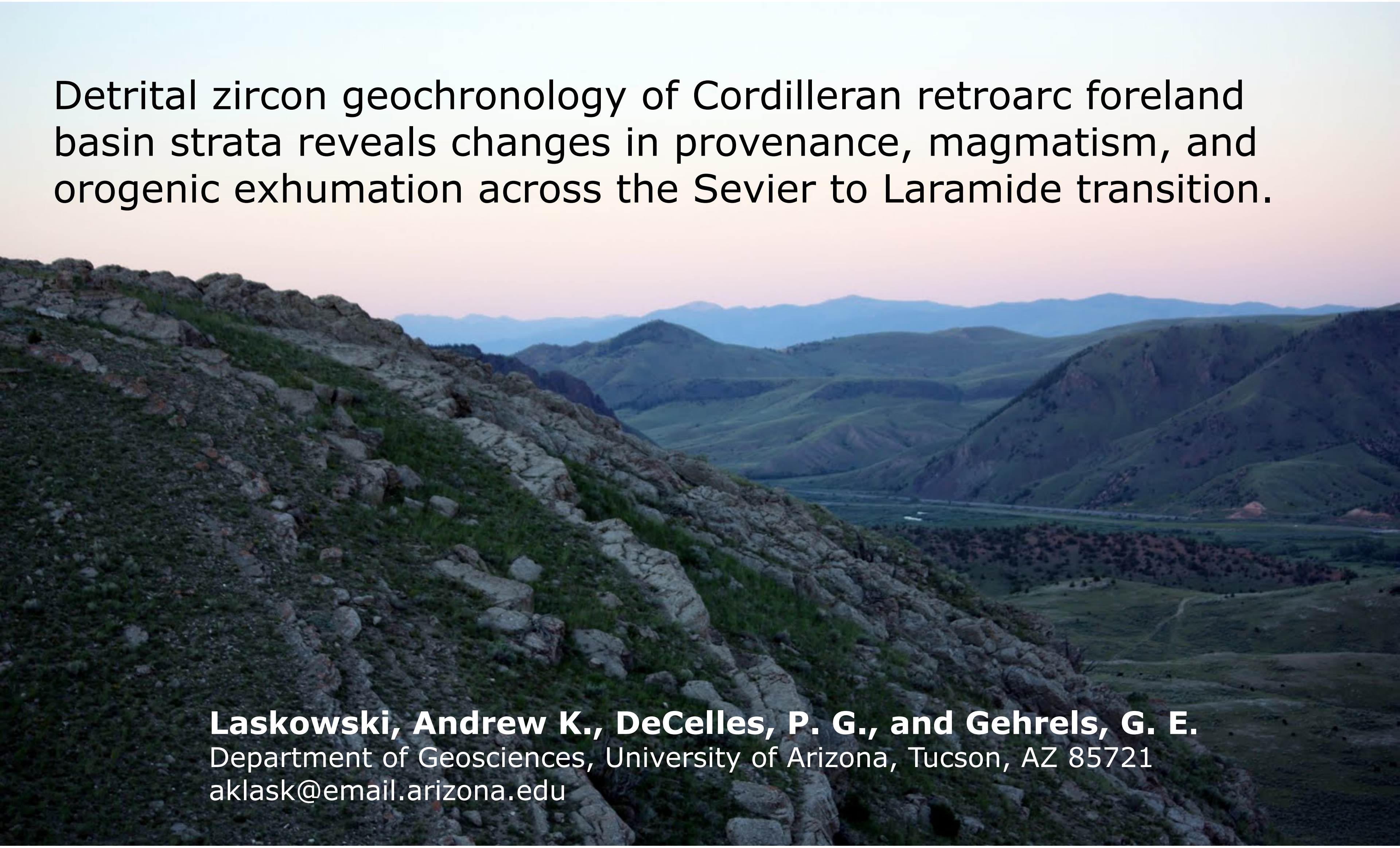

Detrital zircon geochronology of Cordilleran retroarc foreland basin strata reveals changes in provenance, magmatism, and orogenic exhumation across the Sevier to Laramide transition.

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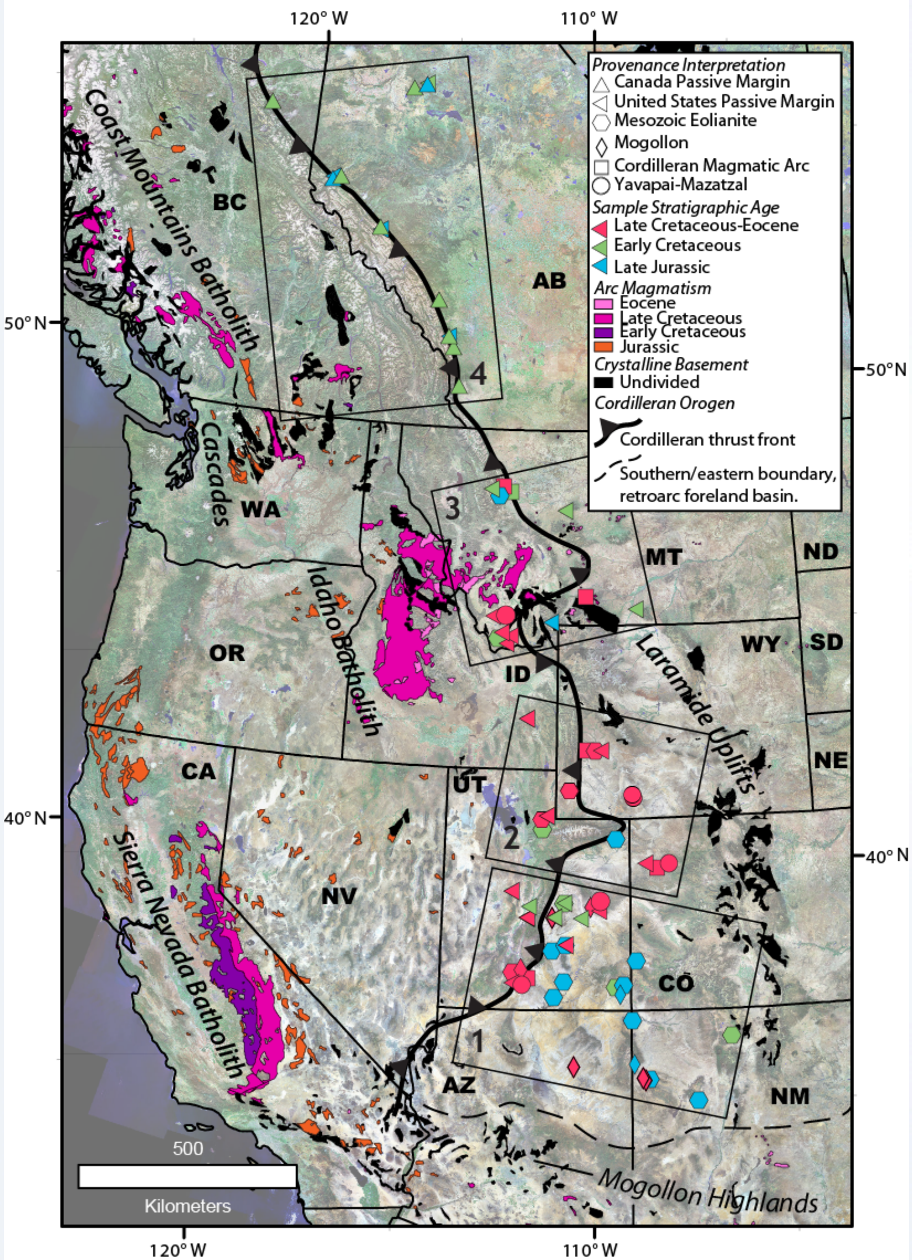
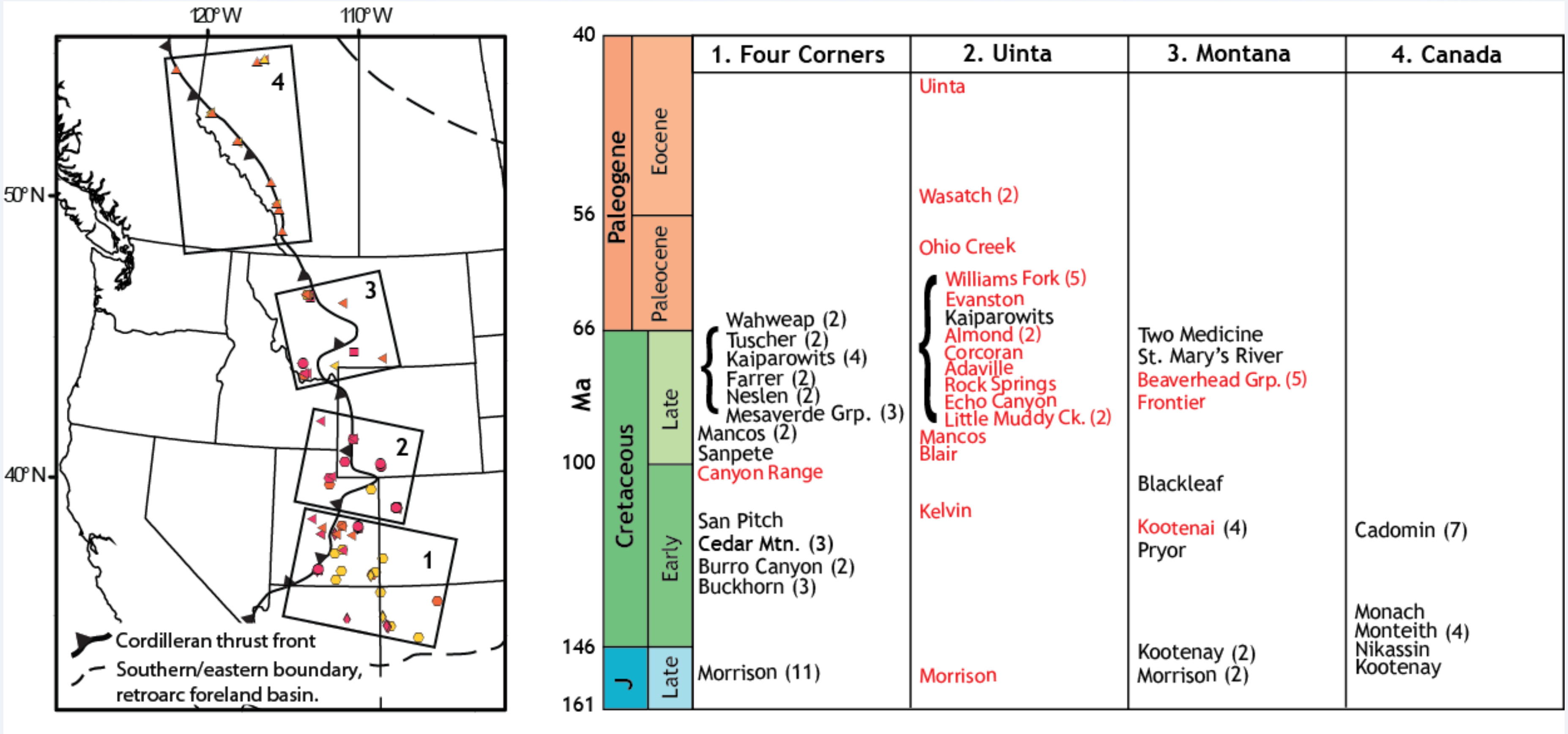
Motivation



Regional scale detrital zircon studies are common, but existing data have not been synthesized and large "gaps" exist.

- Combine new and published DZ data to classify provenance groups
- Utilize provenance interpretations, depositional ages, and paleocurrent data to map Late Jurassic-Eocene sediment dispersal pathways
- Examine Cordilleran arc magmatism using retroarc detrital zircons as a proxy

Data

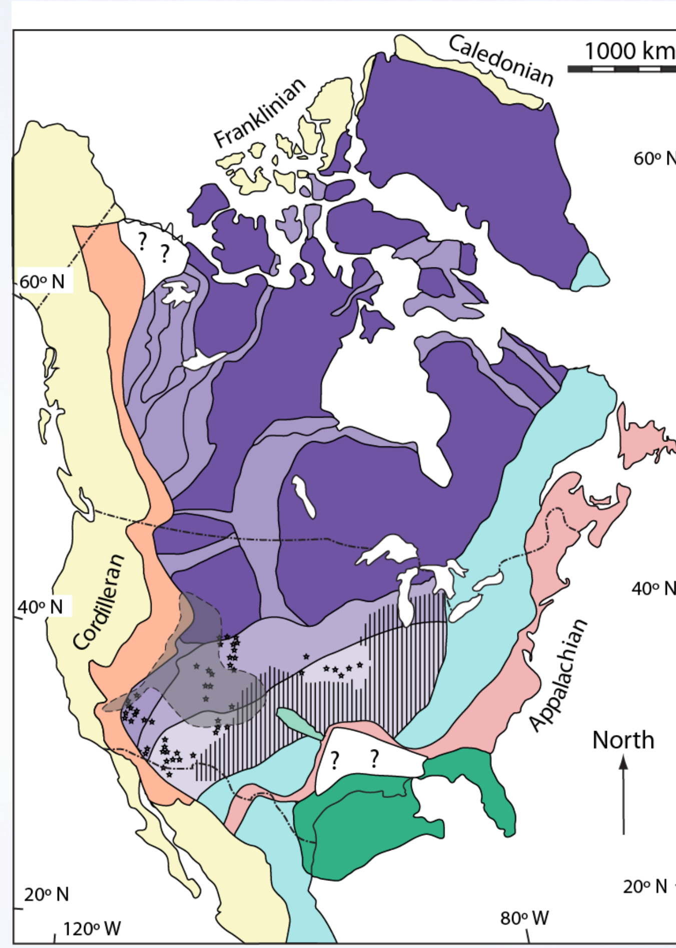


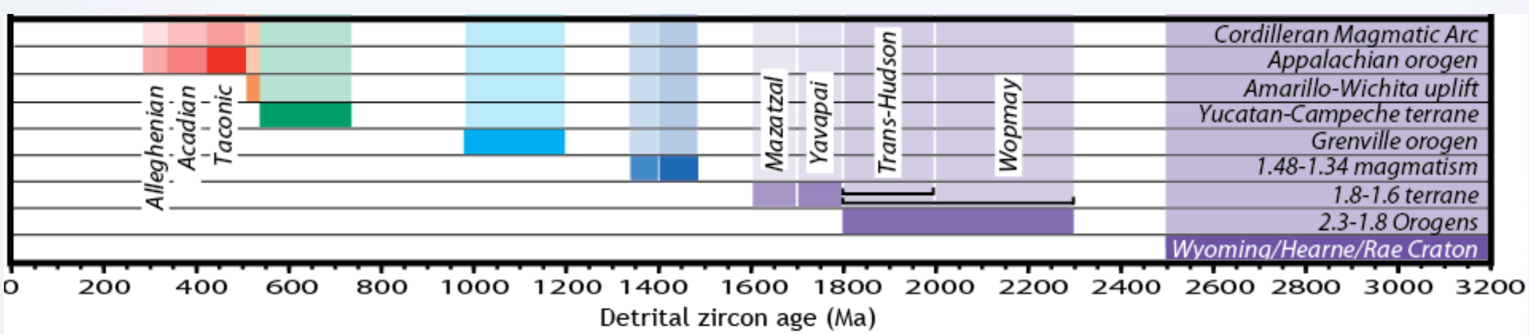
- 8,717 U-Pb ages from 95 samples
- 30 new samples
- All zircons analyzed via LA-ICPMS at the Arizona Laserchron Center (ALC)

Dickinson and Gehrels, 2008
Lawton et al., 2010
Fuentes et al., 2011
Lawton and Bradford, 2011
Leier and Gehrels, 2011
Raines et al., 2013

Provenance Analysis

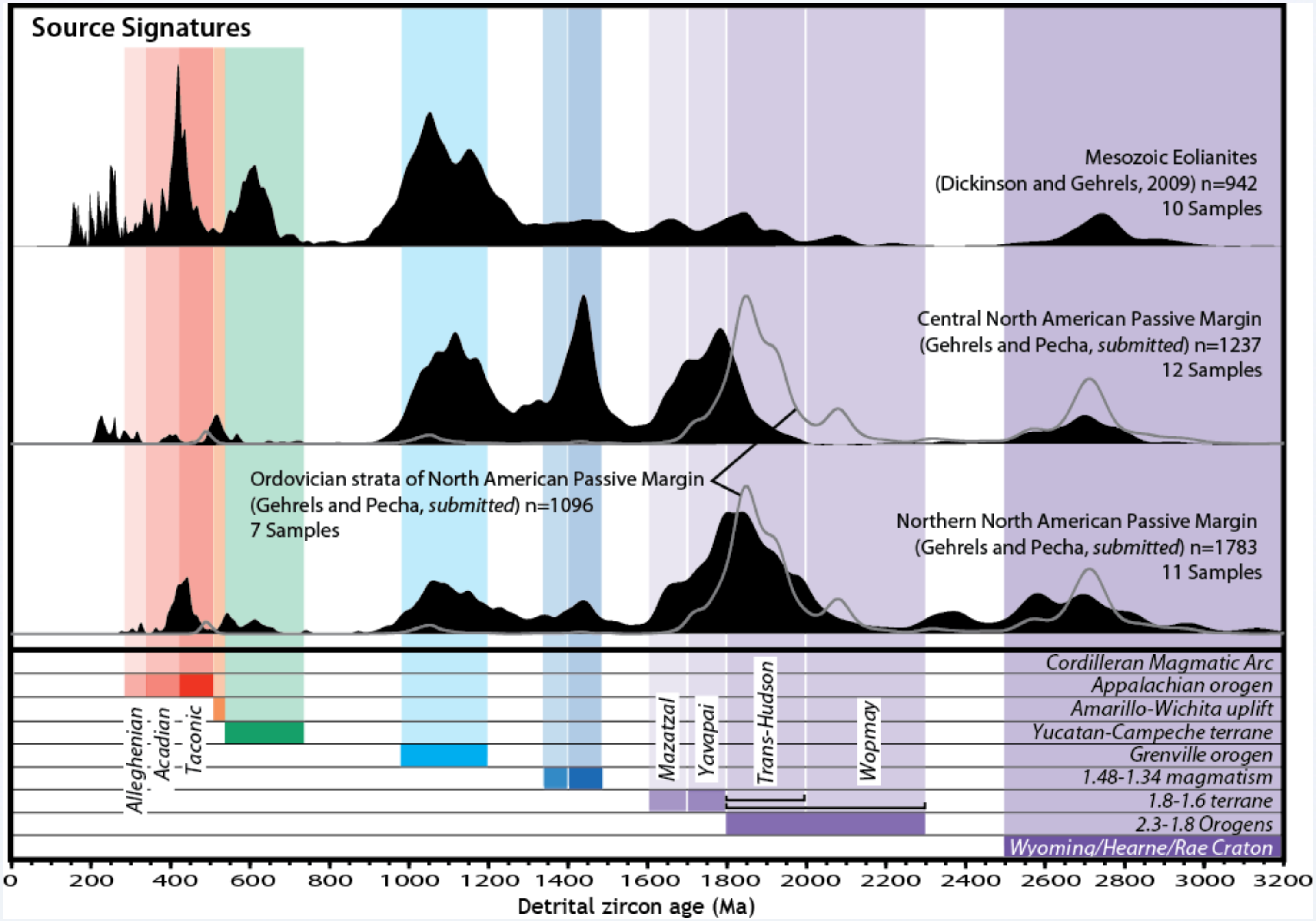
Qualitative grouping by visual inspection of age-probability plots: **first cycle sources**





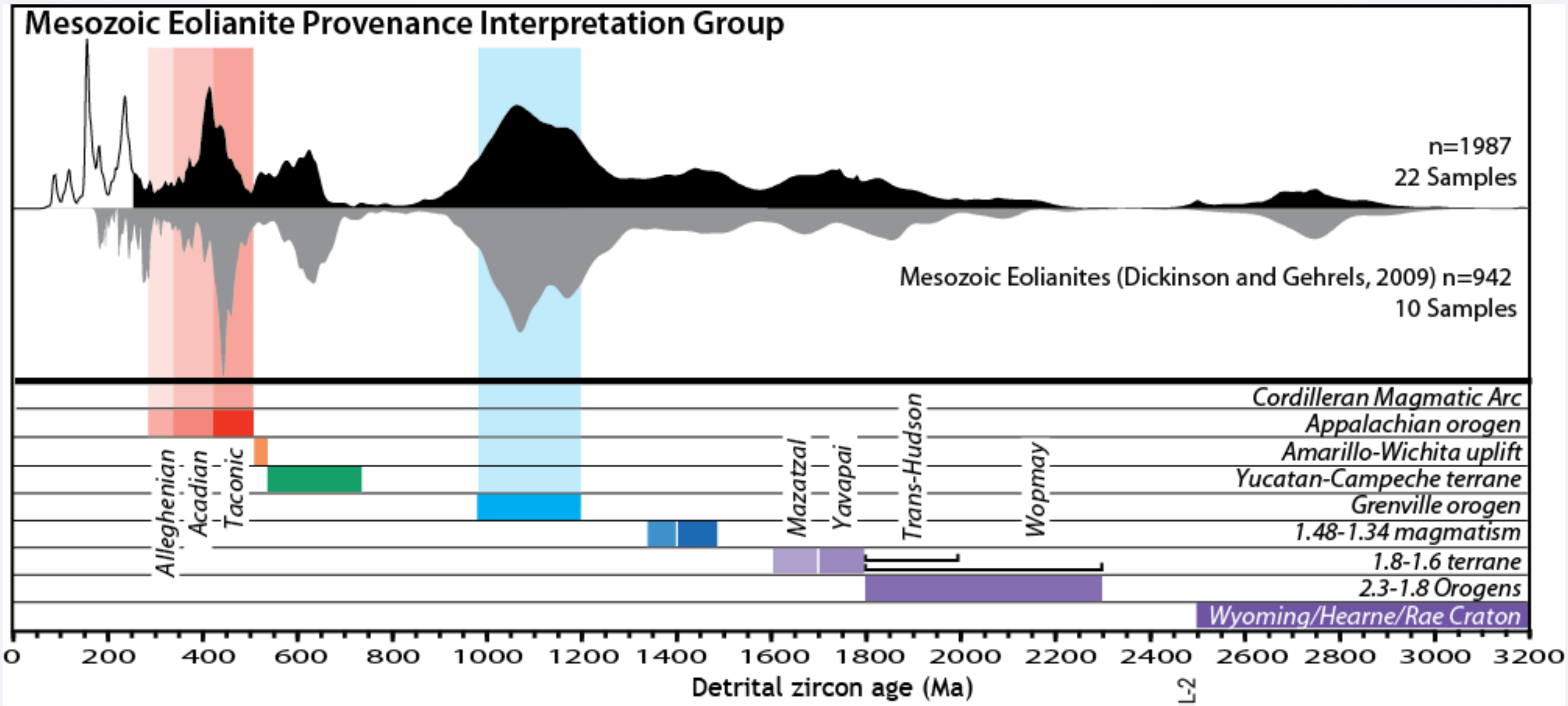
Provenance Analysis

Qualitative grouping by visual inspection of age-probability plots: **recycled sources**



Provenance Analysis

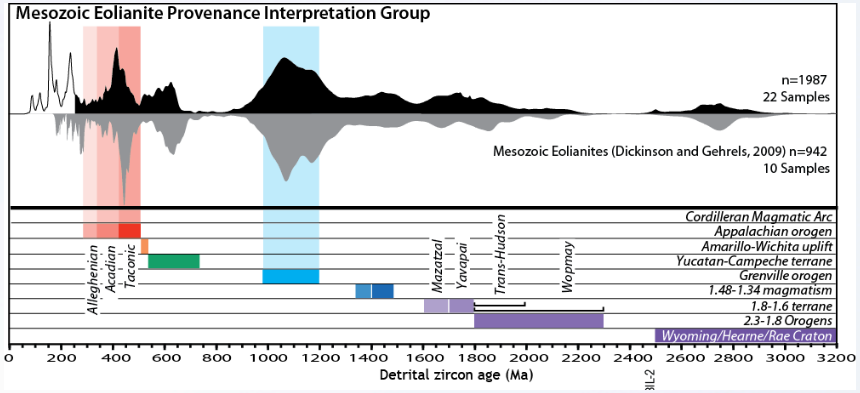
Visual inspection and literature review -> qualitative grouping-> Kolmogorov-Smirnov (K-S) tests for group similarity



Provenance Analysis

Internal consistency (IC) = % comparisons with p≥ 0.05

Samples distinguishable from > 50% grouped samples rejected



LM73	10DM25	1GRZ	1GRX	CP19	CP25	CP29	CP14	CP27	CP35	CP36	CP41	CP49	CP52	CP40	CP53	UT-8A	719062	ECH1	EXXONMOB	K2	LBRG-2900	
	0.172	0.669	0.604	0.531	0.506	0.996	0.435	0.145	0.632	0.974	0.921	0.977	0.406	0.422	0.190	0.335	0.948	0.397	0.716	0.951	0.349	LM73-Little Muddy Creek
0.172		0.274	0.107	0.031	0.118	0.027	0.116	0.749	0.570	0.023	0.134	0.047	0.126	0.344	0.771	0.123	0.044	0.551	0.302	0.022	0.870	10DM25-Kootenai
0.669	0.274		0.973	0.242	0.817	0.756	0.982	0.066	0.757	0.645	0.760	0.533	0.469	0.645	0.238	0.114	0.810	0.738	0.288	0.306	0.416	1GRZ-Morrison
0.604	0.107	0.973		0.158	0.740	0.460	0.472	0.021	0.526	0.401	0.426	0.267	0.247	0.349	0.070	0.040	0.324	0.454	0.340	0.156	0.185	1GRX-Morrison
0.531	0.031	0.242	0.158		0.916	0.270	0.536	0.113	0.306	0.127	0.853	0.328	0.883	0.431	0.196	0.720	0.415	0.066	0.181	0.278	0.191	CP19-Morrison
0.506	0.118	0.817	0.740	0.916		0.322	0.986	0.441	0.842	0.317	0.920	0.447	0.999	0.840	0.743	0.759	0.651	0.400	0.804	0.242	0.435	CP25-Morrison
0.996	0.027	0.756	0.460	0.270	0.322		0.211	0.008	0.339	0.721	0.597	0.514	0.091	0.108	0.011	0.031	0.377	0.118	0.392	0.484	0.120	CP29-Morrison
0.435	0.116	0.982	0.472	0.536	0.986	0.211		0.253	0.854	0.203	0.801	0.362	0.962	0.858	0.538	0.455	0.516	0.329	0.532	0.174	0.679	CP14-Burro Canyon
0.145	0.749	0.066	0.021	0.113	0.441	0.008	0.253		0.518	0.006	0.071	0.006	0.318	0.641	0.861	0.400	0.069	0.605	0.435	0.012	0.793	CP27-Burro Canyon
0.632	0.570	0.757	0.526	0.306	0.842	0.339	0.854	0.518		0.307	0.802	0.274	0.828	1.000	0.810	0.703	0.357	0.981	0.999	0.405	0.995	CP35-Morrison
0.974	0.023	0.645	0.401	0.127	0.317	0.721	0.203	0.006	0.307		0.497	0.974	0.077	0.095	0.008	0.021	0.840	0.105	0.169	0.678	0.105	CP36-Morrison
0.921	0.134	0.760	0.426	0.853	0.920	0.597	0.801	0.071	0.802	0.497		0.266	0.794	0.619	0.271	0.642	0.922	0.395	0.677	0.920	0.462	CP41-Morrison
0.977	0.047	0.533	0.267	0.328	0.447	0.514	0.362	0.006	0.274	0.974	0.266		0.103	0.150	0.021	0.011	0.749	0.210	0.152	0.546	0.085	CP49-Morrison
0.406	0.126	0.469	0.247	0.883	0.999	0.091	0.962	0.318	0.828	0.077	0.794	0.103		0.834	0.827	0.952	0.469	0.398	0.790	0.162	0.574	CP52-Morrison
0.422	0.344	0.645	0.349	0.431	0.840	0.108	0.858	0.641	1.000	0.095	0.619	0.150	0.834		0.946	0.797	0.408	0.777	0.942	0.132	0.993	CP40-Wahweap
0.190	0.771	0.238	0.070	0.196	0.743	0.011	0.538	0.861	0.810	0.008	0.271	0.021	0.827	0.946		0.607	0.122	0.988	0.575	0.034	0.988	CP53-Morrison
0.335	0.123	0.114	0.040	0.720	0.759	0.031	0.455	0.400	0.703	0.021	0.642	0.011	0.952	0.797	0.607		0.351	0.228	0.543	0.115	0.529	UT-8A-Buckhorn
0.948	0.044	0.810	0.324	0.415	0.651	0.377	0.516	0.069	0.357	0.840	0.922	0.749	0.469	0.408	0.122	0.351		0.120	0.385	0.828	0.261	719062-Morrison
0.397	0.551	0.738	0.454	0.066	0.400	0.118	0.329	0.605	0.981	0.105	0.395	0.210	0.398	0.777	0.988	0.228	0.120		0.998	0.138	0.996	ECH1-Echo Canyon
0.716	0.302	0.288	0.340	0.181	0.804	0.392	0.532	0.435	0.999	0.169	0.677	0.152	0.790	0.942	0.575	0.543	0.385	0.998		0.341	0.913	EM-2-Little Muddy Creek
0.951	0.022	0.306	0.156	0.278	0.242	0.484	0.174	0.012	0.405	0.678	0.920	0.546	0.162	0.132	0.034	0.115	0.828	0.138	0.341		0.077	K2-Kelvin
0.349	0.870	0.416	0.185	0.191	0.435	0.120	0.679	0.793	0.995	0.105	0.462	0.085	0.574	0.993	0.988	0.529	0.261	0.996	0.913	0.077		LBRG-2900-Almond

K-S P-values using error in the CDF

Internal Consistency: 92%

Provenance Groupings

K-S
68 samples

Yavapai-Mazatzal (11, 98%)

Mesozoic Eolianite (22, 92%)

U.S. Passive Margin (24, 78%)

Canada Passive Margin (10, 64%)

Mixed Y-M and U.S. Passive Margin (4, 100%)

Qualitative
27 samples

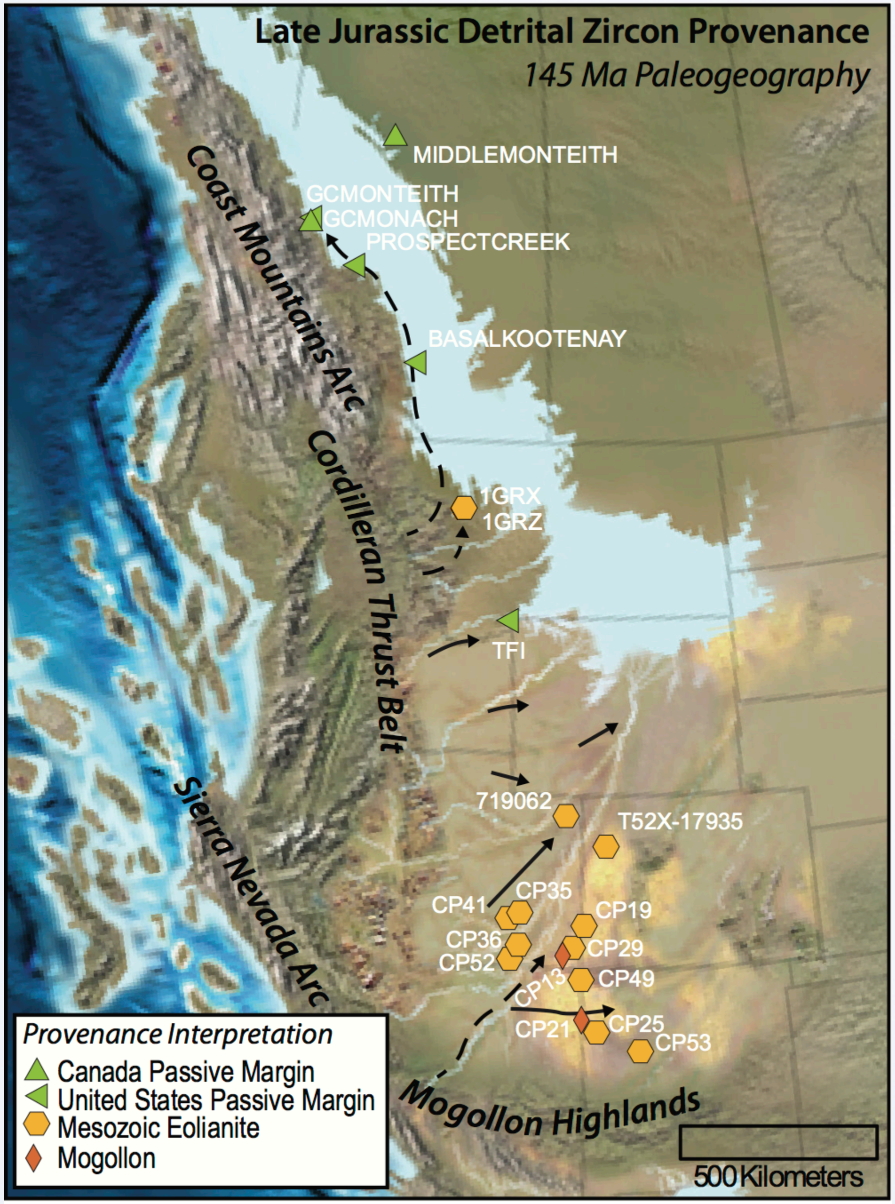
Cordilleran Magmatic Arc (8)

Mogollon Highlands (9)

North America Passive Margin with Ordovician dominance (7)

Laskowski, A. K., P. G. DeCelles, and G. E. Gehrels (2013), Detrital zircon geochronology of Cordilleran retroarc foreland basin strata, western North America, *Tectonics, 32*, doi:10.1002/tect.20065.

Sediment Dispersal Pathways



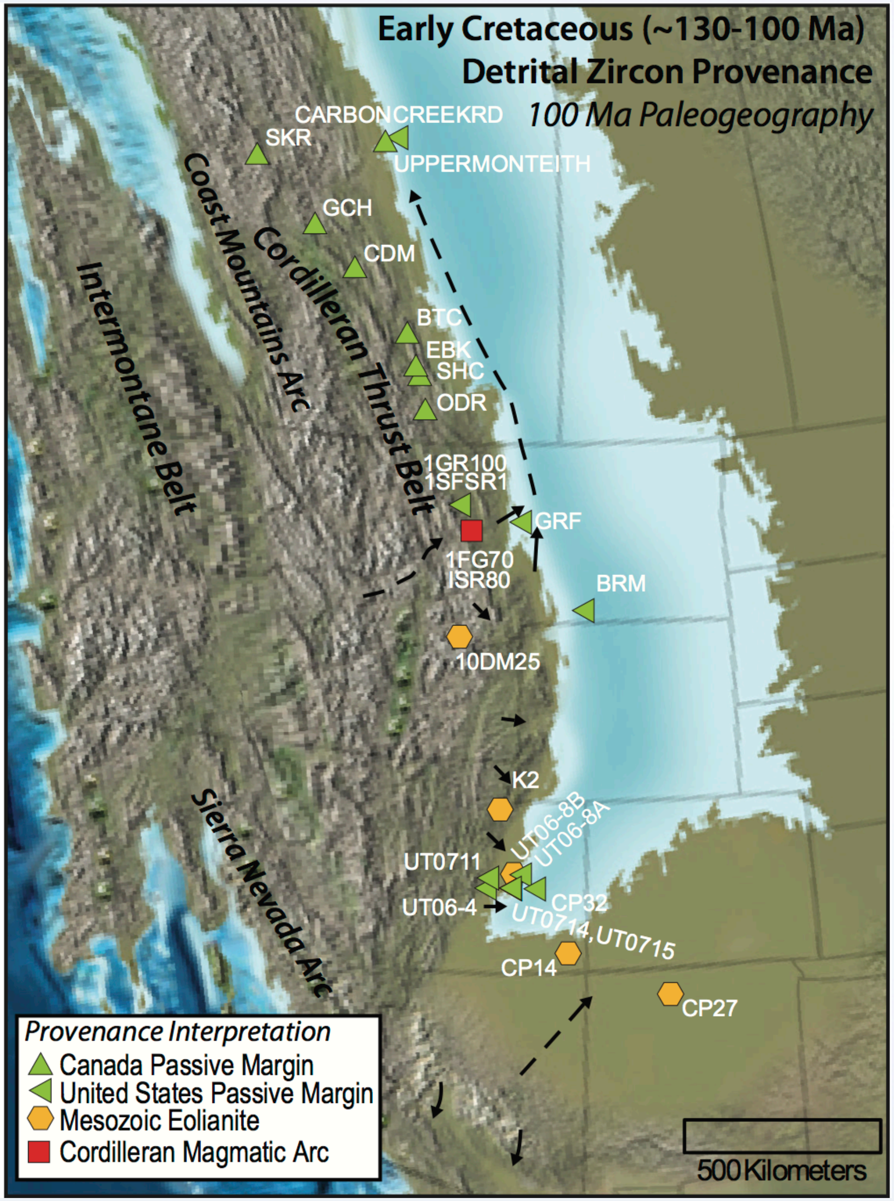
Late Jurassic

- Dominated by Mesozoic Eolianite (U.S.) and passive margin (Canada) recycling
- Paleocurrent data (DeCelles, 2004) indicate east/northeast transport.
- Petrographic data (DeCelles and Burden, 1992; Currie, 1998) document unroofing sequences in the Morrison Fm.
- U.S. passive margin affinities in Canada foreland imply northwards axial transport.
- Jurassic DZ ages constitute ~8% of Morrison Fm. age spectra.

Basemap from R. Blakey, cpgeosystems.com

Sediment Dispersal Pathways

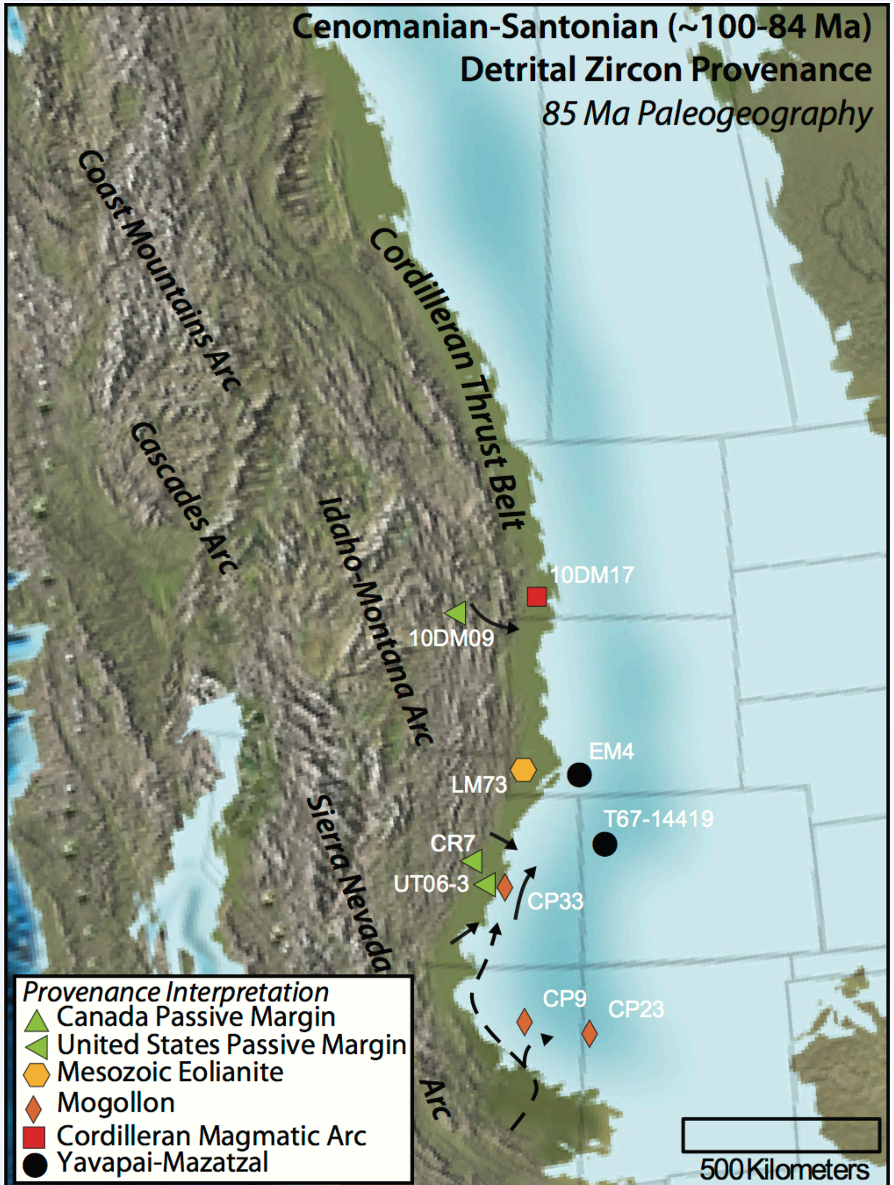
Early Cretaceous



- Transition to passive margin dominance indicative of unroofing in Sevier thrust belt
- Continuation of north directed dispersal into Canada foreland
- Appearance of arc-dominated signature (>50% Jura-Cretaceous)

Basemap from R. Blakey, cpgeosystems.com

Sediment Dispersal Pathways



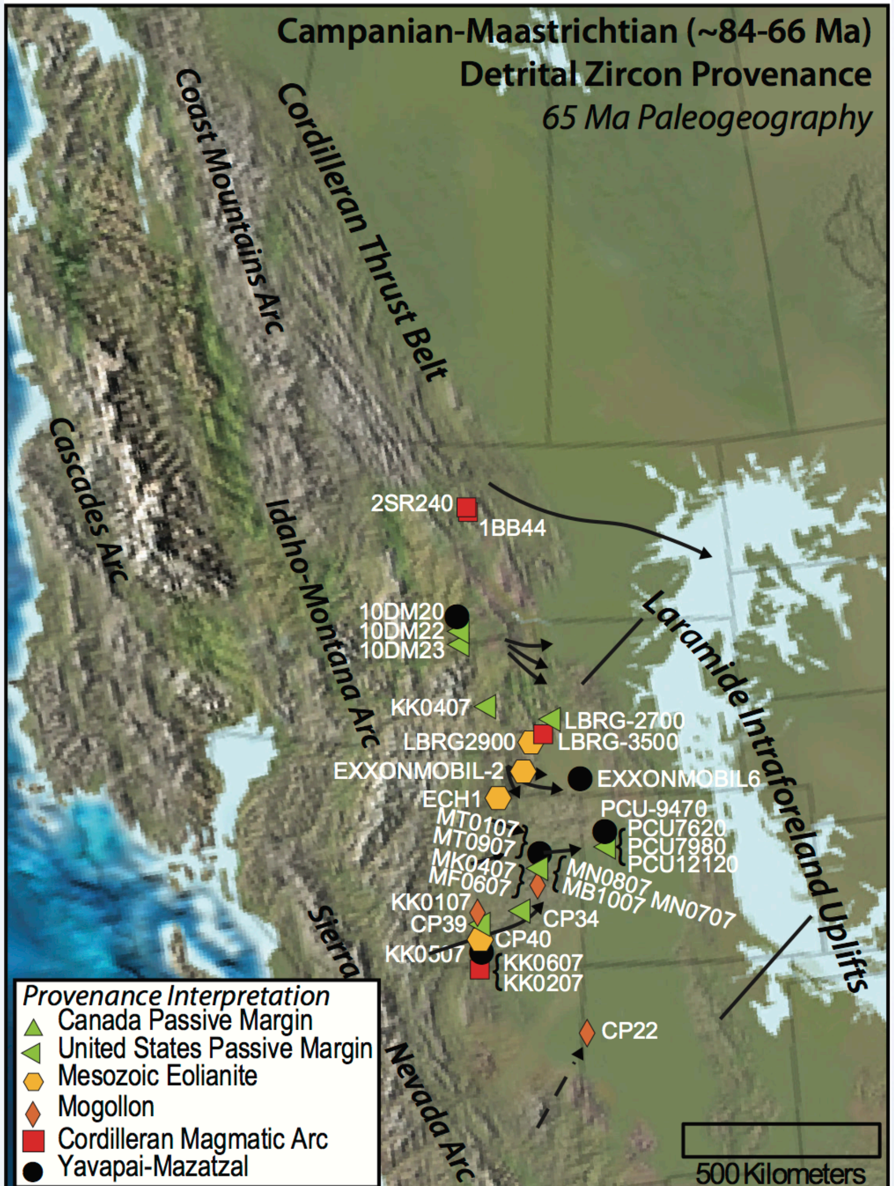
Cenomanian-Santonian

- East and northeast directed dispersal
- Appearance of Yavapai-Mazatzal signature in Wyoming and Colorado
  - Mogollon Highlands?
  - Ancestral Rockies via Morrison?
- No petrographic or structural evidence of basement involved structural culminations in Sevier or Laramide provinces

Basemap from R. Blakey, cpgeosystems.com

Sediment Dispersal Pathways

Campanian-Maastrichtian

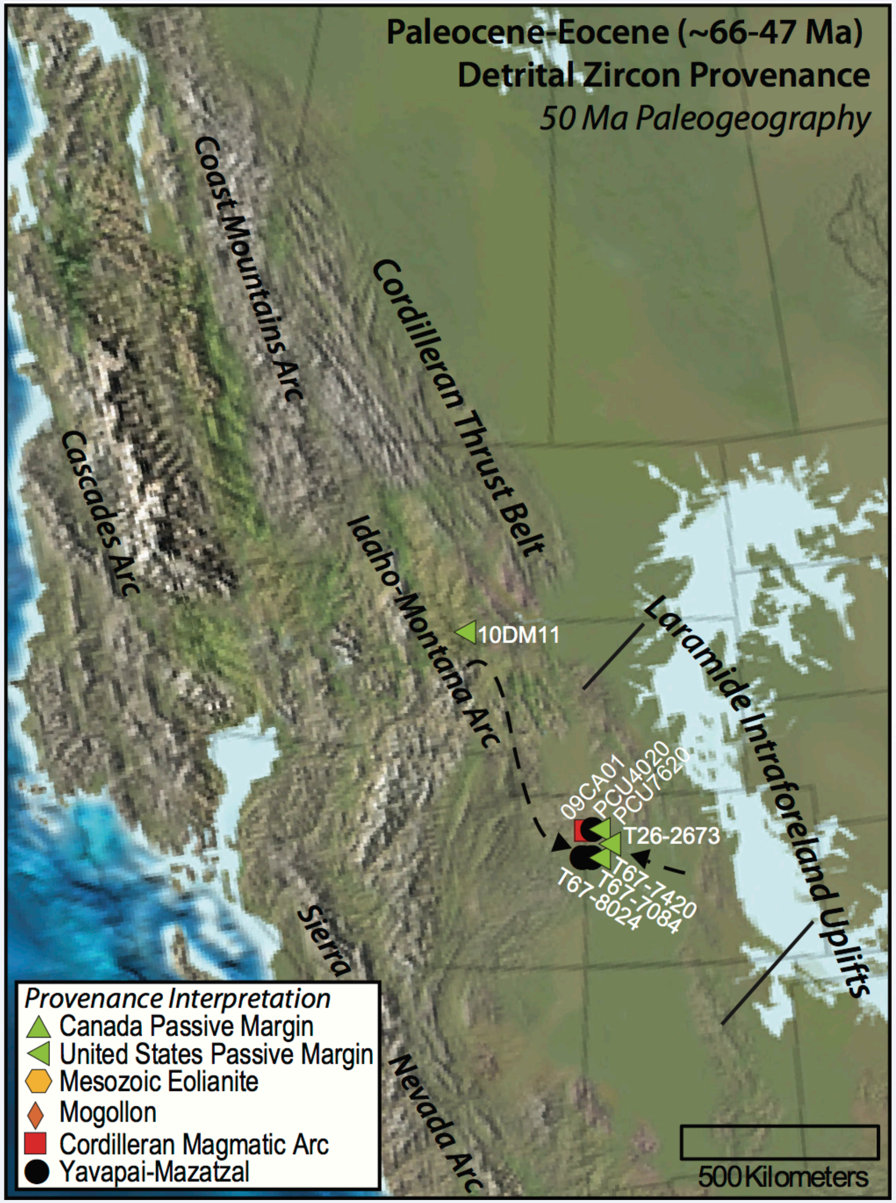


- Arc dominance in northern MT
- Yavapai-Mazatzal affinity sample in southwest MT likely recycled from Belt Supergroup
- Exhumation of basement-involved structures signaled by Y-M affinity in WY, CO, and UT
- Difficult to distinguish between Laramide and Sevier belt sources
- Possible recycling of Morrison equivalents signaled by reemergence of Mesozoic Eolianite affinity

Basemap from R. Blakey, cpgeosystems.com

Sediment Dispersal Pathways

Paleocene-Eocene

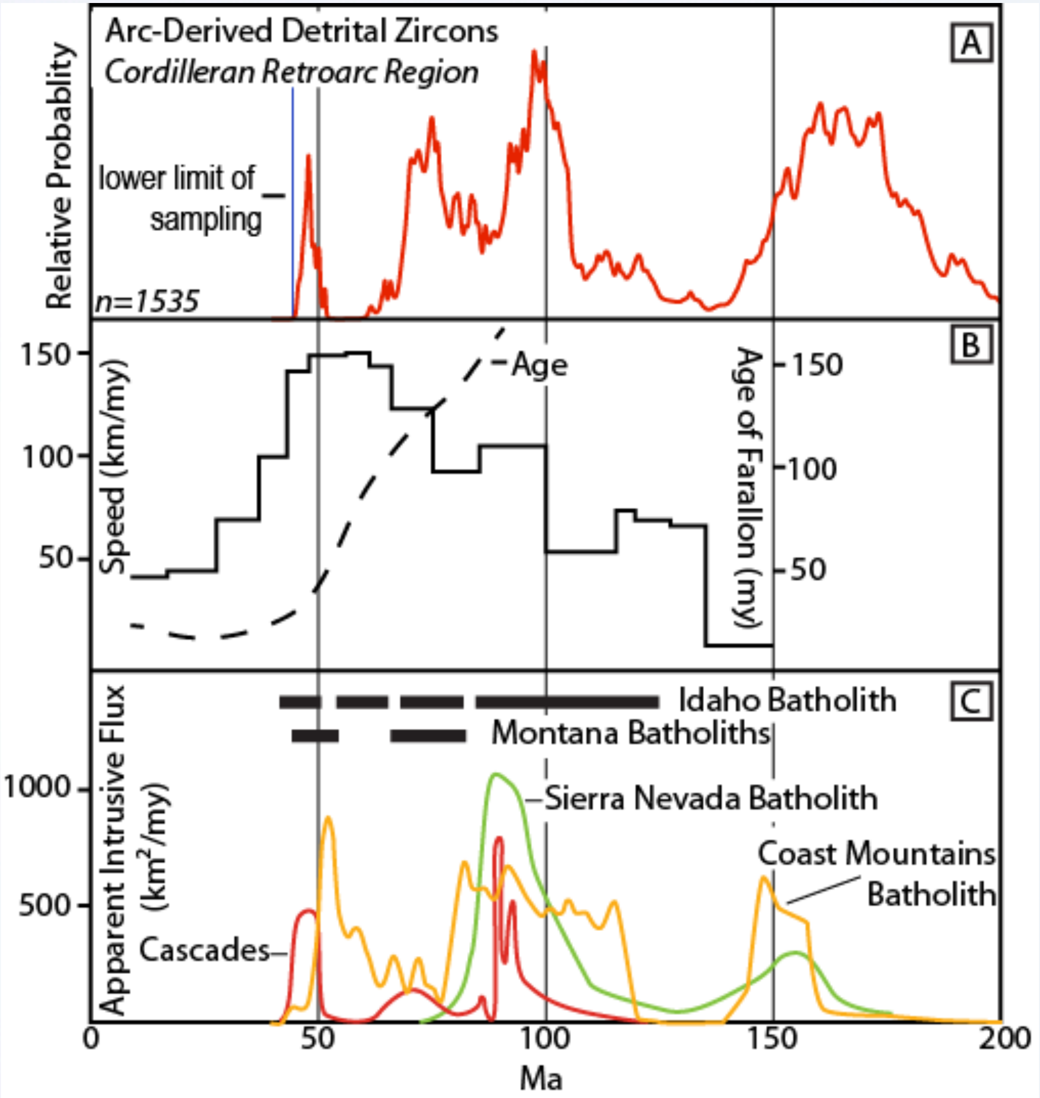


- Continuation of complex, mixed provenance likely from Sevier and Laramide sources

Basemap from R. Blakey, cpgeosystems.com

Arc-Derived Detrital Zircons

- Retroarc region detrital zircons can be used as a proxy for arc magmatic flux
- At least four periods of high flux magmatism
- ~75 Ma event not represented in existing flux curves, indicative of HFE in Idaho-Montana segment?
- Apparent increase in HFE frequency with increase in convergence rate



Farallon speed and age from *Engebretson* [*1984*]
CMB: *Gehrels et al*. [*2009*]; Cascades and SNB: *Paterson et al*. [2011]
Idaho-Montana: *Gaschnig et al*. [*2010*]

Conclusions

- Changes in Jurassic-Eocene foreland basin provenance reveal a basin-wide unroofing sequence characterized by extensive recycling.
- Detrital zircon provenance analysis indicates that basement-involved structural culminations were exhumed by ~86-66 Ma.
- Retroarc region detrital zircons can be applied as a proxy for arc magmatic flux
- Increasing convergence rates are correlated to an increase in high flux event frequency

Laskowski, A. K., P. G. DeCelles, and G. E. Gehrels (2013), Detrital zircon geochronology of Cordilleran retroarc foreland basin strata, western North America, *Tectonics, 32*, doi:10.1002/tect.20065.

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