APPENDIX A

DESCRIPTION OF STRATIGRAPHIC UNITS IN THE SKINNER PEAKS SOUTH TRENCH

Unit, Genesis[1]	Location (on logs)	Textural Name[2]	Texture (%)[3]				Clasts (cm)		Plasticity[4]	Density/ Consistency[5]	Cementation	HCL rx.	Clast Angularity	Bedding	Structure	Sorting	Lower Boundary[6]	Color[7]		Notes
			F	S	G	C/B	Largest	Avg.										Dry	Wet	
Unit 1, B	SPS-1, NW	Weathered tuffaceous bedrock, sandstone	-	-	-	-	-	-	-	lo	weak	none	-	top of bedrock	homogene -ous	well to moderate	-	10 YR 8/2	10 YR 6/2	Deeply weathered tuffaceous bedrock
Unit 2, AF	SPS-2, NW	Gravely sand with minor cobbles	-	78	20	2	17	6	po	so to sh	weak	strong	angular	poor, coarsening upward	gravel lenses in sand matrix	well	a	10 YR 7/6	10 YR 5/4	Small lenses of alluvial gravel in sandy matrix with large channel cuts. Numerous krotovina.
Unit 3, AF	SPS-3, NW	Gravely sand with minor cobbles	-	78	20	2	25	4	po	so to sh	weak to moderate	strong	angular	poor	gravel lenses in sand matrix	well sorted	c	7.5 YR 7/2	7.5 YR 6/2	Discontinuous gravel lenses in sandy matrix.
Unit 4, AF	SPS-4, NW	Gravely sand with minor cobbles	-	78	20	2	14	6	po	h	weak to moderate	strong	angular to subangular	poor to moderate	weak imbricatio n in gravel beds	moderate to well	g	7.5 YR 5/2	7.5 YR 4/3	One continuous gravel bed, others discontinuous, internal weak bedding with weak imbrication.
Unit 5, AF	SPS-5, NW	Gravely sand with minor silt	5	90	5	<1	16	4	ps	vh to h	moderate	strong	angular	very poor	none	moderate to well	d	7.5 YR 5/3	7.5 YR 4/2	Alluvial fan w/modern soil, strong soil pediments, AC – soil distinction, vertical cracks in AC soil at 20 cm depth.
C1, C	SPS-6, SW	Sand with silt and gravel	5	90	5	-	6	2	ps	so to sh	weak	strong	angular	slope fabric near fault zone	slope fabric near fault zone	moderate to well	c	7.5 YR 5/3	7.5 YR 4/3	More gravel/cobbles near base (fining upwards). Modern soil at top of unit.
C1 upper (C2), C	SPS-7	Sand with silt and gravel	5	92	2	1	18	8	ps	h	weak	strong	angular	slope fabric close to free face	slope fabric	moderate to well	c	7.5 YR 5/2	7.5 YR 3/2	Coarse cobbles at free-face, much finer away from free-face. Modern soil at top, numerous krotovina.

[1]Genesis: **AF** - alluvial fan, **S** - stream, **DF** - debris flow, **L** - lacustrine, **C** - colluvium, **F** - fill, **HC** - hillslope colluvium, **FC** - fault colluvium, **B** - bedrock.

[2]Texture name approximated using the Unified Soil Classification System (density/consistency after Birkeland and others [1991]). Textural information may not be representative of entire unit due to vertical and horizontal heterogeneity in units.

[3]Percentages of clast-size fractions (based on area) are field estimates. **F** - fines (silt and clay), **S** - sand, **G** - gravel, **C/B** - cobbles and boulders. We used a U.S. Standard #10 (2 mm) sieve to separate matrix (clay, silt, and sand) from gravel.

[4]Plasticity: **po** - nonplastic, **ps** - slightly plastic, **p** - plastic, **vp** - very plastic

[5]Wet Density/Consistency: **so** - nonsticky, **ss** - slightly sticky, **s** - sticky, **vs** - very sticky. Dry Density/Consistency: **lo** - loose, **so** - soft, **sh** - slightly hard, **h** - hard, **vh** - very hard, **eh** - extremely hard.

[6]Lower Boundary modified from Birkeland and others (1991). Distinctness: **a** - abrupt (1 mm–2.5 cm), **c** - clear (2.5–6 cm), **g** - gradual (6–12.5 cm), **d** - diffuse (>12.5 cm). Topography: **s** - smooth, **w** - wavy, **i** - irregular, **ne** - base of unit not exposed.

[7]Munsell color of matrix (year 2000, revised version).

APPENDIX B

DESCRIPTION OF STRATIGRAPHIC UNITS IN THE HELLS KITCHEN SOUTH TRENCH

Unit, Genesis[1]	Location (on logs)	Textural Name[2]	Texture (%)[3]				Clasts (cm)		Plasticity[4]	Density/ Consistency[5]	Cementation	HCL rx.	Clast Angularity	Bedding	Structure	Sorting	Lower Boundary[6]	Color[7]		Notes
			F	S	G	C/B	Largest	Avg.										Dry	Wet	
Unit 1, LO	HKS-1, SW	Clayey silt	99	-	<1	-	4	1	ps	vh	moderate	strong	angular	massive	none	very well	-	7.5 YR 8/4	5 YR 6/6	Loess with minor pebbles.
Unit 2, AF	HKS-2, SW	Clayey silt with gravel	75	5	20	-	7	2	ps	h	weak	strong	angular	massive with faint bedding, small pebble lenses	faint	well to very well	g	7.5 YR 6/4	7.5 YR 4/6	Sand component is very fine. Some small pebble lenses.
Unit 3, AF	HKS-3, SW	Gravely sand with silt and clay	10	50	34	1	15	5	ps	h	weak	strong	subangular to subrounded	well bedded	imbricated gravels	very poor	a	7.5 YR 6/4	7.5 YR 5/4	Scouring into unit below, abundant pin-hole texture in fine beds.
Unit 4, AF w/soil A horizon	HKS-4, SW	Gravely sand with silt and clay	5	50	44	1	16	5	po	h	weak to moderate	strong	subangular to subrounded	moderate to well bedded	imbricated gravels	very poor to poor	a	10 YR 6/4	10 YR 5/8	Pinholes in fine-grained beds. Platy texture in upper fine-grained beds. A-soil horizon at top.
C1, C	HKS-5, SW	Gravely sand with silt	10	50	38	2	10	4	po	h	weak	strong	subrounded to subangular	slope fabric close to free-face	some slope fabric	very poor	c	7.5 YR 7/3	7.4 YR 5/6	Pinholes in fine-grained material. Coarse gravel/cobbles at free-face, modern A-soil horizon at top.

[1]Genesis: **AF** - alluvial fan, **S** - stream, **DF** - debris flow, **L** - lacustrine, **C** - colluvium, **F** - fill, **HC** - hillslope colluvium, **FC** - fault colluvium, **B** - bedrock, **LO** - loess.

[2]Texture name approximated using the Unified Soil Classification System (density/consistency after Birkeland and others [1991]). Textural information may not be representative of entire unit due to vertical and horizontal heterogeneity in units.

[3]Percentages of clast-size fractions (based on area) are field estimates. **F** - fines (silt and clay), **S** - sand, **G** - gravel, **C/B** - cobbles and boulders. We used a U.S. Standard #10 (2 mm) sieve to separate matrix (clay, silt, and sand) from gravel.

[4]Plasticity: **po** - nonplastic, **ps** - slightly plastic, **p** - plastic, **vp** - very plastic

[5]Wet Density/Consistency: **so** - nonsticky, **ss** - slightly sticky, **s** - sticky, **vs** - very sticky. Dry Density/Consistency: **lo** - loose, **so** - soft, **sh** - slightly hard, **h** - hard, **vh** - very hard, **eh** - extremely hard

[6]Lower Boundary modified from Birkeland and others (1991). Distinctness: **a** - abrupt (1 mm–2.5 cm), **c** - clear (2.5–6 cm), **g** - gradual (6–12.5 cm), **d** - diffuse (>12.5 cm). Topography: **s** - smooth, **w** - wavy, **i** - irregular, **ne** - base of unit not exposed.

[7]Munsell color of matrix (year 2000, revised version).

APPENDIX C

DESCRIPTION OF COLLUVIAL WEDGE UNITS IN THE SKINNER PEAKS SOUTH TRENCH

Colluvial Wedge Unit	Lower Contact Details	Upper Contact Details	Max Thickness (avoiding mini-grabens or wedge heels)	Soil Development Within Wedge?	Soil Development Below Wedge?	Fault Terminations?	Back-Rotation/Unconformities?	Other Evidence that this is a Wedge?	Other Notes (C14/OSL samples)/Evidence Against Colluvial-Wedge Interpretation?
C2, FZ-1	Sitting on soil on fan, clear in places	Soil on upper C2 contact	~50 cm, ~1m east of FZ-1	Weak near top	Yes, on alluvial fan deposit underneath C2, good A-horizon	None	Slight back-rotation of fan below wedge	Nice coarse heel with stone line at base of wedge. Fines upward and outward	Collected C-14 and OSL in wedge and soil buried by wedge
C2, FZ-2 (block zone)	"Zig Zag" sitting on rotated blocks; Mapped based on dark C2 color	Gradational coincidental with modern ground surface	~50 cm	Indistinguishable, looks entirely made up of soil	Indistinguishable, due to block structure	Mapped, but not clear due to block structure. Some shearing in C2 on south wall	Forward-tilted blocks of fan deposits	Seems associated with P2 at FZ-1 due to block movement	Collected C-14 bulk from south wall
C2, FZ-3 (block zone)	Sharp against block deposits to west	Slight soil development below C1	~85 cm fissure fill; ~22 cm thickness away from fissure	Hard to distinguish from soil on top	Indistinguishable	1 on south wall	Block structure defines FZ-3	Fault-bounded surface is colluvial in nature	C-14 and OSL collected from south wall
C1, FZ-1	Pebble line at toe on south wall, otherwise hard to distinguish	Modern A soil	~50 cm	Modern A soil at top	Yes, thin, on top of C2 wedge	None	None	Association with P1 event at FZ-3	
C1, FZ-2	Slight change from C2 below (south wall), darker and finer	Modern A soil	~30–40 cm	Modern A soil at top	Yes, thin, on top of C2 wedge	Yes (south wall)	None	Association with P1 event at FZ-3	
C1, FZ-3	Slight soil development on top of C2	Modern A soil	~50–60 cm	Modern A soil at top	Indistinguishable	None	None	Nice clast geometry and stone line at base	C-14 and OSL collected from south wall

APPENDIX D

DESCRIPTION OF COLLUVIAL WEDGE UNITS IN THE HELLS KITCHEN SOUTH TRENCH

Colluvial Wedge Unit	Lower Contact Details	Upper Contact Details	Max Thickness (avoiding mini-grabens or wedge heels)	Soil Development Within Wedge?	Soil Development Below Wedge?	Fault Terminations?	Back-Rotation/Unconformities?	Other Evidence that this is a Wedge?	Other Notes (C14/OSL samples)/Evidence Against Colluvial-Wedge Interpretation?
C1	Colluvium sitting on soil on fan deposits. Fairly sharp contact, cobbly heel with stone line at base.	Modern A soil	~50–60 cm	None	Yes, Soil on fan deposits buried by C1 wedge	Yes	None	Shear at back end of wedge	C-14 bulk, C-14 macro, and OSL collected from wedge and soil below wedge on both walls

APPENDIX E

PROCESSING AND ANALYSIS OF RADIOCARBON SAMPLE MATERIAL FROM THE SKINNER PEAKS SOUTH AND HELLS KITCHEN SOUTH SITES BY PALEORESEARCH INSTITUTE

MACROFLORAL ANALYSIS AND CHARCOAL IDENTIFICATION OF SEDIMENT SAMPLES FROM THE WASATCH FAULT ZONE, JUAB AND SANPETE COUNTIES, UTAH

By

Peter Kováčik

PaleoResearch Institute, Inc.
Golden, Colorado

PaleoResearch Institute Technical Report 2018-013

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INTRODUCTION

The Skinner Peaks South and Hells Kitchen South trench sites are situated across the Wasatch fault in Juab and Sanpete Counties, Utah. Both sites are located above the Lake Bonneville highstand elevation (Adam Hiscock, personal communication January 29, 2018). Two charcoal and 13 bulk soil samples were submitted for macrofloral analysis to recover and identify charcoal and charred botanic remains suitable for radiocarbon age determination.

METHODS

Macrofloral

Bulk samples were floated using a modification of procedures outlined by Matthews (1979). Each sample was added to approximately three gallons of water, then stirred until a strong vortex formed. The floating material (light fraction) was poured through a 250-micron mesh sieve. All material that passed through the screen was retained for possible microcharcoal, particulate soil organics, and/or humate extraction. Additional water was added and the process repeated until all floating material was removed from the samples (a minimum of five times). The material remaining in the bottom (heavy fraction) was poured through a 0.5-mm mesh screen. The floated portions were allowed to dry.

The light fractions were weighed, then passed through a series of graduated screens (US Standard Sieves with 4-mm, 2-mm, 1-mm, 0.5-mm, and 0.25-mm openings) to separate charcoal debris and to initially sort the remains. Contents of each screen then were examined. Charcoal pieces larger than 2 mm, 1 mm, 0.5 mm in diameter were separated from the rest of the light fraction, and the total charcoal was weighed. Charcoal pieces in a representative sample were broken to expose fresh cross, radial, and tangential sections, then examined under a binocular microscope at a magnification of 70x and under a Nikon Optiphot 66 microscope at magnifications of 320–800x. Weights of each charcoal type within the representative sample were recorded. Material that remained in the 4-mm, 2-mm, 1-mm, 0.5-mm, and 0.25-mm sieves was scanned under a binocular stereo microscope at a magnification of 10x, with some identifications requiring magnifications of up to 70x. Material that passed through the 0.25-mm screen was not examined. Heavy fractions were scanned at a magnification of 2x for the presence of botanic remains. The term "seed" is used to represent seeds, achenes, caryopses, and other disseminules. Remains from the light and heavy fractions were recorded as charred and/or uncharred, whole and/or fragments. Macrofloral remains, including charcoal, were identified using manuals (Carlquist 2001; Hoadley 1990; Martin and Barkley 1961; Musil 1963; Schopmeyer 1974; Schweingruber et al. 2011, 2013) and by comparison with modern and archaeological references. Clean laboratory conditions were used during flotation and identification to avoid contamination of charcoal and botanic remains to be submitted for radiocarbon dating. All instruments were washed between samples, and the samples were protected from contact with modern charcoal.

DISCUSSION

Located above the elevation of the Lake Bonneville highstand in Juab and Sanpete Counties, Utah, the Skinner Peaks South and Hells Kitchen South trench sites lie across the Levan and Fayette segments of the Wasatch fault (Adam Hiscock, personal communication January 29, 2018). Samples collected from these sites were examined for the presence of charcoal and charred macrofloral remains. Identification indicates charred remains suitable for possible AMS radiocarbon age determination based on species or plant part longevity, prioritizing annuals (seeds, fruits etc.), followed by charcoal from twigs and/or short-lived species.

Skinner Peaks South

The Skinner Peaks South trench site lies at an elevation of 5396–5413 ft on the Levan segment of the Wasatch fault zone, Juab County. Local vegetation includes sagebrush (*Artemisia*), grasses (Poaceae), and pinyon-juniper forest (*Pinus edulis/monophylla-Juniperus*). The Skinner Peaks South trench exposed primarily alluvial fan gravels, several prominent buried paleo-soils, and fault-scarp-derived colluvium. Nine sediment samples collected from various deposits were examined for macrofloral remains.

Sample SPS-S-RC04, collected from P1 colluvium (Unit C1) at a depth of 0.3 mbs (Table 1), yielded a charred *Descurainia* seed (0.0003 g), suggesting tansy mustard (Tables 2 and 3), and one charred awn fragment (less than 0.0001 g), reflecting either grass (Poaceae) or storksbill (*Erodium*). The anthracological (charcoal) assemblage includes one *Artemisia* (less than 0.0001 g), two *Atriplex* (0.0005 g), and five *Juniperus* (0.0014 g) charcoal fragments, reflecting sagebrush, saltbush, and juniper wood burned in local fire. Several conifer (0.0006 g) and unidentified hardwood (0.0007 g) charcoal fragments were too small (~ 0.25 mm) for further identification. Either the tansy mustard seed or the awn would be ideal for radiocarbon analysis, however they are likely too small to withstand the chemical pretreatment. Similarly, charcoal from short-lived sagebrush and saltbush also represent preferable material for dating. These remains also did not yield enough mass for radiocarbon analysis. Hardwood charcoal, including saltbush and sagebrush, the charred tansy mustard seed, and charred awn may be combined to provide a more suitable sample size. Uncharred roots and rootlets also were noted, indicating modern plants growing at the site. A few insect chitin and puparia fragments suggest subsurface insect activity.

Collected from the upper portion of the P2 colluvium (Unit C2) at a depth of 0.5 mbs, Macrofloral Sample SPS-S-RC02 yielded five *Artemisia* (0.0068 g), one *Atriplex* (0.0004 g), 20 conifer (0.0045 g), and two *Juniperus* (0.0016 g) charcoal fragments. These pieces (~0.5 mm) indicate burned sagebrush, saltbush, conifer, and juniper wood. The largest single sagebrush charcoal, weighing 0.0030 g, is ideal for radiocarbon analysis. Uncharred rootlets and insect chitin fragments also were noted.

Sediment from the middle (0.5 mbs) of the P2 colluvium (Unit C2), Sample SPS-S-RC05, yielded tiny (~ 0.5 mm) charcoal fragments. One *Artemisia* (less than 0.0001 g), a single *Atriplex* (0.0004 g), and five *Juniperus* (0.0005 g) charcoal fragments indicate local sagebrush, saltbush, and juniper burned in a wild fire. A single unidentified hardwood (less than 0.0001 g) and ten conifer (0.0005 g) charcoal fragments were too small for further identification. Although, juniper charcoal fragments provided the most mass (0.0010 g), it is borderline sufficient. All recovered types may be combined to increase the charcoal mass. Samples that comprise several very small charcoal pieces that have relatively large surface areas compared to their mass likely lose a greater percent of their mass (usually more than 50%) than do samples comprising fewer, larger pieces of charcoal. We recommend using a cold, dilute base (0.05%) for the first base treatment to evaluate the charcoal response. In case these charcoal fragments dissolve during chemical pre-treatment, it is possible to extract microscopic charcoal fragments (microscopic charcoal/microcharcoal) from sediments that passed through the 250-micron mesh sieve during the floatation procedure and have been retained. Uncharred roots/rootlets and insect chitin fragments also were noted in this sample.

Sample SPS-S-RC06 was collected from P2 colluvium (Unit C2) at a depth of 0.5 mbs. Several charred *Atriplex* fruit pieces (0.0039 g), one charred *Atriplex* twig fragment (0.0002 g), and four *Atriplex* charcoal fragments (0.0025 g) indicate burned saltbush fruits and wood/twigs. Charred saltbush fruits are sufficient for radiocarbon analysis. Four *Artemisia* charcoal fragments (0.0008 g) indicate sagebrush wood also burned in the wildfire. Three unidentified hardwood charcoal fragments might represent saltbush, sagebrush, or other local hardwoods. Numerous rootlets and few insect chitin fragments represent uncharred remains suggesting modern contaminants.

The north wall of the trench also was sampled at a depth 0.5 mbs (P2 colluvium). Sample SPS-N-RC09 yielded three conifer (0.0002 g), five *Juniperus* (0.0051 g), and five unidentified hardwood (0.0001 g) charcoal fragments reflecting conifer, juniper, and hardwood. The largest single juniper wood, weighing 0.0027 g, is the most suitable charred remain for radiocarbon analysis. Uncharred remains include rootlets and insect chitin fragments.

The top of the buried soil below P2 colluvium (Unit 5A) was sampled (SPS-S-RC07) at a depth of 0.7 mbs. The charcoal record (~ 0.5 mm) includes three *Artemisia* (0.0005 g), one *Atriplex* (0.0003 g), six vitrified conifer (0.0008 g), five *Juniperus* (0.0015 g), and eight unidentified hardwood (0.0010 g) charcoal fragments reflecting sagebrush, saltbush, conifer, juniper, and unspecified hardwood. Sagebrush, saltbush, and unidentified hardwood charcoal fragments may be combined to provide enough mass for radiocarbon analysis. Vitrified charcoal has a shiny, glassy appearance that can range from still recognizable in structure "to a dense mass, completely 'molten' and non-determinable" (Marguerie and Hunot 2007; McParland et al. 2010). Although charcoal vitrification has been attributed to burning at high temperature and/or burning green wood, the process of vitrification is not completely understood. Experimental studies and reflectance measurements on archaeological charcoal suggest that vitrification can occur at low temperatures (McParland, et al. 2010). Kaelin et al. (2006:1-12) associate vitrification with changes in the lignin structure of wood. Specifically, they implicate changes resulting from "reactions involving and altering the nature of the C3 side-chain unit, reducing the number of β-O-4 linked lignin units" (Kaelin, et al. 2006:10). Experiments examining wood composition changes during heating at low and high temperatures (Rutherford et al. 2005) indicate transformation of lignin, identified using Fourier Transform Infrared (FTIR) analysis. Uncharred insect chitin fragments and rootlets also were noted.

Sample SPS-N-RC10 was collected from Unit 5A (0.75 mbs) in the north wall. Several unidentifiable charcoal fragments (0.0006 g) too small (~ 0.25 mm) and too vitrified for further identification were recovered. Conifer (0.0010 g) charcoal fragments also were extremely small, preventing more specific identification. Seven *Artemisia* (0.0003 g) and three *Atriplex* (0.0004 g) charcoal fragments indicate sagebrush and saltbush. These fragments are not sufficient for radiocarbon analysis. Microscopic charcoal extraction from retained sediments could provide enough mass for AMS radiocarbon age determination. This sample also yielded uncharred roots/rootlets and insect chitin fragments.

A buried soil, Unit 4A, in the footwall portion of the fault zone was sampled at a depth of 1.25 mbs. Sample SPS-S-RC03 yielded very few and tiny (~ 0.25 mm) charcoal fragments. Three unidentified hardwood (less than 0.0001 g) charcoal fragments were too small/vitrified for further identification. Small conifer charcoal pieces (0.0006 g) could indicate juniper or another local conifer taxon. Although macro-charcoal did not provide enough mass, microscopic charcoal extraction might provide enough microcharcoal for radiocarbon analysis. The sample was dominated by uncharred roots/rootlets. A few insect chitin fragments also were noted.

Sample SPS-S-RC08 was collected from the top of the buried soil (Unit 4) at a depth of 1.0 mbs. Several *Atriplex* (saltbush) charcoal fragments, weighing 0.0023 g, may be submitted for radiocarbon analysis. A single unidentified hardwood charcoal fragment (less than 0.0001 g) was too small (~ 0.5 mm) for further identification. Four *Juniperus* (0.0005 g) and 15 conifer (0.0011 g) charcoal fragments indicate juniper and possibly another local conifer. Uncharred roots/rootlets dominated the record. A few uncharred insect chitin fragments indicate limited insect subsurface activity.

Hells Kitchen South

Located at an elevation of 5101–5114 ft, the Hells Kitchen South trench site was excavated across the Fayette segment of the Wasatch fault in Sanpete County. Grasses (Poaceae) dominate the study area, which is heavily affected by sheep grazing. Sparse juniper (*Juniperus*) and pinyon (*Pinus edulis/monophylla*) trees were noted on the landscape. Fine-grained loess deposits near the bottom of the trench, and coarse alluvial fan gravels and fault-scarp-derived colluvium were exposed. Four macrofloral and two charcoal samples were submitted for analysis.

Sediment Sample HKS-S-RC01, collected from top of P1 colluvium (Unit C1) near modern soil, yielded a single *Atriplex* charcoal fragment indicating burned saltbush wood. This charcoal piece, weighing 0.0067 g, is recommended for radiocarbon analysis. In addition, five *Juniperus* (0.0012 g) and five conifer (0.0016 g) charcoal fragments were identified, reflecting juniper and possibly other conifer wood. Uncharred rootlets dominated the light fraction of the sample. Non-floral remains include insect chitin/puparia and snail shells, suggesting insect and snail subsurface activity.

Sample HKS-S-RC03 was collected from the bottom of P1 colluvium (Unit C1) at a depth of 0.4 mbs. This location is only 4–5 meters away from the fault zone. Numerous uncharred rootlets, few insect chitin fragments, few snail shell fragments, and tiny (0.5 mm) charcoal fragments were noted. The anthracological (charcoal) assemblage consisted of four *Atriplex* (0.0005 g), one *Juniperus* (less than 0.0001 g), and 27 conifer (0.0035 g) charcoal fragments, indicating saltbush, juniper, and unspecified conifer. Conifer charcoal fragments provided the largest mass and may be submitted for radiocarbon analysis.

A buried soil (Unit 4A) located below P1 colluvium was sampled at a depth of 0.5 mbs. Sample HKS-S-RC02 yielded a single *Atriplex* (less than 0.0001 g), two conifer (0.0009 g), and nine *Juniperus* (0.0019 g) charcoal fragments indicating burned saltbush, unidentified conifer, and juniper. While saltbush charcoal is not sufficient, the juniper charcoal pieces may be submitted for radiocarbon analysis. Uncharred remains include numerous rootlets, few insect chitin fragments, and moderate quantity of snail shells.

Sediment Sample HKS-S-RC04, collected from a buried soil (Unit 4A) at a depth of 0.65 mbs, contained numerous rootlets, a few insect chitin fragments, a moderate quantity of snail shells, and very small (~ 0.5 mm) charcoal fragments. The charcoal record was dominated by conifer (0.0024 g) and *Juniperus* (0.0085 g) fragments. These charcoal fragments indicate burned conifer wood, including juniper. In addition, a single *Artemisia* (0.0004 g) and two *Atriplex* (0.0004 g) charcoal fragments were identified, suggesting sagebrush and saltbush. Both sagebrush and saltbush charcoal types are not a sufficient mass for dating, whereas the juniper charcoal provided enough mass for radiocarbon analysis.

Charcoal Sample HKS-S-RC09 was collected from Unit 4 (0.5 mbs) in the hanging wall portion of the fault zone. Eight *Juniperus* (juniper) charcoal fragments provided sufficient mass (0.0041 g) for AMS radiocarbon age determination.

Another charcoal sample (HKS-N-RC07) was removed from Unit 4 (0.6 mbs) in the footwall portion of the north trench wall. A single *Juniperus* charcoal fragment (0.0021 g) indicates burned juniper wood. Several conifer charcoal fragments (0.0014 g), probably representing juniper or pinyon, were too small for more specific identification. A single juniper charcoal piece may be submitted for radiocarbon analysis.

SUMMARY AND CONCLUSIONS

Examination of 13 bulk sediment samples and two charcoal samples from the Skinner Peaks South (Levan segment) and the Hells Kitchen South (Fayette segment) trench sites in Utah resulted in recovery of charcoal or charred botanics in various quantities. Identification of charcoal and charred botanics allows selection of the most appropriate material, based on longevity and size, for radiocarbon analysis.

The light fractions of all samples were dominated by uncharred roots/rootlets. Charred annuals, such as seeds, fruits, and nuts are preferred materials for radiocarbon analysis. However, they usually are recovered less frequently than charcoal. Although one tansy mustard (*Descurainia*) seed and a grass/storksbill (Poaceae/*Erodium*) awn were recovered in Sample SPS-S-RC04 (Unit C1), they are too small for radiocarbon analysis. On the other hand, several charred saltbush (*Atriplex*) fruit fragments identified in Sample SPS-S-RC06 (Unit C2) yielded a sufficient mass for radiocarbon analysis. This sample also yielded one saltbush and one unidentified hardwood charcoal twig. Charred twigs also are a very desirable material for AMS radiocarbon dating. However, both twig fragments from Sample SPS-S-RC06 were too small to survive chemical pre-treatment.

Charcoal assemblages from bulk soil samples consisted of extremely small (~ 0.5 or 0.25 mm) pieces, often resulting in identification only to the conifer or hardwood level.

Hardwood species usually have shorter life-spans than conifers. The short-lived hardwoods such as saltbush (*Atriplex*) and sagebrush (*Artemisia*) were present in some of these samples. Saltbush shrubs live on average 20–40 years, representing a good material for radiocarbon dating. The average life-span of sagebrush species varies from 30–100 years, to a maximum of 200 years. Saltbush (*Atriplex*) charcoal was identified in Samples SPS-S-RC04 (Unit C1), SPS-S-RC02 (Unit C2), SPS-S-RC05 (Unit C2), SPS-S-RC06 (Unit C2), SPS-S-RC07 (Unit 5A), SPS-N-RC10 (Unit 5A), SPS-S-RC08 (Unit 4), HKS-S-RC01 (Unit C1), HKS-S-RC03 (C1), HKS-S-RC02 (Unit 4A), HKS-S-RC04 (Unit 4A). However, sufficient saltbush charcoal mass was only obtained in Samples SPS-S-RC06, SPS-S-RC08, and HKS-S-RC01. Sagebrush (*Artemisia*) charcoal was present in Samples SPS-S-RC04 (Unit C1), SPS-S-RC02 (Unit C2), SPS-S-RC05 (Unit C2), SPS-S-RC06 (Unit C2), SPS-S-RC07 (Unit 5A), SPS-N-RC10 (Unit 5A), and HKS-S-RC04 (Unit 4A). Out of these, only Sample SPS-S-RC02 provided a datable mass.

Juniper (*Juniperus*) was the only conifer identified to genus. Recovered conifer charcoal pieces could indicate juniper or other locally available conifers, such as pinyons. Junipers are long-lived trees. They are usually not recommended for radiocarbon analysis, unless no other short-lived species are present. Three juniper species are reported to grow in both Juab and Sanpete Counties, *J. communis* (common juniper) with an average life-span of 100–120 years; *J. osteosperma* (Utah juniper) with an average longevity of 145–250 years and maximum of 650–1000+ years; and *J. scopulorum* (Rocky Mountain juniper), which on average, lives for 200–300 years, although it can live for up to 1500–2000 years. Conifer/*Juniperus* charcoal was identified in all samples, except Sample SPS-S-RC06 (Unit C2). Juniper, or combination of juniper and conifer charcoal, appears to be the only option for radiocarbon analysis in Samples SPS-S-RC05, SPS-N-RC09, SPS-S-RC07, SPS-N-RC10, HKS-S-RC03, HKS-S-RC02, HKS-S-RC04, HKS-S-RC09, and HKS-S-RC07.

The presence of charred plant material in every sample suggests microscopic charcoal is present in retained sediments and can be extracted as needed. In order to obtain sufficient datable charred mass, microscopic charcoal extraction is especially required for Samples SPS-S-RC05, SPS-N-RC10, and SPS-S-RC03. It is possible that macro-charcoal from other samples will not withstand chemical pre-treatment. In these cases microscopic charcoal can be extracted to provide a back-up for samples that dissolve during chemical pre-treatment.

TABLE 1
PROVENIENCE DATA FOR SAMPLES FROM THE WASATCH FAULT ZONE,
JUAB AND SANPETE COUNTIES, UTAH

Sample No.	Unit	Depth (mbs)	Provenience/ Description	Analysis
Skinner Peaks South, Levan Segment				
SPS-S-RC04	C1	0.3	Sediment from P1 colluvium	Macrofloral
SPS-S-RC02	C2	0.5	Sediment from upper P2 colluvium, buried by P1 colluvium	Macrofloral
SPS-S-RC05		0.5	Sediment from middle of P2 colluvium	Macrofloral
SPS-S-RC06		0.5	Sediment near base of P2 colluvium	Macrofloral
SPS-N-RC09		0.5	Sediment from P2 colluvium in north wall of trench	Macrofloral
SPS-S-RC07	5A	0.7	Sediment from top of buried soil under P2 colluvium	Macrofloral
SPS-N-RC10		0.75	Sediment from buried soil under P2 colluvium in north wall of trench	Macrofloral
SPS-S-RC03	4A	1.25	Sediment from buried soil in footwall	Macrofloral
SPS-S-RC08	4	1.0	Sediment from buried soil in hanging wall, top of 4	Macrofloral
Hells Kitchen South, Fayette Segment				
HKS-S-RC01	C1	0.4	Sediment from top of P1 colluvium near modern soil	Macrofloral
HKS-S-RC03		0.4	Sediment from basal P1 colluvium, 4–5 m away from fault zone	Macrofloral
HKS-S-RC02	4A	0.5	Sediment from buried soil below P1 colluvium	Macrofloral
HKS-S-RC04		0.65	Sediment from buried soil below P1 colluvium	Macrofloral
HKS-S-RC09	4	0.5	Charcoal from hanging wall	Charcoal ID
HKS-N-RC07		0.6	Charcoal from footwall	Charcoal ID

TABLE 2
MACROFLORAL REMAINS FROM THE WASATCH FAULT ZONE,
JUAB AND SANPETE COUNTIES, UTAH

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
Skinner Peaks South, Levan Segment							
SPS-S-RC04	Liters Floated						1.00 L
0.3 mbs	Light Fraction Weight						1.881 g
	FLORAL REMAINS:						
	Descurainia	Seed	1				0.0003 g
	Poaceae/*Erodium*	Awn		1			< 0.0001 g
	Roots					X	Few
	Rootlets					X	Numerous
	CHARCOAL/WOOD:						
	Total charcoal ≥ 0.25 mm						0.0032 g
	Artemisia	Charcoal		1			< 0.0001 g
	Atriplex	Charcoal		2			0.0005 g
	Conifer - small	Charcoal		13			0.0006 g
	Juniperus	Charcoal		5			0.0014 g
	Unidentified hardwood - small	Charcoal		10			0.0007 g
	NON-FLORAL REMAINS:						
	Insect	Chitin				X	Few
	Insect	Puparia			X	X	Few
	Rock/Sand					X	Few
SPS-S-RC02	Liters Floated						1.20 L
0.5 mbs	Light Fraction Weight						0.614 g
	FLORAL REMAINS:						
	Rootlets					X	Numerous
	CHARCOAL/WOOD:						
	Total charcoal ≥ 0.5 mm						0.0133 g
	Artemisia (LSP=0.0030 g)	Charcoal		5			0.0068 g
	Atriplex	Charcoal		1			0.0004 g
	Conifer - small	Charcoal		20			0.0045 g
	Juniperus (LSP=0.0011 g)	Charcoal		2			0.0016 g
	NON-FLORAL REMAINS:						
	Insect	Chitin				X	Few
	Rock/Sand					X	Few

TABLE 2 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
SPS-S-RC05	Liters Floated						1.40 L
0.5 mbs	Light Fraction Weight						0.814 g
	FLORAL REMAINS:						
	Roots					X	Few
	Rootlets					X	Numerous
	CHARCOAL/WOOD:						
	Total charcoal ≥ 0.5 mm						0.0020 g
	Artemisia	Charcoal		1			< 0.0001 g
	Atriplex	Charcoal		1			0.0004 g
	Conifer - small	Charcoal		10			0.0005 g
	Juniperus	Charcoal		5			0.0010 g
	Unidentified hardwood - small	Charcoal		1			< 0.0001 g
	NON-FLORAL REMAINS:						
	Insect	Chitin				X	Few
	Rock/Sand					X	Few
SPS-S-RC06	Liters Floated						1.20 L
0.5 mbs	Light Fraction Weight						0.672 g
	FLORAL REMAINS:						
	Atriplex (LSP=0.0010 g)	Fruit		15			0.0039 g
	Rootlets					X	Numerous
	CHARCOAL/WOOD:						
	Total charcoal ≥ 0.5 mm						0.0040 g
	Artemisia	Charcoal		4			0.0008 g
	Atriplex (LSP=0.0012 g)	Charcoal		4			0.0025 g
	Atriplex twig	Charcoal		1			0.0002 g
	Unidentified hardwood - small	Charcoal		2			0.0002 g
	Unidentified hardwood - twig	Charcoal		1			0.0003 g
	NON-FLORAL REMAINS:						
	Insect	Chitin				X	Few
	Rock/Sand					X	Few
SPS-N-RC09	Liters Floated						1.20 L
0.5 mbs	Light Fraction Weight						0.980 g
	FLORAL REMAINS:						
	Rootlets					X	Moderate

TABLE 2 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
SPS-N-RC09	CHARCOAL/WOOD:						
0.5 mbs	Total charcoal ≥ 0.5 mm						0.0054 g
	Conifer - small	Charcoal		3			0.0002 g
	Juniperus	Charcoal		5			0.0051 g
	Unidentified hardwood - small	Charcoal		5			0.0001 g
	NON-FLORAL REMAINS:						
	Insect	Chitin				X	Few
	Rock/Sand					X	Few
SPS-S-RC07	Liters Floated						1.10 L
0.7 mbs	Light Fraction Weight						0.969 g
	FLORAL REMAINS:						
	Rootlets					X	Moderate
	CHARCOAL/WOOD:						
	Total charcoal ≥ 0.5 mm						0.0041 g
	Artemisia	Charcoal		3			0.0005 g
	Atriplex	Charcoal		1			0.0003 g
	Conifer - small, vitrified	Charcoal		6			0.0008 g
	Juniperus	Charcoal		5			0.0015 g
	Unidentified hardwood - small	Charcoal		8			0.0010 g
	NON-FLORAL REMAINS:						
	Insect	Chitin				X	Few
	Rock					X	Few
SPS-N-RC10	Liters Floated						1.50 L
0.75 mbs	Light Fraction Weight						0.506 g
	FLORAL REMAINS:						
	Roots					X	Few
	Rootlets					X	Moderate
	CHARCOAL/WOOD:						
	Total charcoal ≥ 0.25 mm						0.0023 g
	Artemisia	Charcoal					0.0003 g
	Atriplex	Charcoal					0.0004 g
	Conifer - small	Charcoal					0.0010 g
	Unidentifiable - small, vitrified	Charcoal					0.0006 g

TABLE 2 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
SPS-N-RC10	NON-FLORAL REMAINS:						
0.75 mbs	Insect	Chitin				X	Few
	Rock/Sand					X	Few
SPS-S-RC03	Liters Floated						0.80 L
1.25 mbs	Light Fraction Weight						1.871 g
	FLORAL REMAINS:						
	Roots					X	Few
	Rootlets					X	Numerous
	CHARCOAL/WOOD:						
	Total charcoal $\geq$ 0.25 mm						0.0006 g
	Conifer - small	Charcoal		21			0.0006 g
	Unidentified hardwood - small, vitrified	Charcoal		3			< 0.0001 g
	NON-FLORAL REMAINS:						
	Insect	Chitin				X	Few
	Rock/Sand					X	Few
SPS-S-RC08	Liters Floated						1.30 L
1.0 mbs	Light Fraction Weight						0.0039 g
	FLORAL REMAINS:						
	Roots					X	Few
	Rootlets					X	Moderate
	CHARCOAL/WOOD:						
	Total charcoal $\geq$ 0.5 mm						0.0039 g
	Atriplex	Charcoal		11			0.0023 g
	Conifer - small	Charcoal		15			0.0011 g
	Juniperus	Charcoal		4			0.0005 g
	Unidentified hardwood - small	Charcoal		1			< 0.0001 g
	NON-FLORAL REMAINS:						
	Insect	Chitin				X	Few
	Rock/Sand					X	Few

TABLE 2 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
Hells Kitchen South, Fayette Segment							
HKS-S-RC01	Liters Floated						1.10 L
0.4 mbs	Light Fraction Weight						0.651 g
	FLORAL REMAINS:						
	Rootlets					X	Numerous
	CHARCOAL/WOOD:						
	Total charcoal $\geq$ 0.5 mm						0.0095 g
	Atriplex	Charcoal		1			0.0067 g
	Conifer - small, vitrified	Charcoal		5			0.0016 g
	Juniperus	Charcoal		5			0.0012 g
	NON-FLORAL REMAINS:						
	Insect	Chitin				X	Few
	Insect	Puparia			1		
	Rock/Sand					X	Few
	Snail shell - oblong				1		
HKS-S-RC03	Liters Floated						1.20 L
0.4 mbs	Light Fraction Weight						0.561 g
	FLORAL REMAINS:						
	Rootlets					X	Numerous
	CHARCOAL/WOOD:						
	Total charcoal $\geq$ 0.5 mm						0.0040 g
	Atriplex	Charcoal		4			0.0005 g
	Conifer - small, vitrified	Charcoal		27			0.0035 g
	Juniperus	Charcoal		1			< 0.0001 g
	NON-FLORAL REMAINS:						
	Insect	Chitin				X	Few
	Rock/Sand					X	Few
	Snail shell - oblong					X	Few
HKS-S-RC02	Liters Floated						1.20 L
0.5 mbs	Light Fraction Weight						0.431 g
	FLORAL REMAINS:						
	Rootlets					X	Numerous

TABLE 2 (Continued)

Sample No.	Identification	Part	Charred W	Charred F	Uncharred W	Uncharred F	Weights/ Comments
HKS-S-RC02	CHARCOAL/WOOD:						
0.5 mbs	Total charcoal ≥ 0.5 mm						0.0028 g
	Atriplex	Charcoal		1			< 0.0001 g
	Conifer - small	Charcoal		2			0.0009 g
	Juniperus	Charcoal		9			0.0019 g
	NON-FLORAL REMAINS:						
	Insect	Chitin				X	Few
	Rock/Sand					X	Few
	Snail shell - oblong				X	X	Moderate
HKS-S-RC04	Liters Floated						1.60 L
	Light Fraction Weight						0.307 g
	FLORAL REMAINS:						
	Rootlets					X	Numerous
	CHARCOAL/WOOD:						
	Total charcoal ≥ 0.5 mm						0.0117 g
	Artemisia	Charcoal		1			0.0004 g
	Atriplex	Charcoal		2			0.0004 g
	Conifer - small	Charcoal		20			0.0024 g
	Juniperus	Charcoal		15			0.0085 g
	NON-FLORAL REMAINS:						
	Insect	Chitin				X	Few
	Rock/Sand					X	Few
	Snail shell - oblong				X	X	Moderate
HKS-S-RC09	Sample Weight						1.671 g
0.5 mbs	CHARCOAL/WOOD:						
	Total charcoal ≥ 1 mm						0.0041 g
	Juniperus	Charcoal		8			0.0041 g
HKS-N-RC07	Sample Weight						2.930 g
0.6 mbs	CHARCOAL/WOOD:						
	Total charcoal ≥ 0.5 mm						0.0035 g
	Conifer - small	Charcoal		14			0.0014 g
	Juniperus	Charcoal		1			0.0021 g

L = Liter g = grams mm = millimeters
W = Whole F = Fragment X = Presence noted in sample

TABLE 3
INDEX OF MACROFLORAL REMAINS RECOVERED FROM THE WASATCH FAULT ZONE, JUAB AND SANPETE COUNTIES, UTAH

Scientific Name	Common Name
FLORAL REMAINS:	
Atriplex	Saltbush, Shadscale
Descurainia	Tansy mustard, Flixweed
Erodium	Storksbill, Filaree
Fruit	The structure of a plant that contains its seeds, derived from one or more ovaries, including dry fruits such as pod, samara, silique, capsule, cone, etc.
Poaceae	Grass family
CHARCOAL/WOOD:	
Artemisia	Sagebrush
Atriplex	Saltbush, Shadscale
Conifer	Cone-bearing, gymnospermous trees and shrubs, mostly evergreens, including the pine, spruce, fir, juniper, cedar, yew, hemlock, redwood, and cypress
Juniperus	Juniper
Unidentified hardwood	Wood from a broad-leaved flowering tree or shrub
Unidentified hardwood - small	Wood from a broad-leaved flowering tree or shrub, fragments too small for further identification
Unidentified hardwood - vitrified	Wood from a broad-leaved flowering tree or shrub, exhibiting a shiny, glassy appearance
Unidentifiable - small	Charcoal fragments too small for further identification
Unidentifiable - vitrified	Charcoal exhibiting a shiny, glassy appearance
NON-FLORAL REMAINS:	
Chitin	A natural polymer found in insect and crustacean exoskeleton
Insect puparium	A rigid outer shell made from tough material that includes chitin (a natural polymer found in insect exoskeleton and crab shells) and hardens from a larva's skin to protect the pupa as it develops into an adult insect
Snail shell - oblong	Snail shell with an oblong shape where the height is much bigger than the width

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APPENDIX F

SUMMARY OF RADIOCARBON DATING AT THE SKINNER PEAKS SOUTH SITE

Sample No.	**NOSAMS**[1] **Accession No.**	**Unit**[2]	**Sample Description**[3]	**Sample wt.** (mg)	**Lab Age (^{14}C yr B.P.)** - mean, ±1σ		**$D^{13}C$** (if measured)	**Calibrated age (cal yr B.P.)** - 95% range[4]		**Calibrated age (cal yr B.P.)** - mean, ±1σ[5]		**Calibrated age (thous. of cal yr B.P.)** - mean, ±2σ[6]	
SPS-S-RC02	OS-141717	C2	Charred sagebrush (*Artemisia*)	3.0	1730	25	-25.74	1704	1568	1641	40	1.6	0.1
SPS-S-RC03	OS-148373	4	Unidentified conifer charcoal fragments	0.6	3190	20	-21.91	3453	3369	3413	24	3.4	0.1
SPS-S-RC04	OS-141718	C1	Charred juniper tree (*Juniperus*), sagebrush (*Artemisia*), and saltbush (*Atriplex*)	1.9	3560	25	-21.20	3959	3728	3854	44	3.9	0.1
SPS-S-RC05	OS-141719	C2	Charred juniper tree (*Juniperus*) and unidentified charcoal	1.9	3320	25	-20.78	3631	3476	3543	39	3.5	0.1
SPS-S-RC06a	OS-141576	C2	Saltbush (*Atriplex*) fruit fragments	3.9	170	20	-11.63	285	n/a	164	86	0.2	0.2
SPS-S-RC06b	OS-148218	C2	Charred sagebrush (*Artemisia*) and saltbush (*Atriplex*)	3.2	165	20	-15.69	285	n/a	163	85	0.2	0.2
SPS-S-RC07a	OS-141720	5A	Charred sagebrush (*Artemisia*) and saltbush (*Atriplex*)	0.8	895	25	-20.48	908	738	827	51	0.8	0.1
SPS-S-RC07b	OS-148219	5A	Charred juniper tree (*Juniperus*)	1.5	1690	25	-21.97	1693	1538	1598	38	1.6	0.1
SPS-S-RC08	OS-141721	4	Charred saltbush (*Atriplex*)	2.3	3330	25	-10.91	3634	3480	3558	42	3.6	0.1
SPS-N-RC09	OS-141577	C2	Charred juniper tree (*Juniperus*)	2.7	3180	25	-20.95	3450	3364	3407	26	3.4	0.1
SPS-N-RC10a	OS-141722	5A	Unidentified conifer charcoal fragments	1.0	2050	25	-21.59	2113	1934	2014	43	2.0	0.1
SPS-N-RC10b	OS-148372	5A	Charred sagebrush (*Artemisia*) and saltbush (*Atriplex*)	0.7	1170	15	-18.13	1175	1010	1105	44	1.1	0.1

[1] National Ocean Sciences Accelerator Mass Spectrometry Facility, Woods Hole Oceanographic Institution (Woods Hole, Massachusetts).

[2] Units correspond to plates 1 and 2.

[3] Charcoal separation and identification by Paleo Research Institute (Golden, Colorado).

[4] Laboratory-reported radiocarbon age with one standard deviation (1σ) uncertainty. B.P. is before present (AD 1950).

[5] Mean calendar-calibrated age and 1σ uncertainty, determined using OxCal calibration software (v. 4.3.2; Bronk Ramsey, 2009) and the IntCal13 atmospheric data set (Reimer and others, 2013).

[6] Mean age rounded to nearest century, in thousands of years B.P.; 2σ uncertainty shown.

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APPENDIX G

SUMMARY OF RADIOCARBON DATING AT THE HELLS KITCHEN SOUTH SITE

Sample No.	**NOSAMS**[1] **Accession No.**	**Unit**[2]	**Sample Description**[3]	**Sample wt.** (mg)	**Lab Age (^{14}C yr B.P.) -** mean, ±1σ		**D^{13}C** (if measured)	**Calibrated age (cal yr B.P.)** - 95% range[4]		**Calibrated age (cal yr B.P.)** - mean, ±1σ[5]		**Calibrated age (thous. of cal yr B.P.)** - mean, ±2σ[6]	
HKS-S-RC01	OS-141579	C1	Charred saltbush (*Atriplex*)	6.7	150	20	-10.24	284	2	154	84	0.2	0.2
HKS-S-RC02	OS-141723	4A	Charred juniper tree (*Juniperus*)	1.9	4880	30	-20.65	5657	5586	5618	25	5.7	0.1
HKS-S-RC03	OS-141580	C1	Charred unidentified conifer	3.5	4720	25	-21.02	5581	5326	5452	88	5.4	0.2
HKS-S-RC04	OS-141578	4A	Charred juniper tree (*Juniperus*)	6.4	4630	25	-21.63	5455	5305	5396	47	5.4	0.1
HKS-S-RC09	OS-141724	4	Charred juniper tree (*Juniperus*)	4.1	5140	45	--	5990	5749	5872	70	5.9	0.1

[1] National Ocean Sciences Accelerator Mass Spectrometry Facility, Woods Hole Oceanographic Institution (Woods Hole, Massachusetts).

[2] Units correspond to plates 3 and 4.

[3] Charcoal separation and identification by Paleo Research Institute (Golden, Colorado).

[4] Laboratory-reported radiocarbon age with one standard deviation (1σ) uncertainty. B.P. is before present (AD 1950).

[5] Mean calendar-calibrated age and 1σ uncertainty, determined using OxCal calibration software (v. 4.3.2; Bronk Ramsey, 2009) and the IntCal13 atmospheric data set (Reimer and others, 2013).

[6] Mean age rounded to nearest century, in thousands of years B.P.; 2σ uncertainty shown.

References:

Bronk Ramsey, C., 2009, Bayesian analysis of radiocarbon dates: Radiocarbon, v. 51, no. 1, p. 337–360.

Reimer, P.J., Bard, E., Bayliss, A., Beck, J.W., Blackwell, P.G., Bronk Ramsey, C., Buck, C.E., Cheng, H., Edwards, R.L., Friedrich, M., Grootes, P.M., Guilderson, T.P., Haflidason, H., Hajdas, I., Hatté, C., Heaton, T.J., Hoffmann, D.L., Hogg, A.G., Hughen, K.A., Kaiser, K.F., Kromer, B., Manning, S.W., Niu, M., Reimer, R.W., Richards, D.A., Scott, E.M., Southon, J.R., Staff, R.A., Turney, C.S.M., and van der Plicht, J., 2013, IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP: Radiocarbon, v. 55, no. 4, p. 1869–1887.

APPENDIX H

SUMMARY OF OPTICALLY STIMULATED LUMINESCENCE DATING AT THE SKINNER PEAKS SOUTH SITE

Sample No.[1]	% Water Content[2]	K (%)[3]	U (ppm)[3]	Th (ppm)[3]	Total Dose (Gy/ka)[4]	Equivalent Dose (Gy)	n[5]	Scatter[6]	Age (yrs), ±2σ [7]
SPS-S-OSL-01	6 (50)	1.99 ± 0.05	1.66 ± 0.18	11.0 ± 0.47	2.86 ± 0.09	20.8 ± 3.8	18 (20)	76%	7,270 ± 2,700
				MAXIUMUM age model		46.7 ± 3.2	5 (20)	76%	16,330 ± 2,440
SPS-S-OSL-02	4 (45)	1.86 ± 0.09	1.75 ± 0.18	7.16 ± 0.98	2.58 ± 0.20	22.8 ± 3.7	18 (24)	67%	8,840 ± 3,200
				MAXIUMUM age model		61.6 ± 2.0	5 (24)	67%	23,880 ± 4,080
SPS-S-OSL-03	4 (32)	2.16 ± 0.05	1.82 ± 0.23	11.3 ± 0.34	3.51 ± 0.08	8.90 ± 1.29	4 (20)	19%	2,540 ± 760
SPS-S-OSL-04	5 (44)	2.38 ± 0.04	1.58 ± 0.18	11.8 ± 0.29	3.58 ± 0.07	7.22 ± 0.97	12 (24)	46%	2,020 ± 540
SPS-S-OSL-05	5 (28)	2.43 ± 0.06	1.91 ± 0.26	12.7 ± 0.54	3.95 ± 0.12	4.02 ± 0.52	5 (20)	42%	1,020 ± 280

[1]SPS—Skinner Peaks South site; S—South Wall; OSL—optically stimulated luminescence sample.

[2]Field moisture, with figures in parentheses indicating the complete sample saturation %. Ages calculated using 20% of the saturated moisture (i.e., 5 [28] = 28*0.20 = 6).

[3]Analyses obtained using high-resolution gamma spectrometry (high purity Ge detector).

[4]Includes cosmic doses and attenuation with depth calculated using the methods of Prescott and Hutton (1994). Cosmic doses were about 0.17–0.30 Gy/ka.

[5]Number of replicated equivalent dose (D_E) estimates used to calculate the total. Figures in parentheses indicate total number of measurements included in calculating the represented DE and age using the minimum age model (MAM); SPS-1 and SPS-2 have a central age model; analyzed via single aliquot regeneration on quartz grains.

[6]Defined as "over-dispersion" of the D_E values. Obtained by the "R" factor program. Values >30% are considered to be poorly bleached or mixed sediments.

[7]Dose rate and age for fine-grained 250–180 micron-sized quartz. Exponential + linear fit used on D_E, errors to two sigma.

References:

Prescott, J. R., & Hutton, J. T. (1994). Cosmic ray Contributions to Dose-Rates for Luminescence and ESR Dating: Large Depths and Long Terms Time Variations. Radiation Measurements, v. 23, no. 2-3, p. 497-500, doi: 10.1016/1350-4487(94)90086-8.

APPENDIX I

SUMMARY OF OPTICALLY STIMULATED LUMINESCENCE DATING AT THE HELLS KITCHEN SOUTH SITE

Sample No.[1]	% Water Content[2]	K (%)[3]	U (ppm)[3]	Th (ppm)[3]	Total Dose (Gy/ka)[4]	Equivalent Dose (Gy)	n[5]	Scatter[6]	Age (yrs), ±2σ [7]
HKS-S-OSL-01	6 (30)	1.36 ± 0.05	3.05 ± 0.23	4.72 ± 0.64	2.56 ± 0.17	28.9 ± 1.0	21 (24)	12%	11,290 ± 1,160
HKS-S-OSL-02	3 (30)	1.61 ± 0.05	3.24 ± 0.21	9.04 ± 0.32	3.14 ± 0.08	10.6 ± 0.84	3 (20)	52%	3,380 ± 560
HKS-S-OSL-03	7 (26)	1.33 ± 0.04	2.99 ± 0.20	4.66 ± 0.34	2.51 ± 0.10	29.0 ± 2.7	5 (24)	35%	11,550 ± 2,340
HKS-S-OSL-04	9 (23)	2.11 ± 0.05	3.18 ± 0.24	8.97 ± 0.44	3.47 ± 0.11	16.1 ± 1.4	3 (28)	40%	4,640 ± 860
HKS-S-OSL-05	8 (13)	1.67 ± 0.05	2.99 ± 0.22	10.0 ± 0.33	3.21 ± 0.08	40.8 ± 2.3	19 (20)	22%	12,710 ± 1,560

[1]HKS—Hells Kitchen South site; S—South Wall; OSL—optically stimulated luminescence sample.

[2]Field moisture, with figures in parentheses indicating the complete sample saturation %. Ages calculated using 20% of the saturated moisture (i.e., 5 [28] = 28*0.20 = 6).

[3]Analyses obtained using high-resolution gamma spectrometry (high purity Ge detector).

[4]Includes cosmic doses and attenuation with depth calculated using the methods of Prescott and Hutton (1994). Cosmic doses were about 0.17–0.30 Gy/ka.

[5]Number of replicated equivalent dose (D_E) estimates used to calculate the total. Figures in parentheses indicate total number of measurements included in calculating the represented DE and age using the minimum age model (MAM).

[6]Defined as "over-dispersion" of the D_E values. Obtained by the "R" factor program. Values >30% are considered to be poorly bleached or mixed sediments.

[7]Dose rate and age for fine-grained 250–180 micron-sized quartz. Exponential + linear fit used on D_E, errors to two sigma.

References:

Prescott, J. R., & Hutton, J. T. (1994). Cosmic ray Contributions to Dose-Rates for Luminescence and ESR Dating: Large Depths and Long Terms Time Variations. Radiation Measurements, v. 23, no. 2-3, p. 497-500, doi: 10.1016/1350-4487(94)90086-8.

APPENDIX J

OXCAL MODELS FOR THE LEVAN SEGMENT OF THE WASATCH FAULT ZONE AT THE SKINNER PEAKS SOUTH SITE

The OxCal models for the Levan segment of the Wasatch fault zone at the Skinner Peaks South site were created using OxCal calibration and analysis software (version 4.3.2; Bronk Ramsey, 2009) and the IntCal13 radiocarbon calibration curve (Reimer and others, 2013). Two models are presented here, for both one- and two-earthquake scenarios (see text for explanation). The models include *C_Date* for luminescence ages, *R_Date* for radiocarbon ages, and *Boundary* for undated events (paleoearthquakes). These components are arranged into ordered sequences based on the relative stratigraphic positions of the samples. The sequences may contain phases, or groups where the relative stratigraphic ordering information for the individual radiocarbon ages is unknown. The models are presented here in reverse stratigraphic order, following the order in which the ages and events are evaluated in OxCal.

Skinner Peaks South 1 EQ Model Input

```
Plot()
 {
  Sequence("Skinner Peaks South trench, full chronology")
  {
   Boundary("Start");
   Phase("Unit 2")
   {
    C_Date("SPS-S-OSL-02, OSL 23880+/-4080",-21862,2040);
    C_Date("SPS-S-OSL-01, OSL 16330+/-2440",-14312,1220);
   };
   R_Date("SPS-S-RC08, C14 3330+/-25",3330,25);
   R_Date("SPS-S-RC03, C14 3190+/-20",3413,48);
   Phase("Unit 5")
   {
    C_Date("SPS-S-OSL-03, OSL 2540+/-380",-522,380);
    C_Date("SPS-S-OSL-04, OSL 2020+/-270",-2,270);
   };
   Phase("Unit 5A")
   {
    //R_Date("SPS-N-RC10b, C14 1170+/-15",1170,15);
    R_Date("SPS-N-RC10a, C14 2050+/-25",2050,25);
    R_Date("SPS-N-RC07b, C14 1690+/-25",1690,25);
   };
   Boundary("SPS-P1 MRE");
   Phase("Unit C1")
   {
    R_Date("SPS-S-RC02, C14 1730+/-25",1730,25);
    C_Date("SPS-S-OSL-05, OSL 1020+/-140",998,140);
   };
   Boundary("Begin Historical Record",1847 AD);
  };
 };
```

Skinner Peaks South 1 EQ Model Output

Skinner Peaks South Full Chronology	Unmodelled (BP)		Modelled (BP)		Agreement
	mean	sigma	mean	sigma	
Boundary Start			25161	4152	
Phase Unit 2					
C_Date SPS-S-OSL-02, OSL 23880 ± 4080	23813	2040	22203	2110	84.4
C_Date SPS-S-OSL-01, OSL 16330 ± 2440	16263	1220	16259	1217	100.1
R_Date SPS-S-RC08, C14 3330 ± 25	3558	42	3602	36	79.3
R_Date SPS-S-RC03, C14 3190 ± 20	3673	70	3568	44	55.8
Phase Unit 5					
C_Date SPS-S-OSL-03, OSL 2540 ± 380	2473	380	2551	313	107.9
C_Date SPS-S-OSL-04, OSL 2020 ± 270	1953	270	2204	156	91.8
Phase Unit 5A					
R_Date SPS-N-RC10a, C14 2050 ± 25	2014	43	2007	42	100.6
R_Date SPS-N-RC07b, C14 1690 ± 25	1598	38	1660	34	55.4
Boundary SPS-P1 MRE			**1629**	**33**	
Phase Unit C1					
R_Date SPS-S-RC02, C14 1730 ± 25	1641	40	1598	29	78.9
C_Date SPS-S-OSL-05, OSL 1020 ± 140	953	140	952	140	100
Boundary Begin Historical Record, 1847	104	0	104	0	100

Skinner Peaks South 2 EQ Model Input

```
Plot()
 {
 Sequence("Skinner Peaks South trench, full chronology")
  {
  Boundary("Start");
  Phase("Unit 2")
   {
   C_Date("SPS-S-OSL-02, OSL 23880+/-4080",-21862,2040);
   C_Date("SPS-S-OSL-01, OSL 16330+/-2440",-14312,1220);
  };
  Phase("Unit 4-4A")
   {
   R_Date("SPS-S-RC08, C14 3330+/-25",3330,25);
   R_Date("SPS-S-RC03, C14 3190+/-20",3413,48);
  };
  Phase("Unit 5")
   {
   C_Date("SPS-S-OSL-03, OSL 2540+/-380",-522,380);
   C_Date("SPS-S-OSL-04, OSL 2020+/-270",-2,270);
  };
  R_Date("SPS-N-RC10a, C14 2050+/-25",2050,25);
  Boundary("SPS-P1b PE");
  R_Date("SPS-S-RC02, C14 1730+/-25",1730,25);
  Boundary("SPS-P1a MRE");
  C_Date("SPS-S-OSL-05, OSL 1020+/-140",998,140);
  Boundary("Begin Historical Record",1847 AD);
 };
};
```

Skinner Peaks South 2 EQ Model Output

Skinner Peaks South Full Chronology	Unmodelled (BP)		Modelled (BP)		Agreemen t
	mean	sigma	mean	sigma	
Boundary Start			25209	4184	
Phase Unit 2					
C_Date SPS-S-OSL-02, OSL 23880 ± 4080	23813	2040	22220	2117	84.8
C_Date SPS-S-OSL-01, OSL 16330 ± 2440	16263	1220	16260	1216	100.2
Phase Unit 4-4A					
R_Date SPS-S-RC08, C14 3330 ± 25	3558	42	3559	42	99.3
R_Date SPS-S-RC03, C14 3190 ± 20	3673	70	3673	70	99.9
Phase Unit 5					
C_Date SPS-S-OSL-03, OSL 2540 ± 380	2473	380	2552	312	108
C_Date SPS-S-OSL-04, OSL 2020 ± 270	1953	270	2206	156	91.4
R_Date SPS-N-RC10a, C14 2050 ± 25	2014	43	2010	42	100.7
Boundary SPS-P1b PE			**1789**	**114**	
R_Date SPS-S-RC02, C14 1730 ± 25	1641	40	1639	40	98.9
Boundary SPS-P1a MRE			**1366**	**227**	
C_Date SPS-S-OSL-05, OSL 1020 ± 140	953	140	933	140	99.6
Boundary Begin Historical Record, 1847	104	0	104	0	100

APPENDIX K

OXCAL MODELS FOR THE FAYETTE SEGMENT OF THE WASATCH FAULT ZONE AT THE HELLS KITCHEN SOUTH SITE

The OxCal models for the Fayette segment of the Wasatch fault zone at the Hells Kitchen South site were created using OxCal calibration and analysis software (version 4.3.2; Bronk Ramsey, 2009) and the IntCal13 radiocarbon calibration curve (Reimer and others, 2013). Two models are presented here, for both one- and two-earthquake scenarios (see text for explanation). The models include *C_Date* for luminescence ages, *R_Date* for radiocarbon ages, and *Boundary* for undated events (paleoearthquakes). These components are arranged into ordered sequences based on the relative stratigraphic positions of the samples. The sequences may contain phases, or groups where the relative stratigraphic ordering information for the individual radiocarbon ages is unknown. The models are presented here in reverse stratigraphic order, following the order in which the ages and events are evaluated in OxCal.

Hells Kitchen South 1 EQ Model Input

```
Plot()
 {
  Sequence("Hells Kitchen South Trench, full chronology")
  {
   Boundary("Start");
   C_Date("HKS-S-OSL-05, OSL 12710+/-780",-10692,780);
   Phase("Unit 3")
   {
    C_Date("HKS-S-OSL-01, OSL 11290+/-580",-9272,580);
    C_Date("HKS-S-OSL-03, OSL 11550+/-1170",-9532,1170);
   };
   R_Date("HKS-S-RC09, C14 5140+/-40",5140,40);
   R_Date("HKS-S-RC02, C14 4880+/-30",4880,30);
   Boundary("HKS-P1 MRE");
   R_Date("HKS-S-RC03, C14 4720+/-25",4720,25);
   Boundary("Begin Historical Record",1847 AD);
  };
 };
```

Hells Kitchen South 1 EQ Model Output

Hells Kitchen South - 1EQ Full Chronology	Unmodelled (BP)		Modelled (BP)		Agreement
	mean	sigma	mean	sigma	
Boundary Start			14286	2241	
C_Date HKS-S-OSL-05, OSL 12710 ± 780	12643	780	12469	670	105
Phase Unit 3					
C_Date HKS-S-OSL-01, OSL 11290 ± 580	11223	580	11349	500	105.5
C_Date HKS-S-OSL-03, OSL 11550 ± 1170	11483	1170	10441	764	92
R_Date HKS-S-RC09, C14 5140 ± 40	5873	67	5873	67	99.4
R_Date HKS-S-RC02, C14 4880 ± 30	5618	25	5621	24	97.2
Boundary HKS-P1 MRE			**5516**	**77**	
R_Date HKS-S-RC03, C14 4720 ± 25	5452	88	5407	75	99.2
Boundary Begin Historical Record, 1847	104	0	104	0	100

Hells Kitchen South 2 EQ Model Input

```
Plot()
 {
 Sequence("Hells Kitchen South Trench, full chronology")
  {
  Boundary("Start");
  C_Date("HKS-S-OSL-05, OSL 12710+/-780",-10692,780);
  Boundary("E2-Warp");
  Phase("Unit 3")
   {
   C_Date("HKS-S-OSL-03, OSL 11550+/-1170",-9532,1170);
   C_Date("HKS-S-OSL-01, OSL 11290+/-580",-9272,580);
   };
  R_Date("HKS-S-RC09, C14 5140+/-40",5140,40);
  Phase("Unit 4A")
   {
   R_Date("HKS-S-RC02, C14 4880+/-30",4880,30);
   R_Date("HKS-S-RC04, C14 4630+/-25",4630,25);
   };
  Boundary("E1");
  R_Date("HKS-S-RC03, C14 4720+/-25",4720,25);
  Boundary("Begin Historical Record",1847 AD);
  };
 };
```

Hells Kitchen South 2 EQ Model Output

Hells Kitchen South - 2EQ Full Chronology	Unmodelled (BP)		Modelled (BP)		Agreement
	mean	sigma	mean	sigma	
Boundary Start			15093	2873	
C_Date HKS-S-OSL-05, OSL 12710 ± 780	12643	780	12774	683	105.7
Boundary HKS-P2 Warp PE			**11985**	**716**	
Phase Unit 3					
C_Date HKS-S-OSL-03, OSL 11550 ± 1170	11483	1170	10786	891	102.2
C_Date HKS-S-OSL-01, OSL 11290 ± 580	11223	580	11016	536	100.6
R_Date HKS-S-RC09, C14 5140 ± 40	5873	67	5874	67	99.7
Phase Unit 4A					
R_Date HKS-S-RC02, C14 4880 ± 30	5618	25	5618	25	99.4
R_Date HKS-S-RC04, C14 4630 ± 25	5396	47	5427	19	107.2
Boundary HKS-P1 MRE			**5390**	**27**	
R_Date HKS-S-RC03, C14 4720 ± 25	5452	88	5352	18	108.4
Boundary Begin Historical Record	104	0	104	0	100