Chapman, A.D., and Laskowski, A.K., 2019, Detrital zircon U-Pb data reveal a Mississippian sediment dispersal network originating in the Appalachian orogen, traversing North America along its southern shelf, and reaching as far as the southwest USA: Lithosphere, https://doi.org/10.1130/L1068.1.

GSA Data Repository Item 2019260

Alan D. Chapman[1] and Andrew K. Laskowski[2]

[1]*Geology Department, Macalester College, St. Paul MN 55105, USA*
[2]*Department of Earth Sciences, Montana State University, Bozeman MT 59717, USA*

Corresponding author: chapman@macalester.edu

Supporting information and Data Repository

1. SAMPLES

Existing data: Detrital zircon U-Pb data from published papers plus unpublished M.S. theses and Ph.D. dissertations are compiled in Table DR1. For grains younger and older than 900 Ma, $^{206}Pb/^{238}U$ and $^{207}Pb/^{206}Pb$ ages were tabulated, respectively. Analyses with greater than 10% uncertainty, 20% discordance, and/or 5% reverse discordance were excluded, when this information was made available by authors. Each published sample is assigned a sample identifier in Table DR1 and plotted using this identifier on Plates 1-4.

New data: New sampling efforts focused on the Midcontinent region, where existing data was sparse or lacking. Detailed sample location information, including field sample identifiers, abbreviated sample identifiers for plotted locations on Plates 1-4, sample coordinates (WGS 84 datum), unit name, as well as sample descriptions, detrital zircon age distributions, and inferred sources are provided below. New U-Pb detrital zircon data is presented in Table DR2.

1.1.Sampled Ordovician Units

13MO2 (Plate 1 location #3; UTM 15S, 698005E, 4262009N) – Upper Ordovician St. Peter Sandstone

Collected in Pacific, Missouri. Sample is a friable, well-sorted, coarse quartz arenite containing spherically rounded quartz grains and heavy mineral separates. Most detrital zircon grains extracted from sample 13MO2 yield ages of ca. 2.7 Ga (~70% of analyzed grains), with a relatively small proportion (~20%) of grains between ca. 1.0 and 1.35 Ga in age. Most remaining grains yield a minor peak centered at ca. 1.85 Ga. Inferred ultimate provenance: Superior cratonic basement, Penokean orogen, and Grenville orogen (likely recycled from eroded Proterozoic basins once situated in Ontario; Konstantinou et al., 2014) with possible additional input from felsic material of the Midcontinent Rift.

Figure DR1. Sampled exposure of St. Peter Sandstone in Pacific, Missouri. Cliff exposes ~8 m of white to light beige St. Peter Sandstone with silica mine entrances below ~3 m of pale buff Joachim Formation; Photo: Missouri DNR.

13OK1 (Plate 1 location #4; UTM 14S, 695765E, 3816335N) – Upper Ordovician Oil Creek Sandstone

Collected near Mill Creek, Oklahoma. Sample is a friable, well-sorted, coarse quartz arenite containing spherically rounded quartz grains and heavy mineral separates. Like sample 13MO2, this sample contains a significant proportion of ca. 2.7 Ga grains (~70% of analyzed grains), and diminishing proportions of ca. 1.85 Ga grains (~15%), and a small proportion (~5%) of grains between ca. 1.0 and 1.3 Ga in age. One single euhedral concordant grain from sample 13OK1 yields an Early Ordovician ^{206}Pb/^{238}U age of 470.4 ± 7.5 Ma – possibly delivered through the air from an eruption in the Taconic arc. Inferred ultimate provenance: Superior cratonic basement, Penokean orogen, and Grenville orogen (likely recycled from eroded Proterozoic basins once situated in Ontario) with possible additional input from felsic material of the Midcontinent Rift.

GIBBONS-HESS (Plate 1 location #5; UTM 14S, 527636E, 4166839N) – Upper Ordovician Simpson Sandstone

Collected from the Kansas Core Library (Kansas Geological Survey). Sampled core was taken from a depth of 4309-4313' from the Gibbons-Hess 2 well (Pratt County; original operator: William Gruenerwald and Associates). Sample is a friable, well-sorted, oil-saturated medium quartz arenite containing subrounded to subangular quartz grains cemented by iron oxide and silica. Sample contains vertical skolithos burrows. This sample contains a very high proportion of ca. 2.7 Ga grains (~85%) with minor amounts of ca. 1.0-1.35 Ga grains (~5%) and scattered ages from 1.68-1.86 Ga (~5%). Inferred ultimate provenance: Superior cratonic basement with minor contributions from the Grenville orogen (likely recycled from eroded Proterozoic basins once situated in Ontario), and Yavapai/Mazatzal crust.

Figure DR2. Sampled drill core of Simpson Sandstone. Detrital zircon grains were extracted from core sections marked with checks.

13MO1 (Plate 1 location #40; UTM 15S 604575E, 4199858N) – Lower Ordovician Roubidoux Sandstone

Collected in Rolla, Missouri along Interstate 44. Sample is a thick-bedded, well-sorted, coarse quartz arenite showing well-developed ripple marks and contains rounded quartz grains, <5% feldspar, and heavy mineral separates, including zircon, tourmaline, and garnet. Sample 13MO1 contains a significant proportion of ca. 2.7 Ga grains (~75%) with a subsidiary amount of ca. 1.0-1.3 Ga grains (~15%). Inferred ultimate provenance: Superior cratonic basement plus the Grenville orogen (likely recycled from eroded Proterozoic basins once situated in Ontario).

Figure DR3. Sampled exposure of Roubidoux Sandstone in Rolla, Missouri. Roadcut is ~2 m high. Photo: Google street view.

14MO8 (Plate 1 location #41; UTM 15S, 520762E, 4202945N) – Lower Ordovician Gunter Sandstone

Collected in Ha Ha Tonka State Park, Missouri. Sample is from a thin (<10 m), friable, cross-bedded orthoquartzite interval with well-rounded quartz grains and variable silica to calcite cement conformably underlying the Lower Ordovician Gasconade Dolomite and unconformably overlying the Upper Cambrian Eminence Dolomite. This sample contains subequal proportions of ca. 2.7 Ga (~50%) and ca. 1.0-1.3 Ga grains (~40%), with ~10% scattered ages from ca. 1.3-1.5 Ga. Inferred ultimate provenance: Superior cratonic basement plus the Grenville orogen (likely recycled from eroded Proterozoic basins once situated in Ontario), with minor input from local basement sources in the Granite-Rhyolite belt (e.g., the St. Francois Mountains).


Figure DR4. Sampled exposure of cross-bedded Gunter Sandstone at Ha Ha Tonka State Park, central Missouri.

18BH2A (Plate 1 location #59; UTM 13T 603274E, 4916000N) – Middle Ordovician Winnipeg Formation

Collected near Deadwood, South Dakota (northern Black Hills) along U.S. Highway 14 behind the Canyon View Amish Furniture store (Sweet, 1982 locality 75SA). Sample is from a ~2 m thick, light beige-weathering siltstone, containing highly indurated subangular to subrounded quartz grains, that transitions upward into the overlying Whitewood Formation. Detrital zircon grains from this unit are relatively small (generally ~30x15 µm), which required analysis via ion counting mode. This sample consists mainly of ca. 1.8-2.0 Ga grains (~60%) with diminishing amounts of Archean (~30%) and ca. 1.6-1.8 Ga (~10%) grains. Inferred ultimate provenance: Juvenile arcs and orogens of NW Canada plus Archean crust from the same broad region with minor input from Yavapai/Mazatzal basement.

Figure DR5. Sampled exposure of Winnipeg Formation, northern Black Hills (western South Dakota). Picnic tables are ~2 m long. Cliff exposes, from bottom to top: ~3 m of buff, cliff-forming, bedded Winnipeg Formation; ~6 m of pale buff, cliff-forming, massive Whitewood Limestone; ~5 m of slope-forming pink limestone and purplish-gray shale of the Englewood Formation; and is capped by light gray massive Pahasapa Limestone. Sample 18BH2A was collected adjacent to covered picnic table (starred location).

1.2. Sampled Devonian Units

14MO4 (Plate 2 location #41; UTM 15S, 727981E, 4248738N) – Upper Devonian Bushberg Sandstone

Collected along Interstate 55 near Imperial, Missouri. Sample is from a roadcut of yellow to yellow-brown, friable, medium to coarse grained, cross-bedded quartz arenite with well-rounded quartz grains. As noted by Thompson (1995), the Bushberg Sandstone shares several textural and mineralogical similarities with the St. Peter Sandstone. These relations plus similar detrital zircon distributions in the Bushberg and St. Peter sandstones (i.e. abundant ca. 2.7 Ga and ca. 0.95-1.3 Ga grains) strongly suggest that the former represents the reworked equivalent of the latter.

Figure DR6. Sampled exposure of cross-bedded Bushberg Sandstone near Imperial, Missouri.

180721FL1 (Plate 2 location #52; NAD83, -110.97726º, 45.90480º) Devonian Upper Sappington Formation

A sample was collected from ~20 m below the summit of Pomp Peak, north-adjacent to Sacajewea Peak in the Bridger Range northeast of Bozeman, Montana. Sample was collected from a thick-bedded, yellow-weathering, fine sandstone with sparse shale and siltstone interbeds. Sandstone beds near the sample collection site contained hummocky cross stratification, wave ripple cross stratification and parallel lamination. The locality was described by Cole et al., (2015). Detrital zircon grains extracted from this sample are characterized by, in order of decreasing prominence: 1) a Grenville-age peak centered at ca. 1.0 Ga (41% of analyzed grains), 2) Paleozoic grains, with ages ranging from ca. 390-480 Ma (18%), 3) a range of Yavapa-Mazatzal age-probability peaks between 1.6-1.8 Ga (15%), 4) Granite/Rhyolite ages between 1.3-1.5 Ga (13%), Archean grains mainly between 2.6-2.9 Ga with a subordinate age-probability peak at 3.5 Ga (10%), 5) less than three percent total of Suwanee/Meguma and 1.8-2.0 Ga grains. Inferred ultimate provenance: Grenville and Appalachian Orogens plus Superior and/or Wyoming cratons, Granite/Rhyolite province, and the Yavapai-Mazatzal province.

Figure DR7. Sampled exposure of Devonian upper Sappington Formation exposed just below the summit of Pomp Peak, north-adjacent to Sacajewea Peak in the Bridger Range northeast of Bozeman, MT. Sample was collected at chest height.

1.3. Sampled Mississippian Units

14MO3 (Plate 3 location #8; UTM 16S, 236940E, 4200921N) – Mississippian Aux Vases Sandstone

Collected along Highway 61 near Ste. Genevieve, Missouri. Sample is from a roadcut of an exposure of white-light gray mixed siliciclastic-carbonate material showing trough and tabular cross-bedding. The clastic component of the studied Aux Vases sample consists of fine- to medium-grained quartz arenite with well-rounded quartz grains. In comparison to underlying rocks in the vicinity of the Ozark Dome, the Aux Vases Sandstone contains a lower proportion of ca. 2.7 Ga zircon grains (6%) and a higher proportion of detrital zircon ages from ca. 0.95 to 1.3 Ga (53%) plus a significant proportion (23%) of Paleozoic zircon grains, exhibiting prominent Taconic-aged peaks at ca. 425 and 465 Ma. The sample also contains small amounts of ca. 1.6-1.8 Ga (14%) and 1.3-1.5 Ga (12%) grains. Inferred ultimate provenance: Grenville and Taconic orogens with minor input Yavapai/Mazatzal and Granite/Rhyolite crust plus the Superior Craton (possibly recycled from older units).

Figure DR8. Sampled exposure of Aux Vases Sandstone near Ste. Genevieve, Missouri.

PUYEAR (Plate 3 location #9; UTM 14S, 264382E, 4164452N) –Mississippian Ste. Genevieve Limestone

Collected from the Kansas Core Library (Kansas Geological Survey). Sampled core was taken from a depth of 5462-5466’ from the Puyear 1 well (Stanton County; original operator: Amoco Production Company). The studied sample is an oolitic limestone containing undulose quartz-rich silt and sand. This sample contains an age distribution similar to that of the Aux Vases Sandstone, with abundant detrital zircons yielding ages from ca. 0.95 to 1.3 Ga (40%) with diminishing proportions of 1.3-1.5 Ga (18%), 400-470 Ma (13%), and Archean grains (4%), plus scattered ages from ca. 1.6-2.0 Ga (24%). Inferred ultimate provenance: Grenville and Taconic orogens with minor input Granite/Rhyolite and Yavapai/Mazatzal crust plus the Superior Craton (possibly recycled from older units).

180713SWC3 (Plate 3 location #28; NAD83, -109.32626, 46.71101) -Mississippian Kibbey Formation sandstone

A sample was collected from the Swimming Woman Creek locality in the southern Big Snowy Mountains, MT. This is the same locality that was sampled by Shean (1947). Sample was collected from sparsely exposed, brick-red, medium-sorted, fine-grained sandstone. The Kibbey Formation is characterized by a mix of well-rounded, frosted sand grains and subangular grains that are not frosted. This suggests two distinct sources with one involving eolian transport (Shean, 1947). Detrital zircon grains extracted from this sample are characterized by, in order of decreasing prominence: 1) a Grenville-age peak centered at ca. 1.0 Ga (44% of analyzed grains), 2) Paleozoic grains, with ages ranging from ca. 400-470 Ma (21%), 3) two Yavapa-Mazatzal age-probability peaks between 1.6-1.8 Ga (11%), 4) Archean grains mainly between 2.6-2.9 Ga (10%), 5) less than ten percent total of Suwanee/Meguma, Granite/Rhyolite, and 1.8-2.0 Ga grains. Inferred ultimate provenance: Grenville and Appalachian Orogens plus Superior and/or Wyoming cratons and the Yavapai-Mazatzal province.

1.4.Sampled Pennsylvanian Units

15MO1 (Plate 4 location #1; UTM 15S, 533851E, 4360992N) – Upper Pennsylvanian Moberly Sandstone

In central Missouri, Paleozoic units are cut by two (Moberly and Warrensburg) formerly contiguous, ~2 to 8 km-wide, ~30-50 m-deep valley-shaped channels filled with Upper Pennsylvanian (Desmoinesian) sandstone and shale. Whereas pre-Pennsylvanian clastic rocks in the Midcontinent region are dominated by quartz arenite, channel sands are far less mature, consisting chiefly of quartz wacke and containing significant proportions of igneous plus metamorphic detritus and varying amounts of iron oxide and silica cements (Doty and Hubert, 1962). This sample of the Moberly Sandstone was collected from the Moberly Quarry (owned and operated by Norris Quarries), in Salt Springs Township, Missouri. The studied sample consists of ~65% quartz and 10% feldspar, with ~10% metamorphic lithic fragments (chiefly phyllite and schist), ~7% opaque minerals, 6% muscovite, and 1% biotite. Detrital zircon grains extracted from this sample are characterized by, in order of decreasing prominence: 1) a Grenville-age peak centered at ca. 1.0 Ga with shoulders extending from 0.95 to 1.3 Ga (60% of analyzed grains), 2) Paleozoic grains, with ages ranging from ca. 450 to 309 Ma (13%), 3) scattered ages ranging from 1.3 to 1.8 Ga with a subtle peak at ca. 1.65 Ga (12%), 4) a Neoproterozoic peak from 600 to 540 Ma (11%), and 5) a Neoarchean peak centered at ca. 2.7 Ga (3%). Inferred ultimate provenance: Grenville, Taconic, Acadian, and Alleghenian orogens plus Pan-African crust (most likely originating in the northern Appalachians), with minor input from Granite/Rhyolite and Yavapai/Mazatzal crust plus the Superior Craton (possibly recycled from older units).

Figure DR9. Sampled exposure of Moberly Sandstone collected from Moberly Quarry. Note alternating beds containing variable proportions of iron oxide cement (dark orange-light brown=more iron oxide). Photo: John Hogan.

15MO2 (Plate 4 location #2; UTM 15S, 434292E, 4291426N) – Upper Pennsylvanian Warrensburg Sandstone

The Warrensburg Sandstone (the western of the two channel fill sandstones) was sampled at Cave Hollow Park in Warrensburg, Missouri, where it crops out as 0.5-2 m-thick cross-bedded medium- to fine-grained sandstone separated by ~10 cm siltstone intervals. The studied sample is petrographically nearly identical to sample 15MO1, consisting of ~70% quartz and 7% feldspar, with ~18% metamorphic lithic fragments (chiefly phyllite and schist), ~2% opaque minerals, 2% muscovite, and 1% biotite. Like sample 15MO1, this sample contains chiefly 0.95 to 1.3 Ga grains (57%), Paleozoic grains, with scattered peaks from ca. 480 to 300 Ma (10%), scattered ages ranging from 1.3 to 2.0 Ga with a subtle peak at ca. 1.62 Ga (23%), a ca. 600 to 540 Ma peak (3%), and 5) Archean ages (5%). Inferred ultimate provenance: Grenville, Taconic, Acadian, and Alleghenian orogens plus Pan-African crust (most likely originating in the northern Appalachians), with minor input from Granite/Rhyolite and Yavapai/Mazatzal crust plus the Superior Craton (possibly recycled from older units).

Figure DR10. Sampled exposure of Warrensburg Sandstone collected from Warrensburg, Missouri. Note cross-stratified sandstone separated by a ~5 cm shale interval (hammer head). Photo: John Hogan.

SEACAT (Plate 4 location #3; UTM 14S, 443295E, 4131896N) –Lower Pennsylvanian Kearny Formation

Collected from the Kansas Core Library (Kansas Geological Survey). Sampled core was taken from a depth of 5234-5235' from the Seacat 13-19 well (Clark County; original operator: MESA PET). The studied core fragment is a poorly sorted, coarse-grained, glauconitic, porous, carbonate-plus silica-cemented quartz arenite containing chiefly subrounded to rounded detrital quartz and authigenic chlorite. This sample contains detrital zircon grains yielding a spectrum of ages from ca. 0.95 to 1.3 Ga (53%) with diminishing proportions of 1.3-1.5 Ga (15%), 1.8-2.0 Ga, with a sharp peak at ca. 1.85 Ga (10%), 1.6-1.8 Ga (9%), 390-470 Ma (8%), and Archean grains (4%). Inferred ultimate provenance: Grenville, Taconic, and Acadian orogens with subsidiary input from Juvenile arcs and orogens of NW Canada, Granite/Rhyolite and Yavapai/Mazatzal crust, plus the Superior Craton.

Figure DR11. Sampled drill core of Kearny Formation. Detrital zircon grains were extracted from core sections marked with chalk lines.

10DM14 (Plate 4 location #37; UTM 12N 485883E, 4966973N) – Lower Pennsylvanian Amsden Formation

A sample was collected from a resistant calcareous sandstone bed within the Amsden Formation, exposed north of Graycroft Ridge in the southern Madison Range near Hebgen Lake, MT. This sample contains roughly equal proportions of 1.6-1.8 Ga (24%), Archean (18%), 0.95-1.3 Ga (15%), 1.3-1.5 Ga (13%), 1.8-2.0 Ga (13%), and 350-480 Ma (11%), with ~5% of grains falling between 530-610 Ma. Inferred ultimate provenance: Yavapai/Mazatzal crust (likely sourced from the uplifting Ancestral Rockies), Grenville plus Taconic and Acadian orogens, Proterozoic and Archean cratonic material from NW and/or north-central Canada, Granite/Rhyolite crust, and a minor amount of Pan-African material.

Figure DR12. Sampled exposure of Amsden Formation sampled northeast of Hebgen Lake in the southern Madison Range, MT.

10DM15 (Plate 4 location #38; UTM 12N 485717E, 4966991N) – Lower Pennsylvanian Quadrant Formation

A sample was collected from an exposure of thin to medium bedded quartz arenite north of Graycroft Ridge near Hebgen Lake in the southern Madison Range. In comparison with the Amsden Formation, this sample contains somewhat higher proportions of 1.8-2.0 Ga (27%) and 0.95-1.3 Ga (22%) grains, less 1.6-1.8 Ga (16%), Archean (18%), 1.3-1.5 Ga (10%), and 390-480 Ma (10%) grains, and lacks Neoproterozoic ages. Inferred ultimate provenance: Proterozoic and Archean cratonic material from NW and/or north-central Canada, Grenville plus Taconic and Acadian orogens, and Yavapai/Mazatzal (likely sourced from the uplifting Ancestral Rockies) and Granite/Rhyolite crust.

Figure DR13. Sampled exposure of Quadrant Formation sampled northeast of Hebgen Lake in the southern Madison Range, MT.

18BH1 (Plate 4 location #48; UTM 13T 601993E, 4917588N) – Lower Pennsylvanian Minnelusa Formation

A sample was collected from a ~1 m thick sandy interval in a roadcut exposing alternating beds of yellow-orange dolomite, orange sandstone, and red-purple shale (the lower portion of the Minnelusa Formation; Dewitt et al., 1986) along U.S. Highway 85 in the northern Black Hills. The studied sample consists chiefly of fine-grained subangular detrital quartz cemented by calcite. This sample contains significant amounts of 1.6-1.8 Ga grains (35%), with decreasing quantities of 0.95-1.3 Ga (23%), 1.8-2.0 Ga (15%), and 1.3-1.5 Ga (11%) grains, with relatively minor contributions from 370-460 Ma (6%), Archean (18%), and Neoproterozoic (4%) grains. Inferred ultimate provenance: Yavapai/Mazatzal crust (likely sourced from the uplifting Ancestral Rockies), Proterozoic and Archean cratonic material from NW and/or north-central Canada (likely recycled from older strata), Grenville plus Taconic and Acadian orogens, Granite/Rhyolite crust, and a minor amount of Pan-African material.

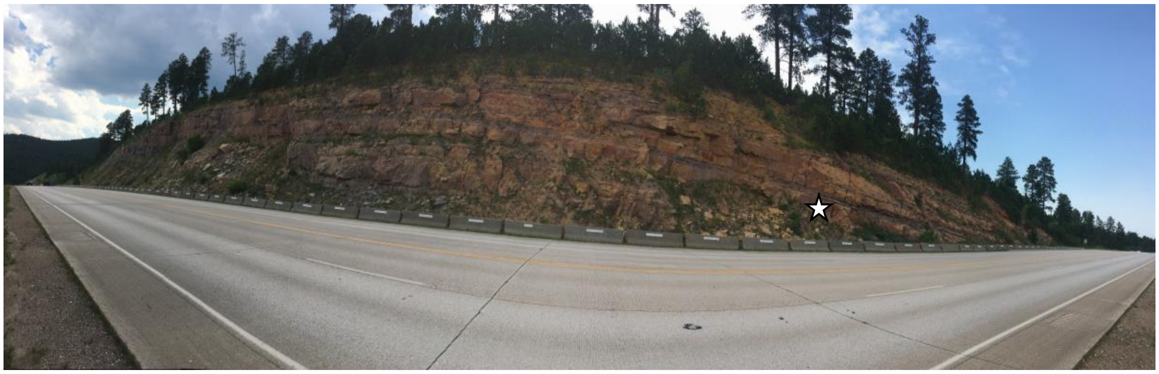


Figure DR14. Panorama along U.S. Highway 85 showing alternating sandstone, shale, and limestone of the Minnelusa Formation, northern Black Hills (western South Dakota). Highway dividers are ~2 m long. Star marks location of sample 18BH1.

2. METHODS

2.1. LA-MC-ICPMS

Detrital zircon U-Pb geochronology was conducted by laser ablation multicollector inductively coupled mass spectrometry (LA-MC-ICPMS) at the Arizona LaserChron Center (ALC) following the methods outlined in Gehrels *et al*. (2006). Zircon grains were extracted from samples using standard mineral separation techniques of crushing, sieveing, magnetic separation, processing through heavy liquids, and hand picking at the Missouri University of Science and Technology and Macalester College. Separates were then mounted in epoxy, polished, and imaged on a JEOL 6610LV Scanning Electron Microscope at Macalester College prior to analysis. Zircon grains were ablated using a 193 nm ArF laser with a pit depth of ~12 μm and spot diameters of 25-30 μm in Faraday collection mode and with a spot diameter of 10 μm for sample 18BH2A in ion counting mode. Unless otherwise noted, most analyzed grains were subhedral to subrounded, ~ 50 – 350 μm in length, inclusion-poor, and exhibit simple oscillatory zoning patterns in cathodoluminescence images that we interpret as magmatic features.

2.2. Data Reduction and analysis

Data reduction was done using in-house ALC Microsoft Excel programs and ISOPLOT/Ex Version 3 (Ludwig, 2003). The “best ages” reported in Table DR2 were calculated using $^{206}Pb/^{238}U$ ages for grains younger than 900 Ma and $^{207}Pb/^{206}Pb$ ages for grains older than 900 Ma. Analyses with greater than 10% uncertainty, 20% discordance, and/or 5% reverse discordance were excluded. Detrital zircon probability distributions for all samples are provided as kernel density estimations (KDEs) in Figure DR15.

The Multidimensional scaling (MDS) mapping algorithm (e.g., Vermeesch, 2013) used here to compare U-Pb detrital zircon spectra is as follows: 1) input square, symmetric matrix of Kolmogorov-Smirnov (K-S) distances between samples; 2) assign points to arbitrary coordinates in 2-dimensional space; 3) compute K-S distances among all pairs of points, to form a new matrix; 4) compare the new matrix with the input matrix by evaluating the stress function, a measure of the degree of correspondence between the observed and reproduced distances; 5) perturb the coordinates of each data point; and 6) repeat steps 2 through 5 until stress is minimized. These operations were carried out using detritalPy (Sharman et al., 2018). The degree of similarity in U-Pb detrital zircon age spectra on an MDS "map" is higher for samples that plot close to each other than for samples that are positioned farther apart. The reader is referred to Borg and Groenen (1997) for a comprehensive treatment of MDS.

Non-negative matrix factorization (NMF) applied to detrital zircon geochronology is a powerful cutting-edge technique that enables characterization, or "unmixing," of "source" (i.e., eroded and transported parent materials) age spectra from large volumes of "sink" (i.e., samples collected from sedimentary rocks) data (Sharman and Johnstone, 2017; Saylor et al., in press). The procedure of Saylor et al. (in press) for characterizing source spectra from sink data is as follows (see this reference for a comprehensive treatment): 1) input m-by-n matrix V (where m are KDE probabilities for each of n samples); 2) compute matrices W (m probabilities at the same spacing-by-k factorized components) and H (k factorized components-by-n samples), such that V≈WH (in detail, V=WH+E, where is a residual); 3) iterate until E is minimized. Results of NMF analysis are in Table DR3.

REFERENCES

Alsalem, O.B., Fan, M., Zamora, J., Xie, X., and Griffin, W.R., 2018, Paleozoic sediment dispersal before and during the collision between Laurentia and Gondwana in the Fort Worth Basin, USA: Geosphere, v. 14, no. 1, p. 325–342, doi: 10 .1130/GES01480.1.

Alsleben, H., Wetmore, P.H., Gehrels, G.E., and Paterson, S.R., 2012, Detrital zircon ages in Palaeozoic and Mesozoic basement assemblages of the Peninsular Ranges batholith, Baja California, Mexico: constraints for depositional ages and provenance. International Geology Review, v. 54, p. 93-110.

Amato, J.M., and Mack, G.H., 2012, Detrital zircon geochronology from the Cambrian-Ordovician Bliss Sandstone, New Mexico: Evidence for contrasting Grenville-age and Cambrian sources on opposite sides of the Transcontinental Arch: Geological Society of America Bulletin, v. 124, p. 1826–1840, doi:10.1130/B30657

Attia, S. Paterson, S.R., Wenrong, C., Chapman, A.D., Saleeby, J., Dunne, G., Stevens, C., Memeti, V., in press, Paleogeographic affinity and tectonic assembly of pre-Mesozoic Sierra Nevada framework terranes, submitted to GSA Special Papers.

Becker, T.P., Thomas, W.A., Samson, S.D. and Gehrels, G.E., 2005, Detrital zircon evidence of Laurentian crustal dominance in the lower Pennsylvanian deposits of the Alleghenian clastic wedge in eastern North America. Sedimentary Geology, 182, 59–86.

Beranek, L.P., Link, P.K., and Fanning, C.M., 2016, Detrital zircon record of mid-Paleozoic convergent margin activity in the northern U.S. Rocky Mountains: Implications for the Antler orogeny and early evolution of the North American Cordillera. Lithosphere, v.8, p 533-550.

Boothroyd, J., 2012, Carboniferous provenance trends from clastic strata of the Michigan Basin, M.S. Thesis, Michigan State University, East Lansing, MI, USA, 189 pp.

Borg, I., and Groenen, P. J. F., 1997, Modern multidimensional scaling: Theory and applications, New York, Springer, 471 pp.

Bradley, D.C. & O'Sullivan, P. 2016. Detrital zircon geochronology of pre-and syn-collisional strata, Acadian orogen, Maine Appalachians. Basin Research, https://doi.org/10.1111/bre.12188.

Bream, B.R., Hatcher, R.D., Jr., Miller, C.F., and Fullagar, P.D., 2004, Detrital zircon ages and Nd isotopic data from the southern Appalachian crystalline core, Georgia, South Carolina, North Carolina, and Tennessee: New provenance constraints for part of the Laurentian margin, in Tollo, R.P., Corriveau, L., McLelland, J., and Bartholomew, M.J., eds., Proterozoic tectonic evolution of the Grenville orogen in North America: Boulder, Colorado, Geological Society of America Memoir 197, p. 459–475.

Cawood, P.A., and Nemchin, A.A. 2000, Provenance record of a rift basin: U/Pb ages of detrital zircons from the Perth Basin, Western Australia. Sediment. Geol. 134:209-234.

Charnock, R.D., 2015. Origin and evolution of the southeastern Merrimack Belt, Massachusetts. M.S. Thesis, Colorado School of Mines, Golden, CO, USA, 107 pp.

Cole, D., Myrow, P., Fike, D.A., Hakim, A., and Gehrels, 2015, Uppermost Devonian (Famennian) to Lower Mississippian events of the western U.S.: Stratigraphy, sedimentology, chemostratigraphy, and detrital zircon geochronology. Palaeogeography, Palaeoclimatology, Palaeoecology. v. 427, p. 1-19.

Darby, B.J., Wyld, S.J., and Gehrels, G.E., 2000, Provenance and paleogeography of the Black Rock terrane, northwestern Nevada: Implications of U-Pb detrital zircon geochronology. In Soreghan., M.J. and Gehrels, G.E., eds. Paleozoic and Triassic paleogeography and tectonics of western Nevada and northern California. Boulder, Colorado. Geological Society of America

Special Paper 347:77-87.
De Souza, S., Tremblay, A. & Ruffet, G. 2014. Taconian orogenesis, sedimentation and magmatism in the southern Quebec–northern Vermont Appalachians: Stratigraphic and detrital mineral record of Iapetan suturing. American journal of science, 314, 1065–1103.
DeWitt, E., Redden, J.A., Wilson, A.B., Buscher, D., 1986. Mineral resource potential and geology of the Back Hills National Forest, South Dakota and Wyoming. U.S. Geological Survey Bulletin, v. 1580. 135 pp.
Dodson, S. 2008. Petrographic and geochronologic provenance analysis of Upper Pennsylvanian fluvial sandstones of the Conemaugh and Monongahela Groups, Athens County, Ohio. Unpublished MS thesis. Ohio University. 86 pp.
Dokken, R. 2017. Detrital Zircon Studies in Silurian Basins of Southern New Brunswick. M.Sc. Thesis, University of Alberta
Dorais, M.J.; Wintsch, R.P.; Nelson, W.R.; and Tubrett, M. 2009. Insights into the Acadian orogeny, New England Appalachians: a provenance study of the Carrabassett and Kittery formations, Maine. Atlantic Geol. 45:50-71.
Doty, Robert W., and Hubert, J.F., 1961, Petrology and Paleogeography of the Warrensburg Channel Sandstone, Western Missouri: Sedimentology, v. 1, no. 1, p. 7–39.
Eriksson, K.A., Campbell, I.H., Palin, J.M., Allen, C.M. and Bock, B., 2004, Evidence for multiple recycling in Neoproterozoic through Pennsylvanian sedimentary rocks of the central Appalachian basin. Journal of Geology, 112, 261–276.
Evans, J.E., and Soreghan, M., 2015, Long-distance sediment transport and episodic resedimentation of Pennsylvanian dust (eolian silt) in cave passages of the Mississippian Leadville Limestone, southwestern Colorado, USA. GSA Special Paper 516
Fyffe, L.R., Barr, S.M., et al. 2009. Detrital zircon ages from Neoproterozoic and Early Paleozoic conglomerate and sandstone units of New Brunswick and coastal Maine: Implications for the tectonic evolution of Ganderia. Atlantic Geology, 45, 110–144.
Gehrels, G., Valencia, V., and Pullen, A., 2006, Detrital zircon geochronology by laser-ablation multicollector ICPMS at the Arizona Laserchron Center: The Paleontological Society Papers, 12, 67-76.
Gehrels, G.E., and Dickinson, W.R., 2000, Detrital zircon geochronology of the Antler overlap and foreland basin assemblages, Nevada, in Gehrels, G.E., and Soreghan, M.J., eds., Paleozoic and Triassic Paleogeography and Tectonics of Western Nevada and Northern California: Boulder, Colorado, Geological Society of America, Spe- cial Paper 347, p. 57–63, doi:10.1130/0-8137-2347-7.57.
Gehrels, G.E., and Miller, M.M., 2000, Detrital zircon geochronologic study of upper Paleozoic strata in the eastern Klamath terrane, northern California, in Soreghan, M.J., and Gehrels, G.E., eds., Paleozoic and Triassic paleogeography and tectonics of western Nevada and northern California: Boulder, Colorado, Geological Society of America Special Paper 347, p. 99–107.
Gehrels, G.E., and Pecha, M., 2014, Detrital zircon U-Pb geochronology and Hf isotope geochemistry of Paleozoic and Triassic passive margin strata of western North America: Geosphere, v. 10, p. 49–65, doi:10.1130/GES00889.1.
Gehrels, G.E., Blakey, R., Karlstrom, K.E.,Timmons, J.M., Dickinson,W.R., and Pecha, M., 2011, Detrital zircon U-Pb geochronology of Paleozoic strata in the Grand Canyon: Lithosphere, v. 3, p. 183–200, doi:10.1130 /L121.1.
Gehrels, G.E., Stewart, J.H., and Ketner, K.B., 2002, Cordilleran margin quartzites in Baja California - implications for tectonic transport, Earth and Planetary Science Letters v. 199

p.201-210
Gillis, R.J., Gehrels, G.E., Ruiz, J., Flores de Dios González, L.A., 2005. Detrital zircon provenance of Cambrian–Ordovician and Carboniferous strata of the Oaxaca terrane, southern Mexico. Sedimentary Geology, v. 182, p. 87-100.
Gleason, J.D., Finney, S.C., and Gehrels, G.E. 2002, Paleotectonic implications of a Mid- to Late-Ordovician provenance shift, as recorded in sedimentary strata of the Ouachita and Southern Appalachian Mountains. J. Geol. 110:291-304.
Gleason, J.G., Gehrels, G.E., Dickinson, W.R., Patchett, P.J., and Kring, D.A., 2007, Laurentian sources for detrital zircon grains in turbidite and deltaic sandstones of the Pennsylvanian Haymond Formation, Marathon Assemblage, West Texas, U.S.A.: Journal of Sedimentary Research, v. 77, no. 11, p. 888–900, doi:10.2110/ jsr.2007.084.
Gray, M.B., and Zeitler, P.K. 1997, Comparison of clastic wedge provenance in the Appalachian foreland using U/Pb ages of detrital zircons. Tectonics. 16:151-160.
Harding, J.P., Gehrels, G.E., Harwood, D.S., and Girty, G.H. 2000, Detrital zircon geochronology of the Shoo Fly Complex, northern Sierra terrane, northeastern California. In Soreghan., M.J. and Gehrels, G.E., eds. Paleozoic and Triassic paleogeography and tectonics of western Nevada and northern California. Boulder, Colorado. Geological Society of America Special Paper 347:43-55.
He, T.X., 2017. Origin and evolution of the Rocky Pond Slice, an enigmatic tectonic block in eastern Massachusetts. M.S. Thesis, Colorado School of Mines, Golden, CO, USA, 138 pp.
Henderson, B.J., Collins, W.J., Murphy, J.B., Gutierrez-Alonso, G. & Hand, M. 2016. Gondwanan basement terranes of the Variscan–Appalachian orogen: Baltican, Saharan and West African hafnium isotopic fingerprints in Avalonia, Iberia and the Armorican Terranes. Tectonophysics, 681, 278–304, https://doi.org/10.1016/j.tecto.2015.11.020.
Ibrahim, D.M., 2016, High-resolution sequence stratigraphy and detrital zircon provenance of the Ordovician Ancell Group in the Iowa and Ilinois Basins: insight into the evolution of midcontinental intracratonic basins of North America. Unpublished Ph.D dissertation. University of Iowa 179 pp.
Kissock, J.K., 2016, Detrital zircon evidence for the unroofing of the northern Appalachians in Early-Middle Pennsylvanian sandstones of North America. Unpublished MS thesis.University of Iowa. 207 pp.
Kissock, J.K., Finzel, E.S., Malone, D.H., and Craddock, J.P., 2018, Lower–Middle Pennsylvanian strata in the North American midcontinent record the interplay between erosional unroofing of the Appalachians and eustatic sea-level rise: Geosphere, v. 14, no. 1, https://doi.org/10.1130/GES01512 .1.
Konstantinou, A., Wirth, K.R., Vervoort, J.D., Malone, D.H., Davidson, C., and Craddock, J.P., 2014, Provenance of quartz arenites of the Early Paleozoic midcontinent region, USA: The Journal of Geology, v. 122, p. 201-216.
Kraft, J.L., 2013, Stratigraphy, paleogeography and tectonic evolution of early Paleozoic to Triassic pericratonic strata in the northern Kootenay Arc, southeastern Canadian Cordillera, British Columbia, Unpublished PhD dissertation. University of Alberta, 361 pp.
Kuiper, Y.D., Shields, C.D., Tubrett, M.N., Bennett, V., and Buchwaldt, R., 2014, Age and provenance of a Paleoproterozoic to Devonian Canadian Cordilleran sequence of metasedimentary rocks, Thor–Odin dome, southeastern British Columbia. GSA Bulletin. v. 126; no. 9/10; p. 1259–1274; doi: 10.1130/B31031.1
Lemieux, Y., Thompson, R.I., Erdmer, P., Simonetti, A., and Creaser, R.A. 2007, Detrital zircon

geochronology and provenance of Late Proterozoic and mid- Paleozoic successions outboard of the miogeocline, southeastern Canadian Cordillera. Can. J. Earth Sci. 44:1675-1693.
Linde, G.M., Trexler, J.H., Jr., Cashman, P.H., Gehrels, G.E., and Dickinson, W.R., 2016, Detrital zircon U-Pb geochronology and Hf isotope geochemistry of the Roberts Mountain allochthon: New insights into the early Paleozoic tectonics of western North America: Geosphere, doi:10.1130/GES01252.1.
Link, P.K., Mahon, R.C., Beranek, L.P., Campbell-Stone, E.A., and Lynds, R., 2014, Detrital zircon provenance of Pennsylvanian to Permian sandstones from the Wyoming craton and Wood River basin, Idaho, U.S.A.: Rocky Mountain Geology, v. 49, p. 115–136, doi: 10.2113/gsrocky.49.2.115.
Loan, M.L., 2011. New Constraints on the Age and Deposition of the Metasedimentary Rocks in the Nashoba terrane, SE New England. M.S. Thesis, Boston College, Chestnut Hill, MA, USA, 125 pp.
Ludwig, K. R., 2003, Mathematical-statistical treatment of data and errors for ^{230}Th/U geochronology: Reviews in Mineralogy and Geochemistry, 52, 631-656.
Malone, D.H., Craddock, J.P, Konstantinou, A., McLaughlin, P.I., and McGillivray, K.M., 2017, Detrital Zircon Geochronology of the Bighorn Dolomite, Wyoming, USA: Evidence for Trans-Hudson Dust Deposition on the Western Laurentian Carbonate Platform. Journal of Geology, v. 125, p. 261-269.
Martens, U., Weber, B., and Valencia, V., 2010, U/Pb geochronology of Devonian and older Paleozoic beds in the southeastern Maya block, Central America: Its affinity with peri-Gondwanan terranes, GSA Bulletin, v. 122. p. 815-829.
May, S.R., Gray, G.G., Summa, L.L., Stewart, N.R., Gehrels, G.E., and Pecha, M.E., 2013, Detrital zircon geochronology from the Bighorn Basin, Wyoming, USA: Implications for tectonostratigraphic evolution and paleogeography: Geological Society of America Bulletin, v. 125(9-10), p. 1403-1422.
McFadden, S., S.H. Emerman, J.P. Dawson, K.A. Rey, and T.K. Anderson, 2012. Evidence from detrital zircon ages for Middle Pennsylvanian uplift and drainage in the source area of the Chariton Conglomerate and Marmaton Group sandstones, southern Iowa and northern Missouri: Journal of the Iowa Academy of Science, v. 119, pp. 8-15.
McGuire, P.R., 2017, U-Pb detrital zircon signature of the Ouachita orogenic belt. Unpublished MS thesis. Texas Christian University. 78 pp.
McLennan, S.M., Bock, B., Compston, W., Hemming, S.R., and McDaniel, D.K. 2001, Detrital zircon geochronology of Taconian and Acadian foreland sedimentary rocks in New England. J. Sediment. Res. 71:305-317.
McWilliams, C.K., Walsh, G.J. & Wintsch, R.P. 2010. Silurian-Devonian age and tectonic setting of the Connecticut Valley-Gaspe trough in Vermont based on U-Pb SHRIMP analyses of detrital zircons. American Journal of Science, 310, 325–363.
Memeti, V., Gehrels, G.E., Paterson, S.R., Thompson, J.M., Mueller, R.M., and Pignotta, G.S., 2010, Evaluating the Mojave-Snow Lake fault hypothesis and origins of central Sierran metasedimentary pendant strata using detrital zircon provenance analyses: Lithosphere, v. 2, p. 341–360, doi: 10.1130/L58.1.
Mohamed, T.I., 2015, Sequence Stratigraphy and Provenance of the Bakken Formation in Southeast Alberta and Southwest Saskatchewan, Unpublished MS thesis. University of Calgary, 106 pp.
Murphy, J.B., and Hamilton, M.A., 2000. U-Pb detrital zircon age constraints on evolution of the

Late Paleozoic St. Marys Basin, central mainland Nova Scotia. Journal of Geology, v. 108, p. 53-72.

Murphy, J.B., and Hamilton, M.A., 2000. U-Pb detrital zircon age constraints on evolution of the Late Paleozoic St. Marys Basin, central mainland Nova Scotia. Journal of Geology, v. 108, p. 53-72.

Murphy, J.B., Fernandez-Suarez, J. & Jeffries, T.E. 2004a. Lithogeochemical and Sm-Nd and U-Pb isotope data from the Silurian-Lower Devonian Arisaig Group clastic rocks, Avalon terrane, Nova Scotia: A record of terrane accretion in the Appalachian-Caledonide orogen. Geological Society of America Bulletin, 116, 1183–1201.

Murphy, J.B., Fernandez-Suarez, J., Keppie, J.D. & Jeffries, T.E. 2004b. Contiguous rather than discrete Paleozoic histories for the Avalon and Meguma Terranes based on detrital zircon data. Geology, 32, 585–588.

Park, H., Barbeau, D.L., Rickenbaker, A., Bachman-Krug, D., Gehrels, G., 2009, Application of Foreland Basin Detrital-Zircon Geochronology to the Reconstruction of the Southern and Central Appalachian Orogen, Journal of Geology, v. 118, p. 23-44.

Pickell, M. J., 2012, Detrital Zircon Geochronology of Middle Ordovician Silicilastic Sediment on the Southern Laurentian Shelf. Unpublished MS thesis. Texas A&M, 120 pp.

Pothier, H.D., Waldron, J.W.F., DuFrane, S.A., White, C.E. & Jamieson, R.A. 2015b. Stratigraphy, Provenance and Tectonic Setting of the Lumsden Dam and Bluestone Quarry Formations (Lower Ordovician), Halifax Group, Nova Scotia. Atlantic Geology, 51, 51–83.

Riley, B.C.D., Snyder, W.S., and Gehrels, G.E., 2000, Detrital zircon geochronology of the Golconda allochton, Nevada. In Soreghan., M.J. and Gehrels, G.E., eds. Paleozoic and Triassic paleogeography and tectonics of western Nevada and northern California. Boulder, Colorado. Geological Society of America Special Paper 347:65-75.

Ross, G.M., McNicoll, V.J., Geldsetzer, H.H.J., Parrish, R.R., Carr, S.D., and Kinsman, A., 1993, Detrital zircon geochronology of Siluro-Devonian sandstones, Rocky Mountains, northeastern British Columbia. B. Can. Petrol. Geol. 41:349-357.

Sarrah, K.L., 2006, Comparative study of the sedimentology and provenance of the Atoka formation in the frontal Ouachita thrust belt, Oklahoma. Ph.D. Dissertation, University of Tulsa, Tulsa, OK, USA, 252 pp.

Saylor, J.E., Sundell, K.E., and Sharman, G.R., in press, Characterizing sediment sources by non-negative matrix factorization: Earth and Planetary Science Letters.

Sharman, G.R., and Johnstone, S.A., 2017, Sediment unmixing using detrital geochronology: Earth and Planetary Science Letters, v. 477, p. 183-194, doi: 10.1016/j.epsl.2017.07.044.

Sharman, G.R., Sharman, J.P., and Sylvester, Z., 2018, detritalPy: A Python-based toolset for visualizing and analyzing detrital geo-thermochronologic data: The Depositional Record, https://doi.org/10.1002/dep2.45.

Shean, Glen, 1947, Kibbey Sandstone in Montana; Bachelors Theses and Reports, 1928-1970. Paper 222. Montana State University. 25pp.

Siddoway, C.S. and Gehrels, G.E., 2014, Basement-hosted sandstone injectites of Colorado: A vestige of the Neoproterozoic revealed through detrital zircon provenance analysis. Lithosphere, v.6, p. 403-408.

Soreghan, G.S., Moses, A.M., Soreghan, M.J., Hamilton, A., Fanning, C.M., and Link, P.K. 2007. Palaeoclimatic inferences from upper Palaeozoic siltstone of the Earp Formation and equivalents, Arizona-New Mexico (USA). Sedimentology. 54:701- 719.

Soreghan, M.J., Soreghan, G.S., and Hamilton, M.A., 2002, Paleowinds inferred from detrital-

zircon geochronology of upper Paleozoic loessite, western equatorial Pangea. Geology. 30:695-698.
Sorota, K.J., 2013. Age and origin of the Merrimack terrane, southeastern New England: a detrital zircon U-Pb geochronology study. M.S. Thesis, Boston College, Chestnut Hill, MA, USA, 217 pp.
Spurlin, M.S., Gehrels, G.E., and Harwood, D.S., 2000, Detrital zircon geochronology of upper Paleozoic and lower Mesozoic strata of the northern Sierra terrane, northeastern California. In Soreghan., M.J. and Gehrels, G.E., eds. Paleozoic and Triassic paleogeography and tectonics of western Nevada and northern California. Boulder, Colorado. Geological Society of America Special Paper 347:89-98.
Sweet, W. C., 1982, Conodonts from the Winnipeg Formation (Middle Ordovician) of the northern Black Hills, South Dakota. Journal of Paleontology, v. 56, p. 1029-1049.
Thomas, W.A., Becker, T.P., Samson, S.D., and Hamilton, M.A., 2004, Detrital zircon evidence of a recycled orogenic foreland provienance for Alleghanian clastic- wedge sandstones. J.Geol. 112:23-37.
Thomas, W.A., Gehrels, G.E., and Romero, M.C., 2016, Detrital zircons from crystalline rocks along the Southern Oklahoma fault system, Wichita and Arbuckle Mountains, USA: Geosphere, v. 12, p. 1224–1234, doi:10.1130/GES01316.1.
Thomas, W.A., Gehrels, G.E., Greb, S.F., Nadon, G.C., Satkoski, A.M., and Romero, M.C., 2017, Detrital zircons and sediment dispersal in the Appalachian foreland. Geosphere, v. 13, p. 2206-2230.
Thompson, Thomas L., 1995, The Stratigraphic Succession in Missouri (Revised 1995): Missouri Department of Natural Resources, Missouri Geological Survey, Volume 40 (2nd Series) Revised, 188 pp.
Wallin, E.T., Noto, R.C., and Gehrels, G.E., 2000, Provenance of the Antelope Mountain Quartzite, Yreka terrane, California: Evidence for large-scale late Paleozoic sinistral displacement along the North American Cordilleran margin and implications for the mid-Paleozoic fringing-arc model, in Soreghan, M.J., and Gehrels, G. E., eds., Paleozoic and Triassic paleogeography and tectonics of western Nevada and northern California: Boulder, Colorado, Geological Society of America Special Paper 347, p. 119–131.
Weber, B., Schaaf, P., Valencia, V., Iriondo, A., Ortega-Gutiérrez, F., 2006, Provenance ages of Late Paleozoic sandstones (Santa Rosa Formation) from the Maya block, SE Mexico – implications on the tectonic evolution of western Pangea: Revista Mexicana de Ciencias Geológicas, 23, 262-276.
West, D.P. Jr., Yates, M.G.,; Gerbi, C., and Barnard, N.Q. 2008, Metamorphosed Ordovician Fe- and Mn-rich rocks in south-central Maine: From peri-Gondwanan deposition through Acadian metamorphism. Am. Min. 93:270-282.
Wilson, R.A., Van Staal, C.R. & McClelland, W.C. 2015. Synaccretionary sedimentary and volcanic rocks in the Ordovician Tetagouche backarc basin, New Brunswick, Canada: Evidence for a transition from foredeep to forearc basin sedimentation. American Journal of Science, 315, 958–1001.
Wintsch, R.P., Aleinikoff, J.N., Walsh, G.J., Bothner, W.A., Hussey, A.M. & Fanning, C.M. 2007. Shrimp U-Pb evidence for a Late Silurian age of metasedimentary rocks in the Merrimack and Putnam-Nashoba terranes, eastern New England. American Journal of Science, 307, 119–167.
Xie, X., Cains, W., Manger, W.L., 2016a, U–Pb detrital zircon evidence of transcontinental sediment dispersal: provenance of Late Mississippian Wedington Sandstone member, NW

Arkansas, International Geology Review, v. 58, p. 1951-1966.
Xie, X., O'Connor, P.M., Alsleben, H., 2016b, Carboniferous sediment dispersal in the Appalachian–Ouachita juncture: Provenance of selected late Mississippian sandstones in the Black Warrior Basin, Mississippi, United States, Sedimentary Geology, v. 342, p. 191-201.

PLATE CAPTIONS

Plate 1. A) Oversized version of Figure 2A (Ordovician). See Figure 2 in the main text for explanation. B) Locations, plotted using sample identifiers from Table DR1, of new and existing U-Pb detrital zircon data.

Plate 2. A) Oversized version of Figure 2B (Silurian-Devonian). See Figure 2 in the main text for explanation. B) Locations, plotted using sample identifiers from Table DR1, of new and existing U-Pb detrital zircon data.

Plate 3. A) Oversized version of Figure 2C (Mississippian). See Figure 2 in the main text for explanation. B) Locations, plotted using sample identifiers from Table DR1, of new and existing U-Pb detrital zircon data.

Plate 4. A) Oversized version of Figure 2D (Pennsylvanian). See Figure 2 in the main text for explanation. B) Locations, plotted using sample identifiers from Table DR1, of new and existing U-Pb detrital zircon data.

NON-EMBEDDED FIGURE CAPTION

Figure DR15. Unnormalized detrital zircon probability distributions as kernel density estimations (KDEs) with 5 Myr bandwidth, for samples with A) Ordovician, B) Silurian and Devonian, C) Mississippian, and D) Pennsylvanian depositional ages. Sample names from Table DR1. For example, sample SD15 refers to Silurian and Devonian sample 15.

TABLE CAPTIONS

Table DR1. Compiled published U-Pb detrital zircon data for Ordovician, Silurian, Devonian, Mississippian, and Pennsylvanian strata from southern Canada, northern Mexico, and the United States.

Table DR2. Newly acquired LA-MC-ICPMS U-Pb detrital zircon data.

Table DR3. Results of NMF analysis.

Chapman, A.D., and Laskowski, A.K., 2019, Detrital zircon U-Pb data reveal a Mississippian sediment dispersal network originating in the Appalachian orogen, traversing North America along its southern shelf, and reaching as far as the southwest USA: Lithosphere, https://doi.org/10.1130/L1068.1.

GSA Data Repository Item 2019260

Figure DR15A_O

Chapman, A.D., and Laskowski, A.K., 2019, Detrital zircon U-Pb data reveal a Mississippian sediment dispersal network originating in the Appalachian orogen, traversing North America along its southern shelf, and reaching as far as the southwest USA: Lithosphere, https://doi.org/10.1130/L1068.1.

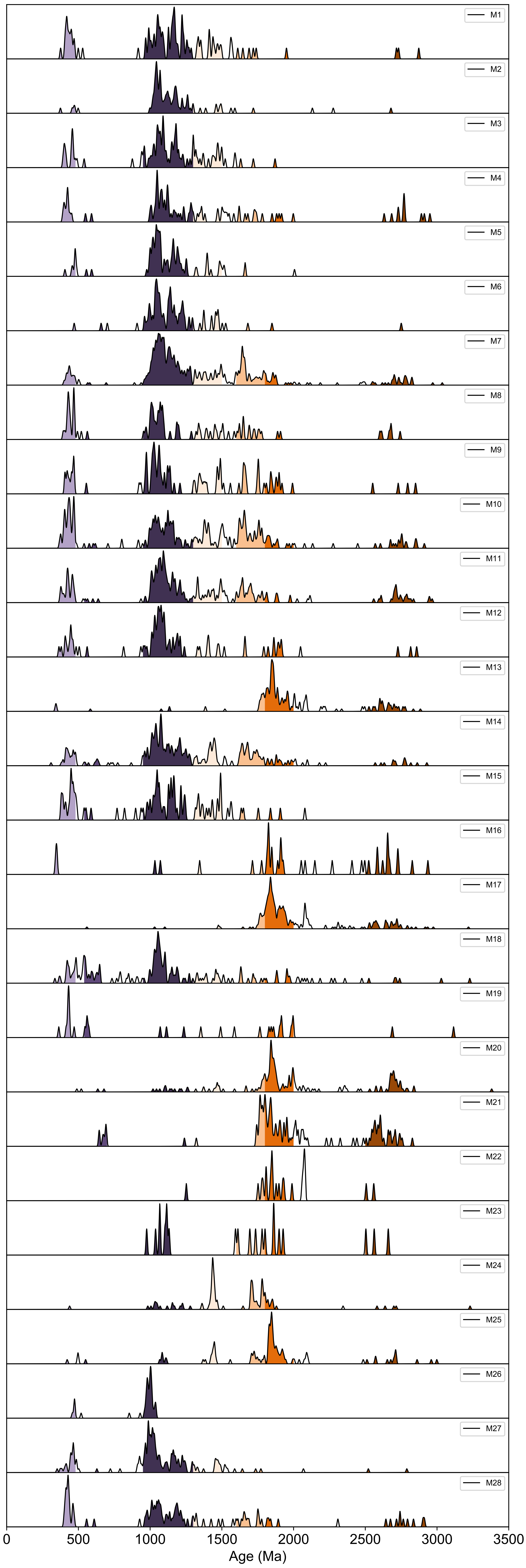
GSA Data Repository Item 2019260

Figure DR15B_SD

Chapman, A.D., and Laskowski, A.K., 2019, Detrital zircon U-Pb data reveal a Mississippian sediment dispersal network originating in the Appalachian orogen, traversing North America along its southern shelf, and reaching as far as the southwest USA: Lithosphere, https://doi.org/10.1130/L1068.1.

GSA Data Repository Item 2019260

Figure DR15C_M



Chapman, A.D., and Laskowski, A.K., 2019, Detrital zircon U-Pb data reveal a Mississippian sediment dispersal network originating in the Appalachian orogen, traversing North America along its southern shelf, and reaching as far as the southwest USA: Lithosphere, https://doi.org/10.1130/L1068.1.

GSA Data Repository Item 2019260

Figure DR15D_P