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INTRODUCTION

This report contains field and laboratory data from a study of the Steens fault zone near Denio, Nev. The 200-km-long Steens fault zone (SFZ) is the largest of the Basin and Range normal faults and has accommodated as much as 2.5 km of vertical offset in southeastern Oregon and northern Nevada. The down-to-the-east normal fault is marked by Holocene fault scarps along nearly half its length, including the southern one-third of the fault from the vicinity of Pueblo Mountain in southern Oregon to the southern margin of Bog Hot Valley, Humboldt County, Nev. (fig. 1). Fault scarps in this area are well preserved in sagebrush steppe and are ideal for studying the SFZ's response to deformation rates derived from a recently established geodetic network in the region (Hammond and Thatcher, 2005). We excavated a trench in May 2003 across one of a series of right-stepping fault scarps that extend south from the southern end of the Pueblo Mountains and bound the floor of Bog Hot Valley, about 8 km south of Nevada State Highway 140 (fig. 2). This site was chosen because of the presence of well-preserved fault scarps, fine sediment on lacustrine deposits thought to be suitable for dating, and the absence of any evidence of previous disturbance. In June 2004, we excavated a trench across the scarp on the southern SFZ but the fault zone in the trench collapsed during excavation and thus no information about fault history was documented from this site. We also excavated a soil pit (fig. 2) on a lacustrine barrier bar in the southern Pueblo Valley (PV) to better constrain the age of the highest lacustrine shoreline in the area. Sediments in the trench and soil pit were described and sampled for analyses of soil development, silts, soils data, luminescence and radiocarbon ages, and unit descriptions obtained during this investigation. We do not attempt to use the data presented herein to construct a paleoseismic history of this part of the Steens fault zone; that history will be the subject of a future report.

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RADIOCARBON AND LUMINESCENCE AGE DATA

We obtained four radiocarbon samples from two burn layers in the youngest fault scarp colluvium (unit 7) in the trench (table 3). The samples were submitted to Beta Analytic Radiocarbon Dating Laboratory for analysis.

We used luminescence dating techniques to determine the ages of lacustrine and colluvial sediments exposed in the trench and soil pit (see logs and table 2). Ti, thermoluminescent; IRSL, infrared stimulated luminescence—a type of optically stimulated luminescence (OSL); and Fading, anomalous fading correction (Aitken, 1985; Wintle, 1973; Huntley and Lamothe, 2001; Lamothe and Auclair, 2003; Lamothe and Huot, 2005). Sampling was conducted with tubes of plastic electrical conduit driven into the freshly cleaned trench and pit walls; after extraction, sample tubes were sealed with plastic tape and stored in airtight plastic bags. Most dose rates were determined in situ with an Exploranium GR-256 gamma ray spectrometer placed in expanded sample holes drilled in the walls after sampling was completed. Field moisture contents of 1–20 percent by weight were determined for each sample in the laboratory. A conversion factor of 0.04 ± 0.02 ka/Gy was used to convert equivalent dose (De) to age for all samples, assuming that the cosmic-ray fraction was isolated for OSL/IRSL samples (Prescott and Hutton, 1994; Aitken, 1998; Lamothe and Auclair, 1999; Lamothe and others, 2003; Lamothe and Huot, 2005). Samples were subjected to combinations of sunlight sensitivity tests, anomalous fading tests (Wintle, 1973), total bleach and partial bleach experiments for Ti (Wintle and Huntley, 1980; Singhvi and others, 1982), and additive dose techniques (Aitken, 1985; Lamothe and others, 2003; Lamothe and Auclair, 2003). Ages were calculated using the central values of fading, as signs were corrected using the anomalous fading correction technique of Huntley and Lamothe (2001). With three exceptions, our luminescence ages are generally consistent and in stratigraphic order. The colluvial sediments exposed in the trench were deposited about 4–13 ka. The lacustrine and fluvial sediments were deposited 10–20 ka.

REFERENCES

Adams, K.D., and Wesnousky, S.G., 1999, The Lake Lahontan highstand—shape, surficial characteristics, and development, and regional shoreline correlation: Geomorphology, v. 30, p. 357–392.

Aitken, M.J., 1998, An introduction to optical dating—The dating of Quaternary sediments by the use of photon-stimulated luminescence: Oxford University Press, 267 p.

Aitken, M.J., 1985, Thermoluminescence dating: Academic Press, 359 p.

Berger, G.W., 2003, Dating Quaternary events by luminescence, in Easterbrook, D.J., ed., Dating Quaternary sediments: Geological Society of America Special Paper 227, p. 13–50.

Birkeland, P.W., 1999, Soils and Geomorphology (3d ed.): New York, Oxford University Press, 430 p.

Brook Ramsey, C., 1995, Radiocarbon calibration and analysis of stratigraphy—The OxCal program: Radiocarbon, v. 37, p. 425–430.

Brook Ramsey, C., 2001, Development of the radiocarbon program OxCal: Radiocarbon, v. 43, p. 355–363.

Bull, W.B., and K.C. and Anderson, R.E., 1978, Estimation of half-scarp ages from a new height-slope-angle relationship: Geology, v. 7, p. 111–14.

Carter, D.T., Ely, L.L., O'Connor, J.E., and Fenton, C.R., 2006, Late Pleistocene outburst flooding from pluvial Lake Alvord into the Owyhee River, Oregon: Geomorphology, v. 75, p. 346–367.

Cunkey, S.J., 1995, Geometric relations of dip slip to a beded ground surface—New nomograms for estimating components of bed displacement: Journal of Structural Geology, v. 17, p. 1203–1208.

Forman, S.L., Pierson, J., and Lepper, K., 2000, Luminescence geochronology, in Noller, J.S., Sowers, J.M., and Lettis, W.R., eds., Quaternary geochronology—Methods and applications: American Geophysical Union Reference Shelf 4, p. 157–176.

Hammond, W.C., and Thatcher, W., 2005, Northwest Basin and Range tectonic deformation observed with the Global Positioning System, 1999–2003: Journal of Geophysical Research, v. 110, B10405, doi: 10.1029/2005JB003678.

Hemphill-Haley, M.A., 1995, Diatom evidence for earthquake-induced subsidence in estuaries along the eastern margin of Steens Mountain, southeastern Oregon: Arcata, Calif., Humboldt State University, M.S. thesis, 88 p.

Huntley, D.J., and Lamothe, M., 2001, Ubiquity of anomalous fading in K-feldspars and the measurement and correction for it in optical dating: Canadian Journal of Earth Sciences, v. 38, p. 1093–1106.

Machette, M.N., Haller, K.M., Dart, R.L., and Rhea, S.B., 2003, Quaternary fault and fold database of the United States: U.S. Geological Survey Open-File Report 03-417, http://earthquake.usgs.gov/regional/qfaults/.

Mansell Color, 1994, Munsell soil color charts: New Windsor, N.Y., Kollmorgen Corp., Macbeth Division.

Personius, S.F., Dart, R.L., Bradley, L.A., and Haller, K.M., 2003, Map and data for Quaternary faults and folds in Oregon: U.S. Geological Survey Open-File Report 03-095, 589 p., 1 sheet, scale 1:750,000.

Rhea, M., 1999, Extent of Pleistocene lakes in the western Great Basin: U.S. Geological Survey Miscellaneous Field Studies Map MF-2323, http://pubs.usgs.gov/mf/2000/mf-2323/.

Skinner, P.G., Bullis, M.G.L., Burd, E., Bayha, A., Beck, J.W., Bertrand, C.J.H., Blackwell, P.G., Buck, C.E., Burr, G.S., Cutler, K.B., Dawson, P.E., Edwards, R.L., Fairbanks, R.G., Friedrich, M., Gabrielson, T.P., Hogg, A.G., Hughen, K.A., Kromer, B., McCormac, G., Olsen, J., Reimer, P.J., Richards, D.A., Scott, E.M., Southon, J.R., Turney, C.S.M., Wacker, L., Adolphi, F., Büntgen, U., Capano, M., Fahrni, S.M., Fogtmann-Schulz, A., Friedrich, R., Köhler, P., Kudsk, S., Miyake, F., Olsen, J., Reinig, F., Sakamoto, M., Sookdeo, A., and Talamo, S., 2020, IntCal20 terrestrial radiocarbon age calibration, 26–0 ka BP: Radiocarbon, v. 62, p. 1029–1058.

Singhvi, A.K., Sharma, Y.P., and Agrawal, D.P., 1982, Th dating of dune sands in Rajasthan, India: Nature, v. 295, p. 313–315.

Soil Survey Staff, 1999, Soil Taxonomy (2d ed.): U.S. Department of Agriculture Agricultural Handbook no. 436, 869 p.

Wintle, A.G., 1973, Anomalous fading of thermoluminescence in mineral samples: Nature, v. 245, p. 143–144.

Wintle, A.G., and Huntley, D.J., 1980, Thermoluminescence dating of ocean sediments: Canadian Journal of Earth Sciences, v. 17, p. 348–360.

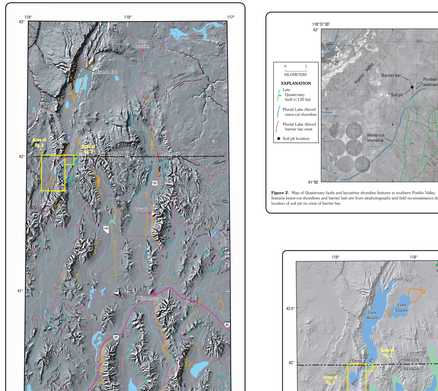


Figure 1. Regional map of Quaternary faults. Faults in the northern part of the map are from Personius and others (2003). Faults in the southern part of the map are from the Quaternary fault database of USGS (Machette and others, 2003).

Photograph 1. View of Bog Hot Valley trench site, looking northeast (fig. 2).

Photograph 2. View looking north along strike of several right-stepping fault scarps (arrows) on floor of Bog Hot Valley (fig. 2). Hills in the distance are the southern end of the Pueblo Mountains, which are composed of Miocene basalt flows. Bar line is generalized trace of the southern Steens fault zone along the Pueblo Mountains.

Photograph 3. View looking southward of 4- to 5-m-high fault scarps (between arrows) on floor of Bog Hot Valley (fig. 2). Trench site is off left side of photograph.

Photograph 4. View looking north of 5–6-m-high fault scarps on eastern flank of Pueblo Mountains (fig. 2). Note sand and other large boulders (probably) were shaken loose from outcrops and rolled to their present positions as a result of strong ground shaking (probably) from one or more recent large magnitude earthquakes on the southern Steens fault zone.

Figure 2. Map of Quaternary faults and lacustrine shoreline features in southern Pueblo Valley. Faults and shoreline features based on stereoscopic aerial photographs and field reconnaissance during this study; note location of soil pit on crest of barrier bar.

Figure 4. Extent of pluvial lakes in the vicinity of Denio, Nev. Modified from Rhea, 1999. Note location of Pueblo Valley (PV) and Bog Hot Valley (BHV) at southern end of Lake Alvord. Lake Alvord reached a maximum elevation of 1,330 m (4,364 ft) and overtopped Oregon across its east side of Lake Alvord down crest of probable late Pleistocene overflow from Izzi Lake Coyote and Owyhee River (Carter and others, 2006).

Table 1. Soils data from Bog Hot Valley and Pueblo Valley sites.

Horizon[1]	Parent[2] material	Depth-top (cm)	Depth-base (cm)	Lower[3] boundary	Color[4] moist	Texture[5]	Gravel pct.	Structure[6]	Dry[7] consistence	Wet[8] consistence	Clay[9] films	Comments[10]
Profile S1-BHV trench footwall, south wall, 29.8 m horizontal datum												
Ah1	A	0	8	cs	10YR 6/3	10YR 4/4	SiCL	fr 2c, 4bk	sh	ss, ps	0	Loess in pans.
2Ah	A	8	18	cs	10YR 6/3	10YR 5/6	LS, SL	s10	l1 p	ss ns, ps	0	Abundant fine rootlets.
2Btk	A	18	33	gw	10YR 7/3	10YR 6/3	L	s10	2m, 4bk	s	s, ps	2d, pf	Stage I carbonate in veinlets.
2Bky	A	33	43	cw	10YR 6/3	10YR 6/4	SL	s10	2m, 4bk	ss	s, ps	0	Stage I carbonate and gypsum in veinlets.
2By	A	43	56	aw	2.5Y 6/3	2.5Y 6/3	SL	s10	2m, 4bk	s	ss, ps	0	Abundant gypsum.
2C	A, S, Z	56	180+	—	10YR 6/3	10YR 6/3	LS	s10	1m, 4bk	sh	ss, ps	0	Lacustrine sand, sparse carbonate on bedding (nonpedogenic).
Profile S2-BHV trench hanging wall, south wall, 4.5 m horizontal datum												
A1	7e	0	15	cs	10YR 4.5/3	10YR 4/3	SiL		2f, 2m	wk	ss, ps	0	None.
A2	7e	15	49	gs	10YR 6/3	10YR 4.5/4	SiCL		s10	1f, 4bk	s	ss, ps	0	None.
2C	7e	49	61	cs	10YR 6/3	10YR 6/3	SiCL		0	m	s	ss, ps	0	None.
3Btjk	4	61	95	gw	10YR 2/2	10YR 5/3	SiL		s10	2m, 4bk	sh	ss, ps	nd	Stage I carbonate.
3Bkc	4	95	135	cw	10YR 7/3	10YR 5/3	SiL		0	2m, 4bk	sh	ss, ps	0	Stage III carbonate.
4C	3f	135	200+	aa	10YR 6/1	10YR 6/1	S		5f	m	sl	ss, ps	0	Stage I carbonate on bedding (nonpedogenic).
Profile S3-BHV soil pit, south wall, -22.0 m horizontal datum												
A1	sp4	0	18	cs	10YR 7/3	10YR 5/4	SiCL		0	2m, 4bk	sc	s, ps	0	Spod(?).
A/B	sp4	18	42	cs	10YR 7/3	10YR 6/3	SiCL		s10	1f, p	s	ss, ps	0	Stage II/I carbonate.
2Btk	sp4	42	54	cw	10YR 6/4	10YR 5.5/4	SiCL		s10	1f, 4bk	s	ss, ps	nd	Stage II carbonate and gypsum.
2Btky	sp4	54	66	gw	10YR 6/3.5	10YR 5.5/4	CL		10	1f, 4bk	s	ss, ps	0	None.
2By	sp4	66	84	cw	10YR 6.5/3	10YR 5.5/4	SiL		10	1f, 4bk	sh	ss, ps	0	None.
2C	sp4	84	130+	aa	10YR 6/2	10YR 6/1	S		5f-75	m	ss	ss, ps	0	Stage I carbonate.
Profile S4-Pueblo Valley soil pit in barrier bar, elevation ~4,250 ft (1,295 m)														
A1	loess	0	8	cs	10YR 6/2	10YR 4/3	SL		0	sp, po	0	Bioturbation (rodents?) common.
A/B	loess	8	14	cs	10YR 7/2	10YR 5/2	L		0	1m, gr	sh	ss, ps	0	Bioturbation (rodents?) common.
Bt	loess	14	24	cs	10YR 6/3	10YR 4/3	SiCL		s5	1f, 4bk	s	s, p	1f, pf	Some discontinuous reddish groundwater oxidation in upper part of sand and gravel.
2Bt	sand, gravel	24	31	cs	10YR 5/2	10YR 4/2	SiCL		75	1vf, 4bk	sh	s, p	1f, pf, po	
2Bk1	sand, gravel	31	40	cs	10YR 5/3	10YR 5/4	LS		75	m	s	ss, ps	0	Stage I/II carbonate; coatings on all grains.
2Bk2	sand, gravel	40	55	cs	10YR 5/3	10YR 6/3	S		50-75	m	ls	ss, ps	0	Stage I carbonate; discontinuous coatings on some pebbles.
2C	sand, gravel	55	120+	aa	10YR 6/3	10YR 5/4	S		50-75	m	ss	ss, ps	0	Sparse carbonate on bedding (nonpedogenic).

[1] Horizon nomenclature from Soil Survey Staff (1999) and Birkeland (1999).
[2] Parent material: A, alluvium; Z, colluvium; S, lacustrine sediments; Pueblo Valley profile: loess=post-lacustrine windblown silt; sand, gravel=reddish pluvial Lake Alvord barrier-bar sand and gravel.
[3] Lower boundary: Distinctness: a, abrupt; c, clear; g, gradual; Topography: s, smooth; w, wavy; a, irregular.
[4] Color nomenclature from Munsell Color (1994).
[5] Texture classes: Cl, clay loam; L, loam; LS, loamy sand; SCL, sandy clay loam; SL, sandy loam; S, sand; SiL, silt loam; SiC, silty clay; SiCL, silty clay loam.
Structure: Grade: m, massive; 1, weak; 2, moderate; Size class: vf, very fine; f, fine; m, medium; c, coarse; Type: abk, angular blocky; sbk, subangular blocky; gr, granular; p, prismatic.
[6] Dry consistence: l, loose; sl, slightly hard; s, hard; vs, very hard; Wet consistence: so, nonsticky; ss, slightly sticky; s, sticky; vs, very sticky.
[7] Clay films: Amount: f, few; c, common; Thickness: d, distinct; f, faint; Location: pf, on peds; pa, in pores; nd, not determined.
[8] Carbonate nomenclature from Birkeland (1999).

Table 2. Luminescence data from the Bog Hot Valley and Pueblo Valley sites.

Sample number	Location[1] x, y (m)	Unit number	Dating[2] method	Temperature[3] data (°C)	Equivalent[4] dose (Gray)	Dose Rate[5] (Gy/ka/ka)	Field[6] moisture (pct)	Ti, IRSL, or OSL age (ka)	Fading[7] (yes/no)	Fading-corrected age (ka)	Preferred age[8] estimate (ka)	Comments
BHV-T03	9.95, 2.15	7e	TL-fn	12/6	16.75 ± 1.36	4.61 ± 0.06	15	3.640 ± 600	y	3.770 ± 620	**3.690 ± 360**	Weighted mean of fading-corrected TL and IRSL ages; calibrated radiocarbon ages from same horizon yield similar age.
			IRSL	12/6/54 bis	15.67 ± 0.91	4.58 ± 0.06	15	3.530 ± 430	y	3.650 ± 450	**No**	None.
BHV-T05	9.30, 1.90	7e	TL-fn	12/6	16.51 ± 1.39	4.53 ± 0.08	20	3.650 ± 630	y	4.790 ± 830	**4.790 ± 830**	Overlying calibrated radiocarbon ages yield similar age.
			IRSL	12/6/54 bis	21.68 ± 0.29	4.30 ± 0.08	20	5.480 ± 160	y	5.220 ± 210	**No**	IRSL age is weighted mean of two analyses; overlying radiocarbon ages indicate age is too young.
BHV-T06	11.60, 2.65	6b	TL-fn	12/6	9.50 ± 0.79	4.97 ± 0.08	19	>1.910 ± 320	S	>2.290 ± 380	**No**	None.
			IRSL	12/6/54 bis	15.25 ± 0.46	4.72 ± 0.08	19	3.280 ± 220	S*	3.930 ± 270	**3.930 ± 270**	Overlying radiocarbon ages indicate age is too young by several hundred years.
BHV-T08	10.43, 1.85	6a	TL-fn	12/6	24.03 ± 1.51	4.89 ± 0.08	15	4.910 ± 840	S*	6.030 ± 540	**6.030 ± 260**	Weighted mean of fading-corrected TL and IRSL ages; fading estimated from sample BHV-T06.
			IRSL	12/6/54 bis	22.99 ± 0.43	4.65 ± 0.07	13	4.960 ± 280	S*	6.060 ± 300	**No**	None.
BHV-T07	11.15, 1.85	5b	TL-fn	12/6	23.09 ± 1.86	5.03 ± 0.07	13	4.610 ± 740	S*	5.690 ± 910	**6.140 ± 310**	Weighted mean of fading-corrected TL and IRSL ages; fading estimated from sample BHV-T06.
			IRSL	12/6/54 bis	29.09 ± 0.56	4.76 ± 0.07	13	5.560 ± 270	Z	6.210 ± 330	**No**	None.
BHV-T09	11.50, 3.10	5a	TL-fn	12/6	84.56 ± 1.91	4.60 ± 0.06	19	10.140 ± 570	Z	13.080 ± 620	**11.330 ± 360**	Weighted mean of fading-corrected TL and IRSL ages.
			IRSL	12/6/54 bis	62.64 ± 0.47	4.18 ± 0.06	19	10.200 ± 400	Y	11.150 ± 440	**No**	IRSL age is weighted mean of two IRSL analyses.
BHV-T04	8.70, 1.75	4	TL-fn	12/6	25.28 ± 2.07	5.080 ± 0.070	1	4.890 ± 1.005	—	4.890 ± 1.005	—	No preferred age, pluvial lake history suggests all ages too young; sample contaminated with infiltrated silt(?).
			IRSL	12/6/54 bis	24.39 ± 0.73	4.09 ± 0.06	19	5.960 ± 400	17	6.180 ± 420	**No**	None.
BHV-T02	11.20, 0.95	4	TL-fn	12/6	18.54 ± 1.36	4.64 ± 0.06	16	3.990 ± 600	17	16.590 ± 2.540	**17.870 ± 1.140**	Weighted mean of fading-corrected TL and IRSL ages.
			IRSL	12/6/54 bis	19.76 ± 0.49	4.14 ± 0.06	16	4.250 ± 270	3	18.190 ± 1.280	**No**	None.
BHV-T01	22.60, 4.90	2a	TL-fn	12/6	56.43 ± 1.27	4.89 ± 0.13	13	11.540 ± 740	3	13.250 ± 850	—	No preferred age, regional pluvial lake history and overlying sample BHV-T02 suggest all ages too young.
			IRSL	12/6/54 bis	52.64 ± 0.74	4.64 ± 0.11	13	11.340 ± 610	3	13.020 ± 700	**No**	None.
PV-T01	15N/564.6 E, 4640.695 N	Barrier bar sand	OSL-L	225/10 min.	76.4 ± 14.1	3.96 ± 0.07	1	19.310 ± 7150	No	—	**17.340 ± 4.120**	Weighted mean of linear and exponential fit OSL ages.
			OSL-E	225/10 min.	76.4 ± 14.1	3.96 ± 0.07	1	16.390 ± 5038	No	—	**No**	None.

[1] All BHV sample locations from gridded south wall of Bog Hot Valley trench; PV sample is from 95 cm depth in soil pit in barrier bar in Pueblo Valley, 23 km northeast of trench site. PV location is UTM coordinates (NAD 84) from handheld GPS.
[2] Ti, Ti thermoluminescence—total bleach; IRSL, infrared-stimulated luminescence; OSL-L, blue-light optically-stimulated luminescence, single aliquot regenerative, linear fit; OSL-E, blue-light optically-stimulated luminescence, single aliquot regenerative, exponential fit.
[3] Temperature at which luminescence was measured; temperatures values for IRSL and OSL are preheat temperatures.
[4] Uncertainties are ± 1 sigma.
[5] Dose rate data from in situ measurements with Exploranium GR-256 gamma ray spectrometer at field moisture, then recalculated to 30 percent moisture (except BHV-T02 and BHV-T09, which are 20 percent moisture); sample PV-T01 dose rate measured by laboratory analysis (high-resolution gamma spectrometry) of bulk sediment sample
[6] Preferred ages; mean ages are error weighted with ± 2 sigma uncertainties; — = not calculated, age likely is zero; No, not applicable.
[7] Fading-corrected ages; anomalous fading factor in previous column applied to each age (Huntley and Lamothe, 2001); No, not applicable to OSL samples.
[8] Preferred ages; mean ages are error weighted with ± 2 sigma uncertainties; — = not calculated, age likely is zero; No, not applicable.

Table 4. Fault scarp profile and slip data from Bog Hot Valley.

Profile[1] number	Scarp[2] height (m)	Surface[3] offset (m)	Max. slope angle (°)	Lower slope angle (°)	Upper slope angle (°)	Avg. slope angle (°)	Dip slope[4] (°)	Dip slope[5] (°, sz)	Comments
BHV-1	4.3	4.3	15.5	0.0	0.0	0.0	5.0	4.5	Trench site profile in lacustrine silt, sand, and gravel on valley floor.
BHV-2	2.8	3.6	16.6	0.0	0.0	0.0	4.4	3.9	Profile in lacustrine silt, sand, and gravel on valley floor.
BHV-3	4.5	3.5	17.2	4.0	3.7	3.8	4.2	3.6	Profile in lacustrine silt, sand, and gravel on valley floor.
BHV-4	4.1	4.0	18.3	0.5	0.7	0.6	4.1	3.6	Profile in lacustrine silt, sand, and gravel on valley floor.
BHV-5	4.2	4.2	15.5	0.0	0.0	0.0	4.8	4.3	Profile in lacustrine sand on valley floor.
BHV-6	3.3	2.9	12.9	0.0	0.0	0.0	3.4	3.0	Profile in lacustrine sand on valley floor.
BHV-7	2.5	2.2	15.0	1.3	1.6	1.4	2.6	2.3	Profile in sandy alluvium on valley floor.
BHV-8	3.7	3.1	22.1	4.2	3.7	3.9	3.7	3.2	Profile in cobbly alluvium at Pine Forest Range mountain front.
BHV-9	2.2	1.9	17.2	2.4	2.4	2.4	2.2	1.9	Triggered(?) scarp on east side of valley in lacustrine pebble gravel.
BHV-10	2.8	2.5	17.0	1.5	1.7	1.6	3.0	2.6	Profile in cobbly alluvium on valley floor.
BHV-11	2.4	2.0	13.1	3.5	1.3	2.4	2.3	2.0	Profile in cobbly alluvium on valley floor.
BHV-12	3.3	2.6	14.1	3.0	3.1	3.1	3.1	2.7	Profile in sandy, pebble-cobble alluvium on valley floor.
BHV-13	5.1	4.6	16.9	2.0	1.1	1.6	5.4	4.8	Collapsed trench site profile in cobbly alluvium on valley floor.

[1] Locations marked on figure 3.
[2] Scarp height and surface offset vertical unpatched to defined by Bucknam and Anderson (1979).
[3] Calculated values using equations of Cunkey (1995) based on surface offset (vertical separation), average slope of the ground surface, and fault dip estimates based on values of typical Basin and Range faults (60°) and dip measured in Bog Hot Valley trench (57°).

Table 5. Radiocarbon data from the Bog Hot Valley trench.

Field number	Lab[1] number	Location x, y (m)	Unit number	$\delta^{13}C$ ‰	Reported[2] age (yr B.P.)	Calibrated age[3] (cal yr B.P.)	Comments
BHV-H01	OS-84943	10.25, 2.18	7e	-24.15	3,960 ± 50	4,280–4,530	Fine disseminated charcoal from lower burn layer.
BHV-H02	OS-83467	10.47, 2.25	7e	-23.55	3,680 ± 90	3,720–4,300	Fine disseminated charcoal from lower burn layer.
BHV-H03	OS-84075	9.35, 2.38	7e	-24.03	3,920 ± 30	4,190–4,430	Fine disseminated charcoal from lower burn layer.
BHV-H04	CAMS 107349	10.80, 2.65	7e	25	3,430 ± 35	3,580–3,830	Fine disseminated charcoal from upper burn layer.

[1] Laboratory identifiers: OS, National Ocean Sciences Accelerator Mass Spectrometry Facility, Woods Hole Oceanographic Institution; CAMS, Center for Accelerator Mass Spectrometry, Lawrence Livermore National Laboratory.
[2] 1 sigma analytical uncertainties reported by AMS laboratory.
[3] 2 sigma calibrated age ranges; calibration from computer program OxCal v. 3.10, Brook Ramsey, 1995, 2001) and the IntCal 2004 atmospheric data set (Reimer and others, 2004).

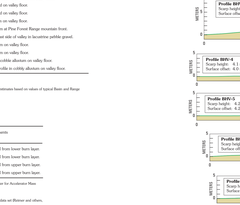


Figure 5. Fault scarp profiles in Bog Hot Valley. See figure 3 for profile locations and table 4 for additional slip data.

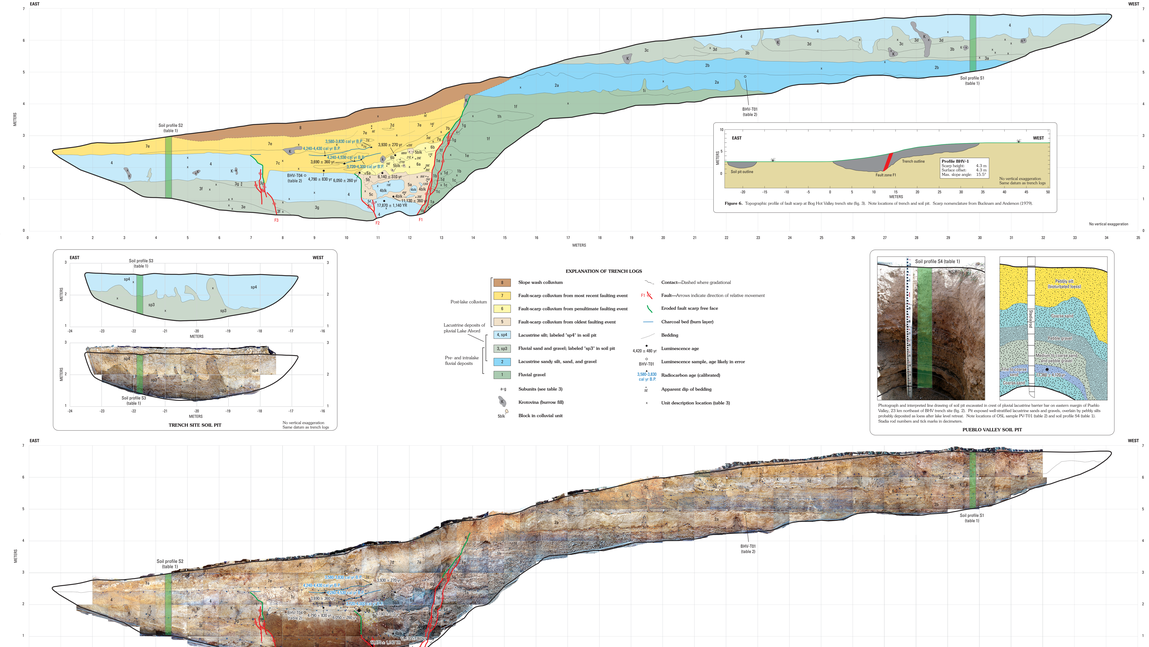
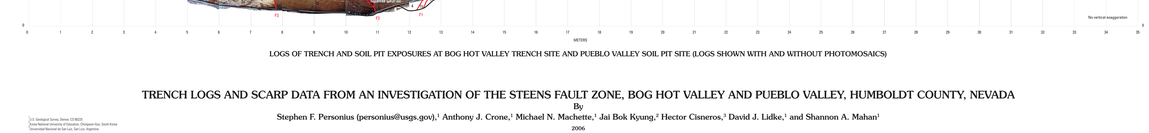


Figure 6. Topographic profile of fault scarp at Bog Hot Valley trench site (fig. 3). Note locations of trench and soil pit. Scarp nomenclature from Bucknam and Anderson (1979).



LOGS OF TRENCH AND SOIL PIT EXPOSURES AT BOG HOT VALLEY TRENCH SITE AND PUEBLO VALLEY SOIL PIT SITE (LOGS SHOWN WITH AND WITHOUT PHOTOMOSAICS)

TRENCH LOGS AND SCARP DATA FROM AN INVESTIGATION OF THE STEENS FAULT ZONE, BOG HOT VALLEY AND PUEBLO VALLEY, HUMBOLDT COUNTY, NEVADA

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