Updates to the SCEC Geologic Slip Rate Database (GSRD)

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Visit the Geologic Slip Rate Database Homepage!

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1: Updates to the SCEC Geologic Slip Rate Database

The SCEC Geologic Slip Rate Database comprises a collection of published, peer-reviewed geologic slip rate estimates for faults in California, Nevada, and a small portion of northernmost Mexico. The first version of the SCEC Geologic Slip Rate Database (GSRD) was released in summer 2023 and consisted of spatially registered geologic fault slip rate estimates from previously published databases, with most entries dated prior to 2021. Here, we report on work in progress to update the GSRD, incuding searches for new slip-rate studies since 2020 on faults in California and Nevada that have been active in the Quaternary. To date literature searches have been completed for over 134 of the 620 fault sections in the USGS Quaternary fault-sections database. So far, 21 new slip-rate estimates on 13 fault sections have been discovered, and we expect to discover many more. Once the literature review and vetting of new additions to the database is complete, we plan to release version 2 of the GSRD complete with a citable doi through Zenodo.org.

Field-derived geologic slip rates are a critical component of seismic hazard estimates (e.g., UCERF3 (Field et al. 2013; Dawson and Weldon, 2013), USGS National Seismic Hazard Model (Petersen et al., 2023; Hatem et al. 2022a, 2022b), Wesnousky, 1986), and are used in a wide range of SCEC-related efforts. Geologic slip rate estimates exist in various publications 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 of the relevant work.

The GSRD is hosted with the SCEC Community Earth Models, and an algorithm cross-references GSRD slip rate sites to the appropriate SCEC Community Fault Model object. The GSRD interface provides web-based tools for users to quickly query, download, and visualize the existing slip rate data. The web tools also allow users direct web links to the GSRD references and the ability to upload their own spatial data (in .kml/.kmz format) to compare directly in the viewer with the GSRD. To keep the GSRD up to date when new data are published, the GSRD homepage provides a user-submission tool for users to notify the GSRD maintainers of new/missing slip rate data.

Screenshot of the SCEC Geologic Slip Rate Database homepage

The Geologic Slip Rate Database Homepage

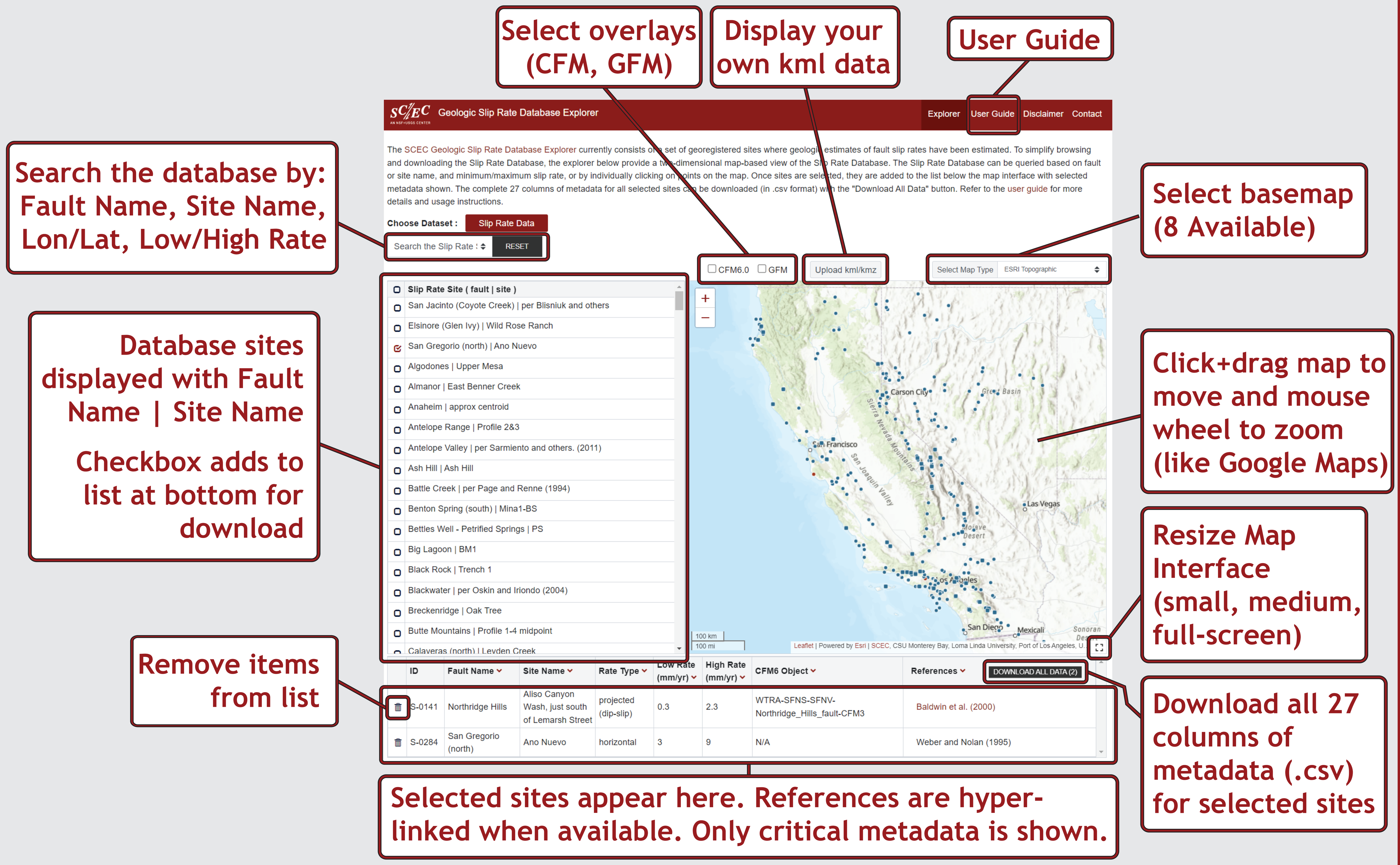
https://www.scec.org/research/gsrd

The Geologic Slip Rate Database Explorer

https://central.scec.org/research/gsrd-explorer/

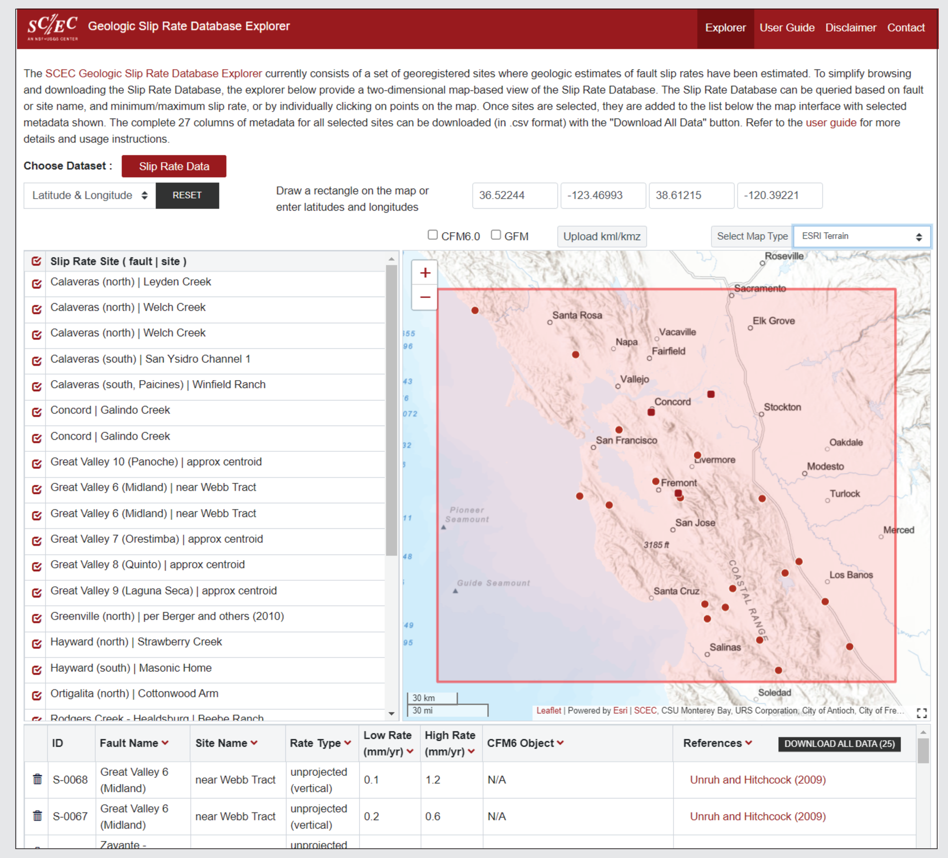
3A: The Geologic Slip Rate Database Explorer

To facilitate broad usage, the SCEC Geologic Slip Rate Database Explorer was created with the first relase. This is a web-based tool that allows users to easily view, query, and download the Geologic Slip Rate Database. This web-tool allows users to visualize geologic slip rate sites in a 2D map-based view. Users can search the database by several useful metrics (fault name, site name, longitude/latitude, min/max slip rate, etc.).

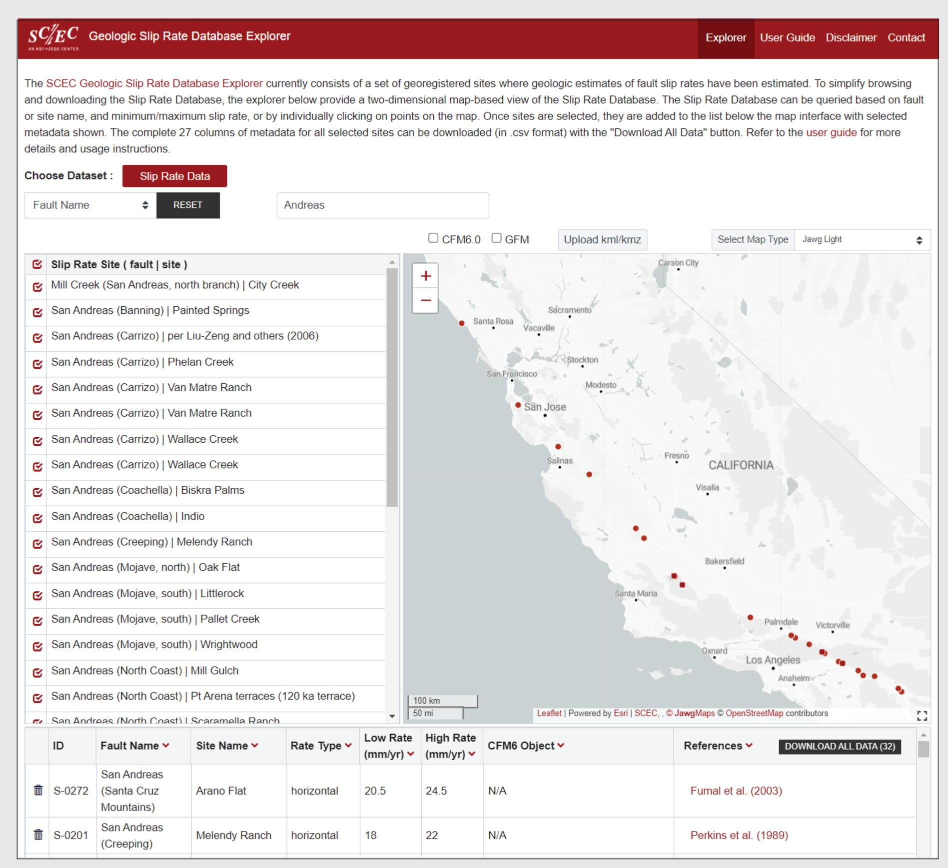


Do you have a geologic slip-rate study published after 2020? Email the reference to smcgill@csusb.edu, or use the submisson tool at https://www.scec.org/research/gsrd

3B:



Search using Longitude/Latitude range. Region can be typed in, or drawn via click and drag. Basemap shown is “ESRI Terrain”.



Search by fault name or site name. Here we show a search for fault name “Andreas” with the “JAWG Light” basemap.

2: Preliminary List of new Additions to the GSRD

(incomplete and not fully vetted yet; not all columns are shown)

Fault Name	State	Site Name	Observation	Preferred Rate	Low Rate	High Rate	Rate Type	Offset Type	Age Type	Num Events	Rate Age (ka)	Short Reference
Canada David detachment	Baja, MX	north of Karlsson et al. (2021) paleoseismic trenches	site 10 km north of Karlsson et al.'s (2021) paleseismic trenches. Karlsson et al. (2021) use optically stimulated luminescence ages from sediments in the trenches that were collected from below a buried soil they interpret to be correlative with Q5, to estimate a minimum dip-slip rate of ~1.4 mm/yr. The rate is a mimimum because additional faulting is distributed across a 2.4-km-wide zone (Serna-Hernandez, 2020).		1.4		dip-slip	alluvial surface	luminescence and soil chronosequence	3	~8	Karlsson et al. (2021)
Laguna Salada	Baja, MX	Q4 (SE end of Segment A in Figure 2)	11-20 m vertical separation of Q4 deposits with an age of 5 +/- 3 ka (based on soil development) yields a average vertical displacement rate of 3 mm/yr. Range is 1.4 to 10 mm/yr, but the upper end of the range is unlikely given the ages of other surfaces.	3	1.4	10	unprojected (vertical)	alluvial surface	soil chronosequence	~3	5 +/- 2	Mueller and Rockwell (1995)
Laguna Salada	Baja, MX	Segment A in Figure 2)	> 20 m vertical separation of Q4+ surfaces, wtih an inferred soil age of 10 +/- 2 ka yield vertical displacment rate of ~1.7-2.5 mm/yr.		1.7	2.5	unprojected (vertical)	alluvial surface	soil chronosequence	~5	10 +/- 2	Mueller and Rockwell (1995)
Laguna Salada	Baja, MX	Segment A in Figure 2)	A slip rate of 0.7 - 2.3 mm/yr is reported for alluvial surface Q5, based on up to 35 m vertical separation of Q5 surfaces, with inferred soil age of 15-50 ka.		0.7	2.3	unprojected (vertical)	alluvial surface	soil chronosequence	unlisted	15-50	Mueller and Rockwell (1995)
Laguna Salada	Baja, MX	Q4, Q4+, Q5 combined	A right-lateral slip rate of 2-3 mm/yr is estimated from the 2-3 mm/yr vertical displacement rate, assuming a 1:1 ratio of strike-slip to vertical displacement rates, as was observed in the most recent earthquake, in 1892.	2-3			right-lateral	alluvial surface	soil chronosequence	unlisted	5 +/- 2, 10 +/- 2, and 15-50	Mueller and Rockwell (1995)
Elsinore (Coyote Mountains)	CA	Coyote Mountains	U-series dating of pedogenic carbonate on offset alluvial fans Q6jk (60-70 ka) yields a right-lateral slip rate of 2.4 +- 0.4 mm/yr. The slip rate for older, Q7, fans is similar or possibly faster, depending on the age model used.	2.4	2.0	2.8	right-lateral	alluvial fans	U-series dating on pedogenic carbonate	unlisted	60-70 and probably back to 150	Rockwell et al. (2019)
Earthquake Valley (center)	CA	Warner Basin	Offset of two main drainages that cut into the sedimentary fill of Warner basin		1.95 +/- 0.4		right lateral	offset drainages	C14?	3	~2	Akciz and Rockwell (2022)
Brawley	CA	Harris Road	Vertical offsets measured in stratigraphic exposures.	2.8	1.4	6.9	vertical	contact between stratigraphic units 95 and 100	C14		0.817-0.964	Meltzner et al. (2006)
Whittier	CA	Olinda oil field	Three buried channel deposits exposed in 3-D trenching are offset from the same source with increasing offset with age. A slip rate of 1-1.5 mm/yr was measured on one fault strand, and a parallel fault strand with similar geomorphic expression is inferred to have a similar rate, yieding a total inferred rate of 2.5-3 mm/yr	2.5-3	1-1.5		right-lateral	buried channels offset from source	C14	>=5	10.6, 14.7 and 17.7-19.0	Gath et al. (2017)
San Andreas (Banning)	CA	Washington Street	Alluvial fan (Qf3b) offset 13-17 m right-laterally and 1.8 to 2.1 m vertically across three strands of the fault combined.	2.5	1.5	3.5	right-lateral	alluvial fan	10Be depth profile		6.1 +2.2/-2.0	Blisniuk et al. (2021)
San Andreas (Banning)	CA	Washington Street	Alluvial fan (Qf3b) offset 13-17 m right-laterally and 1.8 to 2.1 m vertically across three strands of the fault combined.	0.3	0.2	0.5	vertical (NE-up)	alluvial fan	10Be depth profile		6.1 +2.2/-2.0	Blisniuk et al. (2021)
Blue Cut	CA	Hexie Mountains	Alluvial fan deposits of six different ages have been dated and correlated across the fault. The slip rate prior to 71 ka appears to be faster than after that date.	2.93	0.95	9.07	left-lateral	alluvial fans	10Be exposure dating		0-71	Guns et al. (2022)
Blue Cut	CA	Hexie Mountains	Alluvial fan deposits of six different ages have been dated and correlated across the fault. The slip rate after 71 ka appears to be slower than prior to that date.	0.66	0.46	0.86	left-lateral	alluvial fans	10Be exposure dating		71-121	Guns et al. (2022)
San Gorgonio Pass	CA	Millard Canyon	Alluvial fan terrace offsets summed over two fault strands	5.7	4.5	8.3	oblique	alluvial fan terraces	10B and C14		8.6	Heermance et al. (2023)
Mission Creek	CA	Three Palms (Indio Hills)	The Three Palms fan is offset approximately 57 +/- 3 meters. U-series dating on pedogenic carbonate rinds collected at 25-100 cm depth within the fan deposit constrain the minimum depositional age to 3.49 +/- 0.92 ka, yielding a maximum slip rate of 16 +6.1/-3.8 mm/yr			16 +6.1	right-lateral	Three Palms alluvial fan	U-series dating on pedogenic carbonate rinds		>= 3.49 +/- 0.92	Munoz et al. (2016)
Mission Creek	CA	Indio Hills (Pushawalla Canyon)	The proposed 640 +/- 80 m right-lateral offset of "fan 3" is not clearly explained or documented. The dated sample used to calculate the slip rate is not from "fan 3" and its interpreted relationship to "fan 3" is not explained. (The focus of the study was on luminescence dating techniques and alluvial fan ages at various locations in the Coachella Valley).		7.0 +/	8.4 +/-	right-lateral	"fan 3"	luminesence		75.83+/-8.68	Ataee (2019). Se also Spencer et al. (2022)
Mission Creek	CA	Pushawalla Canyon	Average slip rate of 21.6 +/- 2 mm/yr based on three paleochannels of Pushawalla canyon (downstream from fault) offset from three fluvial terraces within Pushawall Canyon (upstream from fault). The preferred ages for the three channel/terrace pairs are 87.1 +/- 7.0 ka, 74.4 + 5.1/-5.2 ka, and 26.0 +7.6/-7.5 ka.	21.6	19.6	23.6	right-lateral	paleochannels downstream from fault, offset from terraces upstream from fault	Be-10 surface exposure ages and U-series dates on pedogenic carbonate rinds		95	Blisniuk et al. (2021)