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Lithostratigraphy of the Cane Hill Member of the Hale Formation (Type Morrowan), Northwest Arkansas

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ABSTRACT

The Hale Formation (lower Morrowan Series) is a sequence of sandstones and shales divided into the Cane Hill (lower) and Prairie Grove Members. In Washington County, Arkansas, the type Cane Hill consists predominantly of interbedded fine-grained, noncalcareous sandstones and silty shales often with a pebble conglomerate at its base. The member rests unconformably on Chesterian Strata of either the Pitkin Formation or underlying Fayetteville Formation, and it is unconformably overlain by the Prairie Grove Member. In Washington County, the Cane Hill exhibits a slight thickening trend to the south and east. Interpretation of sedimentary structures indicates that the Cane Hill was deposited in a near shore, tidal current-dominant environment throughout the type region.

Eastward from Washington County, the Cane Hill thickens both southward and eastward to nearly 160 feet in southern Newton County. The sandstone content of the unit increases markedly in Madison County, then decreases again into eastern Newton County, where the Cane Hill is dominated by shales. Basal conglomerates are extremely rare in Madison County, but appear occasionally in Newton County. Thick linear sandstone bodies, apparently related to fluvial processes, occur in southeastern Carroll County and eastern Madison County, but the bulk of Cane Hill deposits are still of tidal origin.

INTRODUCTION

Morrowan age sediments outcrop throughout northern Arkansas along the trend of the Boston Mountains. Lithostratigraphy of the units within the Morrowan Series is complex. The units are similar lithologically, boundaries are gradational or unconf ormable, and lateral changes in lithology are common. Although the lowest Morrowan unit, the Hale Formation, has been recognized for nearly 75 years (Taff, 1905; Adams and Ulrich, 1905), little progress has been made toward understanding the lithostratigraphy of the unit.

In northwest Arkansas the Hale Formation has been divided into two members (Henbest, 1953, 1962): an upper Prairie Grove Member and a lower Cane Hill Member. The Prairie Grove Member is commonly composed of medium grained calcareous sandstones and bioclastic limestones, while the Cane Hill Member is normally a sequence of interbedded noncalcareous, fine-grained sandstones, silts, and shales.

LITHOSTRATIGRAPHY

In northwest Arkansas the Cane Hill Member of the Hale Formation unconformably overlies either the Pitkin Formation or the Fayetteville Formation both of upper Mississippian age. These variable positions reflect the amount of pre-Morrowan erosion on the underlying Mississippian sequence. Generally the member over the Pitkin Formation south of the latitude (36°04'1)° of Fayetteville, Arkansas, and the Fayetteville Formation north of Fayetteville. The Cane Hill is unconformably overlain by the Prairie Grove Member of the Hale Formation throughout northwest Arkansas.

A regional isopach (Fig. 1) of the Cane Hill shows general thickening of the unit to the south and east. In outcrop the Cane Hill thickens from about 40 feet at its type section in southwestern Washington County to nearly 160 feet in southeastern Newton County. Well data indicates that in the subsurface the unit continues to thicken southward to about 250 feet in southern Franklin and Pope Counties.

Throughout its type region, Washington County, the Cane Hill is a sequence of interbedded sandstones, shales, and siltstones, commonly with a conglomerate at its base (Fig. 2, sections A and B). In the type area sandstones are present as both locally continuous medium beds of ripple marked fine-grained quartzarenite, and as very fine-grained quartzarenite thinly interbedded with flaser shale beds. In thin section, these sandstones are fine to very fine-grained, micaeous, supermature quartzarenites. The sandstones are dominated by siliceous cement in the form of quartz overgrowths, but locally may contain one to two percent calcareous or limonitic cement. Chert and shale fragments generally compose about one to two percent of the rock, and feldspars make up one percent of the grains. In cross section the sandstones are composed of small scale trough cross-stratification often with silty or muddy troughs. Shales found in the type area occur as thin to thick beds that are micaeous and silty. Silstones are commonly thinly bedded and micaeous. Randomly occurring carbonate units are found in the Cane Hill within Washington County. These carbonates are generally thin, lenticular, bioclastic limestones with as much as 50 percent quartz sand.

Eastward from the type area in Washington County marked changes take place in the sandstone and shale content of the Cane Hill. Throughout Madison County the Cane Hill is dominated by a sequence of medium bedded sandstones as much as 70 feet thick (Fig. 2, sections B and C). Typically this sequence of sandstones is bounded by shales above and below. The sandstones seen in Madison County show silstone partings, lunate or asymmetrically ripple marked upper surfaces and, in cross section, small scale trough cross-stratification. Petrographic study by Wiggins (1978) indicates that the sandstones found in Madison County are very similar to those sampled in Washington County. The shales which bound this thick sandstone interval are silty and commonly contain thin lenticular or wavy beds of silstone or very fine-grained sandstone. Basal conglomerates analogous to those found in Washington County are extremely rare in Madison County, but often silstone pebble conglomerates are present within bedded sandstone intervals well above the base of the member.

In the western half of Newton County the Cane Hill Member is dominated by thick shale intervals (Fig. 2, sections E and F). These shales, though rarely well exposed, are silty and micaeous, often containing thin lenticular beds of silstone or very fine-grained sandstone. Bedded sandstones analogous to those found in Madison County are present in the lower part of the member, but are reduced in thickness. Limestone pebble basal conglomerates similar to those exposed in Washington County are extremely rare in Madison County when the base of the unit is exposed.

Thick linear sandstone bodies that rest on the Fayetteville Formation are commonly present in southeast Carroll County, northeastern Madison County, but less commonly in Washington County (Fig. 1). Thickness ranges from 20 feet to more than 100 feet of medium to fine grained quartzarenite. Some of the sand bodies show a fining upward sequence, and most are conglomeratic at their basal con...
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tacts. The sandstone is sometimes calcareous and contains variable amounts of carbonized wood. The sandstone bodies are generally massive in appearance, but occasionally show a variety of sedimentary structures including large scale tabular cross-stratification, small scale trough cross-stratification, and rarely herringbone cross-stratification (Black, 1975).

Figure 1. Isopach map of the Cane Hill Member of the Hale Formation, northwestern Arkansas.

Figure 2. Lithostratigraphic sequence in selected measured sections of the Cane Hill Member, northwestern Arkansas.

DEPOSITIONAL ENVIRONMENTS

Interpretation of sedimentary structures found within the Cane Hill Member indicates that the bulk of Cane Hill sediments were deposited in a near-shore, tidal current-dominated environment. Flaser, wavy, and lenticular bedding, following the classification of Reineck and Wunderlich (1968), are common within the unit, and are associated with bipolar dip directions on small scale trough cross-strata (Wiggins, 1978). Such structures indicate alteration of tidal current bedload transport with suspension settlement during slack water periods and bipolar reversals of flow direction (Klein, 1977). Black (1975) reported the presence of mudcracks from the northernmost extremities of the outcrop belt. This occurrence of mudcracks may indicate that a belt of intertidal sediment at one time existed to the north of the outcrop belt, but has subsequently been stripped off by erosion. The thick sandstone bodies found associated with lower Cane Hill strata are apparently relic fluvial channels developed on the Mississippian surface prior to the initial Morrowan transgression. As the Morrowan Sea transgressed the Ozark Platform, these fluvial channels were still active but became tide dominated and reworked as evidenced by reports of bipolar dip directions for some of the cross-stratification (Black, 1975).

CONCLUSIONS

Regional studies of the Cane Hill indicates that the member is a viable and recognizable unit throughout northwestern Arkansas. The consistent occurrence of fine-grained supermatre sandstones, siltstones, and micaceous siltstones provide adequate criteria for recognition of the unit and its separation from strata lying above and below it. Typically the unit is composed of interbedded sandstones and siltstones at Washington County, dominated by medium bedded sandstones in Madison County, and dominated by shale in western Newton County. The bulk of Cane Hill sediments were probably deposited in a shallow tidal current dominated environment as evidenced by sedimentary structures which indicate alternation of tidal current-bedload transport with suspension settling during slack water periods and bipolar reversals of flow direction. The relationship of the Cane Hill Member to units occupying the same stratigraphic interval in northcentral Arkansas, such as the Imo Formation of Gordon (1965), is problematic. Units corresponding to those found in northcentral Arkansas do not occur within the study area with the possible exception of a thin shale and limestone interval found in southwestern Newton County (Fig. 2, section E). This thin interval may be the western-most extremity of late Mississippian strata that unconformably wedge between presumed Cane Hill strata and the Mississippian Pitkin Limestone to the east. However, further studies to the east must be initiated in order to tie the two areas together.

LITERATURE CITED


