Detrital Zircon U-Pb Geochronology and Paleodrainage Reconstruction of the Blackhawk-Castlegate Succession, Book Cliffs and Wasatch Plateau, Utah*

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Abstract

The Blackhawk Formation and Castlegate Sandstone are Campanian fluvial-deltaic and shoreline deposits within the Sevier foreland-basin fill along the Wasatch Plateau and Book Cliffs in Utah. Existing age constraints on the Blackhawk and Castlegate are based on correlation to ammonite zones in downdip mudstones, which are themselves constrained by radiometric dating of volcanic ash beds, and are therefore dependent on correlation methods and models. This study examines the Blackhawk-Castlegate succession with the following objectives: (i) develop an independent geochronological framework of maximum depositional ages through U-Pb dating of volcanogenic detrital zircons (DZs); (ii) test a hypothesis that very fine sands and coarse silts yield a more robust population of maximum depositional ages from volcanogenic DZs that approximate true depositional age than medium to fine sands; and (iii) revisit geochronological interpretations and deposition rate calculations of the Blackhawk-Castlegate succession in light of new data. Preliminary U-Pb dating of DZs in the uppermost Blackhawk produced U-Pb ages as young as 76.0 ± 2.8 Ma, with a calculated maximum depositional age (MDA) of 77.7 ± 1.6 Ma (n=7), and, in the lower Castlegate, produced U-Pb ages as young as 73.0 ± 4.0 Ma with a calculated MDA of 75.9 ± 2.0 Ma (n=13). In both cases, these dates are significantly younger than previous age models, and raise questions concerning the temporal significance of the classic Castlegate Sequence Boundary and relationships with basin-evolution models. U-Pb dating of DZs in the uppermost Blackhawk to test the facies dependence hypothesis produced no young (< 80 Ma) grains, but can aid in reconstructing paleodrainage patterns. Results of this study will contribute to future quantitative analyses of this heavily-studied foreland basin fill.

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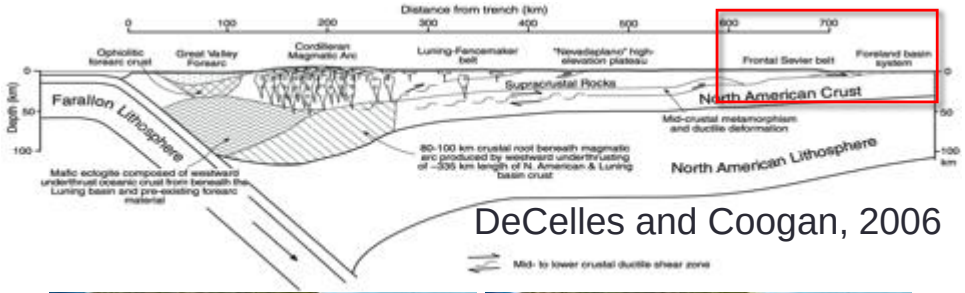
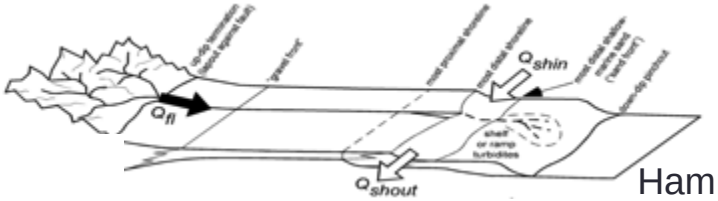
General Outline

- *History of the Sevier Foreland Basin and deposition of the Blackhawk-Castlegate Succession*
- *Project objectives*
- *Building a geochronological framework using Maximum Depositional Ages (MDAs)*
- *Revisiting correlation models*
- *Interpreting paleodrainage patterns using multi-dimensional scaling, statistical cluster identification, and parent-daughter analysis*

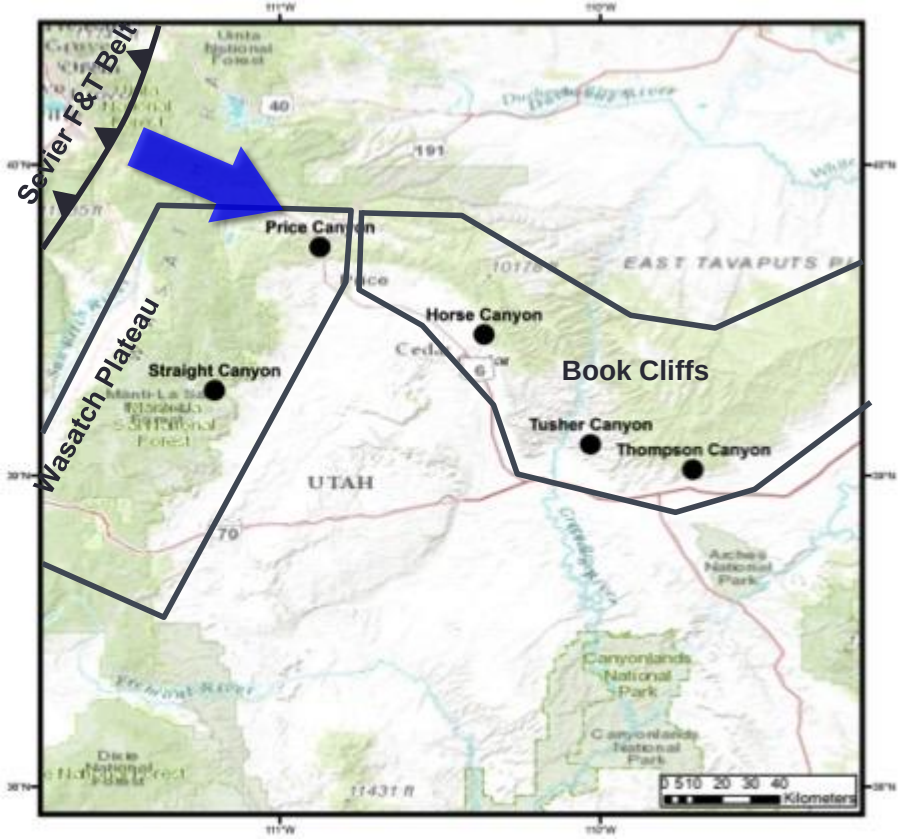
Tectonic and Depositional History



DeCelles and Coogan, 2006



Hampson, 2016



Project Objectives

I. Test a hypothesis that fine-grained flood-plain and channel-fill facies (very fine sands and coarse silts) yield a more robust population of maximum depositional ages from volcanogenic DZs that approximate true depositional age, when compared to traditional channel-belt sandstones (medium to fine sand)

II. Develop an independent geochronological framework of maximum depositional ages through U-Pb dating of volcanogenic detrital zircons

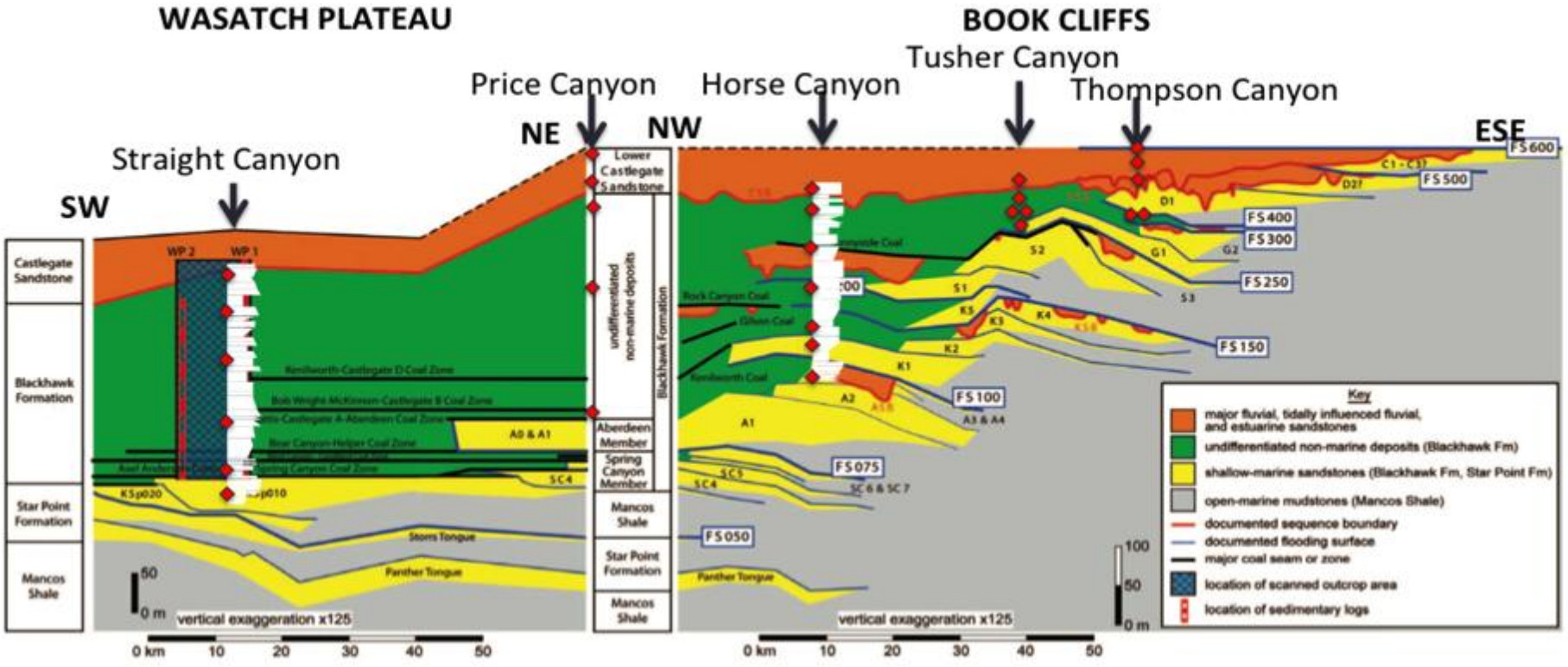
III. Revisit geochronological and provenance interpretations of the Blackhawk-Castlegate succession in light of new data

OBJECTIVE 2: BUILD A GEOCHRONOLOGICAL FRAMEWORK

Develop an independent geochronological framework of maximum depositional ages through U-Pb dating of volcanogenic detrital zircons

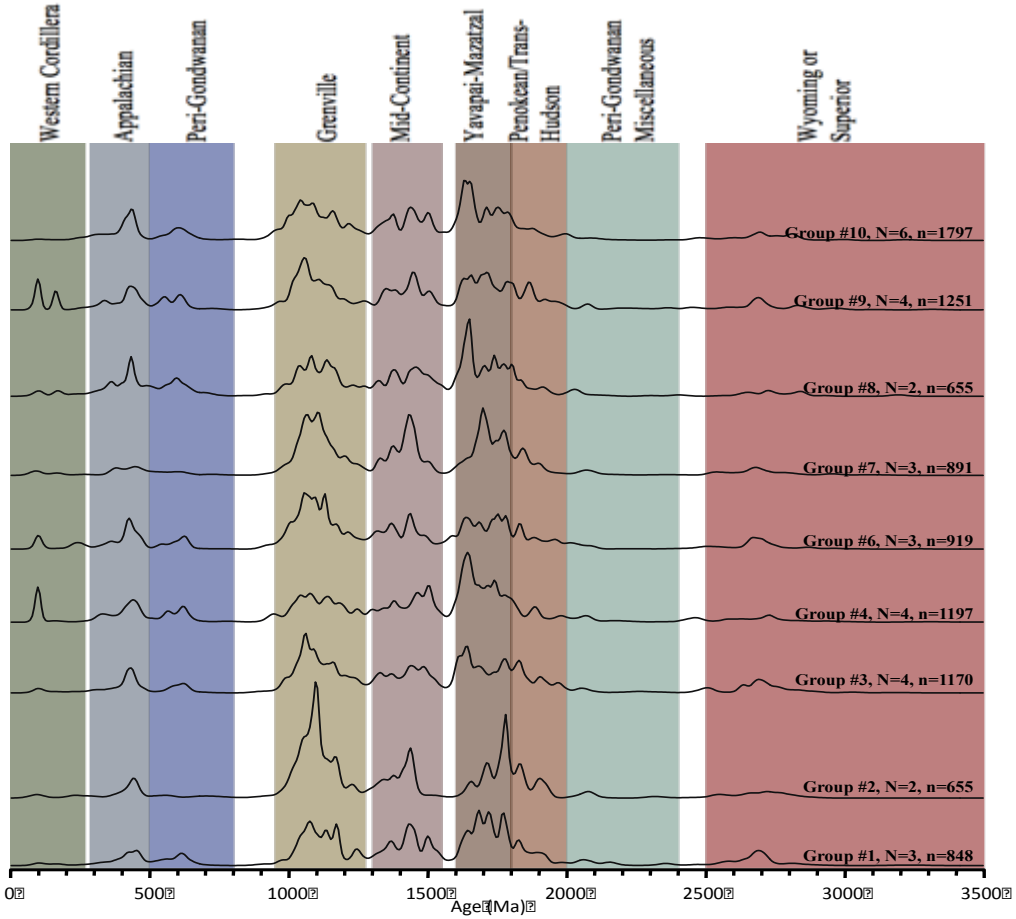
The framework is built using N=31 at n=300, as recent studies show that n≥300 reduces the probability of missing low abundance populations to <1% (e.g. Dodson et al., 1988; Fedo et al., 2003; Andersen, 2005; Pullen et al., 2014; Saylor and Sundell, 2016)

Sampling Methodology



Modified from Rittersbacher et al., 2014

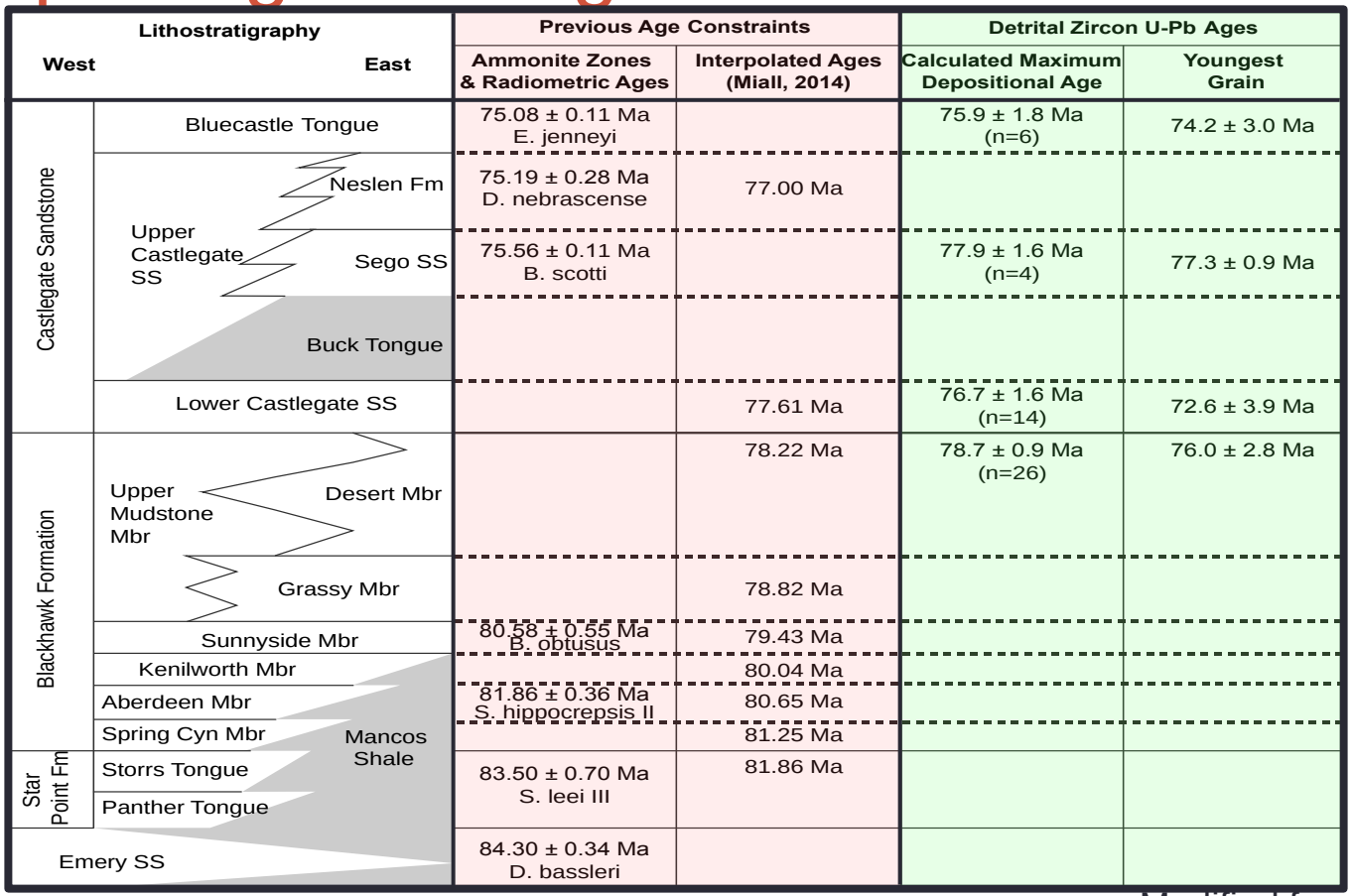
Age Distributions



Signal Proportions:

- **18-28%** = Grenville, Yavapai-Mazatzal, and Mid-Continent age
- **4-8%** = Penokean/Trans-Hudson, Appalachian, Wyoming or Superior, and Peri-Gondwanan ages
- **0-12%** = Western Cordillera
- **≤ 2%** = Misc. Peri-Gondwanan and other various ages

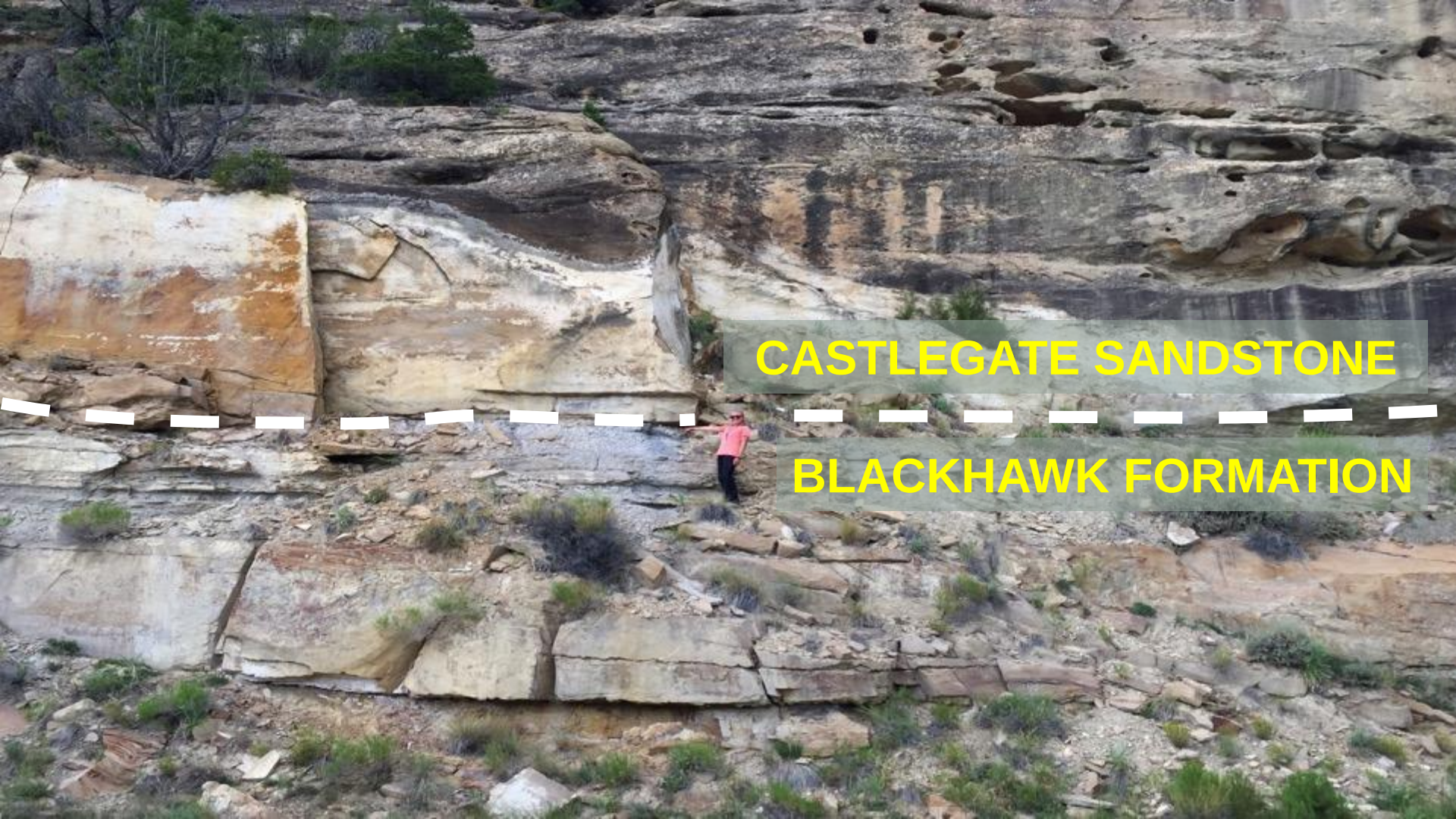
Stratigraphic ages through the Mesaverde Group



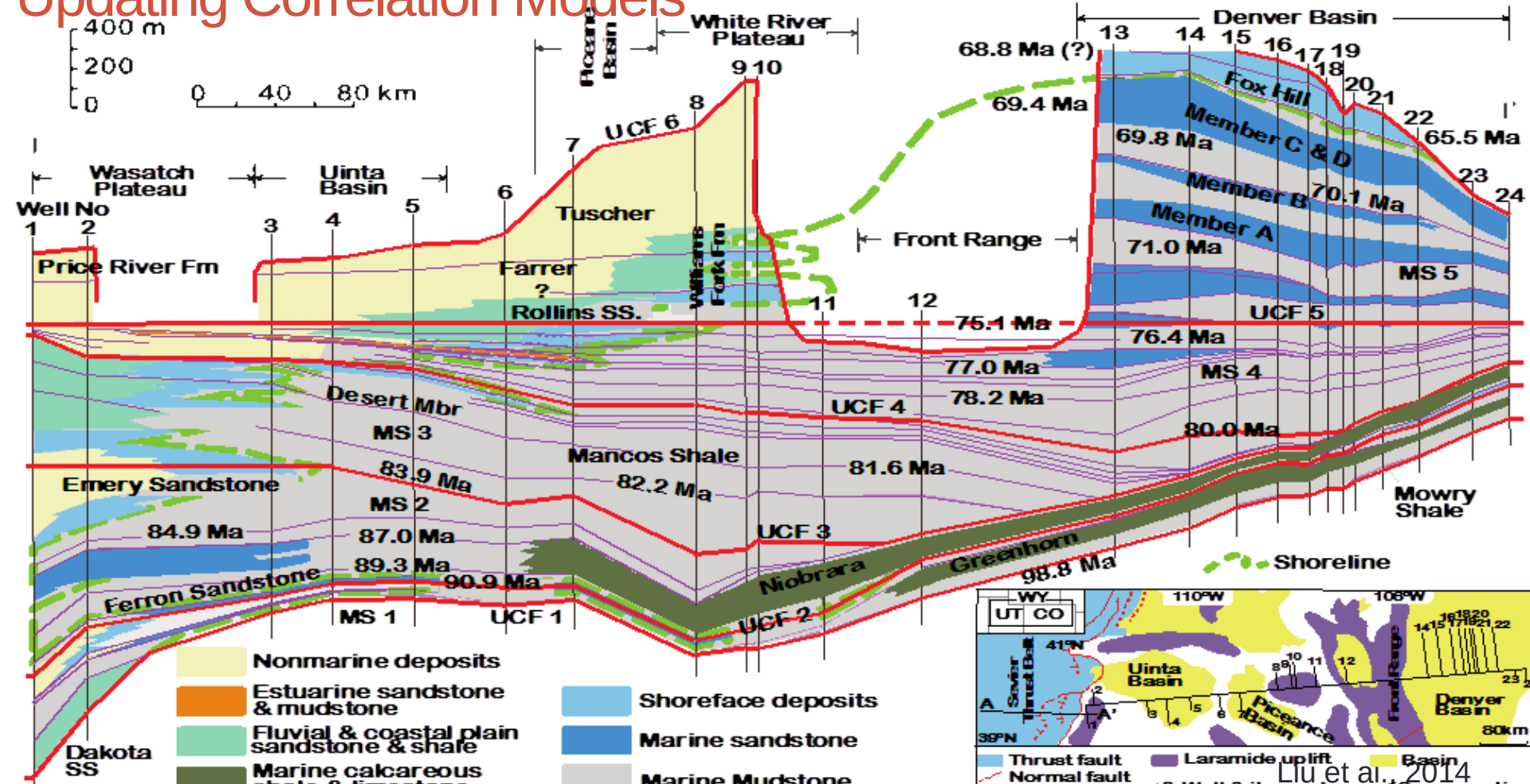
Modified from Yoshida, 2000

OBJECTIVE 3: REVISIT INTERPRETATIONS

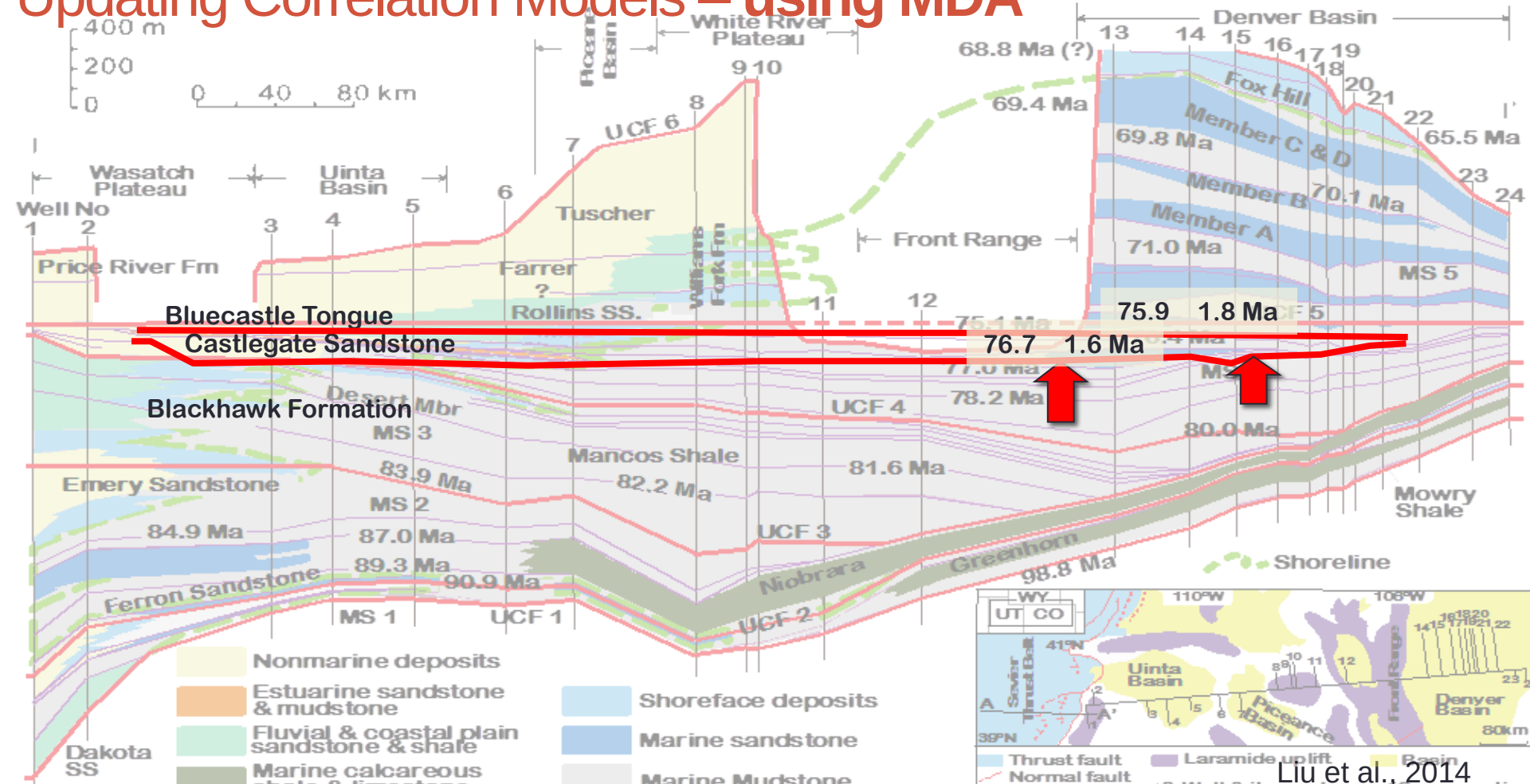
Revisit geochronological and provenance interpretations of the Blackhawk-Castlegate succession in light of new data


CASTLEGATE SANDSTONE
BLACKHAWK FORMATION

Updating Correlation Models

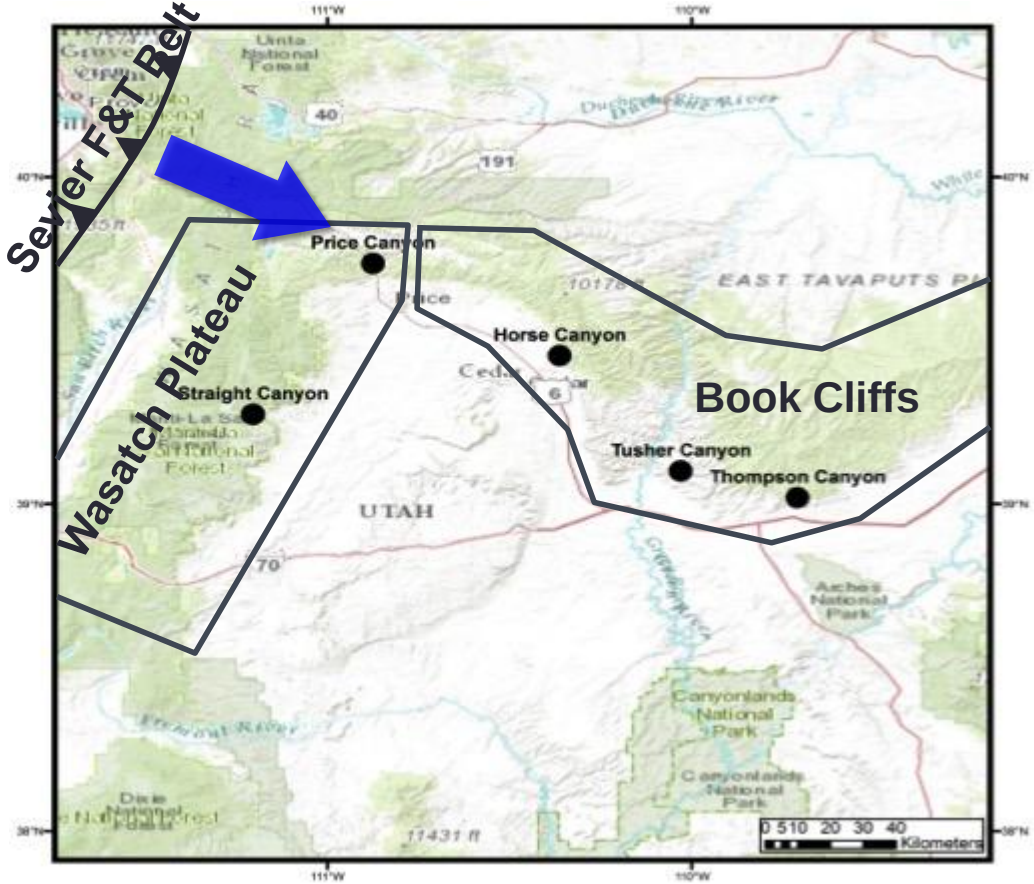


Updating Correlation Models – using MDA



Liu et al., 2014

Canyon positions in a depositional framework



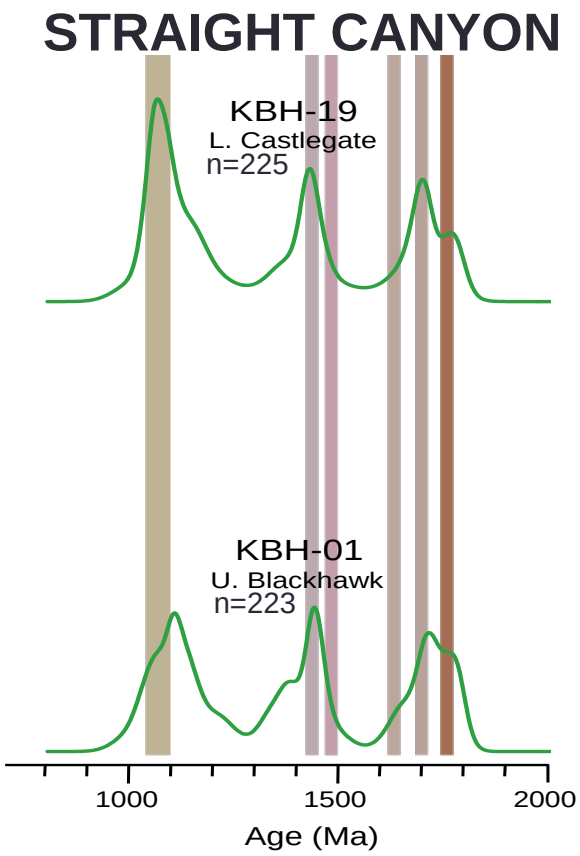
Parent Candidates (most proximal):

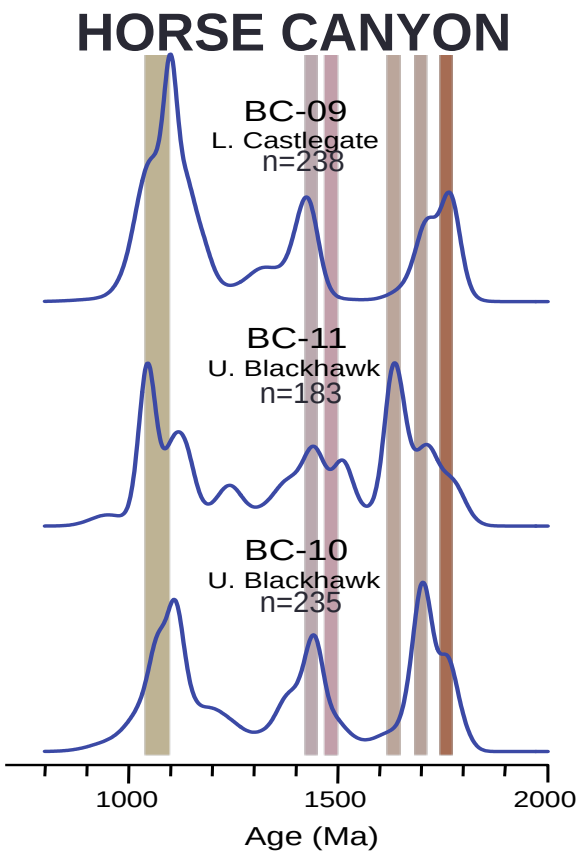
- Straight Canyon
- Price Canyon

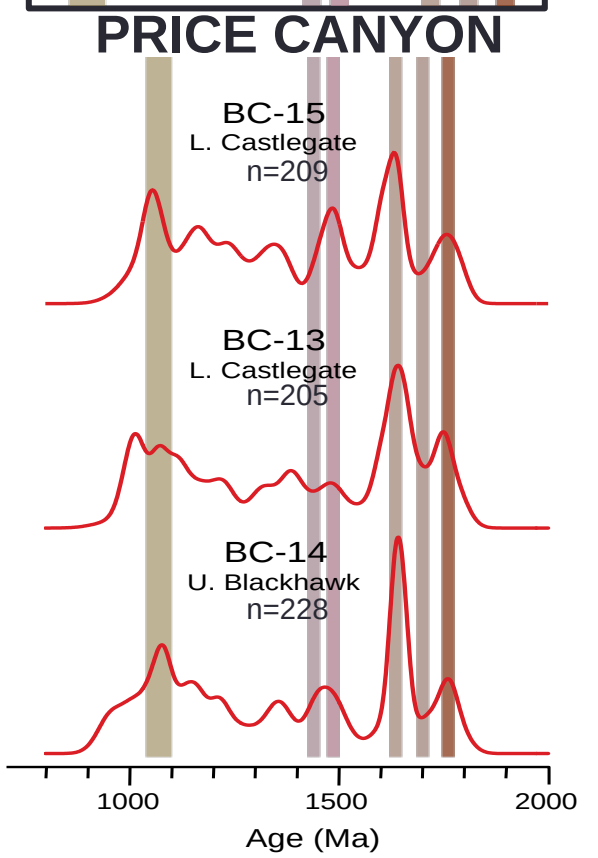
Daughter Candidates (more distal):

- Horse Canyon
- Tusher Canyon
- Thompson Canyon

Parent and Daughter Analysis



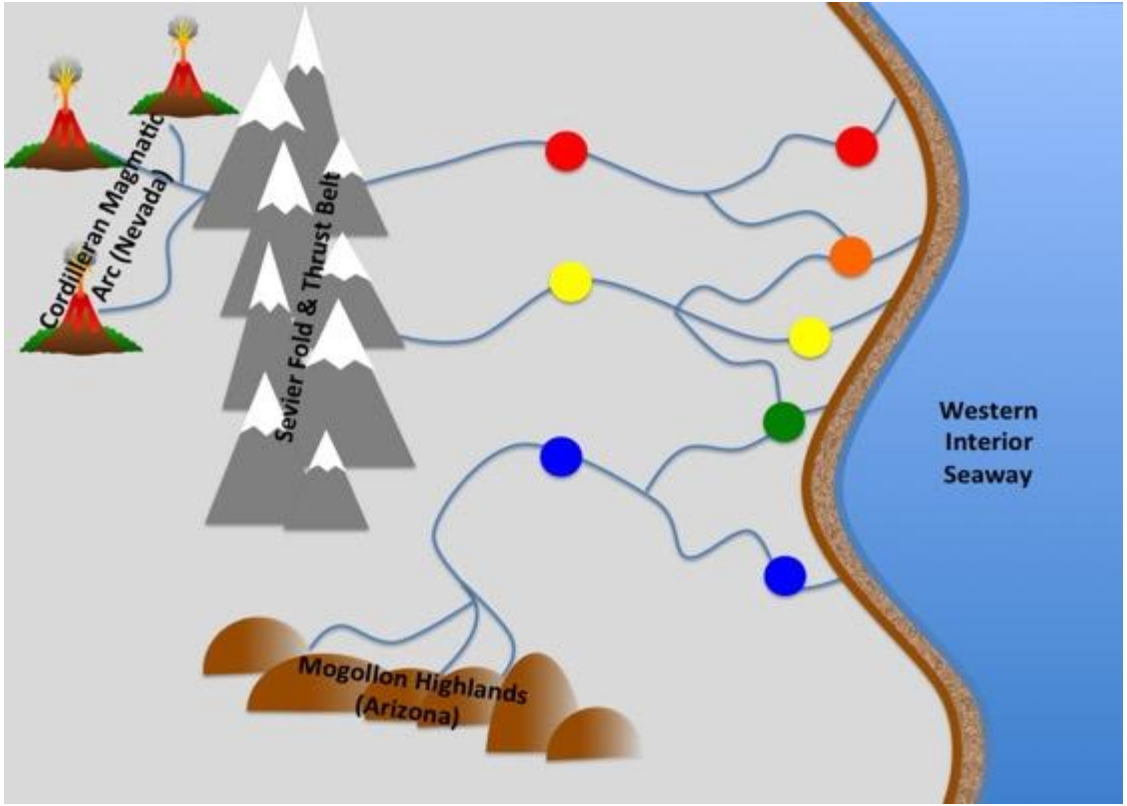




Deciphering Paleodrainage

Three overarching signals:

- **Western Cordillera magmatic arc signal from Nevada**
- **Reworked passive margin**
- **Yavapai-Mazatzal signal from Mogollon Highlands**



Summary

- ***Detrital zircon U-Pb geochronology in the Blackhawk-Castlegate Succession is a quantitative way to test correlation models, create a systematic geochronologic framework in terrestrial stratigraphy, and help understand how time is preserved in deposits.***
- ***There is no evidence to suggest that young volcanogenic zircons preferentially fractionate into finer-grained deposits.***
- ***MDAs calculated throughout the succession approximate the time of deposition for each unit.***
- ***MDAs for the Blackhawk and Castlegate are ~0.3 m.y. younger than previously age assignments, and the youngest grains suggest each unit is up to 4 Myrs younger than each MDA.***
- ***Sediment routing systems may be reconstructed using multi-dimensional scaling, cluster identification, and parent-daughter analysis.***

Acknowledgements and References

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AWG Association for Women Geoscientists

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