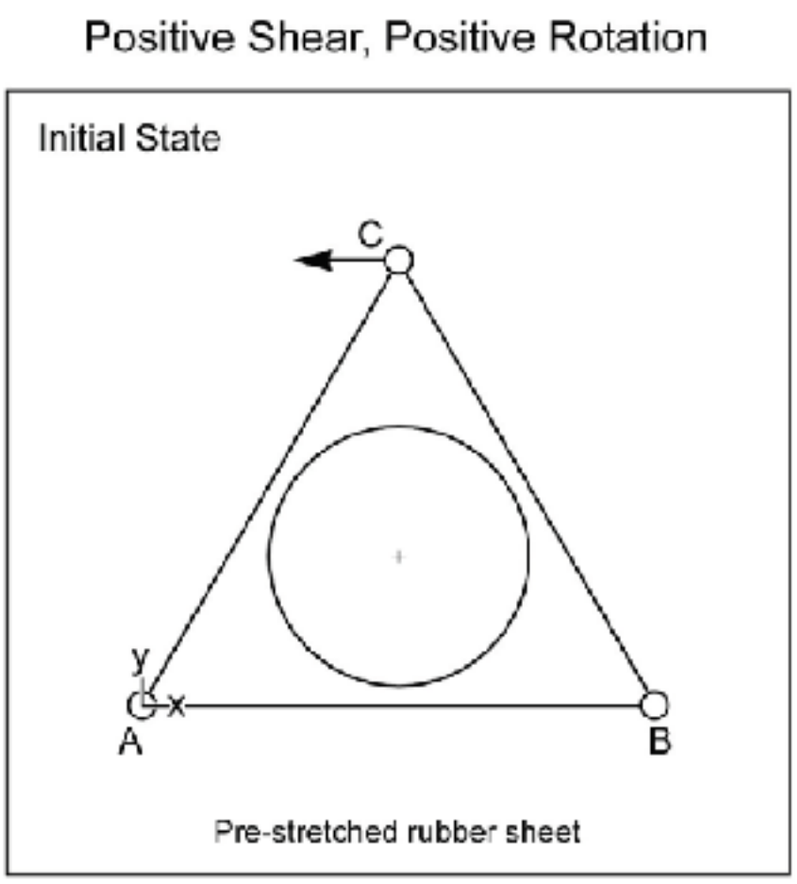
Translation (change of position)
Rotation (change of orientation)

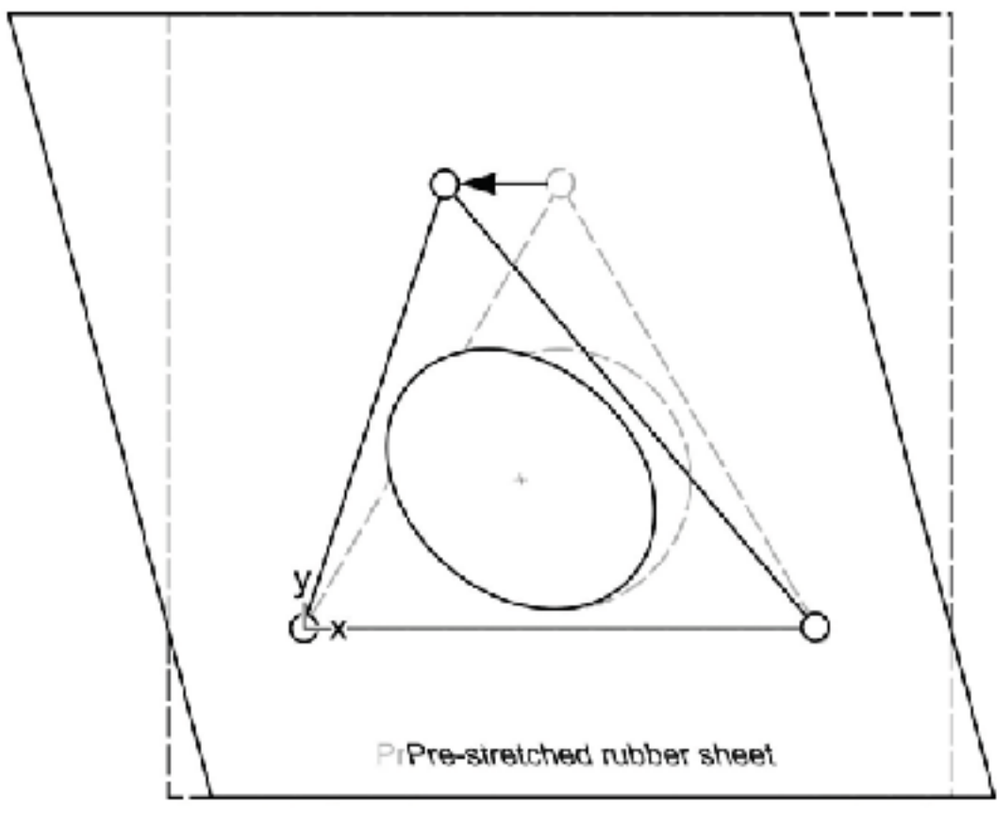
Components of deformation

Translation (change of position)
Rotation (change of orientation)
Dilation (change of volume/area)

Components of deformation

Translation (change of position)
Rotation (change of orientation)
Dilation (change of volume/area)
Distortion (change of shape)

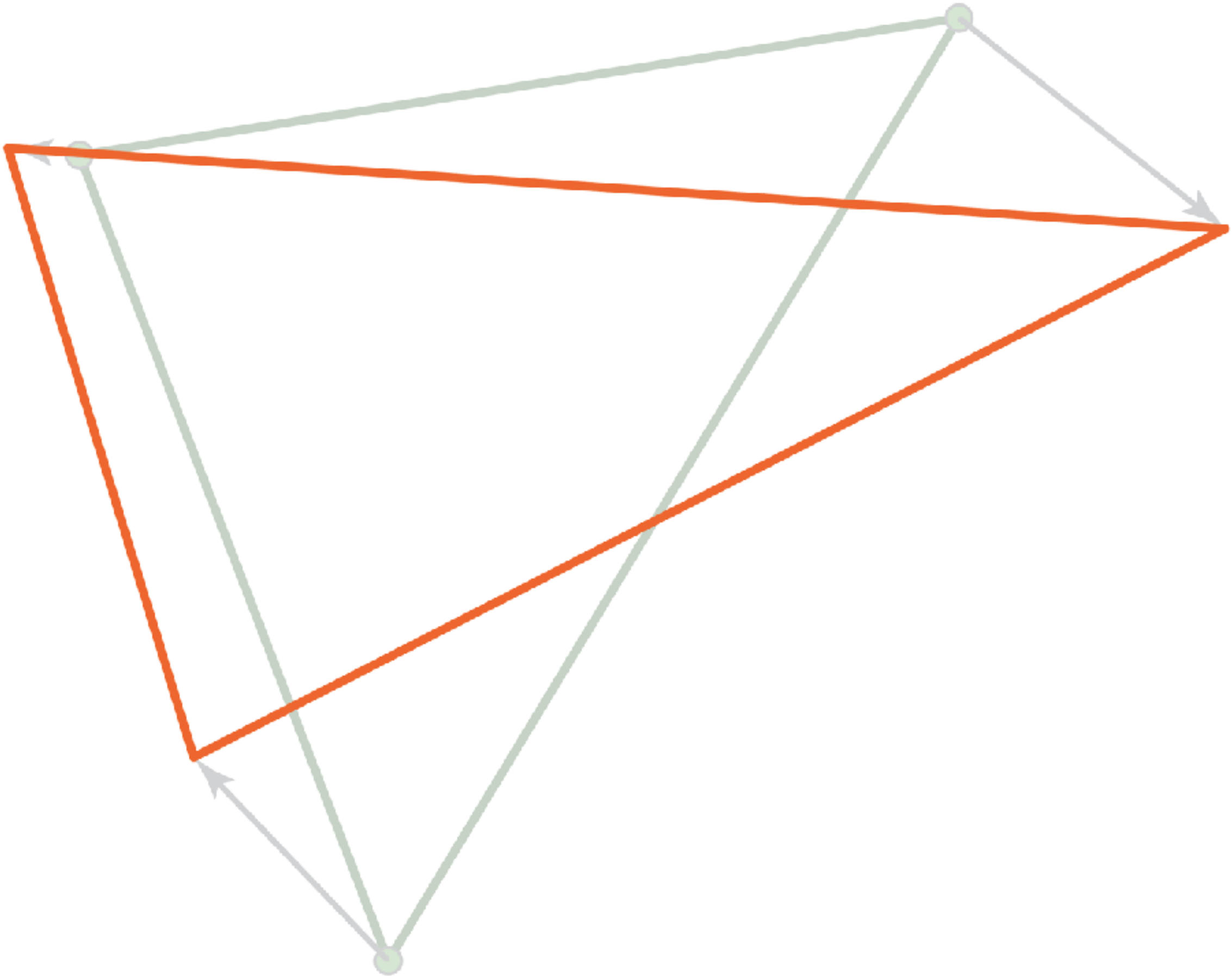


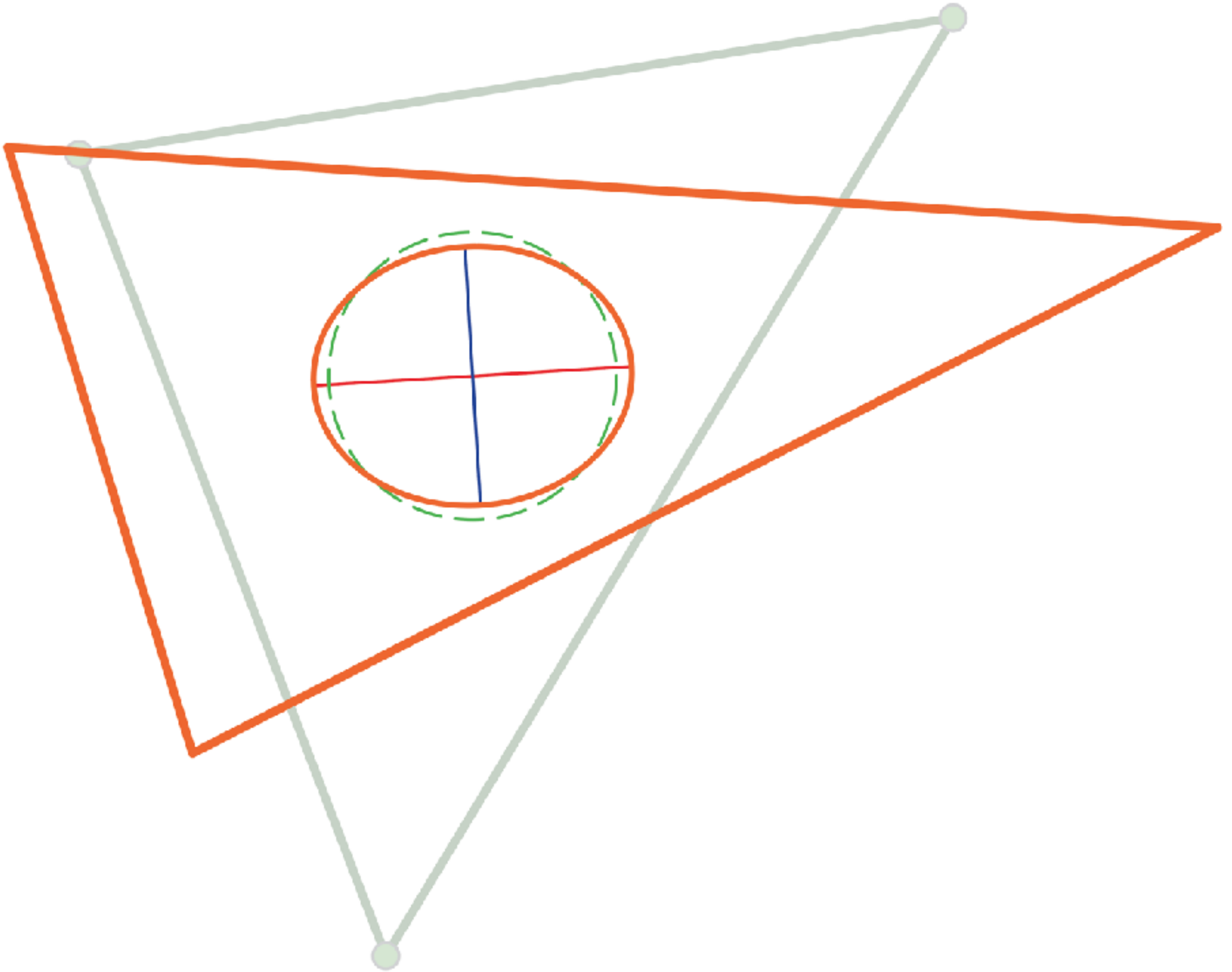


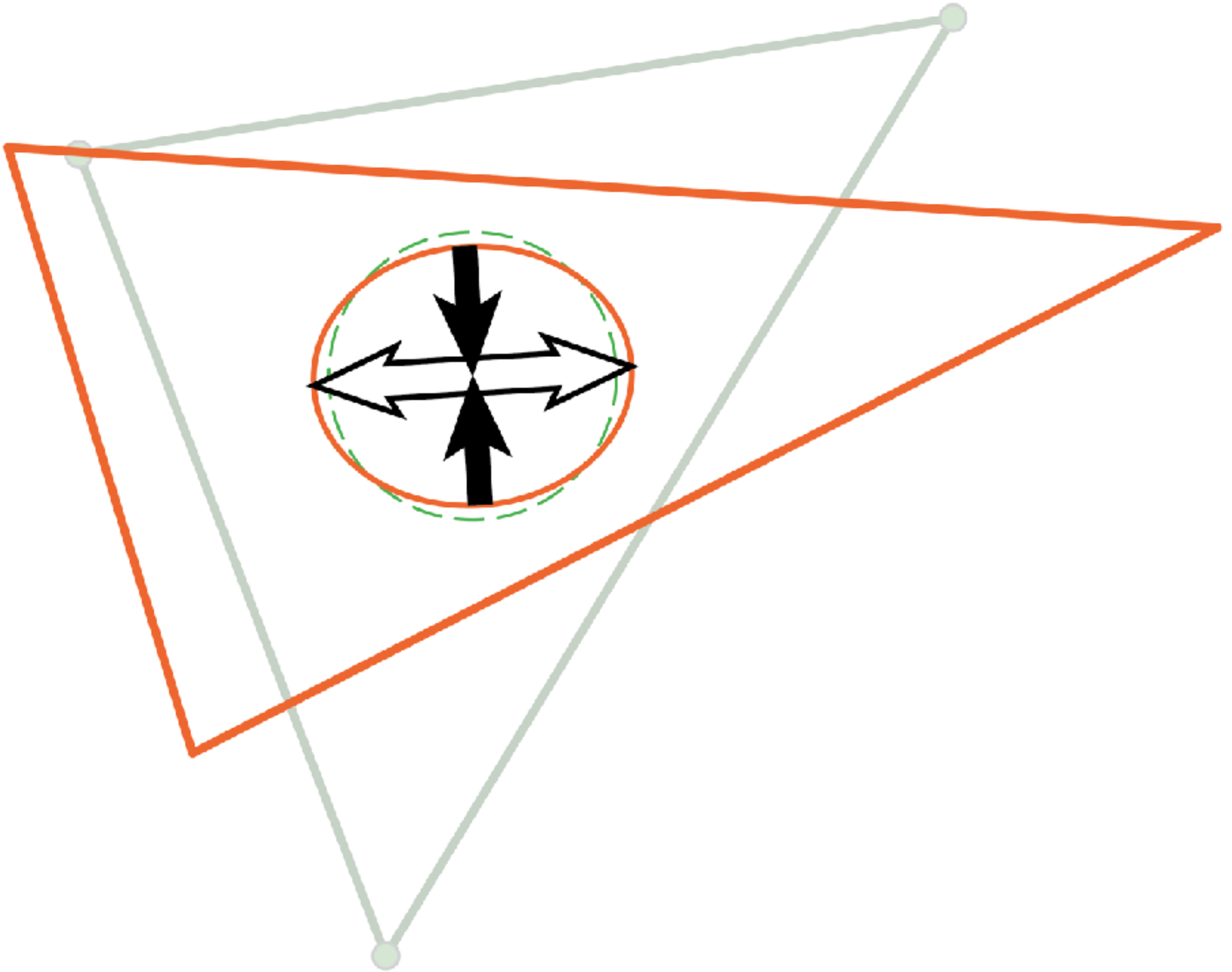
One of 9 strain scenarios depicted in "gps_triangle_strain_ellipse.pdf"

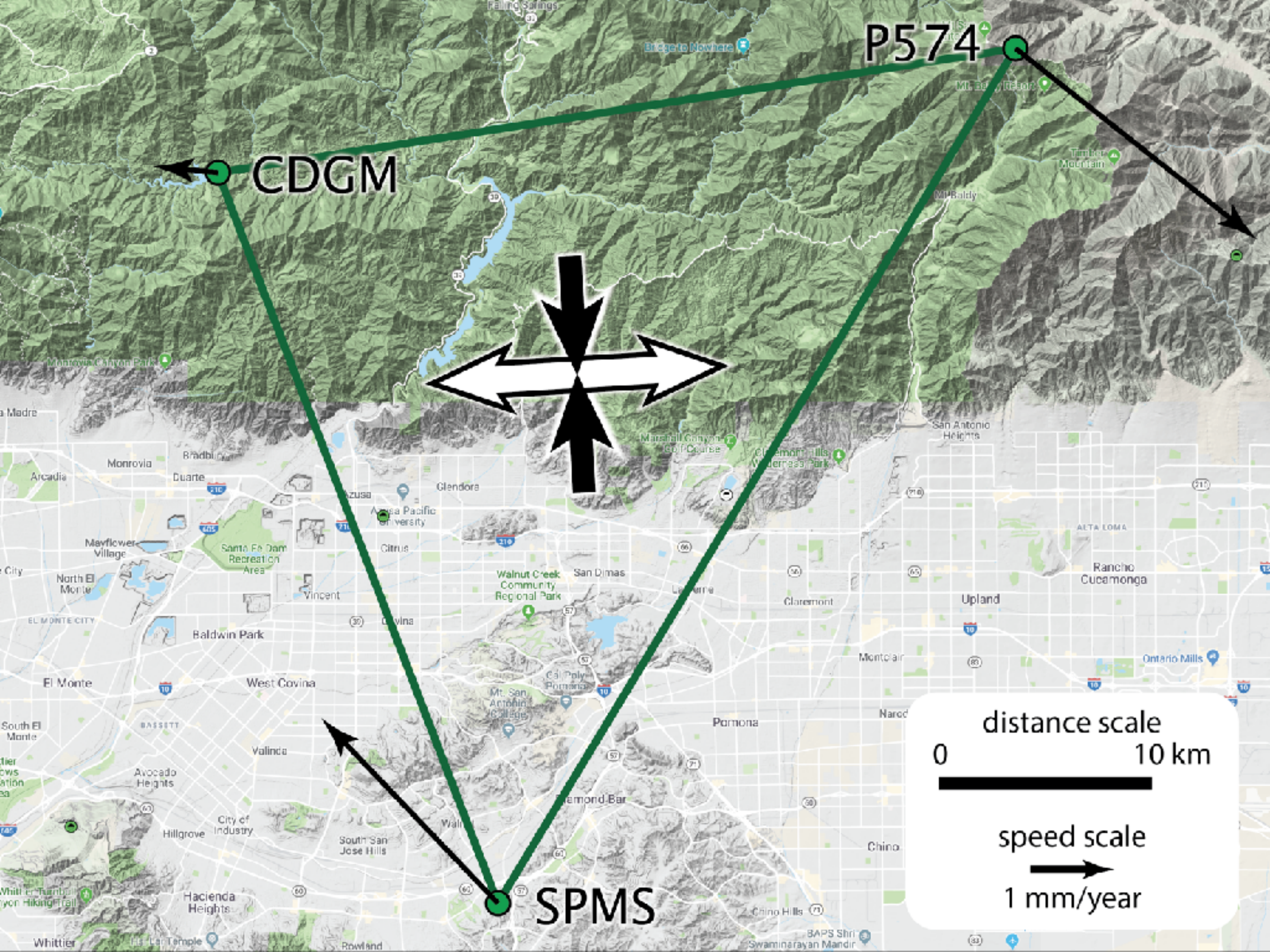
http://www.marlimillerphoto.com/SrD-53.html

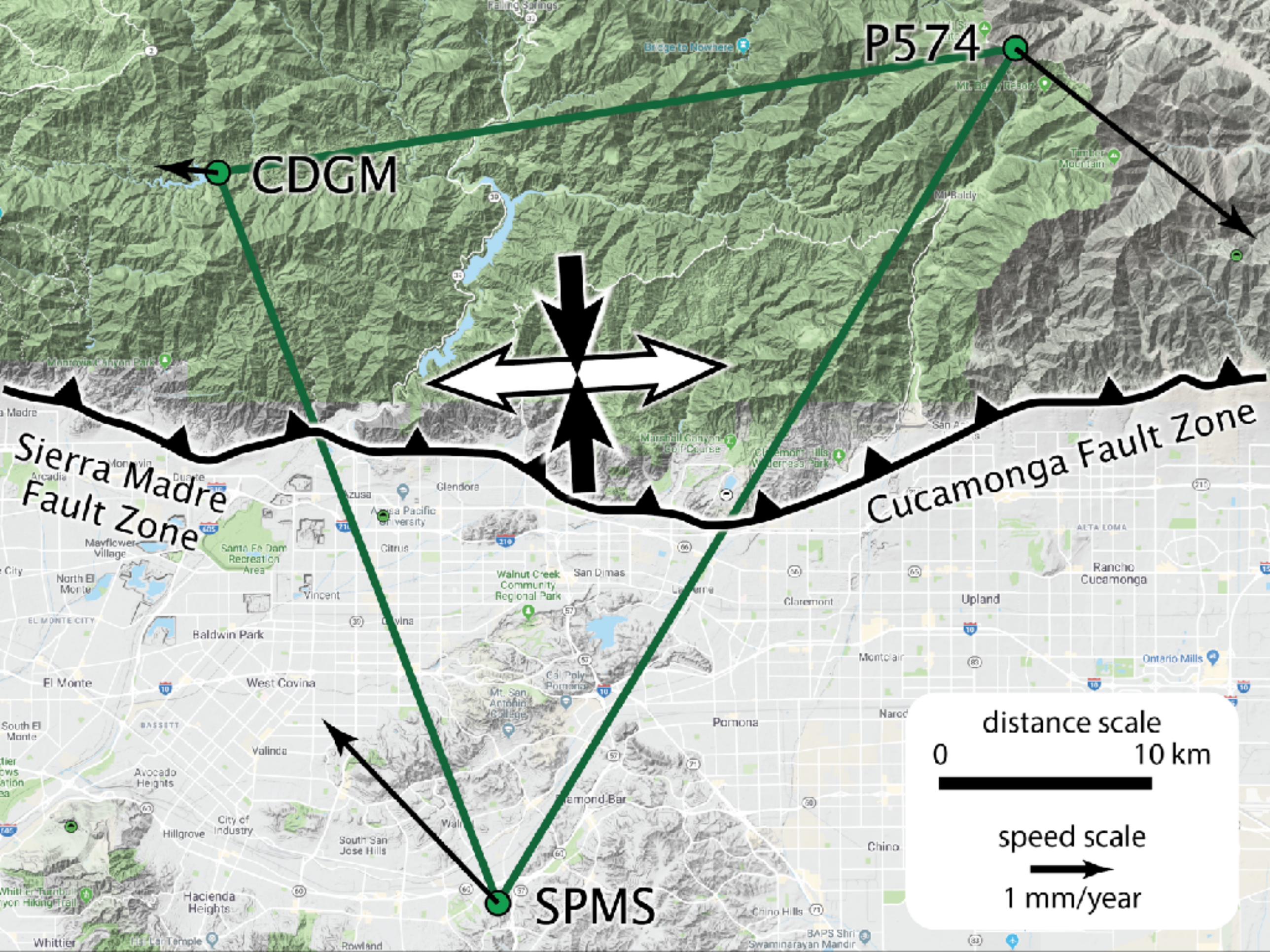
deformed trilobite

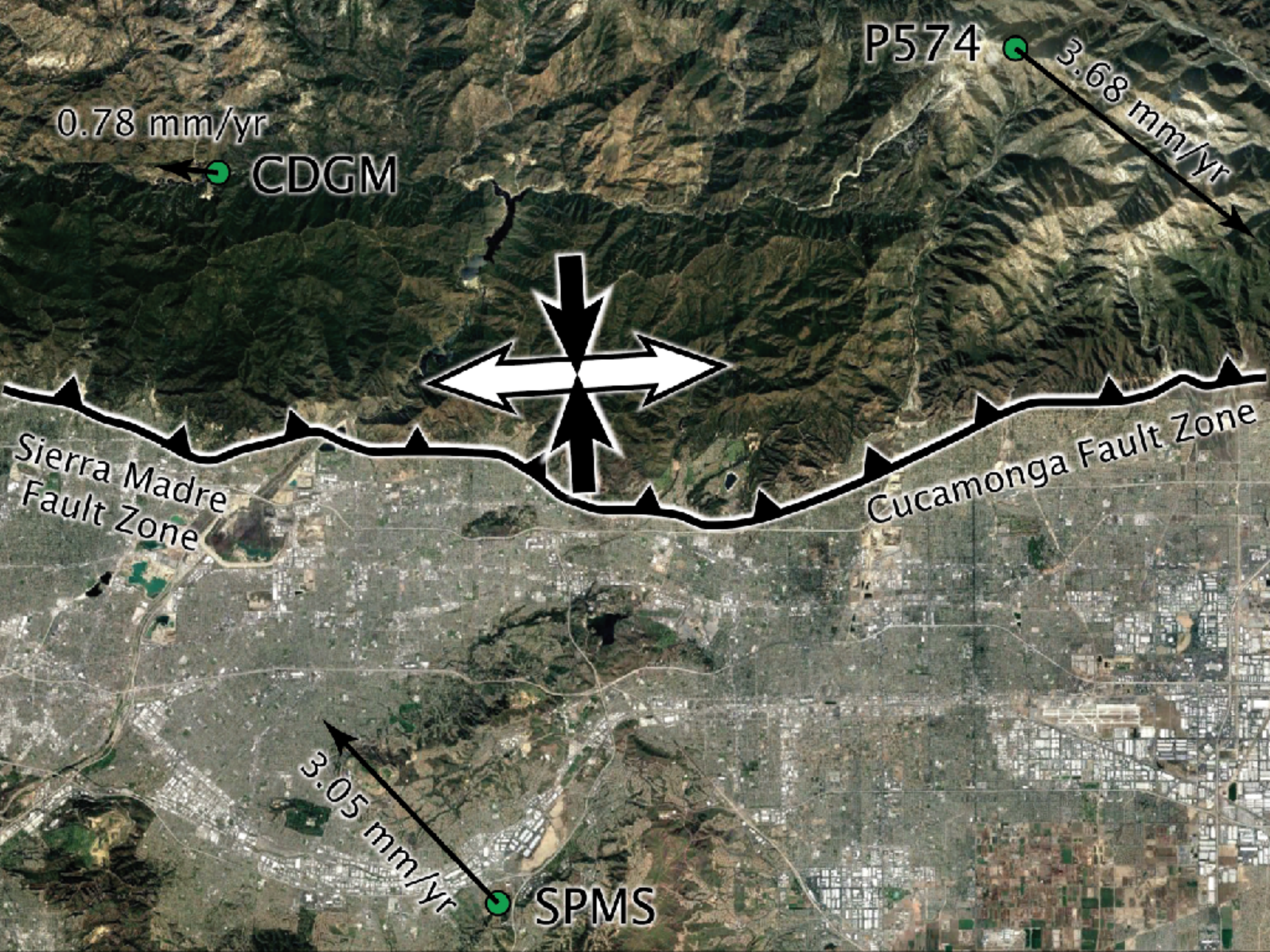







P574
CDGM
SPMS
distance scale
0
10 km
speed scale
1 mm/year
Monrovia Canyon Park
Monrovia
Arcadia
Duarte
Bradbury
Glendora
Azusa
Azusa Pacific University
Mayflower Village
Santa Fe Dam Recreation Area
North El Monte
Vincent
Citrus
Walnut Creek Community Regional Park
San Dimas
Claremont
Upland
Rancho Cucamonga
Baldwin Park
El Monte
West Covina
Covina
Mt. San Antonio College
Pomona
Valinda
Avocado Heights
Hillgrove
City of Industry
South San Jose Hills
Hacienda Heights
Whittier
Rowland
Chino
Chino Hills
Montclair
Ontario Mills
San Antonio Heights
Marshall Canyon Golf Course
Bridge to Nowhere
Timber Mountain
Mt Baldy


P574
CDGM
SPMS
Sierra Madre Fault Zone
Cucamonga Fault Zone
distance scale
0
10 km
speed scale
1 mm/year


P574
3.68 mm/yr
0.78 mm/yr
CDGM
Sierra Madre
Fault Zone
Cucamonga Fault Zone
3.05 mm/yr
SPMS


Baby
Girl!

Societal motivations for students to learn how to use these tools

Base map from GeoMapApp

Geoscience exists within a social context.

Geoscience exists within a social context.

Why do we study the active deformation of the crust?

Geoscience exists within a social context.

Why do we study the active deformation of the crust?

Natural hazards like earthquakes can harm people, destroy property, diminish wealth, and adversely impact social institutions after a disaster

Onward to an overview of the GPS strain module…