

A Sequence Stratigraphy Approach to Utilizing Detrital Zircon to Understand the Ozark Plateau

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Geosciences and Geological
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- Pennsylvanian Sandstone Reinterpreted as Middle Ordovician Everton Formation.
- Ozark Plateau Paleozoic Strata Provenance Shifts in Response to Regional Tectonics.

Geologic Settings

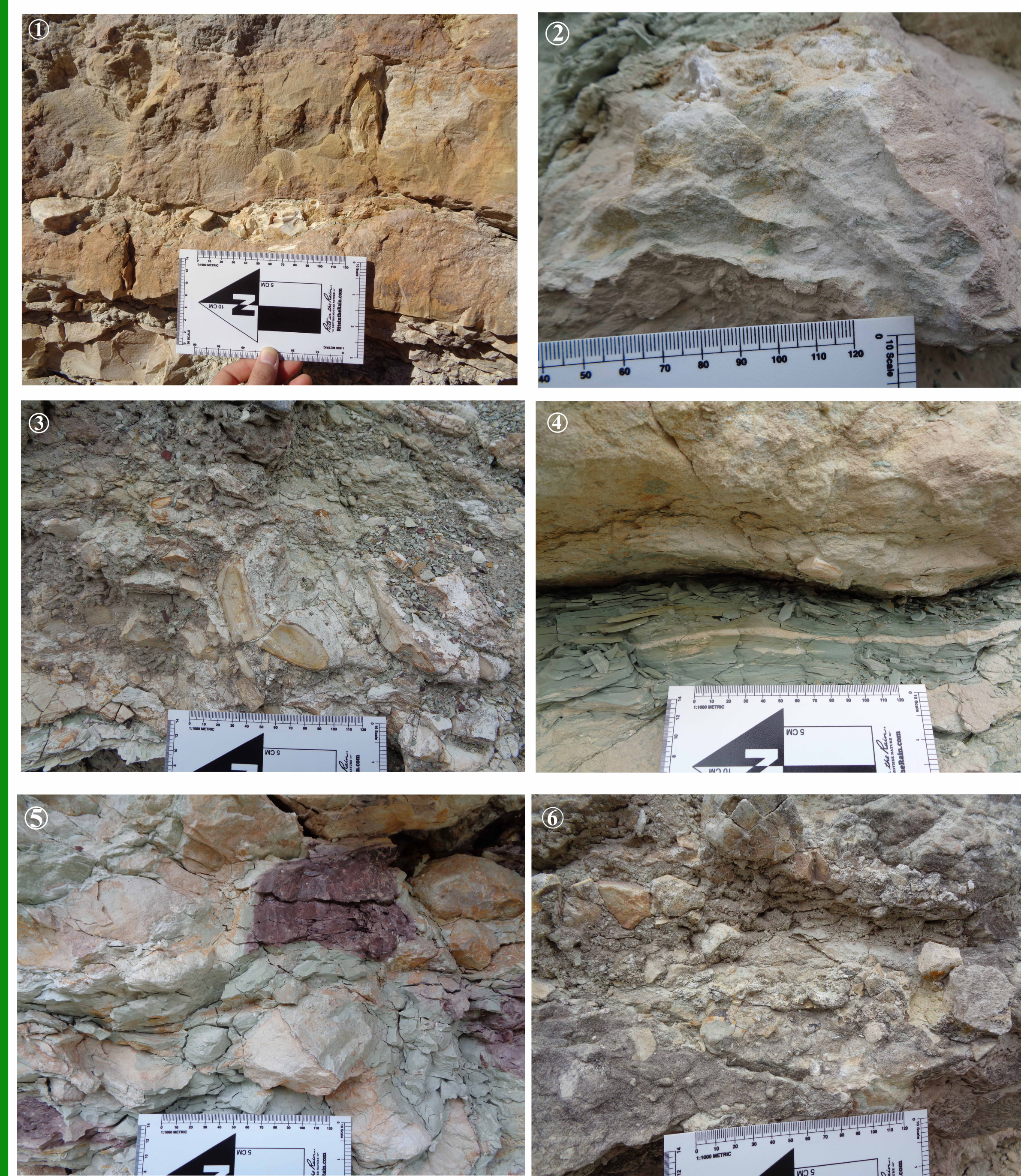
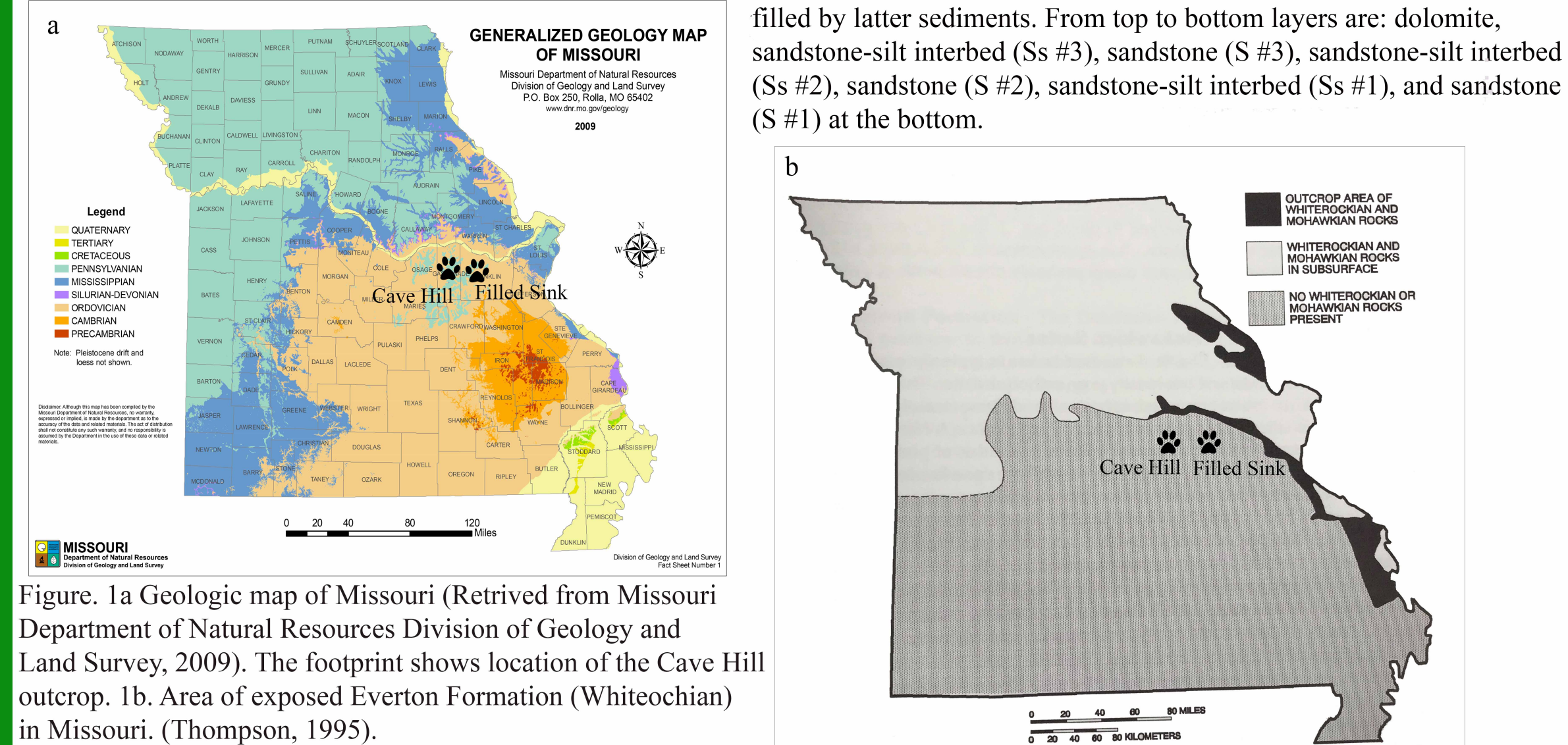
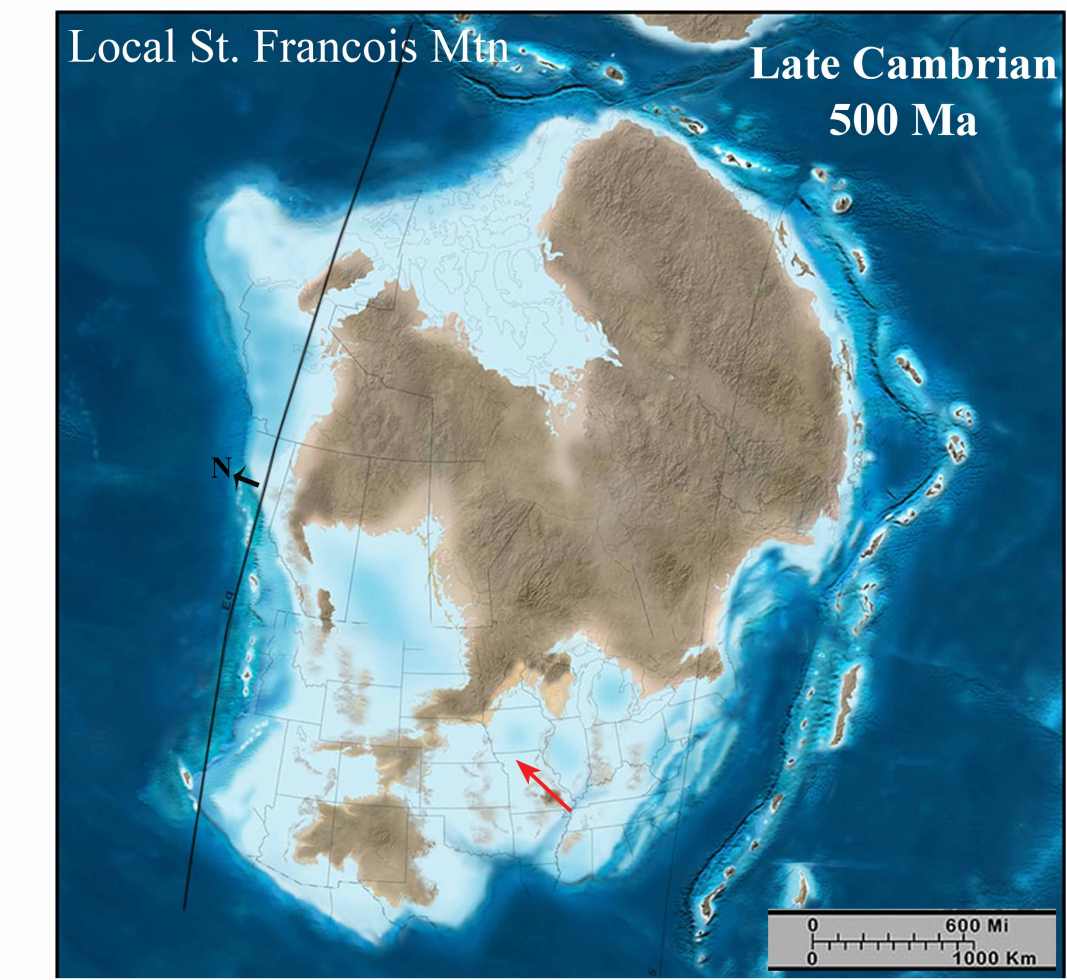


Figure 3. Detailed pictures of outcrop. 1. Chert in dolomite. 2. Silt chips in sandstone. 3. Chert conglomerate. 4. Sandstone in silt. 5. Silt "coated" sandstone pebble. 6. Gravels in sandstone.



Discussion

Previously, "Cave Hill" and "Filled sink" to the east of "Cave Hill" were interpreted as "Pennsylvanian". However, the younger clastics at Cave Hill are similar in composition and style to the basal Middle Ordovician Everton Formation - sandstone, +/- silt, overlain by sandy dolomite. Thompson (1995) describes the Everton as "The sandstone contains silt and the sand grains are rounded and pitted. Chert with shape of lenses and nodules are sporadically distributed throughout most of the formation". In addition, the detrital zircon "fingerprint" of the "Cave Hill" is best matched by clastics of known Ordovician age and not by Pennsylvanian age strata.

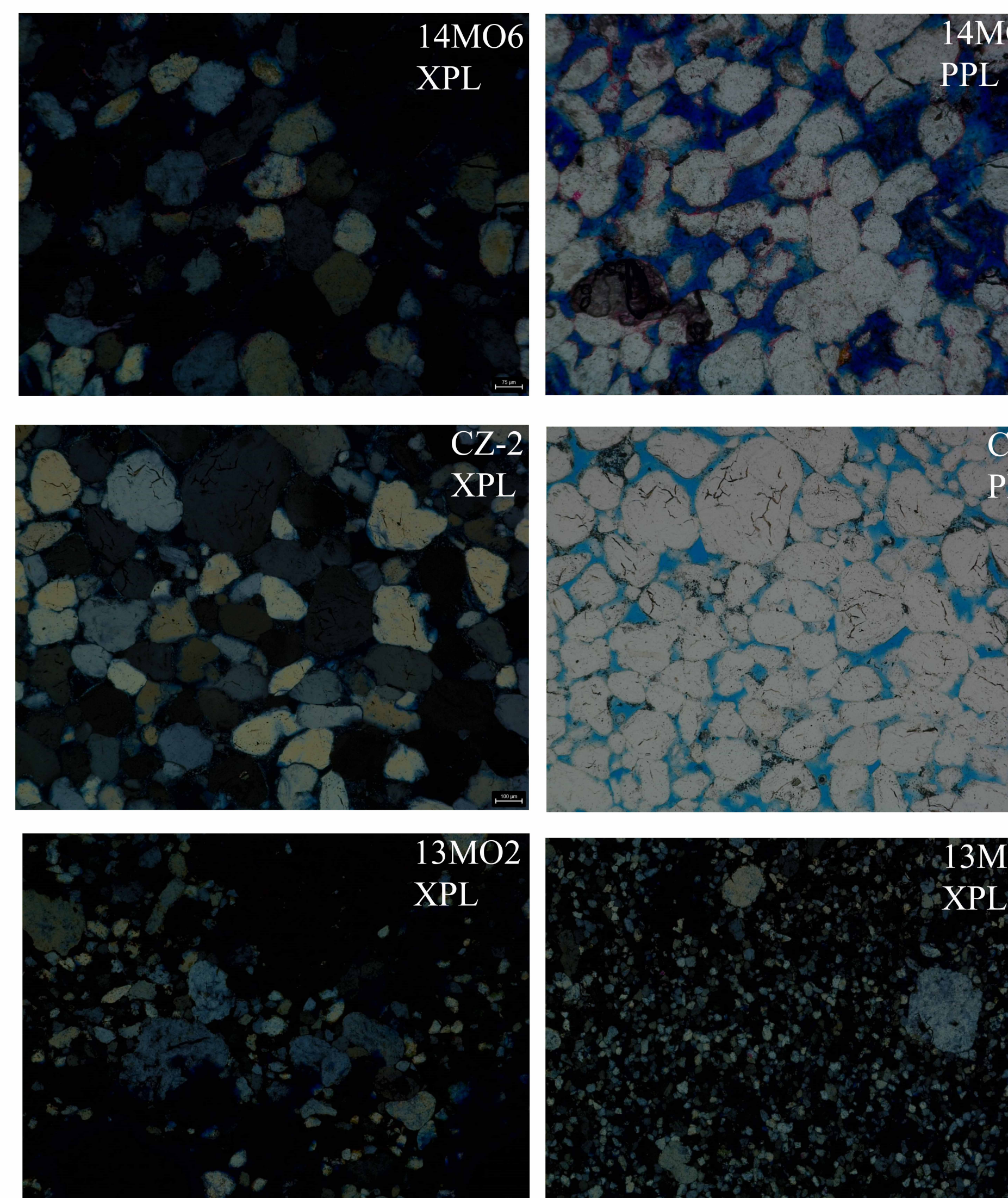


Figure 4. Thin section images from "Filled sink" (14MO6), "Cave Hill" (CZ-2), and St. Peter Sandstone (13MO2). Compared these images, 14MO6 resembles CZ-2. Both have pits, overgrowth and similar grain size. Red arrow pointed pits in grains. 13MO2 has less in common with 14MO6 and CZ-2. Scale bar in 14MO6 is 0.075mm, in CZ-2 is 0.1mm, in 13MO2 is 0.25mm.

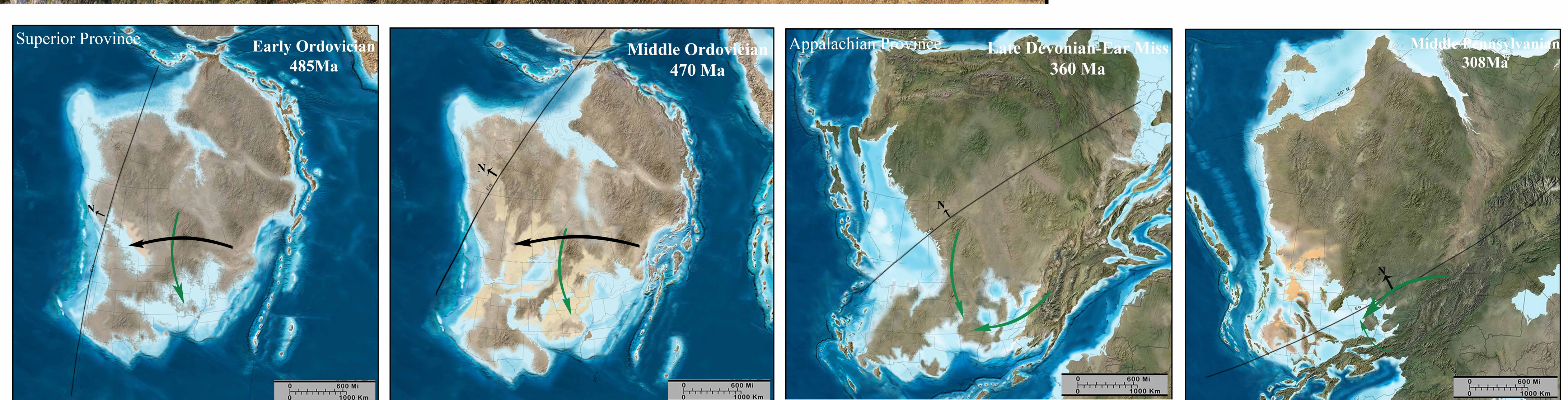
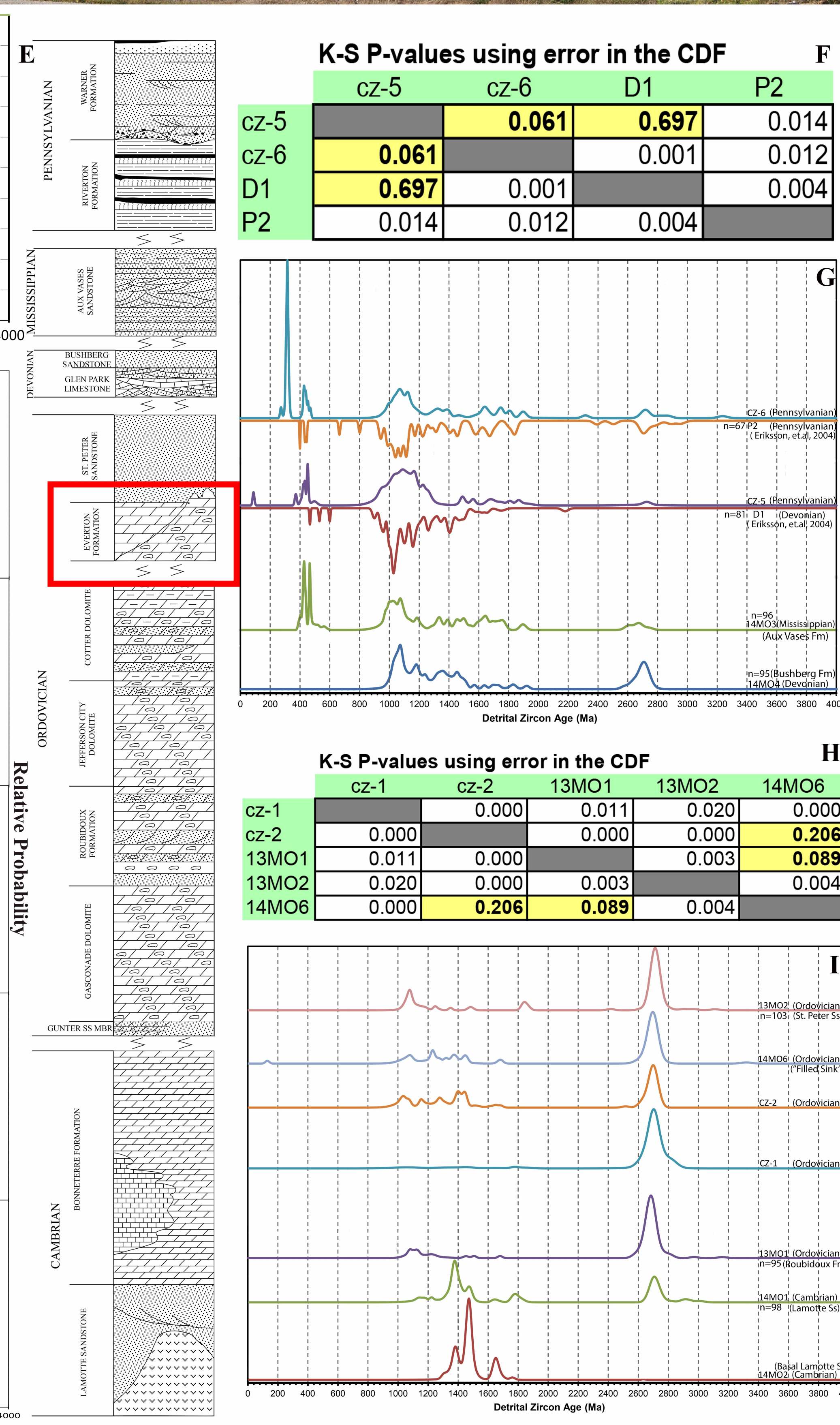
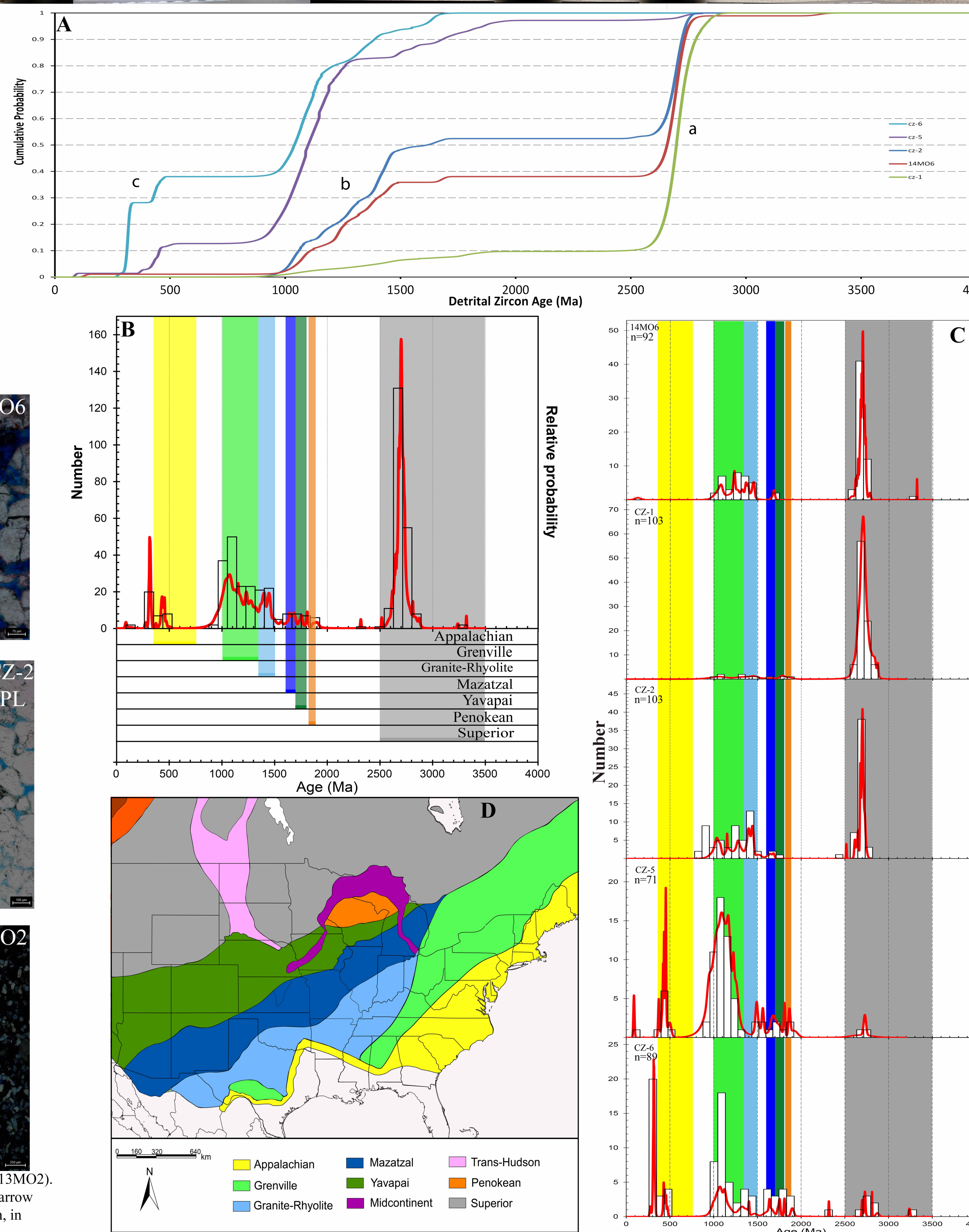


Figure 6. Schematic paleogeographic map with dispersal path (arrows) edited after Blakey, 2013.

Figure 5. A. Cumulative age probability curve. B. Combined normalized age probability plot for CZ-1, CZ-2, 14MO6, CZ-5, and CZ-6. C. Normalized age probability plot of individual samples. D. Map of main age provenances in south Laurentia edited after Whitemeyer & Karlstrom, 2007. E. Lithologic column of Missouri, edited after Thompson, 1995. F. K-S test of Pennsylvanian samples. G. Normalized age probability plot comparing Devonian to Pennsylvanian samples. H. K-S test of Ordovician samples. I. Normalized age probability plot comparing Cambrian to Ordovician samples.

CZ-5 & CZ-6 from Pennsylvanian Warner Formation. Provenance shifting is indicated by Fig 5A&C. In Fig 5A, provenance shifted from a-Superior province to c-Appalachian province with stable minor c-Grenville. This shift can be also observed in Fig 5C. In Fig 5E, the unconformity (red rectangular) is the surface in Fig 2 marked by yellow dashed line. The K-S test, a statistical detrital zircon provenance comparison, indicate derivation from the same provenance when the P-values are >0.05 (marked by yellow). In Fig 5F, the provenance for CZ-5 matches well with the Appalachian foreland basin consistent with sources for basal Pennsylvanian strata in MO originating from uplifted Appalachian foreland basin. 14MO6 matches well with CZ-2 and 13MO1 (Fig 5H). While, CZ-2 does not match 13MO1. This "mismatch" implies Roubidoux sandstone (13MO1) was uplifted and eroded locally near the "Filled sink". Although 13MO2 and CZ-2 are "coeval", "Everton" sandstones have a different source than the "Filled sink".

Summary

1. The provenance for Paleozoic clastics on the Ozark Plateau shifted: 1) from local St. Francois Mountains to Superior Province in Ordovician. 2) from the Superior Province to East Laurentia after the uplift of Appalachian Mountains during Devonian orogenic activity.
2. CZ-5 & CZ-6 might be the base of the Pennsylvanian Warner Formation.
3. The "Filled sink" likely contains grains recycled from the Roubidoux Formation. We suggest the erosional unconformity at "Filled sink" was produced in Sub-Tippecanoe and likely cut into Roubidoux Formation.
4. "Cave Hill" sandstones belong to the Everton Formation which is the basal unit of the Middle Ordovician in Missouri. We suggest the erosional unconformity at Cave Hill was produced in Sub-Tippecanoe and Cave Hill may be an incised valley fill.

Acknowledgement

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References

Bunker, B. J., Witzke, B. J., Watney, W. L., & Ludvigson, G. A. (1988). Phanerozoic history of the central midcontinent, United States. *Sedimentary Cover—North American Craton*: Boulder, Colorado, Geological Society of North America, The Geology of North America, 2, 243-260.

Eriksson, K.A., Campbell, L.H., Palin, M., Allen, C.M., & Bock, B., (2004) Evidence for Multiple Recycling in Neoproterozoic through Pennsylvanian Sedimentary Rocks of the Central Appalachian Basin, the Journal of Geology, volume 112, p. 261-276.

Gehrels, G.E., Blakey, R., Karlstrom, K.E., J.M., Dickinson, B., & Pecha, M. (2011). Detrital zircon U-Pb geochronology of Paleozoic strata in the Grand Canyon, Arizona, *Lithosphere*, 3(3), 183-200.

Muller, P.A., Foster, D.A., Mogk, D.W., Wooden, J.L., Kamenov, G.D., & Vogl, J.J., (2007). Detrital chronology of the Uinta Mountain Group: Implications from the Grenville flood in southwestern Laurentia, *Geology*, v. 35, no. 5, p. 431-434.

Thompson, T. L. (1995). The stratigraphic succession in Missouri. Missouri Department of Natural Resources Division of Geology and Land Survey, 40.