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Running title: Lower Mississippian Tripolitic Chert Stratigraphy

Abstract

Tripolitic chert development in the southern Ozark region is associated with a third-order, transgressive-regressive cycle comprising St. Joe transgressive packstones, succeeded by lower Boone calcisiltites, with black, penecontemporaneous, nodular chert deposited during maximum flooding, overlain by basal upper Boone calcisiltites deposited during highstand. The onset of regression produced upper Boone packstones and grainstones with white-gray, later diagenetic chert reflecting groundwater replacement along bedding planes. Tripolitic chert is a product of the highstand calcisiltites at the base of the upper Boone Formation of Arkansas, and its equivalent, the Elsey Formation of southern Missouri. This tripolitic chert appears to reflect a hydrothermal event likely occurring after the emplacement processes of both Boone cherts that had ended by Chesterian time. After hydrothermal silicification, the interval experienced groundwater removal of most of the remaining carbonate leaving open porosity characteristic of tripolitic chert. A second hydrothermal event precipitated terminated and doubly terminated quartz crystals as well as quartz druse in the cavities produced by the earlier carbonate leaching from the tripolitic chert. Timing of the hydrothermal events is not clear, but they may reflect lateral secretion produced by the Ouachita Orogeny in the late Pennsylvanian.

Introduction

Tripolitic chert is a microcrystalline, porous form of sedimentary quartz (SiO_2), resulting from the alteration of chert or novaculite, or by the leaching of highly siliceous limestones (Tarr 1938). In northern Arkansas and southern Missouri, tripolitic chert can be found within the basal portion of the upper Boone Formation, which corresponds to the highstand interval of a third-order, transgressive-regressive sequence stratigraphic cycle. According to Tarr (1926), the initial presence of disseminated carbonate within the chert is essential for tripolitic chert formation. The silica replacing the calcisiltites of the basal upper Boone Formation was likely emplaced by hydrothermal fluids produced by the Ouachita Orogeny in the late Pennsylvanian. A second hydrothermal event precipitated terminated quartz crystals in some of the void spaces left by decalcitization.

Geologic Setting

In the southern midcontinent, most of the Paleozoic and Mesozoic section reflects eustatic cycles of transgression and regression by epeiric seas in a cratonic setting. This resulted in the deposition of thin lithostratigraphic units of a variety of sedimentary lithologies, including both marine and non-marine sediments. These sedimentary units dip radially away from the Ozark Dome, which is a broad cratonic uplift cored by Precambrian granite and rhyolite centered in southeastern Missouri (Chinn and Konig 1973). Limestones dominate the rock record until the Pennsylvanian, when clastic sequences of sandstone and shale suppressed carbonate deposition (Manger *et al.* 1988).

Lithostratigraphy and Sequence Stratigraphy

The limestones comprising the Lower Mississippian Boone Formation were produced on a broad, shallow carbonate platform called the Burlington Shelf (Lane 1978) and were subsequently transported down-ramp and deposited. This interval reflects a single, third order, transgressive-regressive cycle bounded by regional unconformities. The transgressive interval is reflected by the primarily chert-free limestones of the St. Joe Formation. The lower Boone, referred to as the Reeds Spring Formation in southern Missouri (Figure 1), reflects the maximum flooding interval (Manger and Shelby 2000). This unit comprises calcisiltites and contains penecontemporaneous chert, which is dark, nodular and disrupts the bedding of the limestone,

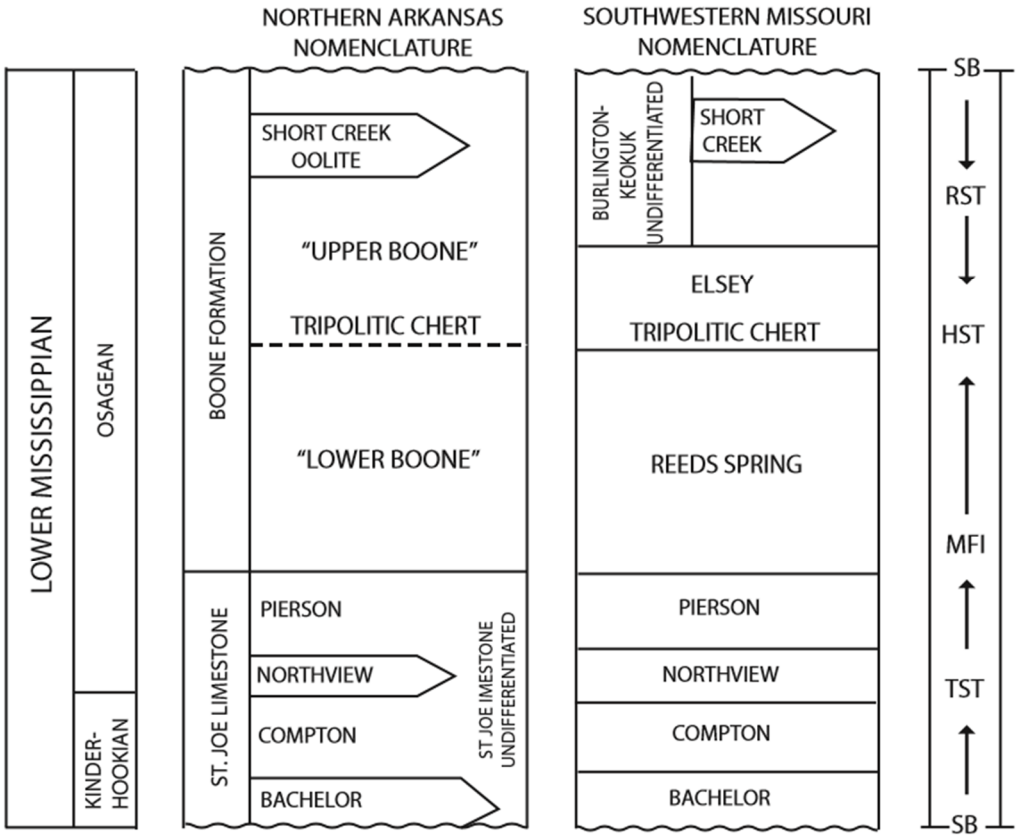

Figure 1. Stratigraphic column representing northern Arkansas and southern Missouri, modified from Manger and Thompson, 1982.

Figure 2. Roadcut along US Highway 71, near Bella Vista, displaying the upper Boone Limestone. Lowest beds are tripolitic chert.

exhibiting compaction features, indicating deposition prior to lithification of the surrounding limestone (Manger and Thompson 1982). The upper Boone marks the highstand and regressive interval and consists of sand to gravel size bioclastic grains (Shelby 1986), usually crinozoan detritus (McFarlin 2016). This interval contains later diagenetic chert, which is white and clearly a replacement of carbonate grains by silica following bedding planes, and favoring the finer grained intervals due to a greater surface area. The groundwater replacement of carbonate grains in the upper Boone must have preceded the unconformity between the Osagean upper Boone and Chesterian Hindsville Limestone, evident by a chert breccia in the Hindsville Limestone containing later diagenetic chert clasts.

The tripolitic chert in northern Arkansas and southern Missouri is confined stratigraphically to the lower portion of upper Boone and its equivalents (Elsey Formation in Missouri, see Figure 1). The chert in this interval is the result of hydrothermal replacement of carbonate by silica, producing massive, white, very fine-grained chert with disseminated carbonate between the lower Boone and the upper Boone (Figures 2, 3). This chert replacement left pseudo-nodular limestone bodies (Figure 4). It then becomes tripolitic as groundwater dissolves the remaining carbonate within the chert, creating porosity (Figures 5, 6).

Discussion

The tripolitic chert of northern Arkansas and southern southern Missouri is characterized by its porous texture

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(Figures 5, 6) caused by the decalcitization of the remaining carbonate grains in the fine-grained chert of the basal upper Boone.

Figure 3. View looking south from the tripolitic chert exposure toward the Boone (= Reeds Spring) with penecontemporaneous chert.

Figure 4. Photograph of upper Boone outcrop displaying pseudo-nodular limestone bodies (gray) surrounded by tripolitic chert (white).

The occurrence of the tripolitic chert at the basal upper Boone is the consequence of an isolated hydrothermal event. Hydrothermal, silica-rich fluid, possibly reflecting lateral secretion produced by the Ouachita Orogeny in the late Pennsylvanian, was confined by the penecontemporaneous chert below and the upper Boone above (Figures 2, 3). These formations are nearly impermeable and acted as a confined aquifer, allowing the movement of hydrothermal fluids between the two layers, but preventing the migration either up or down in the formations. This hydrothermal replacement leaves pseudo-nodular limestone bodies surrounded by massive, white, very fine-grained chert (Figures 4, 6).

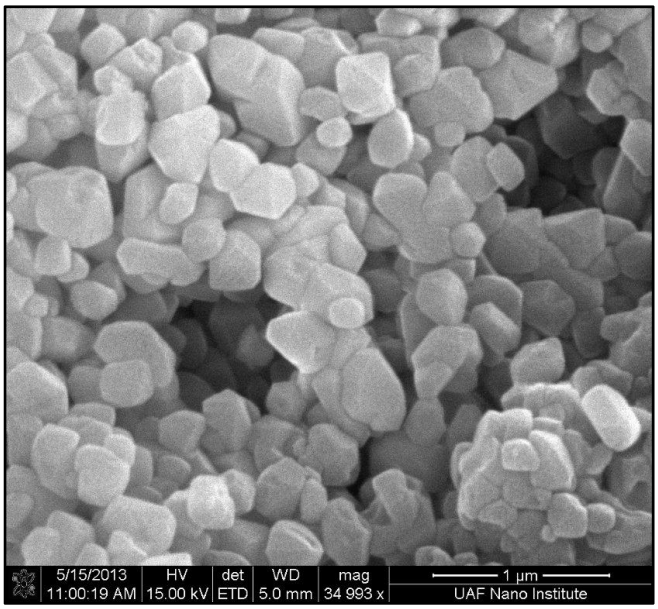

Figure 5. Scanning electron microscopy shows fine-grained, crystalline character of the silica and porosity within the chert.

Conclusions

The presence of terminated and doubly terminated quartz crystals within the cavities of the tripolitic chert strongly indicates two hydrothermal events in this interval. The first hydrothermal event occurred within the lower portion of the upper Boone formation, creating the very fine-grained chert. Groundwater decalcitized this fine-grained chert, leaving void spaces, which created the tripolitic chert. Terminated quartz crystals within those pore spaces indicates a second, silica-rich, hydrothermal event that possibly emplaced the lead-zinc deposits of the southern Ozarks.

Acknowledgements

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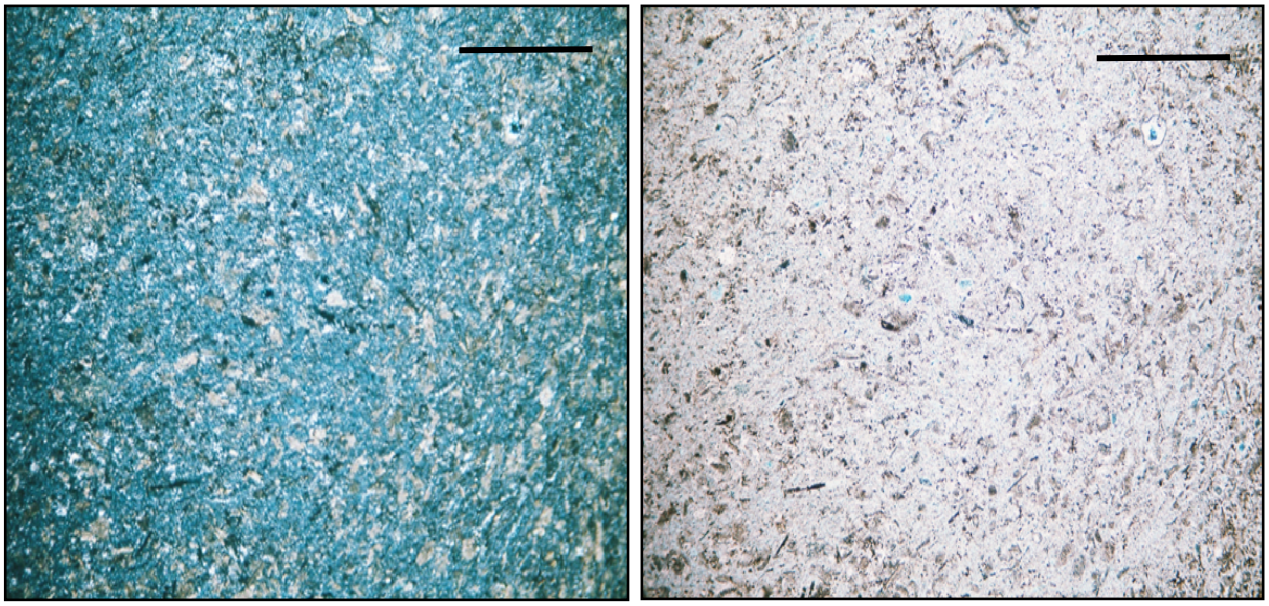

Figure 6. Thin section of tripolitic chert. Left image displays sample under crossed nicols, right image displays sample under plane light. Note abundant pin-point porosity (blue areas) from decalcitization in right image. Scale bar: 5mm.

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