STATE OF ARKANSAS

Arkansas Geological Commission

Norman F. Williams, Geologist-Director

INFORMATION CIRCULAR 25

SILURIAN AND DEVONIAN ROCKS OF NORTHERN ARKANSAS

By
O. A. Wise and W. M. Caplan

Little Rock, Arkansas

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CONTENTS

ILLUSTRATIONS

PLATE PAGE

TABLE

SILURIAN AND DEVONIAN ROCKS OF NORTHERN ARKANSAS

O. A. Wise and W. M. Caplan[1]

ABSTRACT

The Silurian and Devonian rocks of northern Arkansas are widespread in the subsurface reaching an aggregate thickness of over 480 feet in Pope County. This thickening may continue southward into the Ouachita region.

The surface exposures are generally restricted to the Springfield Plateau physiographic province where outcrop thicknesses are quite variable due to contemporaneous, and post-depositional erosion. No single formation is well-developed on the outcrop across the entire area, although the Chattanooga Shale is rather extensive in the northwestern and the St. Clair Limestone in the northeastern, portions of the region.

The regional structural strike of the Silurian and Devonian formations in northern Arkansas is generally east-west, and the dip is to the south. The angle of dip is slight in the Ozark region and becomes increasingly steeper to the south into and across the Arkansas Valley where it becomes mantled by a thick wedge of Pennsylvanian and Mississippian sediments.

SILURIAN SYSTEM

Rocks of Silurian age are exposed in a few scattered outcrops in the Ozark region of north-central Arkansas. The outcrops are generally restricted to the Springfield Plateau physiographic province (see Figure 1). The Silurian rocks are predominantly carbonates and have been assigned to the Brassfield Limestone (Ulrich, 1911), the St. Clair Limestone (Penrose, 1891), and the Lafferty Limestone (Miser, 1920) (see Figure 2).

Recent field observations and paleontological data suggest that a part of the Cason Shale, previously considered as Ordovician by a number of workers, is also Silurian and is possibly a facies of the Brassfield Limestone.

The Silurian section of north Arkansas has for the most part been treated as an undifferentiated unit in the subsurface. It ranges in thickness from a feather edge (due to truncation) to over 250 feet in the Arkansas Valley (see Figure 3). This thickening appears to reach its maximum in the southern part of the Valley and begins a thinning trend which indicates the possibility of a separate basin, not directly connected to the Ouachitas where the Silurian is represented by over 1200 feet of clastic rocks. Insufficient evidence is available at present to indicate whether the nature of the change from Ozark to Ouachita facies is one of transition, overthrust, or separate basin deposition.

Rocks thought to be Silurian in age have been identified in well cuttings from Pulaski and Crittenden Counties, Arkansas, and DeSoto County, Mississippi, indicating the extension of Silurian rocks into the Mississippi Embayment.

BRASSFIELD LIMESTONE

The Brassfield Limestone was named for exposures in Madison County, Kentucky, by Foerste (1905), and was identified in Arkansas by Ulrich in 1911.

Miser (1922) found Brassfield fossils (replaced by manganese oxide) at the Montgomery Mine 6 miles northeast of Cushman, Independence County, Arkansas, and stated that they came from residual clays lying on the Cason Shale (Ordovician). He

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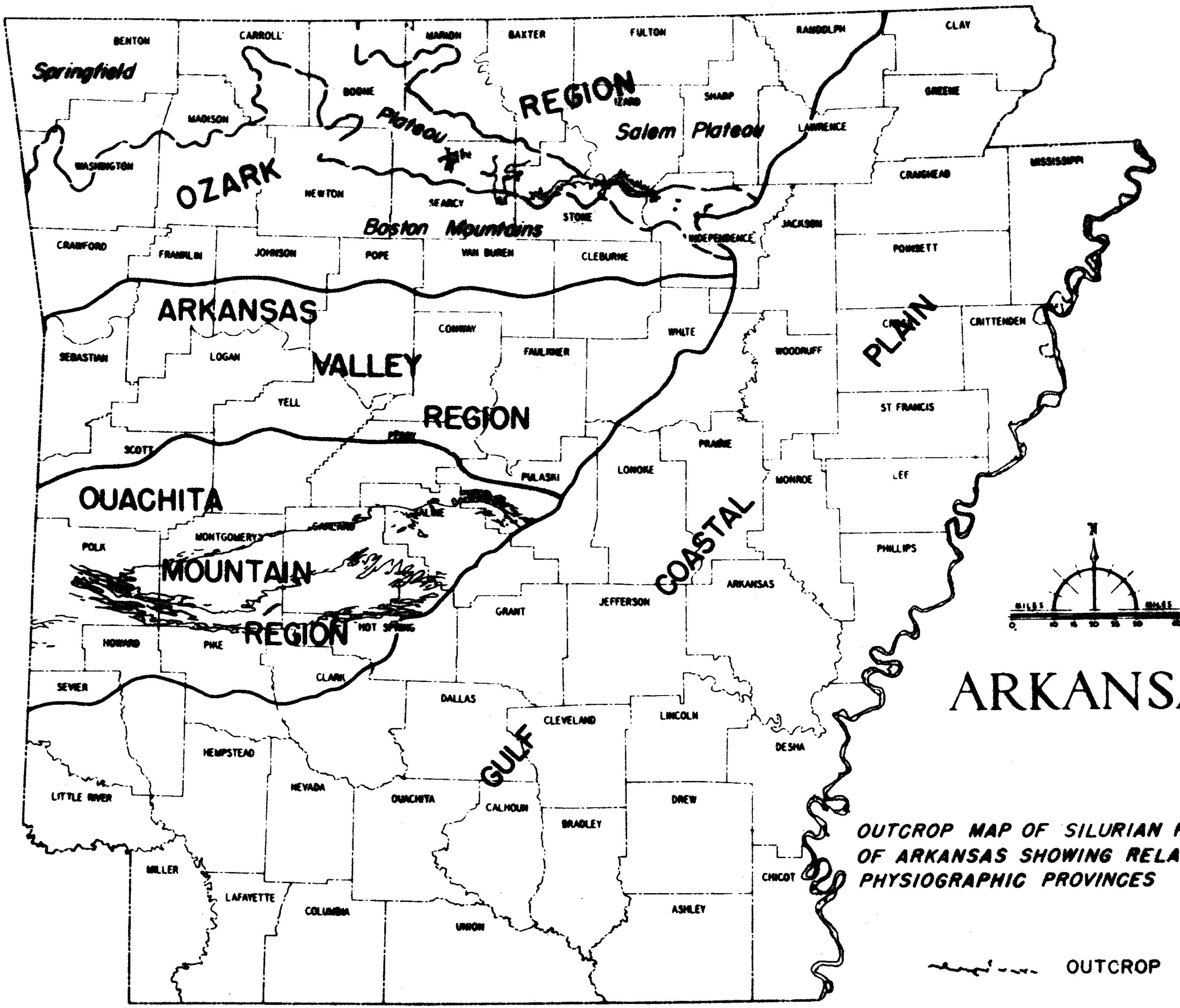


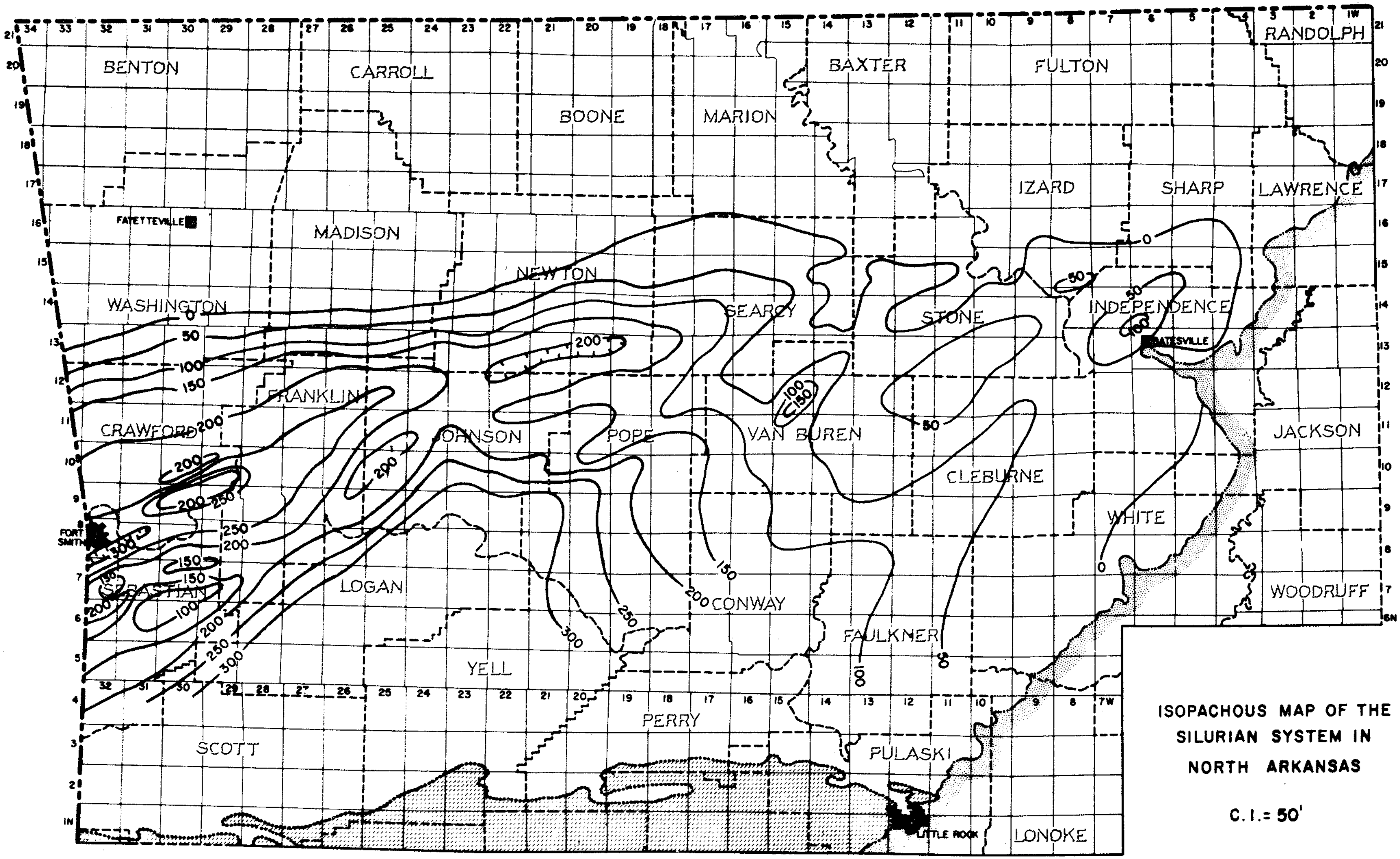
OUTCROP MAP OF SILURIAN FORMATIONS OF ARKANSAS SHOWING RELATION TO PHYSIOGRAPHIC PROVINCES

PLATE 1

CORRELATION CHART OF DEVONIAN & SILURIAN SYSTEMS IN ARKANSAS

	GENERALIZED SECTION	OZARK REGION	OUACHITA MTS.	
MISSISSIPPIAN			Arkansas Novaculite	Upper Mbr.
DEVONIAN	UPPER	Chattanooga Sh.		Middle Mbr.
	MIDDLE	Sylamore Ss. Mbr. Clifty Fm.		Lower Mbr.
	LOWER	Penters Chert		
SILURIAN	UPPER		Missouri Mtn. Sh.	
	? MIDDLE	? Lafferty Ls. St. Clair Ls.	? Blaylock Ss.	
	LOWER	Brassfield Ls.		
ORDOVICIAN	UPPER	Cason Sh.	Polk Creek Sh.	

TABLE 1



ISOPACHOUS MAP OF THE SILURIAN SYSTEM IN NORTH ARKANSAS

C.I.= 50'

SCALE IN MILES

0 5 10 20 30 40 50

PLATE 2.

also mentioned exposures of Brassfield in the Yellville Quadrangle, Arkansas.

Maher and Lantz (1953) mapped exposures of Brassfield which attain a maximum thickness of 26 feet in the northern part of the Marshall Quadrangle in the Gilbert area of Searcy County, Arkansas. Here they described the formation as consisting of beds of coarsely crystalline fossiliferous limestone about a foot thick, containing crinoids, brachiopods, trilobites, and an abundance of calcite-filled vugs. They stated that while the Brassfield resembled the St. Clair there were recognizable lithologic differences.

Recent stripping operations at the Love Hollow Quarry, Izard County, Arkansas, have exposed a fossiliferous limestone on the north and south sides of the main quarry pit, within the Cason Shale. The exposure on the north side of the pit was removed before it could be sampled or described. The exposure on the south side occurs in the middle of a 10-foot thick bed of Cason Shale. At this latter exposure the limestone is 100 feet long, lensing out to the east and west. It is 3 feet thick at the thickest point, being equally divided between two rock types; the lower foot and a half consisting of white oolitic limestone, and the upper foot and a half being a coarsely crystalline fossiliferous sparite quite similar to the Ordovician Fernvale Limestone that underlies the Cason Shale.

Amsden made a collection of fossils while examining this outcrop and states (written communication, 1967) that "the limestone bed in the Cason Shale at Love Hollow Quarry carries the brachiopod *Triplesia alata.*" This fossil had previously been described from the Brassfield of Arkansas by Ulrich and Cooper (Amsden, 1965).

Craig (written communication, 1967) states that conodonts, collected at Love Hollow Quarry from the lower part of the Cason Shale, indicate a Late Ordovician age; and that the conodonts from the "pelmatozoan limestone are definitely Early Silurian in age."

This would, in effect, make the shale mapped as Cason at Love Hollow in part Ordovician and in part Silurian, and presents the possibility that in some localities the limestone underlying that shale may be Silurian and not Fernvale (Upper Ordovician). It is also quite possible that the fossils found by Miser in the "residual clays" at the Montgomery Mine were in place in the weathered shale facies of this interval.

The question of the age of the Cason Shale is not a new subject. In the Arkansas Geological Survey Report for 1892 (p. 284), H. S. Williams states that the St. Clair Limestone, and the Cason Shale contain a Silurian fauna and that the "Polk Bayou Limestone" (now called Fernvale) contains an Ordovician fauna. Ulrich considered the Cason Shale age to be Ordovician in 1904, and Silurian in 1911.

Miser (1922) placed the Cason in the Ordovician. However, in 1964 (personal communication) he indicated that he was not satisfied with this placement, and thought a re-examination was in order.

Although the relationship of the shales and limestone of the Cason-Brassfield interval is of considerable interest, it does not appear, at this time, that any useful purpose could be served by changing the existing nomenclature, or adding a new name or names to those presently in general use. However, if in the future this sequence could be extended either on the surface or in the subsurface so as to be of some benefit in stratigraphic work, it might then justify the introduction of new terminology.

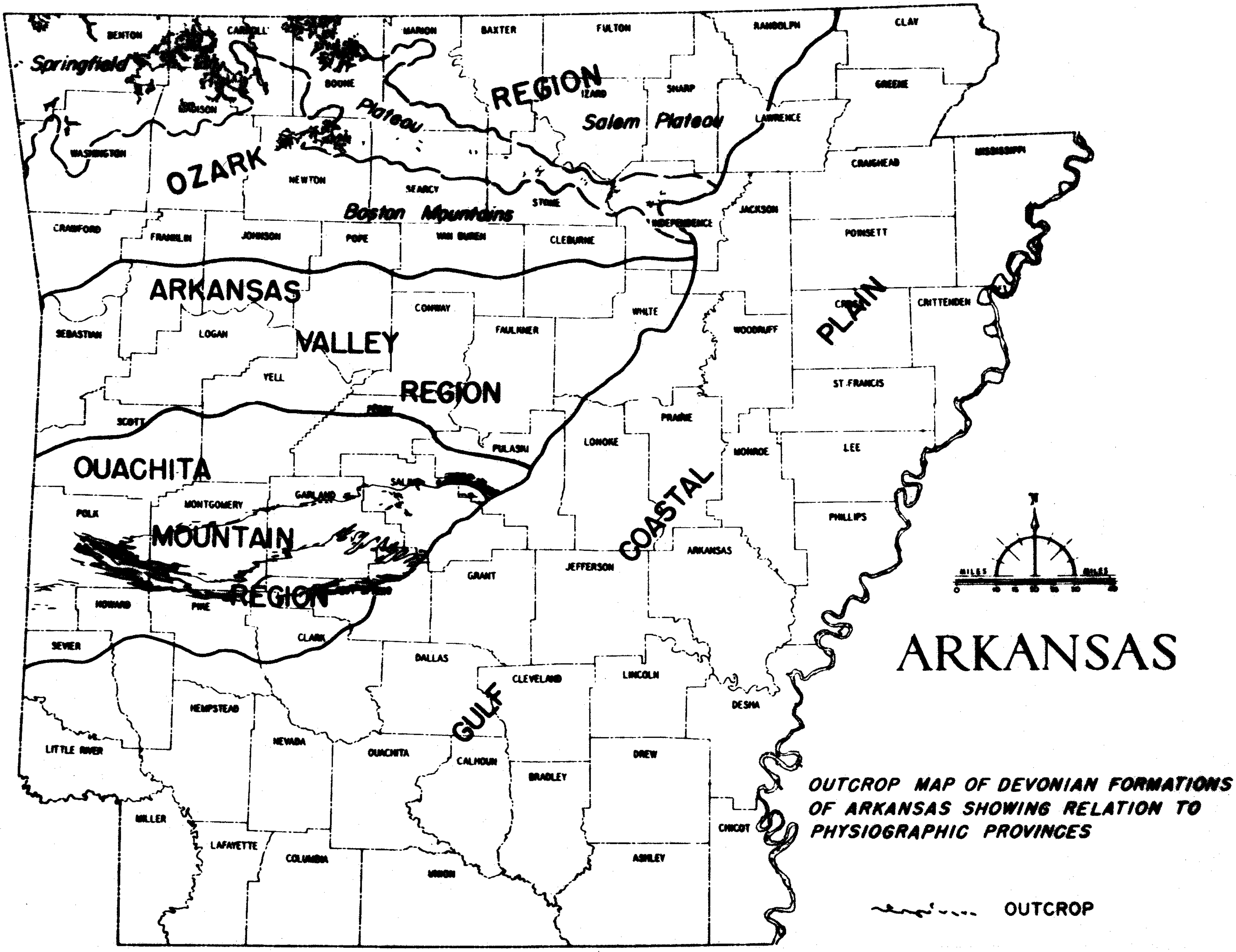
The Brassfield Limestone is correlated with the Brassfield of Kentucky, Missouri and Tennessee, and is equivalent or partially equivalent to the Chimneyhill Formation of Oklahoma (Caplan, 1954).

ST. CLAIR LIMESTONE

The St. Clair, as originally described by Penrose (1891), included the interval now mapped as Kimmswick Limestone (Ordovician) through Lafferty (Silurian). Williams (1892) redefined the St. Clair to include only that part now mapped as the St. Clair and Lafferty. The Lafferty, until separated by Miser (1920) was variously referred to as upper or gray-dense St. Clair.

Surface exposures are scattered in the north-central part of Arkansas principally between Batesville, Independence County, and Harrison, Boone County, and attain a maximum outcrop thickness of 100 feet. The St. Clair is thought to be widely distributed in the subsurface, but thickness data are not readily available.

Usually, the St. Clair is characterized as being a gray to pink, fossiliferous limestone with a micritic matrix. Locally the St. Clair contains an appreciable amount of sparry cement with spar-filled cavities



OUTCROP MAP OF DEVONIAN FORMATIONS OF ARKANSAS SHOWING RELATION TO PHYSIOGRAPHIC PROVINCES

PLATE 3.

and fossil molds. The St. Clair is quarried, two miles north of Batesville, as a commercial marble. The pink and tan color of the host rock contrasts with the white calcite-filled vugs, fractures, and fossil molds, and as a result makes a very attractive finishing stone.

A white oolitic limestone unit is sometimes present at the base of the St. Clair. This unit was identified by Maher and Lantz (1953) on the surface at St. Clair Springs, Independence County, and in the subsurface from the town of Marshall (deep water well), Searcy County. It is also present near Blanchard Springs, Stone County.

The St. Clair is thin to medium-bedded but generally occurs as a single, massive, sharp faced ledge on the outcrop. The St. Clair is a hard, brittle, resistant rock and, when struck, frequently causes the hammer to ring as if striking steel.

The St. Clair Limestone is correlated with the Laurel Limestone of Tennessee and is a partial equivalent of the Chimneyhill Formation of Oklahoma (Caplan, 1954).

LAFFERTY LIMESTONE

The Lafferty Limestone (Miser, 1920) was named for exposures at Tate Springs, 1¼ miles north of Penters Bluff Station on the Missouri Pacific Railroad, and one-half mile west of West Lafferty Creek.

The Lafferty at the type locality is about 85 feet thick, at its maximum thickness, and is an earthy, compact gray to red, thin to medium, even-bedded limestone. The reddish color, so conspicuous at the type locality, varies both laterally and vertically, and is thought to be related to the weathering of the rocks.

The Lafferty is considered to be unconformable with the overlying formations and appears to be disconformable with the underlying St. Clair Limestone. The contact with the St. Clair is characterized by a bedding break and an abrupt lithologic change from the biomicrite of the typical St. Clair to the earthy appearing micrite of the Lafferty.

The Lafferty is thought to be equivalent to, or partially equivalent to, the Henryhouse Shale of Oklahoma and to the Bainbridge Limestone of Missouri (Caplan, 1954).

DEVONIAN SYSTEM

The Devonian System of the Arkansas portion of the Ozark region is represented by three formations: (1) the Penters Chert, (2) the Clifty Limestone, and (3) the Chattanooga Shale. The surface crops of these formations are generally restricted to the Springfield Plateau physiographic province (see Figure 4), and with the exception of the Chattanooga are very spotty and local in exposure. A generalized structure map contoured on the top of the Devonian is shown on Figure 5.

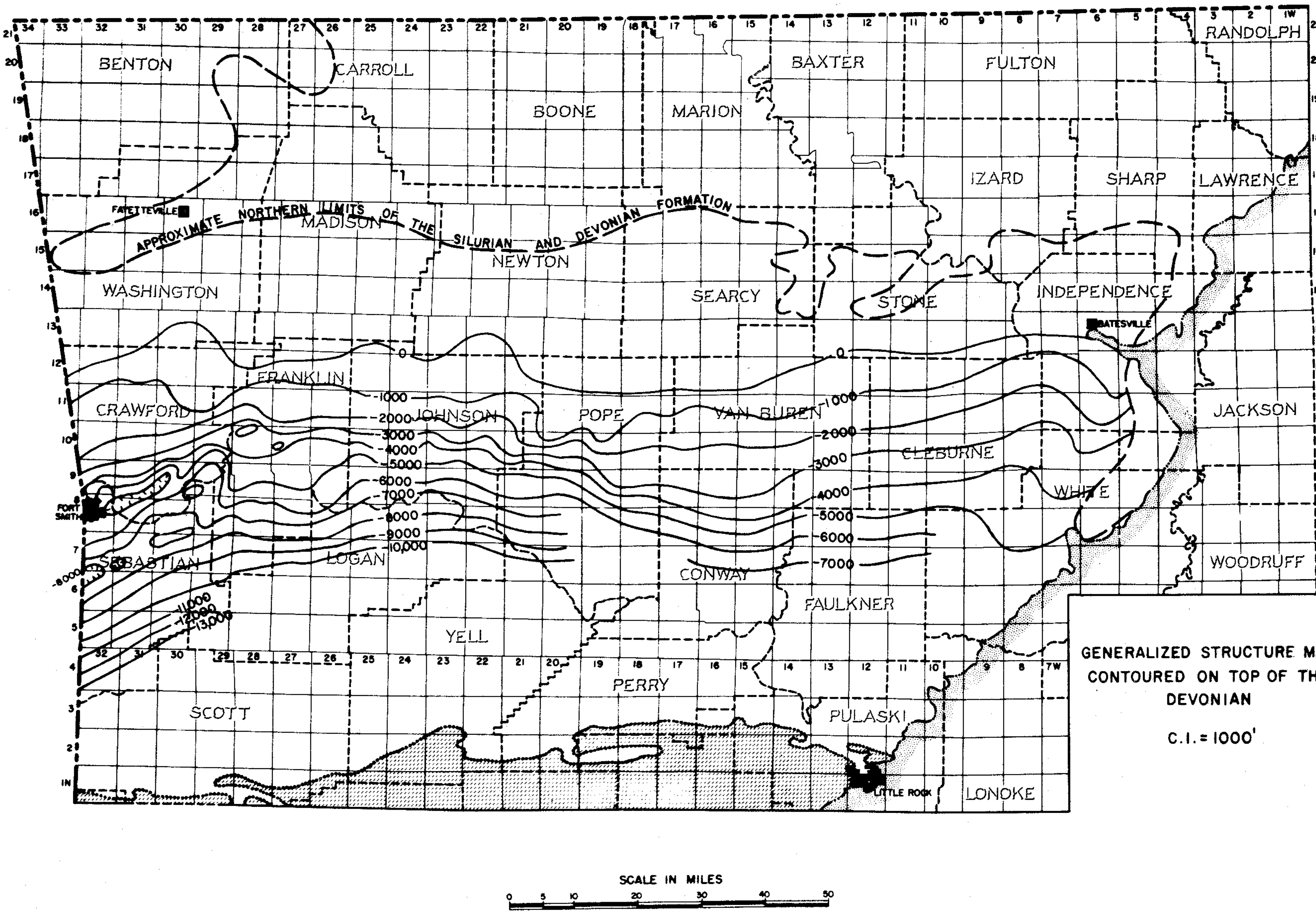
PENTERS CHERT

The Penters Chert, although widely developed in the subsurface, crops out only in the area around Batesville, Independence County, Arkansas (see Figure 6). The Penters is a brownish-gray to blue-gray, dense to translucent chert with thin interbeds of dolomitic limestone. In western Arkansas the Penters contains varying amounts of sand and ranges from a sandy chert to a cherty sandstone. The Penters Chert is often fractured and brecciated, with sand from the overlying Sylamore member filling the fractures at the top of the formation. The best surface exposures are found between Penters Bluff and Biltmore Switch, Izard and Independence Counties, Arkansas, along the Missouri Pacific Railroad's right-of-way on the White River. The formation thickens in the subsurface both in the Arkansas Valley, where it is in excess of 250 feet; and in the Mississippi Embayment, where it reaches an apparent thickness of 300 feet.

The Penters Chert is unconformable with both overlying and underlying formations. It correlates with the Camden Chert of Tennessee, the Clear Creek Chert of Missouri, the Sallisaw Formation of Oklahoma and the lower portion of the Arkansas Novaculite Formation of Oklahoma and Arkansas (Kinney, 1946). As a result of recent discoveries, the Penters Chert is now included as a gas producing formation in the Arkansas Valley portion of the Arkoma Basin.

CLIFTY FORMATION

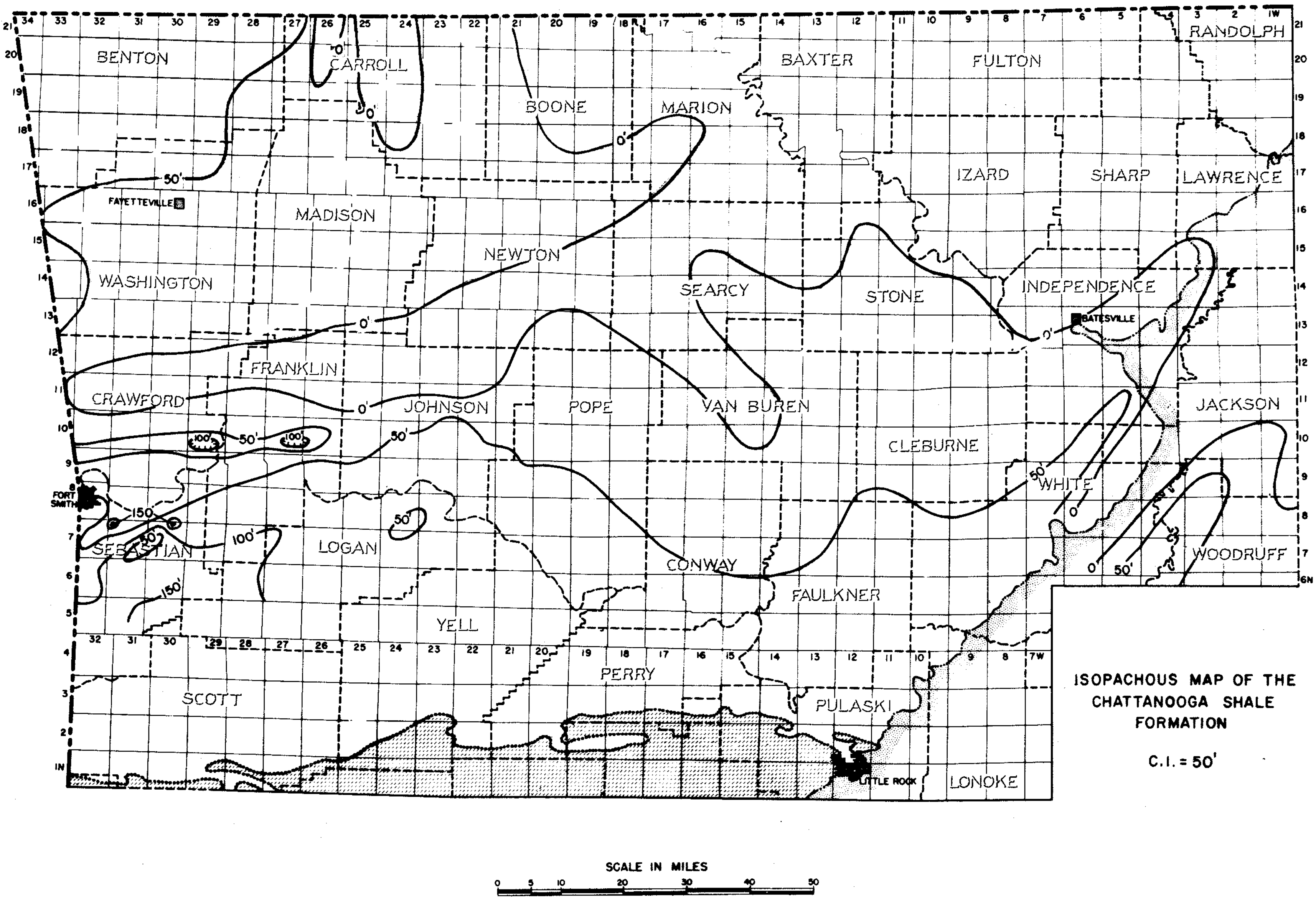
The Clifty Formation crops out in a limited area along the shoreline of Beaver Reservoir in Benton and Carroll Counties, Arkansas. Some of the exposures have been covered by the impounded water of the reservoir. In the original work (Purdue



GENERALIZED STRUCTURE MAP CONTOURED ON TOP OF THE DEVONIAN

C.I. = 1000'

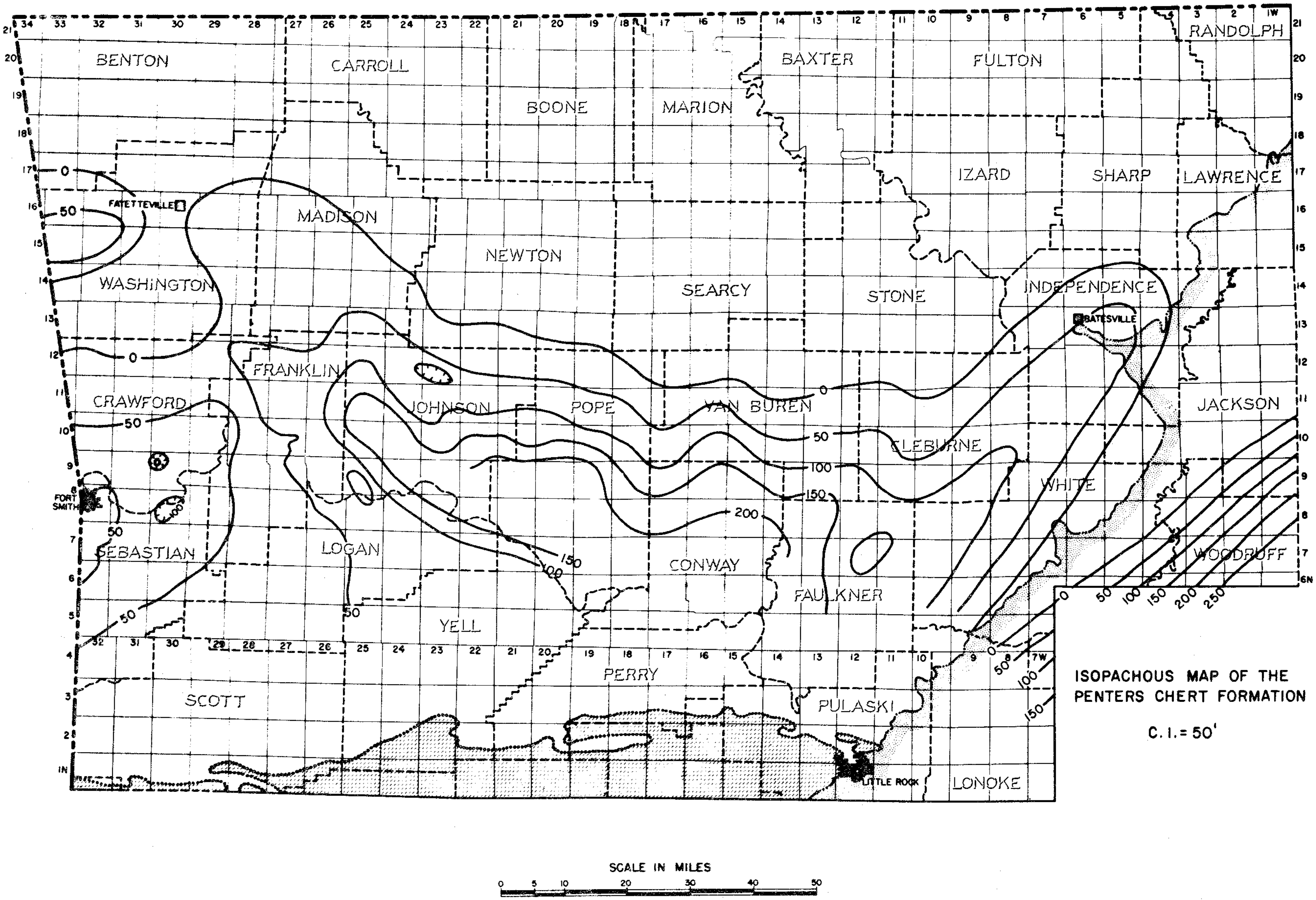
PLATE 4.



ISOPACHOUS MAP OF THE CHATTANOOGA SHALE FORMATION

C.I. = 50'

PLATE 5.



ISOPACHOUS MAP OF THE PENTERS CHERT FORMATION

C. I. = 50'

PLATE 6.

and Miser, 1916) the Clifty was described as a limestone up to 2¼ feet thick. However, recent work has indicated that the Clifty Limestone is actually a lens in a sandstone, and both units contain a Clifty fauna. The Clifty Formation attains a thickness of approximately 20 feet.

The Clifty Formation is considered to be Middle Devonian in age on the basis of the fauna and is correlated with the Hamilton Group of New York and the Sellersburg Limestone of Indiana (Purdue and Miser, 1916). The subsurface extent of the Clifty is unknown. The contact with overlying and underlying formations is unconformable.

CHATTANOOGA SHALE

The Chattanooga Shale is a black to brownish-black, fissile, pyritic shale averaging about 30 feet in thickness on the outcrop, and with the Sylamore Sandstone Member locally present at the base. The Chattanooga thickens down dip into both the Arkansas Valley portion of the Arkoma Basin where it reaches 100 feet just east of Fort Smith (see Figure 7), and the Mississippi Embayment where it reaches a thickness in excess of 180 feet in Lee and Monroe Counties.

The Chattanooga is unconformable with both overlying and underlying formations. The unconformity at the base is of a regional nature truncating rocks of Devonian, Silurian and Ordovician age and places the Chattanooga in contact with rocks as old as the Cotter Dolomite.

In Arkansas, as elsewhere, the age of the Chattanooga Shale has been a point of considerable contention. In the past it has been (a) restricted to the Mississippian System, (b) placed in both the Mississippian and Devonian Systems, or (c) restricted entirely to the Devonian System. It appears at this time that the formation is Devonian in age. The Chattanooga is correlated with the Chattanooga Shale and Woodford Shale of Oklahoma (Frezon, 1962) and the Chattanooga Shale of Tennessee (Cooper, et al., 1942).

The Sylamore Sandstone Member is very restricted in outcrop. Surface exposures are limited to the drainage basins of North and South Sylamore Creeks west of the White River in Stone County and a short distance along the White River between Guion and Walls Ferry, Izard and Independence Counties, Arkansas.

The Sylamore is a brown to white, medium to coarse-grained rounded sand, conglomeratic in part, with considerable chert fragment debris, and with lenses and nodules of brownish to bluish chalcedonic chert in the basal portion.

The outcrops appear to be lenticular, thickening from a feather edge to 15 or 20 feet and then rapidly thinning again. The Sylamore has been recognized in well cuttings in a few instances. The exact location of the type section is not known, but is thought to be upstream from the Gaylor Crossing, five miles north of Mountain View, Stone County, Arkansas.

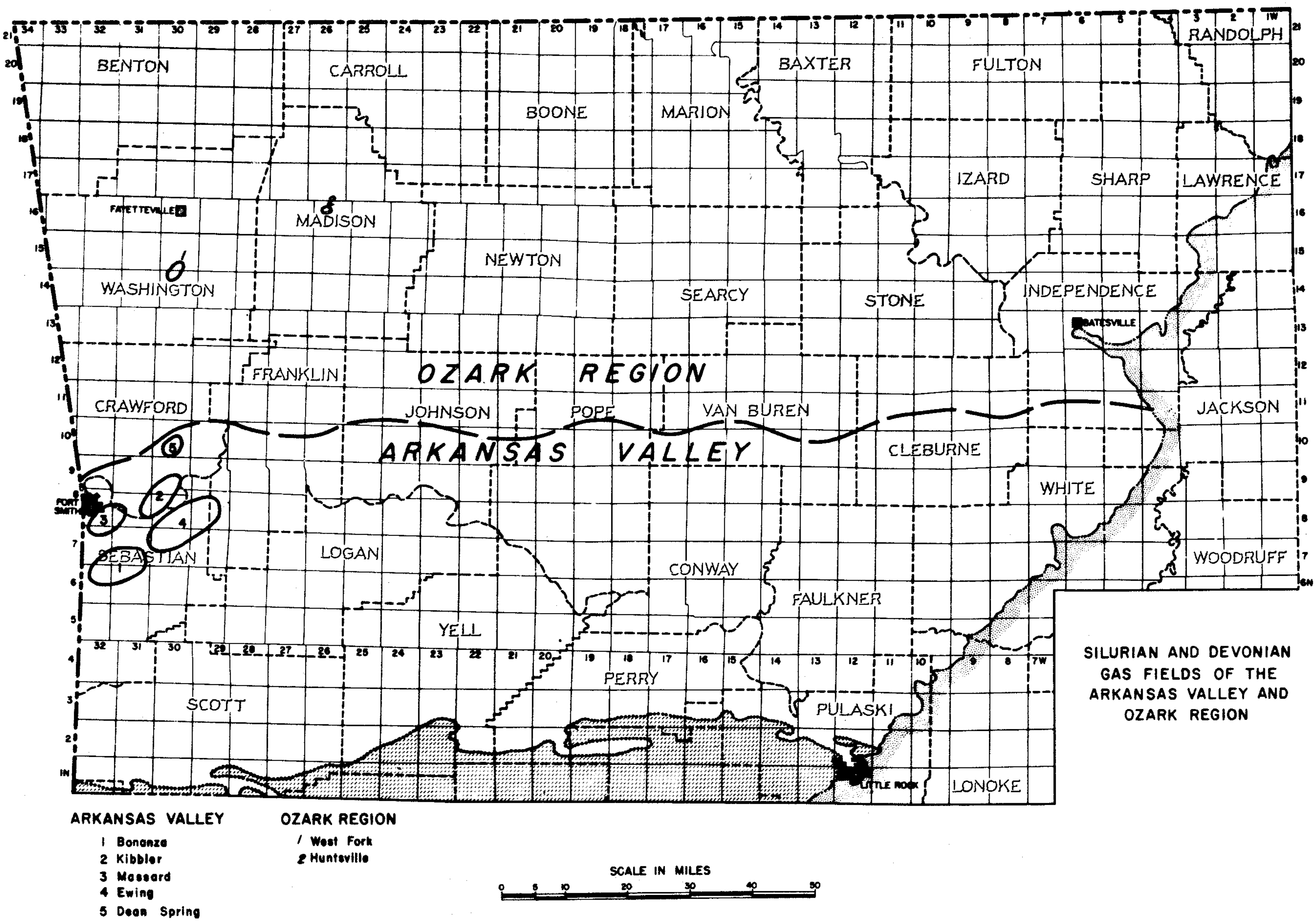
In the past, the Sylamore Sandstone has been confused with the basal sand of the Mississippian System and therefore assigned a Mississippian age by some workers. The Sylamore is correlated with the Misener Sandstone of Oklahoma and the Hardin Sandstone of Tennessee (Cooper, et al., 1942). The West Fork Field of Washington County, Arkansas and the Huntsville Field of Madison County are reported to be producing natural gas from the Sylamore Sandstone.

There is some question as to the identification of the producing formation or formations in the Ozark region. There are several sands in the Devonian and Ordovician sections with quite similar lithologies and, from place to place, any one might easily be mis-identified or go unrecognized where one is in contact with another.

PRODUCTION

The first commercial production of natural gas in Arkansas, attributed to rocks of Silurian or Devonian age, was the discovery well of the West Fork Field, Washington County, in the Ozark region. In 1953 the Arkansas Western No. 1 Threlkeld, sec. 5, T. 11 N., R. 30 W., was completed with an IPCOF of 1,500,000 CFGPD from a sandstone identified as Sylamore (Devonian). Production was from a depth of about 550 feet.

In 1962 Shell Oil Company reported an IPCOF of 9,400,000 CFGPD from the Hunton interval, 7936-58 feet, in the No. 1 Western Coal and Mining Company, discovery well of Bonanza Field. This well, located in sec. 36, T. 7 N., R. 32 W., Sebastian County, produced dry gas from a limy dolomite section, now generally regarded as St. Clair. Hence, this is the first Silurian producer in Arkansas.



SILURIAN AND DEVONIAN GAS FIELDS OF THE ARKANSAS VALLEY AND OZARK REGION

PLATE 7.

Also during 1962, two wells discovered dry gas in commercial amounts in the Penters Formation (Devonian). These were the Stephens Production Company No. 1 Fontaine in the Kibler Field, Crawford County, which reported an IPCOF of 7,500,000 CFGPD from 5922-54 feet, and the Stephens Production Company No. 1 Young in the Massard Field, Sebastian County, which had a reported IPCOF of 3,400,000 CFGPD from a depth of 6281-97 feet.

The discovery of Penters gas in the Stephens No. 1 Keck, sec. 16, T. 8 N., R. 29 W., Sebastian County, during 1966, in the Ewing Field, established the fourth field with commercial Silurian or Devonian production in the Arkansas Valley. The well had a reported IPCOF of 1,100,000 CFGPD from 6590-97 feet.

The opening of the Dean Spring Field in Crawford County, in 1976, added a fifth Arkansas Valley Hunton field. The discovery well, the Arkansas Western Gas Company No. 1-27 Williams, sec. 27, T. 10 N., R. 30 W., had an IPCOF of 110,000 CFGPD commingled from lower Boone (Mississippian) and Hunton zones at 3832-48 feet, 4002-04 feet, and 4010-14 feet.

A second Sylamore field was added in 1976 in the Ozark region. This field, designated as Huntsville Field, was opened by the Hardy and Minor No. 1 Cox, sec. 8, T. 16 N., R. 26 W., Madison County. An IPCOF of 890,000 CFGPD was reported from an acidized zone between 542 and 557 feet.

The seven fields noted above contain a total of thirty-six wells producing gas from Silurian or Devonian rocks in Arkansas. A number of these wells also produce from Pennsylvanian or Mississippian formations. Ordovician gas was noted by the operator in one well in Huntsville Field.

CONCLUSIONS

Silurian and Devonian rocks are widespread in the subsurface in central and northern Arkansas, and extend into the Mississippi Embayment in eastern Arkansas.

Discoveries over the past several years indicate that the Silurian-Devonian sequence is an important production interval in the Arkansas Valley.

A lithofacies map of the Penters showing sand development might be of assistance in projecting reservoir trends.

The Silurian, in the subsurface, has local areas of dolomitization, possibly associated with faulting, which may prove significant in the accumulation of hydrocarbons.

The thinning of the Silurian and Devonian sections over the Bonanza Field indicates some pre-Pennsylvanian structural activity.

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