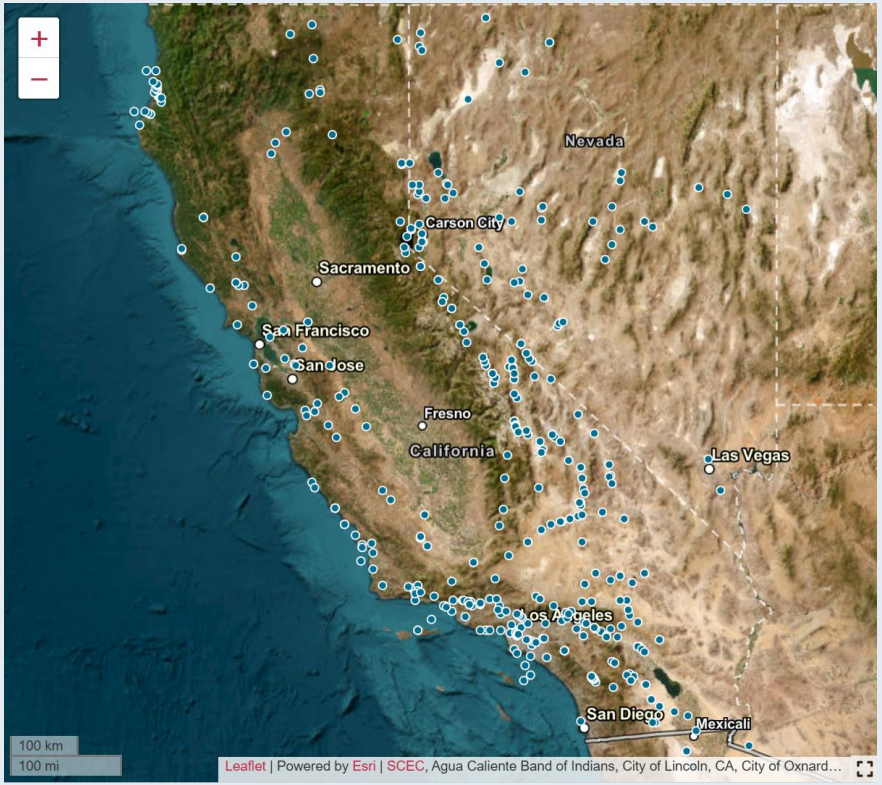
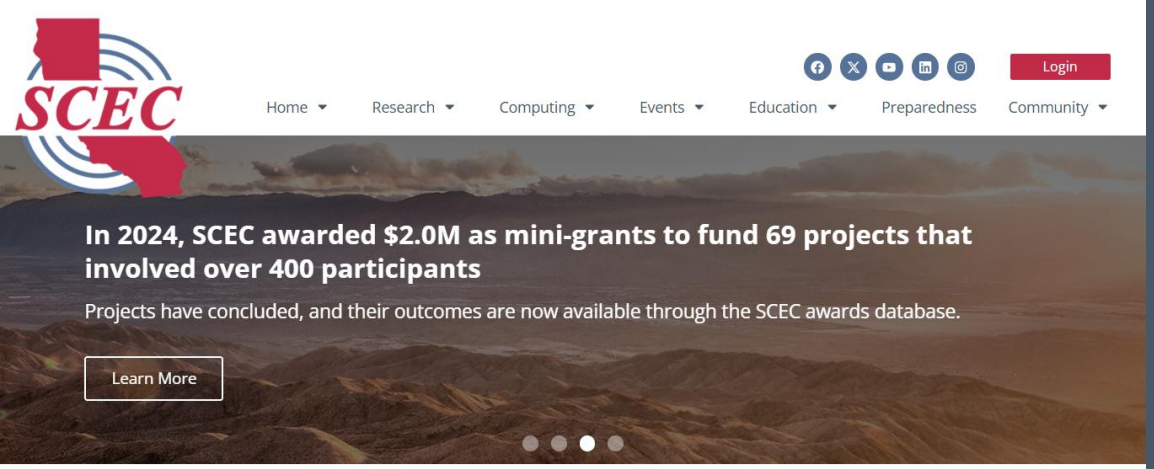
The Geologic Slip Rate Database (GSRD) the Community Fault Model (CFM) and Cyberinfrastructure for SCEC-hosted databases

Scott Marshall
Appalachian State University



GSRD Homepage | https://southern.scec.org/research/gsrd
New GSRD Explorer | https://moho.scec.org/gsrd-explorer/

June 3, 2026
UNREST Workshop, Pismo Beach, CA



SCEC IT/Web Team

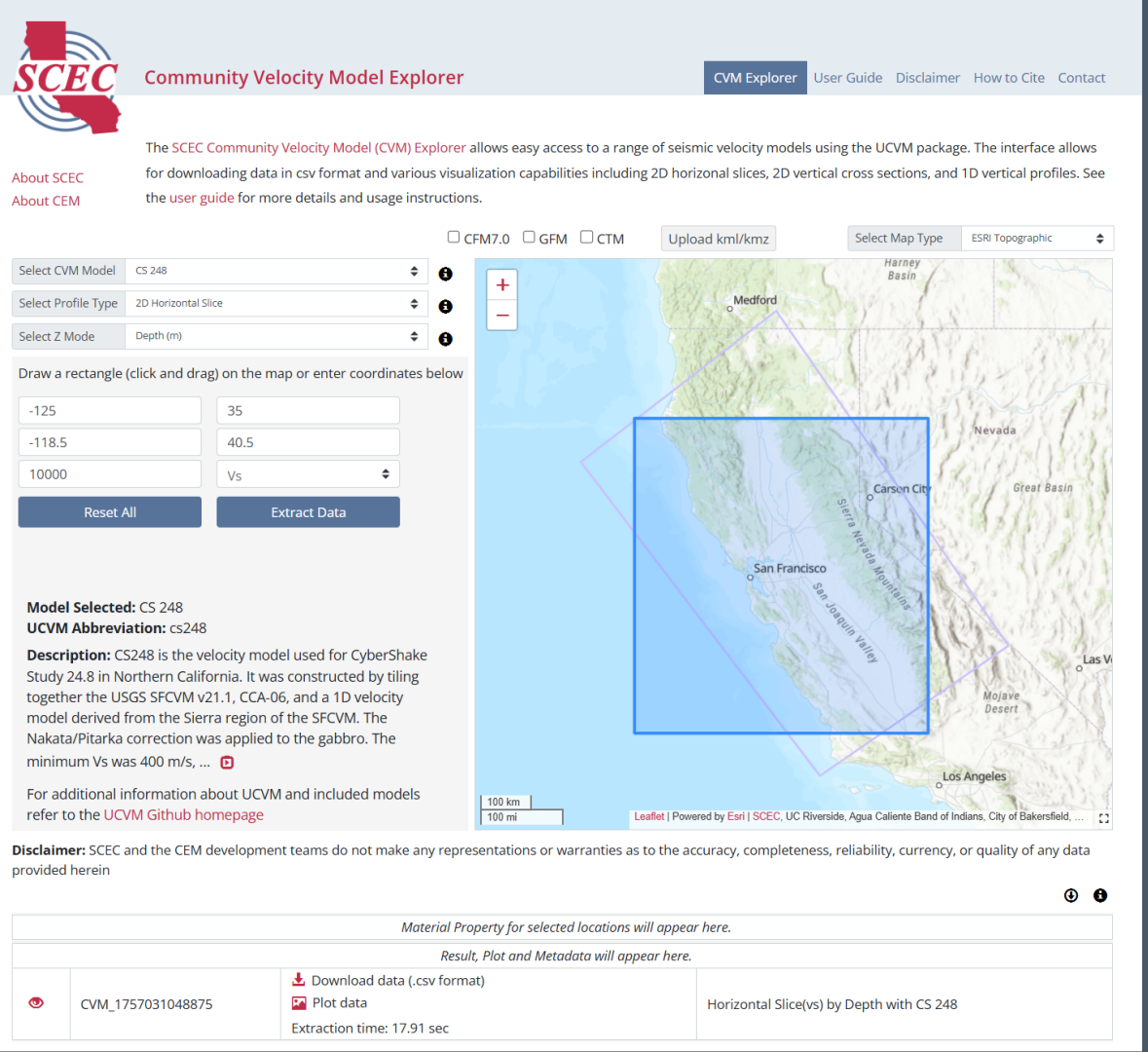
CEMs: A collaboration between scientists, IT professionals, and the community

Tran Huynh
Associate Director for Science Operations
USC/SCEC

Scott Callaghan
Associate Director for Information Technology
USC/SCEC

Edric Pauk
Software Engineer / Web Developer
USC/SCEC

Mei-Hui Su
CXM Software Engineer
USC/SCEC



CEM Explorers

Web-based tools for Community Earth Models

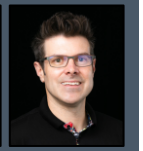
All CEMs have an “Explorer” that helps users explore the model (leaflet-based map)

Some are still “Provisional”
moho.scec.org

If you have any issues, let us know!

Community Earth Model Collaboration

SCEC CEM Developers

…and contributors!

Photo Not Found

*Apologies if I missed anyone

SCEC Software & Web Team


Tran Huynh


Scott Callaghan


Mei-Hui Su


Edric Pauk

CEM Users

Mockups

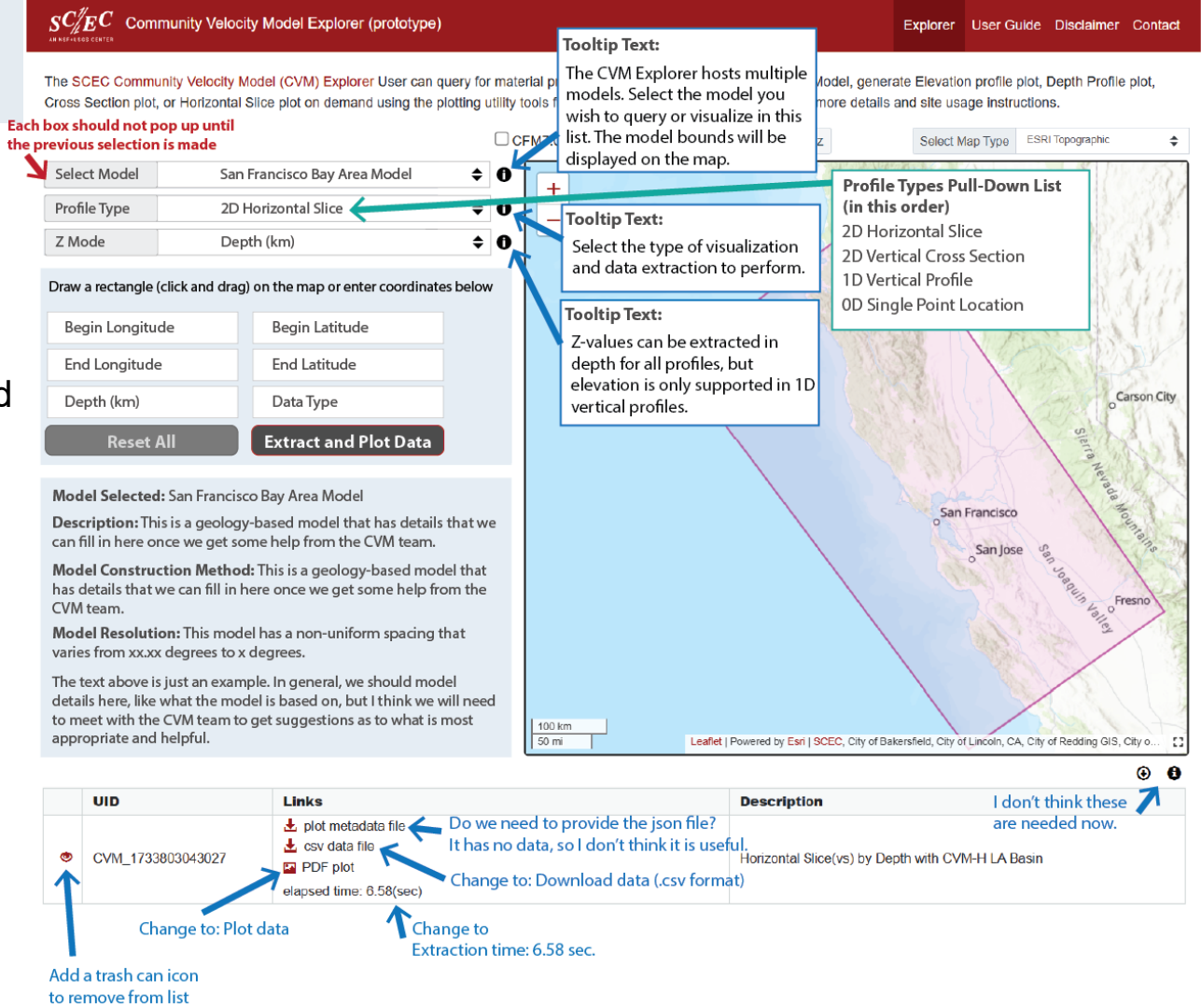
How Do We Build SCEC CEM Tools?

SCEC Scientists (us!):

- Organize and build data
- Write code to quality check and visualize data
- Create mockups of web tools
- Write documentation

SCEC IT/Web Team:

- Build web tool
- Build homepage with input from scientists
- Post Zenodo archive with SCEC products



The Community Fault Model (CFM)

What is the CFM?

The CFM is an object-oriented, **fully 3D** geometric representation of active faults in California, adjacent offshore basins, and beyond

Who develops the CFM?

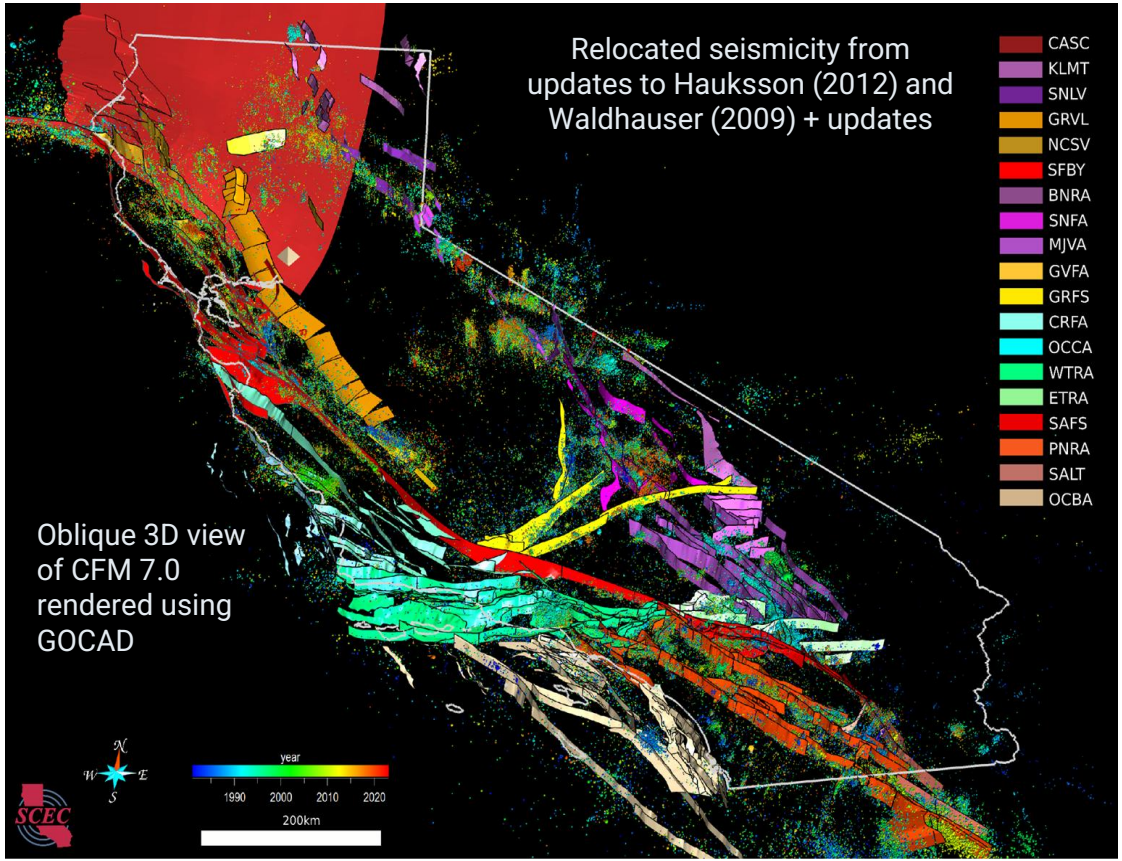
Andreas Plesch

John Shaw

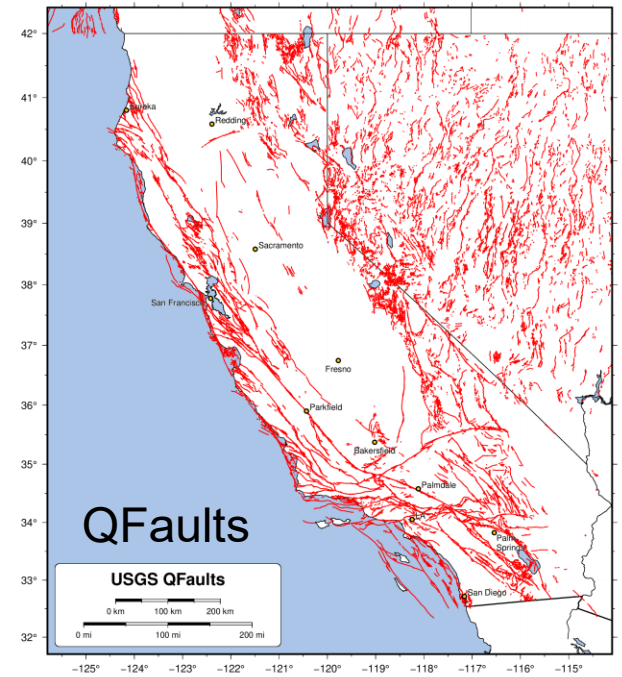
Harvard University

Scott Marshall

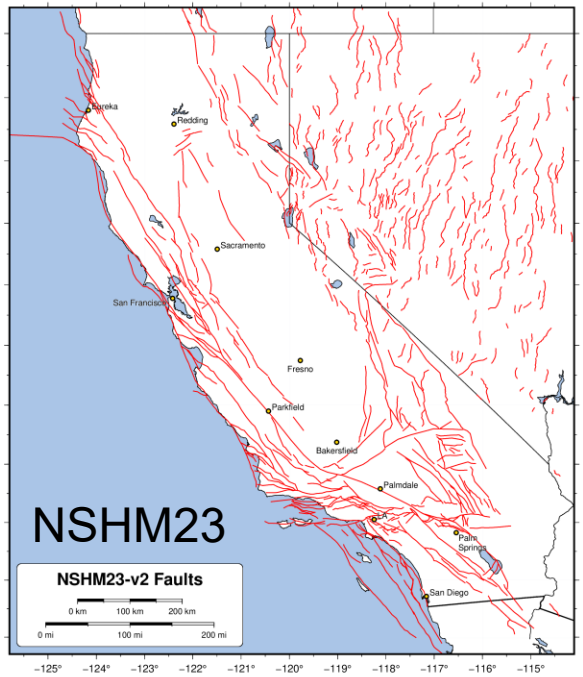
Appalachian State University



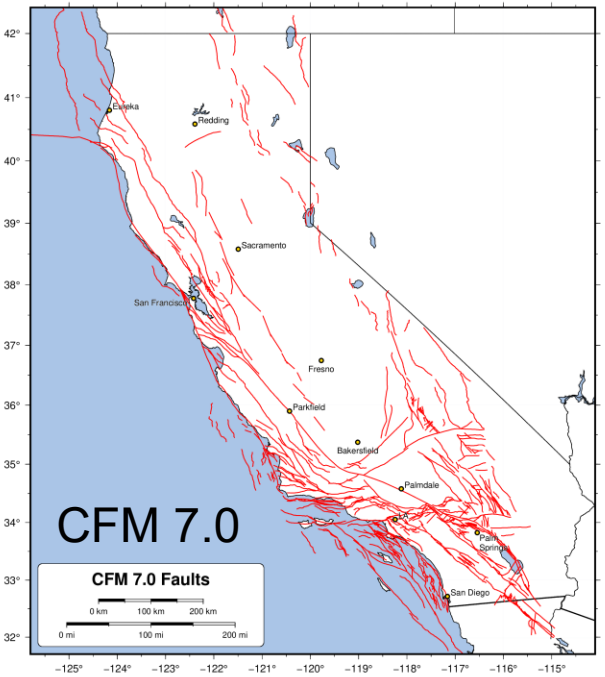
Fault Models Comparison



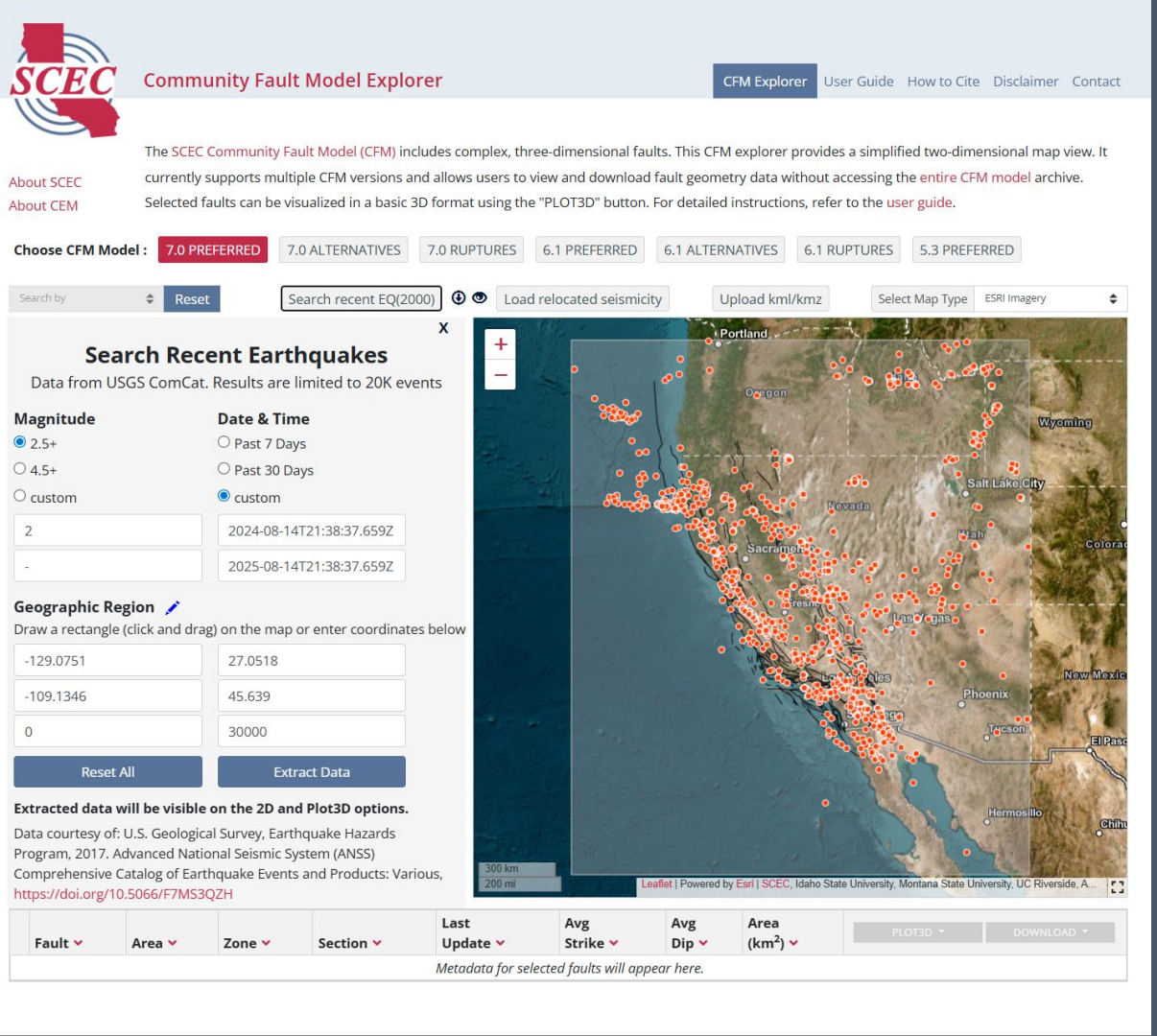
- 2D Model (traces)
- Geometrically complex
  - Defined mainly by mapping
- Identifies activity of faulting



- 2.5D Model
  - Builds on UCERF3/CFM
- Geometrically smooth
- Developed for hazard analyses



- Full 3D Model
- Geometrically complex
  - Defined by source data
- Serves a variety of SCEC initiatives



CFM Explorer

Web-based tools for the Community Fault Model

What does the Explorer do?

- Search/Query/Download
  - CFM 7.0, 6.1, and 5.3
- Several basemaps
- Search recent USGS EQs! NEW!
- Display relocated EQs
  - Red circles: >M6 since 1900
  - Hauksson et al. (2012+updates)
  - Waldhauser (2009+updates)
- Upload/Display kml files
- View faults in 3D!!
  - Includes relocated seismicity in 3D

Statewide California Earthquake Center (SCEC)

Published September 4, 2024 | Version 7.0

Dataset Open

SCEC Community Fault Model (CFM)

Plesch, Andreas[1] ; Marshall, Scott[2] ; Shaw, John[1]

Show affiliations

Introduction

The Statewide California Earthquake Center (SCEC) Community Fault Model (CFM) is an object-oriented, fully three-dimensional geometric representation of active faults in California and adjacent offshore basins. For each fault object, the CFM provides triangulated surface representations (t-surfs) in several resolutions, fault traces in several different file formats (shape files, GMT plain text, and GoogleEarth kml), and complete metadata including references used to constrain the surfaces. The CFM faults are defined based on available data including surface traces, seismicity, seismic reflection profiles, well data, geologic cross sections, and various other types of data and models. The CFM serves SCEC as a unified resource for physics-based fault systems modeling, strong ground-motion prediction, probabilistic seismic hazards assessment (e.g., the USGS National Seismic Hazard Model), and many other uses. Together with the Community Velocity Model (CVM-H 15.1.0), the CFM comprises SCEC's Unified Structural Representation of the Southern California crust and upper mantle (Shaw et al., 2015).

Current Model Version: CFM 7.0

The current version of the SCEC CFM is version 7.0 (CFM 7.0), which builds on the previous CFM releases and serves as the latest update to Plesch et al. (2007). CFM 7.0 is a significant update as this is the first CFM to cover the entire state of California, spanning the Pacific-North American plate boundary from northern Mexico to the southern Cascadia subduction zone. This latest version has no changes to the southern California portion of the model, but now includes 113 new fault representations in central and northern California in the preferred model. These new central and northern California fault representations will undergo a community evaluation in 2024-2025, therefore, the central and northern California faults should be considered preliminary representations.

CFM 7.0 contains three fully-documented sub models: preferred, ruptures, and alternatives. In total, CFM 7.0 comprises the following components:

1. **CFM 7.0 Preferred**: A set of 556 fault objects that constitute the preferred set of active faults. These faults have attained preferred status based on past community evaluations or are new representations.
2. **CFM 7.0 Ruptures**: A set of 13 fault objects assembled from the CFM 7.0 preferred model that ruptured during selected significant historic events. These are not earthquake source models, but are representations of the entire fault surfaces where a significant historic rupture occurred. This model is intended to indicate which CFM fault objects were involved with selected significant historic ruptures.
3. **CFM 7.0 Alternatives**: A set of 39 alternative representations where structural differences have been proposed that could

The CFM Archive

Available at Zenodo

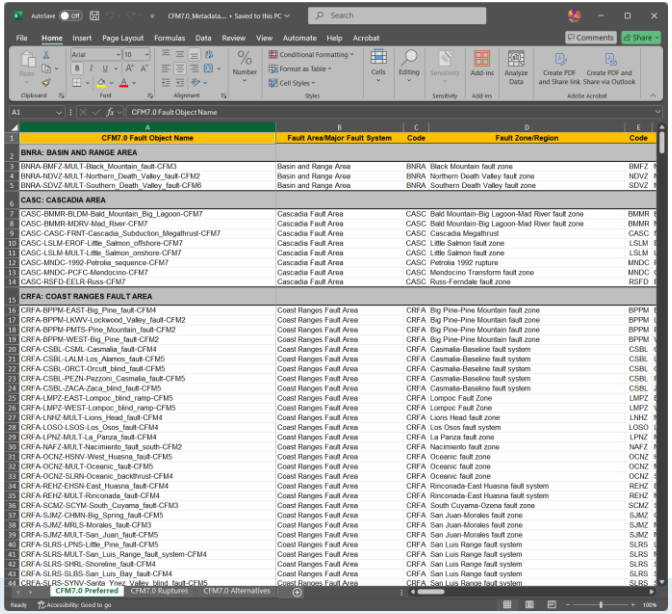
Complete CFM Archive

- .zip archives of CFM versions back to v5.3
- Contains data not available in the CFM Explorer
- What is in the archive?

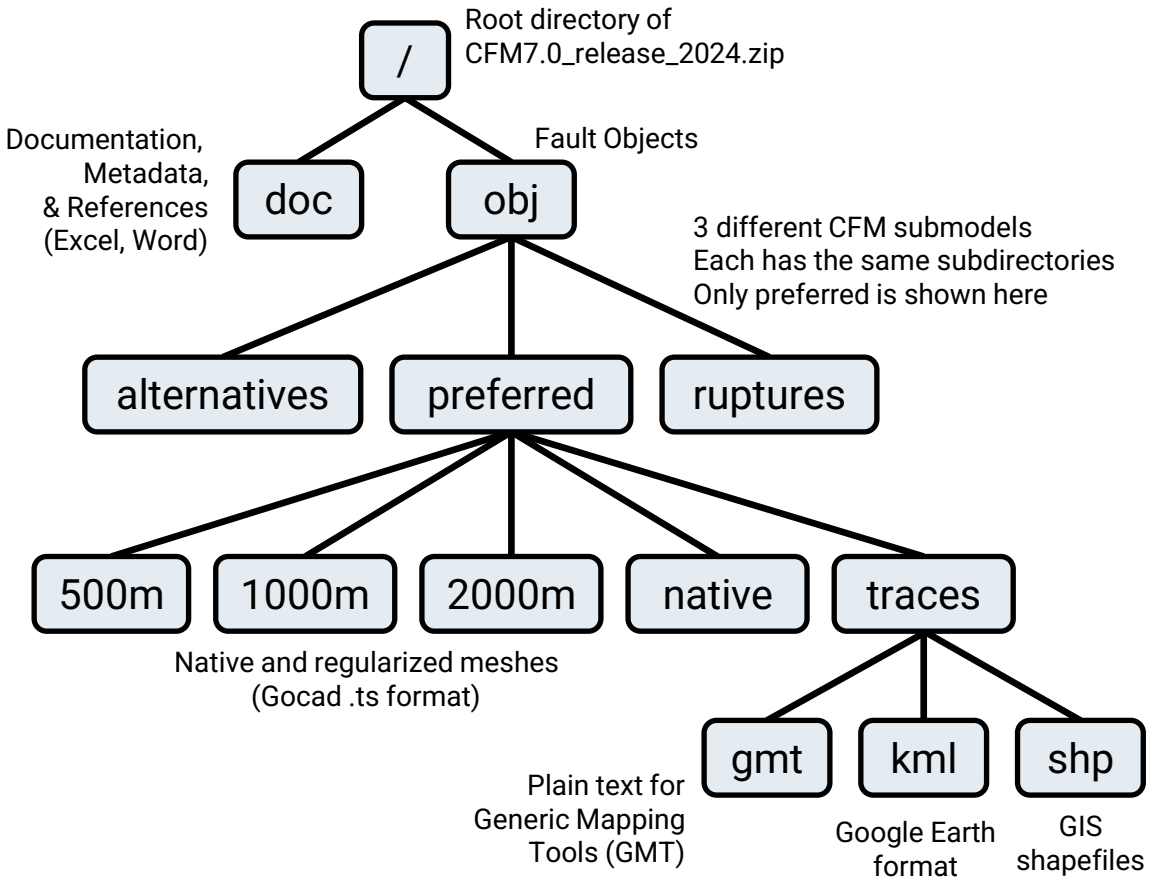
CFM Directory Structure

The Zenodo archive has data not available in the web tools

Screenshot of CFM Metadata spreadsheet



CFM7.0 Fault Object Name	Fault Area/Major Fault System	Code	Fault Zone/Region	Code
BNRA: BASIN AND RANGE AREA				
BNRA-BMFZ-MULT-Black_Mountain_fault-CFM3	Basin and Range Area	BNRA	Black Mountain fault zone	BMFZ
BNRA-NDVZ-MULT-Northern_Death_Valley_fault-CFM2	Basin and Range Area	BNRA	Northern Death Valley fault zone	NDVZ
BNRA-SDVZ-MULT-Southern_Death_Valley_fault-CFM6	Basin and Range Area	BNRA	Southern Death Valley fault zone	SDVZ
CASC: CASCADIA AREA				
CASC-BMMR-BLDM-Bald_Mountain_Big_Lagoon-CFM7	Cascadia Fault Area	CASC	Bald Mountain-Big Lagoon-Mad River fault zone	BMMR
CASC-BMMR-MDRV-Mad_River-CFM7	Cascadia Fault Area	CASC	Bald Mountain-Big Lagoon-Mad River fault zone	BMMR
CASC-CASC-FRNT-Cascadia_Subduction_Megathrust-CFM7	Cascadia Fault Area	CASC	Cascadia Megathrust	CASC
CASC-LSLM-EROF-Little_Salmon_offshore-CFM7	Cascadia Fault Area	CASC	Little Salmon fault zone	LSLM
CASC-LSLM-MULT-Little_Salmon_onshore-CFM7	Cascadia Fault Area	CASC	Little Salmon fault zone	LSLM
CASC-MNDC-1992-Petrolia_sequence-CFM7	Cascadia Fault Area	CASC	Petrolia 1992 rupture	MNDC
CASC-MNDC-PCFC-Mendocino-CFM7	Cascadia Fault Area	CASC	Mendocino Transform fault zone	MNDC
CASC-RSFD-EELR-Russ-CFM7	Cascadia Fault Area	CASC	Russ-Ferndale fault zone	RSFD
CRFA: COAST RANGES FAULT AREA				
CRFA-BPPM-EAST-Big_Pine_fault-CFM4	Coast Ranges Fault Area	CRFA	Big Pine-Pine Mountain fault zone	BPPM
CRFA-BPPM-LKWV-Lockwood_Valley_fault-CFM2	Coast Ranges Fault Area	CRFA	Big Pine-Pine Mountain fault zone	BPPM
CRFA-BPPM-PMTS-Pine_Mountain_fault-CFM2	Coast Ranges Fault Area	CRFA	Big Pine-Pine Mountain fault zone	BPPM
CRFA-BPPM-WEST-Big_Pine_fault-CFM2	Coast Ranges Fault Area	CRFA	Big Pine-Pine Mountain fault zone	BPPM
CRFA-CSBL-CSML-Casmalia_fault-CFM4	Coast Ranges Fault Area	CRFA	Casmalia-Baseline fault system	CSBL
CRFA-CSBL-LALM-Los_Alamos_fault-CFM5	Coast Ranges Fault Area	CRFA	Casmalia-Baseline fault system	CSBL
CRFA-CSBL-ORCT-Orcutt_blind_fault-CFM5	Coast Ranges Fault Area	CRFA	Casmalia-Baseline fault system	CSBL
CRFA-CSBL-PEZN-Pezzoni_Casmalia_fault-CFM5	Coast Ranges Fault Area	CRFA	Casmalia-Baseline fault system	CSBL
CRFA-CSBL-ZACA-Zaca_blind_fault-CFM5	Coast Ranges Fault Area	CRFA	Casmalia-Baseline fault system	CSBL
CRFA-LMPZ-EAST-Lompoc_blind_ramp-CFM5	Coast Ranges Fault Area	CRFA	Lompoc Fault Zone	LMPZ
CRFA-LMPZ-WEST-Lompoc_blind_ramp-CFM5	Coast Ranges Fault Area	CRFA	Lompoc Fault Zone	LMPZ
CRFA-LNMZ-MULT-Lions_Head_fault-CFM4	Coast Ranges Fault Area	CRFA	Lions Head fault zone	LNMZ
CRFA-LOSO-LSOS-Los_Osos_fault-CFM4	Coast Ranges Fault Area	CRFA	Los Osos fault system	LOSO
CRFA-LPNZ-MULT-La_Panza_fault-CFM4	Coast Ranges Fault Area	CRFA	La Panza fault zone	LPNZ
CRFA-NAFZ-MULT-Nacimiento_fault_south-CFM2	Coast Ranges Fault Area	CRFA	Nacimiento fault zone	NAFZ
CRFA-OCNZ-HSNV-West_Huasna_fault-CFM5	Coast Ranges Fault Area	CRFA	Oceanic fault zone	OCNZ
CRFA-OCNZ-MULT-Oceanic_fault-CFM5	Coast Ranges Fault Area	CRFA	Oceanic fault zone	OCNZ
CRFA-OCNZ-SLRI-Oceanic_backthrust-CFM4	Coast Ranges Fault Area	CRFA	Oceanic fault zone	OCNZ
CRFA-REHZ-EHSN-East_Huasna_fault-CFM4	Coast Ranges Fault Area	CRFA	Rinconada-East Huasna fault system	REHZ
CRFA-REHZ-MULT-Rinconada_fault-CFM4	Coast Ranges Fault Area	CRFA	Rinconada-East Huasna fault system	REHZ
CRFA-SCMZ-SCYM-South_Cuyama_fault-CFM3	Coast Ranges Fault Area	CRFA	South Cuyama-Ozena fault zone	SCMZ
CRFA-SJMZ-CHMN-Big_Spring_fault-CFM5	Coast Ranges Fault Area	CRFA	San Juan-Morales fault zone	SJMZ
CRFA-SJMZ-MRLS-Morales_fault-CFM3	Coast Ranges Fault Area	CRFA	San Juan-Morales fault zone	SJMZ
CRFA-SJMZ-MULT-San_Juan_fault-CFM5	Coast Ranges Fault Area	CRFA	San Juan-Morales fault zone	SJMZ
CRFA-SLRS-LPNS-Little_Pine_fault-CFM5	Coast Ranges Fault Area	CRFA	San Luis Range fault system	SLRS
CRFA-SLRS-MULT-San_Luis_Range_fault_system-CFM4	Coast Ranges Fault Area	CRFA	San Luis Range fault system	SLRS
CRFA-SLRS-SHRL-Shoreline_fault-CFM4	Coast Ranges Fault Area	CRFA	San Luis Range fault system	SLRS
CRFA-SLRS-SLBS-San_Luis_Bay_fault-CFM4	Coast Ranges Fault Area	CRFA	San Luis Range fault system	SLRS
CRFA-SLRS-SYNV-Santa_Ynez_Valley_blind_fault-CFM5	Coast Ranges Fault Area	CRFA	San Luis Range fault system	SLRS



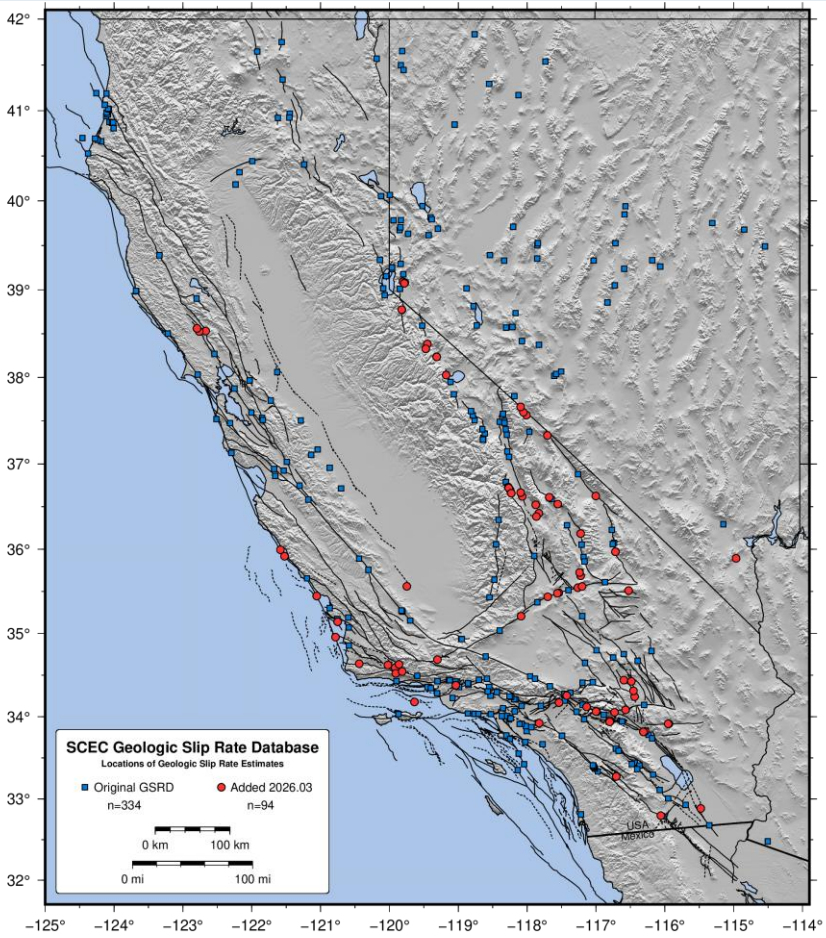
The SCEC Geologic Slip Rate Database (GSRD)

SCEC Geologic Slip Rate Database
https://www.scec.org/research/gsrd
New GSRD Explorer (not publicly released yet)
https://moho.scec.org/gsrd-explorer/

Geologic field-based estimates of fault slip rates
A subset of the NSHM23 and UCERF3
Direct hyperlinked references (where available)

Updated in 2025
94 new slip rates; 5 updated rates

GSRD Developers:
Sally McGill, Scott Marshall, Alex Hatem, and Sinan Akçiz



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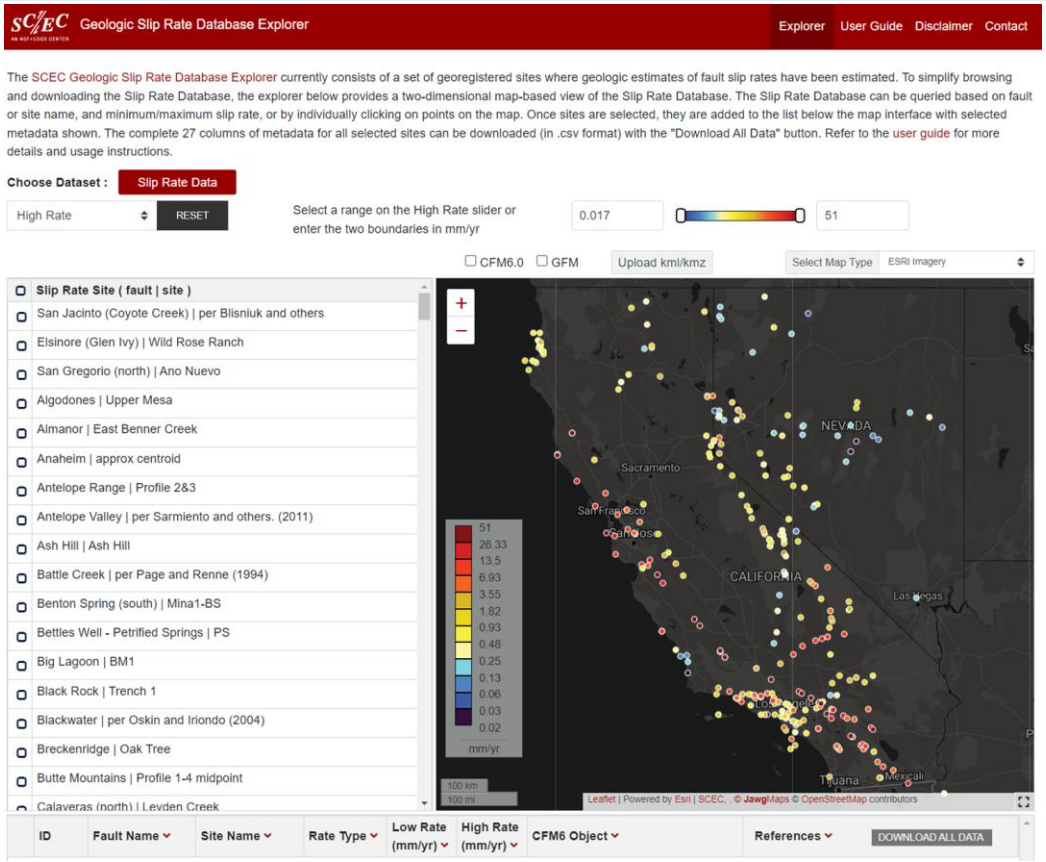


The Geologic Slip Rate Database Explorer showing slip rate sites colored by max slip rate (McGill, Marshall, Hatem, and Akçiz)

GSRD Metadata Format and Content

SCEC Geologic Slip Rate Database

https://www.scec.org/research/gsrd

New GSRD Explorer (not publicly released yet)

https://moho.scec.org/gsrd-explorer/

The GSRD is built from a metadata spreadsheet

Metadata is just as important as data!

28 Columns

Spreadsheet can be easily maintained/modified by SCEC scientists (or students)

Must be well-planned and consistent

Should be checked by scripts

A9 | Antelope Valley / West Walker River

	A	B	C	D	E	F	G	H
1	Fault Name	NSHM23 Fault ID	Last Update	SCEC ID	NSHM23 Rate ID	State	Site Name	Longitu
2	Algodones	2000	2023.09	S-0258	SR-0571	AZ	Upper Mesa	-114.50498
3	Almanor	2	2023.09	S-0001	SR-0002	CA	East Benner Creek	-121.23849
4	Anaheim	5	2023.09	S-0002	SR-1221	CA	approx centroid	-118.00649
5	Antelope Range	1140	2023.09	S-0269	SR-0768	NV	Profiles 2 and 3	-116.18390
6	Antelope Valley	1000	2023.09	S-0003	SR-0429	CA	per Sarmiento and others. (2011)	-119.52395
7	Antelope Valley / West Walker River	1000	2026.03	S-0423	N/A	CA	Sonora Junction	-119.44900
8	Antelope Valley / West Walker River	1000	2026.03	S-0424	N/A	CA	Sonora Junction	-119.47260
9	Antelope Valley / West Walker River	1000	2026.03	S-0425	N/A	CA	Sonora Junction	-119.47250
10	Ash Hill	6	2023.09	S-0004	SR-0003	CA	Ash Hill	-117.41990
11	Baseline	N/A	2026.03	S-0375	N/A	CA	Santa Cruz Creek (Qt2)	-119.91600
12	Baseline	N/A	2026.03	S-0376	N/A	CA	Santa Cruz Creek (Qt3)	-119.91700
13	Baseline	N/A	2026.03	S-0377	N/A	CA	Santa Agueda Creek (Qt2)	-120.02200
14	Battle Creek	9	2023.09	S-0005	SR-0006	CA	per Page and Renne (1994)	-121.99128
15	Benton Spring (south)	1006	2023.09	S-0223	SR-0438	NV	Mina1-BS	-118.07476
16	Bettles Well - Petrified Springs	1008	2023.09	S-0224	SR-0440	NV	PS	-118.16786
17	Big Lagoon	13	2023.09	S-0006	SR-0010	CA	BM1	-124.10981
18	Big Pine (east)	15	2026.03	S-0379	N/A	CA	Cuyama Valley	-119.30332
19	Black Hills	1009	2026.03	S-0391	N/A	NV	Black Hills (Fosset)	-114.96570
20	Black Rock	1010	2023.09	S-0225	SR-0443	NV	Trench 1	-119.05208
21	Blackwater	17	2023.09	S-0007	SR-0014	CA	per Oskin and Iriondo (2004)	-117.19988
22	Blue Cut	18	2026.03	S-0352	N/A	CA	Hexie Mountains	-115.94020
23	Blue Cut	18	2026.03	S-0353	N/A	CA	Hexie Mountains	-115.95220
24	Brawley	19	2026.03	S-0348	N/A	CA	Harris Road	-115.47800
25	Breckenridge	21	2023.09	S-0008	SR-0017	CA	Oak Tree	-118.54604
26	Butte Mountains	1017	2023.09	S-0226	SR-0450	NV	Profile 1-4 midpoint	-115.31025
27	Calaveras (north)	923	2023.09	S-0009	SR-0425	CA	Welch Creek	-121.84970
28	Calaveras (north)	923	2023.09	S-0010	SR-0426	CA	Welch Creek	-121.84970
29	Calaveras (north)	923	2023.09	S-0011	SR-0427	CA	Leyden Creek	-121.83784
30	Calaveras (south)	921	2023.09	S-0013	SR-0424	CA	San Ysidro Channel 1	-121.48852

GSRD_v2026.03

The GSRD Metadata Spreadsheet. This is what we build the database from

GSRD Data Automation and Quality Checking

Scripts Check:

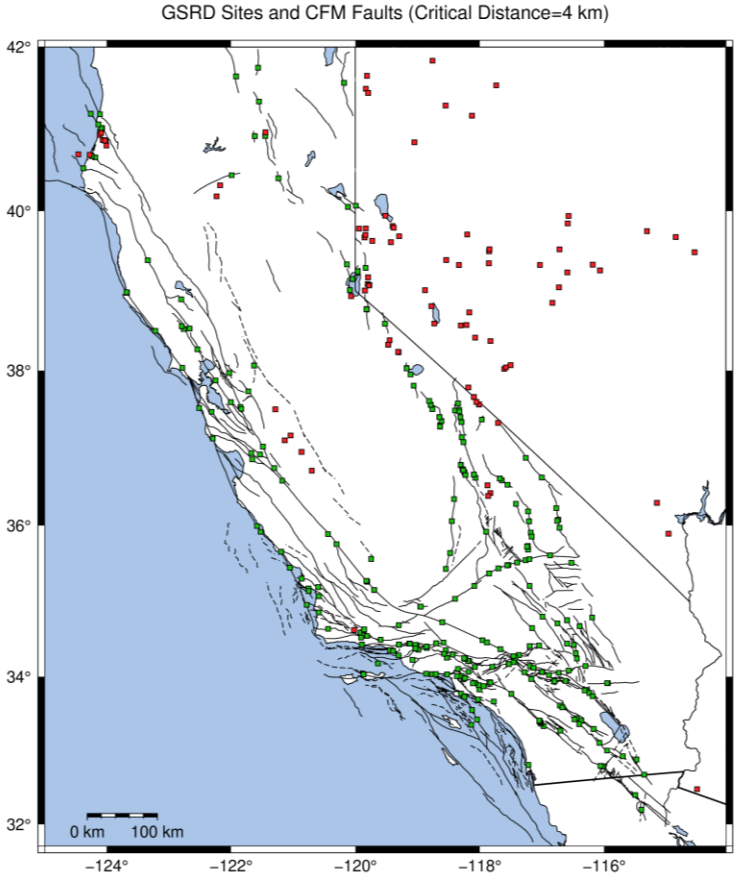
Do all faults have references?

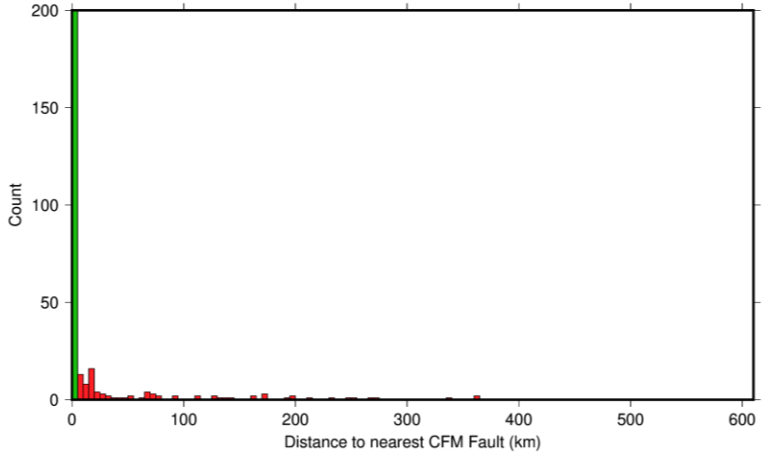
Correct num references?

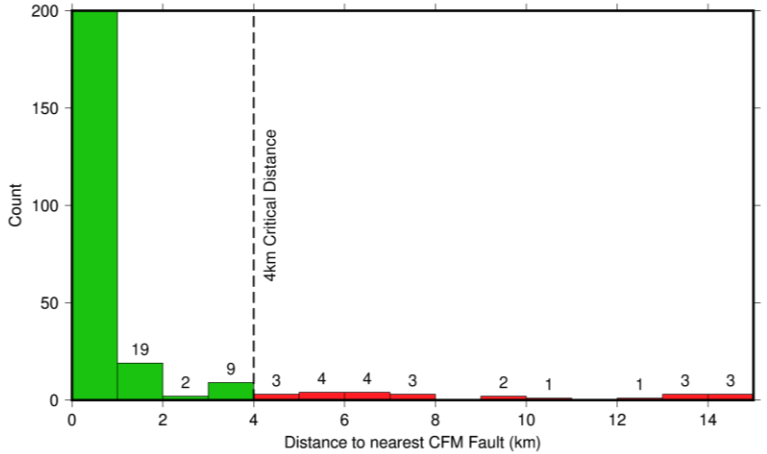
No non-ASCII chars

Calculates nearest CFM fault to associate sites with the CFM

Generates kml version of GSRD







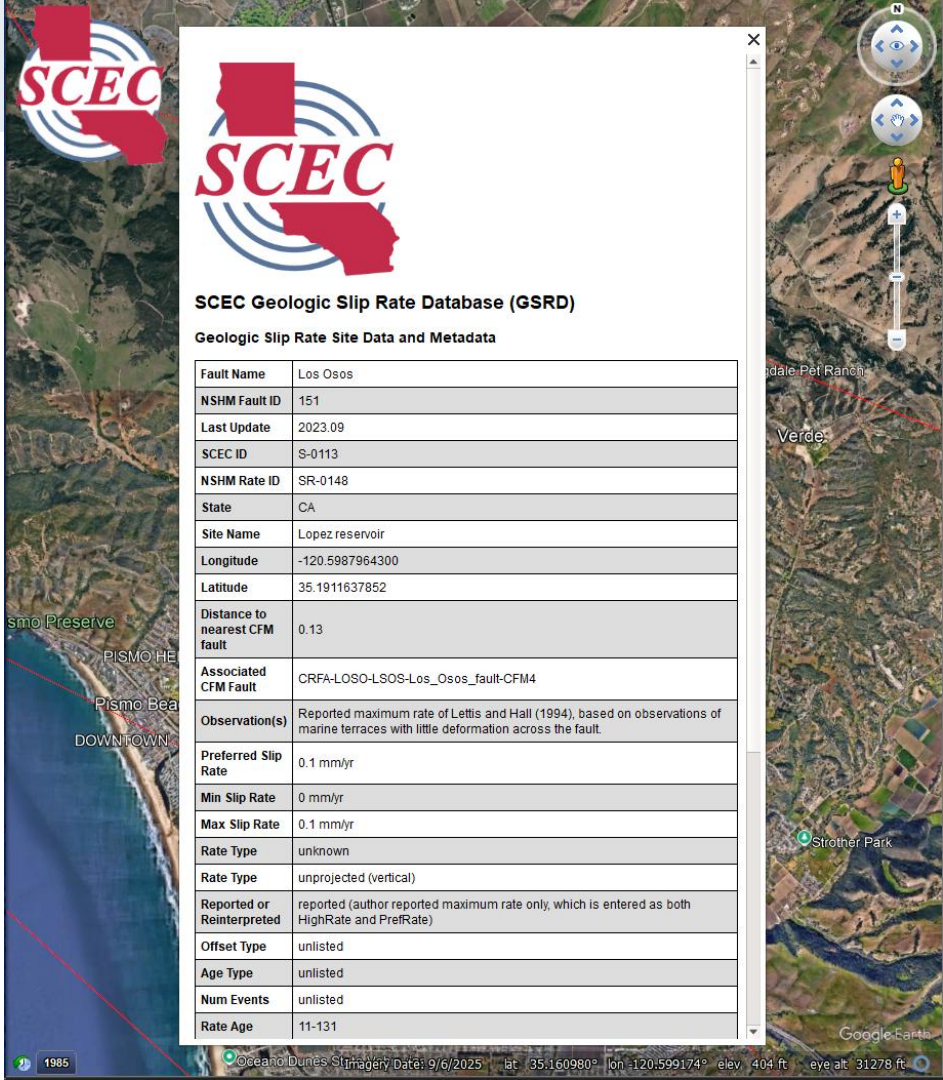
GSRD KML Version

Once we have organized data…

We can produce other data products

E.g., kml versions (Google Earth, QGIS)

Can embed metadata into kml files



SCEC Cyberinfrastructure Take-Aways

SCEC Provides IT Support

Model data should be created, maintained, and quality checked by SCEC investigators

IT professionals should focus on web development, not data cleaning

All SCEC CEMs Have

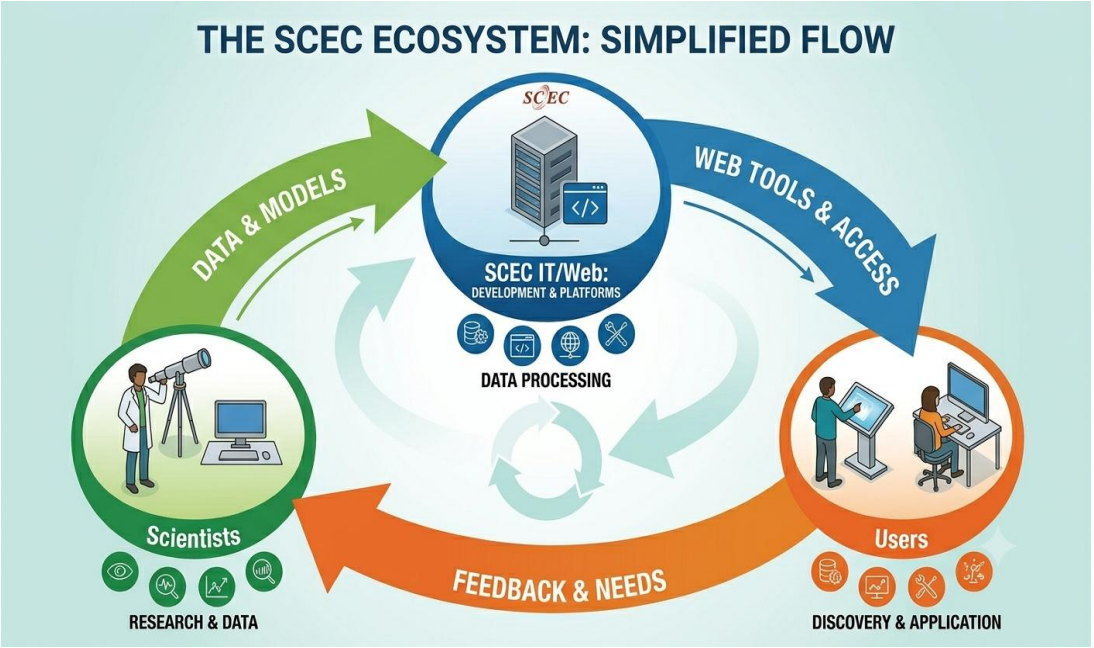
A model homepage

A Zenodo archive (with other SCEC products)

A web-based interactive Explorer

IT Development Time is Limited

Developing resources requires time and careful planning/scheduling



Yes, this is AI-generated, but you get the idea.
We all need to work together.