2024 SCEC Report

Creation of the Community Paleoseismic Database (CPD) and its IT infrastructure to support SCEC science

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1. Summary

Active faults pose a natural hazard to communities and infrastructure throughout California. Understanding the slip rates and recurrence intervals of active faults is critical for defining associated hazards and risks. While the U.S. Geological Survey (nationally and regionally) and California Geological Survey (statewide) often take the lead on these efforts, SCEC community also contributes significantly by providing the results of scientific investigations and critical evaluation of the findings by experts. Given that SCEC already hosts several community models, a Community Paleoseismic Database (CPD) is a logical expansion of these resources. Since our proposal, community decided to group these earthquake geology data under the name of "SCEC Earthquake Geology Information Warehouse" (see https://www.scec.org/research/earthquake-geology) and include not only geologic slip rate and paleoseismic data, but also data compiled in the precariously balanced rocks data archive. Here we report the status of our efforts as of March, 2024.

2. Geologic Slip Rate Database

In September 06, 2023, the SCEC Geologic Slip Rate Database webpage went online (see https://www.scec.org/research/gsrd).

The SCEC Geologic Slip Rate Database (Figure 1) comprises a collection of geologic slip rate estimates for faults in California, Nevada, and a small portion of northernmost Mexico. Field-derived geologic slip rates are a critical component of seismic hazard estimates (e.g., UCERF3 (Field et al. 2013) USGS NSHM (Hatem et al. 2022a, 2022b), Wesnousky, 1986), and are used in a wide range of SCEC-related efforts. Geologic slip rate estimates for active faults in California and Nevada exist in various publications including (but not limited to) peer-reviewed journals, technical reports, field guidebooks, theses, but are not always easy or even possible to access. The purpose of the SCEC Geologic Slip Rate Database is to simplify the process of identifying existing geologic slip rate estimates for a given region or fault(s) and to provide direct web links to the relevant publications (where available) so that users can find, read, and gain an understanding the relevant work. Importantly, the SCEC Geologic Slip Rate Database is meant to be a living archive with an approximately annual update cycle, so as new results are published, we have created a user submission form for the community to provide feedback and/or let us know about new and/or missing information.

The current version of the SCEC Geologic Slip Rate Database is version 2023.09. As this is the first released version, the database currently contains only sites and slip rate information from the USGS NSHM23_EQGeoDB_v2 database (Hatem et al., 2022a, 2022b) that meet our criteria. This database contains data from studies published up to December 2020. From these sites, we only include sites that meet the following criteria:

- Study sites are within the spatial region encompassing -125.00 < Longitude < -114.04 and 31.70 < Latitude < 42.00. This covers all of California and Nevada and a small portion of Arizona and northern Mexico.
- Slip rate estimates are based on geologic field measurements (i.e., not geodetic) and are not categorical slip rate estimates used in seismic hazard estimates.

- Future additions must be published in a peer-reviewed scholarly journal and publicly available (i.e., have a DOI). We recognize that this may prevent certain types of studies from being included, but the Geologic Slip Rate Database focuses on peer-reviewed and published data.

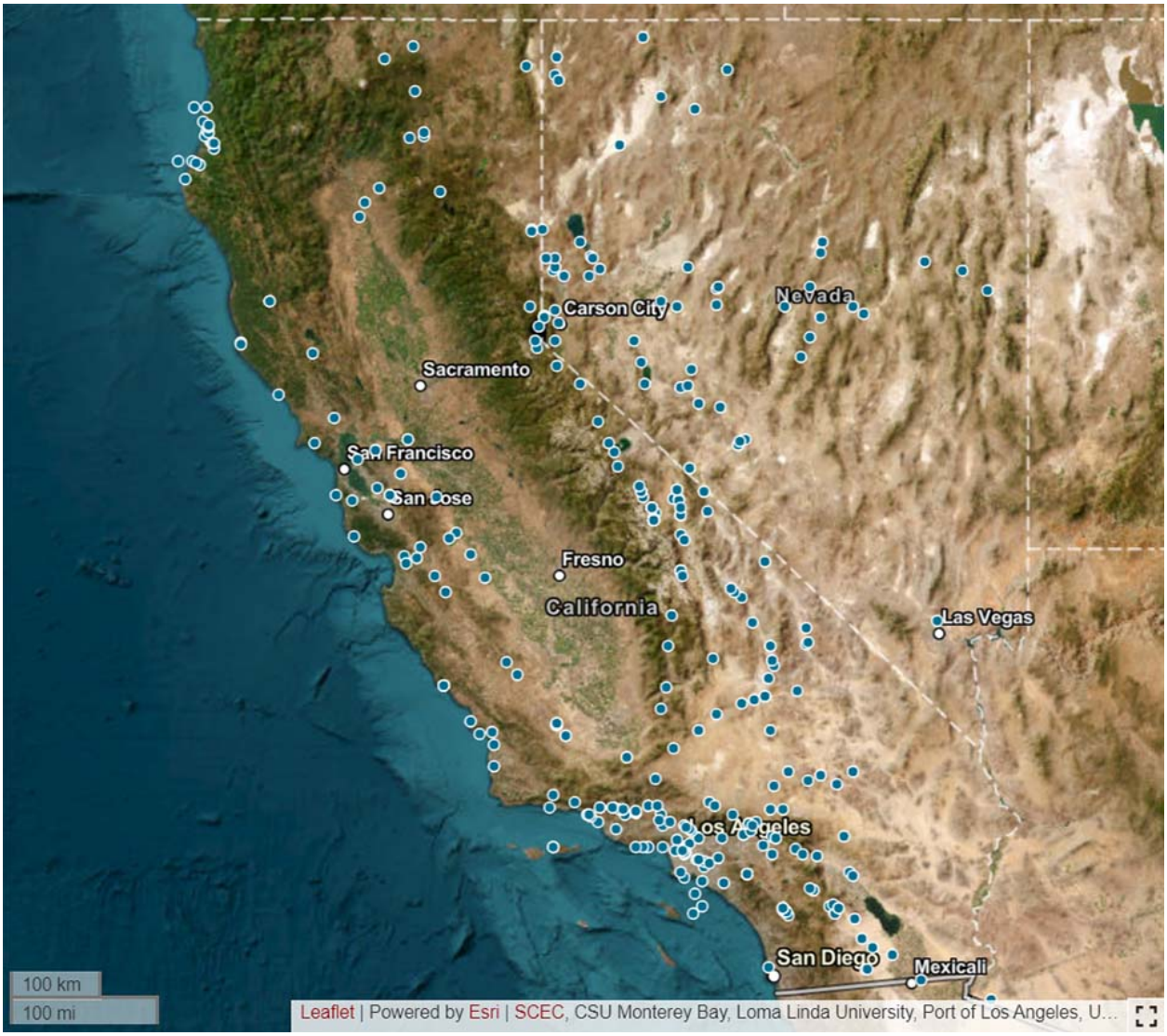

Figure 1. View of the SCEC Geologic Slip Rate Database Explorer interface which provides quick and easy access to geologic fault slip rate data for California, Nevada, and a small portion of Arizona and northern Mexico.

The Geologic Slip Rate Database contains a detailed and extensive set of metadata associated with each site including, but not limited to, longitude/latitude, slip rate and uncertainty (where available), references, and other useful information about each study site. Integrated hyperlinked references with the metadata and web tools allow users to quickly find the existing slip rates on a given fault or region and provides direct access to the primary references where/when available. The SCEC Geologic Slip Rate Database is not intended to replace careful reading and understanding of primary literature, but is designed to simplify the discovery process when searching for existing slip rate estimates. The database

information is provided without any evaluation of the quality or accuracy of individual published slip rate estimates and is simply a collection of what geologic slip rate estimates have been made. We hope that the SCEC Geologic Slip Rate Database will greatly simplify the process of discovering and cataloging existing slip rate estimates and will provide more equitable access to this critical information.

Geologic Slip Rate Database Explorer

To facilitate broad usage, we have created the SCEC Geologic Slip Rate Database Explorer, a web-based tool that allows users to easily view, query, and download the database (Figure 2). This web-tool allows users to visualize geologic slip rate sites in a 2D map-based view. Users can also search the database by several useful metrics (fault name, site name, longitude and latitude, min/max slip rate, etc.). The explorer also provides overlays of the SCEC Community Fault Model, the Geologic Framework Model (from the Community Rheology Model), and the ability for users to upload their own spatially registered data (e.g., image overlays, paths, lines, points, etc.) in .kml/.kmz format. The map interface can be resized (small, medium, and full screen) using the square in the bottom right corner of the map interface to allow for detailed comparisons.

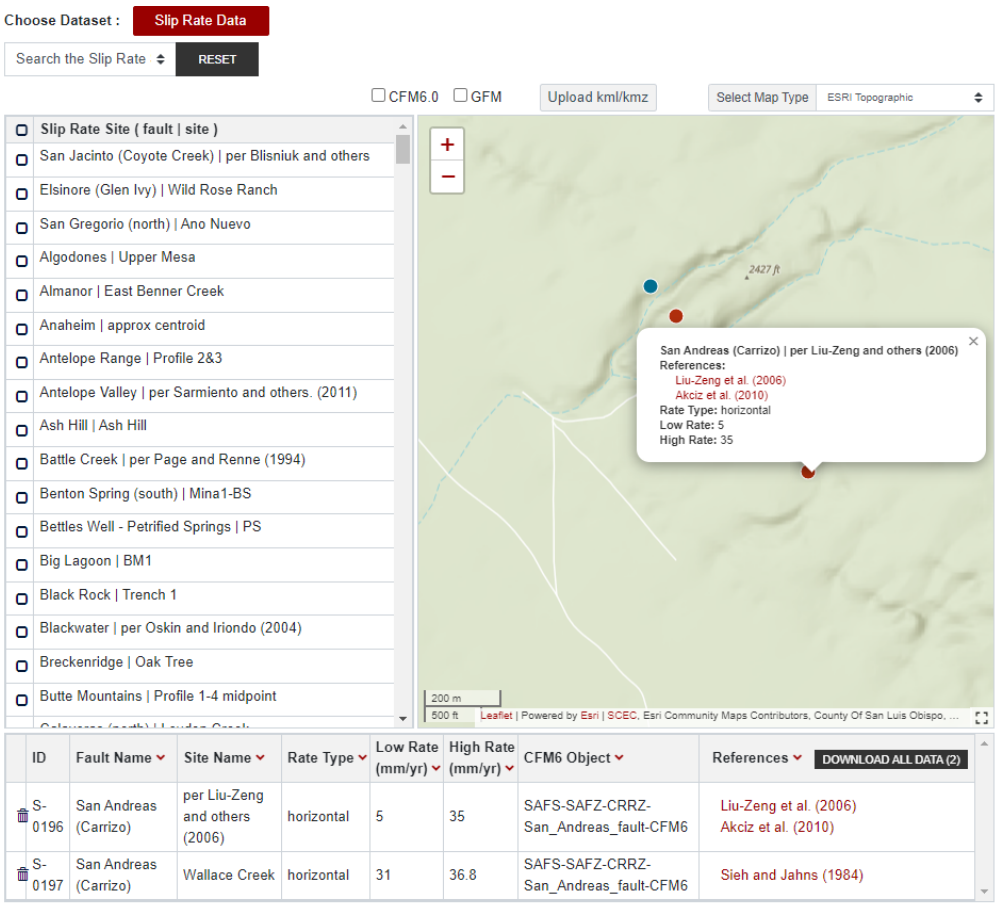

Figure 2. The SCEC Geologic Slip Rate Database Explorer currently consists of a set of georegistered sites where geologic estimates of fault slip rates have been estimated. To simplify browsing and downloading the Slip Rate Database, the explorer below provides a two-dimensional map-based view of the Slip Rate Database. The Slip Rate Database can be queried based on fault or site name, and minimum/maximum slip rate, or by individually clicking on points on the map. Once sites are selected, they are added to the list below the map interface with selected metadata shown. The complete 27 columns of metadata for all selected sites can be downloaded (in .csv format) with the "Download All Data" button.

User Submission and Feedback Form

Creating and maintaining a database like the SCEC Geologic Slip Rate Database involves consistent data management, detailed literature review, and assistance from the community. Thus, it is reasonable to expect that we may not have identified all existing geologic slip rate estimates, or that some information may be inaccurate. If you know of a site that is not in the current database, please use the Geologic Slip Rate Database User Submission and Feedback Form to provide the necessary information so missing sites may be included in the next release. We plan on an approximately annual update cycle, but this depends on funding, personnel, and other considerations. Currently, all slip rate sites sites included in the USGS NSHM23_EQGeoDB_v2 database (which contains studies up to December 2020) and the UCERF3 appendix B that meet our previously stated criteria have been grandfathered in, but future additions must be published in a peer-reviewed scholarly journal and publicly available (i.e., have a DOI). We recognize that this may prevent certain types of studies from being included, but the Slip Rate Database focuses on peer-reviewed and published data. Suggesting slip rate additions to the SCEC Geologic Slip Rate Database does not guarantee inclusion to future database versions, USGS NSHM updates, or other products.

3. Chronology Database

Chronological data collected from paleoseismic trenching work, similar to fault slip data, exist in various publications including peer-reviewed journals, technical reports, field guidebooks, MS and PhD theses, but are not always easy to access. This has put the burden on researchers, often not paleoseismology experts, who periodically compile published and online information from these many different literature sources.

SiteName LocationID Latitude Longitude AltID AltIDsource FaultArea FaultZone FaultName FaultSecName	AvgStrike AvgDip SlipSense Reference DOI: LastUpdate InvestigationType DataType NumEvents AgeType Lab	NumDatedSamples 14Cuncalibrated: **link** NumModelSamples: CalibSftwrOrig: CalibCurveOrig Event1name: AgeMin1 AgeMax1 --- as many events as listed	CalibSftwrNew CalibCurveNew OxCalModelScript: **link** Event1name: NewAgeMin1 NewAgeMax1 --- as many numbers of events as listed	SlipLowRate SlipHighRate SlipRateUnct RateType OffType RateAge

Figure 3. Structure of the geochronology data from paleoseismic investigations.

We are organizing the published data into a database in a structure shown on Figure 3. This data structure is similar to the one utilized for the geologic slip database, but in addition, will include not only the published data, but also the results of modeled calibrated ages using OXCAL and the source code for easy replication in the future. This effort is still ongoing.

4. Application to SCEC5 Goals

This work represents a primary effort to address the following SCEC priority:

> P5.c. Assess the limitations of long-term earthquake rupture forecasts by combining pattern of earthquake occurrence and strain accumulation with neotectonic and paleoseismic observation of the last millennium.

Moreover, through the development and delivery of the CPD this project contributes to the CXM efforts and a range of other SCEC goals that incorporate paleoseismic data.

5. Related Publications and Presentations

Marshall, S. T., Akciz, S. O., Hatem, A., Su, M-H., Maechling, P. J., Huynh, T. T., & Pauk, E. (2022, 09). The SCEC Community Paleoseismic Database (CPD). Poster Presentation at 2022 SCEC Annual Meeting, SCEC Contribution 12172

Marshall, S. T., Hatem, A., Akciz, S. O., Su, M-H., Maechling, P. J., Huynh, T. T., & Pauk, E. (2023, 09). The SCEC Earthquake Geology Database (EGD). Poster Presentation at 2023 SCEC Annual Meeting, SCEC Contribution 13125

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Field, E.H., Biasi, G.P., Bird, P., Dawson, T.E., Felzer, K.R., Jackson, D.D., Johnson, K.M., Jordan, T.H., Madden, C., Michael, A.J., Milner, K.R., Page, M.T., Parsons, T., Powers, P.M., Shaw, B.E., Thatcher, W.R., Weldon, R.J., II, and Zeng, Y., 2013, Uniform California earthquake rupture forecast, version 3 (UCERF3)—The time-independent model: U.S. Geological Survey Open-File Report 2013–1165, 97 p., California Geological Survey Special Report 228, and Southern California Earthquake Center Publication 1792, http://pubs.usgs.gov/of/2013/1165, SCEC Contribution 1792.

Hatem, A.E., Collett, C.M., Briggs, R.W., Gold, R.D., Angster, S.J., Powers, P.M., Field, E.H., Anderson, M., Ben-Horin, J.Y., Dawson, T., DeLong, S., DuRoss, C., Thompson Jobe, J., Kleber, E., Knudsen, K.L., Koehler, R., Koning, D., Lifton, Z., Madin, I., Mauch, J., Morgan, M., Pearthree, P., Pollitz, F., Scharer, K., Sherrod, B., Stickney, M., Wittke, S., and Zachariasen, J., 2022, Earthquake geology inputs for the U.S. National Seismic Hazard Model (NSHM) 2023 (western US) (ver. 2.0, February 2022): U.S. Geological Survey data release, https://doi.org/10.5066/P9AU713N.

Hatem, A.E., Collett, C.M., Briggs, R.W., Gold, R.D., Angster, S.J., Field, E.H., Powers, P.M., & Earthquake Geology Working Group, 2022b. Simplifying complex fault data for systems-level analysis: Earthquake geology inputs for U.S. NSHM 2023. Sci Data 9, 506 (2022). https://doi.org/10.1038/s41597-022-01609-7

Wesnousky, S. G. (1986). Earthquakes, Quaternary faults, and seismic hazard in California. Journal of Geophysical Research: Solid Earth, 91(B12), 12587-12631. https://doi.org/10.1029/JB091iB12p12587