Detrital zircon provenance of Pennsylvanian to Permian sandstones from the Wyoming craton and Wood River Basin, Idaho, U.S.A.

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ABSTRACT

Pennsylvanian rocks of the northern U.S. Rocky Mountains are mature quartzose sandstones. This paper uses detrital zircon geochronology on seven samples from the Wood River Formation, Tensleep Sandstone, and Weber Sandstone to determine if these sandstones have a common provenance, representing eastern Laurentian and Appalachian sand reworked within shallow-marine and eolian environments from the Wyoming craton westward to the Pioneer thrust plate of south-central Idaho. Our work suggests that this continental sand blanket was mixed with local sources on the south in the Yavapai-Mazatzal provinces of the Ancestral Rocky Mountains and in samples from the western Cordilleran thrust belt in south-central Idaho. In total, these Pennsylvanian sandstones contain a broad spectrum of detrital zircon U-Pb ages including, from old to young: A) minor Archean-age (3300–2550 Ma) populations; B) Paleoproterozoic (2000–1600 Ma), Mesoproterozoic (1470–1350 Ma), and major "Grenvillian" (1250–950 Ma) populations; and C) Cryogenian- to Ediacaran-age (665–565 Ma) and minor Paleozoic (495–410 Ma) populations. We interpret these detrital zircon ages to represent provenance mainly from the Appalachian mountain belt of eastern North America; however, central Appalachian versus northern Appalachian derivation is not clearly distinguished. The Weber Sandstone from the north flank of the Uinta Mountains in northeast Utah contains a strong 1700–1640 Ma age population derived from the Yavapai-Mazatzal provinces in the adjacent Ancestral Rocky Mountains. The shallow-marine Hailey Member of the Wood River Formation in south-central Idaho yields a population of >1800 Ma detrital zircons reworked from the uplifted Mississippian Copper Basin Formation. Both the Hailey and Wilson Creek Members of the Wood River Formation contain unique 640–490 Ma grains that may represent provenance from the Big Creek-Beaverhead plutonic belt of east-central Idaho and/or eastern Klamath terrane in the Klamath Mountains of northwest California and southwest Oregon. These new data support published models for Pennsylvanian–Permian transport of siliciclastic sediment with sources mainly from the North American craton, north of the Ancestral Rocky Mountains, into continental margin basins.

KEY WORDS: detrital zircon, Idaho thrust belt, Pennsylvanian, Tensleep Sandstone, Weber Sandstone, Wood River Formation, Wyoming craton.

INTRODUCTION

This paper investigates the detrital zircon composition of Pennsylvanian and Permian sandstones of the northern U.S. Rocky Mountains, from the Wyoming craton on the east and the western Cordilleran thrust belt on the west (Figs. 1 and 2). The main objective is to describe the detrital zircon provenance of the Upper Paleozoic sandstones. In doing so, we test the predictions of Geslin

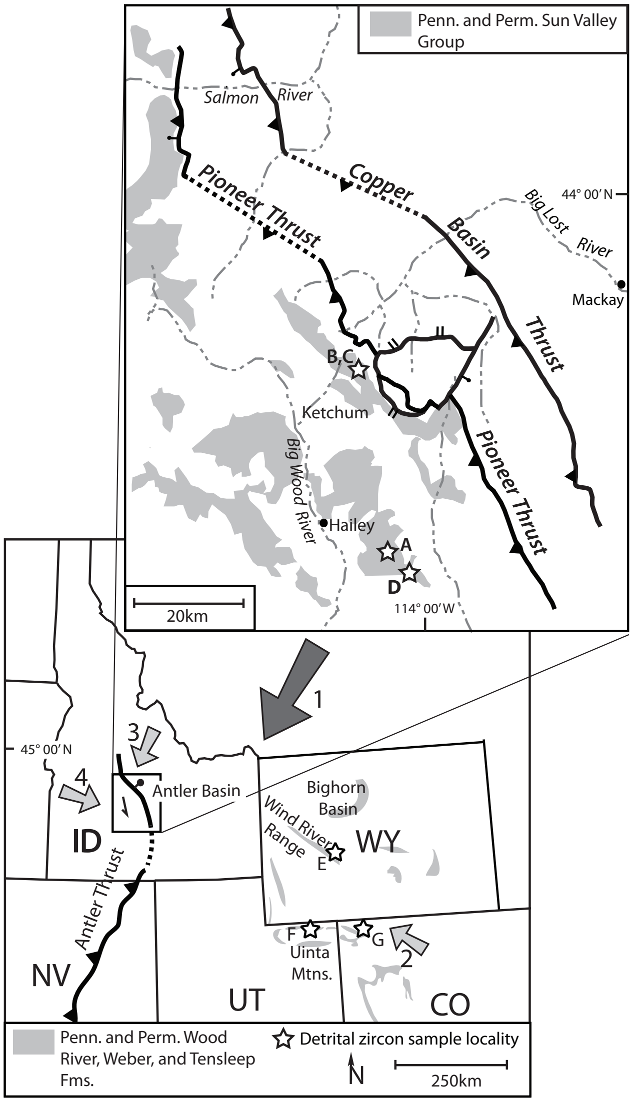

Figure 1. Simplified geologic map showing sample localities A through G. Arrows show interpreted provenance of zircon grains. 1—Regional Laurentian provenance form the Appalachian-Ellesmerian orogenic system. 2—Local provenance from the Yavapai-Mazatzal provinces in northern Colorado. 3—Local provenance from south-central Idaho, including reworked grains more than 1800 Ma reworked from the Mississippian Copper Basin Group and Cryogenian to Cambrian grains from plutons of the Big Creek-Beaverhead plutonic belt. 4—Uncertain western provenance of Ordovician and Silurian magmatic grains. Base from Dickinson and Gehrels (2003) and Lewis et al. (2012).

(1998) that the Pennsylvanian and Permian Wood River Formation of south-central Idaho has shared provenance with the eolian and shallow-marine Tensleep and Weber Sandstones of Wyoming, northern Utah, and northwestern Colorado. The implications of this similarity are that Pennsylvanian Laurentia was blanketed by sand grains sourced from the Appalachian Orogen, with subordinate local provenance from the Ancestral Rocky Mountains and within the western Cordillera.

After the early Cambrian appearance of the Transcontinental Arch, which blocked transport of sand grains from eastern Laurentia, detrital zircon age populations in western North America show eastern and southern derivation from the Paleoproterozoic and Mesoproterozoic (1800–1650 and 1500–1400 Ma, respectively) Yavapai-Mazatzal provinces in Cambrian and Devonian time and the Paleoproterozoic (>1800 Ma) Peace River Arch in Alberta, Canada, in Ordovician time (Ketner, 1968; Smith and Gehrels, 1994; Gehrels et al., 1995; Balgord et al., 2013; May et al., 2013; Gehrels and Pecha, 2014; Yonkee et al., 2014). After the Late Devonian, 1250–950 Ma detrital zircons from the complex Grenville Orogen are present in sandstones of the thrust belt, having been recycled through the Appalachian (e.g., Gehrels et al., 2011) and/or Ellesmerian-Caledonian orogenic belts (e.g., Patchett et al., 1999, 2004; Beranek et al., 2010). A major sediment dispersal network originating from the Appalachian, Ellesmerian, and Caledonian mountain belts directed siliciclastic sediment to the west and south across the North American craton from mid- to late Paleozoic time, with regional eolian transport and winnowing (e.g., Patchett et al., 1999, 2004; Gehrels et al., 2011). Fluvial and shoreface Pennsylvanian sandstones of the Colorado Plateau contain subequal proportions of 1800–1400 Ma detrital zircons derived from the Ancestral Rocky Mountains, 1250–950 Ma "Grenvillian" zircons derived from the Appalachian mountain belt, and 465–410 Ma Paleozoic detrital zircons from various magmatic arc sources (Gehrels et al., 2011).

We use U-Pb detrital zircon provenance analyses to test whether the Pennsylvanian and Lower Permian Wood River Basin—located west of the Pioneer Thrust Fault, the westernmost of several thrusts in east- and south-central Idaho—has similar provenance to the cratonal Tensleep and Weber Sandstones. This paper clarifies existing models for the paleogeographic setting of western North America after the Late Devonian–Early Mississippian Antler Orogeny, and it provides a regional framework

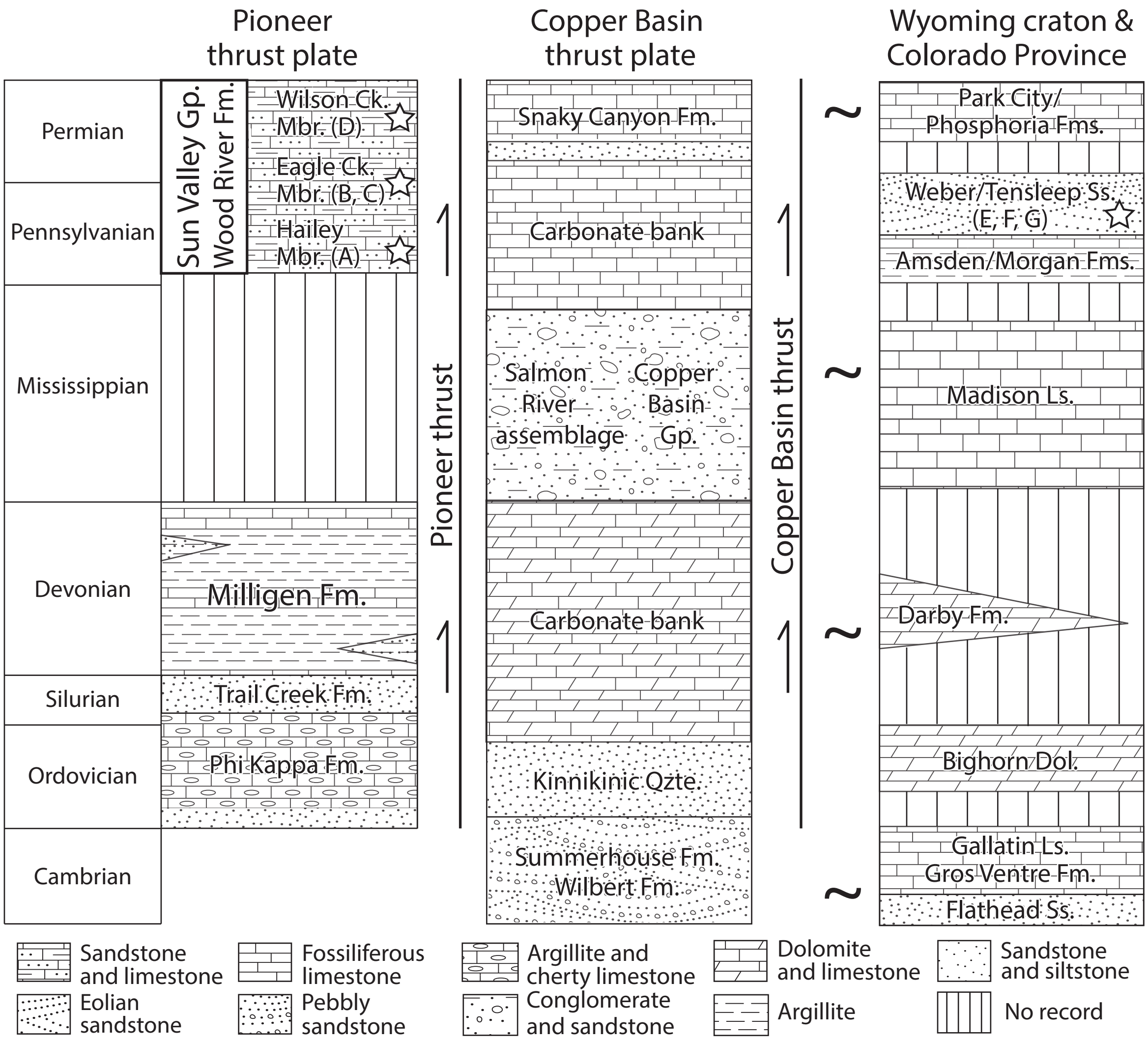

Figure 2. Correlation chart for Middle and Upper Paleozoic strata in the northern Rocky Mountains. Stratigraphic locations of samples A through F described in this paper are shown.

to understand the development of the post-Antler foreland during Pennsylvanian–Permian time.

GEOLOGIC SETTING

Wood River Basin

Middle Pennsylvanian to Lower Permian rocks of the Sun Valley Group (Wood River, Grand Prize, and carbonaceous Dollarhide Formations) are found west of the Pioneer thrust fault in the western part of the south-central Idaho thrust belt (Dover, 1980; Rodgers et al., 1995; Skipp et al., 2009). East of the Pioneer thrust, the Pennsylvanian and Permian Snaky Canyon Formation (Fig. 2) is broadly correlative to the Sun Valley Group. South of the Snake River Plain, the Oquirrh Group represents part of the same system of post-Antler basins (Geslin, 1998).

The Wood River Formation (Fig. 2) contains the Middle and Upper Pennsylvanian Hailey Member composed of shallow-marine conglomerate, overlying limestone bioherms, and upper shallow-marine sandstone. The formation also contains about 3,000 m of upward coarsening and then fining mixed carbonate-siliciclastic turbidites of the Upper Pennsylvanian to Lower Permian Eagle Creek and Wilson Creek Members (Mahoney et al., 1991; Link et al., 1995). The sand in the Eagle Creek and Wilson Creek Members of the formation is mainly subrounded to rounded, texturally mature quartz, although up to 10% feldspar is locally present.

Wyoming Craton Eolianites

Middle and Upper Pennsylvanian eolian sandstones are recognized across much of interior western North America (Hoare and Burgess, 1960; Verille et al., 1970). They include the Tensleep Sandstone in Wyoming and Weber Sandstone in southeast Wyoming, northern Colorado, and Utah (Fig. 2). These units are temporally correlative to eolianites including the Quadrant Quartzite of Montana and the lower Casper Formation of eastern Wyoming. They are predominantly well-sorted, texturally mature quartzose (80–90% quartz) sandstones with subordinate potassium feldspar. They show abundant cross-stratification of predominantly eolian origin (see Fig. 3*A–B*). Both eolian and shallow-marine facies are recognized (e.g., Mallory, 1967), and deposition is interpreted to have occurred in a sabkha-coastal dune environment (e.g., Mallory, 1967; Mankiewicz and Steidtmann, 1979).

Eolian transport during Middle to Late Pennsylvanian time was predominantly to the south–southeast across much of Wyoming and northern Utah/Colorado (e.g., Knight, 1929 [data from the Casper Sandstone]; Opdyke and Runcorn, 1960; Kerr and Dott, 1988). Similar paleo-wind transport directions are reported from Pennsylvanian eolianites in Montana to the north (Quadrant Sandstone). These units represent deposits from consistent, low-latitude trade winds (e.g., Opdyke and Runcorn, 1960; Peterson, 1988).

DETRITAL ZIRCON ANALYSES

Methods

Detrital zircons were separated from samples of fine- to coarse-grained sandstone. Locations are shown in Table 1 and Figure 1, stratigraphic locations are shown in Figure 2, and photos are shown in Figure 3. We used conventional crushing, grinding, wet shaking table, heavy liquid, and magnetic separation (1.5 amperes) techniques. Detrital zircon samples (100 grains) were analyzed by laser ablation–inductively coupled plasma–mass spectrometry methods at the Arizona LaserChron Center using methods described by Gehrels et al. (2008). Full analytical results are provided in the Data Repository table (Table DR 1). Statistical overlap, similarity, and Kolmogorov-Smirnov (K-S) comparison tests (Gehrels, 2000; Guynn and Gehrels, 2010) are shown in Table 2 and are discussed below. U-Pb detrital zircon ages are presented in 1) relative probability-frequency plots with histograms (Fig. 4); 2) a cumulative-frequency plot (Fig. 5); and 3) relative probability-frequency plots as lumped probability-density curves (Fig. 6). These were prepared with software from the Arizona LaserChron Center and the Isoplot/Ex 3.0 macro of Ludwig (2003). Analyses with high error (>10% uncertainty in $^{206}Pb/^{238}U$ or $^{206}Pb/^{207}Pb$ age) or excessive discordance (>20% discordant or >5% reverse discordant) were rejected and not included in the relative probability plots. In most cases, these represent less than 10% of the analyses.

Results

Wood River Formation

Middle Pennsylvanian medium-grained sandstone near the top of the Hailey Member (Sample A, 01PL12, n=79 grains, Figs. 1, 4, and 5) contains moderately rounded zircon grains 50 to 150 microns in diameter, of variable brown, pink, purple, and clear colors. No euhedral grains were observed. A six-grain Silurian peak at 429 ± 2 Ma is present and also found in several other samples. This age-peak is interesting since it suggests a Paleozoic magmatic source. There are two three-grain Cryogenian–Ediacaran peaks at 648 ± 8 and 566 ± 2 Ma, which are unique in samples we examined. There are dispersed late Paleoproterozoic (1735 and 1630 Ma) and Grenville-age (1150 and 1040 Ma) peaks. There is a major population of grains 2000–1800 Ma, which comprises 30% of the zircons present. There are peaks at 1918 ± 3 Ma (five grains) and 1841 ± 2 Ma (nine grains).

Two samples (Sample B, 04TD10, n=95; and Sample C, 14TD10, n=90) of the Virgilian to Wolfcampian Eagle Creek Member are medium-grained quartz arenites (Diedesch, 2011). Zircon grains are 50 to 100 microns in diameter, are clear, pink and brown, and are moderately rounded. None are euhedral. Both of these samples contain a 425 Ma age-peak (five grains in each sample). They also

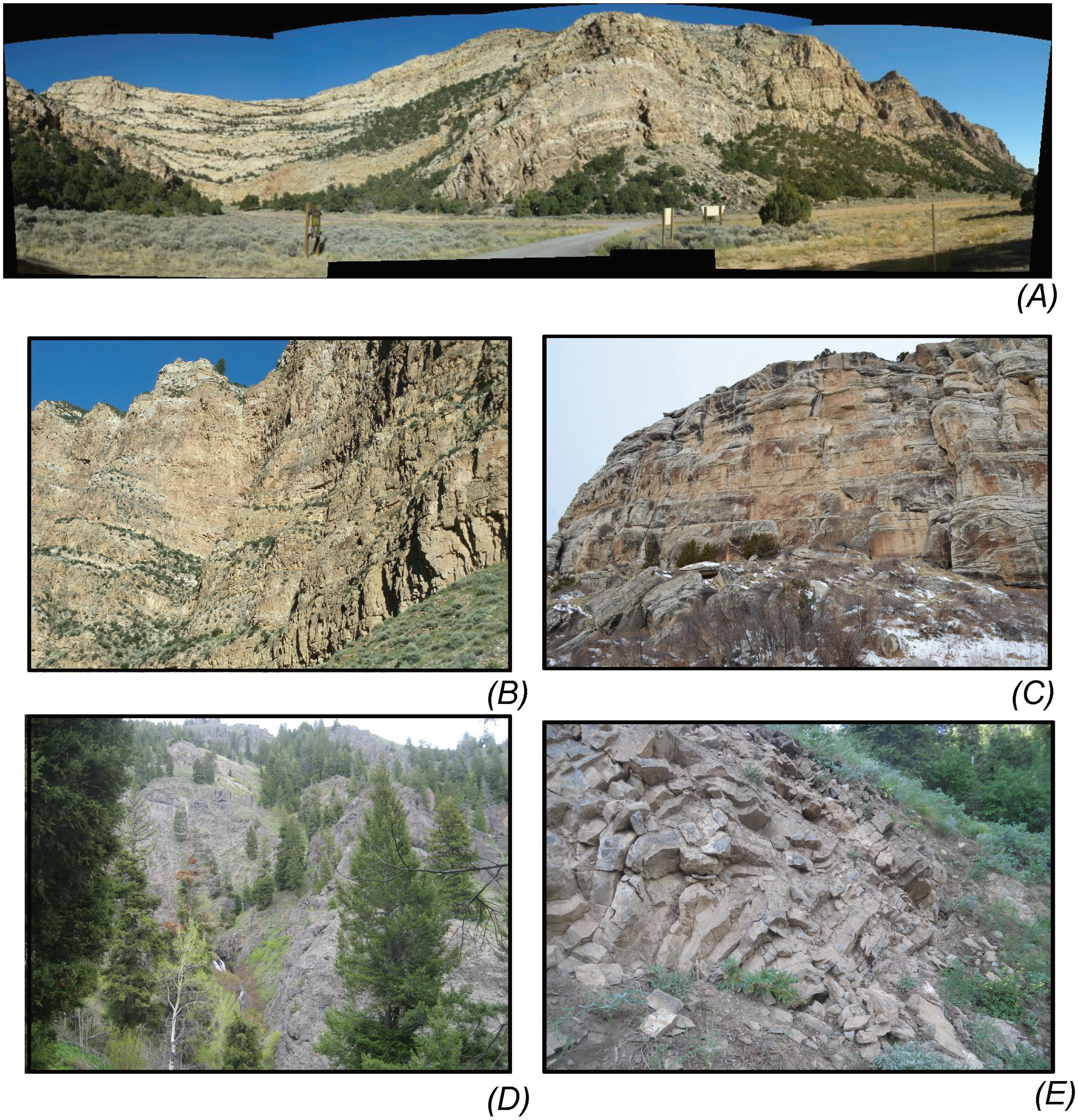

Figure 3. Outcrop and sample locality photographs of: ***A***, Panorama of Weber Sandstone at Irish Canyon, northwest Colorado; ***B***, eolian cross-stratification in cliff wall, Weber Sandstone in Sheep Creek, northern Uinta Mountains, northeast Utah; ***C***, eolian deposits of Tensleep Sandstone in Sinks Canyon, southern Wind River Range, western Wyoming; ***D***, thick-bedded calcareous sandstone, Eagle Creek Member, Wood River Formation, Pioneer Cabin Trail, in the Pioneer Mountains, south-central Idaho; ***E***, thin-bedded deep-water distal turbidites of the Wilson Creek Member, Wood River Formation, near the summit of Bell Mountain, southern Pioneer Mountains, south-central Idaho.

contain a broad distribution of Neoarchean (2700–2500 Ma) and Proterozoic (2000–1400 Ma and 1200–950 Ma) zircons (Figs. 4 and 5). Sample B has a six-grain peak at 1788 ± 3 Ma. Sample C has a nine-grain peak at 1751 ± 4 Ma and a three-grain peak at 1816 ± 9 Ma.

Table 1. GPS coordinates and location information for samples analyzed.

Sample letter	Number		Easting	Northing	Elev. ft.	Description
A	01PL12	Hailey Member, Wood River Fm.	11T 0726500	4816500	5560	Fine-medium sandstone with some quartz pebbles, near top of member, along Seamans Ck, north of pond with bubbler.
B	04TD10	Eagle Creek Mbr., Wood River Fm.	11T 0725964	4846347	9408	Upper Pioneer Cabin Trail
C	14TD10	Eagle Creek Mbr., Wood River Fm.	11T 0726115	4842686	8177	Lower Pioneer Cabin Trail
D	03PL12	Wilson Creek Member, Wood River Fm.	11T 0733509	4812885	7400	Along road near top Bell Mtn. unit wr7 of Hall et al., 1974, gray, fine-grained quartz arenite, just beyond bedded outcrop
E	ECS-13-2	Tensleep Ss., Sinks Cyn., WY	12T 678350	4734400	~6700	Sinks Canyon Road near wildlife viewing area, from top 100 feet of section
F	ECS-13-4	Weber Ss., Sheep Ck., UT	12T 603162	4531910	6525	Sheep Creek Geological Loop Road 218, 120 feet from top of section
G	ECS-13-5	Weber Ss., Irish Cyn., CO	12T 690989	4522449	6539	Moffat Country Road 10N near Irish Canyon Campground

One sample of the Lower Permian Wilson Creek Member (Sample D, 03PL12, n=63, Figs. 4 and 5) from the southern Pioneer Mountains east of Bellevue, Idaho, contains three-grain Ordovician and Silurian 487 ± 6 and 422 ± 7 Ma age peaks, the former of which is not found in other samples. The bulk of the grains are older than 1000 Ma, with dispersed older Proterozoic age peaks at 1795–1755, 1670–1650, 1462, and 1374 Ma, and with Grenville-age peaks at 1280, 1135, and 1080 Ma.

Pennsylvanian Sandstones from Wyoming Craton and Colorado Province

The Tensleep Sandstone from Sinks Canyon in western Wyoming's southern Wind River Range is of Late Pennsylvanian age. The sandstone is generally eolian, with shallow-marine portions, reworking the eolian sand blanket. Sample E (ECS-13-2; n=101) is a quartz arenite containing a wide distribution of zircon age populations (Figs. 4 and 5), generally similar to Eagle Creek Member samples B and C. Ordovician to Silurian detrital zircons form a prominent six-grain age peak at 438 ± 8 Ma. There are Paleoproterozoic peaks at 1750 and 1650 Ma; there is a Mesoproterozoic 1490 Ma peak; and there are six- to eight-grain Grenville-age 1160 and 1080 Ma peaks. Most Paleoproterozoic ages are less than 1800 Ma.

The Weber Sandstone at Sheep Creek, north flank of the Uinta Mountains, northeast Utah (Sample F, ECS-13-4, n=105), and from nearby Irish Canyon, northwest Colorado (Sample G, ECS-13-5, n=100) both contain a strong Paleoproterozoic population peak at about 1655 Ma. Both samples have a range of grains from 2000–1700 Ma, consistent with basement ages in the adjacent Yavapai-Mazatzal provinces of Colorado. The samples contain sparse Grenville-age grains and isolated Silurian detrital zircons from 440–425 Ma.

Statistical Comparisons

Statistical comparisons of the seven samples analyzed are shown in Table 2. The overlap-similarity tests compare the presence and size of various grain-age populations (Gehrels, 2000). The comparative values are all greater than 0.66. The overlap and similarity values are generally close to each other, within 0.3. The highest values are >0.83,

Table DR 1 (Data Repository) (continued on pages 122–128). U-Pb data from detrital zircons from samples analyzed.

Sample A, 01PL12, Hailey Member, along Seamans Creek, southern Pioneer Mountains, ID

				Isotope ratios							Apparent ages (Ma)								
Analysis	U (ppm)	206Pb 204Pb	U/Th	206Pb* 207Pb*	± (%)	207Pb* 235U*	± (%)	206Pb* 238U	± (%)	error corr.	206Pb* 238U*	± (Ma)	207Pb* 235U	± (Ma)	206Pb* 207Pb*	± (Ma)	Best age (Ma)	± (Ma)	Conc (%)
01PL12-55	1168	24408	1.3	18.2498	0.8	0.4578	1.0	0.0606	0.7	0.65	379.2	2.4	382.7	3.3	403.8	17.4	379.2	2.4	NA
01PL12-19	56	15302	2.3	18.4561	7.3	0.4703	7.8	0.0630	2.7	0.35	393.6	10.4	391.4	25.3	378.6	164.6	393.6	10.4	NA
01PL12-37	134	59960	1.4	18.0649	5.3	0.4971	5.5	0.0651	1.4	0.25	406.7	5.4	409.7	18.5	426.6	118.6	406.7	5.4	95.3
01PL12-119	91	42604	0.8	18.2389	4.3	0.5166	4.5	0.0683	1.2	0.26	426.1	4.8	422.9	15.5	405.2	96.9	426.1	4.8	105.2
01PL12-86	86	59339	0.9	18.5156	5.2	0.5101	5.2	0.0685	1.0	0.18	427.1	3.9	418.5	18.0	371.4	116.1	427.1	3.9	115.0
01PL12-95	329	12029	1.0	17.5694	2.5	0.5389	3.1	0.0687	1.8	0.57	428.1	7.3	437.7	10.9	488.3	55.7	428.1	7.3	87.7
01PL12-44	662	4479	1.8	17.4032	3.7	0.5477	4.4	0.0691	2.3	0.52	431.0	9.5	443.5	15.7	509.3	82.1	431.0	9.5	84.6
01PL12-07	299	67658	0.9	17.8075	2.6	0.5419	3.5	0.0700	2.4	0.67	436.1	9.9	439.7	12.5	458.6	57.6	436.1	9.9	95.1
01PL12-98	263	154710	1.0	17.8428	1.7	0.5415	2.2	0.0701	1.4	0.63	436.6	6.0	439.4	8.0	454.2	38.4	436.6	6.0	96.1
01PL12-13	60	14581	1.0	17.1160	10.6	0.5750	12.6	0.0714	6.8	0.54	444.5	29.4	461.3	46.7	545.7	231.4	444.5	29.4	81.4
01PL12-67	229	42566	1.0	17.8461	2.2	0.5784	2.4	0.0749	0.9	0.38	465.4	4.1	463.4	8.8	453.8	48.6	465.4	4.1	102.6
01PL12-49	171	35608	2.9	17.4187	2.1	0.5999	4.5	0.0758	3.9	0.88	470.9	17.9	477.2	17.0	507.3	46.6	470.9	17.9	92.8
01PL12	540	254410	4.4	16.9606	0.5	0.7449	1.2	0.0916	1.1	0.91	565.2	5.8	565.3	5.1	565.6	10.3	565.2	5.8	99.9
01PL12	517	266214	4.5	16.9712	0.7	0.7464	1.0	0.0919	0.7	0.72	566.6	3.9	566.1	4.3	564.2	15.1	566.6	3.9	100.4
01PL12	456	149086	4.4	16.9631	0.7	0.7475	0.9	0.0920	0.5	0.54	567.1	2.6	566.7	3.9	565.3	16.3	567.1	2.6	100.3
01PL12-26	454	316325	0.9	16.7721	0.5	0.7858	1.0	0.0956	0.9	0.87	588.5	5.0	588.8	4.6	589.9	11.1	588.5	5.0	99.8
01PL12-84	223	110366	2.7	16.4927	0.9	0.8811	1.7	0.1054	1.4	0.85	645.9	8.8	641.6	8.0	626.2	19.3	645.9	8.8	103.1
01PL12-51	202	57128	1.3	16.1920	3.1	0.9040	5.2	0.1062	4.2	0.81	650.4	26.3	653.9	25.3	665.8	65.8	650.4	26.3	97.7
01PL12-90	73	40335	2.5	16.3149	2.6	0.9176	4.8	0.1086	4.1	0.84	664.5	25.6	661.1	23.4	649.5	56.0	664.5	25.6	102.3
01PL12-81	210	409609	1.3	14.0655	0.7	1.5765	2.5	0.1608	2.4	0.96	961.4	21.4	961.0	15.4	960.2	13.5	960.2	13.5	100.1
01PL12-24	120	108968	1.9	13.5407	1.2	1.7708	1.7	0.1739	1.2	0.72	1033.6	11.6	1034.8	11.0	1037.4	23.8	1037.4	23.8	99.6
01PL12-70	999	9405	1.7	13.5089	0.9	1.6614	8.7	0.1628	8.6	0.99	972.2	78.0	993.9	55.2	1042.1	18.0	1042.1	18.0	93.3
01PL12-25	764	383135	5.3	13.4969	0.3	1.8031	1.6	0.1765	1.6	0.99	1047.9	15.2	1046.6	10.4	1043.9	5.2	1043.9	5.2	100.4
01PL12-99	73	65015	2.3	13.4664	2.7	1.8726	2.8	0.1829	1.0	0.34	1082.8	9.7	1071.5	18.8	1048.5	54.0	1048.5	54.0	103.3
01PL12-56	86	21043	1.0	13.4093	1.9	1.6807	4.6	0.1635	4.2	0.91	975.9	37.8	1001.3	29.3	1057.1	39.0	1057.1	39.0	92.3
01PL12-23	288	197348	4.8	13.1187	0.6	1.9674	1.1	0.1872	1.0	0.86	1106.1	9.8	1104.4	7.5	1101.0	11.4	1101.0	11.4	100.5
01PL12-114	352	13890	1.9	13.0841	1.2	1.7970	7.2	0.1705	7.1	0.99	1015.0	66.5	1044.4	46.9	1106.3	23.5	1106.3	23.5	91.7
01PL12-64	227	275848	3.0	12.8500	0.7	2.0925	0.7	0.1950	0.3	0.42	1148.5	3.3	1146.4	5.1	1142.3	13.4	1142.3	13.4	100.5
01PL12-17	460	157298	4.7	12.8377	0.5	2.0666	2.5	0.1924	2.5	0.98	1134.4	25.5	1137.8	17.2	1144.2	10.9	1144.2	10.9	99.1
01PL12-105	396	39606	1.6	12.7396	0.4	1.9067	3.5	0.1762	3.5	0.99	1046.0	33.5	1083.4	23.3	1159.4	8.5	1159.4	8.5	90.2
01PL12-65	127	108404	0.9	12.6973	1.0	2.1778	1.8	0.2006	1.6	0.85	1178.3	16.9	1174.0	12.8	1166.0	19.2	1166.0	19.2	101.1
01PL12-61	161	105432	3.1	12.5377	0.8	2.2184	2.3	0.2017	2.2	0.93	1184.6	23.7	1186.9	16.4	1191.1	16.7	1191.1	16.7	99.5
01PL12-102	228	348643	2.3	12.4299	0.6	2.2755	1.3	0.2051	1.1	0.90	1202.9	12.4	1204.7	8.9	1208.1	11.0	1208.1	11.0	99.6
01PL12-79	22	25369	2.9	12.2317	2.6	2.4160	5.1	0.2143	4.4	0.86	1251.9	50.3	1247.4	36.7	1239.7	50.4	1239.7	50.4	101.0
01PL12-62	128	101882	1.8	12.1057	0.9	2.5163	3.4	0.2209	3.3	0.96	1286.8	38.8	1276.8	25.1	1259.9	17.9	1259.9	17.9	102.1
01PL12-109	222	44435	1.6	11.7287	0.6	2.7708	2.2	0.2357	2.1	0.96	1364.3	25.5	1347.7	16.1	1321.5	11.6	1321.5	11.6	103.2
01PL12-106	142	9118	1.7	11.5549	1.7	2.3474	5.5	0.1967	5.2	0.95	1157.7	55.4	1226.8	39.2	1350.3	33.0	1350.3	33.0	85.7
01PL12-16	353	5659	1.8	11.4778	1.1	2.5151	7.7	0.2094	7.6	0.99	1225.4	85.0	1276.4	56.0	1363.2	20.9	1363.2	20.9	89.9
01PL12-40	117	75062	1.3	11.3184	1.1	2.7215	2.4	0.2234	2.1	0.89	1299.9	24.5	1334.4	17.5	1390.1	20.9	1390.1	20.9	93.5
01PL12-118	25	67203	1.7	11.3063	2.8	2.8863	3.2	0.2367	1.6	0.49	1369.4	19.6	1378.3	24.5	1392.2	54.3	1392.2	54.3	98.4
01PL12-34	134	170133	0.9	11.0565	0.9	3.1885	2.3	0.2557	2.1	0.92	1467.7	27.8	1454.4	17.9	1434.9	17.7	1434.9	17.7	102.3
01PL12-89	61	96458	1.4	10.9350	0.8	3.3161	1.4	0.2630	1.1	0.80	1505.1	14.8	1484.8	10.8	1456.0	16.0	1456.0	16.0	103.4
01PL12-63	77	41675	1.8	10.8750	1.5	2.9097	4.9	0.2295	4.7	0.96	1331.8	56.4	1384.4	37.1	1466.4	27.6	1466.4	27.6	90.8
01PL12-76	137	59644	2.7	10.7239	0.6	3.1486	4.2	0.2449	4.2	0.99	1412.0	53.1	1444.6	32.6	1492.9	11.7	1492.9	11.7	94.6
01PL12-04	165	53551	2.2	10.7178	0.9	3.1755	3.4	0.2468	3.2	0.96	1422.2	41.4	1451.2	26.1	1494.0	18.0	1494.0	18.0	95.2
01PL12-116	118	130692	2.2	10.5671	0.6	3.4439	1.7	0.2639	1.6	0.94	1510.0	21.1	1514.5	13.2	1520.8	11.1	1520.8	11.1	99.3
01PL12-94	444	90642	1.9	10.5573	0.3	3.4122	3.2	0.2613	3.2	1.00	1496.3	42.4	1507.2	25.1	1522.5	5.5	1522.5	5.5	98.3
01PL12-59	353	438288	1.6	10.4301	0.3	3.6030	1.4	0.2726	1.4	0.98	1553.8	18.7	1550.2	11.0	1545.3	5.2	1545.3	5.2	100.5
01PL12-72	146	26843	1.0	10.2448	1.3	3.5742	4.9	0.2656	4.7	0.96	1518.3	64.1	1543.8	39.0	1579.0	24.6	1579.0	24.6	96.2
01PL12-35	1060	1398	2.0	10.0004	3.0	1.2717	6.1	0.0922	5.3	0.87	568.7	28.9	833.1	34.6	1624.0	55.5	1624.0	55.5	35.0
01PL12-05	116	211518	0.8	9.9838	0.5	3.8263	1.6	0.2771	1.5	0.94	1576.5	21.7	1598.3	13.2	1627.1	10.1	1627.1	10.1	96.9
01PL12-50	1092	141641	2.5	9.9424	0.3	3.8771	2.7	0.2796	2.7	0.99	1589.2	38.5	1608.9	22.2	1634.8	5.4	1634.8	5.4	97.2
01PL12-52	135	179797	0.7	9.9086	0.7	4.0821	2.0	0.2934	1.9	0.94	1658.3	27.1	1650.7	16.0	1641.1	12.4	1641.1	12.4	101.0
01PL12-83	191	138376	2.4	9.9016	2.2	4.2512	4.2	0.3053	3.5	0.85	1717.5	53.0	1684.0	34.2	1642.4	41.1	1642.4	41.1	104.6
01PL12-85	37	39955	1.6	9.8710	1.0	4.0229	2.4	0.2880	2.2	0.92	1631.6	31.8	1638.8	19.6	1648.2	18.0	1648.2	18.0	99.0
01PL12-18	158	33931	0.6	9.8580	2.2	3.7172	4.2	0.2658	3.6	0.86	1519.3	48.9	1575.1	33.7	1650.6	40.1	1650.6	40.1	92.0
01PL12-103	64	111025	1.0	9.7545	0.8	4.4171	2.9	0.3125	2.8	0.96	1753.0	43.3	1715.6	24.3	1670.2	14.5	1670.2	14.5	105.0
01PL12-47	131	19343	1.6	9.7446	0.7	4.0853	3.2	0.2887	3.1	0.98	1635.1	45.2	1651.4	26.2	1672.0	12.7	1672.0	12.7	97.8
01PL12-33	139	655803	0.9	9.6754	0.5	4.2791	0.9	0.3003	0.8	0.86	1692.7	11.9	1689.3	7.6	1685.2	8.5	1685.2	8.5	100.4
01PL12-02	461	578910	3.9	9.4143	0.2	4.2178	1.9	0.2880	1.9	1.00	1631.5	27.7	1677.5	15.8	1735.5	3.3	1735.5	3.3	94.0
01PL12-48	108	190564	1.3	9.3765	0.9	4.5901	2.2	0.3122	1.9	0.90	1751.3	29.7	1747.5	17.9	1742.9	17.1	1742.9	17.1	100.5
01PL12-93	144	314141	1.5	9.3311	0.4	4.6463	1.5	0.3144	1.5	0.97	1762.5	22.7	1757.6	12.7	1751.8	7.2	1751.8	7.2	100.6
01PL12-82	324	389139	2.3	9.2189	1.3	4.6812	2.9	0.3130	2.6	0.89	1755.4	40.2	1763.9	24.5	1773.9	24.1	1773.9	24.1	99.0
01PL12-09	120	263629	1.2	9.0156	0.3	4.7130	1.7	0.3082	1.6	0.98	1731.7	24.7	1769.6	13.9	1814.5	6.0	1814.5	6.0	95.4
01PL12-22	62	16490	2.2	9.0016	1.1	4.3727	10.4	0.2855	10.3	0.99	1618.9	147.9	1707.2	86.0	1817.3	19.4	1817.3	19.4	89.1
01PL12-60	64	99129	1.1	8.9101	1.0	5.1050	1.3	0.3299	0.8	0.64	1837.9	13.0	1836.9	10.8	1835.9	17.9	1835.9	17.9	100.1
01PL12-21	159	109490	1.7	8.9022	0.3	5.0825	3.5	0.3281	3.5	1.00	1829.4	55.2	1833.2	29.5	1837.5	5.2	1837.5	5.2	99.6
01PL12-54	85	135594	1.6	8.8865	0.5	5.1416	0.8	0.3314	0.6	0.80	1845.1	9.9	1843.0	6.5	1840.7	8.3	1840.7	8.3	100.2
01PL12-12	179	495997	3.7	8.8836	0.2	5.1805	2.3	0.3338	2.3	0.99	1856.7	36.4	1849.4	19.3	1841.3	4.1	1841.3	4.1	100.8
01PL12-46	127	383740	1.8	8.8740	0.4	5.1863	1.0	0.3338	1.0	0.94	1856.8	15.7	1850.4	8.8	1843.2	6.5	1843.2	6.5	100.7
01PL12-31	101	196748	1.4	8.8726	0.6	5.1602	2.3	0.3321	2.3	0.97	1848.4	36.4	1846.1	19.9	1843.5	10.1	1843.5	10.1	100.3
01PL12-74	28	137613	1.6	8.8702	1.7	5.1179	2.0	0.3292	1.0	0.52	1834.7	16.4	1839.1	16.6	1844.0	30.2	1844.0	30.2	99.5
01PL12-53	93	97669	1.2	8.8592	0.8	5.1199	1.7	0.3290	1.6	0.90	1833.4	25.0	1839.4	14.8	1846.2	13.6	1846.2	13.6	99.3
01PL12-06	102	244088	2.0	8.8327	0.6	5.2125	1.0	0.3339	0.8	0.79	1857.3	12.6	1854.7	8.4	1851.7	11.0	1851.7	11.0	100.3
01PL12-78	5	6969	1.2	8.7419	8.5	5.3794	9.0	0.3411	3.2	0.35	1891.8	52.0	1881.6	77.6	1870.3	153.2	1870.3	153.2	101.1
01PL12-97	350	164825	1.5	8.6775	0.4	5.2061	4.1	0.3276	4.1	0.99	1827.0	65.3	1853.6	35.2	1883.6	7.8	1883.6	7.8	97.0
01PL12-15	96	118857	1.0	8.5501	0.4	5.5540	0.8	0.3444	0.7	0.88	1907.9	12.0	1909.0	7.1	1910.2	7.0	1910.2	7.0	99.9
01PL12-119	214	146046	1.4	8.5115	0.2	5.1925	1.5	0.3205	1.5	0.99	1792.3	24.0	1851.4	13.2	1918.3	3.4	1918.3	3.4	93.4
01PL12-39	26	8209	0.5	8.5105	3.0	5.3489	3.4	0.3302	1.7	0.49	1839.1	26.8	1876.7	29.3	1918.6	53.7	1918.6	53.7	95.9
01PL12-28	152	303908	1.7	8.4915	0.3	5.7712	2.2	0.3554	2.2	0.99	1960.5	37.6	1942.1	19.4	1922.6	5.3	1922.6	5.3	102.0
01PL12-91	108	167747	0.7	8.4749	0.5	5.7211	2.0	0.3517	1.9	0.96	1942.5	31.9	1934.6	17.1	1926.1	9.7	1926.1	9.7	100.9
01PL12-68	108	230058	1.9	8.0641	0.3	6.2712	0.8	0.3668	0.8	0.95	2014.2	13.9	2014.4	7.4	2014.6	4.6	2014.6	4.6	100.0
01PL12-80	25	74788	0.9	7.9606	1.8	6.5286	2.6	0.3769	1.9	0.71	2061.9	32.9	2049.8	23.1	2037.5	32.6	2037.5	32.6	101.2
01PL12-29	70	112843	0.7	7.8832	0.5	6.6337	3.1	0.3793	3.1	0.99	2072.9	55.0	2063.8	27.7	2054.8	8.2	2054.8	8.2	100.9
01PL12-43	147	500465	1.5	6.5727	0.3	9.3540	1.0	0.4459	1.0	0.95	2377.0	19.3	2373.3	9.4	2370.2	5.4	2370.2	5.4	100.3
01PL12-08	127	319461	2.4	6.2084	0.3	10.3200	0.9	0.4647	0.9	0.93	2460.2	17.4	2463.9	8.5	2466.9	5.8	2466.9	5.8	99.7
01PL12-75	30	84860	0.9	6.0788	0.7	10.8297	1.3	0.4775	1.1	0.82	2516.2	22.0	2508.6	12.0	2502.5	12.5	2502.5	12.5	100.5
01PL12-45	106	306360	1.1	5.7973	0.3	11.6857	1.1	0.4913	1.1	0.97	2576.5	23.3	2579.6	10.5	2582.0	4.3	2582.0	4.3	99.8
01PL12-01	46	76836	0.6	5.7069	0.6	11.8139	2.0	0.4890	1.9	0.95	2566.3	41.1	2589.8	19.1	2608.2	10.6	2608.2	10.6	98.4

between samples F and G, the two Weber Sandstone samples; between samples B and C, the two Eagle Creek Member samples; and between samples C and E, the second Eagle Creek sample and the Tensleep Sandstone from Sinks Canyon. The samples that appear different on the probability-density curves (Figs. 4 and 6)—that is, Weber Sandstone (samples F and G) versus Wilson Creek Member (Sample D)—do not have notably lower overlap or similarity values (values >0.75). Further, the several samples that fail

Table DR 1 (Data Repository) (cont.). U-Pb data from detrital zircons from samples analyzed.

Sample B, 04TD10, Eagle Creek Member, Wood River Formation, upper Pioneer Cabin Trail, Pioneer Mountains, ID																			
						Isotope ratios							Apparent ages (Ma)						
Analysis	U (ppm)	206Pb 204Pb	U/Th	206Pb* 207Pb*	± (%)	207Pb* 235U*	± (%)	206Pb* 238U	± (%)	error corr.	206Pb* 238U*	± (Ma)	207Pb* 235U	± (Ma)	206Pb* 207Pb*	± (Ma)	Best age (Ma)	± (Ma)	Conc (%)
04TD10-1	211	206321	3.1	13.1343	1.7	1.9534	3.1	0.1861	2.6	0.84	1100.1	26.6	1099.6	21.1	1098.7	34.6	1098.7	34.6	100.1
04TD10-2	569	681857	3.7	12.2544	0.4	2.3953	2.5	0.2129	2.5	0.99	1244.2	28.3	1241.2	18.2	1236.0	8.2	1236.0	8.2	100.7
04TD10-3	128	151928	1.4	13.0617	1.9	1.9338	2.9	0.1832	2.3	0.77	1084.4	22.6	1092.9	19.6	1109.7	37.3	1109.7	37.3	97.7
04TD10-4	206	312770	2.9	9.1988	0.7	4.6574	2.1	0.3107	1.9	0.94	1744.3	29.5	1759.6	17.2	1777.9	13.0	1777.9	13.0	98.1
04TD10-5	247	596619	1.3	9.8703	0.5	4.1201	3.1	0.2949	3.1	0.99	1666.2	45.0	1658.3	25.3	1648.3	8.5	1648.3	8.5	101.1
04TD10-6	134	232259	2.6	11.6332	1.5	2.6784	4.2	0.2260	3.9	0.93	1313.4	46.7	1322.5	31.1	1337.3	29.0	1337.3	29.0	98.2
04TD10-7	99	222285	1.6	8.1848	1.1	5.9555	3.3	0.3535	3.1	0.95	1951.4	52.5	1969.4	28.6	1988.2	18.7	1988.2	18.7	98.1
04TD10-8	223	304133	1.9	13.7926	2.2	1.7265	4.3	0.1727	3.7	0.86	1027.0	35.4	1018.4	27.8	1000.1	44.1	1000.1	44.1	102.7
04TD10-9	265	658452	1.6	9.4622	0.6	4.3959	2.4	0.3017	2.4	0.96	1699.6	35.1	1711.6	20.2	1726.2	11.8	1726.2	11.8	98.5
04TD10-10	96	242761	1.9	10.7397	1.9	3.2936	2.8	0.2565	2.1	0.74	1472.1	27.7	1479.5	22.0	1490.2	35.8	1490.2	35.8	98.8
04TD10-11	313	656096	1.2	8.8883	0.3	5.0581	2.0	0.3261	2.0	0.99	1819.3	31.6	1829.1	17.1	1840.3	5.2	1840.3	5.2	98.9
04TD10-12	223	263094	1.9	13.5436	1.6	1.8110	3.1	0.1779	2.7	0.86	1055.4	26.1	1049.4	20.4	1037.0	32.4	1037.0	32.4	101.8
04TD10-13	292	342699	2.8	13.3815	1.6	1.8444	3.1	0.1790	2.7	0.86	1061.5	26.3	1061.4	20.5	1061.3	31.5	1061.3	31.5	100.0
04TD10-14	172	400799	2.6	13.3876	1.9	1.8550	2.8	0.1801	2.0	0.73	1067.6	19.9	1065.2	18.3	1060.4	38.4	1060.4	38.4	100.7
04TD10-15	465	885503	1.2	11.3279	0.7	2.8877	1.9	0.2372	1.8	0.94	1372.4	22.4	1378.7	14.6	1388.5	12.9	1388.5	12.9	98.8
04TD10-16	150	394446	1.4	9.0353	1.0	4.9057	2.1	0.3215	1.8	0.86	1796.9	28.1	1803.2	17.5	1810.5	19.0	1810.5	19.0	99.2
04TD10-17	149	251038	1.4	11.4477	0.6	2.8936	2.5	0.2402	2.5	0.98	1388.0	31.0	1380.2	19.2	1368.3	10.7	1368.3	10.7	101.4
04TD10-18	174	172979	1.3	13.6703	2.1	1.7508	2.6	0.1736	1.5	0.58	1031.8	14.4	1027.5	16.7	1018.1	42.7	1018.1	42.7	101.3
04TD10-19	98	257243	2.1	7.3159	0.7	7.5596	2.7	0.4011	2.6	0.97	2174.2	48.3	2180.1	24.2	2185.6	11.8	2185.6	11.8	99.5
04TD10-20	84	149381	1.8	13.9451	5.0	1.6991	5.8	0.1718	3.1	0.53	1022.2	29.0	1008.2	37.3	977.7	101.1	977.7	101.1	104.6
04TD10-21	103	218186	1.1	9.9418	2.7	3.9069	3.6	0.2817	2.3	0.64	1599.9	32.1	1615.1	28.7	1634.9	50.8	1634.9	50.8	97.9
04TD10-22	297	107897	2.2	18.1427	3.0	0.5220	3.8	0.0687	2.2	0.59	428.2	9.3	426.5	13.2	417.0	67.8	428.2	9.3	NA
04TD10-23	284	604242	2.6	9.3874	0.8	4.4007	1.2	0.2996	0.9	0.75	1689.4	13.2	1712.5	9.8	1740.8	14.5	1740.8	14.5	97.0
04TD10-25	119	248445	3.2	13.3403	2.4	1.7056	3.2	0.1650	2.2	0.67	984.6	19.8	1010.6	20.6	1067.5	48.1	1067.5	48.1	92.2
04TD10-26	616	964404	3.5	13.1331	1.0	1.8879	2.2	0.1798	1.9	0.88	1066.0	18.7	1076.8	14.3	1098.8	20.1	1098.8	20.1	97.0
04TD10-27	96	248748	2.2	9.1777	1.2	4.7596	1.9	0.3168	1.5	0.80	1774.2	23.9	1777.8	16.3	1782.1	21.4	1782.1	21.4	99.6
04TD10-28	81	123266	1.0	11.3507	2.4	2.9687	3.8	0.2444	2.9	0.77	1409.5	36.7	1399.6	28.7	1384.6	46.4	1384.6	46.4	101.8
04TD10-29	247	599865	2.7	11.6928	0.9	2.7335	2.7	0.2318	2.5	0.94	1344.0	30.6	1337.6	19.9	1327.4	17.0	1327.4	17.0	101.2
04TD10-30	163	382507	2.3	9.0265	1.2	4.8406	2.1	0.3169	1.7	0.83	1774.5	26.4	1792.0	17.4	1812.3	21.2	1812.3	21.2	97.9
04TD10-31	284	108834	2.4	18.3530	1.2	0.5233	2.6	0.0697	2.3	0.88	434.1	9.5	427.4	9.0	391.2	27.2	434.1	9.5	NA
04TD10-32	345	512232	3.6	10.7355	0.8	3.1797	2.1	0.2476	1.9	0.93	1425.9	24.4	1452.2	15.9	1490.9	14.8	1490.9	14.8	95.6
04TD10-33	187	414857	1.7	8.6121	0.7	5.3854	2.1	0.3364	2.0	0.95	1869.2	33.0	1882.5	18.4	1897.2	12.6	1897.2	12.6	98.5
04TD10-34	416	889398	2.2	9.8464	0.6	3.9931	2.5	0.2852	2.4	0.97	1617.3	34.6	1632.8	20.2	1652.8	10.7	1652.8	10.7	97.9
04TD10-35	36	141564	1.5	5.7609	1.4	11.4882	2.1	0.4800	1.5	0.74	2527.3	32.3	2563.6	19.6	2592.5	23.5	2592.5	23.5	97.5
04TD10-36	1470	759112	15.4	17.9671	0.9	0.5224	1.5	0.0681	1.3	0.82	424.6	5.2	426.8	5.3	438.7	19.5	424.6	5.2	NA
04TD10-37	274	422438	0.7	13.1848	1.3	1.9734	1.9	0.1887	1.5	0.76	1114.4	15.0	1106.5	13.0	1091.0	25.3	1091.0	25.3	102.1
04TD10-38	335	1312293	2.3	11.4268	0.7	2.6650	1.8	0.2209	1.7	0.93	1286.4	19.8	1318.8	13.5	1371.8	13.1	1371.8	13.1	93.8
04TD10-39	430	818471	2.4	9.1377	0.3	4.7161	1.4	0.3125	1.4	0.97	1753.2	21.0	1770.1	11.8	1790.0	6.1	1790.0	6.1	97.9
04TD10-40	215	394002	1.6	10.6795	1.3	3.3271	1.7	0.2577	1.1	0.64	1478.1	14.1	1487.4	13.1	1500.8	24.3	1500.8	24.3	98.5
04TD10-41	54	81230	1.2	10.2566	2.8	3.4985	3.6	0.2602	2.3	0.64	1491.1	31.0	1526.9	28.6	1576.8	52.0	1576.8	52.0	94.6
04TD10-42	130	112981	10.3	13.6360	2.3	1.7126	3.4	0.1694	2.5	0.74	1008.7	23.5	1013.3	21.8	1023.2	46.1	1023.2	46.1	98.6
04TD10-43	506	821163	2.9	12.8114	0.6	2.0473	1.8	0.1902	1.7	0.93	1122.6	17.2	1131.4	12.2	1148.3	12.8	1148.3	12.8	97.8
04TD10-44	203	294387	3.4	10.8123	0.9	3.2888	2.5	0.2579	2.3	0.92	1479.1	30.0	1478.4	19.1	1477.4	17.9	1477.4	17.9	100.1
04TD10-45	418	634673	1.3	9.8512	0.4	4.0956	2.4	0.2926	2.4	0.98	1654.6	34.6	1653.4	19.6	1651.9	7.8	1651.9	7.8	100.2
04TD10-46	41	130073	5.3	4.7764	1.1	15.8989	1.5	0.5508	1.0	0.67	2828.3	23.2	2870.7	14.5	2900.6	18.2	2900.6	18.2	97.5
04TD10-47	78	254961	1.2	8.2412	1.5	5.8647	1.9	0.3505	1.2	0.63	1937.1	19.9	1956.0	16.4	1976.0	26.1	1976.0	26.1	98.0
04TD10-48	59	163309	2.0	9.1780	2.8	4.7363	4.2	0.3153	3.1	0.74	1766.6	48.5	1773.7	35.5	1782.0	51.7	1782.0	51.7	99.1
04TD10-49	303	708125	1.9	9.6136	1.2	4.0829	3.3	0.2847	3.1	0.94	1614.9	44.6	1650.9	27.2	1697.0	21.3	1697.0	21.3	95.2
04TD10-50	87	234148	1.2	10.8855	2.0	3.0782	5.4	0.2430	5.0	0.93	1402.4	63.5	1427.3	41.4	1464.6	37.3	1464.6	37.3	95.8
04TD10-51	177	327653	3.2	13.8300	2.3	1.5916	3.2	0.1596	2.2	0.69	954.8	19.3	966.9	19.7	994.6	46.3	994.6	46.3	96.0
04TD10-52	171	383027	1.3	9.9292	1.6	3.7881	3.7	0.2728	3.4	0.91	1555.0	46.4	1590.2	29.7	1637.3	28.8	1637.3	28.8	95.0
04TD10-53	195	1079459	1.2	6.6432	0.7	9.1458	2.6	0.4407	2.5	0.96	2353.6	50.1	2352.7	24.2	2351.9	12.7	2351.9	12.7	100.1
04TD10-54	535	879646	1.2	9.8560	0.5	4.0823	2.0	0.2918	2.0	0.97	1650.6	28.8	1650.8	16.7	1651.0	9.4	1651.0	9.4	100.0
04TD10-55	114	112905	2.1	13.6484	3.5	1.6164	4.7	0.1600	3.0	0.65	956.8	27.0	976.6	29.3	1021.4	71.6	1021.4	71.6	93.7
04TD10-56	549	842509	6.1	12.6510	0.6	2.2112	2.3	0.2029	2.2	0.97	1190.8	24.4	1184.6	16.3	1173.3	11.7	1173.3	11.7	101.5
04TD10-58	526	479046	5.1	16.0877	1.0	0.9364	2.4	0.1093	2.1	0.90	668.4	13.6	671.0	11.7	679.6	22.2	668.4	13.6	98.4
04TD10-59	241	552794	0.7	9.8642	0.5	4.2372	2.0	0.3031	1.9	0.97	1706.9	28.6	1681.3	16.2	1649.5	9.2	1649.5	9.2	103.5
04TD10-60	102	138765	0.9	13.8621	3.7	1.6576	4.0	0.1667	1.6	0.40	993.7	14.8	992.5	25.6	989.8	75.3	989.8	75.3	100.4
04TD10-61	156	67031	1.2	18.1025	5.1	0.5490	5.6	0.0721	2.3	0.41	448.6	9.9	444.3	20.1	422.0	113.7	448.6	9.9	NA
04TD10-62	494	2761932	3.0	9.4475	0.5	4.4404	4.1	0.3043	4.1	0.99	1712.4	61.0	1719.9	33.9	1729.1	9.1	1729.1	9.1	99.0
04TD10-63	184	274419	1.3	12.1112	1.3	2.3818	2.3	0.2092	1.9	0.82	1224.6	20.7	1237.1	16.1	1259.1	25.1	1259.1	25.1	97.3
04TD10-64	454	1342830	2.6	13.2388	1.2	1.9462	3.0	0.1869	2.7	0.91	1104.4	27.3	1097.1	19.9	1082.8	24.6	1082.8	24.6	102.0
04TD10-65	87	204290	1.3	8.2619	1.3	5.4079	2.8	0.3240	2.5	0.88	1809.5	38.8	1886.1	23.9	1971.6	23.5	1971.6	23.5	91.8
04TD10-67	144	367606	2.9	8.3268	0.6	6.0431	3.4	0.3650	3.4	0.99	2005.6	58.2	1982.1	29.9	1957.6	10.3	1957.6	10.3	102.5
04TD10-68	154	381157	2.5	9.3189	1.2	4.2241	2.1	0.2855	1.8	0.82	1619.0	25.3	1678.7	17.6	1754.2	22.2	1754.2	22.2	92.3
04TD10-69	253	416374	3.3	10.6229	0.7	3.4401	2.2	0.2650	2.1	0.96	1515.6	28.6	1513.6	17.4	1510.8	12.4	1510.8	12.4	100.3
04TD10-70	240	401993	2.1	9.0404	0.6	4.8651	2.2	0.3190	2.1	0.96	1784.8	33.1	1796.2	18.7	1809.5	11.7	1809.5	11.7	98.6
04TD10-71	300	424914	2.0	10.5744	0.6	3.4622	3.2	0.2655	3.1	0.98	1518.1	42.1	1518.7	25.1	1519.5	12.2	1519.5	12.2	99.9
04TD10-72	73	150366	0.7	10.6188	3.2	3.2574	4.1	0.2509	2.7	0.64	1442.9	34.3	1470.9	32.1	1511.6	59.6	1511.6	59.6	95.5
04TD10-73	167	285711	2.0	9.8229	1.2	3.6835	4.0	0.2624	3.8	0.95	1502.2	50.5	1567.8	31.7	1657.2	22.9	1657.2	22.9	90.6
04TD10-74	427	571282	3.4	11.5310	0.8	2.6156	1.2	0.2187	0.9	0.73	1275.3	10.2	1305.0	8.9	1354.3	15.9	1354.3	15.9	94.2
04TD10-75	565	215516	19.7	17.8810	2.4	0.4897	2.8	0.0635	1.4	0.50	396.9	5.4	404.7	9.4	449.4	54.3	396.9	5.4	NA
04TD10-76	447	1154007	1.8	10.5797	0.3	3.5243	3.1	0.2704	3.1	1.00	1542.9	42.3	1532.7	24.5	1518.5	5.4	1518.5	5.4	101.6
04TD10-77	62	228707	0.6	5.2296	0.9	14.3854	1.2	0.5456	0.8	0.65	2806.9	17.6	2775.5	11.3	2752.7	14.8	2752.7	14.8	102.0
04TD10-78	263	851538	1.9	10.5666	1.0	3.3997	2.4	0.2605	2.2	0.91	1492.6	29.7	1504.3	19.1	1520.9	18.6	1520.9	18.6	98.1
04TD10-79	331	227545	40.3	17.3556	2.7	0.5522	3.6	0.0695	2.3	0.64	433.2	9.5	446.4	12.9	515.3	60.3	433.2	9.5	NA
04TD10-80	128	51166	1.1	19.9559	10.4	0.4786	10.8	0.0693	2.9	0.27	431.8	12.1	397.1	35.4	200.1	241.7	431.8	12.1	NA
04TD10-81	110	156531	2.3	12.3028	2.6	2.3234	3.5	0.2073	2.4	0.67	1214.5	26.1	1219.5	24.9	1228.3	51.2	1228.3	51.2	98.9
04TD10-82	321	924683	3.5	9.2040	0.4	4.7946	1.8	0.3201	1.8	0.98	1790.0	28.0	1784.0	15.4	1776.9	7.0	1776.9	7.0	100.7
04TD10-83	35	40149	2.3	13.4240	6.1	1.8335	7.7	0.1785	4.6	0.60	1058.8	44.9	1057.5	50.3	1054.9	123.3	1054.9	123.3	100.4
04TD10-84	188	295999	2.5	11.2309	0.9	2.8995	1.4	0.2362	1.1	0.80	1366.8	14.0	1381.8	10.8	1405.0	16.5	1405.0	16.5	97.3
04TD10-85	99	409855	1.1	5.4263	1.6	11.9162	5.7	0.4690	5.4	0.96	2479.0	111.9	2597.8	53.2	2691.8	27.0	2691.8	27.0	92.1
04TD10-86	243	810956	5.1	5.2305	1.5	13.9585	4.1	0.5295	3.9	0.94	2739.4	86.6	2746.9	39.3	2752.4	24.0	2752.4	24.0	99.5
04TD10-87	65	243327	1.7	5.8927	1.1	10.8984	2.8	0.4658	2.6	0.92	2465.0	52.7	2514.5	26.0	2554.7	18.5	2554.7	18.5	96.5
04TD10-88	116	497523	0.6	4.1735	0.5	20.0473	2.1	0.6068	2.0	0.97	3057.2	48.8	3093.6	20.0	3117.4	7.8	3117.4	7.8	98.1
04TD10-89	121	200017	0.9	11.1738	2.4	2.9243	4.5	0.2370	3.8	0.85	1371.0	47.2	1388.2	34.0	1414.8	45.3	1414.8	45.3	96.9
04TD10-90	414	656716	3.1	9.1082	0.3	5.0617	1.5	0.3344	1.4	0.98	1859.5	23.3	1829.7	12.5	1795.9	5.5	1795.9	5.5	103.5
04TD10-93	197	389892	1.8	10.9629	1.4	3.1803	2.9	0.2529	2.5	0.87	1453.3	32.6	1452.4	22.3	1451.1	27.3	1451.1	27.3	100.1
04TD10-95	160	296883	1.6	13.6754	1.4	1.7949	3.3	0.1780	2.9	0.90	1056.2	28.6	1043.6	21.3	1017.4	29.3	1017.4	29.3	103.8
04TD10-96	447	1202537	1.7	9.3696	0.5	4.4080	1.5	0.2995	1.4	0.94	1689.1	21.2	1713.8	12.5	1744.3	9.2	1744.3	9.2	96.8
04TD10-97	206	160766	1.0	18.2339	5.1	0.5110	6.6	0.0676	4.2	0.63	421.5	17.0	419.1	22.6	405.8	113.9	421.5	17.0	NA
04TD10-98	52	78289	1.9	13.1242	7.1	1.8750	7.4	0.1785	2.3	0.32	1058.6	22.9	1072.3	49.3	1100.2	141.5	1100.2	141.5	96.2
04TD10-99	352	706701	2.1	8.6322	0.5	5.4466	1.8	0.3410	1.7	0.97	1891.5	28.2	1892.2	15.3	1893.0	8.2	1893.0	8.2	99.9
04TD10-100	109	474379	0.9	5.3053	2.5	12.8147	4.2	0.4931	3.4	0.80	2584.0	72.1	2666.1	39.9	2729.0	41.9	2729.0	41.9	94.7

the K-S test do not have notably lower overlap or similarity values (samples F and G vs. samples D and E, and Sample E vs. Sample C) all with overlap values >0.72.

The K-S comparison tests whether two distributions could have been taken at random from the same distribution of grain ages (Guynn and Gehrels, 2010). Samples with a *p*-value <0.05

Table DR 1 (Data Repository) (cont.). U-Pb data from detrital zircons from samples analyzed.

Sample C, 14TD10, Eagle Creek Member, Corral Creek, lower Pioneer Cabin Trail, Pioneer Mountains, ID																			
						Isotope ratios							Apparent ages (Ma)						
Analysis	U (ppm)	206Pb 204Pb	U/Th	206Pb* 207Pb*	± (%)	207Pb* 235U*	± (%)	206Pb* 238U	± (%)	error corr.	206Pb* 238U*	± (Ma)	207Pb* 235U	± (Ma)	206Pb* 207Pb*	± (Ma)	Best age (Ma)	± (Ma)	Conc (%)
14TD10-1	83	125061	2.8	13.1394	3.7	1.8077	4.3	0.1723	2.2	0.52	1024.6	21.1	1048.2	28.3	1097.9	74.2	1097.9	74.2	93.3
14TD10-2	167	384143	1.4	9.9408	0.6	3.8499	4.0	0.2776	4.0	0.99	1579.1	56.0	1603.3	32.5	1635.1	10.5	1635.1	10.5	96.6
14TD10-5	93	149106	3.7	13.6888	3.7	1.6871	3.9	0.1675	1.0	0.27	998.3	9.6	1003.7	24.6	1015.4	75.2	1015.4	75.2	98.3
14TD10-6	351	3992765	4.2	5.0727	0.2	15.0320	1.4	0.5530	1.3	0.99	2837.8	30.7	2817.3	12.9	2802.6	3.2	2802.6	3.2	101.3
14TD10-7	112	805561	4.3	8.9724	1.5	4.9420	2.0	0.3216	1.4	0.69	1797.5	21.8	1809.5	17.1	1823.2	26.6	1823.2	26.6	98.6
14TD10-8	70	325347	1.8	9.8638	2.1	3.9247	2.5	0.2808	1.3	0.53	1595.2	18.5	1618.8	19.9	1649.5	38.6	1649.5	38.6	96.7
14TD10-9	154	813204	3.9	8.7600	0.6	5.2732	2.2	0.3350	2.1	0.96	1862.7	33.7	1864.5	18.5	1866.6	10.9	1866.6	10.9	99.8
14TD10-10	205	784041	3.1	10.7272	0.6	3.3414	1.6	0.2600	1.5	0.93	1489.7	20.0	1490.8	12.7	1492.4	11.6	1492.4	11.6	99.8
14TD10-11	321	604982	2.3	13.6723	0.6	1.6987	1.5	0.1684	1.3	0.90	1003.5	12.4	1008.0	9.5	1017.8	12.8	1017.8	12.8	98.6
14TD10-12	96	434744	2.9	9.8615	1.6	4.0219	2.2	0.2877	1.6	0.71	1629.8	22.8	1638.6	18.2	1650.0	29.2	1650.0	29.2	98.8
14TD10-13	255	769028	3.7	11.6890	1.0	2.6889	2.2	0.2280	1.9	0.88	1323.8	23.2	1325.4	16.2	1328.0	20.1	1328.0	20.1	99.7
14TD10-14	149	1390001	1.6	5.2165	0.2	14.1765	2.6	0.5363	2.6	1.00	2768.1	58.8	2761.6	24.9	2756.8	4.0	2756.8	4.0	100.4
14TD10-15	217	991273	3.8	9.3665	0.8	4.4356	1.6	0.3013	1.4	0.86	1697.8	20.6	1719.0	13.3	1744.9	15.0	1744.9	15.0	97.3
14TD10-16	463	437803	7.0	18.3461	1.5	0.5020	1.8	0.0668	0.9	0.52	416.8	3.7	413.0	5.9	392.1	33.6	416.8	3.7	NA
14TD10-17	68	210925	2.5	13.0522	4.7	1.9407	5.0	0.1837	1.6	0.32	1087.2	16.1	1095.2	33.5	1111.2	94.4	1111.2	94.4	97.8
14TD10-18	199	736808	3.0	12.7968	0.7	2.0234	1.3	0.1878	1.1	0.85	1109.4	11.4	1123.4	9.0	1150.5	14.0	1150.5	14.0	96.4
14TD10-19	86	68899	2.3	16.7497	14.3	0.5554	14.6	0.0675	3.0	0.20	420.9	12.2	448.5	53.2	592.8	312.3	420.9	12.2	71.0
14TD10-20	236	193994	2.6	17.9816	3.3	0.5067	4.1	0.0661	2.4	0.58	412.5	9.4	416.3	13.9	436.9	73.9	412.5	9.4	NA
14TD10-21	360	1461473	3.0	9.2673	0.3	4.7572	0.6	0.3197	0.5	0.82	1788.5	7.5	1777.4	5.0	1764.3	6.3	1764.3	6.3	101.4
14TD10-22	236	687974	2.1	9.8744	0.6	4.1376	3.2	0.2963	3.1	0.98	1673.0	45.7	1661.8	25.9	1647.5	11.6	1647.5	11.6	101.5
14TD10-23	136	378444	3.1	8.9767	1.3	5.0282	2.7	0.3274	2.3	0.88	1825.6	37.2	1824.1	22.5	1822.4	22.8	1822.4	22.8	100.2
14TD10-24	107	780101	2.8	9.2347	1.4	4.6333	3.5	0.3103	3.2	0.92	1742.3	49.0	1755.3	29.1	1770.8	24.9	1770.8	24.9	98.4
14TD10-25	87	189359	4.5	13.2760	5.5	1.8345	6.2	0.1766	2.8	0.46	1048.6	27.6	1057.9	40.4	1077.2	109.5	1077.2	109.5	97.3
14TD10-26	45	159862	2.3	8.4205	1.6	5.6572	2.0	0.3455	1.1	0.57	1913.0	18.7	1924.9	17.0	1937.6	29.0	1937.6	29.0	98.7
14TD10-27	364	4338658	14.4	3.1505	0.7	29.8269	2.2	0.6815	2.0	0.94	3350.2	53.3	3481.1	21.3	3557.3	11.3	3557.3	11.3	94.2
14TD10-28	44	232266	4.1	9.3037	1.6	4.5441	2.2	0.3066	1.5	0.68	1724.0	23.0	1739.1	18.6	1757.2	29.8	1757.2	29.8	98.1
14TD10-30	37	159457	1.7	7.8076	1.8	6.8259	2.2	0.3865	1.3	0.56	2106.7	22.7	2089.1	19.8	2071.8	32.5	2071.8	32.5	101.7
14TD10-31	110	215123	1.9	9.8983	1.1	3.9523	2.6	0.2837	2.3	0.91	1610.1	33.1	1624.5	20.8	1643.1	20.0	1643.1	20.0	98.0
14TD10-32	200	415594	1.9	9.9094	0.9	3.9475	2.0	0.2837	1.8	0.90	1610.0	25.4	1623.5	16.1	1641.0	16.1	1641.0	16.1	98.1
14TD10-33	34	103052	3.0	11.0969	3.4	3.0977	6.0	0.2493	5.0	0.82	1434.9	64.1	1432.1	46.4	1428.0	65.3	1428.0	65.3	100.5
14TD10-34	61	99111	2.8	13.0660	4.7	2.0242	5.3	0.1918	2.6	0.49	1131.2	27.1	1123.7	36.3	1109.1	93.0	1109.1	93.0	102.0
14TD10-35	247	1281064	4.9	7.9947	0.3	6.5792	3.1	0.3815	3.1	0.99	2083.2	55.7	2056.6	27.7	2030.0	5.9	2030.0	5.9	102.6
14TD10-36	48	116436	2.9	11.5105	3.2	2.6315	3.8	0.2197	2.0	0.54	1280.2	23.6	1309.5	27.7	1357.8	61.0	1357.8	61.0	94.3
14TD10-37	266	398647	5.4	13.7178	0.9	1.6839	2.2	0.1675	2.0	0.91	998.5	18.5	1002.4	13.9	1011.1	17.9	1011.1	17.9	98.8
14TD10-38	119	682070	1.2	5.4296	0.7	12.3146	1.8	0.4849	1.7	0.93	2548.7	35.5	2628.7	17.0	2690.8	11.0	2690.8	11.0	94.7
14TD10-39	63	761598	4.9	5.0129	0.6	14.3320	1.5	0.5211	1.4	0.93	2703.7	31.3	2771.9	14.5	2822.0	9.4	2822.0	9.4	95.8
14TD10-40	53	533142	2.0	5.2653	1.3	13.2751	3.8	0.5069	3.5	0.93	2643.6	76.3	2699.4	35.6	2741.5	22.1	2741.5	22.1	96.4
14TD10-41	429	4509867	6.2	5.6216	0.2	10.9772	2.8	0.4476	2.8	1.00	2384.4	56.6	2521.2	26.5	2633.2	3.8	2633.2	3.8	90.6
14TD10-43	176	1125539	2.1	9.7062	0.6	3.7977	7.0	0.2673	7.0	1.00	1527.3	95.5	1592.3	56.7	1679.3	11.3	1679.3	11.3	90.9
14TD10-44	69	212878	1.5	9.9252	2.9	3.9935	3.5	0.2875	2.0	0.57	1628.9	28.5	1632.9	28.2	1638.0	53.0	1638.0	53.0	99.4
14TD10-45	106	609945	2.9	5.8944	0.6	10.5591	1.5	0.4514	1.4	0.91	2401.5	27.1	2485.1	13.8	2554.2	10.5	2554.2	10.5	94.0
14TD10-46	27	60718	4.5	12.5993	8.7	2.0268	9.3	0.1852	3.2	0.35	1095.4	32.6	1124.6	63.2	1181.4	172.4	1181.4	172.4	92.7
14TD10-47	60	249711	2.7	8.7348	1.0	5.2609	2.3	0.3333	2.1	0.89	1854.3	33.2	1862.5	19.6	1871.8	18.6	1871.8	18.6	99.1
14TD10-49	32	164732	12.4	9.5472	2.9	4.0910	5.7	0.2833	4.8	0.85	1607.8	68.7	1652.5	46.2	1709.8	54.3	1709.8	54.3	94.0
14TD10-50	59	395225	2.0	5.5897	0.8	12.2925	2.2	0.4983	2.0	0.93	2606.6	43.3	2627.0	20.5	2642.7	13.5	2642.7	13.5	98.6
14TD10-52	322	1693484	3.5	9.3443	0.4	4.5336	3.3	0.3073	3.3	0.99	1727.2	50.2	1737.2	27.8	1749.2	7.9	1749.2	7.9	98.7
14TD10-53	99	1441286	1.8	7.4670	0.6	6.8192	1.0	0.3693	0.9	0.84	2026.1	15.2	2088.2	9.2	2150.0	9.9	2150.0	9.9	94.2
14TD10-54	468	7435673	7.4	5.1955	0.2	13.5396	1.2	0.5102	1.2	0.99	2657.4	26.8	2718.1	11.8	2763.4	3.1	2763.4	3.1	96.2
14TD10-55	137	247524	4.4	13.5808	2.1	1.7352	3.0	0.1709	2.2	0.72	1017.1	20.7	1021.7	19.6	1031.4	42.4	1031.4	42.4	98.6
14TD10-56	72	178358	2.8	9.3385	0.7	4.4634	3.2	0.3023	3.1	0.98	1702.7	46.9	1724.2	26.6	1750.4	12.9	1750.4	12.9	97.3
14TD10-57	56	171514	1.4	8.3206	1.7	5.6317	3.4	0.3399	3.0	0.88	1886.0	49.3	1921.0	29.7	1958.9	29.8	1958.9	29.8	96.3
14TD10-58	227	495086	6.3	11.7270	1.1	2.4985	1.6	0.2125	1.1	0.70	1242.1	12.5	1271.6	11.5	1321.7	22.0	1321.7	22.0	94.0
14TD10-59	57	173506	1.8	9.6947	2.9	4.1598	3.6	0.2925	2.2	0.60	1654.0	31.9	1666.1	29.7	1681.5	53.4	1681.5	53.4	98.4
14TD10-60	93	199402	4.1	13.3151	2.6	1.9655	3.7	0.1898	2.6	0.71	1120.3	27.0	1103.8	25.0	1071.3	52.7	1071.3	52.7	104.6
14TD10-61	298	2677783	7.1	10.6702	0.8	3.2645	2.4	0.2526	2.3	0.95	1452.0	30.1	1472.6	19.0	1502.4	14.5	1502.4	14.5	96.6
14TD10-62	544	2488809	4.9	13.1762	0.7	1.9409	1.3	0.1855	1.1	0.86	1096.9	11.5	1095.3	8.9	1092.3	13.6	1092.3	13.6	100.4
14TD10-63	143	798720	1.8	5.2098	0.7	14.0164	1.5	0.5296	1.3	0.88	2739.8	29.7	2750.8	14.3	2758.9	11.8	2758.9	11.8	99.3
14TD10-64	218	306565	3.0	17.2789	2.2	0.5462	5.3	0.0684	4.8	0.91	426.8	19.8	442.5	18.9	525.0	47.4	426.8	19.8	NA
14TD10-65	210	456852	6.1	9.9620	0.8	3.9646	1.5	0.2864	1.2	0.82	1623.7	17.2	1627.0	11.9	1631.1	15.7	1631.1	15.7	99.5
14TD10-66	46	123671	3.8	9.1543	2.5	4.7025	4.4	0.3122	3.7	0.83	1751.6	56.3	1767.7	37.2	1786.7	45.5	1786.7	45.5	98.0
14TD10-67	162	93176	2.4	17.5237	4.2	0.5365	5.0	0.0682	2.8	0.55	425.2	11.3	436.1	17.9	494.1	93.2	425.2	11.3	NA
14TD10-69	441	3478982	3.8	5.7025	0.2	11.1987	2.3	0.4632	2.3	1.00	2453.5	47.5	2539.8	21.8	2609.5	2.9	2609.5	2.9	94.0
14TD10-70	372	626482	3.6	12.5514	0.9	2.1952	1.7	0.1998	1.4	0.86	1174.4	15.4	1179.5	11.7	1188.9	17.0	1188.9	17.0	98.8
14TD10-72	77	228904	3.3	13.2041	4.2	1.9095	4.9	0.1829	2.5	0.50	1082.6	24.4	1084.4	32.6	1088.1	84.8	1088.1	84.8	99.5
14TD10-73	602	1071931	2.5	18.0389	1.5	0.5447	4.1	0.0713	3.8	0.93	443.8	16.4	441.5	14.7	429.8	33.9	443.8	16.4	NA
14TD10-74	82	214642	3.3	11.6668	2.6	2.6897	3.6	0.2276	2.4	0.69	1321.9	29.3	1325.6	26.4	1331.7	50.1	1331.7	50.1	99.3
14TD10-75	278	2725860	3.9	8.3490	0.4	5.8304	2.3	0.3530	2.2	0.98	1949.1	37.8	1950.9	19.8	1952.9	7.7	1952.9	7.7	99.8
14TD10-76	59	166247	1.3	9.8208	3.1	3.9141	4.6	0.2788	3.5	0.75	1585.3	48.6	1616.6	37.5	1657.6	57.3	1657.6	57.3	95.6
14TD10-77	100	363224	2.5	13.4176	1.8	1.8335	2.7	0.1784	2.0	0.73	1058.4	19.2	1057.5	17.7	1055.8	37.1	1055.8	37.1	100.2
14TD10-78	193	135655	9.3	19.2277	8.5	0.3908	9.2	0.0545	3.4	0.37	342.0	11.4	334.9	26.3	285.8	195.6	342.0	11.4	NA
14TD10-79	141	1253849	2.6	9.6442	1.0	4.2100	2.6	0.2945	2.4	0.92	1663.8	34.5	1676.0	21.1	1691.2	19.0	1691.2	19.0	98.4
14TD10-80	62	278305	1.7	9.8384	1.9	3.9652	2.4	0.2829	1.5	0.63	1606.1	21.6	1627.1	19.6	1654.3	34.9	1654.3	34.9	97.1
14TD10-81	260	200798	3.0	17.9441	3.4	0.5668	5.3	0.0738	4.0	0.77	458.8	17.9	455.9	19.3	441.5	75.1	458.8	17.9	NA
14TD10-82	316	1567653	6.2	9.3951	0.4	4.5328	1.4	0.3089	1.4	0.97	1735.1	21.2	1737.0	12.0	1739.3	6.9	1739.3	6.9	99.8
14TD10-83	82	267568	3.7	13.0093	2.7	2.0242	3.0	0.1910	1.3	0.44	1126.7	13.7	1123.7	20.4	1117.8	53.6	1117.8	53.6	100.8
14TD10-84	106	591628	1.8	5.6632	0.6	12.4534	2.2	0.5115	2.1	0.97	2663.1	46.3	2639.2	20.7	2621.0	9.5	2621.0	9.5	101.6
14TD10-85	37	139326	1.7	9.7254	4.3	4.2248	5.3	0.2980	3.0	0.57	1681.4	44.5	1678.8	43.4	1675.7	80.4	1675.7	80.4	100.3
14TD10-86	89	248270	2.7	8.1658	1.9	5.9701	3.5	0.3536	3.0	0.85	1951.6	49.8	1971.5	30.4	1992.4	33.1	1992.4	33.1	98.0
14TD10-87	172	1283256	3.0	10.1212	0.9	3.8811	1.4	0.2849	1.1	0.77	1616.0	15.7	1609.8	11.4	1601.6	16.8	1601.6	16.8	100.9
14TD10-88	125	459666	3.1	11.1041	1.1	3.0623	1.4	0.2466	0.9	0.65	1421.0	11.5	1423.3	10.7	1426.7	20.4	1426.7	20.4	99.6
14TD10-90	97	505089	3.0	8.1430	1.0	5.8635	2.1	0.3463	1.8	0.89	1916.9	30.3	1955.9	17.9	1997.4	16.9	1997.4	16.9	96.0
14TD10-91	128	280417	4.4	11.4952	1.2	2.9122	2.9	0.2428	2.6	0.91	1401.2	33.3	1385.1	22.0	1360.3	23.4	1360.3	23.4	103.0
14TD10-92	336	730178	3.1	13.3602	0.7	1.8251	2.2	0.1768	2.1	0.95	1049.7	20.4	1054.5	14.6	1064.5	14.6	1064.5	14.6	98.6
14TD10-93	93	161550	3.9	14.3645	2.2	1.4939	3.2	0.1556	2.3	0.72	932.5	19.7	927.9	19.3	917.1	45.5	917.1	45.5	101.7
14TD10-94	184	2004720	3.6	9.4129	0.8	4.5356	1.6	0.3096	1.4	0.88	1739.0	21.8	1737.5	13.5	1735.8	14.1	1735.8	14.1	100.2
14TD10-97	143	388972	2.2	13.1303	2.5	1.8889	3.2	0.1799	2.0	0.62	1066.3	19.5	1077.2	21.3	1099.3	50.4	1099.3	50.4	97.0
14TD10-98	54	120386	2.4	12.5174	4.3	2.1883	6.4	0.1987	4.7	0.74	1168.2	50.4	1177.3	44.7	1194.2	85.7	1194.2	85.7	97.8
14TD10-99	129	709194	2.2	9.5922	1.0	4.2574	2.1	0.2962	1.8	0.87	1672.4	27.2	1685.2	17.5	1701.1	19.2	1701.1	19.2	98.3
14TD10-100	125	301256	1.7	13.1794	2.1	1.8274	2.7	0.1747	1.7	0.62	1037.8	15.9	1055.3	17.4	1091.8	41.5	1091.8	41.5	95.1

fail this test, and the probability that they were not drawn from the same pool is 95%. The K-S results show that nearly all samples could have been derived from random picking of the same source (Table 2). The five sample pairs that fail the K-S test (shown in normal vs. bold type on the bottom three lines of Table 2) do not have corresponding lower overlap or similarity values. That said, visual inspection of the probability-density curves suggests that the two Weber Sandstone samples (F and G) have a much larger contribution of 1700–1650 Ma grains than the other samples, and this is what the K-S test detects.

Table DR 1 (Data Repository) (cont.). U-Pb data from detrital zircons from samples analyzed.

Sample D, 03PL12, Wilson Creek Member, Wood River Formation, near top of Bell Mountain, southern Pioneer Mountains, ID																		
				Isotope ratios								Apparent ages (Ma)						
Analysis	U (ppm)	206Pb/204Pb	U/Th	206Pb*/207Pb*	± (%)	207Pb*/235U*	± (%)	206Pb*/238U	± (%)	error corr.	206Pb*/238U*	± (Ma)	207Pb*/235U	± (Ma)	206Pb*/207Pb*	± (Ma)	Best age (Ma)	± (Ma)	Conc (%)
03PL12-01	75	47854	1.5	12.7576	2.6	2.1488	3.6	0.1988	2.5	0.68	1169.0	26.6	1164.7	25.2	1156.6	52.6	1156.6	52.6	101.1
03PL12-02	197	252527	2.3	13.3313	0.8	1.8378	2.2	0.1777	2.1	0.94	1054.4	20.1	1059.1	14.5	1068.8	15.1	1068.8	15.1	98.6
03PL12-03	128	182453	1.3	9.9998	1.0	3.9606	1.7	0.2872	1.4	0.83	1627.8	20.8	1626.2	14.0	1624.1	17.7	1624.1	17.7	100.2
03PL12-04	242	174809	1.8	12.9627	0.6	1.9510	1.3	0.1834	1.1	0.89	1085.6	11.2	1098.8	8.4	1124.9	11.5	1124.9	11.5	96.5
03PL12-05	101	72536	1.2	11.8692	1.1	2.4873	2.0	0.2141	1.6	0.83	1250.7	18.6	1268.3	14.3	1298.4	21.3	1298.4	21.3	96.3
03PL12-06	104	95917	3.8	9.3354	0.9	3.9101	7.8	0.2647	7.8	0.99	1514.1	105.0	1615.8	63.4	1751.0	16.7	1751.0	16.7	86.5
03PL12-07	98	23562	0.9	9.8253	0.9	3.6159	6.9	0.2577	6.9	0.99	1477.9	90.8	1553.0	55.2	1656.8	16.0	1656.8	16.0	89.2
03PL12-08	274	242182	1.4	12.8822	0.6	2.1090	3.1	0.1970	3.0	0.98	1159.4	31.8	1151.8	21.0	1137.3	11.3	1137.3	11.3	101.9
03PL12-09	112	117753	0.9	18.8005	5.8	0.5494	8.6	0.0749	6.4	0.74	465.7	28.7	444.6	31.0	336.9	131.3	465.7	28.7	138.2
03PL12-10	383	278633	2.1	8.3653	0.5	5.5520	1.6	0.3368	1.5	0.95	1871.5	24.0	1908.7	13.3	1949.4	8.5	1949.4	8.5	96.0
03PL12-11	304	90208	1.4	16.5524	0.9	0.8308	2.6	0.0997	2.4	0.94	612.8	14.1	614.0	11.8	618.4	19.4	612.8	14.1	99.1
03PL12-12	122	161114	1.2	9.7984	0.8	4.1020	0.9	0.2915	0.4	0.47	1649.0	6.4	1654.7	7.7	1661.9	15.3	1661.9	15.3	99.2
03PL12-13	445	323114	1.0	12.2456	0.3	2.4010	0.7	0.2132	0.6	0.90	1246.1	7.2	1242.9	5.0	1237.4	6.0	1237.4	6.0	100.7
03PL12-14	151	332341	1.5	9.5952	0.4	4.3900	1.2	0.3055	1.1	0.94	1718.6	16.5	1710.5	9.6	1700.6	7.3	1700.6	7.3	101.1
03PL12-15	250	30051	7.1	13.2087	1.0	1.7749	2.4	0.1700	2.1	0.90	1012.3	19.8	1036.3	15.3	1087.3	21.0	1087.3	21.0	93.1
03PL12-16	205	205191	0.8	10.0406	0.3	3.9629	1.2	0.2886	1.2	0.97	1634.5	17.3	1626.6	10.0	1616.5	5.6	1616.5	5.6	101.1
03PL12-17	80	136795	1.3	9.8039	0.8	4.1455	1.7	0.2948	1.6	0.90	1665.3	22.8	1663.3	14.2	1660.8	14.3	1660.8	14.3	100.3
03PL12-18	107	169467	1.1	9.1099	0.5	4.8118	1.5	0.3179	1.4	0.93	1779.6	21.5	1787.0	12.4	1795.6	9.7	1795.6	9.7	99.1
03PL12-19	52	30402	2.0	12.0781	2.4	2.4091	2.8	0.2110	1.6	0.55	1234.3	17.7	1245.3	20.4	1264.4	46.2	1264.4	46.2	97.6
03PL12-21	176	68128	2.0	17.8893	4.2	0.5406	4.5	0.0701	1.7	0.38	437.0	7.1	438.8	16.0	448.4	92.6	437.0	7.1	97.5
03PL12-22	285	88692	1.3	18.1895	1.1	0.5225	1.7	0.0689	1.2	0.73	429.7	5.1	426.8	5.9	411.3	25.6	429.7	5.1	104.5
03PL12-23	391	8131	4.0	17.5999	2.0	0.5193	4.0	0.0663	3.4	0.86	413.8	13.6	424.7	13.7	484.5	44.5	413.8	13.6	85.4
03PL12-24	288	64444	3.7	9.6529	0.5	3.5564	4.3	0.2490	4.3	0.99	1433.2	55.4	1539.9	34.5	1689.5	10.1	1689.5	10.1	84.8
03PL12-25	224	338795	1.4	9.1419	0.3	4.6876	1.2	0.3108	1.2	0.97	1744.7	17.8	1765.0	10.1	1789.2	5.7	1789.2	5.7	97.5
03PL12-26	112	25966	1.2	17.8668	5.1	0.6241	5.4	0.0809	1.7	0.32	501.3	8.3	492.4	21.1	451.1	114.0	501.3	8.3	111.1
03PL12-27	245	610935	2.4	5.9449	0.2	11.1695	1.3	0.4816	1.3	0.99	2534.2	27.6	2537.4	12.4	2539.9	3.1	2539.9	3.1	99.8
03PL12-28	650	167936	2.1	9.1093	0.2	4.8025	0.9	0.3173	0.8	0.98	1776.5	13.1	1785.3	7.3	1795.7	3.2	1795.7	3.2	98.9
03PL12-30	479	412870	2.0	11.9816	0.5	2.5937	1.0	0.2254	0.9	0.86	1310.3	10.1	1298.9	7.2	1280.0	9.6	1280.0	9.6	102.4
03PL12-31	486	317194	2.4	13.3867	0.5	1.8096	1.5	0.1757	1.4	0.94	1043.4	13.5	1048.9	9.7	1060.5	9.8	1060.5	9.8	98.4
03PL12-32	241	101633	0.7	17.2685	1.9	0.7217	2.8	0.0904	2.1	0.74	557.8	11.2	551.7	12.1	526.3	42.0	557.8	11.2	106.0
03PL12-34	192	105483	1.0	9.8456	0.5	4.1089	2.0	0.2934	2.0	0.97	1658.5	28.8	1656.1	16.6	1653.0	9.6	1653.0	9.6	100.3
03PL12-35	1462	891136	2.6	13.2430	0.2	1.9321	1.1	0.1856	1.1	0.99	1097.4	11.3	1092.3	7.6	1082.2	3.5	1082.2	3.5	101.4
03PL12-36	301	22886	3.6	18.5604	2.4	0.3792	4.0	0.0510	3.2	0.80	321.0	10.1	326.5	11.3	365.9	54.6	321.0	10.1	NA
03PL12-37	453	18542	3.3	9.3154	0.3	4.7036	1.4	0.3178	1.3	0.97	1778.9	20.9	1767.9	11.6	1754.9	5.7	1754.9	5.7	101.4
03PL12-38	348	242530	1.5	10.6855	0.3	3.3604	0.9	0.2604	0.8	0.94	1492.0	10.8	1495.2	6.8	1499.7	5.7	1499.7	5.7	99.5
03PL12-39	59	64601	2.2	13.7590	4.9	1.6372	4.9	0.1634	0.8	0.17	975.5	7.4	984.6	31.1	1005.0	98.8	1005.0	98.8	97.1
03PL12-40	71	17200	1.7	19.2063	12.2	0.4775	12.5	0.0665	2.6	0.21	415.1	10.5	396.4	41.0	288.3	279.7	415.1	10.5	144.0
03PL12-42	106	95091	1.2	13.7809	1.8	1.6615	2.0	0.1661	1.0	0.47	990.4	8.8	993.9	12.8	1001.8	36.0	1001.8	36.0	98.9
03PL12-43	444	520195	3.4	11.2951	0.8	2.9454	1.6	0.2413	1.3	0.84	1393.4	16.4	1393.7	11.8	1394.1	16.0	1394.1	16.0	100.0
03PL12-44	51	47466	1.1	12.1901	2.5	2.3402	2.8	0.2069	1.3	0.48	1212.3	14.9	1224.6	19.9	1246.3	48.0	1246.3	48.0	97.3
03PL12-45	61	32721	2.0	12.8830	2.0	1.9074	2.3	0.1782	1.0	0.44	1057.3	9.7	1083.7	15.1	1137.2	40.6	1137.2	40.6	93.0
03PL12-46	100	184437	2.5	9.3349	0.6	4.6687	1.4	0.3161	1.3	0.91	1770.6	19.8	1761.6	11.7	1751.1	10.6	1751.1	10.6	101.1
03PL12-47	84	206554	1.8	9.5050	0.8	4.4270	1.5	0.3052	1.3	0.85	1717.0	19.1	1717.4	12.4	1717.9	14.7	1717.9	14.7	99.9
03PL12-49	436	371026	3.0	10.8949	0.2	3.1746	0.7	0.2508	0.7	0.96	1442.9	9.2	1451.0	5.7	1462.9	3.9	1462.9	3.9	98.6
03PL12-50	289	24455	0.6	16.5206	1.9	0.7932	3.6	0.0950	3.0	0.85	585.3	17.0	593.0	16.2	622.6	41.4	585.3	17.0	94.0
3PL12-053	64	64503	1.3	13.2397	4.1	1.9220	6.1	0.1846	4.5	0.74	1091.8	45.1	1088.8	40.7	1082.7	82.4	1082.7	82.4	100.8
3PL12-054	144	291019	0.7	9.7059	0.7	4.2032	0.8	0.2959	0.4	0.50	1670.8	6.2	1674.6	6.9	1679.4	13.4	1679.4	13.4	99.5
3PL12-055	1178	2275	2.2	17.5444	3.3	0.3846	4.1	0.0489	2.5	0.61	308.0	7.6	330.4	11.7	491.4	72.6	308.0	7.6	NA
3PL12-056	47	82084	2.3	5.4596	0.8	12.4700	1.3	0.4938	1.0	0.80	2587.0	22.2	2640.5	12.2	2681.7	12.8	2681.7	12.8	96.5
3PL12-057	127	78533	2.0	4.7461	0.6	15.0711	7.0	0.5188	7.0	1.00	2694.0	154.2	2819.7	67.0	2910.9	9.9	2910.9	9.9	92.5
3PL12-058	142	37657	2.2	12.7291	1.8	2.0880	2.7	0.1928	2.0	0.74	1136.4	20.5	1144.9	18.3	1161.1	35.6	1161.1	35.6	97.9
3PL12-059	208	216020	2.3	10.9082	0.5	3.2821	1.9	0.2597	1.8	0.97	1488.1	23.8	1476.8	14.4	1460.6	8.9	1460.6	8.9	101.9
3PL12-060	19	20074	1.6	12.4091	9.3	2.2430	9.4	0.2019	1.5	0.16	1185.3	15.8	1194.6	66.0	1211.3	182.9	1211.3	182.9	97.9
3PL12-061	377	260292	2.5	12.9106	0.6	2.0495	1.4	0.1919	1.2	0.91	1131.7	12.9	1132.1	9.3	1132.9	11.2	1132.9	11.2	99.9
3PL12-062	172	123224	2.6	12.4639	0.9	2.2488	1.2	0.2033	0.8	0.64	1192.9	8.6	1196.4	8.7	1202.7	18.7	1202.7	18.7	99.2
3PL12-063	244	88595	1.6	8.5942	0.4	4.8027	3.4	0.2994	3.3	0.99	1688.1	49.5	1785.4	28.2	1901.0	6.7	1901.0	6.7	88.8
3PL12-064	105	209454	2.0	10.4932	0.8	3.4447	1.1	0.2622	0.7	0.64	1500.8	9.4	1514.7	8.6	1534.0	15.8	1534.0	15.8	97.8
3PL12-065	172	58468	1.0	16.5499	3.3	0.6661	5.9	0.0800	4.8	0.82	495.8	23.0	518.3	23.8	618.7	71.8	495.8	23.0	80.1
3PL12-066	420	61674	2.3	12.0171	0.7	2.1261	3.4	0.1853	3.4	0.98	1095.9	33.8	1157.3	23.8	1274.3	14.5	1274.3	14.5	86.0
3PL12-067	969	1153194	11.0	11.4114	0.2	2.7858	1.2	0.2306	1.2	0.98	1337.4	14.3	1351.7	9.1	1374.4	4.8	1374.4	4.8	97.3
3PL12-068	174	115389	1.2	9.8692	0.4	3.8499	0.6	0.2756	0.5	0.75	1569.0	6.7	1603.2	5.1	1648.5	7.8	1648.5	7.8	95.2
3PL12-069	122	76781	1.4	13.4092	1.3	1.8524	1.5	0.1802	0.7	0.48	1067.8	7.1	1064.3	9.8	1057.1	26.2	1057.1	26.2	101.0
3PL12-070	201	97158	0.7	17.6420	2.1	0.5937	2.2	0.0760	0.5	0.25	472.0	2.5	473.2	8.3	479.2	46.8	472.0	2.5	98.5
3PL12-071	169	167020	2.0	9.2832	1.2	4.3962	4.6	0.2960	4.5	0.97	1671.4	65.9	1711.6	38.2	1761.2	21.2	1761.2	21.2	94.9
3PL12-072	23	56254	1.0	4.7329	1.3	16.6466	5.4	0.5714	5.2	0.97	2913.6	123.0	2914.7	51.7	2915.4	20.6	2915.4	20.6	99.9
3PL12-073	174	115277	1.9	12.8584	0.7	2.0370	1.7	0.1900	1.6	0.91	1121.2	16.2	1128.0	11.8	1141.0	14.2	1141.0	14.2	98.3
3PL12-074	680	257976	3.5	5.5375	0.4	11.2778	2.7	0.4529	2.7	0.99	2408.3	53.6	2546.4	25.1	2658.3	5.9	2658.3	5.9	90.6
3PL12-075	96	112808	1.3	9.9356	0.7	4.0431	1.1	0.2913	0.8	0.75	1648.2	11.7	1642.9	8.8	1636.1	13.3	1636.1	13.3	100.7
3PL12-076	74	101156	1.2	9.8891	1.5	4.1168	1.7	0.2953	1.0	0.55	1667.8	14.2	1657.6	14.3	1644.8	27.1	1644.8	27.1	101.4
3PL12-077	228	976821	0.9	9.2714	0.6	4.4138	1.7	0.2968	1.6	0.94	1675.4	23.9	1714.9	14.3	1763.5	10.7	1763.5	10.7	95.0
3PL12-078	177	301544	0.8	5.4060	0.4	13.4600	2.8	0.5277	2.7	0.99	2731.9	60.9	2712.5	26.2	2698.0	7.4	2698.0	7.4	101.3
3PL12-079	31	11712	0.2	18.1411	23.9	0.5111	24.4	0.0672	4.9	0.20	419.5	19.8	419.2	83.9	417.2	540.2	419.5	19.8	100.6
3PL12-080	313	351862	10.1	9.7059	0.2	4.2295	1.2	0.2977	1.2	0.99	1680.1	17.8	1679.8	10.0	1679.4	3.6	1679.4	3.6	100.0

Eagle Creek Member Sample C and Tensleep Sandstone Sample E also fail the K-S test, likely due to the abundance of Archean grains in the second Eagle Creek Sample C.

DISCUSSION

Our detrital-zircon data are generally similar to those from the Pennsylvanian Tensleep Sandstone in the Bighorn Basin, northwest Wyoming (May et al., 2013), and Spray Lakes Group of southern British Columbia, Canada (Gehrels and Pecha, 2014). This suggests a huge (third order of Ingersoll et al., 1993) sand-dispersal system. This Pennsylvanian Laurentian sand blanket contains Archean grains 2800–2500 Ma, Paleoproterozoic grains 1800–1600 Ma, Grenville-age grains 1250–950 Ma, and Ordovician and Silurian grains 445–425 Ma. All sandstone samples that we discuss display this mixed Laurentian derivation (provenance arrow 1 on Fig. 1). This basin drained the Appalachian mountain belt to the north and east and contained areas of eolian recycling (Soreghan and Soreghan, 2013). This eolian system was the precursor to a Permian big river carrying grains westward from

Table DR 1 (Data Repository) (cont.). U-Pb data from detrital zircons from samples analyzed.

Sample E, ECS-13-2, Tensleep Sandstone, Sinks Canyon, WY																			
						Isotope ratios							Apparent ages (Ma)						
Analysis	U	206Pb	U/Th	206Pb*	±	207Pb*	±	206Pb*	±	error	206Pb*	±	207Pb*	±	206Pb*	±	Best age	±	Conc
	(ppm)	204Pb		207Pb*	(%)	235U*	(%)	238U	(%)	corr.	238U*	(Ma)	235U	(Ma)	207Pb*	(Ma)	(Ma)	(Ma)	(%)
ECS-13-2-1	258	180155	2.3	12.7913	0.6	2.1206	0.9	0.1967	0.7	0.77	1157.8	7.2	1155.5	6.1	1151.4	11.1	1151.4	11.1	100.5
ECS-13-2-2	568	216832	13.2	13.2302	0.3	1.9016	0.6	0.1825	0.6	0.91	1080.5	5.7	1081.7	4.2	1084.1	5.2	1084.1	5.2	99.7
ECS-13-2-4	47	32279	1.2	10.8639	1.8	3.3169	2.1	0.2613	1.1	0.52	1496.7	14.8	1485.0	16.7	1468.4	34.7	1468.4	34.7	101.9
ECS-13-2-5	355	48117	1.9	9.2759	0.3	4.6732	1.4	0.3144	1.4	0.97	1762.3	21.4	1762.5	11.9	1762.7	5.8	1762.7	5.8	100.0
ECS-13-2-6	276	194740	2.8	12.9017	0.6	2.1026	1.0	0.1967	0.9	0.82	1157.8	9.1	1149.7	7.1	1134.3	11.7	1134.3	11.7	102.1
ECS-13-2-7	183	67018	1.6	11.5874	1.0	2.7428	1.3	0.2305	0.8	0.65	1337.1	9.9	1340.1	9.4	1344.9	18.6	1344.9	18.6	99.4
ECS-13-2-8	170	149038	2.9	9.1379	0.6	4.8679	1.0	0.3226	0.9	0.84	1802.5	13.9	1796.7	8.8	1790.0	10.3	1790.0	10.3	100.7
ECS-13-2-9	157	26845	1.3	5.6078	0.6	9.9671	5.1	0.4054	5.1	0.99	2193.7	94.4	2431.7	47.2	2637.3	9.7	2637.3	9.7	83.2
ECS-13-2-10	146	99832	2.0	12.3196	0.9	2.3193	1.1	0.2072	0.5	0.47	1214.0	5.6	1218.2	7.5	1225.6	18.4	1225.6	18.4	99.1
ECS-13-2-11	317	586686	3.1	9.3363	0.3	4.6352	0.7	0.3139	0.7	0.92	1759.7	10.4	1755.6	6.2	1750.8	5.5	1750.8	5.5	100.5
ECS-13-2-12	82	197832	1.2	4.5487	0.2	17.7183	0.8	0.5845	0.7	0.97	2967.2	17.5	2974.6	7.3	2979.5	2.9	2979.5	2.9	99.6
ECS-13-2-13	147	107967	2.7	9.3353	0.5	4.6309	0.8	0.3135	0.5	0.70	1758.1	8.4	1754.9	6.5	1751.0	10.0	1751.0	10.0	100.4
ECS-13-2-14	70	69896	1.2	5.2123	0.3	14.1228	0.6	0.5339	0.4	0.79	2757.8	10.0	2758.0	5.3	2758.1	5.7	2758.1	5.7	100.0
ECS-13-2-15	112	99412	3.2	9.3346	0.3	4.6580	1.3	0.3153	1.2	0.96	1767.0	18.7	1759.7	10.5	1751.1	6.2	1751.1	6.2	100.9
ECS-13-2-16	194	50178	1.1	17.9117	3.2	0.5279	3.6	0.0686	1.5	0.42	427.6	6.3	430.4	12.6	445.6	72.2	427.6	6.3	96.0
ECS-13-2-17	94	113533	1.1	9.8822	1.2	3.9312	1.7	0.2818	1.3	0.72	1600.2	17.8	1620.1	14.1	1646.1	22.5	1646.1	22.5	97.2
ECS-13-2-18	23	32668	2.0	11.6982	5.4	2.7024	5.7	0.2293	1.8	0.32	1330.7	21.7	1329.1	42.3	1326.5	104.9	1326.5	104.9	100.3
ECS-13-2-20	55	54670	1.5	10.8235	1.8	3.3703	1.9	0.2646	0.8	0.41	1513.2	10.8	1497.5	15.3	1475.4	33.7	1475.4	33.7	102.6
ECS-13-2-21	225	18893	0.9	17.2064	4.2	0.5758	4.3	0.0719	1.1	0.25	447.4	4.7	461.8	15.9	534.2	90.9	447.4	4.7	83.7
ECS-13-2-22	27	29361	0.9	12.4229	5.4	2.2264	5.6	0.2006	1.6	0.28	1178.5	17.1	1189.4	39.6	1209.2	106.7	1209.2	106.7	97.5
ECS-13-2-23	38	73759	1.1	6.7226	1.2	8.3992	2.2	0.4095	1.8	0.83	2212.7	34.6	2275.1	20.1	2331.6	20.9	2331.6	20.9	94.9
ECS-13-2-24	85	60976	2.4	11.0435	1.0	3.0651	1.3	0.2455	0.9	0.66	1415.2	11.1	1424.0	10.2	1437.2	19.0	1437.2	19.0	98.5
ECS-13-2-25	65	32891	1.2	17.8706	10.9	0.5339	11.1	0.0692	1.7	0.15	431.3	7.0	434.4	39.1	450.7	243.2	431.3	7.0	95.7
ECS-13-2-26	27	21926	1.8	12.6093	4.6	2.0617	5.5	0.1885	3.0	0.55	1113.5	31.0	1136.2	37.5	1179.8	90.4	1179.8	90.4	94.4
ECS-13-2-27	37	11211	1.1	19.4013	17.2	0.5951	17.6	0.0837	3.9	0.22	518.4	19.3	474.1	66.8	265.2	396.5	518.4	19.3	195.5
ECS-13-2-28	26	37798	0.3	5.3695	1.1	13.3789	1.8	0.5210	1.4	0.78	2703.5	30.7	2706.8	16.9	2709.2	18.7	2709.2	18.7	99.8
ECS-13-2-29	36	24904	1.0	9.9394	1.5	3.8378	2.7	0.2767	2.2	0.83	1574.5	31.4	1600.7	21.7	1635.4	27.6	1635.4	27.6	96.3
ECS-13-2-30	20	15816	2.1	13.1083	9.4	2.0199	9.6	0.1920	2.1	0.22	1132.4	21.6	1122.2	65.3	1102.6	187.9	1102.6	187.9	102.7
ECS-13-2-31	77	53610	2.2	12.8713	1.6	2.0739	1.8	0.1936	0.7	0.37	1140.8	6.9	1140.2	12.1	1139.0	32.6	1139.0	32.6	100.2
ECS-13-2-32	57	61864	1.5	10.8346	1.5	3.3359	1.8	0.2621	1.1	0.60	1500.8	14.8	1489.5	14.4	1473.5	28.0	1473.5	28.0	101.9
ECS-13-2-33	88	35731	0.4	13.9539	2.3	1.6037	2.4	0.1623	0.6	0.24	969.5	5.1	971.6	14.9	976.4	47.2	976.4	47.2	99.3
ECS-13-2-34	28	28395	0.9	12.8290	4.7	2.1116	5.0	0.1965	1.6	0.32	1156.4	17.2	1152.6	34.5	1145.6	94.2	1145.6	94.2	100.9
ECS-13-2-35	71	11762	1.9	19.6174	9.9	0.4895	10.0	0.0696	1.5	0.15	434.0	6.3	404.6	33.5	239.7	229.4	434.0	6.3	181.1
ECS-13-2-36	18	4943	0.5	5.3660	2.5	12.5008	2.9	0.4865	1.4	0.50	2555.5	30.5	2642.8	27.3	2710.3	41.5	2710.3	41.5	94.3
ECS-13-2-39	32	56876	1.6	9.8610	3.0	4.0466	3.1	0.2894	1.0	0.31	1638.6	13.9	1643.6	25.4	1650.1	55.0	1650.1	55.0	99.3
ECS-13-2-40	32	32501	1.6	11.7502	4.0	2.7800	4.2	0.2369	1.3	0.32	1370.6	16.3	1350.2	31.3	1317.9	77.0	1317.9	77.0	104.0
ECS-13-2-41	61	28582	2.7	13.7194	4.2	1.7420	4.3	0.1733	0.9	0.20	1030.5	8.1	1024.2	27.4	1010.9	84.5	1010.9	84.5	101.9
ECS-13-2-42	64	64480	0.9	9.8586	1.4	4.1088	1.7	0.2938	0.9	0.56	1660.4	13.6	1656.1	13.6	1650.5	25.6	1650.5	25.6	100.6
ECS-13-2-43	31	9725	0.7	13.3766	5.6	1.8571	10.5	0.1802	8.9	0.85	1067.9	87.7	1066.0	69.4	1062.0	112.0	1062.0	112.0	100.6
ECS-13-2-44	182	166559	1.8	12.5670	0.9	2.2292	1.0	0.2032	0.5	0.48	1192.4	5.4	1190.3	7.2	1186.5	17.9	1186.5	17.9	100.5
ECS-13-2-45	141	256936	0.9	5.3246	0.2	13.6341	0.9	0.5265	0.9	0.98	2726.7	20.1	2724.6	8.7	2723.1	3.2	2723.1	3.2	100.1
ECS-13-2-46	162	130462	2.1	12.7789	1.4	2.1274	1.7	0.1972	1.0	0.59	1160.1	10.8	1157.7	11.8	1153.3	27.2	1153.3	27.2	100.6
ECS-13-2-48	11	13715	2.2	10.8372	7.7	3.0627	9.0	0.2407	4.7	0.52	1390.5	58.2	1423.4	68.8	1473.0	145.8	1473.0	145.8	94.4
ECS-13-2-49	71	74116	1.7	9.1708	1.2	4.6684	1.4	0.3105	0.7	0.50	1743.2	10.8	1761.6	11.9	1783.5	22.4	1783.5	22.4	97.7
ECS-13-2-50	62	95694	1.7	10.6413	1.7	3.4177	2.0	0.2638	1.2	0.57	1509.1	15.7	1508.5	16.0	1507.6	31.5	1507.6	31.5	100.1
ECS-13-2-51	108	80855	1.5	9.9171	0.5	4.0247	1.1	0.2895	1.0	0.88	1638.9	14.3	1639.2	9.1	1639.5	9.7	1639.5	9.7	100.0
ECS-13-2-52	87	46850	2.3	13.5209	1.4	1.7542	1.8	0.1720	1.2	0.66	1023.3	11.5	1028.7	11.9	1040.3	28.0	1040.3	28.0	98.4
ECS-13-2-53	87	54809	1.2	13.3838	2.8	1.8478	2.9	0.1794	0.8	0.27	1063.5	7.7	1062.6	19.1	1060.9	56.1	1060.9	56.1	100.2
ECS-13-2-54	66	52815	1.6	10.6737	1.5	3.3765	1.9	0.2614	1.1	0.58	1496.9	14.6	1499.0	14.7	1501.8	28.7	1501.8	28.7	99.7
ECS-13-2-56	128	86751	1.0	9.7886	0.6	4.2249	0.9	0.2999	0.7	0.77	1691.0	10.2	1678.9	7.3	1663.7	10.6	1663.7	10.6	101.6
ECS-13-2-57	85	129006	1.3	6.8525	1.6	8.5608	2.0	0.4255	1.2	0.59	2285.2	22.7	2292.4	18.2	2298.8	27.8	2298.8	27.8	99.4
ECS-13-2-58	138	95952	3.2	12.0810	1.2	2.3013	2.9	0.2016	2.6	0.90	1184.1	27.8	1212.7	20.2	1263.9	24.4	1263.9	24.4	93.7
ECS-13-2-59	102	43546	1.5	13.0968	1.8	1.9365	3.1	0.1839	2.5	0.80	1088.5	24.9	1093.8	20.7	1104.4	36.7	1104.4	36.7	98.6
ECS-13-2-60	73	44176	1.3	12.8419	2.3	2.1136	2.9	0.1969	1.8	0.62	1158.4	19.0	1153.2	19.9	1143.6	45.0	1143.6	45.0	101.3
ECS-13-2-61	69	56222	1.9	13.2703	4.0	1.8493	4.1	0.1780	0.6	0.14	1056.0	5.7	1063.2	26.8	1078.0	80.9	1078.0	80.9	98.0
ECS-13-2-62	50	38565	2.2	13.6391	4.5	1.7606	4.6	0.1742	0.9	0.20	1035.0	8.7	1031.1	30.1	1022.7	92.1	1022.7	92.1	101.2
ECS-13-2-63	80	82124	1.9	12.2353	2.0	2.4133	2.3	0.2142	1.0	0.45	1250.9	11.7	1246.6	16.3	1239.1	39.5	1239.1	39.5	101.0
ECS-13-2-64	17	13623	2.9	10.0876	5.9	3.8770	6.1	0.2836	1.6	0.27	1609.7	23.2	1608.9	49.3	1607.8	109.8	1607.8	109.8	100.1
ECS-13-2-65	34	20710	1.4	10.8140	2.2	3.4147	2.8	0.2678	1.8	0.64	1529.7	24.6	1507.8	22.2	1477.1	41.4	1477.1	41.4	103.6
ECS-13-2-66	52	140387	2.6	9.0580	1.6	4.9066	2.6	0.3223	2.1	0.80	1801.1	33.0	1803.4	22.0	1806.0	28.2	1806.0	28.2	99.7
ECS-13-2-67	57	52680	1.4	9.7431	0.8	4.1741	1.6	0.2950	1.4	0.87	1666.3	20.8	1669.0	13.3	1672.3	14.6	1672.3	14.6	99.6
ECS-13-2-68	68	56088	1.0	9.8126	1.7	4.0937	1.9	0.2913	0.8	0.44	1648.2	12.2	1653.0	15.4	1659.2	31.4	1659.2	31.4	99.3
ECS-13-2-69	27	54469	1.0	9.9795	3.3	3.9944	3.9	0.2891	2.2	0.56	1637.1	32.0	1633.0	32.1	1627.9	60.8	1627.9	60.8	100.6
ECS-13-2-70	35	33778	1.3	11.9774	4.9	2.5211	5.2	0.2190	1.7	0.34	1276.6	20.1	1278.1	37.6	1280.7	94.8	1280.7	94.8	99.7
ECS-13-2-72	63	75652	1.8	9.8701	1.5	4.0852	1.6	0.2924	0.6	0.37	1653.7	8.5	1651.4	12.8	1648.3	26.9	1648.3	26.9	100.3
ECS-13-2-73	254	200449	2.2	8.4892	0.2	5.6923	0.7	0.3505	0.6	0.94	1936.8	10.3	1930.2	5.7	1923.1	4.1	1923.1	4.1	100.7
ECS-13-2-74	72	60222	1.7	13.5084	2.1	1.8257	2.3	0.1789	1.1	0.48	1060.8	11.0	1054.7	15.4	1042.2	41.5	1042.2	41.5	101.8
ECS-13-2-75	35	32250	0.7	10.7580	2.9	3.3635	3.1	0.2624	1.2	0.37	1502.3	15.5	1495.9	24.2	1486.9	54.3	1486.9	54.3	101.0
ECS-13-2-76	96	14890	1.4	18.5198	6.9	0.5215	7.0	0.0700	1.1	0.16	436.4	4.7	426.1	24.2	370.9	155.0	436.4	4.7	117.7
ECS-13-2-77	69	29169	1.4	8.0141	0.6	6.2764	5.7	0.3648	5.6	0.99	2004.9	96.8	2015.2	49.5	2025.7	10.8	2025.7	10.8	99.0
ECS-13-2-78	83	49811	2.3	12.8589	2.3	2.0599	2.5	0.1921	0.8	0.34	1132.8	8.7	1135.6	16.9	1140.9	46.1	1140.9	46.1	99.3
ECS-13-2-79	113	43317	1.8	12.4052	1.0	2.2696	1.4	0.2042	1.0	0.71	1197.8	10.6	1202.9	9.6	1212.0	19.0	1212.0	19.0	98.8
ECS-13-2-80	39	90529	1.1	4.4755	0.6	18.2188	1.1	0.5914	0.9	0.83	2995.0	22.3	3001.4	10.8	3005.6	10.0	3005.6	10.0	99.6
ECS-13-2-81	191	291975	1.8	5.5707	0.3	11.5346	0.8	0.4660	0.8	0.94	2466.1	15.4	2567.4	7.5	2648.3	4.5	2648.3	4.5	93.1
ECS-13-2-82	42	44714	1.9	10.6285	3.0	3.3574	3.1	0.2588	0.9	0.30	1483.7	12.5	1494.5	24.3	1509.8	55.9	1509.8	55.9	98.3
ECS-13-2-83	67	160357	1.3	10.5226	1.5	3.4114	1.7	0.2603	0.7	0.41	1491.6	9.1	1507.0	13.2	1528.7	28.9	1528.7	28.9	97.6
ECS-13-2-84	28	9882	1.0	13.3858	8.2	1.6262	8.4	0.1579	1.8	0.21	945.0	15.5	980.4	52.9	1060.6	165.5	1060.6	165.5	89.1
ECS-13-2-85	102	195650	2.0	8.6794	0.8	5.4238	1.4	0.3414	1.1	0.79	1893.5	17.8	1888.6	11.8	1883.2	15.1	1883.2	15.1	100.5
ECS-13-2-86	37	34621	1.1	11.1351	3.6	2.8114	5.6	0.2270	4.3	0.77	1319.0	51.0	1358.6	41.8	1421.4	68.5	1421.4	68.5	92.8
ECS-13-2-87	176	268461	2.8	10.5214	0.5	3.5263	0.8	0.2691	0.6	0.79	1536.2	8.1	1533.1	6.0	1528.9	8.8	1528.9	8.8	100.5
ECS-13-2-88	21	21036	2.0	12.8739	8.3	1.9796	8.7	0.1848	2.7	0.31	1093.3	27.4	1108.6	58.9	1138.6	165.1	1138.6	165.1	96.0
ECS-13-2-89	68	65649	1.3	12.2727	1.6	2.3142	1.7	0.2060	0.8	0.45	1207.4	8.6	1216.7	12.3	1233.1	30.5	1233.1	30.5	97.9
ECS-13-2-90	120	68932	1.4	13.2874	1.5	1.8381	2.2	0.1771	1.6	0.74	1051.3	15.7	1059.2	14.4	1075.5	29.5	1075.5	29.5	97.8
ECS-13-2-91	196	284548	2.9	9.1193	0.5	4.7751	1.3	0.3158	1.3	0.93	1769.3	19.4	1780.5	11.3	1793.7	9.0	1793.7	9.0	98.6
ECS-13-2-92	277	471436	2.0	11.6017	0.6	2.7839	2.0	0.2342	1.9	0.95	1356.7	23.1	1351.2	14.9	1342.5	12.2	1342.5	12.2	101.1
ECS-13-2-93	56	19333	1.1	13.0085	4.6	1.8718	5.1	0.1766	2.2	0.43	1048.3	21.1	1071.2	33.4	1117.9	91.0	1117.9	91.0	93.8
ECS-13-2-94	56	69232	1.7	9.8696	1.7	4.0976	2.4	0.2933	1.7	0.70	1658.1	24.6	1653.8	19.6	1648.4	31.6	1648.4	31.6	100.6
ECS-13-2-95	23	54373	1.2	5.3048	1.3	13.6557	2.3	0.5254	1.9	0.82	2722.0	42.7	2726.1	22.1	2729.2	21.9	2729.2	21.9	99.7
ECS-13-2-97	189	44835	1.5	12.7437	1.2	2.1230	1.3	0.1962	0.6	0.45	1155.0	6.3	1156.3	9.2	1158.8	23.7	1158.8	23.7	99.7
ECS-13-2-98	188	385925	2.7	9.9517	0.5	4.0031	0.7	0.2889	0.5	0.76	1636.2	7.8	1634.8	5.8	1633.1	8.6	1633.1	8.6	100.2
ECS-13-2-99	157	90966	1.7	12.7544	1.1	2.1499	1.3	0.1989	0.8	0.59	1169.2	8.4	1165.0	9.3	1157.1	21.4	1157.1	21.4	101.0
ECS-13-2-100	72	40066	0.8	13.2894	1.9	1.8899	2.3	0.1822	1.3	0.54	1078.7	12.4	1077.5	15.3	1075.1	38.9	1075.1	38.9	100.3
ECS-13-2-101	182	92355	2.1	12.6871	1.1	2.1855	1.5	0.2011	1.0	0.68	1181.2	10.9	1176.4	10.3	1167.6	21.5	1167.6	21.5	101.2
ECS-13-2-102	29	23400	0.9	13.1643	8.5	1.9905	8.8	0.1900	2.1	0.24	1121.6	21.5	1112.3	59.4	1094.1	171.1	1094.1	171.1	102.5
ECS-13-2-104	266	235563	1.3	9.3456	0.4	4.6015	1.1	0.3119	1.0	0.92	1750.0	15.1	1749.5	8.9	1749.0	7.7	1749.0	7.7	100.1
ECS-13-2-105	38	41225	1.3	12.7937	3.2	2.1763	3.5	0.2019	1.5	0.42	1185.7	16.2	1173.5	24.7	1151.0	63.8	1151.0	63.8	103.0
ECS-13-2-106	46	37909	1.7	9.9666	1.0	3.6183	1.9	0.2616	1.6	0.84	1497.8	21.4	1553.6	15.2	1630.3	19.4	1630.3	19.4	91.9
ECS-13-2-107	106	127264	1.7	12.6340	2.1	2.1248	2.6	0.1947	1.5	0.57	1146.8	15.7	1156.9	17.9	1175.9	42.0	1175.9	42.0	97.5
ECS-13-2-108	46	26113	1.2	18.1761	12.0	0.5374	12.1	0.0708	1.2	0.10	441.2	5.3	436.7	43.0	412.9	269.9	441.2	5.3	106.9
ECS-13-2-109	122	100801	1.1	13.1211	1.7	1.9394	3.6	0.1846	3.1	0.88	1091.8	31.3	1094.8	23.8	1100.7	34.4	1100.7	34.4	99.2
ECS-13-2-110	22	17477	1.8	11.6865	4.1	2.7088	4.5	0.2296	1.7	0.39	1332.4	20.9	1330.9	33.0	1328.4	79.4	1328.4	79.4	100.3

Table DR 1 (Data Repository) (cont.). U-Pb data from detrital zircons from samples analyzed.

Sample F, ECS-13-4, Weber Sandstone, Sheep Creek, UT.																		
						Isotope ratios							Apparent ages (Ma)					
Analysis	U (ppm)	206Pb 204Pb	U/Th	206Pb* 207Pb*	± (%)	207Pb* 235U*	± (%)	206Pb* 238U	± (%)	error corr.	206Pb* 238U*	± (Ma)	207Pb* 235U	± (Ma)	206Pb* 207Pb*	± (Ma)	Best age (Ma)
ECS-13-4-5	100	29010	1.6	19.0842	8.6	0.3848	9.2	0.0533	3.3	0.36	334.5	10.8	330.6	26.0	302.9	196.4	334.5
ECS-13-4-66	465	10282	2.1	17.6912	1.9	0.5131	2.6	0.0658	1.8	0.68	411.0	7.1	420.5	9.0	473.1	42.0	411.0
ECS-13-4-4	328	140998	2.0	17.9933	1.9	0.5222	2.0	0.0681	0.8	0.38	425.0	3.1	426.6	7.0	435.5	41.6	425.0
ECS-13-4-16	94	26939	1.7	18.0389	6.2	0.5231	6.6	0.0684	2.3	0.36	426.8	9.7	427.2	23.0	429.8	137.7	426.8
ECS-13-4-10	79	27301	1.0	18.0004	6.9	0.5459	7.5	0.0713	2.9	0.39	443.8	12.6	442.3	27.0	434.6	154.4	443.8
ECS-13-4-31	37	9833	0.8	16.0275	12.5	0.6581	12.9	0.0765	3.0	0.23	475.2	13.7	513.4	51.9	687.6	268.1	475.2
ECS-13-4-22	28	24243	0.5	14.4453	8.2	1.4998	8.6	0.1571	2.3	0.27	940.8	19.8	930.3	52.1	905.5	170.2	905.5
ECS-13-4-9	39	9802	1.7	13.9889	5.3	1.5072	5.7	0.1529	2.1	0.37	917.3	17.8	933.3	34.6	971.3	107.8	971.3
ECS-13-4-28	94	36222	0.4	13.8798	1.1	1.6061	1.4	0.1617	0.8	0.58	966.1	7.3	972.6	8.8	987.3	23.3	987.3
ECS-13-4-103	47	23906	1.9	13.7551	2.2	1.7200	2.6	0.1716	1.4	0.55	1020.9	13.3	1016.0	16.6	1005.6	44.0	1005.6
ECS-13-4-68	118	79731	2.5	13.6824	1.7	1.7736	2.1	0.1760	1.2	0.56	1045.1	11.1	1035.8	13.3	1016.3	34.5	1016.3
ECS-13-4-57	198	130906	1.1	13.5746	0.7	1.7816	1.4	0.1754	1.1	0.85	1041.8	11.0	1038.8	8.8	1032.3	14.4	1032.3
ECS-13-4-101	39	13331	1.0	13.5640	4.6	1.7661	4.8	0.1737	1.5	0.31	1032.7	14.4	1033.1	31.1	1033.9	92.2	1033.9
ECS-13-4-24	63	33600	2.3	13.5355	3.1	1.8487	3.2	0.1815	1.0	0.32	1075.1	10.3	1063.0	21.3	1038.2	61.8	1038.2
ECS-13-4-47	21	20662	1.4	13.5130	8.2	1.7330	8.4	0.1698	1.8	0.21	1011.2	16.4	1020.8	54.0	1041.5	165.6	1041.5
ECS-13-4-17	40	27395	1.2	13.3368	5.7	1.8401	5.9	0.1780	1.4	0.24	1056.0	13.8	1059.9	38.7	1068.0	115.0	1068.0
ECS-13-4-51	92	36131	1.7	13.3118	2.8	1.9090	3.0	0.1843	1.1	0.37	1090.5	11.1	1084.2	19.9	1071.8	55.7	1071.8
ECS-13-4-83	111	67951	0.8	13.2734	2.6	1.9207	2.7	0.1849	0.9	0.33	1093.7	9.1	1088.3	18.1	1077.6	51.2	1077.6
ECS-13-4-53	36	23086	1.3	13.1538	3.9	1.8921	4.6	0.1805	2.4	0.53	1069.8	23.7	1078.3	30.4	1095.7	77.9	1095.7
ECS-13-4-106	35	20984	2.5	12.9201	5.6	2.0948	6.0	0.1963	2.1	0.35	1155.4	22.3	1147.1	41.4	1131.5	112.4	1131.5
ECS-13-4-92	53	21139	0.9	12.8422	3.8	2.1527	4.0	0.2005	1.0	0.26	1178.0	11.3	1165.9	27.5	1143.5	76.0	1143.5
ECS-13-4-54	150	101503	2.4	12.7793	1.3	2.0933	1.5	0.1940	0.7	0.48	1143.1	7.5	1146.6	10.4	1153.2	26.3	1153.2
ECS-13-4-1	119	142807	1.7	12.6352	1.5	2.1415	1.9	0.1962	1.0	0.56	1155.1	11.1	1162.3	12.9	1175.7	30.5	1175.7
ECS-13-4-84	87	106110	1.3	12.3914	0.9	2.3235	2.4	0.2088	2.2	0.92	1222.5	24.3	1219.5	16.8	1214.2	18.2	1214.2
ECS-13-4-94	28	33402	0.8	12.2151	6.6	2.4538	7.0	0.2174	2.5	0.35	1268.1	28.4	1258.5	50.6	1242.3	128.6	1242.3
ECS-13-4-15	148	117559	2.0	12.1699	0.9	2.4382	1.4	0.2152	1.1	0.78	1256.5	12.1	1254.0	9.8	1249.6	16.8	1249.6
ECS-13-4-7	25	20390	0.8	12.1174	5.1	2.3043	5.9	0.2025	2.9	0.50	1188.8	31.7	1213.6	41.5	1258.0	99.4	1258.0
ECS-13-4-35	22	18460	1.2	11.8956	7.3	2.2803	8.3	0.1967	4.0	0.48	1157.8	42.0	1206.2	58.6	1294.0	141.9	1294.0
ECS-13-4-81	69	47346	2.9	11.8391	3.0	2.4671	3.2	0.2118	1.3	0.40	1238.6	14.7	1262.4	23.4	1303.3	57.4	1303.3
ECS-13-4-56	65	60147	1.4	11.7818	2.1	2.6015	2.8	0.2223	1.8	0.66	1294.0	21.5	1301.1	20.3	1312.7	40.0	1312.7
ECS-13-4-13	28	25913	2.4	11.2494	4.8	2.9654	5.0	0.2419	1.1	0.23	1396.8	14.1	1398.8	37.8	1401.9	92.9	1401.9
ECS-13-4-65	29	24202	0.5	11.1905	5.4	2.9494	5.5	0.2394	1.4	0.25	1383.5	17.4	1394.7	42.1	1411.9	102.8	1411.9
ECS-13-4-109	237	113731	2.1	11.0526	0.6	3.1150	1.4	0.2497	1.2	0.90	1436.9	15.9	1436.4	10.5	1435.6	11.4	1435.6
ECS-13-4-30	23	21464	0.7	11.0287	4.0	3.2024	4.7	0.2562	2.3	0.50	1470.1	30.6	1457.7	36.1	1439.7	77.0	1439.7
ECS-13-4-27	85	41387	1.2	11.0012	1.8	2.9884	4.1	0.2384	3.7	0.90	1378.6	45.5	1404.7	31.1	1444.5	34.2	1444.5
ECS-13-4-61	91	137760	1.9	10.9101	1.2	3.2413	1.5	0.2565	1.0	0.66	1471.8	13.3	1467.1	11.9	1460.3	22.0	1460.3
ECS-13-4-59	59	44343	1.0	10.8096	1.3	3.2714	1.5	0.2565	0.8	0.52	1471.8	10.3	1474.3	11.6	1477.9	24.2	1477.9
ECS-13-4-38	57	74822	0.9	10.7492	2.2	3.3390	2.8	0.2603	1.7	0.60	1491.4	22.1	1490.2	21.5	1488.5	41.7	1488.5
ECS-13-4-48	137	113479	1.6	10.6802	0.6	3.4023	1.4	0.2635	1.2	0.91	1508.0	16.7	1504.9	10.7	1500.7	10.8	1500.7
ECS-13-4-73	100	96277	1.6	10.6569	0.8	3.4176	1.2	0.2641	0.9	0.75	1511.0	11.9	1508.4	9.2	1504.8	14.6	1504.8
ECS-13-4-6	244	140511	1.9	10.6538	0.4	3.3501	1.0	0.2589	0.9	0.92	1484.0	11.7	1492.8	7.5	1505.3	7.1	1505.3
ECS-13-4-60	46	49038	1.5	10.5572	2.2	3.4692	2.4	0.2656	0.9	0.39	1518.6	12.6	1520.2	18.9	1522.5	41.7	1522.5
ECS-13-4-86	91	137431	1.0	10.5503	1.6	3.4772	1.7	0.2661	0.6	0.34	1520.8	7.5	1522.1	13.1	1523.8	29.5	1523.8
ECS-13-4-67	92	97802	2.4	10.4703	2.4	3.6231	4.7	0.2751	4.1	0.86	1566.8	56.7	1554.6	37.7	1538.1	45.6	1538.1
ECS-13-4-32	131	216298	0.9	10.4489	0.8	3.5329	1.1	0.2677	0.8	0.70	1529.3	10.7	1534.6	9.0	1541.9	15.3	1541.9
ECS-13-4-74	85	74353	1.1	10.1226	2.2	3.1627	3.2	0.2322	2.3	0.72	1346.0	28.0	1448.1	24.7	1601.4	41.5	1601.4
ECS-13-4-36	66	102572	0.7	10.0759	1.1	3.9038	3.0	0.2853	2.7	0.93	1617.9	39.3	1614.5	24.0	1610.0	20.6	1610.0
ECS-13-4-78	58	85829	1.4	10.0336	1.2	4.0135	1.5	0.2921	0.9	0.59	1651.8	13.3	1636.9	12.5	1617.8	23.2	1617.8
ECS-13-4-40	27	14948	1.6	10.0089	3.4	3.9305	3.7	0.2853	1.5	0.41	1618.1	21.7	1620.0	30.2	1622.4	63.5	1622.4
ECS-13-4-50	43	37561	1.1	9.9586	2.6	3.9159	3.3	0.2828	2.0	0.60	1605.6	28.0	1617.0	26.7	1631.8	49.2	1631.8
ECS-13-4-62	170	175155	4.4	9.9366	0.7	4.0107	1.2	0.2890	1.0	0.82	1636.7	14.0	1636.4	9.7	1635.9	12.8	1635.9
ECS-13-4-55	38	38661	1.1	9.9200	4.0	4.0278	4.1	0.2898	0.9	0.23	1640.5	13.5	1639.8	33.6	1639.0	74.8	1639.0
ECS-13-4-34	121	139811	0.9	9.9157	1.1	3.9165	1.8	0.2817	1.4	0.80	1599.7	20.5	1617.1	14.6	1639.8	19.9	1639.8
ECS-13-4-26	73	59881	2.1	9.9126	1.0	3.9090	1.1	0.2810	0.5	0.46	1596.5	6.9	1615.5	8.6	1640.4	17.6	1640.4
ECS-13-4-2	52	28218	1.2	9.9053	2.0	4.0200	2.5	0.2888	1.5	0.58	1635.5	21.0	1638.3	20.4	1641.7	37.9	1641.7
ECS-13-4-44	31	23165	0.8	9.8984	4.1	3.9428	4.5	0.2831	2.0	0.44	1606.7	28.5	1622.5	36.6	1643.0	75.2	1643.0
ECS-13-4-18	73	70533	1.4	9.8881	0.9	4.0318	1.2	0.2891	0.7	0.62	1637.2	10.4	1640.6	9.4	1645.0	16.7	1645.0
ECS-13-4-90	83	108322	2.2	9.8749	1.2	4.0192	2.6	0.2879	2.3	0.89	1630.8	33.5	1638.1	21.2	1647.4	22.1	1647.4
ECS-13-4-85	65	47412	0.6	9.8622	1.2	4.0863	2.0	0.2923	1.6	0.80	1652.9	23.8	1651.6	16.7	1649.8	22.9	1649.8
ECS-13-4-69	125	184720	1.0	9.8508	0.8	4.1207	1.3	0.2944	1.0	0.80	1663.5	14.9	1658.4	10.3	1652.0	13.9	1652.0
ECS-13-4-20	41	30297	1.1	9.8442	3.0	4.0339	4.0	0.2880	2.6	0.65	1631.6	37.3	1641.1	32.2	1653.2	55.4	1653.2
ECS-13-4-76	14	12799	2.1	9.8373	5.3	4.0071	6.2	0.2859	3.1	0.50	1621.0	44.7	1635.6	50.3	1654.5	99.0	1654.5
ECS-13-4-46	37	83615	0.8	9.8328	2.8	4.0722	2.8	0.2904	0.6	0.22	1643.6	8.9	1648.8	23.0	1655.4	51.0	1655.4
ECS-13-4-108	34	41973	0.9	9.8314	4.0	4.1337	4.3	0.2948	1.5	0.35	1665.2	21.7	1661.0	34.9	1655.6	74.2	1655.6
ECS-13-4-41	73	142745	1.5	9.8196	1.7	4.1602	2.0	0.2963	1.1	0.55	1672.9	16.5	1666.2	16.6	1657.9	31.2	1657.9
ECS-13-4-93	146	101246	0.7	9.8185	0.5	4.1233	1.1	0.2936	1.0	0.90	1659.6	15.1	1658.9	9.4	1658.1	9.3	1658.1
ECS-13-4-49	105	81630	0.8	9.7875	0.8	4.1800	1.5	0.2967	1.3	0.86	1675.0	19.5	1670.1	12.6	1663.9	14.6	1663.9
ECS-13-4-42	250	351730	2.8	9.7788	0.4	4.1472	0.9	0.2941	0.8	0.91	1662.1	12.4	1663.7	7.6	1665.6	7.0	1665.6
ECS-13-4-8	162	119692	2.8	9.7172	0.4	4.2988	0.9	0.3030	0.8	0.90	1706.0	11.9	1693.1	7.2	1677.3	6.9	1677.3
ECS-13-4-64	83	104038	1.7	9.7150	1.5	4.2196	1.8	0.2973	1.0	0.57	1678.0	14.9	1677.8	14.5	1677.7	26.9	1677.7
ECS-13-4-71	33	37640	1.0	9.6995	1.9	4.3503	4.3	0.3060	3.8	0.89	1721.1	57.3	1702.9	35.2	1680.6	35.9	1680.6
ECS-13-4-97	105	261959	0.8	9.5895	1.1	4.4251	1.7	0.3078	1.3	0.76	1729.7	19.2	1717.0	13.8	1701.7	19.8	1701.7
ECS-13-4-3	103	87179	0.6	9.4891	0.8	4.3604	1.5	0.3001	1.2	0.83	1691.7	18.0	1704.9	12.0	1721.0	15.0	1721.0
ECS-13-4-12	28	7270	1.3	9.3387	4.7	3.8041	10.6	0.2577	9.5	0.90	1477.8	126.0	1593.6	85.6	1750.3	85.4	1750.3
ECS-13-4-88	84	103647	2.1	9.3331	0.5	4.5996	1.1	0.3113	0.9	0.86	1747.3	14.4	1749.2	9.1	1751.4	10.0	1751.4
ECS-13-4-63	97	101035	0.6	9.3176	1.0	4.5139	2.0	0.3050	1.7	0.87	1716.3	25.7	1733.5	16.3	1754.5	17.9	1754.5
ECS-13-4-58	157	106057	1.6	9.2745	0.7	4.2094	2.0	0.2831	1.8	0.93	1607.2	25.9	1675.9	16.1	1762.9	13.4	1762.9
ECS-13-4-105	93	137218	1.4	9.1767	0.4	4.8050	0.8	0.3198	0.7	0.84	1788.7	10.7	1785.8	6.9	1782.3	8.1	1782.3
ECS-13-4-89	75	50152	1.1	9.1315	0.9	4.8939	1.3	0.3241	0.9	0.68	1809.8	14.0	1801.2	10.9	1791.3	17.2	1791.3
ECS-13-4-91	533	164701	3.3	9.0606	0.3	5.0027	2.1	0.3287	2.1	0.99	1832.3	33.3	1819.8	17.9	1805.5	6.3	1805.5
ECS-13-4-95	205	138378	1.7	9.0464	0.5	4.9628	1.9	0.3256	1.8	0.97	1817.1	28.6	1813.0	15.7	1808.3	8.3	1808.3
ECS-13-4-37	93	154263	0.7	9.0207	1.1	4.9712	1.2	0.3252	0.6	0.50	1815.3	9.7	1814.4	10.3	1813.5	19.2	1813.5
ECS-13-4-98	126	163357	2.7	8.9859	0.5	5.0658	0.8	0.3301	0.6	0.76	1839.1	9.4	1830.4	6.5	1820.5	9.2	1820.5
ECS-13-4-75	134	114008	2.8	8.9560	0.5	5.0839	0.8	0.3302	0.7	0.79	1839.5	10.7	1833.4	7.2	1826.6	9.5	1826.6
ECS-13-4-107	97	76809	1.3	8.9079	0.6	5.1543	1.0	0.3330	0.8	0.80	1852.9	13.3	1845.1	8.8	1836.3	11.4	1836.3
ECS-13-4-82	108	87306	1.6	8.8157	0.4	5.2501	0.8	0.3357	0.7	0.85	1865.9	11.7	1860.8	7.2	1855.1	7.9	1855.1
ECS-13-4-39	87	21315	2.0	8.7505	0.8	5.0468	5.7	0.3203	5.6	0.99	1791.2	88.0	1827.2	48.2	1868.5	13.9	1868.5
ECS-13-4-19	115	145175	0.7	8.7164	0.5	5.3698	0.7	0.3395	0.5	0.69	1884.1	7.9	1880.1	6.0	1875.6	9.1	1875.6
ECS-13-4-77	131	128859	1.9	8.6765	0.4	5.4555	0.8	0.3433	0.7	0.87	1902.5	11.6	1893.6	7.0	1883.8	7.2	1883.8
ECS-13-4-43	65	25969	1.9	8.3349	1.3	5.6905	1.6	0.3440	0.8	0.50	1905.8	12.9	1929.9	13.4	1955.9	23.9	1955.9
ECS-13-4-45	99	82772	2.2	8.2494	0.8	5.7313	5.6	0.3429	5.5	0.99	1900.6	91.1	1936.1	48.4	1974.3	13.8	1974.3
ECS-13-4-33	99	45403	2.0	8.2368	0.5	5.6970	2.0	0.3403	1.9	0.97	1888.3	31.9	1930.9	17.4	1977.0	9.3	1977.0
ECS-13-4-21	177	370354	2.8	8.1756	0.5	6.0183	0.8	0.3569	0.6	0.74	1967.2	10.1	1978.5	7.0	1990.2	9.7	1990.2
ECS-13-4-72	16	27620	1.4	6.6936	2.7	7.9683	3.6	0.3868	2.4	0.68	2108.1	43.7	2227.4	32.5	2339.0	45.4	2339.0
ECS-13-4-102	47	72709	1.3	5.8887	0.4	11.4900	1.1	0.4907	1.0	0.92	2573.8	22.3	2563.8	10.7	2555.8	7.5	2555.8
ECS-13-4-23	96	286247	1.2	5.3916	0.3	13.3071	1.1	0.5204	1.1	0.96	2700.7	23.5	2701.7	10.5	2702.4	5.0	2702.4
ECS-13-4-96	210	329056	2.2	5.3782	0.2	13.5943	1.0	0.5303	1.0	0.98	2742.6	22.4	2721.9	9.6	2706.5	3.0	2706.5
ECS-13-4-100	18	38101	0.2	5.3158	0.8	13.5995	1.3	0.5243	1.0	0.77	2717.5	22.0	2722.2	12.3	2725.8	13.7	2725.8
ECS-13-4-79	49	124371	0.8	5.3001	0.6	13.7613	1.2	0.5290	1.0	0.87	2737.2	23.2	2733.4	11.3	2730.6	9.8	2730.6
ECS-13-4-25	20	69484	0.5	5.2907	1.7	13.5719	2.2	0.5208	1.4	0.64	2702.5	30.3	2720.3	20.3	2733.6	27.3	2733.6
ECS-13-4-80	74	281537	1.1	5.1475	0.5	14.4914	0.7	0.5410	0.5	0.77	2787.7	12.4	2782.4	6.8	2778.6	7.5	2778.6
ECS-13-4-52	60	209441	1.5	4.9743	0.3	15.3915	0.7	0.5553	0.6	0.92	2847.1	14.5	2839.8	6.6	2834.6	4.5	2834.6
ECS-13-4-104	32	17420	0.6	4.8982	1.6	13.6451	3.8	0.4847	3.5	0.91	2547.9	73.1	2725.4	36.2	2859.7	26.0	2859.7
ECS-13-4-14	17	22670	1.8	4.5144	0.6	17.8014	1.5	0.5829	1.4	0.91	2960.4	32.9	2979.1	14.6	2991.7	9.9	2991.7
ECS-13-4-70	115	188658	1.7	3.2462	0.3	30.8154	1.2	0.7255	1.2	0.98	3516.7	32.2	3513.2	11.9	3511.2	3.9	3511.2

Table DR 1 (Data Repository) (cont.). U-Pb data from detrital zircons from samples analyzed.

Sample G, ECS-13-5, Weber Sandstone, Irish Canyon, CO.

				Isotope ratios									Apparent ages (Ma)						
Analysis	U (ppm)	206Pb 204Pb	U/Th	206Pb* 207Pb*	± (%)	207Pb* 235U*	± (%)	206Pb* 238U	± (%)	error corr.	206Pb* 238U*	± (Ma)	207Pb* 235U	± (Ma)	206Pb* 207Pb*	± (Ma)	Best age (Ma)	± (Ma)	Conc (%)
ECS-13-5-47	20	4866	27.4	19.4391	15.7	0.4352	16.3	0.0614	4.5	0.28	383.9	16.9	366.8	50.3	260.7	362.4	383.9	16.9	NA
ECS-13-5-17	272	81765	2.1	17.9916	1.2	0.5390	1.4	0.0703	0.8	0.56	438.1	3.4	437.7	5.1	435.7	26.6	438.1	3.4	100.6
ECS-13-5-106	52	3245	1.6	15.4121	30.1	0.6306	30.8	0.0705	6.6	0.21	439.1	28.1	496.5	121.6	770.6	647.6	439.1	28.1	57.0
ECS-13-5-91	48	31362	3.0	13.9958	4.0	1.5929	4.8	0.1617	2.7	0.56	966.2	23.9	967.4	29.8	970.3	81.0	970.3	81.0	99.6
ECS-13-5-28	158	167259	1.6	13.9649	1.2	1.5934	1.7	0.1614	1.2	0.71	964.5	10.9	967.6	10.7	974.8	24.6	974.8	24.6	98.9
ECS-13-5-101	48	34250	1.3	13.8786	5.2	1.5374	5.7	0.1547	2.3	0.40	927.5	19.7	945.5	34.8	987.4	105.4	987.4	105.4	93.9
ECS-13-5-69	51	57588	2.1	13.4451	4.6	1.9079	4.9	0.1860	1.8	0.37	1099.9	18.5	1083.8	32.8	1051.7	92.0	1051.7	92.0	104.6
ECS-13-5-34	688	226308	2.7	13.4313	0.3	1.8195	0.8	0.1772	0.7	0.92	1051.9	6.7	1052.5	4.9	1053.8	5.8	1053.8	5.8	99.8
ECS-13-5-29	86	23505	2.0	13.4077	2.9	1.7896	3.7	0.1740	2.4	0.64	1034.2	22.9	1041.7	24.4	1057.3	58.0	1057.3	58.0	97.8
ECS-13-5-15	65	63737	2.0	13.3421	4.1	1.7512	4.4	0.1695	1.5	0.33	1009.1	13.6	1027.6	28.4	1067.2	83.2	1067.2	83.2	94.6
ECS-13-5-110	217	207211	1.7	13.3241	0.7	1.9034	1.1	0.1839	0.9	0.78	1088.4	8.8	1082.3	7.5	1069.9	14.2	1069.9	14.2	101.7
ECS-13-5-46	35	19626	1.0	13.2477	8.1	1.8388	9.6	0.1767	5.1	0.53	1048.8	49.2	1059.4	62.9	1081.4	162.6	1081.4	162.6	97.0
ECS-13-5-37	32	27939	1.0	13.1943	2.6	1.8818	3.0	0.1801	1.4	0.48	1067.4	14.1	1074.7	19.9	1089.5	53.0	1089.5	53.0	98.0
ECS-13-5-90	14	10733	1.1	12.9779	8.9	2.1101	9.1	0.1986	1.5	0.17	1167.9	16.1	1152.1	62.4	1122.6	178.3	1122.6	178.3	104.0
ECS-13-5-102	57	38765	1.2	12.8731	2.7	2.0976	2.8	0.1958	0.8	0.30	1152.9	8.9	1148.0	19.3	1138.7	53.4	1138.7	53.4	101.2
ECS-13-5-26	31	33537	3.0	12.8506	3.8	2.0784	4.0	0.1937	1.4	0.35	1141.4	14.9	1141.7	27.5	1142.2	74.7	1142.2	74.7	99.9
ECS-13-5-71	120	156434	1.5	12.8362	1.7	2.1302	1.9	0.1983	1.0	0.50	1166.3	10.3	1158.6	13.3	1144.4	33.3	1144.4	33.3	101.9
ECS-13-5-35	27	23305	1.3	12.7288	6.8	2.1259	6.9	0.1963	1.2	0.17	1155.2	12.6	1157.2	47.7	1161.1	135.1	1161.1	135.1	99.5
ECS-13-5-94	62	45468	2.4	12.5904	1.6	2.1964	1.9	0.2006	1.0	0.52	1178.3	10.8	1179.9	13.4	1182.8	32.5	1182.8	32.5	99.6
ECS-13-5-16	40	29556	1.5	12.5417	4.8	2.2038	5.1	0.2005	1.7	0.33	1177.8	18.4	1182.2	35.7	1190.4	95.1	1190.4	95.1	98.9
ECS-13-5-38	31	18219	2.1	12.4574	4.0	2.2016	4.3	0.1989	1.6	0.36	1169.5	16.7	1181.5	30.1	1203.7	79.2	1203.7	79.2	97.2
ECS-13-5-86	14	11041	2.0	12.2467	6.5	2.2366	8.0	0.1987	4.8	0.59	1168.1	50.9	1192.6	56.4	1237.3	126.9	1237.3	126.9	94.4
ECS-13-5-95	37	48480	1.7	12.1053	2.7	2.5186	3.0	0.2211	1.3	0.43	1287.8	15.0	1277.4	21.7	1260.0	52.6	1260.0	52.6	102.2
ECS-13-5-100	65	61661	1.4	11.9835	2.6	2.5346	3.5	0.2203	2.4	0.68	1283.4	27.8	1282.0	25.7	1279.7	50.6	1279.7	50.6	100.3
ECS-13-5-5	54	51447	1.6	11.8914	2.0	2.6448	2.4	0.2281	1.4	0.56	1324.6	16.3	1313.2	17.7	1294.7	38.6	1294.7	38.6	102.3
ECS-13-5-1	40	25542	1.4	11.8803	3.3	2.5414	3.5	0.2190	0.9	0.26	1276.5	10.7	1284.0	25.3	1296.5	65.1	1296.5	65.1	98.5
ECS-13-5-77	83	33533	2.3	11.8684	2.1	2.4766	5.2	0.2132	4.7	0.91	1245.7	53.8	1265.2	37.6	1298.5	40.7	1298.5	40.7	95.9
ECS-13-5-33	166	122486	1.4	11.8036	0.9	2.6347	1.4	0.2256	1.0	0.72	1311.1	11.6	1310.4	10.0	1309.1	18.4	1309.1	18.4	100.2
ECS-13-5-18	348	332664	2.6	11.7821	0.3	2.6285	0.7	0.2246	0.6	0.85	1306.2	6.7	1308.6	4.9	1312.6	6.7	1312.6	6.7	99.5
ECS-13-5-65	47	44160	2.0	11.5757	2.2	2.8163	2.6	0.2364	1.3	0.51	1368.2	16.3	1359.9	19.5	1346.9	43.2	1346.9	43.2	101.6
ECS-13-5-R56	18	25159	0.7	11.4114	4.9	2.7113	5.2	0.2244	1.8	0.34	1305.1	21.1	1331.6	38.9	1374.4	94.8	1374.4	94.8	95.0
ECS-13-5-93	86	77582	2.0	11.3122	1.9	2.9792	2.5	0.2444	1.7	0.66	1409.7	21.0	1402.3	19.0	1391.2	36.0	1391.2	36.0	101.3
ECS-13-5-109	66	54963	1.6	11.2932	1.7	2.9497	2.0	0.2416	1.0	0.53	1395.0	13.0	1394.8	14.9	1394.4	32.0	1394.4	32.0	100.0
ECS-13-5-98	76	28006	2.3	11.2908	2.3	2.9895	2.8	0.2448	1.6	0.56	1411.6	19.9	1404.9	21.3	1394.8	44.4	1394.8	44.4	101.2
ECS-13-5-62	68	68502	1.6	11.0776	2.5	3.1194	2.7	0.2506	1.0	0.38	1441.7	13.4	1437.5	20.8	1431.3	47.6	1431.3	47.6	100.7
ECS-13-5-60	236	248995	2.8	11.0456	0.4	3.1030	0.8	0.2486	0.7	0.88	1431.2	8.6	1433.4	5.8	1436.8	6.9	1436.8	6.9	99.6
ECS-13-5-40	34	29310	1.0	10.9966	2.9	3.1930	3.5	0.2547	1.9	0.56	1462.4	25.4	1455.5	26.8	1445.3	54.8	1445.3	54.8	101.2
ECS-13-5-66	40	39528	1.6	10.8181	1.2	3.3306	1.7	0.2613	1.1	0.66	1496.6	14.6	1488.2	12.9	1476.4	23.5	1476.4	23.5	101.4
ECS-13-5-30	139	114395	1.5	10.6652	0.7	3.3165	2.0	0.2565	1.9	0.93	1472.1	24.7	1484.9	15.8	1503.3	14.0	1503.3	14.0	97.9
ECS-13-5-31	14	7386	1.7	10.6019	9.9	3.6157	12.6	0.2780	7.8	0.62	1581.4	109.2	1553.0	100.3	1514.6	186.7	1514.6	186.7	104.4
ECS-13-5-78	66	85287	1.1	10.5829	1.8	3.4690	2.1	0.2663	1.0	0.51	1521.8	14.1	1520.2	16.2	1517.9	33.4	1517.9	33.4	100.3
ECS-13-5-74	118	98419	1.5	10.4748	1.1	3.5396	1.2	0.2689	0.5	0.43	1535.2	7.1	1536.1	9.6	1537.3	20.7	1537.3	20.7	99.9
ECS-13-5-103	73	120717	0.9	10.0617	1.0	3.9037	1.7	0.2849	1.4	0.80	1615.8	19.4	1614.4	13.7	1612.6	18.8	1612.6	18.8	100.2
ECS-13-5-9	86	76330	1.6	9.9971	1.2	3.9991	1.5	0.2900	0.9	0.62	1641.3	13.4	1634.0	12.1	1624.6	21.9	1624.6	21.9	101.0
ECS-13-5-105	20	31380	1.7	9.9900	4.6	4.0075	5.0	0.2904	1.9	0.38	1643.3	27.1	1635.7	40.5	1625.9	86.0	1625.9	86.0	101.1
ECS-13-5-10	127	104082	1.4	9.9097	0.4	3.9871	0.7	0.2866	0.6	0.82	1624.3	8.6	1631.6	5.9	1640.9	7.6	1640.9	7.6	99.0
ECS-13-5-81	106	95913	2.3	9.9083	1.2	4.0121	1.4	0.2883	0.7	0.54	1633.1	10.8	1636.7	11.3	1641.2	21.7	1641.2	21.7	99.5
ECS-13-5-63	444	693104	1.9	9.9066	0.2	4.1015	0.6	0.2947	0.5	0.93	1664.9	7.9	1654.6	4.8	1641.5	4.0	1641.5	4.0	101.4
ECS-13-5-104	40	32751	2.0	9.9020	2.7	4.0885	2.9	0.2936	1.0	0.36	1659.6	15.1	1652.0	23.4	1642.4	49.7	1642.4	49.7	101.1
ECS-13-5-82	66	84981	1.1	9.9009	1.5	4.1504	1.7	0.2980	0.9	0.51	1681.6	13.2	1664.3	14.3	1642.6	27.8	1642.6	27.8	102.4
ECS-13-5-76	300	220900	2.2	9.8778	0.4	4.1520	1.8	0.2974	1.7	0.97	1678.6	25.5	1664.6	14.5	1646.9	7.6	1646.9	7.6	101.9
ECS-13-5-44	46	35206	0.9	9.8744	1.4	4.0152	1.9	0.2876	1.3	0.69	1629.3	19.3	1637.3	15.8	1647.5	26.2	1647.5	26.2	98.9
ECS-13-5-58	46	72238	0.8	9.8624	1.5	4.0607	2.2	0.2905	1.6	0.74	1643.8	23.5	1646.5	17.9	1649.8	27.5	1649.8	27.5	99.6
ECS-13-5-23	187	122570	1.2	9.8450	0.7	4.0958	1.2	0.2925	1.0	0.83	1653.8	14.3	1653.5	9.7	1653.1	12.2	1653.1	12.2	100.0
ECS-13-5-52	70	41028	0.8	9.8330	1.5	4.0358	1.6	0.2878	0.5	0.33	1630.6	7.5	1641.4	12.9	1655.3	27.8	1655.3	27.8	98.5
ECS-13-5-48	47	48923	1.1	9.8283	1.7	4.1441	1.9	0.2954	0.9	0.49	1668.4	13.8	1663.0	15.7	1656.2	31.0	1656.2	31.0	100.7
ECS-13-5-32	217	363413	1.4	9.8274	0.3	4.1819	0.9	0.2981	0.8	0.93	1681.7	12.1	1670.5	7.2	1656.4	5.8	1656.4	5.8	101.5
ECS-13-5-88	103	121619	1.5	9.8228	0.7	4.1630	1.1	0.2966	0.9	0.78	1674.3	12.8	1666.8	9.1	1657.2	12.9	1657.2	12.9	101.0
ECS-13-5-68	43	59148	1.5	9.7853	1.4	4.1400	1.6	0.2938	0.7	0.46	1660.5	10.9	1662.2	13.1	1664.3	26.2	1664.3	26.2	99.8
ECS-13-5-8	180	15427	1.4	9.7605	1.0	3.7109	7.5	0.2627	7.4	0.99	1503.6	99.5	1573.7	60.0	1669.0	18.6	1669.0	18.6	90.1
ECS-13-5-36	24	41479	0.7	9.7569	2.4	4.1276	2.7	0.2921	1.3	0.46	1651.9	18.3	1659.8	22.4	1669.7	45.1	1669.7	45.1	98.9
ECS-13-5-39	75	7307	1.1	9.7258	1.1	4.2908	1.7	0.3027	1.3	0.77	1704.5	19.3	1691.6	13.7	1675.6	19.5	1675.6	19.5	101.7
ECS-13-5-61	107	109011	1.4	9.6774	0.7	4.2784	1.1	0.3003	0.9	0.79	1692.8	12.9	1689.2	9.1	1684.8	12.6	1684.8	12.6	100.5
ECS-13-5-4	49	37539	1.8	9.6569	1.5	4.2918	1.7	0.3006	0.7	0.42	1694.2	10.4	1691.8	13.7	1688.7	27.9	1688.7	27.9	100.3
ECS-13-5-89	93	81085	1.2	9.6534	0.7	4.2885	1.3	0.3002	1.0	0.84	1692.5	15.6	1691.2	10.3	1689.4	12.5	1689.4	12.5	100.2
ECS-13-5-84	26	27654	3.7	9.6436	3.0	4.1621	3.3	0.2911	1.2	0.38	1647.0	18.0	1666.6	26.9	1691.3	56.0	1691.3	56.0	97.4
ECS-13-5-80	43	29046	1.0	9.6099	6.3	4.0310	9.2	0.2809	6.7	0.73	1596.1	95.3	1640.5	75.0	1697.7	115.6	1697.7	115.6	94.0
ECS-13-5-96	41	30808	1.3	9.6055	1.4	4.2837	1.7	0.2984	1.0	0.56	1683.5	14.4	1690.2	14.3	1698.6	26.6	1698.6	26.6	99.1
ECS-13-5-51	146	219216	1.0	9.5608	0.6	4.3843	0.9	0.3040	0.7	0.79	1711.2	11.1	1709.4	7.7	1707.2	10.5	1707.2	10.5	100.2
ECS-13-5-99	46	39943	1.6	9.4246	2.2	4.2300	5.5	0.2891	5.1	0.92	1637.2	73.6	1679.9	45.4	1733.5	39.5	1733.5	39.5	94.4
ECS-13-5-72	70	64922	4.1	9.3820	0.7	4.5780	1.0	0.3115	0.7	0.71	1748.1	11.3	1745.3	8.7	1741.8	13.4	1741.8	13.4	100.4
ECS-13-5-7	28	40323	0.9	9.2226	2.4	4.5793	2.8	0.3063	1.4	0.49	1722.5	20.6	1745.5	23.3	1773.2	44.6	1773.2	44.6	97.1
ECS-13-5-59	29	49023	2.4	9.2000	2.8	4.6822	4.3	0.3124	3.3	0.76	1752.6	50.8	1764.1	36.3	1777.7	51.0	1777.7	51.0	98.6
ECS-13-5-108	47	37006	2.7	9.1465	1.4	4.8136	2.2	0.3193	1.7	0.77	1786.4	26.5	1787.3	18.6	1788.3	25.8	1788.3	25.8	99.9
ECS-13-5-49	35	22588	2.2	9.1257	3.8	4.8747	4.7	0.3226	2.9	0.60	1802.6	44.9	1797.9	39.9	1792.4	68.8	1792.4	68.8	100.6
ECS-13-5-67	41	113347	4.7	9.1000	2.0	4.6701	2.8	0.3082	1.8	0.67	1732.0	28.1	1761.9	23.0	1797.6	37.1	1797.6	37.1	96.4
ECS-13-5-12	62	89796	1.1	9.0371	0.7	4.9492	1.6	0.3244	1.5	0.90	1811.1	23.0	1810.7	13.7	1810.2	13.1	1810.2	13.1	100.1
ECS-13-5-83	91	92634	2.7	9.0088	0.7	4.7619	3.8	0.3111	3.7	0.98	1746.3	57.0	1778.2	31.8	1815.9	12.9	1815.9	12.9	96.2
ECS-13-5-73	117	141281	2.4	8.8556	0.8	5.1782	1.3	0.3326	1.0	0.76	1850.9	16.0	1849.0	11.0	1847.0	15.1	1847.0	15.1	100.2
ECS-13-5-97	16	17103	12.3	8.7839	4.8	4.9121	5.1	0.3129	1.7	0.34	1755.1	26.3	1804.3	42.7	1861.6	86.0	1861.6	86.0	94.3
ECS-13-5-87	180	450550	1.4	8.7508	0.7	5.4415	1.5	0.3454	1.3	0.88	1912.4	22.2	1891.4	13.0	1868.5	12.8	1868.5	12.8	102.4
ECS-13-5-24	69	62427	0.4	8.7374	0.6	5.2801	1.1	0.3346	0.9	0.84	1860.6	15.2	1865.7	9.5	1871.2	10.8	1871.2	10.8	99.4
ECS-13-5-42	97	75823	1.3	8.6163	0.8	5.4930	1.3	0.3433	1.0	0.79	1902.4	17.0	1899.5	11.2	1896.4	14.2	1896.4	14.2	100.3
ECS-13-5-45	53	78480	1.0	8.5983	1.6	5.5096	2.0	0.3436	1.3	0.63	1903.9	20.8	1902.1	17.2	1900.1	28.0	1900.1	28.0	100.2
ECS-13-5-75	95	44440	1.3	8.5902	1.0	5.2342	3.4	0.3261	3.2	0.95	1819.5	51.0	1858.2	28.8	1901.8	18.1	1901.8	18.1	95.7
ECS-13-5-92	37	51545	3.3	8.5747	2.3	5.4510	3.4	0.3390	2.5	0.74	1881.8	41.0	1892.9	29.1	1905.1	40.7	1905.1	40.7	98.8
ECS-13-5-20	23	16901	0.6	8.4407	2.5	5.5173	4.0	0.3378	3.2	0.79	1875.9	51.5	1903.3	34.6	1933.3	44.4	1933.3	44.4	97.0
ECS-13-5-85	131	126645	1.8	8.3487	0.2	5.7882	1.0	0.3505	1.0	0.97	1936.9	16.7	1944.6	8.9	1952.9	4.4	1952.9	4.4	99.2
ECS-13-5-79	60	43990	4.0	8.1707	1.0	6.1744	4.5	0.3659	4.4	0.97	2010.0	76.0	2000.8	39.6	1991.3	18.6	1991.3	18.6	100.9
ECS-13-5-107	91	124984	1.1	8.1579	0.9	6.2408	1.5	0.3692	1.2	0.81	2025.9	21.2	2010.2	13.2	1994.1	15.7	1994.1	15.7	101.6
ECS-13-5-13	63	55047	0.5	6.6072	1.5	7.7204	2.8	0.3700	2.4	0.85	2029.2	41.5	2199.0	25.2	2361.2	25.1	2361.2	25.1	85.9
ECS-13-5-19	13	26027	0.9	5.8464	3.4	11.2667	3.9	0.4777	1.8	0.48	2517.4	38.5	2545.4	36.1	2567.9	56.9	2567.9	56.9	98.0
ECS-13-5-14	24	34247	2.3	5.6504	0.9	12.2665	1.3	0.5027	1.0	0.73	2625.3	20.8	2625.0	12.5	2624.8	15.2	2624.8	15.2	100.0
ECS-13-5-27	32	41322	1.3	5.6380	1.0	12.1157	2.3	0.4954	2.1	0.90	2594.1	44.5	2613.4	21.8	2628.4	17.0	2628.4	17.0	98.7
ECS-13-5-53	221	334126	2.2	5.5296	0.2	12.5689	1.2	0.5041	1.2	0.99	2631.3	25.7	2647.9	11.3	2660.6	3.0	2660.6	3.0	98.9
ECS-13-5-22	33	54764	1.0	5.4457	0.7	12.7794	1.2	0.5047	0.9	0.78	2634.1	19.8	2663.5	11.1	2685.9	12.3	2685.9	12.3	98.1
ECS-13-5-6	105	154794	0.9	5.4339	0.3	11.9652	2.0	0.4716	2.0	0.99	2490.4	40.3	2601.7	18.5	2689.5	4.5	2689.5	4.5	92.6
ECS-13-5-54	42	251077	1.3	5.2700	0.5	13.7758	1.8	0.5265	1.7	0.95	2726.8	37.8	2734.4	16.9	2740.0	8.8	2740.0	8.8	99.5
ECS-13-5-21	127	191070	1.1	5.1866	0.2	13.6848	0.9	0.5148	0.9	0.97	2677.0	19.5	2728.1	8.7	2766.2	3.7	2766.2	3.7	96.8
ECS-13-5-70	40	276723	1.5	3.8437	0.5	23.6111	1.4	0.6582	1.3	0.95	3260.2	34.4	3252.5	13.8	3247.7	7.2	3247.7	7.2	100.4

Table DR 1 (Data Repository) (cont.). U-Pb data from detrital zircons from samples analyzed.

Notes:
1. Analyses with >10% uncertainty (1-sigma) in 206Pb/238U age are not included.
2. Analyses with >10% uncertainty (1-sigma) in 206Pb/207Pb age are not included, unless 206Pb/238U age is <500 Ma.
3. Best age is determined from 206Pb/238U age for analyses with 206Pb/238U age <1000 Ma and from 206Pb/207Pb age for analyses
with 206Pb/238Uage >1000 Ma.
4. Concordance is based on 206Pb/238U age / 206Pb/207Pb age. Value is not reported for 206Pb/238U ages <500 Ma because of .
large uncertainty in 206Pb/207Pb age
5. Analyses with 206Pb/238U age >500 Ma and with >20% discordance (<80% concordance) are not included.
6. Analyses with 206Pb/238U age >500 Ma and with >5% reverse discordance (<105% concordance) are not included.
7. All uncertainties are reported at the 1-sigma level, and include only measurement errors.
8. Systematic errors are as follows (at 2-sigma level): [sample 1: 2.5% (206Pb/238U) & 1.4% (206Pb/207Pb)] These values are reported on
cells U1 and W1 of NUagecalc.
9. Analyses conducted by LA-MC-ICP-MS (see text), as described by Gehrels et al., 2008.
10. U concentration and U/Th are calibrated relative to Sri Lanka zircon standard and are accurate to ~20%.
11. Common Pb correction is from measured 204Pb with common Pb composition interpreted from Stacey and Kramers (1975).
12. Common Pb composition assigned uncertainties of 1.5 for 206Pb/204Pb, 0.3 for 207Pb/204Pb, and 2.0 for 208Pb/204Pb.
13. U/Pb and 206Pb/207Pb fractionation is calibrated relative to fragments of a large Sri Lanka zircon of 563.5 ± 3.2 Ma (2-sigma).
14. U decay constants and composition as follows: 238U = 9.8485 x 10-10, 235U = 1.55125 x 10-10, 238U/235U = 137.88.
15. Weighted mean and concordia plots determined with Isoplot (Ludwig, 2008).
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the central Appalachians (Dickinson and Gehrels; 2003). This same Laurentian sand provenance for the Wood River Basin and Oquirrh Basin (northwestern Utah) was interpreted by Geslin (1998) based on geologic and petrographic evidence.

It is not clear whether the ultimate source of this sand blanket was the central Appalachians or coeval mountain belts to the north in northern Canada. The differences between these provenance areas is more subtle than we would like, as age provinces in the East Greenland and Canadian Appalachians and the Ellesmerian orogenic belt in the Canadian Arctic broadly match those in the central Appalachians.

The possibility that the Grenville-age grains are recycled from the Neoproterozoic Brigham Group of southeast Idaho is rejected because there are thick Cambrian and younger strata overlying the group (Yonkee et al., 2014), rather than an unconformity to Permian rocks, as would be expected if it had been uplifted in Pennsylvanian time.

In detail, the data contain age populations that, when combined with geologic constraints, provide provenance information about specific Pennsylvanian sandstones. The Hailey and Wilson Creek Members of the Wood River Formation (samples A and D, respectively) have more Neoproterozoic and Paleozoic grains than the other samples, as best seen on the cumulative-frequency plot (Fig. 5). The Hailey Member yields 648 Ma (Cryogenian), 566 Ma (Ediacaran), and 429 Ma (Silurian) grain-populations.

The Hailey Member has a significant percentage of Paleoproterozoic grains *older than* 1800 Ma. This age-grouping is characteristic of the Peace River Arch in Alberta, Canada, and is found in Ordovician quartzites of Idaho (Link et al., 2011). It is also found in the Mississippian Copper Basin Group (Fig. 2), suggesting recycling from those Ordovician quartzites (Link et al., 1996). The provenance for the Hailey Member can be interpreted to contain three components: 1) the regional Laurentian sand blanket, 2) local reworking of the Mississippian Copper Basin Group with its contribution of >1800 Ma grains (Fig. 2), and 3) undetermined western Cordilleran sources of Paleozoic magmatic grains (Link et al., 2011). These three provenance areas are shown as numbers 1, 3, and 4 on Figure 1.

The Hailey Member (Sample A) has 11 grains and the Wilson Creek Member (Sample D) has nine grains between 500 and 400 Ma, with groupings at 487 and 422 Ma. Further study of the ages and isotopic composition of these Paleozoic zircons may demonstrate linkages with magmatic rocks of the western Cordillera. One candidate is 570 Ma synrift volcanic rocks in southern British Columbia (Colpron et al., 2002). Another more local source (included in arrow 3 on Fig. 1) is 650–500 Ma alkaline intrusive rocks in the Big Creek-Beaverhead plutonic belt of east-central Idaho (Lund, 2008; Lund et al., 2010).

Table 2. Statistical overlap, similarity, and K-S comparisons between samples, using the Excel macros of the Arizona LaserChron Center website.

	A--Hailey	B--Eagle	C--Eagle	D--Wilson	E--Tensleep Sinks	F--Weber Sheep
OVERLAP						
B--Eagle	0.747					
C--Eagle	0.786	0.830				
D--Wilson	0.774	0.766	0.775			
E--Tensleep Sinks	0.692	0.790	0.794	0.728		
F--Weber Sheep	0.667	0.813	0.797	0.724	0.815	
G--Weber Irish	0.781	0.872	0.843	0.773	0.807	0.821
SIMILARITY						
B--Eagle	0.759					
C--Eagle	0.738	0.820				
D--Wilson	0.714	0.766	0.760			
E--Tensleep Sinks	0.715	0.805	0.784	0.771		
F--Weber Sheep	0.733	0.832	0.820	0.758	0.808	
G--Weber Irish	0.771	0.837	0.845	0.775	0.809	0.845
K-S *p*-values using error in the CDF						
B--Eagle	**0.763**					
C--Eagle	**0.496**	**0.313**				
D--Wilson	**0.160**	**0.381**	**0.152**			
E--Tensleep Sinks	**0.295**	**0.621**	0.032	**0.551**		
F--Weber Sheep	**0.339**	**0.243**	**0.890**	0.018	0.015	
G--Weber Irish	**0.159**	**0.230**	**0.593**	0.014	0.020	**0.992**

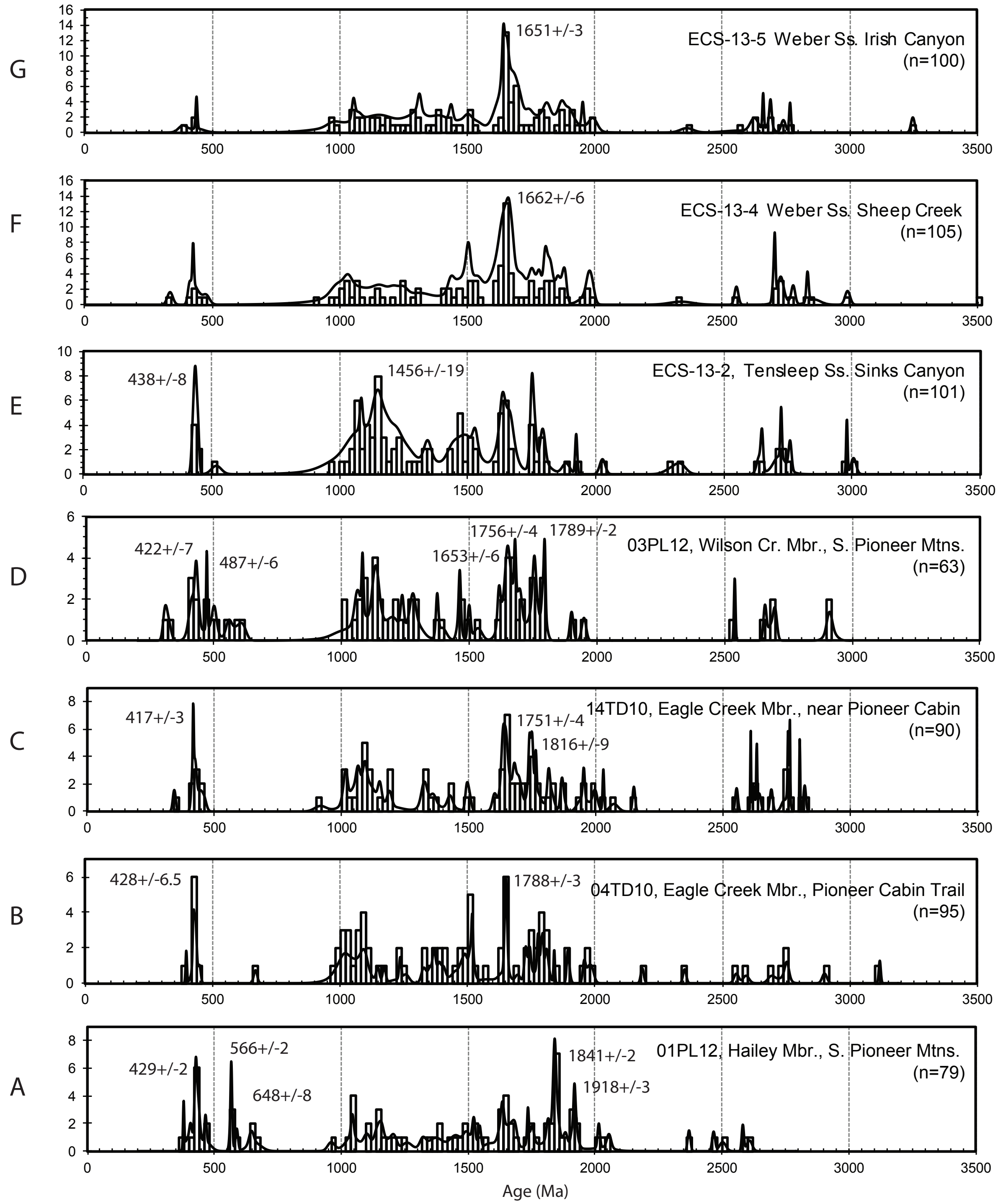


Figure 4. Detrital zircon probability-frequency curves for Pennsylvanian and Permian sandstones analyzed in this paper. Geographic location of samples is shown on Figure 1. Stratigraphic location of samples is shown on Figure 2. Samples are as follows: A=01PL12, Hailey Member of Wood River Formation, east of Bellevue, Pioneer Mountains, south-central Idaho; B=04TD10, Eagle Creek Member of Wood River Formation, Pioneer Cabin Trail, Pioneer Mountains, south-central Idaho; C=14TD10, Eagle Creek Member of Wood River Formation, near Pioneer Cabin, Pioneer Mountains, south-central Idaho; D=03PL12, Wilson Creek Member of Wood River Formation, Pioneer Mountains, south-central Idaho; E=ECS-13-2, Tensleep Sandstone, Sinks Canyon, Wind River Range, western Wyoming; F=ECS-13-4, Weber Sandstone, Sheep Creek, Uinta Mountains, northeast Utah; G=ECS-13-5, Weber Sandstone, Irish Canyon, northwest Colorado. Sample locations detailed in Table DR 1. N is number of analyses accepted (<20% discordant). Bin size is 20 m.y. Data are in Table DR 1.

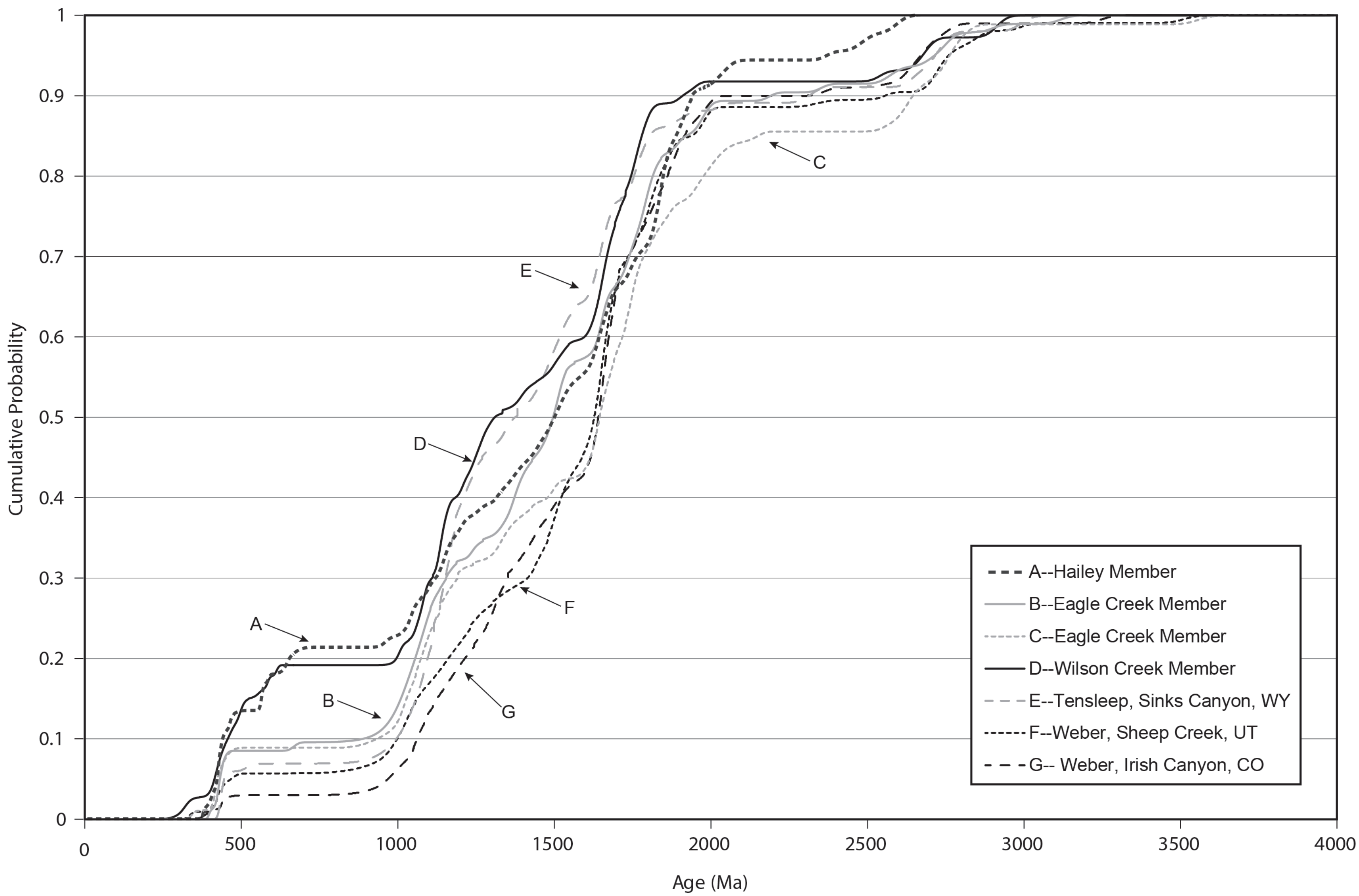
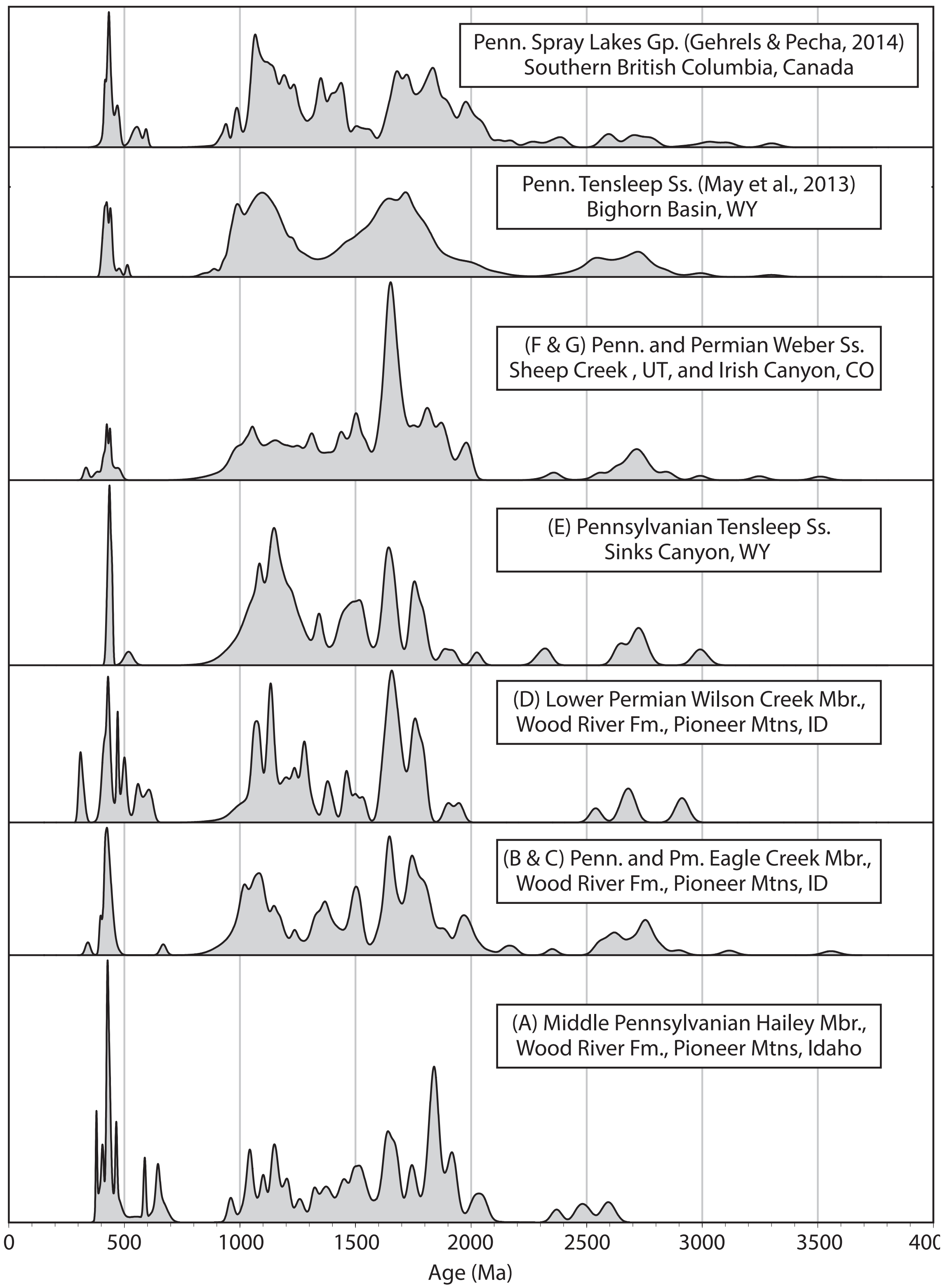


Figure 5. Cumulative-frequency curves for same seven samples as in Figure 4. The Hailey Member and Wilson Creek Member (samples A and D, respectively) stand out in having more grains younger than 1000 Ma. The Weber Sandstone (samples F and G) from Sheep Creek, Utah, and Irish Canyon, Colorado, respectively, have more 1700–1650 Ma grains than the others, so they have a lower slope through this interval.



Another possible provenance for the Paleozoic grains is the Klamath Mountains of northwest California and southwest Oregon (provenance area 4 on Fig. 1). The area is primarily underlain by the eastern Klamath terrane, comprising variably deformed and metamorphosed rocks of the Yreka

Figure 6, (facing page). Lumped and stacked probability-density plots with no histograms. Samples B and C (Eagle Creek Member) and samples F and G (Weber Sandstone) are lumped. Lumped data of three Tensleep Sandstone samples of May et al. (2013) are shown, plotted above the lumped Weber Sandstone. They resemble the Eagle Creek and Tensleep distributions. Lumped data from the Pennsylvanian Spray Lakes Group in southern British Columbia, Canada, from Gehrels and Pecha (2014), are plotted at the top of the diagram and generally contain the same groupings. There appear to be three provenance inputs: 1) the general Laurentian-Appalachian signature of the Eagle Creek Member of the Wood River Formation and Tensleep Sandstone, 2) local Yavapai-Mazatzal 1700–1650 Ma influence on the Weber Sandstone, and 3) Cryogenian-, Ediacaran-, and Cambrian-age grains in the Hailey and Wilson Creek Members of the Wood River Formation, which have possible sources in east-central Idaho or to the west and north within exotic terranes.

and Trinity subterranes (e.g., Lindsley-Griffin et al., 2006, 2008). The Trinity subterrane is an Ediacaran and Cambrian–Ordovician(?) ophiolitic complex intruded by Ordovician and Silurian to Lower Devonian granitoids. The Yreka subterrane is an Ordovician and Silurian–Devonian forearc complex with mélange and tectonic slivers that include Ediacaran (571 and 565 Ma) tonalite and Ordovician (454 Ma) blueschist (Wallin et al., 1988; Grove et al., 2008). Lower to Middle Devonian metaclastic units of Yreka subterrane yield abundant 470–380 Ma detrital zircons, with resolved age peaks around 430, 420, and 400 Ma (Grove et al., 2008). These early Paleozoic-age populations are mixed with 635–540 Ma distributions and a cratonal provenance defined by 2000–1000 Ma detrital zircons, including 1610–1490 Ma constituents that correspond to the so-called North American magmatic gap (Grove et al., 2008). Colpron and Nelson (2009) argued for the Yreka subterrane to be broadly associated with the Late Devonian–Early Mississippian Antler orogenic b elt in southern Idaho and Nevada.

Link et al. (2011) attributed early Paleozoic detrital zircon populations in the Upper Devonian Milligen Formation to a western source from the Yreka subterrane. It is possible that some early Paleozoic detrital zircons in, at least, the Hailey Member of the Wood River Formation were recycled from the underlying Milligen Formation.

The two Eagle Creek Member samples (B and C) and the Tensleep Sandstone sample (E) are similar, with subequal amounts of Paleo- and Mesoproterozoic grains. The Paleoproterozoic ages are mainly *less than* 1800 Ma, consistent with ages in the mid-continent Paleoproterozoic province. This age distribution is comparable to those in the eolian Tensleep Sandstone of the Bighorn Basin (May et al., 2013) (Fig. 6). The Eagle Creek and Tensleep samples represent the regional Laurentian sand blanket, without significant local contributions.

The two Weber Sandstone samples (F and G) have a significant 1700–1650 Ma grain-component (over 15 grains in each sample), consistent with their derivation partly from the adjacent Yavapai-Mazatzal provinces, uplifted as part of the Ancestral Rocky Mountains (provenance arrow 2 on Fig. 1). As such, they are distinct from the Tensleep Sandstone from western Wyoming's Sinks Canyon, and they display both the continental Laurentian provenance and the southern Yavapai-Mazatzal provinces. This suggests that the Ancestral Rocky Mountains were exposed and providing detrital zircons northward in Late Pennsylvanian time. In Pennsylvanian sandstones of New Mexico, Soreghan and Soreghan (2013) found that most of the sand came from the southern Appalachian system to the east and south.

CONCLUSIONS

We conclude that a continental-scale system (arrow 1 on Fig. 1) transported most of the sand grains in the Wood River Formation and Tensleep Sandstone. In addition to this regional sand blanket, the Weber Sandstone of the north flank of the Uinta Mountains had a significant input of 1700–1650 Ma zircon grains from the Yavapai-Mazatzal provinces in northwest Colorado (arrow 2 on Fig. 1). The Hailey Member of the Wood River Formation contains two other components: the larger component is >1800 Ma reworked zircons from the Copper Basin Group (arrow 3 on Fig. 1), and the smaller component is Cryogenian to Ediacaran grains that may have a western Cordilleran provenance (arrow 4 on Fig. 1).

We interpret most of the late Mesoproterozoic–Neoproterozoic grains in these sandstones to have an ultimate source from the Grenville Province of eastern North America, recycled during early to mid-Paleozoic plate convergence and mountain building. Early Paleozoic detrital zircons that form minor—but consistent—populations are derived from some as yet undecipherable mix of magmatic arc rocks of the Appalachian, Caledonian, and Ellesmerian orogenic belts along the plate margins of northern and eastern North America.

We note that the overlap, similarity, and K-S statistical comparisons of the data do not, in general, reveal the same differences interpreted from visual inspection of the probability-frequency and cumulative-frequency plots. Nor do these statistical tests—in particular, the overlap-similarity values versus the K-S values—necessarily agree with each other in terms of which samples are clearly different.

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