The Cause of Gas Saturation in the Coals of the Cherokee Formation (Desmoinesian Age) in the Cherokee and Forest City Basins, Mid-Continent, USA*

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Abstract

The cause of significant gas saturation in Pennsylvanian age coals and carbonaceous shale of the Cherokee Group, Cherokee and Forest City basins has been generally not well understood. Some coals are gas productive whereas others within the same strata are not. The Cherokee and Forest City basins are shallow intracratonic depressions that are sub-basins of the Pennsylvanian age Western Interior Basin. The coals in both basins were partially or completely subject to thermal maturation caused by migration of low temperature hydrothermal fluids expelled from the Anadarko, Ardmore and Arkoma basins in Oklahoma to the south that migrated north through the Cherokee and Forest City basins in late Carboniferous times. These fluids thermally altered the carbonaceous shale and coals within select areas of both basins causing significant gas generation. In both basins select seams are more highly gas saturated due to higher sulfur content in productive versus non-productive coals. The Riverton, Rowe, Weir-Pittsburg and Mulky coals and the Excello shale are gas productive in the Cherokee Basin. Only the Riverton coals in the Forest City Basin are productive. The area of primary production from unconventional reservoirs in the Cherokee Basin is also situated over the Silurian-Devonian age Chautauqua Arch. The coal bed methane production in the Forest City Basin is related to a localized intrusion(s) in the Leavenworth and Jefferson county area. Identifying the relationship between sedimentary thins, structural elements, timing of fluid migration, migration paths and sulfur contents of unconventional reservoirs provide an exploration model that can be useful in identifying potentially coal bed methane productive areas.

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The Cause of Gas Saturation in the Coals of the Cherokee Formation (Desmoinesian Age) in the Cherokee and Forest City Basins, Mid-Continent, USA

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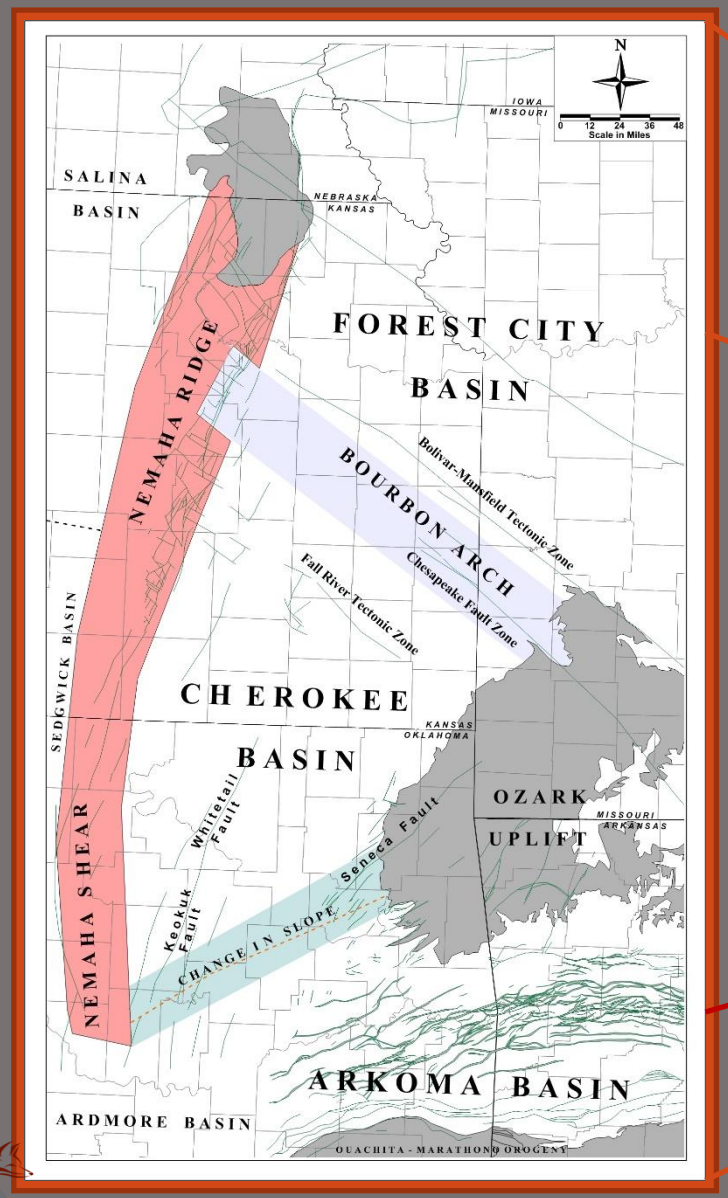
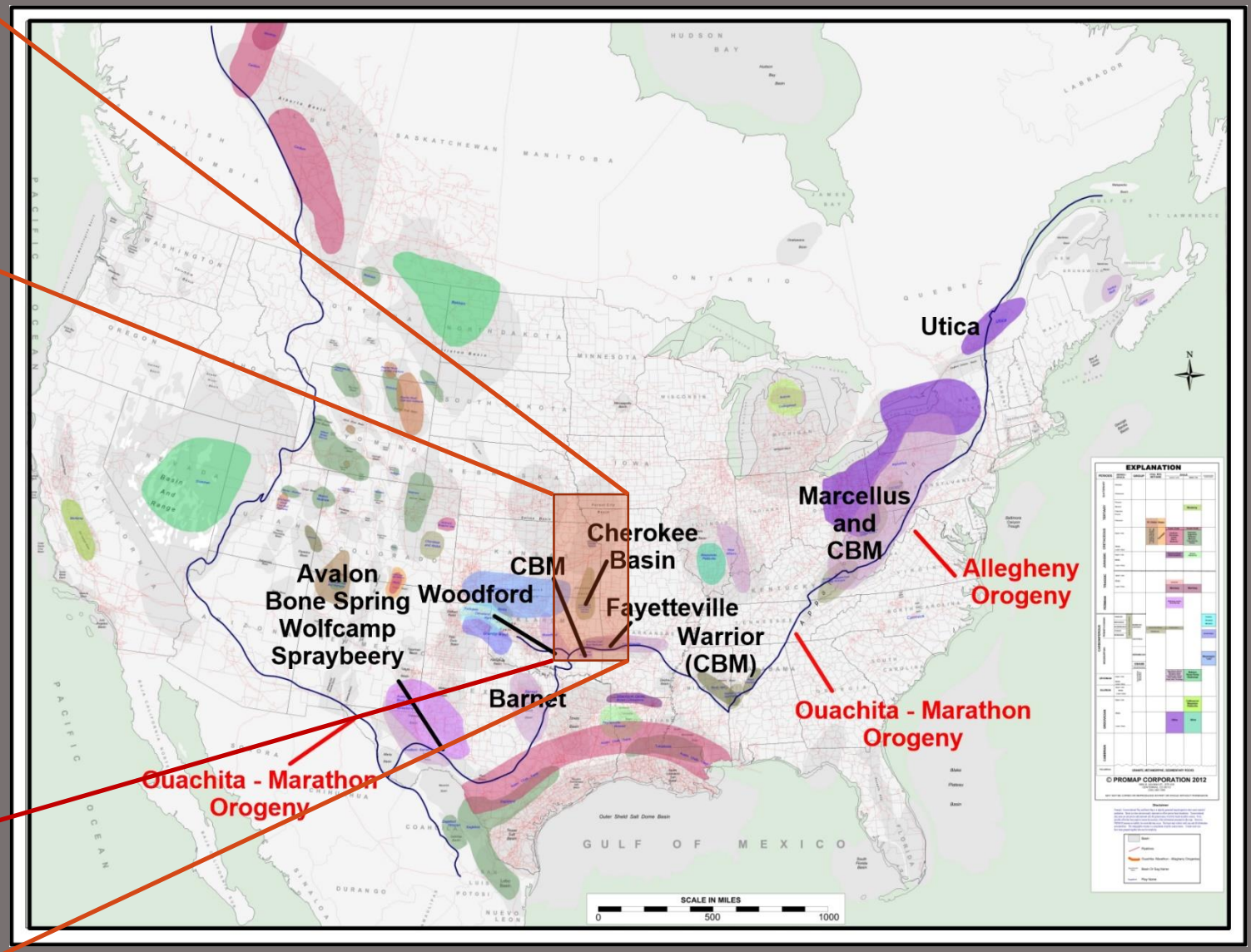
Location of the Cherokee Basin

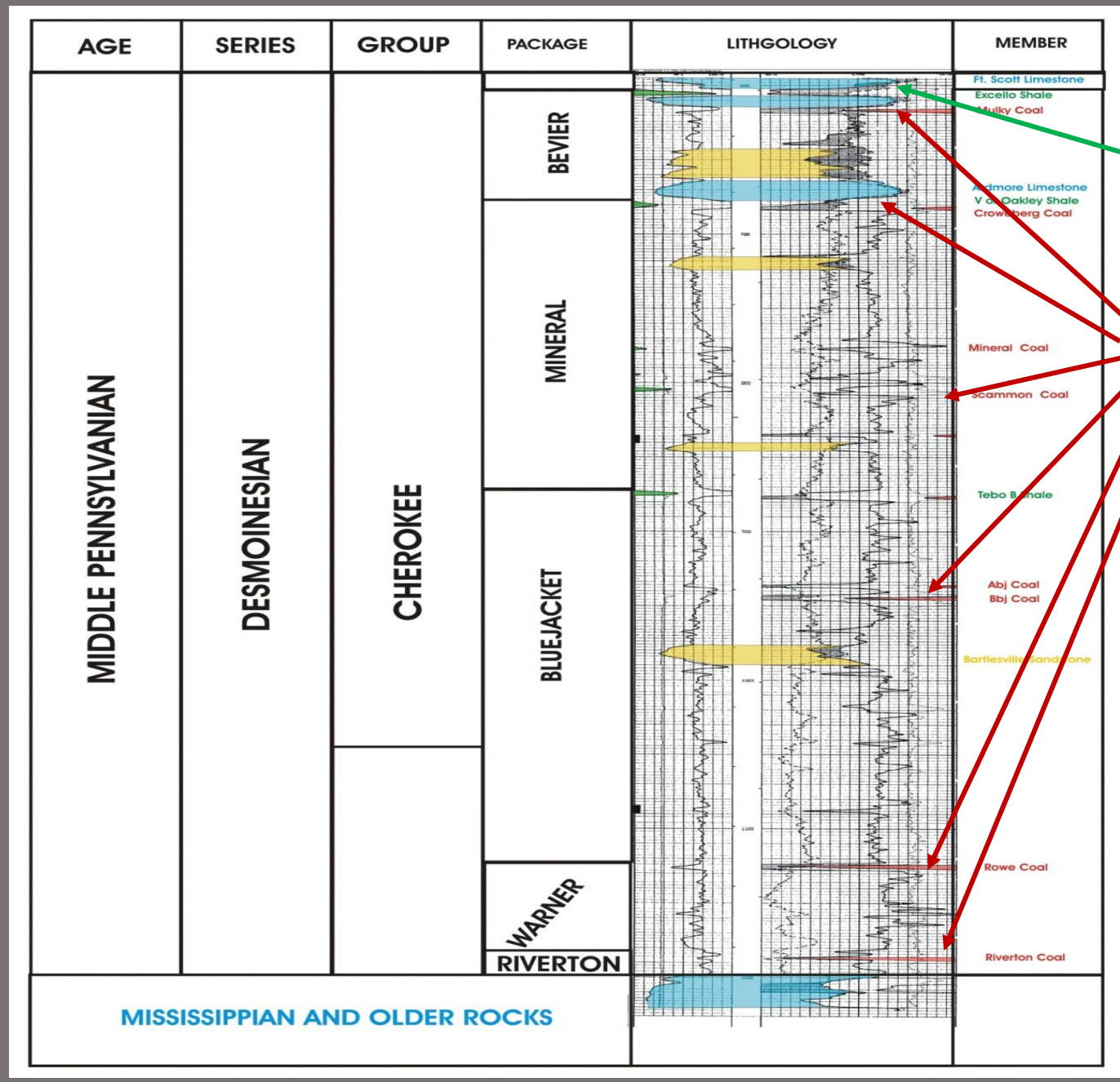




Promap, 2012

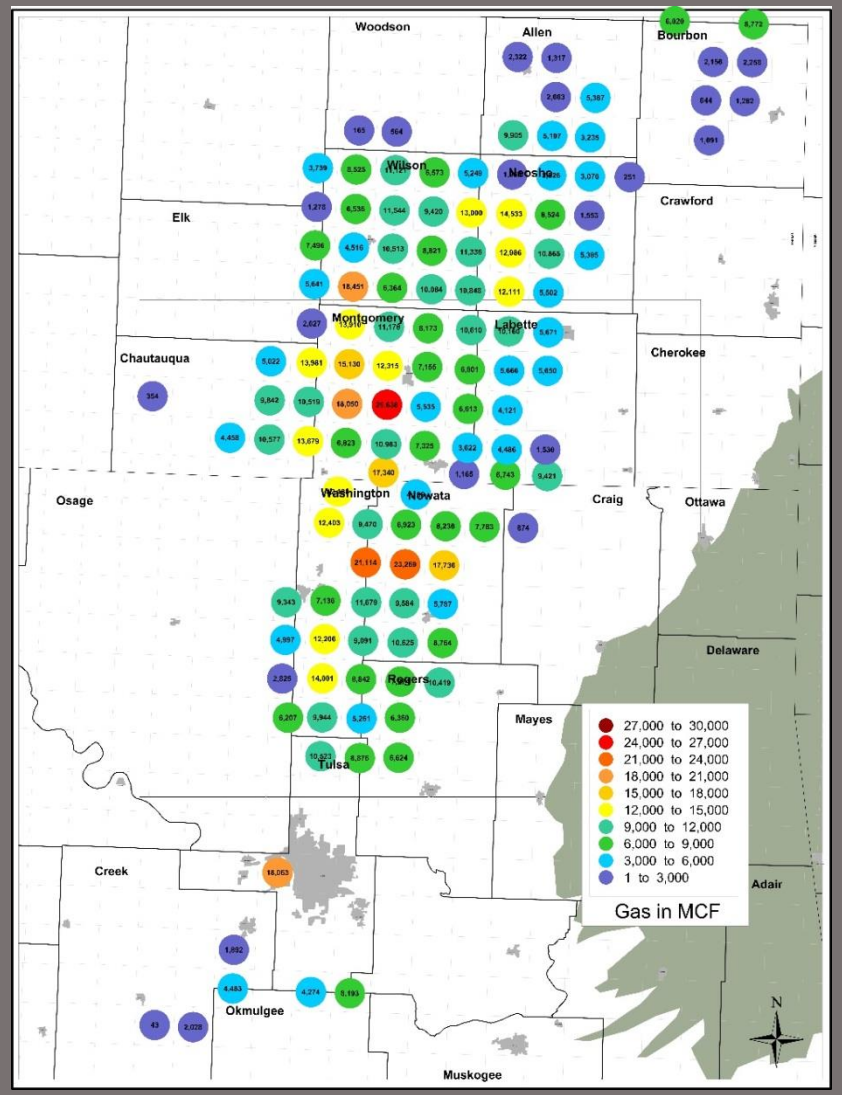
Typical Log for the Cherokee Basin

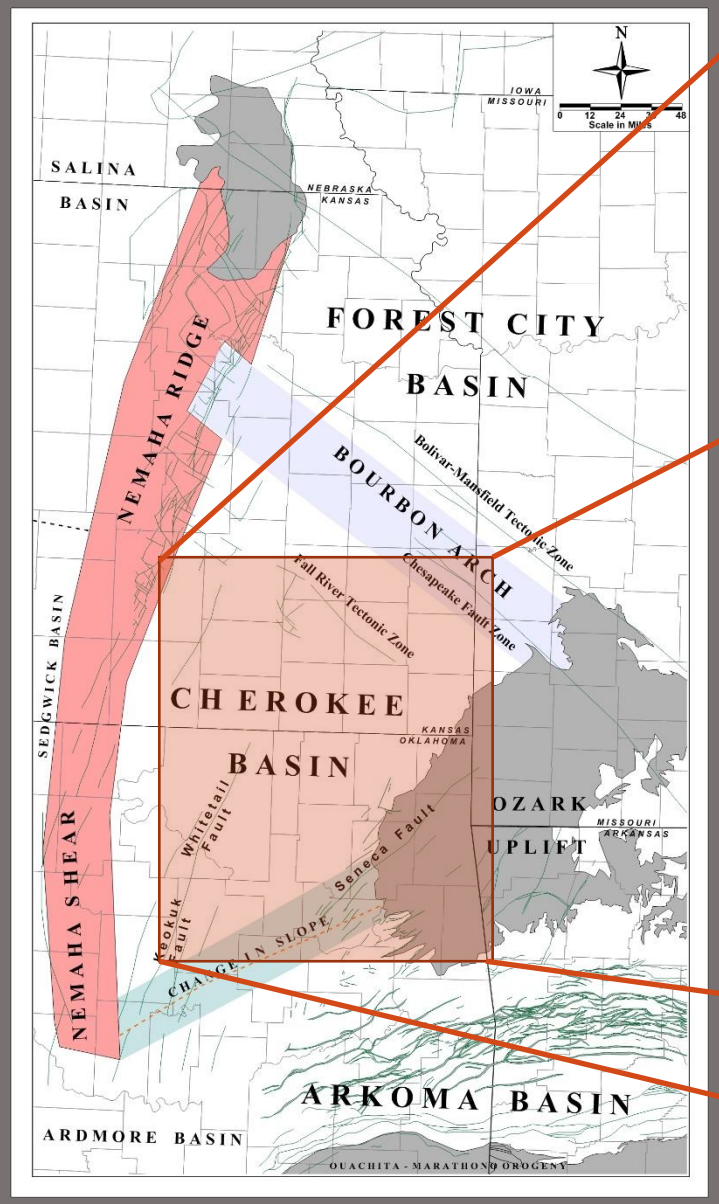
- Coals found in the Cherokee Group
- Depths - surface to 2,600 feet
- High sulfur coals
- Rank - High Volatile A Bituminous coal
- Coals contain thin ash lamination – 5 to 50%

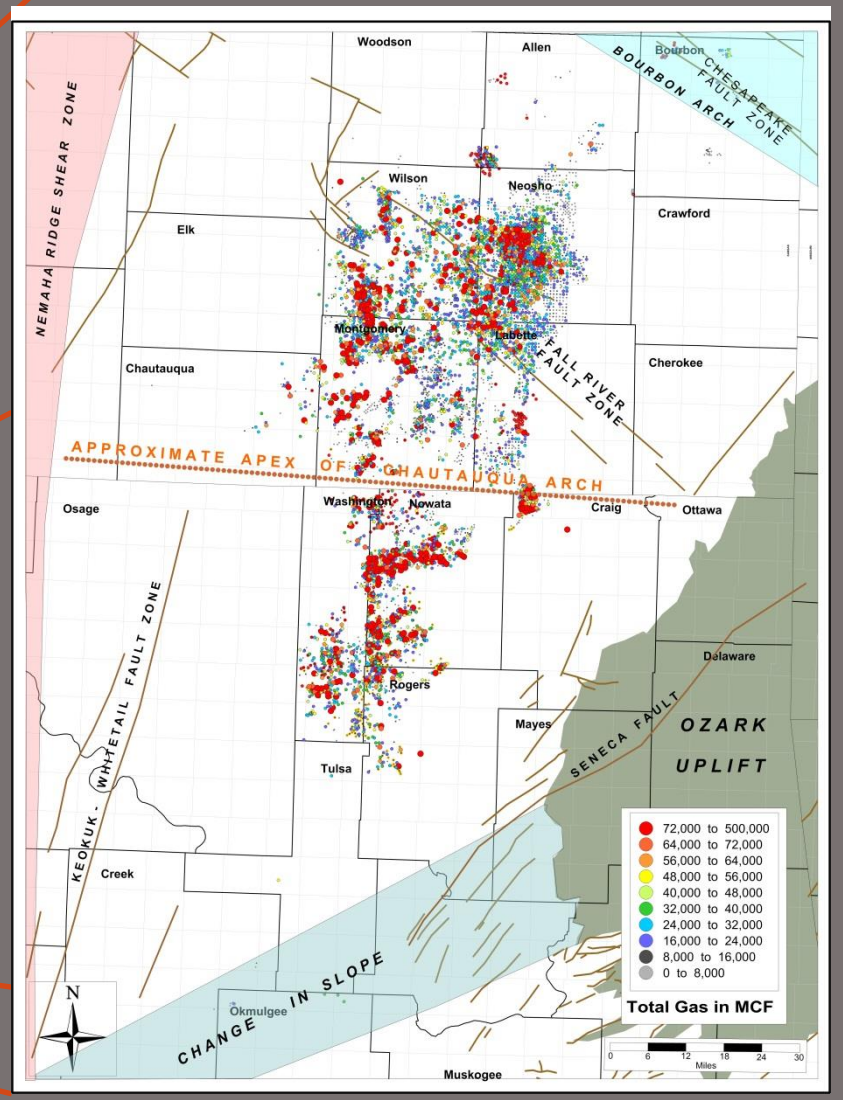


Tedesco, 2014

Cumulative Production up to 2011







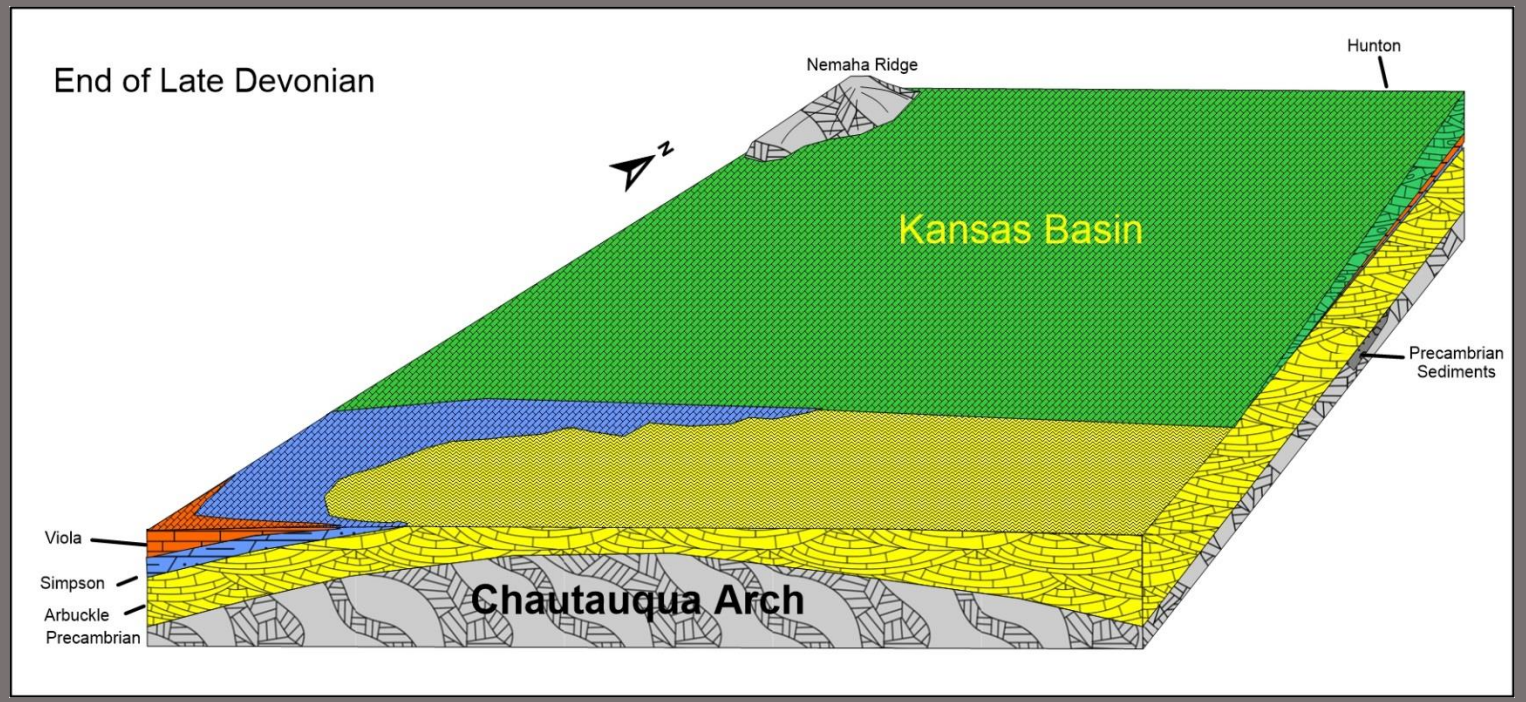
Tedesco, 2014

Depth of Burial Problem

- Cherokee and Forest City basins presently have maximum depth of 4,000 feet;
- Maximum depth of burial for both basins is 6,000 feet;
- Coal rank is High volatile B to Medium Volatile (oil window);
- Chattanooga-Woodford Shale is in the oil window;

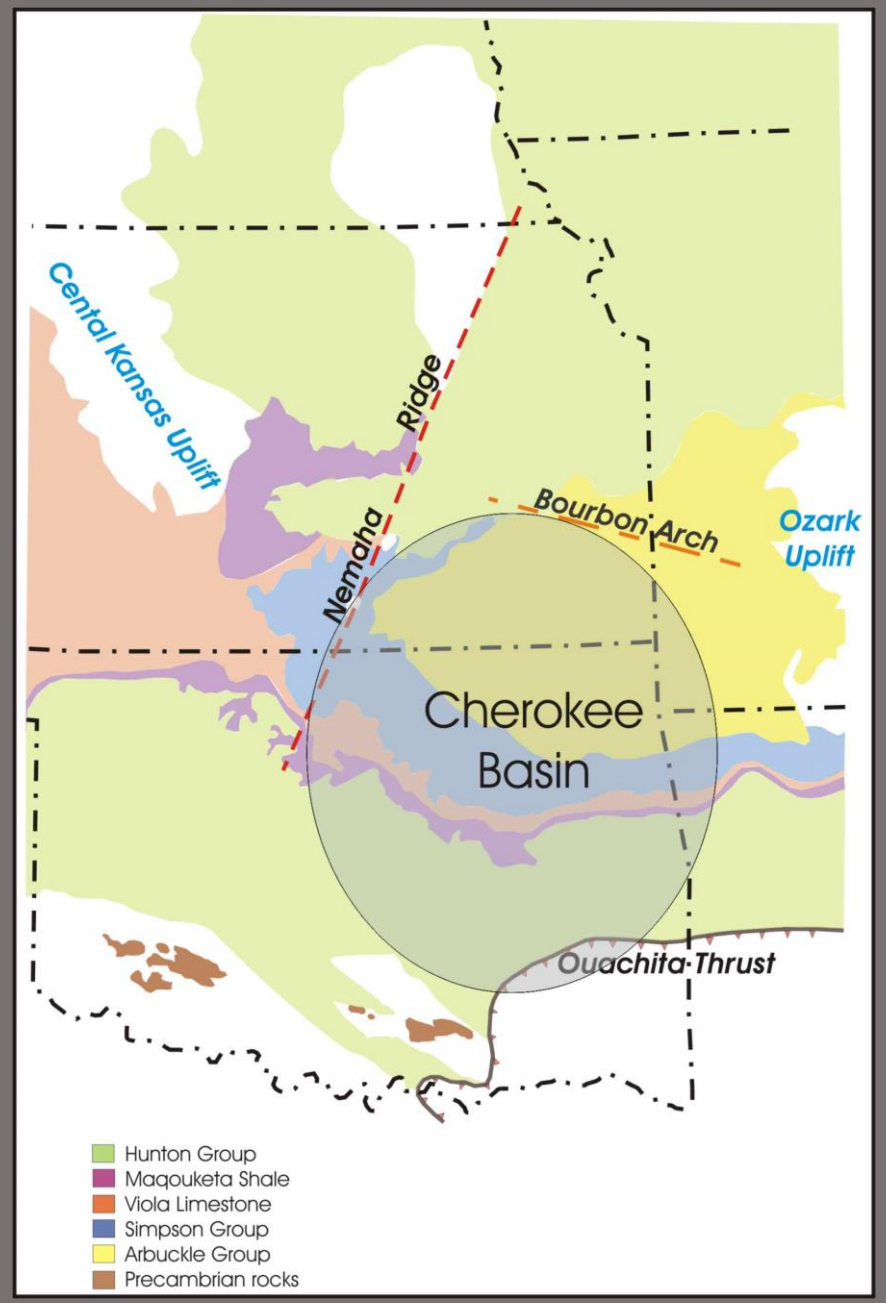
- Problem: how did the coals and gas shales become thermally altered sufficiently to produce gas?

Pre-Chattanooga Shale Paleogeography



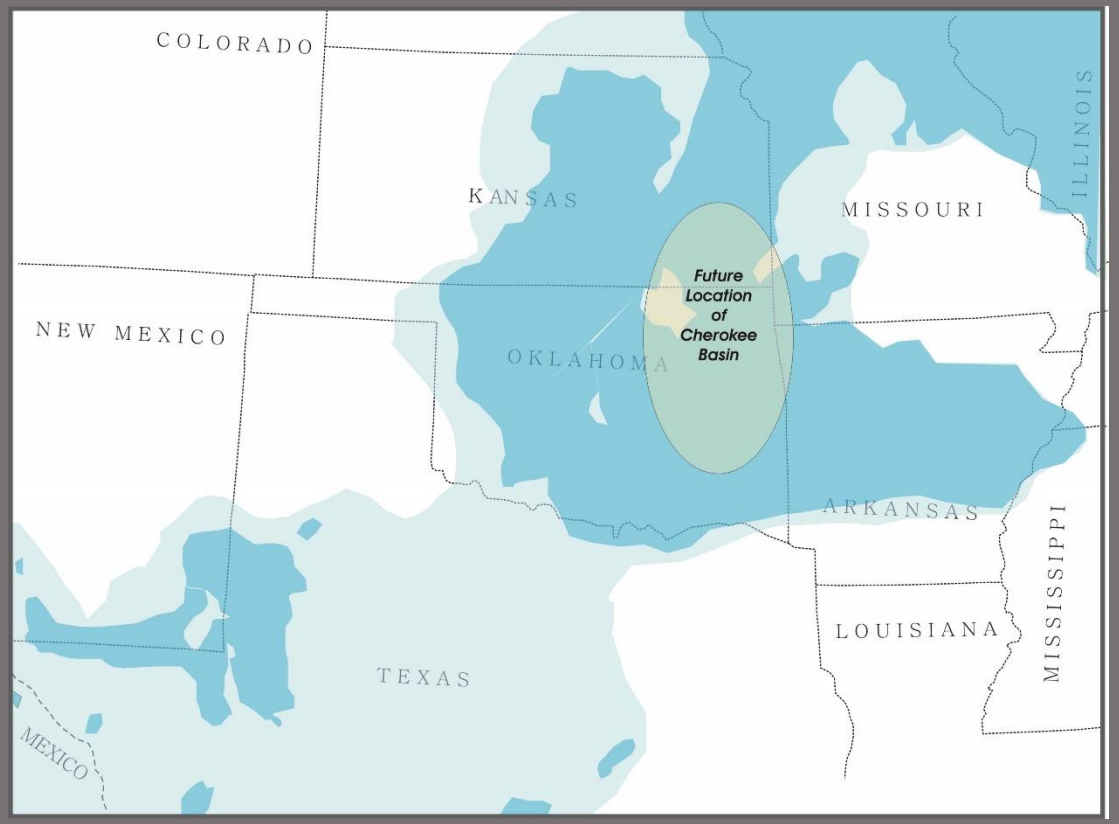
Tedesco, 2014

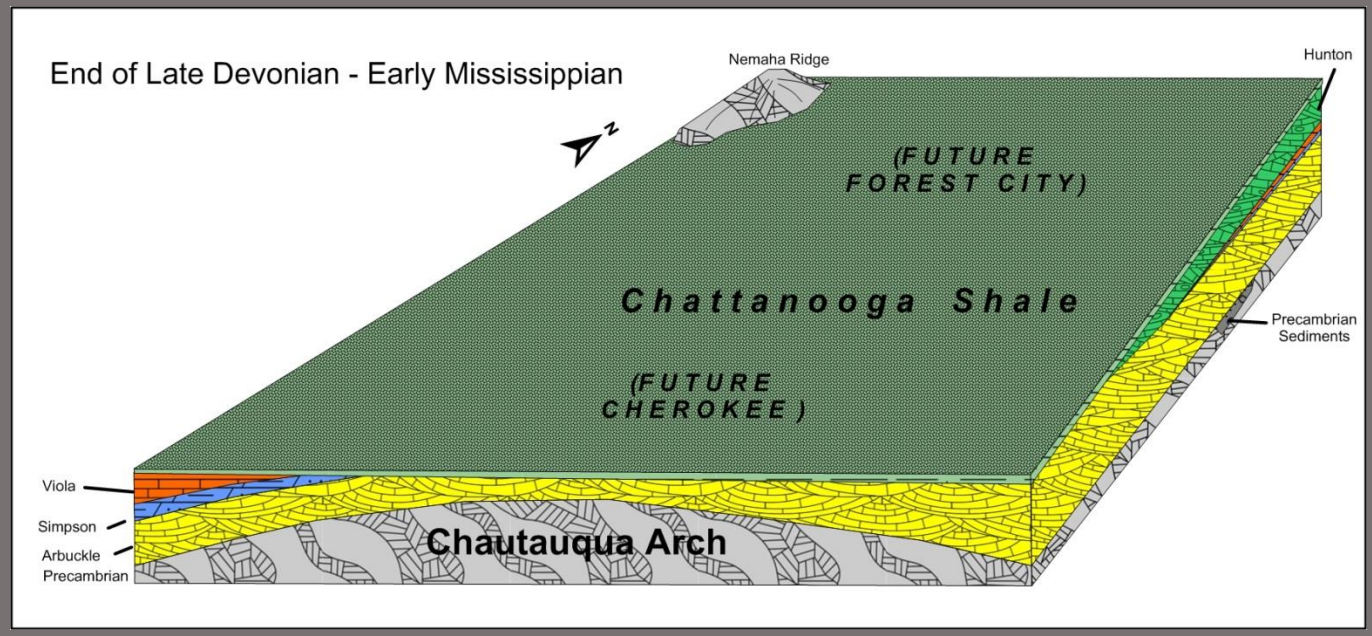
- Erosional surface across the Chautauqua Arch late Devonian



Adler et al., 1971

Stage 2 – Deposition of the Chattanooga –Woodford Shale



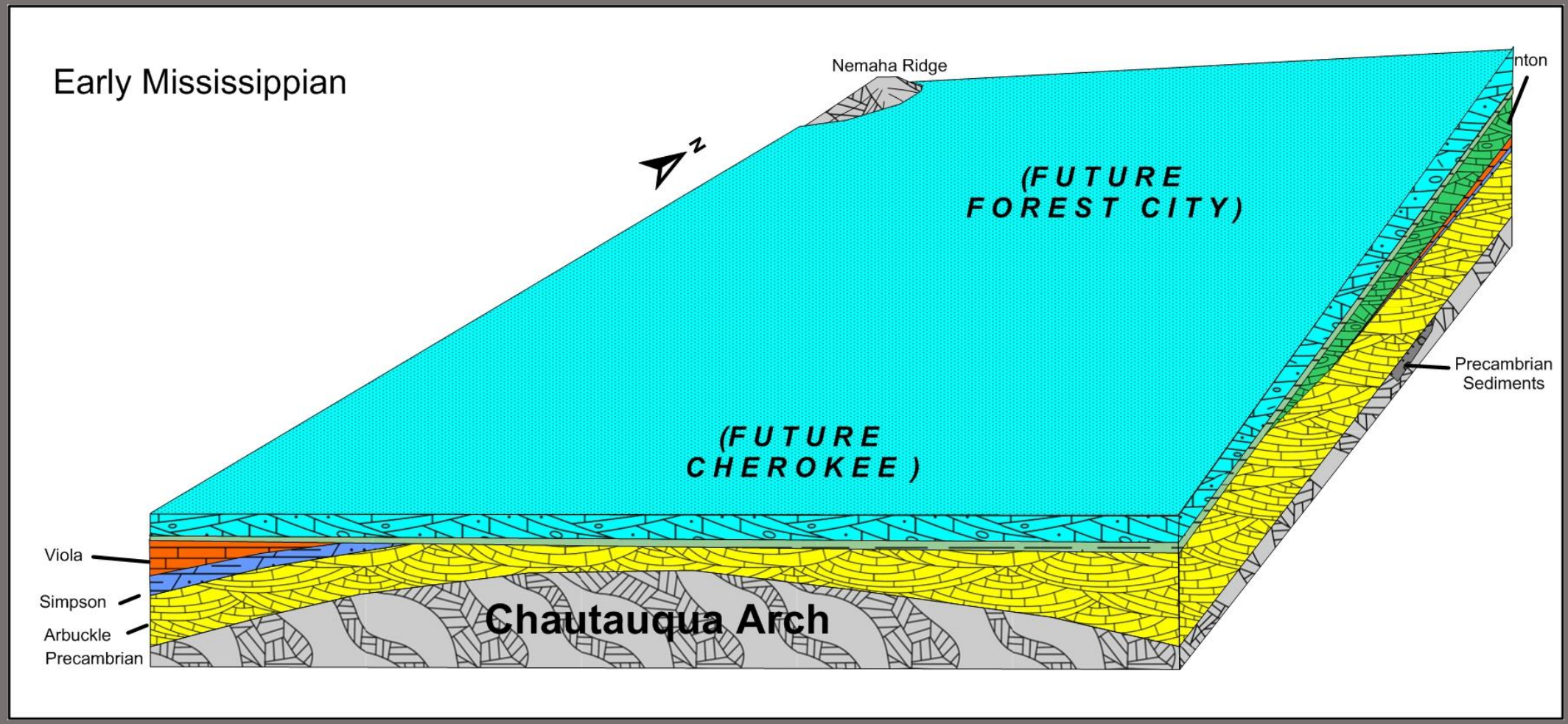


Tedesco, 2014

Conant and Swanson, 1963

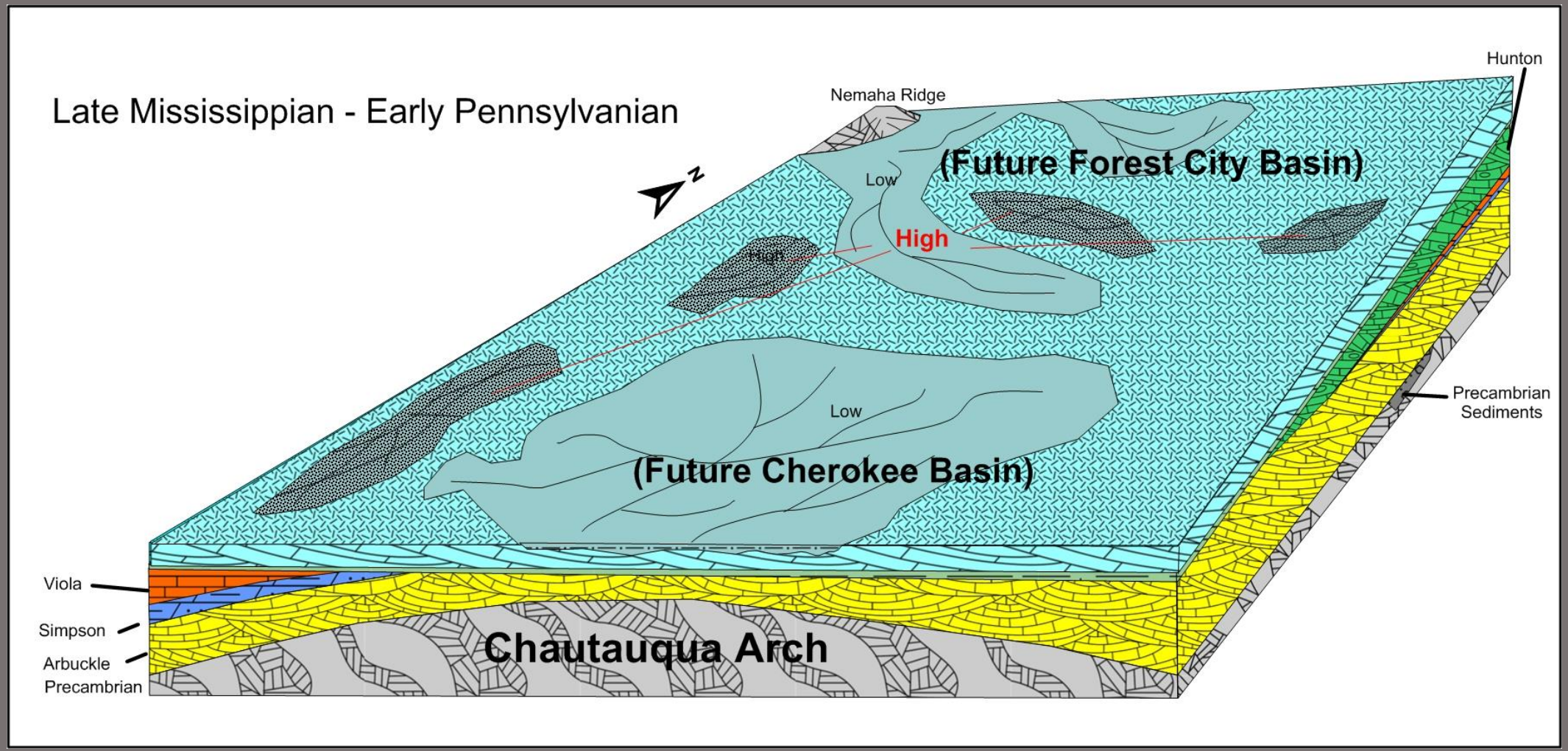
- Submerging of the Chautauqua Arch;
- Nemaha Ridge remains exposed.

Deposition of Mississippian sediments



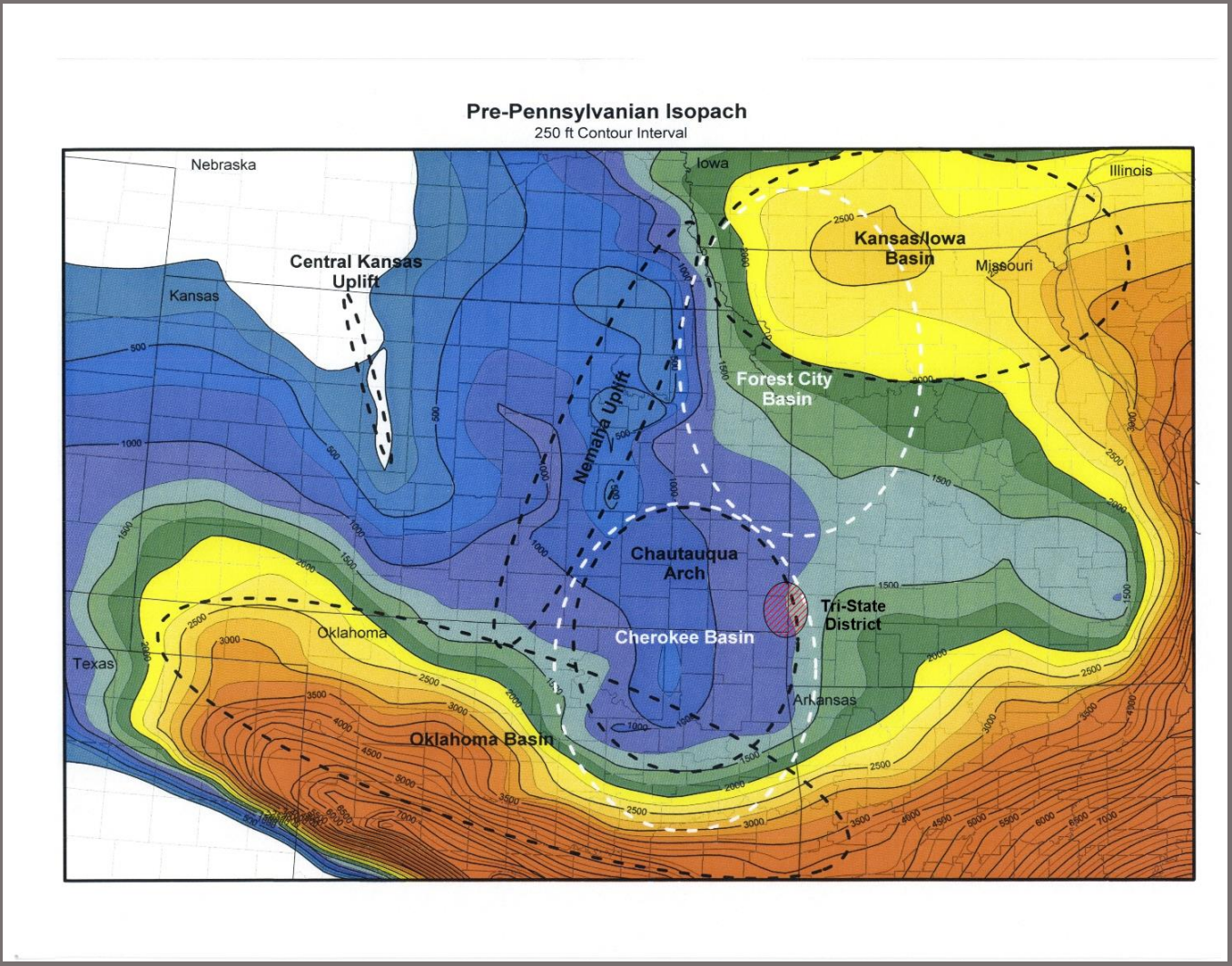
Tedesco, 2014

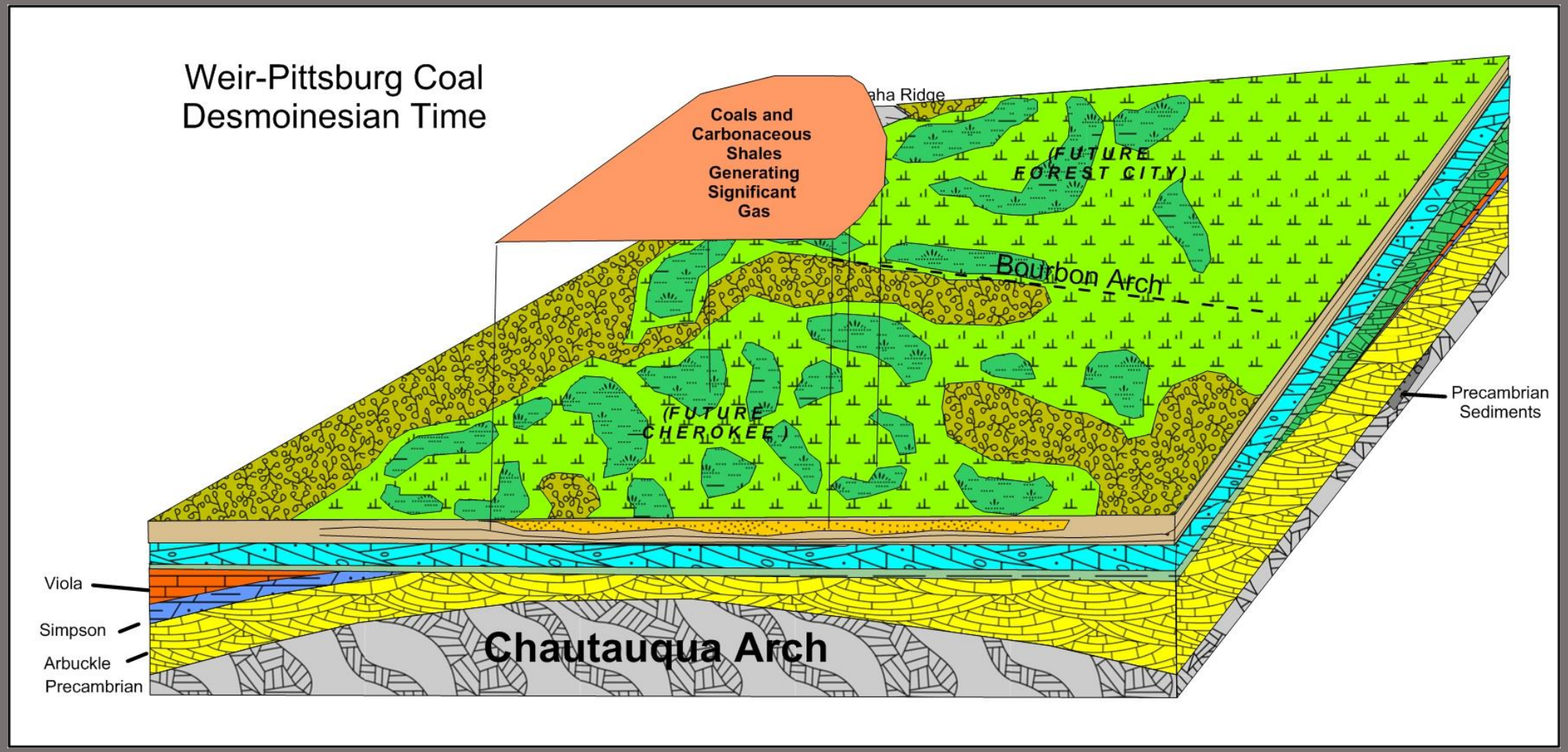
Erosion and Subaerial Exposure of Mississippian Sediments



Tedesco, 2014

Pre-Pennsylvanian Thickness of Paleozoic Rocks



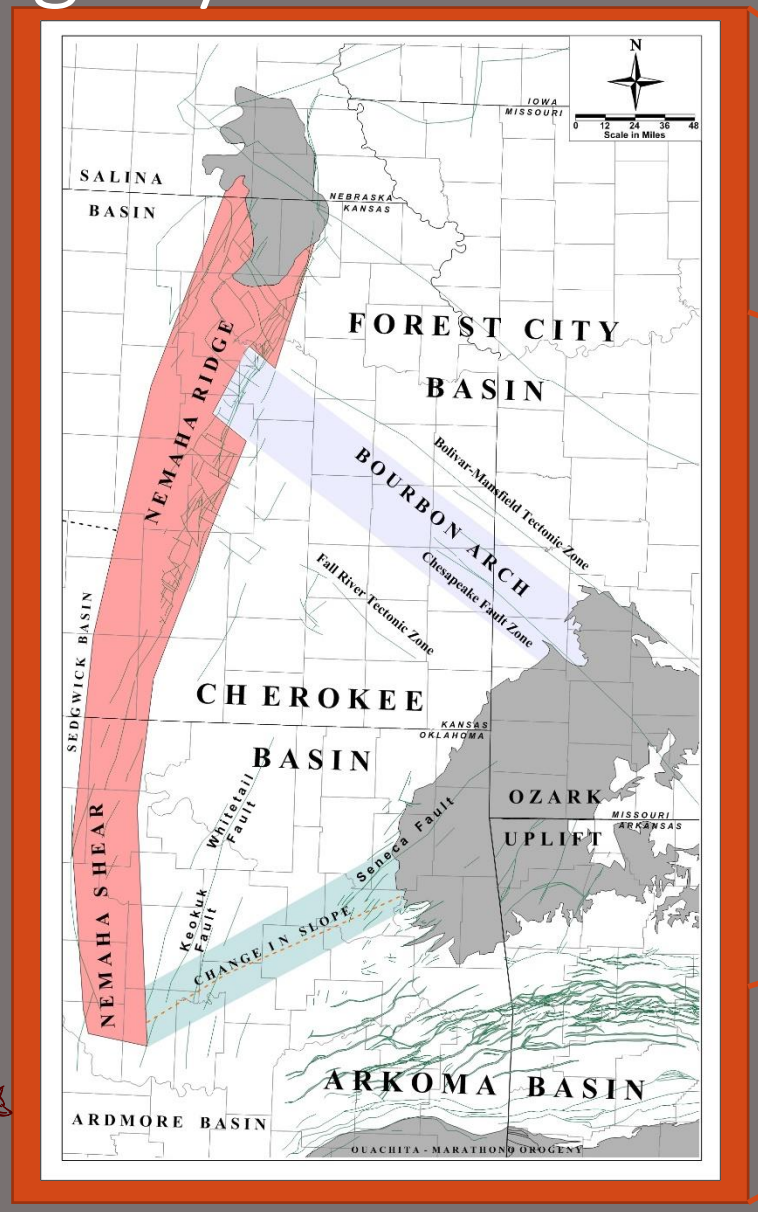


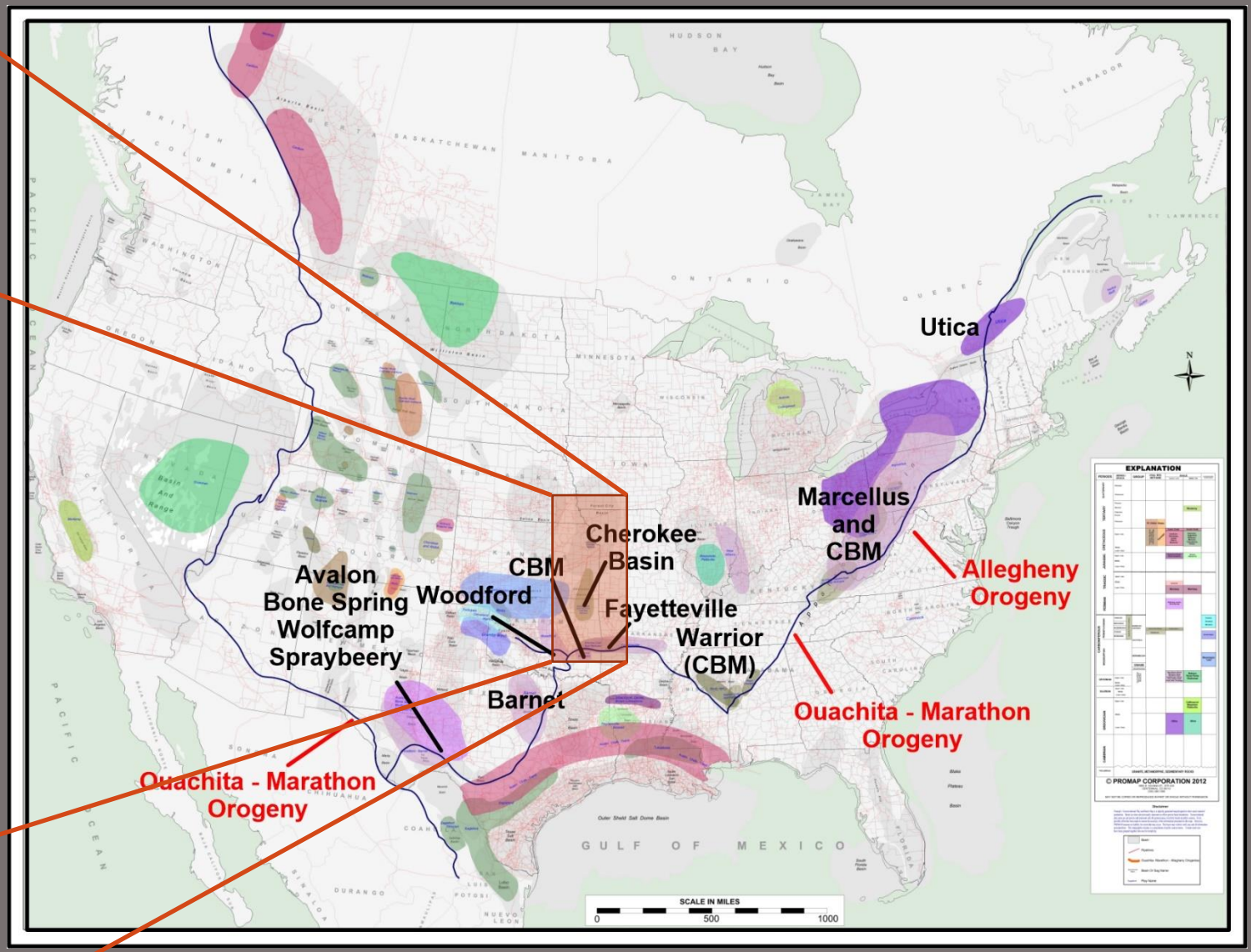
- Deposition of Morrow sediments in the Forest City;
- Deposition of Atokan sediments across both basins;
- Deposition of Desmoinesian sediments across the Forest City southward through the Cherokee Basin into the Arkoma Basin.

Tedesco, 2014

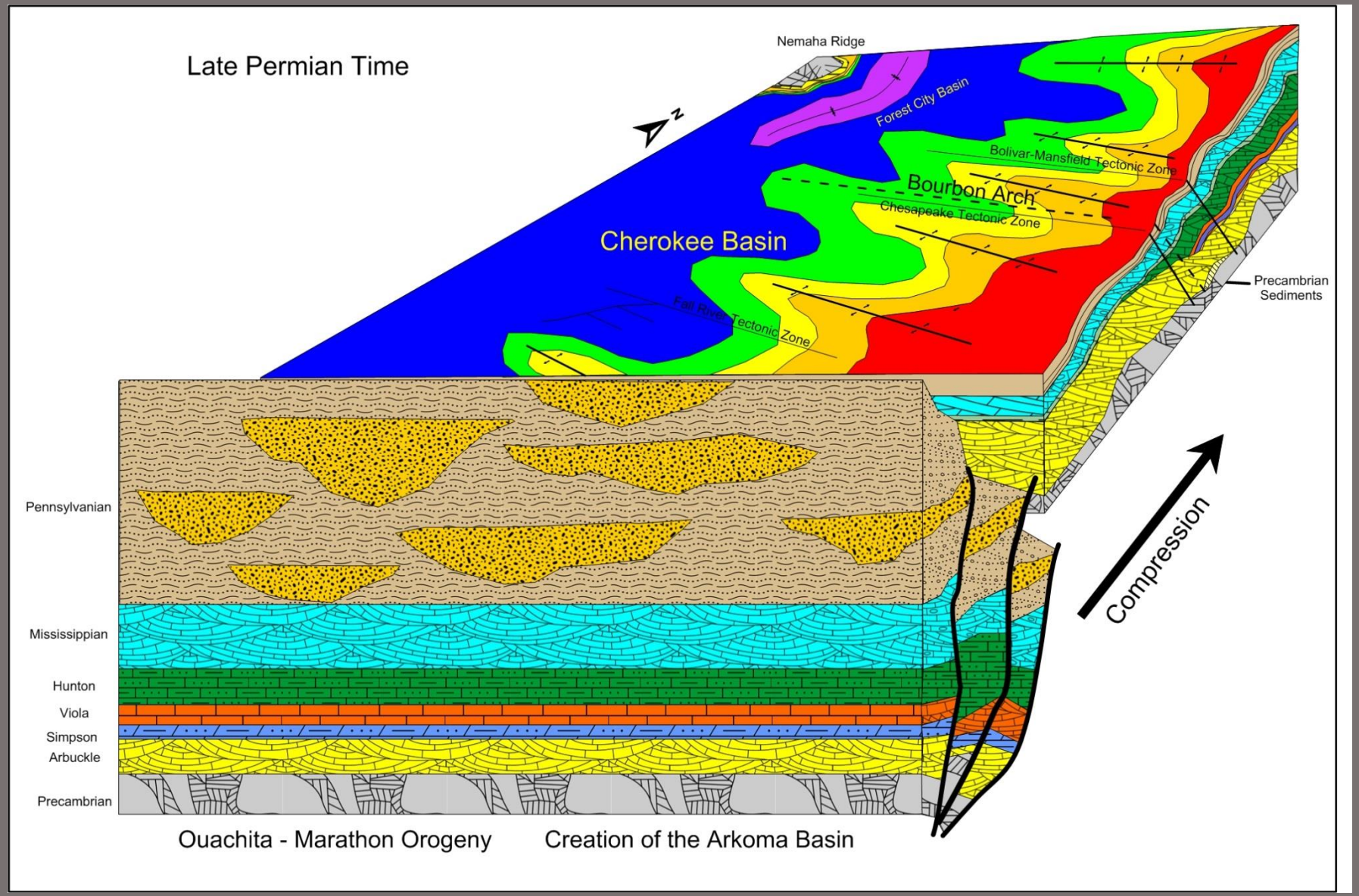
Cherokee Basin in relation to the Ouachita – Marathon Orogeny

Tedesco, 2014



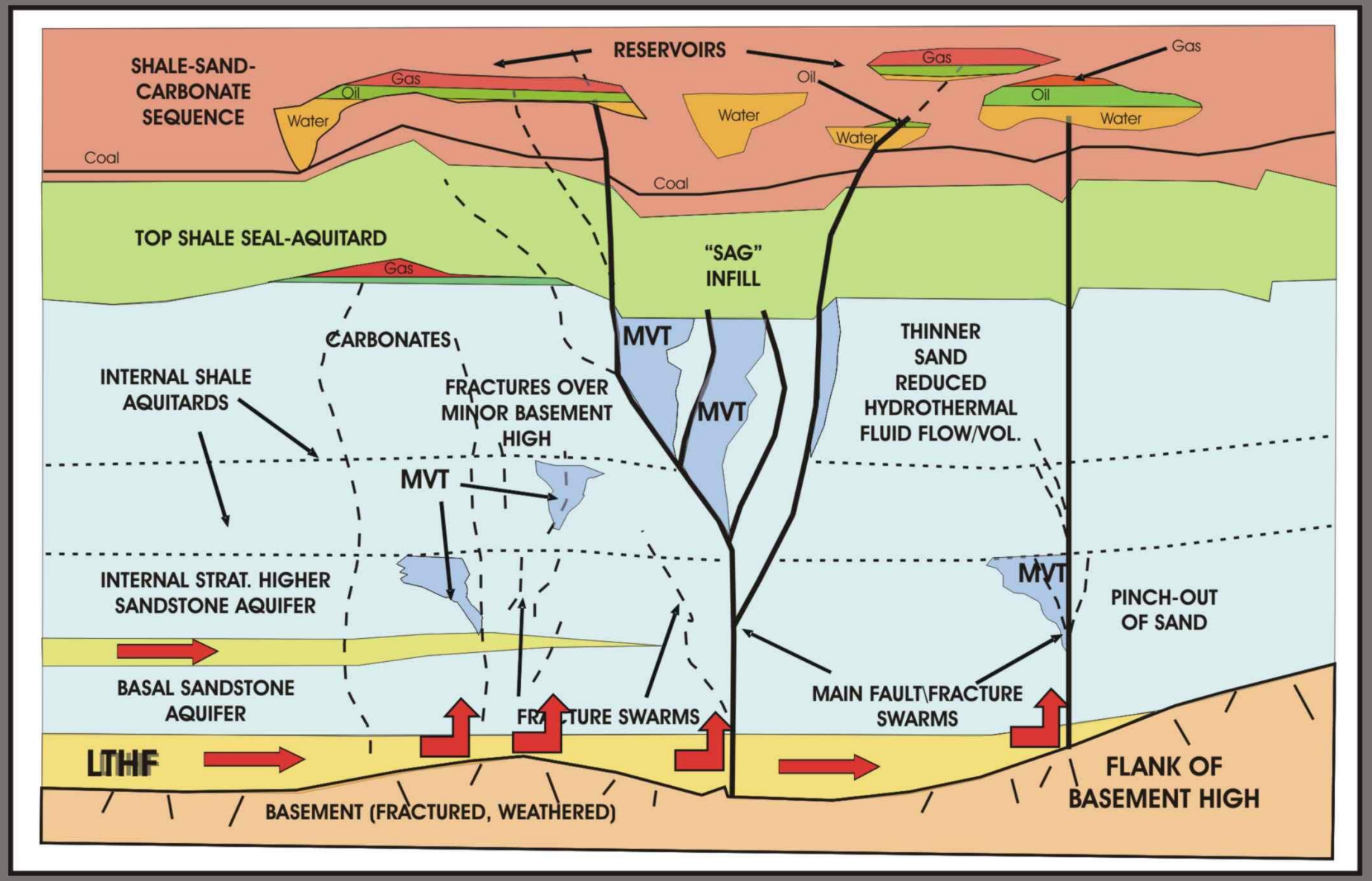


Compression, Expulsion and Migration of Low Temperature Hydrothermal Fluids



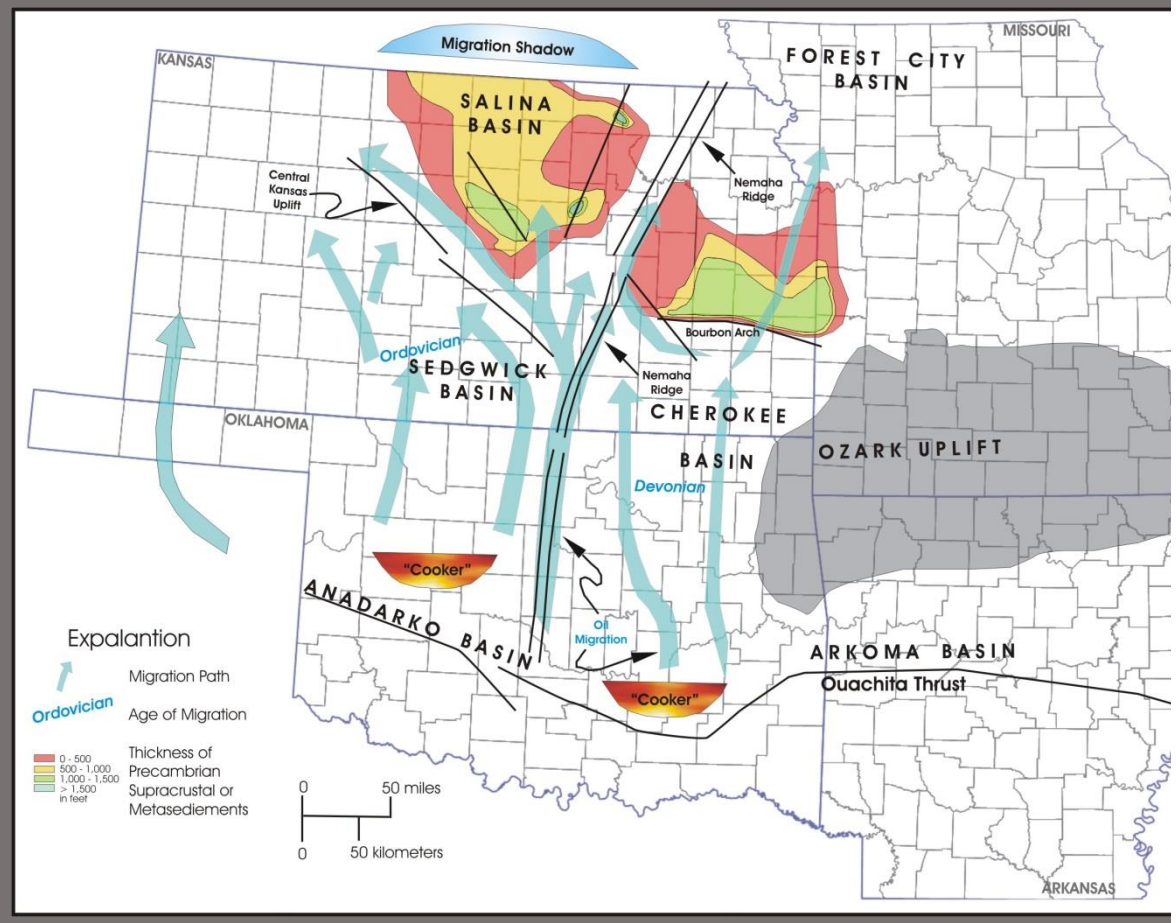
Tedesco, 2014

Migration of Low Temperature Hydrothermal Fluids

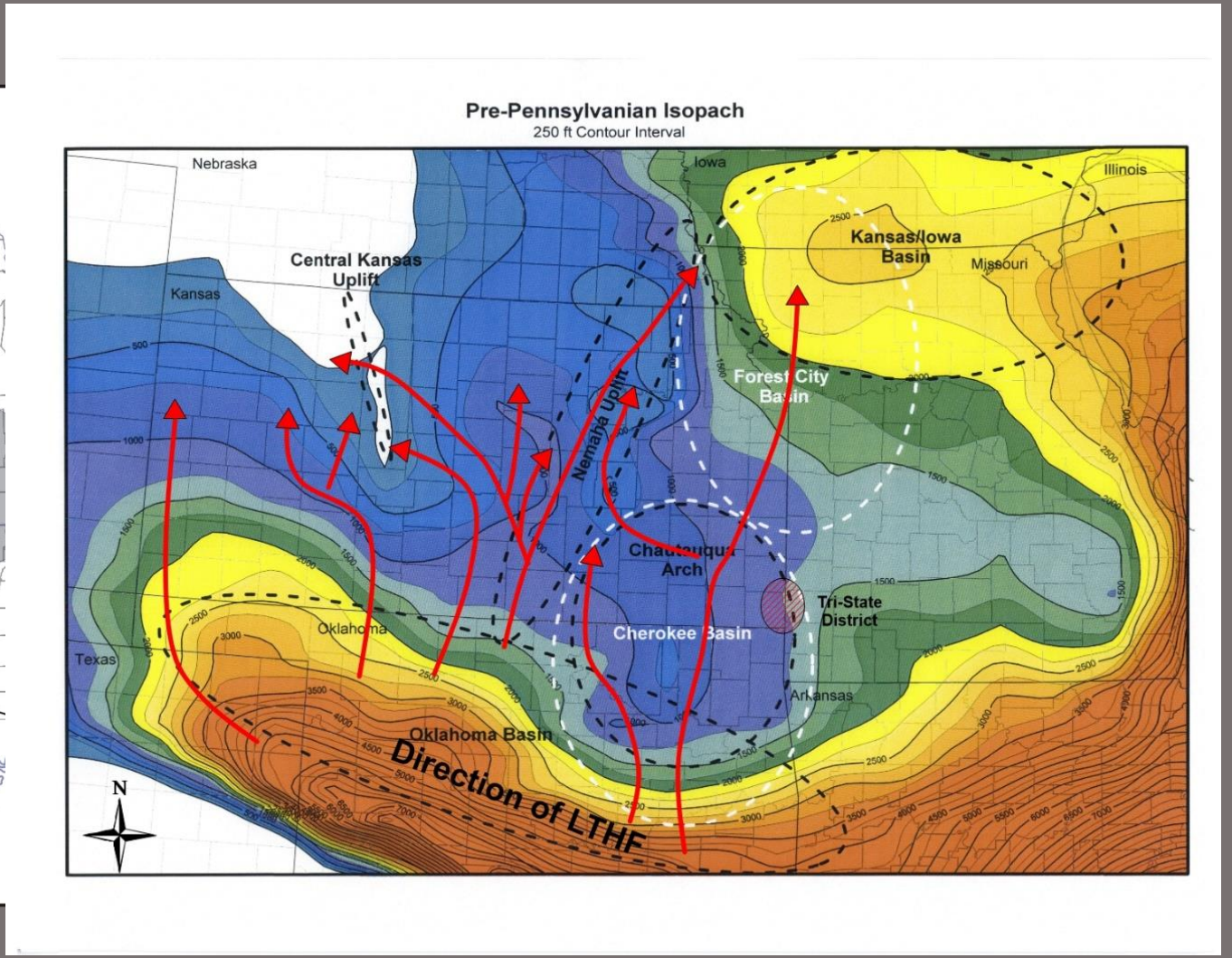


Davies and Smith (2006)

Migration of Low Temperature Hydrothermal Fluids



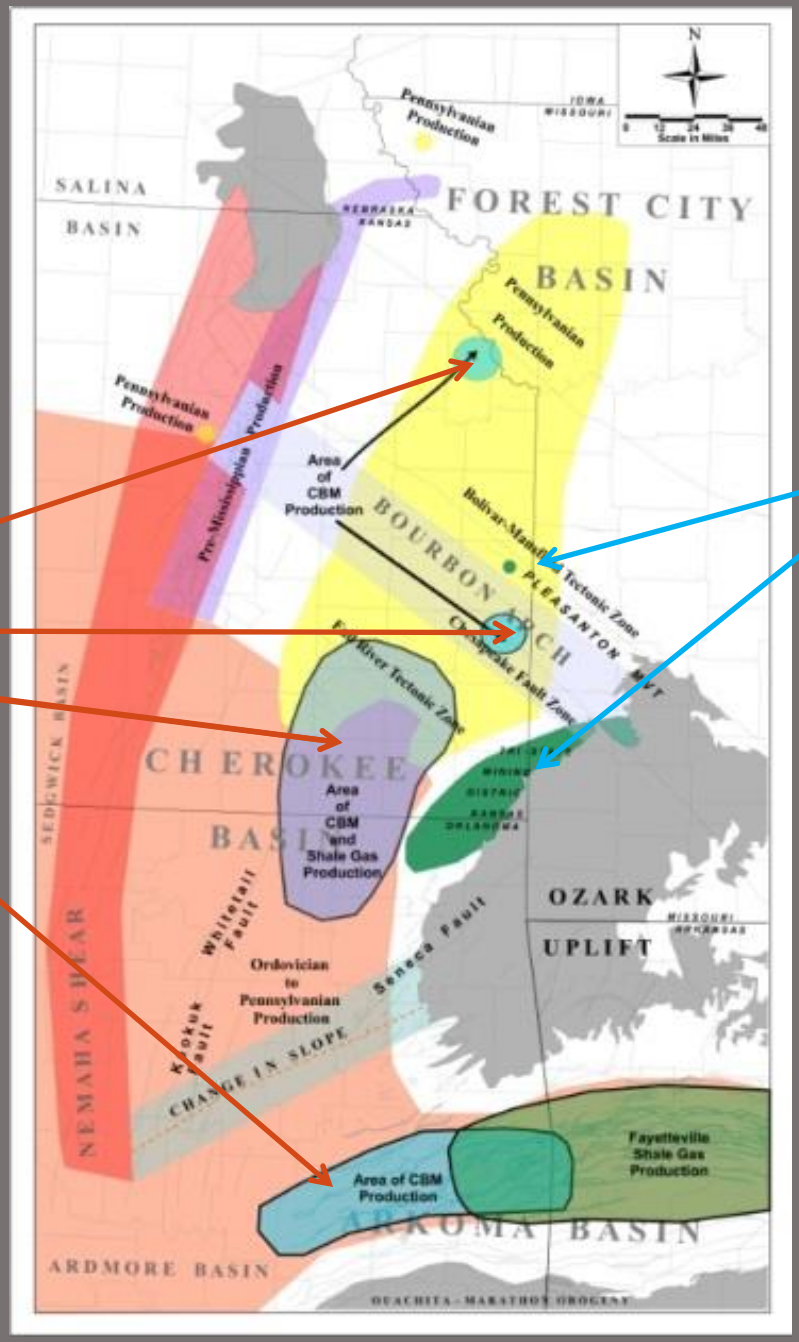
Gerhard, 2004



Adler et al., 1971 and Tedesco, 2014

Petroleum and Base Metal Deposits in the Western Interior Basin (Pennsylvanian)

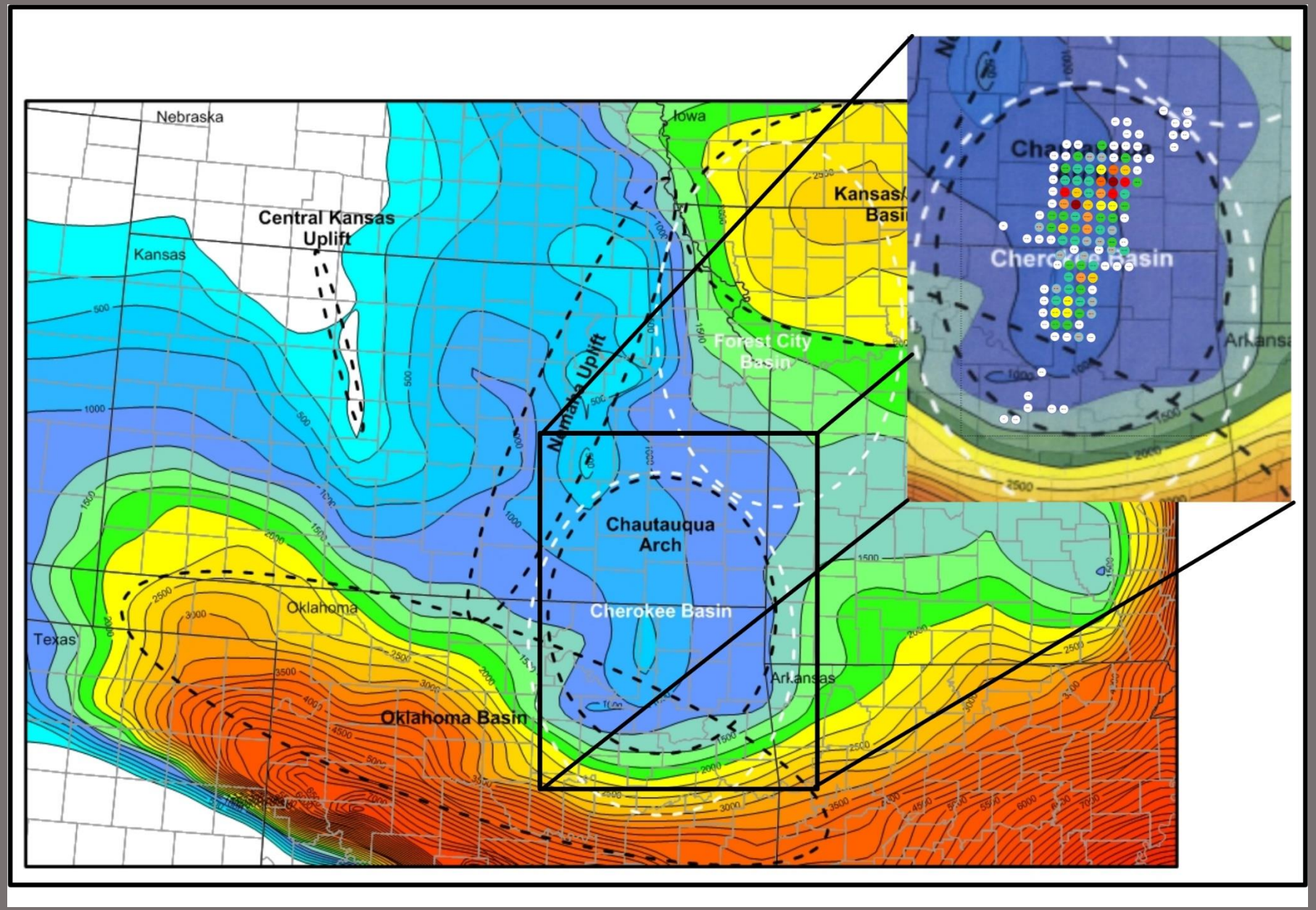
CBM Production



Base Metals

Tedesco, 2014

Coal and Shale Gas Production



Adler et al., 1971 and Tedesco, 2014

Summary

- Sequence of Events
- Development of the Chautauqua Arch, thinning of Pre-Chattanooga-Woodford rocks pre late Devonian – Early Mississippian;
- Deposition of Pennsylvanian Atokan and Desmoinesian;
- In late Pennsylvanian to Permian times the Ouachita-Marathon Orogeny occurred driving low temperature fluids northward into the Cherokee and Forest City basins;
- These fluids thermally altered the coals and carbonaceous shales that resulted in gas generation in the center and isolated structural features within the Cherokee Basin.

The End

Thank You For Coming