DETRITAL ZIRCON GEOCHRONOLOGY OF PALEOZOIC TO LATE CRETACEOUS SILICICLASTIC STRATA OF THE OZARK DOME, SOUTHERN MISSOURI

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1 Abstract

Siliciclastic strata exposed in the Ozark Dome provide Late Cambrian to Late Cretaceous snapshots of an evolving paleogeography and regional to far-field tectonic events. Detrital zircon geochronology in the Ozark Dome reflect an evolving depositional environment involving two significant provenance shifts:

1) a Cambrian–Ordovician shift from local basement to Superior Province-derived detritus, attributed to the rise in base level associated with the Sauk transgression and/or the inversion of Proterozoic basins perched on Superior Province and midcontinent rift basement at the onset of the Taconic orogeny.

2) an Ordovician–Devonian shift to detritus sourced from the emerging Appalachian Mountains to the east. Westward transport of clastic sediment originating from the Appalachian highlands continued sporadically until at least Late Cretaceous time.

Additionally, the originally assigned “Pennsylvanian sink fill deposits” in the Ordovician Gasconade Dolomite is reinterpreted here as Ordovician in age on the basis of petrographic and detrital zircon age similarities between this unit and the St. Peter Sandstone and cross cutting relationships with the surrounding strata.

2 Background

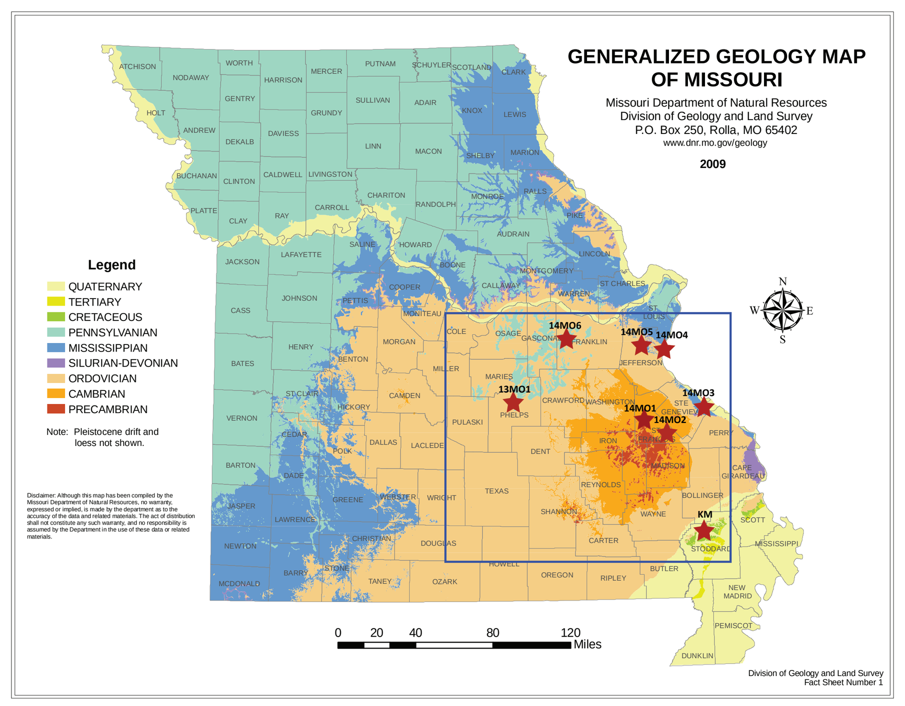


Fig. 1 Geologic map of the study area, southeastern Missouri (Map from Missouri Department of Natural Resources Division of Geology and Land Survey, 2009). Red stars indicate locations where detrital zircon samples were collected.

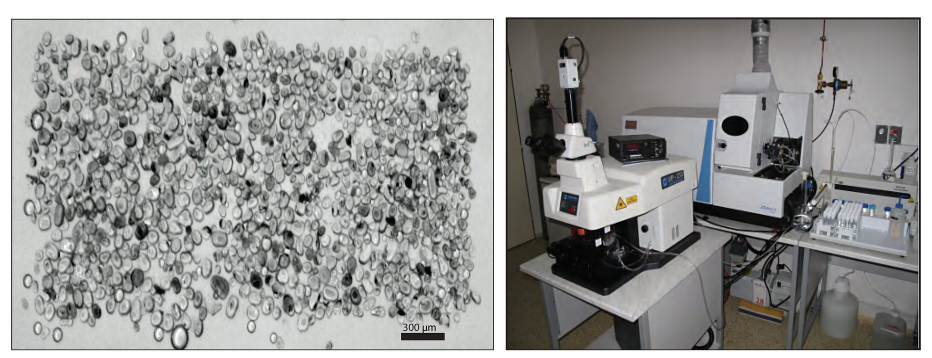


Fig. 2 Detrital zircon geochronology study.
Left: Zircon analyzed using a laser ablation mass spectrometer system to determine their age through uranium-lead isotopic ratios. The image is rounded zircon from the St. Peter sandstone (13MO2). Right: laser-ablation–inductively coupled plasma–mass spectrometer (LA-ICP-MS) (Internet reference 1).

The Ozark Dome is an asymmetric uplift of the Earth's crust with the apex located in southeastern Missouri. The repeated rising and falling of the sea deposited a series of sandstones, limestones and dolomites of unknown provenance. Our samples are collected from clastic intervals in this otherwise carbonate-dominated sedimentary system to help better understand the origin of this region. Among the 8 samples, the originally assigned Pennsylvanian age sandstone 14MO6, that fills a sinkhole in the Ordovician Gasconade Dolomite is reinterpreted here as Ordovician in age (further discussion is provided later).

Detrital zircons are ubiquitous in sandstones, due to its highly resistance to both chemical and physical weathering. The U-Pb age of a single zircon grain is interpreted to reflect the time at which that grain crystallized within its parent rock. Here detrital zircon geochronology and petrography of these clastic sediments permit evaluation of the ultimate sources of these units, and the degree to which they have been reworked, the relative importance of sea level variations versus tectonic events.

3 Sandstone Petrography

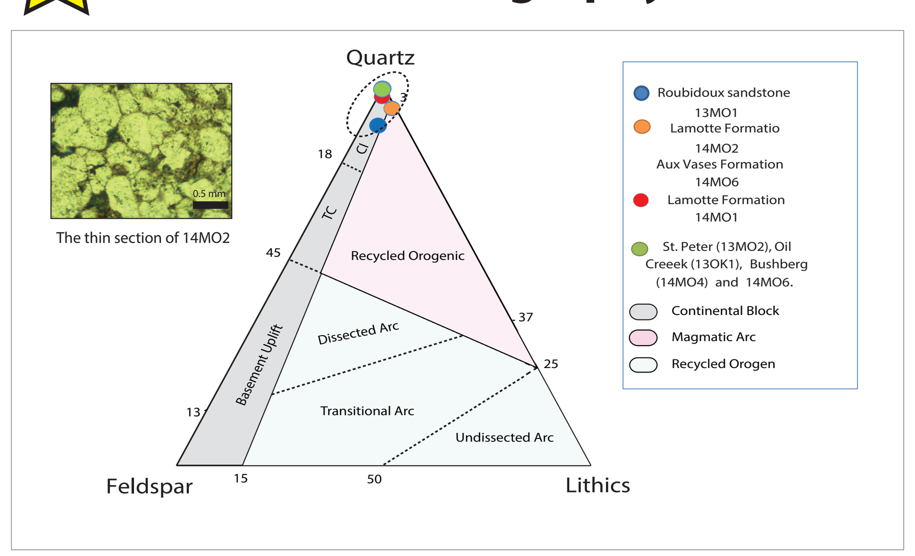


Fig. 3 QFL provenance diagram of the Paleozoic samples (Dickinson et al., 1983). Abbreviations: CI=Craton Interior, TC=Transitional Continental.

We performed point counts of the 8 Paleozoic samples. QFL provenance diagrams were constructed from the point counts. All the 8 Paleozoic samples are mature quartz arenites and suggest craton interior provenance. Although there are slight changes in feldspar and lithic fragment content, the textural maturity and compositional purity of such deposits leave few clues about the source of detritus.

4 Detrital Zircon Geochronology

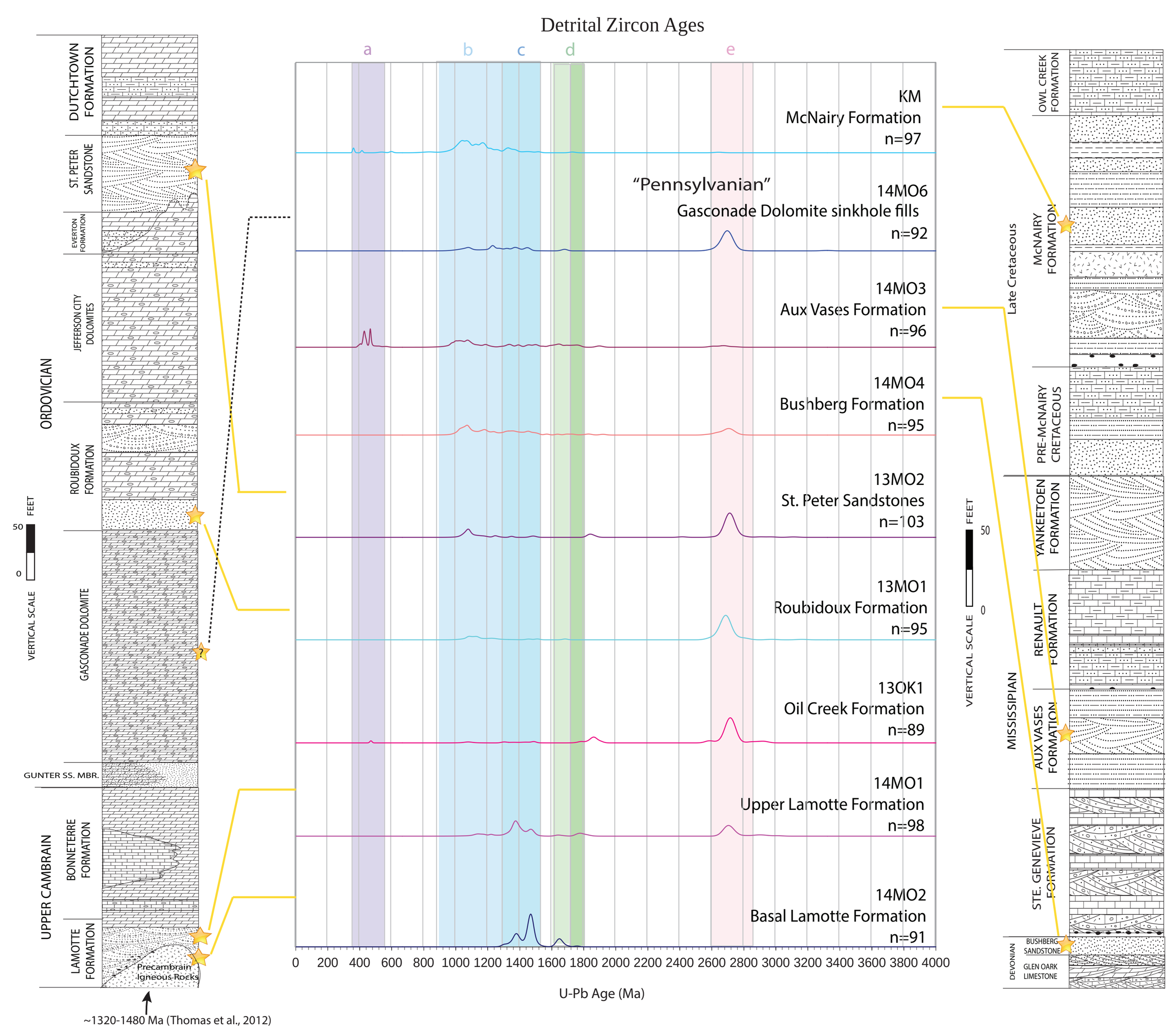


Fig. 4 Generalized Paleozoic to Late Cretaceous stratigraphy of Missouri (compiled from Thompson, 1995), showing the location of the samples discussed in this study. The detrital zircon normalized probability curves for each sample are also shown. The colored bands indicate the ages of important nearby basement terranes (from left to right): (a) Appalachian orogen, (b) Grenville orogen and midcontinent rift, (c) anorogenic granite-rhyolite suite, (d) Mazatzal-Yavapai orogens, (e) Superior Province (Gehrels et al., 2011; Konstantinou et al., 2013).

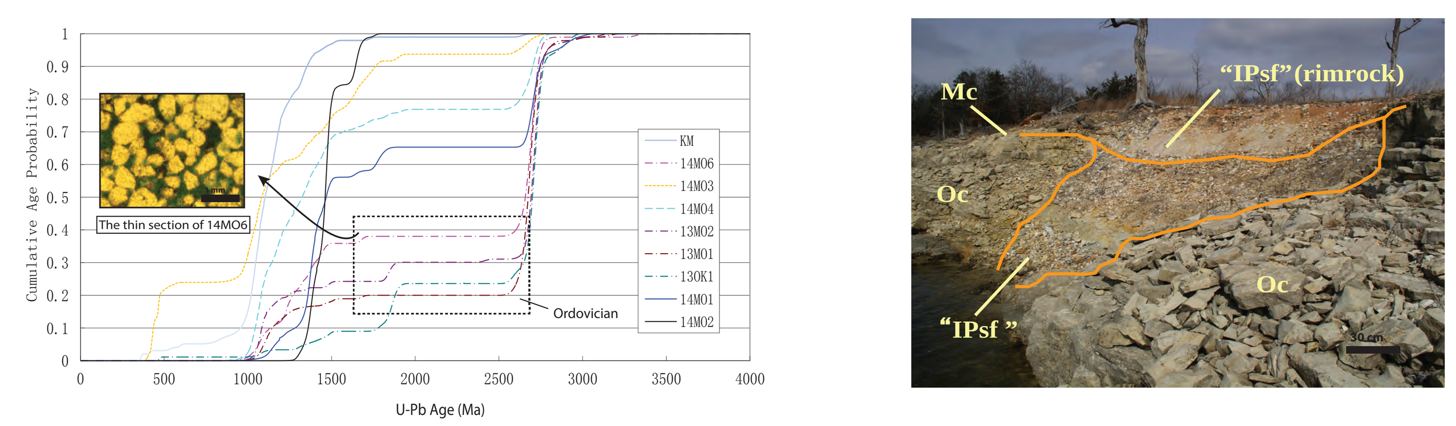


Fig. 5 Left: Detrital zircon cumulative probability plot of each sample. Right: The typical outcrop originally assigned “Pennsylvanian filled-sink (IPsf)” deposits. Both sides are bounded by the Ordovician Cotter Dolomite (Oc). We can see exposure of the Mississippian Compton Limestone (Mc) in the distance (Little, 2004).

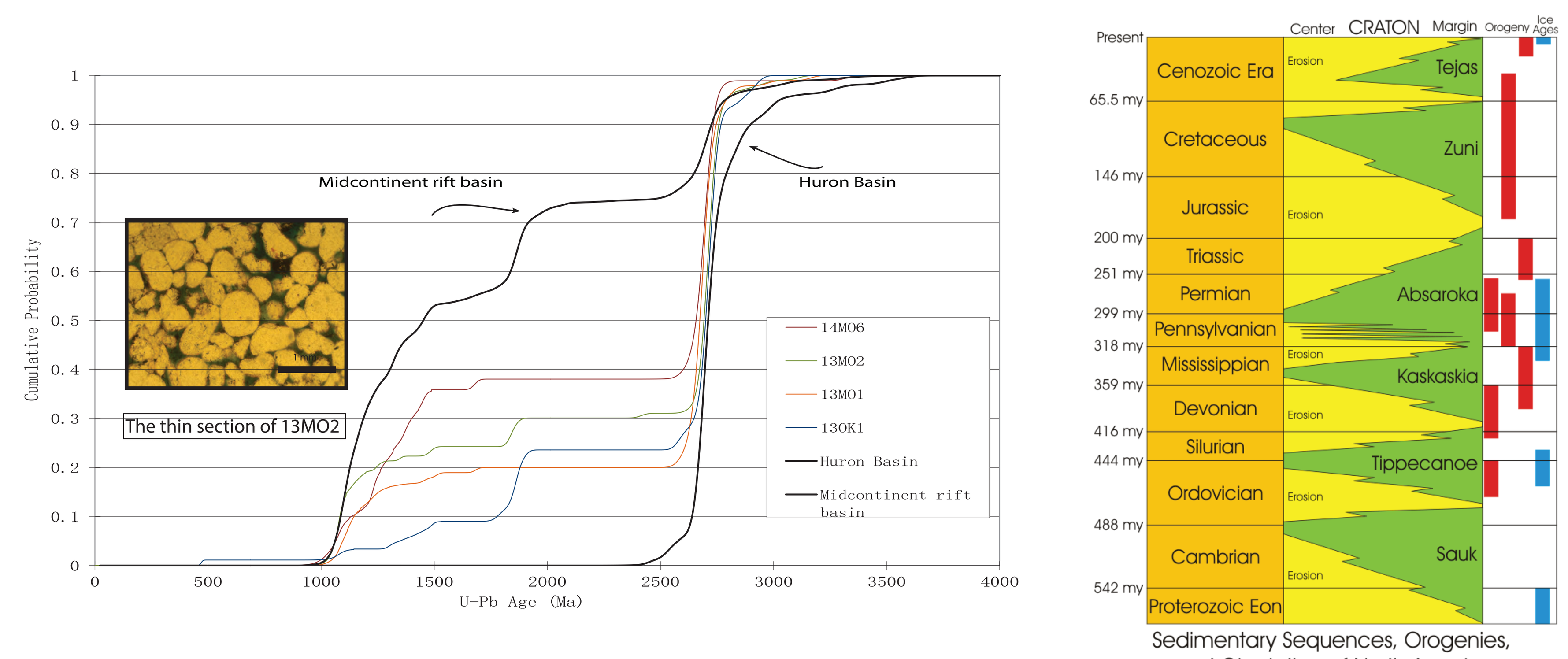


Fig. 6 Left: Mixing model of the Ordovician sediments between the Huron basin (data compiled from Rainbird, 2006) and the midcontinent rift basins (data compiled from Craddock, 2013). Detrital zircon cumulative probability density function plots of Ordovician samples and the two older basins. Right: Diagram showing time relationship of major transgressive and regressive sequences (Sloss, 1963).

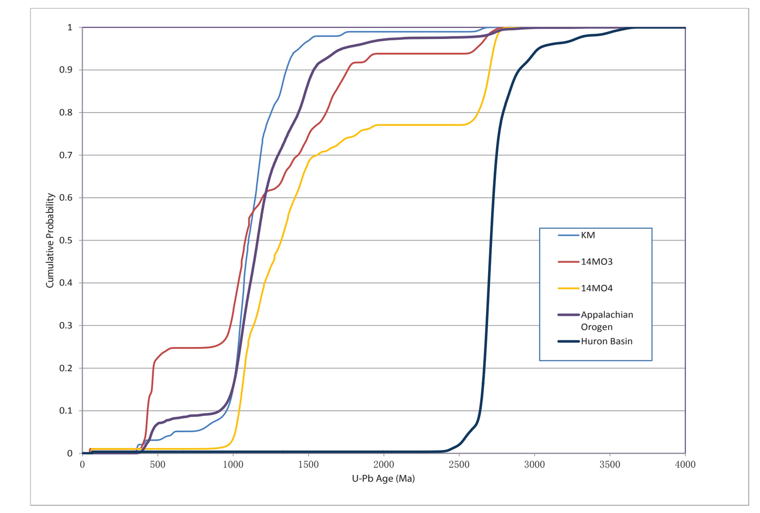
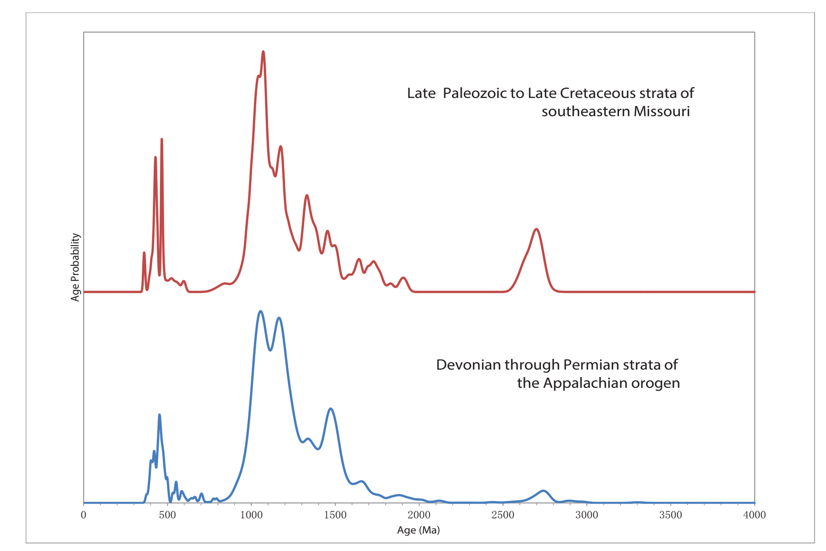


Fig. 7 Above: Mixing model of the late Paleozoic to Late Cretaceous sediments between the Huron basin and the Appalachian orogen. Detrital zircon cumulative probability density function plots of the late Paleozoic to Late Cretaceous samples, the Huron basin (Rainbird, 2006) and the Appalachian orogen (Park et al., 2010).

Below: Comparison of detrital zircon ages from late Paleozoic and Late Cretaceous strata of southeastern Missouri with detrital zircon age distributions from Devonian through Permian strata of the Appalachian orogen (Park et al., 2010)



5 Paleogeography

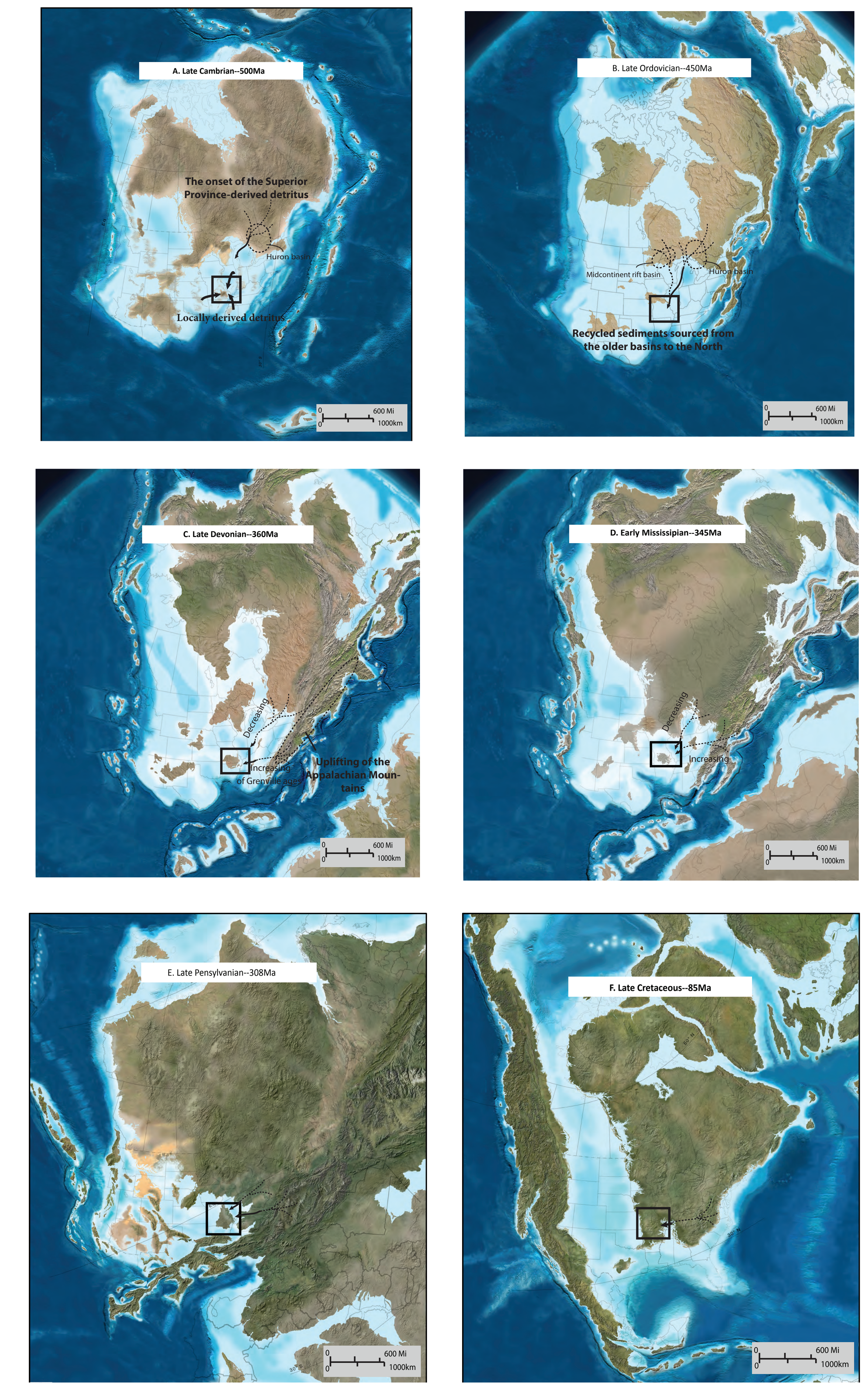


Fig. 8 Schematic depiction of interpreted paleogeography and sediment provenance during accumulation of Cambrian through Late Cretaceous sandstones of the Ozark Dome, Southern Missouri (map compiled from Ron Blakey, Colorado Plateau Geosystems, Arizona USA).

6 Summary

- The originally assigned “Pennsylvanian sink fill deposits” in the Ordovician Gasconade Dolomite is reinterpreted here as Ordovician in age.
- Cambrian sediments suggest locally derived detritus.
- Ordovician sediments shift from local basement to Superior Province-derived detritus.
- Devonian-Mississippian shift to detritus sourced from the emerging Appalachian Mountains to the east.

7 References

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