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Title of article: Late Cenozoic History and Slip Rates of the Fish Lake Valley, Emigrant Peak, and Deep Springs Fault Zones, Nevada and California

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TABLE DR1. MAPPING CRITERIA AND AGE CONTROLS FOR ALLUVIAL-FAN DEPOSITS IN FISH LAKE VALLEY

Unit name (map symbol)	Surface form	Desert varnish	Soil development	Age control*
Alluvium of Marble Creek (Qfc)	Unmodified to subdued bar-and-swale and debris-flow topography; little or no pavement.	Little (thin spots on clasts) or none	Vesicular A horizon absent or thin and sandy; Bw horizon absent or moderately developed; no $CaCO_3$ to stage I $CaCO_3$.	Twenty-eight ^{14}C ages from sites in many drainages range from 0.11 ka to 5.68 ka at depths from 0.2 to 4 m below surface. At more than twenty-six sites in three drainages, contains 0.6- to 3.6-ka tephra layers at depths from 0.3 to 6 m below surface.
Alluvium of Leidy Creek (Qfl)	Depositional topography preserved on large debris flows; smooth areas of pavement surrounded by rougher pavement; smooth pavement has unsorted interlocking clasts.	Thin but continuous on most clasts; shiny and iridescent in protected sites.	Continuous, loamy vesicular A horizon, 5-7 cm thick; Bw or weak argillic B horizon--common thin clay films; stage II $CaCO_3$--stronger in calcareous alluvium.	Four ^{14}C ages from different drainages range from 5.01 to 6.55 ka at depths from 1 to 3.3 m below surface. At Rock Creek (fig. 3), contains <10-ka tephra 6 m below surface. Buried deposits contain the Mazama ash bed (6.85 ka) at two sites near Furnace Creek and one near Leidy Creek. Thermoluminescence ages on buried vesicular A horizons: 7.5±1.0 ka and 11±2 ka (Slate, 1992).
Alluvium of Indian Creek (Qfi)	Commonly dissected; well packed and sorted clasts in continuous pavement; prominent solifluction treads and risers.	Continuous, thick varnish on most clasts--often shiny and iridescent.	Continuous, silty vesicular A horizon, 5-10 cm thick; moderate argillic B horizon--abundant thin to moderately thick clay films; stage II-III $CaCO_3$--stronger in calcareous alluvium.	Contains 40- to 80-ka tephra at mouth of Leidy Creek, 60- to 80-ka tephra in core at distal end of Leidy Creek fan, and 60- to 100-ka tephra near Rock Creek (fig. 3). Thermoluminescence age on buried vesicular A horizon is >50 ka (Slate, 1992). ^{36}Cl age on granitic surface boulder near Perry Aiken Creek is ca. 57 ka (Zreda, 1994†). Preliminary ^{3}He age on olivine from basalt surface boulder near Indian Creek is 125 ka (R. Poreda, oral commun., 1995). ^{10}Be exposure age on unit Qfi soil profile buried by sediment dated at about 10 ka is >40 ka (Reheis and others, 1996).
Alluvium of Trail Canyon (Qft)	Commonly deeply dissected; well packed and sorted clasts, including fragments of pedogenic $CaCO_3$, in continuous pavement where preserved; prominent solifluction treads and risers where preserved.	Where preserved, continuous, thick varnish on most clasts--shiny and iridescent.	Continuous, silty A horizon, vesicular at lower elevation; strong argillic horizon--abundant thin to thick clay films; stage III $CaCO_3$, 1 m or more thick.	Older than 60-100 ka and younger than Bishop ash bed (760 ka) near Rock Creek (fig. 3). Younger than Bishop ash bed northwest of Oasis. Silt layer at Rock Creek has normal polarity (D. Burbank, oral commun., 1991).
Alluvium of McAfee Creek (Qfm)	Very deeply dissected; relict surface generally not preserved; ridge crests concordant; more stable sites have moderately well packed and sorted pavements with abundant carbonate rubble.	Where preserved, locally continuous and thick.	Where preserved, thick silty vesicular A horizon; strong argillic B horizon; Bkm horizon--stage IV laminar $CaCO_3$.	Overlies and interfingers with Bishop ash bed (760 ka) at six sites in several drainages. Preliminary ^{3}He age on olivine from basalt surface boulder near Wildhorse Creek is >200 ka (R. Poreda, oral commun., 1995).
Alluvium of Perry Aiken Creek (Qfp)	Very deeply dissected; relict surface not preserved; crops out as lag gravel on top of bedrock	Where preserved, locally continuous and thick	No relict soil preserved	Older than Bishop ash bed south of mouth of Perry Aiken Creek (fig. 3).

Note: Detailed information on dated samples, stratigraphic relations, and sample sites are on maps of Reheis (1991, 1992, 1994) and Reheis and others (1993a, 1995).]
* Radiocarbon ages were obtained on detrital charcoal and buried logs. Listed ages are not calibrated by dendrochronology.
† Original ages presented by Zreda (1994) in his dissertation were converted by F. Phillips (1997, personal commun.) using new calibration standards of Phillips et al. (1996).

Zreda, M.G., 1994, Development and calibration of the cosmogenic 36Cl surface exposure dating method and its application to the chronology of late Quaternary glaciations: Ph.D. dissertation, New Mexico Institute of Mining and Technology, Socorro, 318 p.

Phillips, F.M., Zreda, M.G., Flinsch, M.R., Elmore, D., and Sharma, P., 1996, A reevaluation of cosmogenic 36Cl production rates in terrestrial rocks: Geophysical Research Letters, v. 23, p. 949-952.

Table DR-2. Calculation of slip rates for the Fish Lake Valley, Emigrant Peak, and Deep Springs fault zones

Section or fault+	Site no.@	Fault strike	Site location	Offset marker	Amount of offset (m) Min.	Max.	Pref.	Duration of slip (kyr) Max.	Min.	Pref.	Slip rate (mm/yr) Min.	Max.	Pref.
RIGHT-LATERAL													
FLVFZ	1-1'		Southern FLV to northern DV	Jurassic pluton, Precambrian facies, 0.706 Sr line	40000	100000	50000	11900	8200	10000	3.4	12.2	5.0
FLVFZ	2-2'		Northern FLV	Width of northern valley; separation of thrust fault	15000	20000	20000	6900	4000	5000	2.2	5.0	4.0
CH	3		800 m southeast of Indian Creek	Debris-flow levees on surface of unit Qfi*	83	165	122	75	50	50	1.1	3.3	2.4
CH	3		100 m southeast of Indian Creek	Drainage channel on surface of unit Qfl*	3	15	3	7.4	1.9	5.0	0.4	7.9	0.6
CH	4a		1200 m northwest of Leidy Creek	Debris-flow levees on surface of unit Qfi*	72	107	92	75	50	50	1.0	2.1	1.8
OA	5		Wildhorse Creek to Furnace Creek	Shutterridge of unit Qfm--clast lithologies	4500	7000	5900	700	600	620	6.4	11.7	9.5
OA	6		800 m southeast of Furnace Creek	Apparent Qfi-Qft contact normal to faults	520	575	550	190	100	130	2.7	5.8	4.2
OA	6		650 m southeast of Furnace Creek	Oldest debris-flow channel, surface of unit Qfi*	245	465	400	130	50	100	1.9	9.3	3.1
OA	6		430 m southeast of Furnace Creek	Youngest debris-flow channel, surface of unit Qfi*	111	130	120	75	50	50	1.5	2.6	2.4
CU	7		Willow Spring area	Restoration of offset side-canyon fans of unit Qfi*	110	180	150	75	50	50	1.5	3.6	3.0
CU	8		1100 m west of Willow Spring	Offset channel on surface of unit Qfl	13	25	21	8	5	6.5	1.6	5.0	3.2
CU	9		700 m south of Willow Spring	Offset channel on surface of unit Qfl	13	32	23	8	5	6.5	1.6	6.4	3.5
VERTICAL													
CH	10		1.7 km north of Indian Creek	Top of andesite capping Davis Mountain	580	1150	1000	3300	2900	3000	0.18	0.40	0.33
CH	11		1.1 km south of Indian Creek	Top of channel-filling andesite flow	470	1060	1000	3100	2900	3000	0.15	0.37	0.33
CH	3		800 m southeast of Indian Creek	Debris-flow levees on surface of unit Qfi*	27	52	40	75	50	50	0.36	1.04	0.80
CH	3		100 m southeast of Indian Creek	Drainage channel on surface of unit Qfl*	0.7	1.3	1.0	7.4	1.9	5.0	0.09	0.68	0.20
CH	4a		1200 m northwest of Leidy Creek	Debris-flow levees on surface of unit Qfi*	2	-12	0	75	50	50	0.03	-0.24	0.00
CH	4b		1200 m south of Leidy Creek	Surface of unit Qfi	16	32		75	50	50	0.21	0.64	
DY	12		Headwaters of Toler Creek	Eroded surface of basalt flow	780	1280	1000	6900	4000	5000	0.11	0.32	0.20
DY	13		North side of Perry Aiken Creek	Eroded surface and deposits of unit Qfm	135	445	210	760	760	760	0.18	0.59	0.28
DY	13		do	Surface of unit Qft	105	210		360	190	200	0.29	1.11	
DY	13		do.	Surface of unit Qfi	90	180		75	50	50	1.20	3.60	
DY	14		Mouth of McAfee Creek	Eroded surface and deposits of unit Qfm	100	465	230	760	760	760	0.13	0.61	0.30
DY	14		do.	Surface of unit Qfi	35	70		75	50	50	0.47	1.40	
DY	14		do.	Surface of unit Qfl	13	26		8	5	6.5	1.63	5.20	

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OA	15	West of Furnace Creek	Top of basalt flows projected from the west	55	490	490	6900	4000	5000	0.01	0.12	0.10
OA	6	Mouth of Furnace Creeek	Surface of unit Qfi	15	15	15	75	50	50	0.20	0.30	0.30
OA	16-16'	Top of Chocolate Mountain to base of section at Willow Wash	Top of basalt flows	670	690	680	6900	4000	5000	0.10	0.17	0.14
OA	17	3-4 km west of Oasis	Surface of unit Qft	95	145	120	360	190	200	0.26	0.76	0.60
OA	17	do.	Surface of unit Qfi	34	65		75	50	50	0.45	1.30	
	18	5-10 km southeast of Oasis	Surface of unit Qfi at several localities	17	50		75	50	50	0.23	1.00	
EPFZ	21-21'	4 km north of Cave Spring Wash	Base of unit QTg across all but eastern fault**	635	800	735	3400	2000	2800	0.19	0.40	0.26
EPFZ	22-22'	Cave Spring Wash	Offset tephra layers across all but eastern fault*	335		410	2220	1920	2000	0.15		0.21
EPFZ	23	3 km north of Cave Spring Wash	Offset beach deposits across two faults*	125			760	760	760	0.16		
EPFZ	24	0.5 km southwest of C.S. Wash	Surface of unit Qfi	30	66		75	50	50	0.40	1.32	
EPFZ	25	0-2 km southwest of C.S. Wash	Surface of unit Qfl	20	26	22	8	5	6.5	2.50	5.20	3.38
DSFZ	19	North end of Deep Springs Valley	Eroded top of basalt flows on Chocolate Mtn.	715	800	760	6900	4000	5000	0.10	0.20	0.15
DSFZ	19	do.	Top of Chocolate Mtn. to Bishop-age windgap	538	538	538	6140	3240	4240	0.09	0.17	0.13
DSFZ	19	do.	Wind gap to valley floor	200	400		760	760	760	0.26	0.53	
DSFZ	20	Center of Deep Springs Valley	Top of footwall ridge to bedrock in hanging wall*	1680	2020		6900	4000	5000	0.24	0.51	

+ FLVFZ, Fish Lake Valley fault zone: includes CH, Chiatovich Creek section; OA, Oasis section; CU, Cucomongo Canyon section; and DY, Dyer section. DSFZ, Deep Springs fault zon
EPFZ, Emigrant Peak fault zone. Surface ages of alluvial fan units Qfm, Qft, Qfl, and Qfl are estimated from data in table 2 of text (DR-1 in repository) and inferred deposition during int

@ Site numbers are keyed to circled numbers on several figures in text of paper.

* Marker is offset across the main active fault strand but not all strands, or is eroded on footwall block, hence gives a minimum rate.

** Base of unit QTg becomes younger to the west, hence values for down-to-the-west offset and slip rates are minimum.

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Site no.	Notes
1	Stewart (1967); Saleeby and others (1986); 50 km from McKee (1968). 8.2 Ma is min. age of rhyolite near base of unit Ts in Eureka Valley; 11.9 Ma is max. age of basalt predating onset of motion.
2	Maximum age of 6.9 Ma is maximum age of basalt beneath unit Tm in Eureka Valley, reflecting inferred uplift of hills along Deep Springs fault; 4 Ma is minimum age of landslide unit in Willow Wash, reflecting opening of Fish Lake Valley (Reheis, 1993).
3	Estimated surface age of unit Qfi from table DR-1 and table 2 in text. Offset measured by EDM theodolite.
3	Cal. yrs. B.P. 7.4 ka is maximum age of unit Qfl dated at site C-13, 500 m upstream of offset channel; 1.9 is minimum age of unit Qfce at site C-5, 550 m downstream of offset channel (Reheis and others, 1993a). Offset measured by EDM theodolite.
4a	Estimated surface age of unit Qfi from table DR-1 and table 2 in text. Offset measured by EDM theodolite.
5	760 ka is age of Bishop ash interbedded with sediment of unit Qfm at 6 sites; 600 ka is age of maximum extent of glacial oxygen-isotope stage 16; 620 ka is age of the stage 17-16 transition (Williams and others, 1988). Offset measured from maps.
6	190 ka is minimum age of Qft, 130 ka is maximum age of Qfi. Offset measured from topographic maps and air photos.
6	For preferred slip rate, use maximum age of Qfi because the slip is based on the oldest channel. Offset measured by tape.
6	Preferred slip duration is 50 ka because offset channel is youngest of several on unit Qfi surface. Offset measured by tape.
7	Preferred slip duration is 100 ka because offset channel is oldest of several on unit Qfi surface. Offset measured by tape.
8	Offset measured by tape.
9	Offset measured by tape.
10	Minimum offset from projecting eastward slope of top of andesite (95 m/km) to range front; maximum includes estimated depth of alluvium from bedrock projections and well logs. Age range of most dated samples of andesite of Davis Mountain (table 1).
11	Minimum offset from projecting gradient of Indian Creek (79 m/km) from hill 7917T to range front; maximum adds estimated depth of alluvium from bedrock projections and well logs. Age range of andesite dated at this site (table 1of ms., KA-6, -7, -23).
3	Minimum offset because not all faults are included. Measured by EDM theodolite.
3	Minimum offset because not all faults are included. Measured by EDM theodolite.
4a	Minimum offset because not all faults are included; offset is antithetic. Measured by EDM theodolite.
4b	Scarp height measured by Jacob staff.
12	Minimum offset from projecting 11-Ma basalt east to range front at gradient of remnant 95 m/km to elev. 2377, actual 1598; maximum offset from estimated depth to bedrock of 3600' (1098m). Age estimates as for site 2.
13	Minimum offset from difference in height of units Qfm and Qfi west of faults plus minimum offset of unit Qfi (Reheis and others, 1994); maximum offset is projected elevation of Qfm at range front (gradient of modern creek) minus shoreline elev.
13	Minimum offset from offset of unit Qfi plus additional scarp height on unit Qft; depth of burial east of faults unknown. Scarp height measured by Jacob staff.
13	Minimum offset includes offsets of unit Qfi across two small faults plus scarp height of eastern fault; depth of burial east of faults unknown. Scarp height measured by Jacob staff.
14	Minimum offset from elevation of lacustrine? Bishop ash bed above valley floor at range front plus offset across western fault; maximum offset includes depth to estimated pluvial-lake shoreline elevation (1460 m).
14	Depth of burial on east side of faults is unknown. Scarp height measured by Jacob staff.
14	Depth of burial on east side of faults is unknown. Scarp height measured by Jacob staff.

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15 Offsets are range of estimated depths from projected elevation of basalt flows at range front (eastward slope of 135 m/km on unfaulted flows to the west) to bedrock beneath valley alluvium. Age estimates as for site 2.

6 Scarp height measured by Jacob staff.

16 Offsets are difference in elevation from top of Chocolate Mountain to estimated depth of bedrock beneath valley floor of Fish Lake Valley. Age estimates as for site 2.

17 Offsets are calculated from backtilted beds within unit Qft between the main fault strands. Ages assume unit Qft was deposited in isotope stages 11 to 7 (commonly contains two buried soils); stage boundaries from Williams et al. (1988).

17 Offset; includes that measured across western fault and the scarp height at the eastern fault; depth of burial on the east is unknown. Scarp heights measured by Jacob staff.

18 Offset range is derived from several different sites; depth of burial unknown. Scarp heights measured by Jacob staff.

21 Offset is minimum cumulative; base of QTg is at 6080' at S.P. range front and is deeper than 3150' in drill hole FLH-34 on west side of faults; excludes offset on range-front fault. Ages from tephrochonology.

22 Offset is minimum cumulative; western 2 faults offset Bishop shoreline 125 m + 75-130m to TTC at 147-CS; central fault has 95 m offset minimum using thickness of strata below GM ash and above TTC ash; eastern fault offset is 35-60 m from projections.

23 Offset is from highest elevation of Bishop-ash beach sand on footwall to elevation of shoreline from sinter mound on hanging wall 6.5 km to west; does not include faults to east.

24 Depth of burial is unknown. Scarp heights measured using Jacob staff.

25 Measured across a graben using Jacob staff.

19 Offset is the difference in elevation from top of Chocolate Mountain to floor of Deep Springs Valley; basalt cropping out to N has gradient of 102 m/km, proj. elev. 1590 m at surf. elev. of 1635 m. Age estimates as for site 2.

19 Offset is the difference in elevation from top of Chocolate Mountain to Bishop ash and stream gravel in wind gap. Stream-gravel lag is strewn down the slope, suggesting progressive side-slipping during faulting. Ages as for site 2 and of Bishop ash.

19 Minimum offset because depth of burial is unknown.

20 Offset is minimum due to erosion of footwall: difference in elevation from the highest point on the footwall block to bedrock below alluvium in the hanging wall, about 790 m from gravity data (Wilson, 1975). Age estimates as for site 2.

glacial periods (Reheis and others, 1996).