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# Depositional Systems of the Sells and Cecil Sandstones, Atoka Formation (Pennsylvanian), Eastern Crawford And Western Franklin Counties, Arkansas

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## ABSTRACT

The Cecil and Sells sandstones of the Atoka Formation (Pennsylvanian) were studied in the subsurface of eastern Crawford and western Franklin Counties. Sand of the Cecil sandstone was delivered to a high destructive, wave dominated delta southeast of Fort Smith and reworked laterally by longshore currents to form coastal barrier sands to the east. The Sells sandstone unit accumulated as a distributary channel system that bifurcates to the southeast and southwest. The interdistributary areas are characterized by immature sands interbedded with shales. These immature sands were deposited by crevasse splays and reworking of the distributary mouth bars by marine processes causing sand transport into the interdistributary areas.

## INTRODUCTION

The lower part of the Atoka Formation (Pennsylvanian) in eastern Crawford and western Franklin Counties, Arkansas, is a succession of sandstone and shale units. Data from 118 mechanical well logs were used to establish the depositional systems of the Cecil and Sells units. The gamma ray and resistivity curves were used to determine the thickness and well log signature of the sandstone units. Isopach and well log signature maps were constructed and used to establish the depositional systems important in the emplacement of these sandstones. The Cecil and Sells sandstone units accumulated on the continental shelf of the Arkoma Basin. Basinward shale deposition was simultaneous with sandstone deposition.

## REGIONAL STRUCTURE

The Arkoma Basin is north of the Ouachita overthrust belt and is characterized by east trending anticlines and synclines. Dips on the flanks of these structural features decrease in magnitude toward the northwest Arkansas structural platform and are only a few degrees in the northern part of the basin. The Arkoma Basin is separated from the northwest Arkansas structural platform by large east trending normal faults which displace lower Atoka strata into the subsurface to the south (Diggs, 1961).

## REGIONAL STRATIGRAPHY

Regionally the Atoka Formation is underlain on the northwest Arkansas structural platform and in the Arkoma Basin by the Bloyd Formation. In the Arkoma Basin the Atoka Formation is overlain by the Hartshorne Sandstone. The Atoka Formation thickens from a featheredge on the northwest Arkansas structural platform to cover 20,000 feet in the Arkoma Basin (Branan, 1968).

## AREA OF INVESTIGATION

The Cecil and Sells sandstones were investigated in eastern Crawford and western Franklin Counties, Arkansas. This area is approximately 350 square miles and extends from the northern boundary of T12N to the southern boundary of T9N. On the west, the area includes all of R29W and extends eastward to include the western half of R27W.

## STRATIGRAPHIC SUCCESSION

The stratigraphic succession studied extends from the top of the Kessler Limestone to the top of the Sells sandstone unit (Fig. 1). This interval contains seven laterally persistent sandstone units bounded by equally persistent shale units. The Cecil sandstone is the third major sandstone unit above the Kessler Limestone, and the Sells sandstone is the seventh major sandstone unit above the Kessler Limestone.

## CECIL SANDSTONE UNIT

The Cecil sandstone unit is the lowermost sandstone of the Cecil series and is bounded both above and below by shale units (Fig. 1). This sandstone is correlated to the basal Atoka sandstone of Washington County, Arkansas.

An isopach map (Fig. 2) of the Cecil depicts a blanket sandstone averaging 120 feet in thickness. This body of sand thins gradually northward and abruptly eastward.

The Cecil unit is characterized by a semi-inverted "Christmas tree" log signature which is illustrated in Figure 1. This log signature is suggestive of an upward increase in textural maturity, bedding thicknesses, and grain size of the sediments involved. The log signature of the Cecil unit suggests a gradational base, but not as gradational as one would expect from a delta front succession of sediments. The semi-inverted "Christmas tree" log signature has been interpreted as progradation of coastal barrier sands over a thin sequence of prodelta silts and shelf muds.

An isopach map of the Cecil sandstone unit in western Crawford County shows a broad southeast trending belt of thickened strata. This thickened belt is on trend with approximately 200 feet of Cecil sand located south and southwest of the area investigated. This succession possesses an inverted "Christmas tree" log signature, suggestive of a delta front succession.

Haley and Hendricks (1972) show the western and southern limits of the Cecil sandstone unit. The western limit occurs just east of the Oklahoma-Arkansas border. The southern or basinward limit is a few miles south of the southern boundary of T8N.

The Cecil sandstone has been interpreted as forming in a wave dominated basin as a cupate destructional delta. The southeast thickened trend in western Crawford County represents an area of occupation by distributary channels which fed sediments to distributary mouth bars in township 8N, ranges 30W and 29W. The absence of Cecil sandstone in the vicinity of the Oklahoma-Arkansas border suggests that longshore drift was from the west to the east. Reworked sand was carried northward from distributary mouth bars in the south

and later deposited on the eastern flank of the delta as coastal barrier sands. The delta flank is represented by the blanket accumulation of sand depicted in Figure 2.

**SELLS SANDSTONE UNIT**

The Sells sandstone unit is the uppermost sandstone of the Cecil series and is bounded above and below by laterally extensive shale units (Fig. 1). This sandstone unit is correlated to the uppermost part of the second Atoka sandstone of Washington, County.

An isopach map (Fig. 3) of the Sells sandstone shows a bifurcating thickening trend to the southwest and southeast. These thickened areas of strata are bounded laterally by areas of thinner strata.

The Sells sandstone unit is characterized by two types of well log signatures. The "Christmas tree" log signature illustrated in Figure 1 occurs on the thickened trends of strata shown in Figure 3. This log signature with its abrupt base and diminished response of the gamma ray and resistivity curve is suggestive of channels cut into previously deposited sediments with an accompanying decrease in textural maturity, bedding thickness, and the grain size of the sediments involved and is characteristic of a channel sandstone deposit. The area of occupation by distributary channels is exhibited on the log map of the Sells sandstone (Fig. 4). The other type of mechanical log signature shows immature sandstones interbedded with shales. This log signature (Fig. 4) occurs in the areas of thinner strata (Fig. 3) and is representative of a sandstone unit formed from crevasse splays, and reworking of the distributary mouth bar sediments into inter-distributary areas.

The occurrence of the "Christmas tree" log signature on the thickened trends suggest that the Sells sandstone accumulated as a distributary channel system with sporadic interdistributary sand deposition. Sediment transport of Sells sediments was from the north.

**SUMMARY**

The Cecil sandstone unit accumulated in a wave dominated basin as a cupsate destructional delta. Sand reworked by marine processes was distributed to coastal barrier sands on the delta flank. The Sells sandstone unit was deposited as a distributary channel system which bifurcates to the southwest and southeast. These distributary channels fed a Sells delta farther to the south.

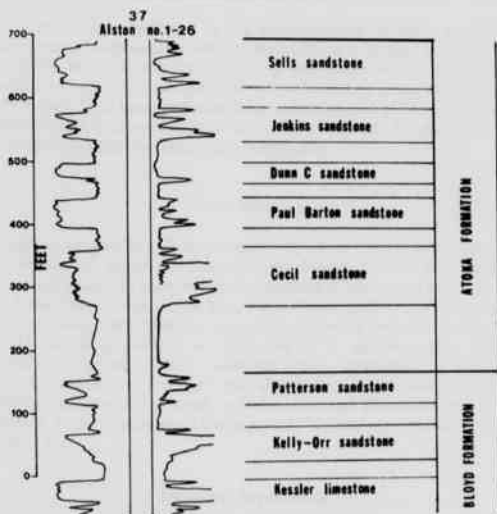


Figure 1. Alston no. 1-26 illustrating typical expression of Atoka sandstone units and their nomenclature.

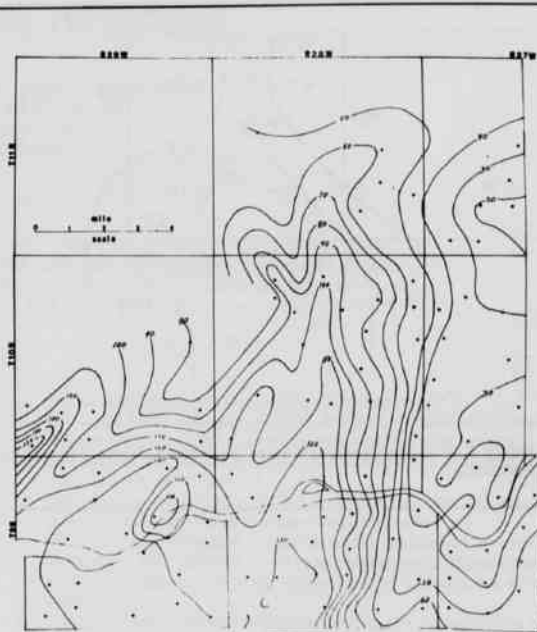


Figure 2. Isopach map of the Cecil sandstone unit, Atoka Formation. Contour interval is 10 feet.

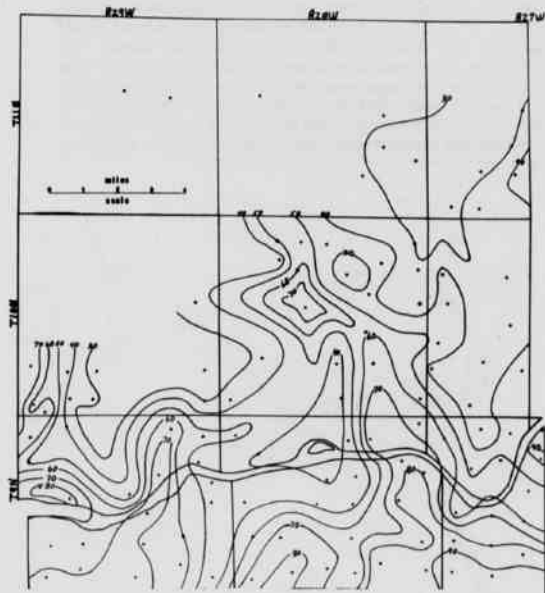


Figure 3. Isopach map of the Sells sandstone unit, Atoka Formation. Contour interval is 10 feet.

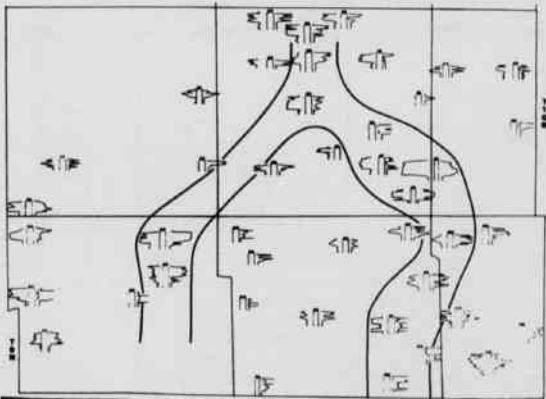


Figure 4. Well log signature map of the Sells sandstone unit, Atoka Formation.

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