Using Zircon Geochronology to Determine Sand Provenance in Northeast Oklahoma

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Introduction

Research Question:

- What is the provenance for the sediment that composes the Cleveland and Seminole Sandstone in Oklahoma?

What's New:

- Detrital zircon provenance studies have shown that Appalachian synorogenic grains are present in Pennsylvanian age strata in the western North American Craton.
- Using provenance studies combined with detrital zircon geochronology, it is possible to unmix the sediment sources that contributed to detrital compositions.

Why do we care:

- Sediment provenance places the initial influences on the composition of sedimentary rocks.
- Sandstones lose primary porosity due to silica cementation, but gain secondary porosity via acid dissolution. The amount of secondary porosity formed depends on detrital composition.

Background/Study Area

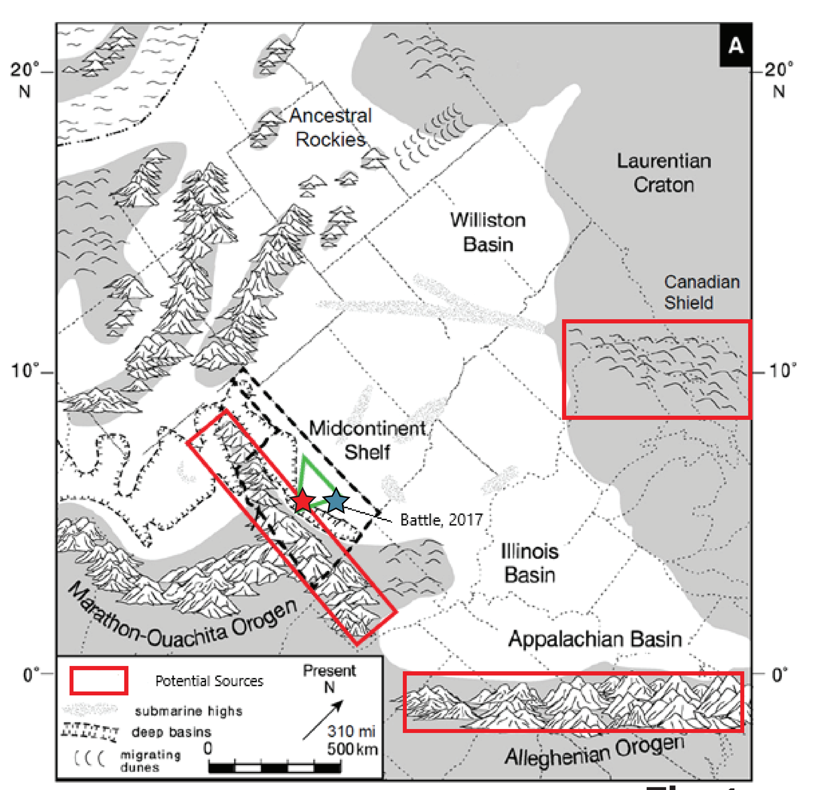


Fig. 1

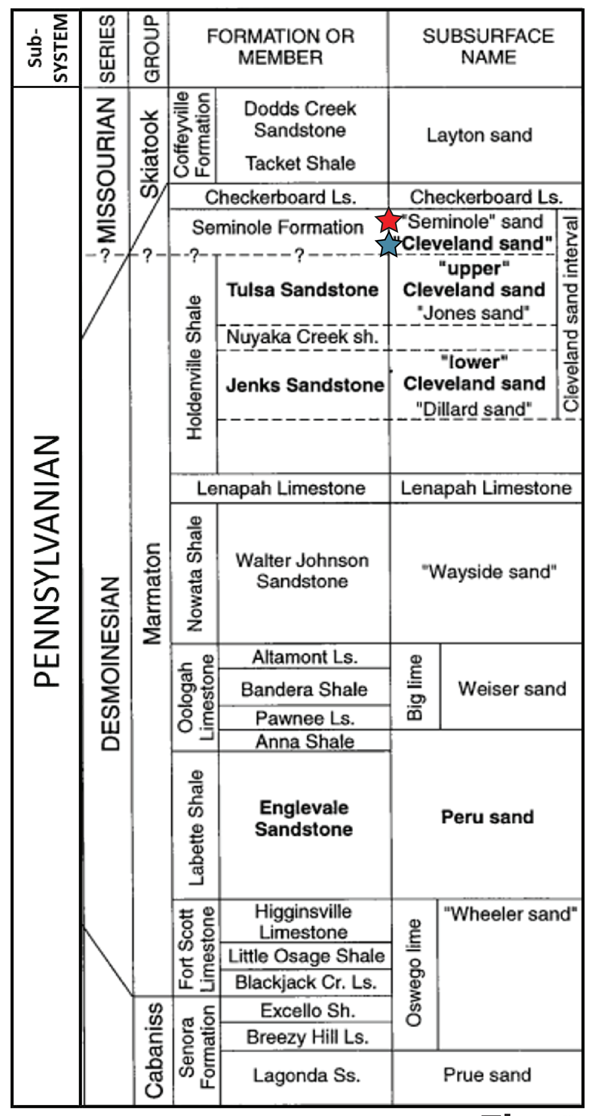


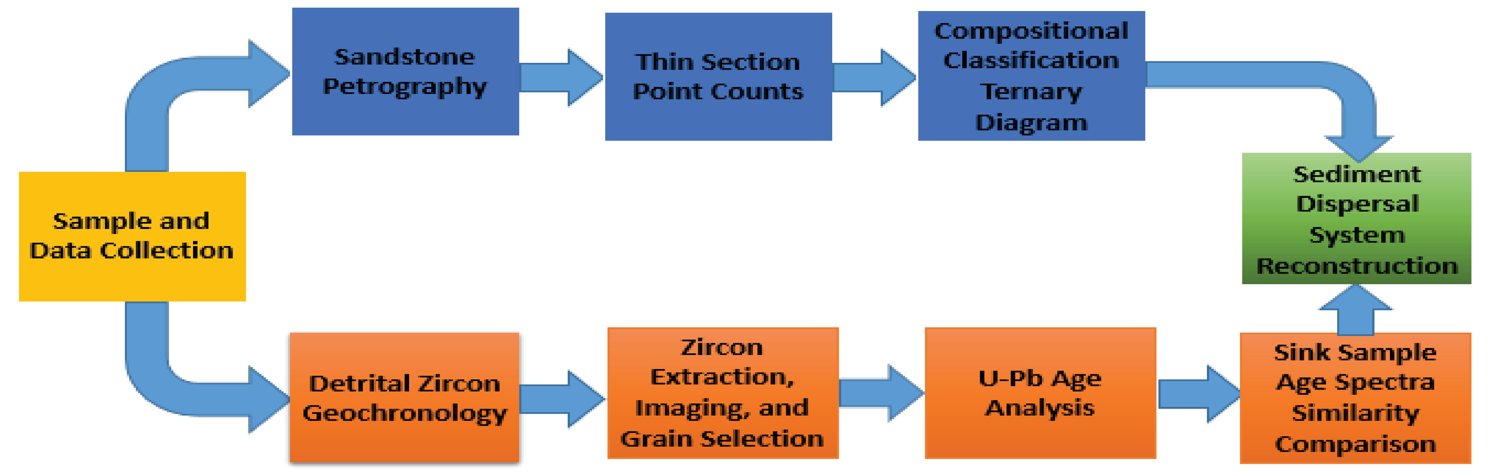
Fig. 2

Fig. 1 Paleogeographic reconstruction of the Late Pennsylvanian showing potential sediment sources. Modified from Algeo and Heckel (2008).

Fig. 2 Stratigraphic column showing the surface and subsurface names of Pennsylvanian strata. Modified from Campbell 1997.

Methods

Zircon geochronology is implemented to better determine the origin of sandstone components. The hardy nature of a zircon preserves its crystallization age, keeping it in a chemically closed system, which allows for U-Pb dating to determine provenance age signatures of a sedimentary unit.



Results

Sandstone Petrography

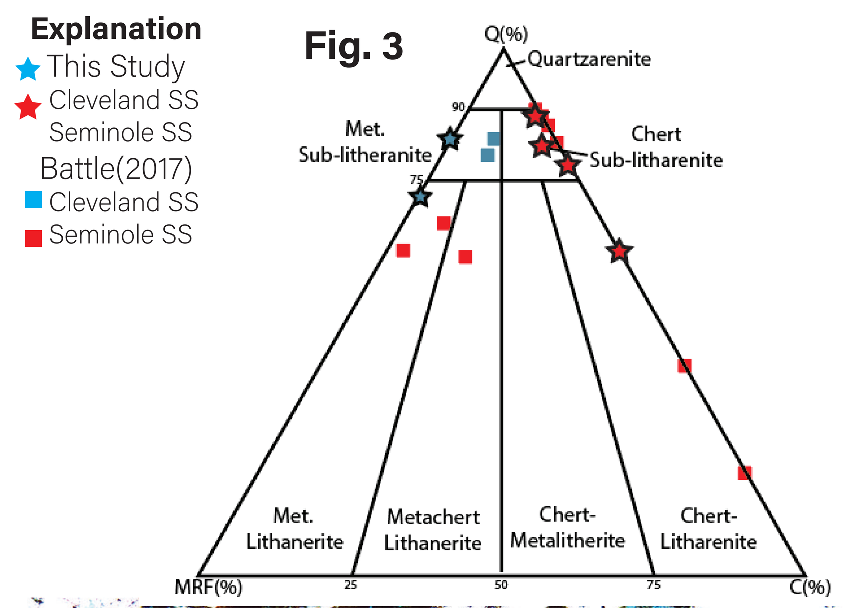
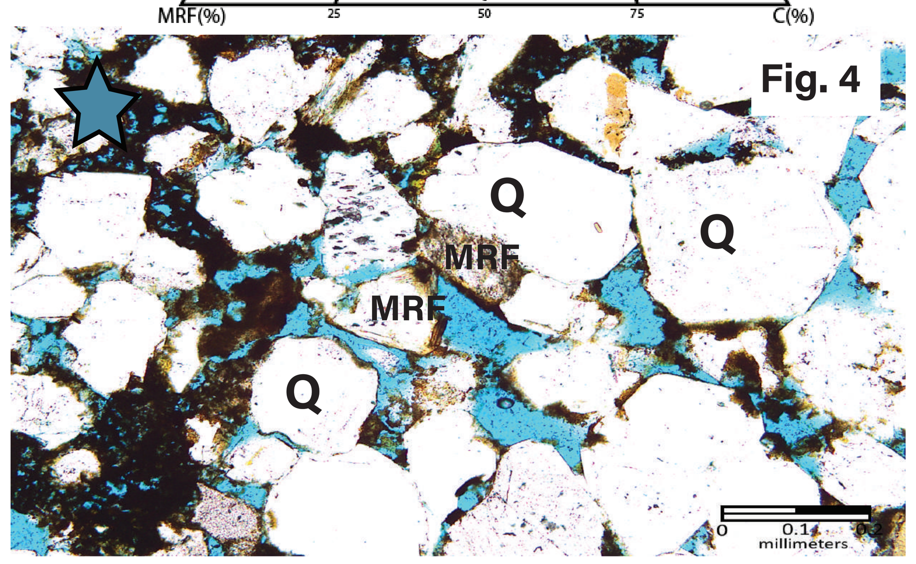
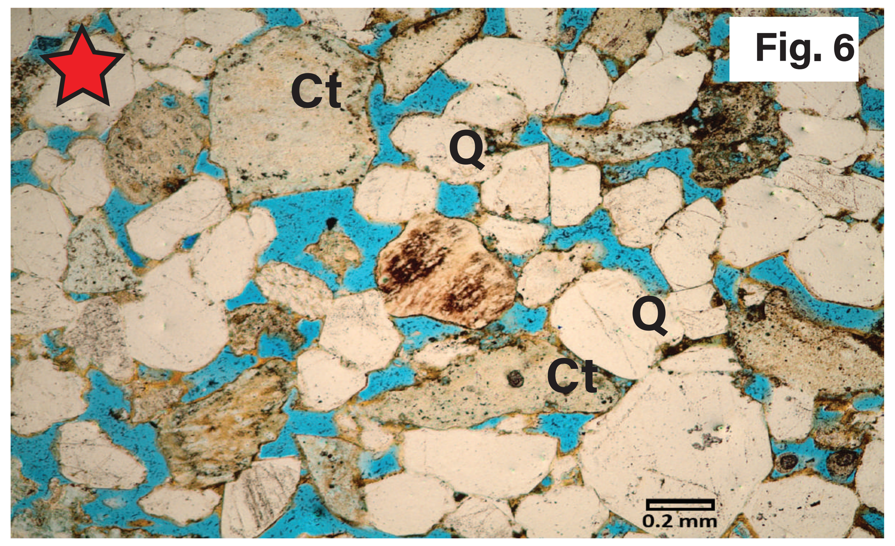


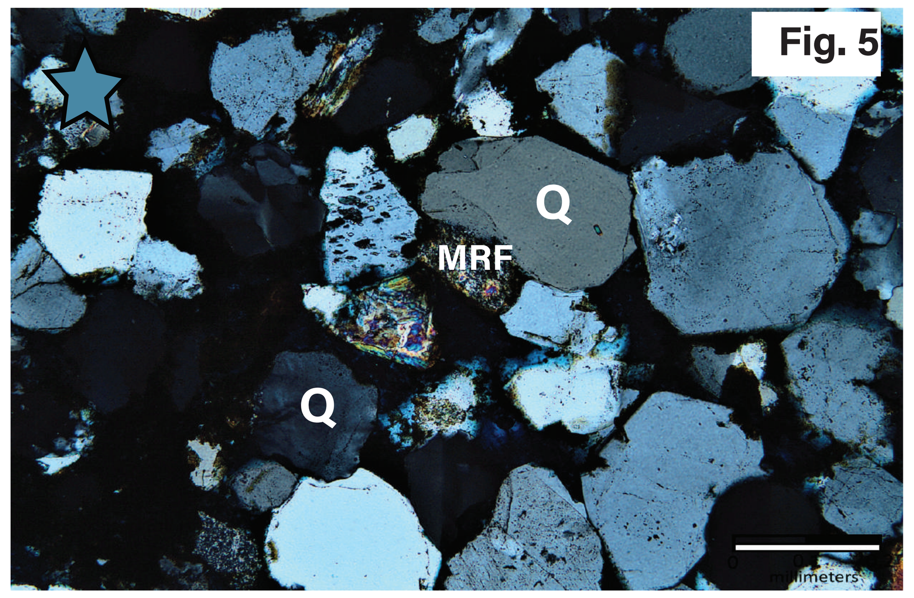
Fig. 3 Ternary diagram based on normalized point counts of quartz, chert, and metamorphic rock fragments. Modified from Battle 2017 .

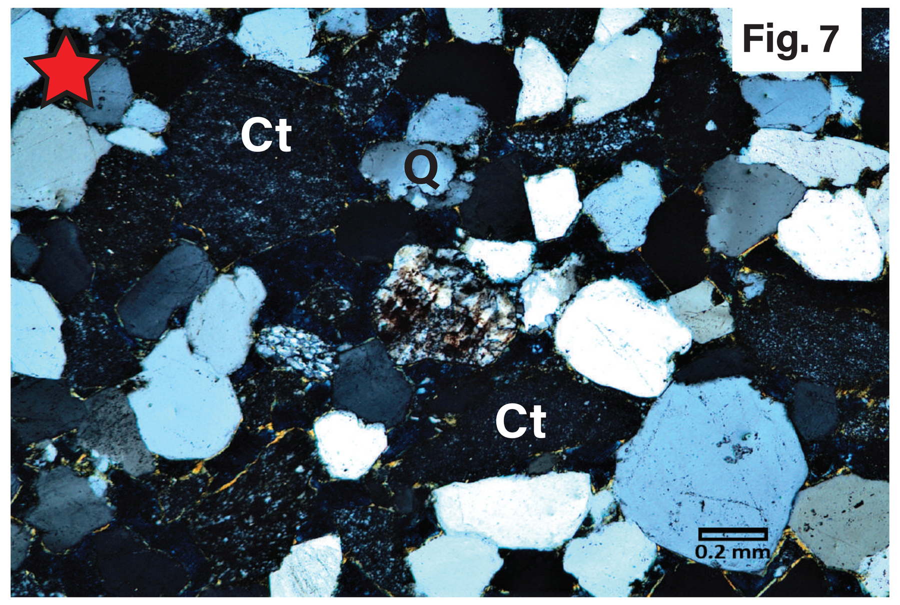
Fig. 4-5 Photomicrograph of the Cleveland Sandstone collected from Southern Hills Country Club, Tulsa, OK. Quartz-Q; metamorphic rock fragments (MRF). Plane polarized light (**4**); cross polarized light (**5**).

Fig. 6-7 Photomicrograph of the Seminole Sandstone collected from the Sasakwa outcrop, Seminole Co., OK Quartz-Q; chert (Ct). Plane polarized light (**6**); cross polarized light (**7**).









U-Pb Dating

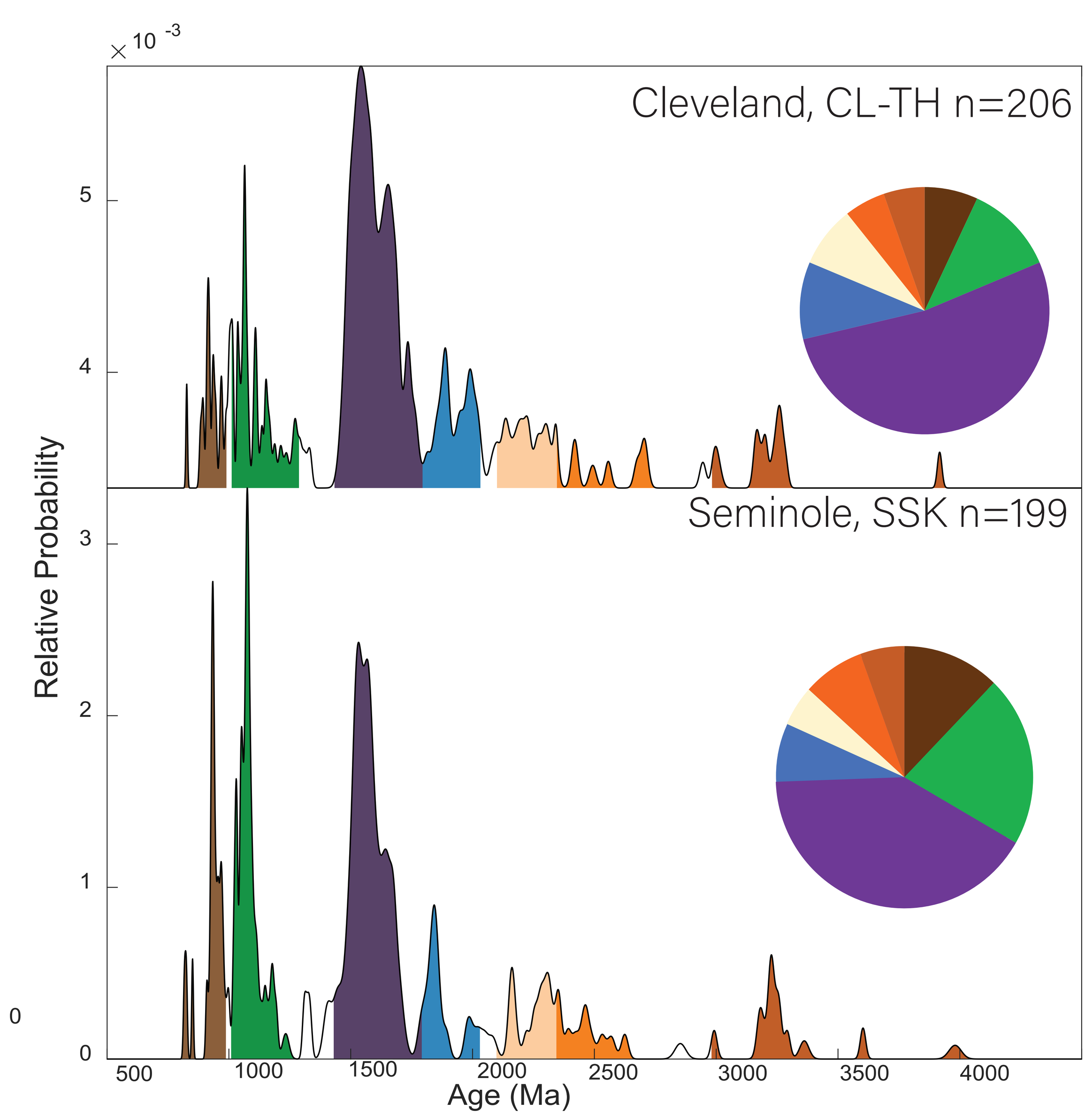


Fig. 8 Normalized relative age probability plots for the Cleveland and Seminole samples.

Fig. 9 Chart detailing age ranges for zircon provinces for North America.

Fig. 10 Basement map showing major North American geologic provinces. Ancestral Rocky Mountains (ARM), Appalachian Mountains (AM), Cambrian Syn-Rift (CSR), Midcontinent Rift (MCR), Grand Canyon (GC). Modified from Chapman and Laskowski (2019)

North American Provinces	Age
1. Appalachian Synorogenies	270-490 Ma
2. Wichita Cambrian Igneous Rocks	530-540 Ma
3. Pan-African/Gondwana Terranes	530-760 Ma
4. Grenville Orogen	950-1300 Ma
5. Midcon. Granite/Rhyolite	1300-1500 Ma
6. Yavapai-Mazatzal	1600-1800 Ma
7. Reworked Archean&Juvenile Arcs	1800-2300 Ma
8. Superior/Archean Craton	2500-3000 Ma

Interpretation and Discussion

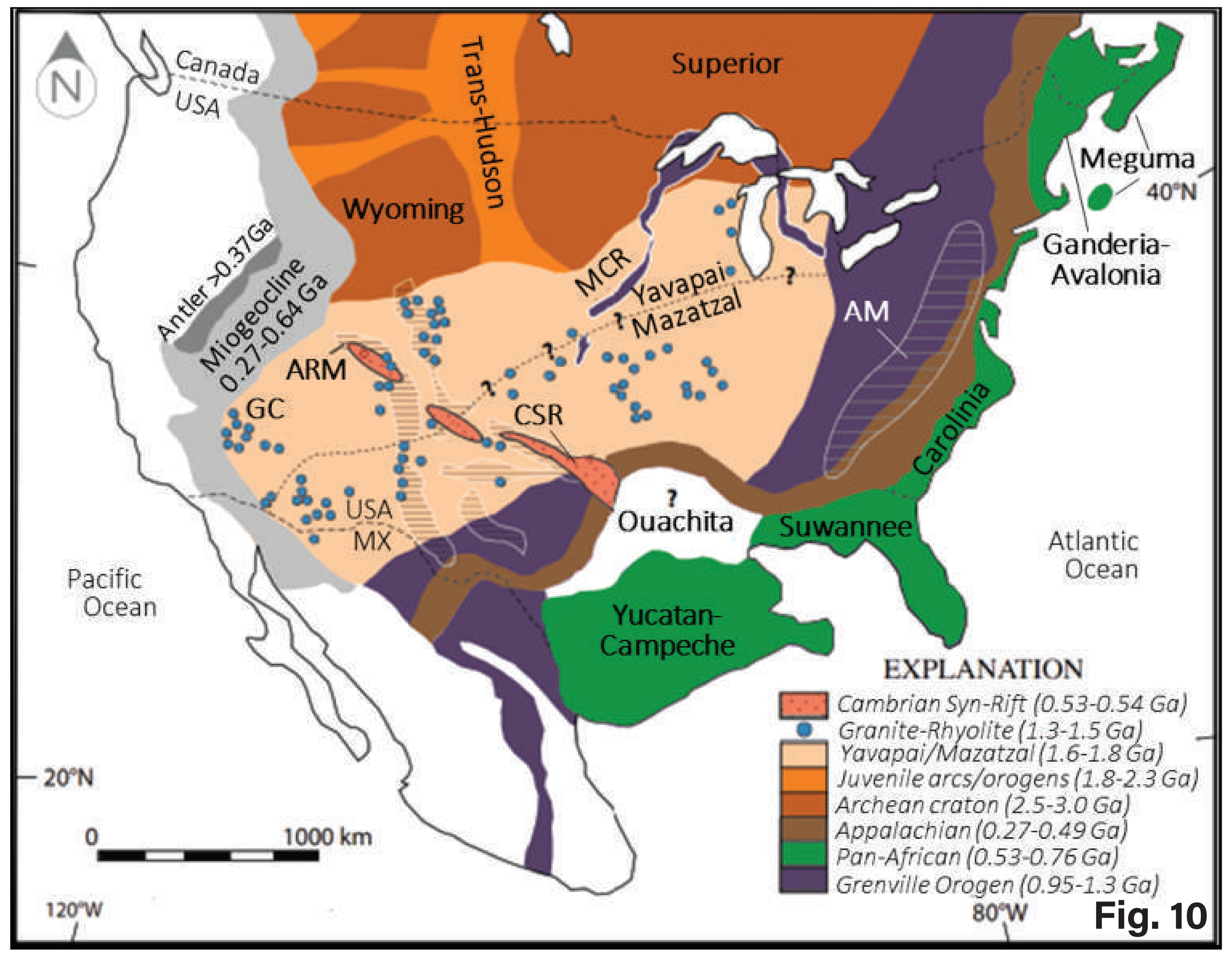


Fig. 10

Results differ from the hypothesis such that the petrography of the two samples differs considerable as expected, but the zircon geochronology data is remarkably similar. These results, along with the scarcity of feldspars and metamorphic rock fragments in the Seminole sample implies that the non-chert detrital grains are recycled, while the chert is still most likely derived from the Ouachita Mts. The reason for the similar zircon geochronologies is due to the resilient and near-immutable zircons staying in the system even when other evidence of the original source was removed via dissolution and/or weathering.

Future Work

- **Acquire additional samples from the Cleveland Sandstone and compare provenance of samples from Northeast OK with samples from subsurface Anadarko Basin.**
- **Compare detrital composition of the Cleveland Sandstone with composition of the Hepler Sandstone in Kansas.**
- **Build comprehensive sediment dispersal model for the late Pennsylvanian in North America.**

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