Witts Springs Formation of Morrow Age in the Snowball Quadrangle North-Central Arkansas

By ERNEST E. GLICK, SHERWOOD E. FREZON, *and* MACKENZIE GORDON, JR.

CONTRIBUTIONS TO STRATIGRAPHY

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WITTS SPRINGS FORMATION OF MORROW AGE IN THE SNOWBALL QUADRANGLE, NORTH-CENTRAL ARKANSAS

By ERNEST E. GLICK, SHERWOOD E. FREZON, and MACKENZIE GORDON, JR.

ABSTRACT

The Witts Springs Formation is named for the village of Witts Springs in the Snowball quadrangle, north-central Arkansas. Its thickness ranges from less than 300 feet to nearly 600 feet in the quadrangle, where it rests unconformably in the Cane Hill Formation and is overlain unconformably by the Atoka Formation. At one locality in the southwestern part of the quadrangle, a post-Cane Hill channel cuts through the Cane Hill Formation; and the channel-fill facies of the Witts Springs rests on the Pitkin Limestone.

The Witts Springs Formation is stratigraphically equivalent to the Prairie Grove Member of the Hale Formation and to the overlying Bloyd Shale, both of which have their type localities in northwestern Arkansas. The entire faunal assemblage of the Witts Springs is distinctly and typically Morrow.

INTRODUCTION

The rocks that overlie the Pitkin Limestone of Late Mississippian age in the Snowball quadrangle, Newton and Searcy Counties, Ark. (figs. 1, 2, 3), constitute three mappable units. The lowermost unit is as much as 320 feet thick in the quadrangle and contains fossils of latest Mississippian age in its lower 100 feet. Because of its mappability in the Snowball quadrangle (fig. 3), this unit is herein designated as the Cane Hill Formation (Pennsylvanian and Mississippian in age) rather than as the Cane Hill Member of the Hale Formation (Early Pennsylvanian in age in northwestern Arkansas), with which it is homotaxial. Gordon (1964, p. 34) gave a new name, Imo Formation,

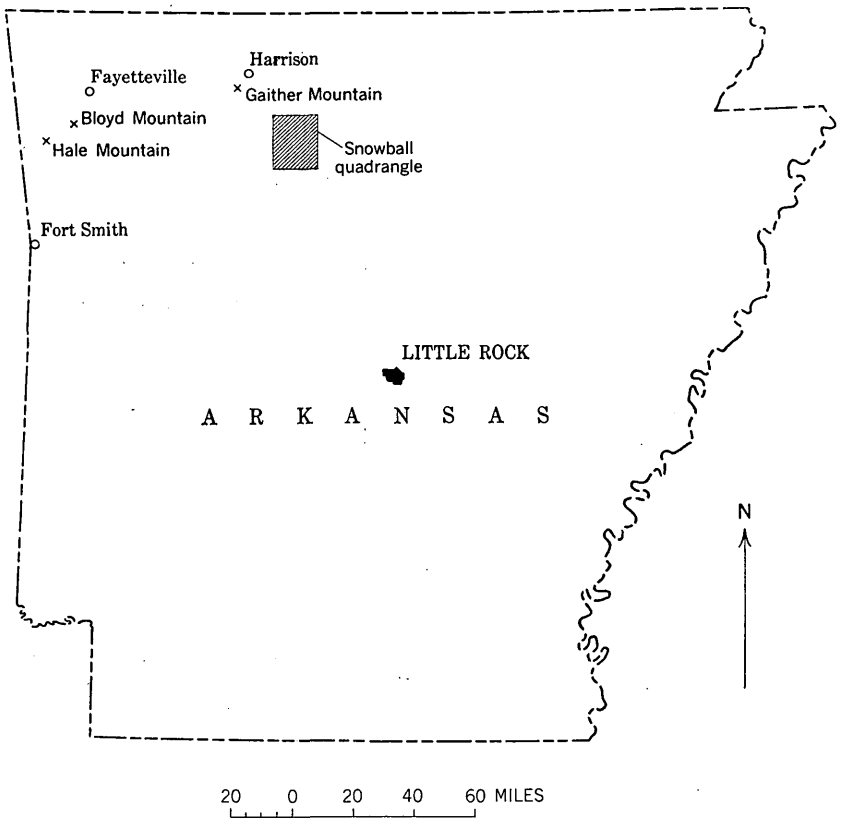

FIGURE 1.—The location of the Snowball quadrangle and other localities in northern Arkansas discussed in this report.

to this unit in a report which was transmitted to the printer just prior to the decision to use the name Cane Hill Formation for this unit. Thus, Imo Formation is abandoned.

The middle unit of the post-Pitkin sequence in the Snowball quadrangle, the subject of this report, is here designated the Witts Springs Formation. It is stratigraphically equivalent to the Prairie Grove Member of the Hale Formation and to the overlying Bloyd Shale of northwestern Arkansas. The new name is applied in the Snowball quadrangle because the Prairie Grove and Bloyd were not found to be individually mappable throughout the quadrangle. The Witts Springs is underlain by the Cane Hill Formation and overlain by the uppermost unit, the Atoka Formation.

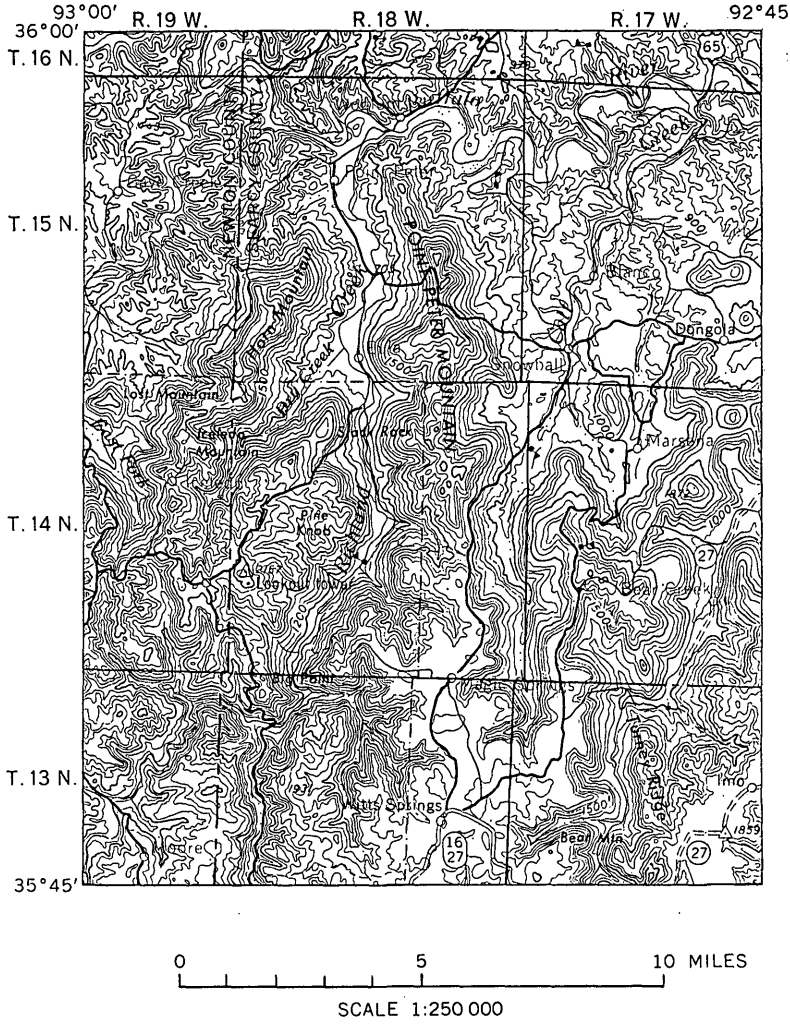

FIGURE 2.—Generalized topography of the Snowball quadrangle, Arkansas.

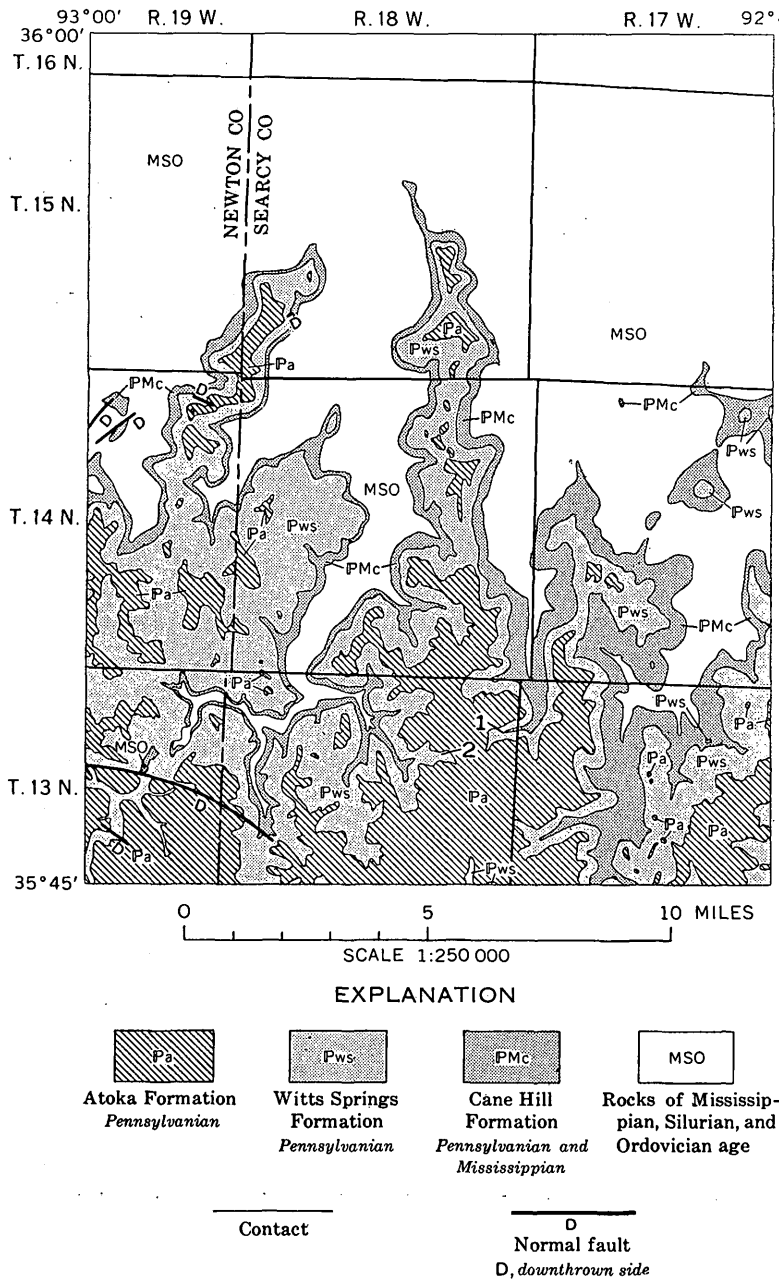

FIGURE 3.—Generalized geology of the Snowball quadrangle, Arkansas, showing the location of the type section (1) and the reference section (2) of the Witts Spring Formation.

TYPE SECTION

The Witts Springs Formation is named for the village of Witts Springs in the south-central part of the Snowball quadrangle, Searcy County, Ark., near which it is exposed.

Its type section is here designated as the section in the western headwater branch of Calf Creek, which is 2 miles northeast of Witts Springs (figs. 4, 5). The base of the section is in the valley bottom in the N½NW¼NE¼NE¼ sec. 12, T. 13 N., R. 18 W. The section extends westward 150 feet up the main valley and then northwestward up the valley of a small southward-flowing tributary and crosses into sec. 1, T. 13 N., R. 18 W., near the middle of the south edge of the SE¼ sec. 1. No access road is closer than half a mile.

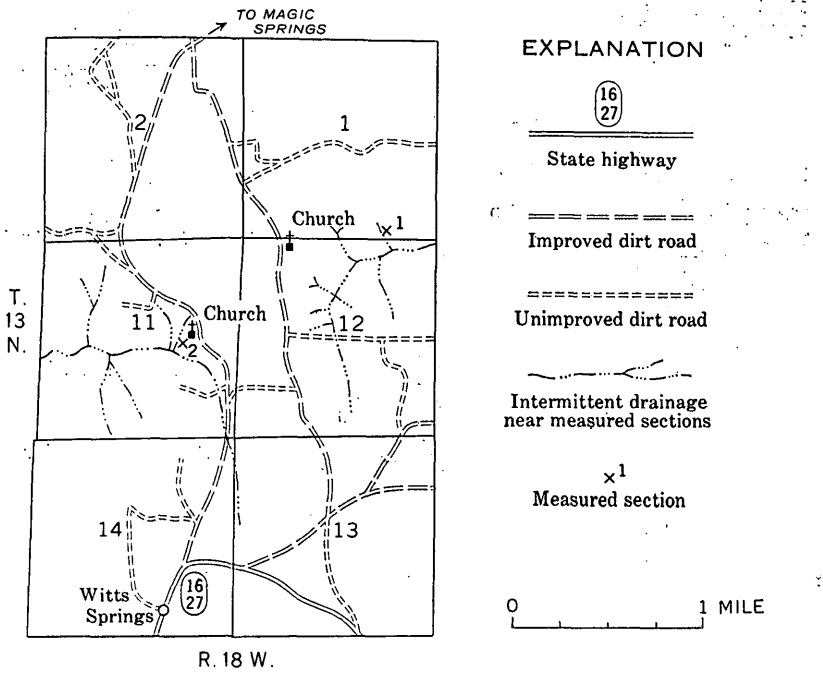

FIGURE 4.—The location of the type section (1) and the reference section (2) of the Witts Springs Formation in the Snowball quadrangle, Arkansas.

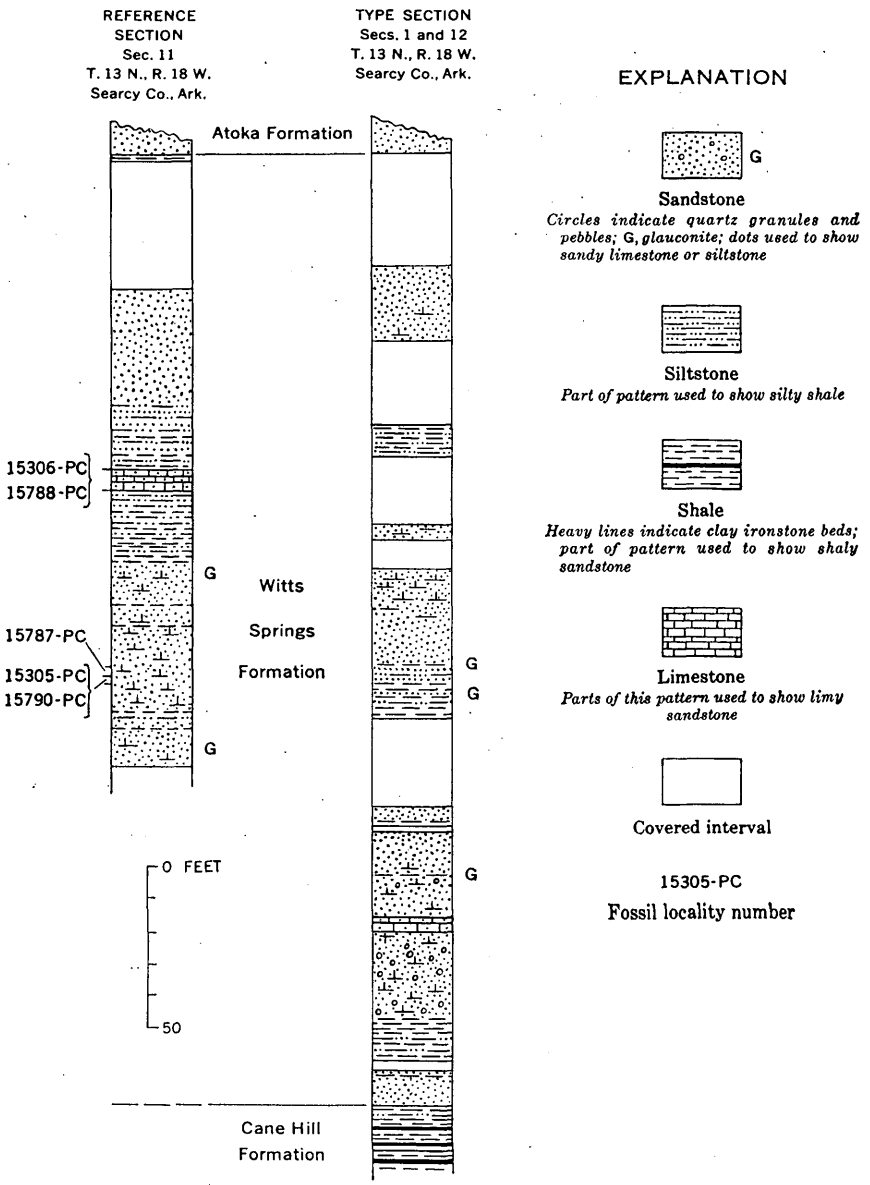

FIGURE 5.—Graphic illustration of the type section and reference section of the Witts Springs Formation, Snowball quadrangle, Arkansas.

Type section

[Measured and sampled by S. E. Frezon and W. A. Chisholm; samples examined under binocular microscope by W. A. Chisholm]

	Thickness (feet)
Pennsylvanian:	
Atoka Formation:	
About 65 ft of massive coarse-grained sandstone is exposed in cliffs along the sides of the valley.	
Witts Springs Formation:	
43. Covered interval (estimated to be pre-Atoka)	36.0
42. Sandstone, massive, silty, fine-grained; weathered brownish gray. Top of resistant unit over which there is an intermittent waterfall	12.3
41. Sandstone, massive, cross-laminated, medium-light-gray, limy, silty, very fine to fine-grained	5.5
40. Sandstone, massive, medium-light-gray, limy, silty, very fine to fine-grained; contains shale pebbles. Poorly exposed at foot of cliff	6.0
39. Covered interval	26.0
38. Siltstone, thin-bedded, light-olive-gray; dark-gray shale beds as much as 3 in. thick	4.7
37. Shale, dark-gray; interbedded with very thin to thin beds of medium-gray siltstone	5.0
36. Covered interval. Topography and nearby outcrops indicate that silty shale occupies this interval	21.0
35. Sandstone, very thin to thin-bedded, limy, silty, fine- to medium-grained; weathered brownish gray; upper foot contains fissile to platy gray silty shale laminae and beds as much as 2 in. thick	5.4
34. Covered interval	8.8
33. Sandstone, massive, medium-grained, weathered brownish gray; very limy where not leached; crinoid and gastropod remains and casts of brachiopods in upper 2 ft	11.0
32. Sandstone, medium-bedded to massive, iron-stained, leached, fine- to medium-grained	9.0
31. Sandstone, medium- to thick-bedded, iron-stained, fine- to medium-grained; shale pebbles	5.5
30. Sandstone, platy to thin-bedded, light-olive-gray, iron-stained, silty, very fine grained	5.0
29. Sandstone, very thin to medium-bedded, medium-light-gray, glauconitic, very fine to fine-grained; contains beds of dark-gray shale and platy medium-gray micaceous siltstone	5.5
28. Shale, dark-gray	1.0
27. Shale, dark-gray; interbedded with platy beds of medium-light-gray to medium-gray siltstone and medium-light-gray to olive-gray silty glauconitic very fine to fine-grained sandstone	6.3
26. Shale, dark-gray; interbedded with platy greenish-gray siltstone and very thin bedded brownish-gray, limy, silty, medium-grained sandstone	2.0
25. Shale, medium-dark-gray	2.0
24. Covered interval	28.0

	Thickness (feet)
Pennsylvanian—Continued	
Witts Springs Formation—Continued	
23. Sandstone, thick-bedded, medium-light-gray, very limy, silty, medium- to coarse-grained; crinoid remains	4.2
22. Shale, dark-gray	2.4
21. Covered interval	2.0
20. Sandstone, medium- to thick-bedded, medium-gray, limy, silty, fine- to medium-grained; coral colonies in lower half; shale pebbles in upper 4 in	13.0
19. Shale, dark-gray	0.3
18. Sandstone, very thin bedded, brownish-gray, iron-stained, limy, silty, glauconitic, fine-grained to very coarse grained; scattered white quartz granules and pebbles; brachiopod and crinoid remains	3.8
17. Sandstone, very thin bedded, grayish-brown, iron-stained, limy, silty, glauconitic, very fine to fine-grained; crinoid remains	9.0
16. Limestone, very thin bedded, medium-gray, very sandy (medium to very coarse grains), crinoidal, finely granular	4.5
15. Sandstone, very thin bedded, medium-gray, very limy, silty, medium- to coarse-grained; crinoid, brachiopod, and gastropod remains	5.7
14. Sandstone, medium- to thick-bedded, medium-gray, very limy, silty, fine-grained to very coarse grained; contains white quartz granules and pebbles; crinoid, gastropod, and pelecypod remains	5.5
13. Sandstone, medium- to thick-bedded, medium-gray, limy, silty, fine-grained to very coarse grained; contains trace of white quartz granules and pebbles in upper half; crinoid stems	5.7
12. Sandstone, thin- to medium-bedded, grayish-brown, iron-stained, very limy, silty, fine- to medium-grained; partings and thin lenses of shale	5.0
11. Sandstone, thin- to medium-bedded, grayish-brown, iron-stained, very limy, silty, medium-grained; shale pebbles and white quartz granules and pebbles (more abundant in the lower 2 ft); crinoid stems	5.0
10. Shale, dark-gray; interbedded with platy to very thin bedded medium-dark-gray sandy (very fine grains) micaceous siltstone	2.0
9. Shale, dark-gray; medium-dark-gray siltstone laminae	11.8
8. Covered interval	2.5
7. Sandstone, single bed, medium-gray, limy, pyritic, medium-grained; shale pebbles; crinoid and pelecypod casts	0.5
6. Shale, dark-gray	0.5
5. Sandstone, very thin to thin-bedded, medium-gray, limy, pyritic, medium-grained; shale pebbles; pelecypods	0.7
4. Shale, dark-gray	0.5
3. Sandstone, very thin to thin-bedded, limy, silty, fine- to medium-grained; shale partings; crinoid stems and brachiopods	2.4
2. Sandstone, platy to very thin bedded, medium-gray, silty, fine- to medium-grained; lenticular beds of dark-gray shale as much as 6 in. thick	1.3

Pennsylvanian—Continued	Thickness (feet)
Witts Springs Formation—Continued	
1. Sandstone, platy to thin-bedded, medium-gray, limy, silty, fine- to medium-grained; shale pebbles, plant impressions, and pelecypod casts; dark-gray shale partings in upper half	5.7
Total thickness, Witts Springs Formation	300.0

The base of the Witts Springs Formation overlies the top of the Cane Hill Formation in the valley bottom. About one-fourth of a mile downstream on the south side of the valley, the following section of the upper part of the Cane Hill Formation is exposed directly below the Witts Springs Formation.

Pennsylvanian and Mississippian:	Thickness (feet)
Cane Hill Formation:	
Shale, fissile to platy, dark-gray; platy to thin-bedded medium-dark-gray siltstone; layers of ironstone concretions near top	21.0
Shale, dark-gray; platy medium-dark-gray siltstone beds	14.0
Shale, dark-gray	22.0
Shale, dark-gray; ironstone beds as much as 1 in. thick about 3 ft apart	44.0
Partial thickness of Cane Hill Formation	101.0

REFERENCE SECTION

The upper two-thirds of the Witts Springs Formation for the most part is well exposed in a section 1.2 miles southwest of the type section (fig. 4). Here designated the reference section, it is in the easternmost headwater branch of a tributary to Richland Creek near the center of the E½ sec. 11, T. 13 N., R. 18 W. The base of the section is at the mouth of the westernmost of two small southward-flowing tributaries to the branch. Most of the section was measured and sampled in the easternmost tributary, although poorly exposed intervals were measured and sampled in the valley of the westernmost tributary. The top of the section is in the easternmost tributary, west of a white church on the west side of the road from Witts Springs to Magic Springs.

Reference section

[Measured and sampled by S. E. Frezon and E. E. Glick; samples examined under binocular microscope by W. A. Chisholm]

Pennsylvanian:	Thickness (feet)
Atoka Formation:	
About 50 ft of massive coarse-grained sandstone is exposed in a cliff at top.	
Witts Springs Formation:	
24. Shale, dark-gray; trace of platy brownish-gray micaceous siltstone	2.0
23. Covered interval (probably shale, as indicated by scattered outcrops in this valley)	41.0

Pennsylvanian—Continued

Witts Springs Formation—Continued

22.	Sandstone, thick-bedded to massive, cross-laminated, grayish-brown, iron-stained, leached, silty, fine-grained	3.7
21.	Sandstone, thick-bedded to massive, cross-laminated, light-olive-gray, limy, silty, fine-grained	30.8
20.	Siltstone and sandstone interbedded; platy to thin-bedded light-olive-gray siltstone and thin- to medium-bedded light-olive-gray to olive-gray silty slightly limy very fine grained sandstone	10.2
19.	Siltstone, shale, and sandstone, interbedded; very thin to thin-bedded olive-gray to dark-gray micaceous siltstone, dark-gray shale, and very thin to thin-bedded medium-light-gray to medium-gray silty sandstone	5.7
18.	Shale, dark-gray; interbedded with very thin to thin-bedded brownish-gray to dark-gray micaceous sandy siltstone	5.0
17.	Limestone, thick-bedded to massive, cross-laminated, medium-gray to dark-gray, oolitic (in part), very sandy (fine to medium grains), finely granular; crinoid stems, gastropods, bryozoans, and brachiopods; lenticular unit 5–10 ft thick	7.0
16.	Siltstone, very thin to medium-bedded, light-gray to light-olive-gray, sandy (very fine grains), micaceous	3.9
15.	Siltstone, very thin to thin-bedded, light-olive-gray to olive-gray, micaceous; dark-gray shale beds as much as 3 in. thick	10.0
14.	Shale, dark-gray; medium-gray to dark-gray micaceous siltstone beds as much as 2 in. thick	10.3
13.	Sandstone, very thin to thin-bedded, cross-laminated, grayish-brown, iron-stained, very limy, fine- to medium-grained; dark-gray shale partings and stringers	4.7
12.	Sandstone, thin- to medium-bedded, grayish-brown, iron-stained, silty, fine- to medium-grained; limy where not leached; locally glauconitic; contains dark-gray shale beds	9.4
11.	Sandstone, thin- to medium-bedded, medium-gray to medium-dark-gray, silty, very limy, fine- to medium-grained; dark-gray shale beds; crinoid stems	4.4
10.	Sandstone, thin-bedded, brownish-gray, iron-stained, silty, very limy, fine- to medium-grained; dark-gray shale beds and shale pebbles; crinoid stems and gastropods	4.0
9.	Sandstone, thin-bedded (lower foot) to massive, medium-gray to grayish-brown, iron-stained, limy, fine- to medium-grained; crinoid stems	5.0
8.	Sandstone, massive, cross-laminated, medium-gray, weathered to grayish brown, silty, very limy, fine- to medium-grained; plant impressions, crinoid stems, and brachiopods	4.0
7.	Sandstone, thick-bedded, cross-laminated, medium-gray, silty, very limy, fine- to medium-grained; crinoid stems, cephalopods (goniatites), and gastropods	2.0
6.	Sandstone, thick-bedded, slightly cross-laminated, medium-light-gray, silty, very limy, fine- to medium-grained; cephalopods (goniatites) and gastropods	2.0

Pennsylvanian—Continued

Witts Springs Formation—Continued

5. Sandstone, massive, cross-laminated, grayish-brown, iron-stained, silty, very limy, fine- to medium-grained; crinoid stems	4.4
4. Sandstone, massive, cross-laminated, brownish-gray, iron-stained, silty, very limy, fine- to medium-grained (scattered coarse grains); crinoid stems	4.3
3. Shale, siltstone, and sandstone, interbedded; dark-gray silty shale, platy to very thin bedded medium- to dark-gray micaceous siltstone, and platy to thin-bedded olive-gray silty glauconitic very fine to fine-grained sandstone	7.5
2. Sandstone, very thin to thin-bedded, grayish-brown, iron-stained, silty, fine- to medium-grained; shale fragments	1.0
1. Sandstone, thin- to thick-bedded, cross-laminated, grayish-brown, iron-stained, silty, limy, glauconitic (in part), fine- to medium-grained; shale fragments and plant impressions	10.5
Thickness (rounded), Witts Springs Formation	193.0

The base of the Witts Springs Formation crops out to the west about half a mile downstream.

GENERAL FEATURES AND STRATIGRAPHIC RELATIONS

The Witts Springs Formation unconformably overlies the Cane Hill Formation or, where the Cane Hill is absent, the Pitkin Limestone; it is unconformably overlain by the Atoka Formation. The thickness of the Witts Springs ranges from less than 300 feet in the northern part of the Snowball quadrangle to nearly 600 feet in the southwestern part. Both the upper and lower boundaries are easily mappable, as each generally is at the base of a massive sandstone unit that has a sharp contact with a shale unit below.

The sandstone unit at the base of the Witts Springs Formation is fine to coarse grained and is conglomeratic in the lower part, commonly containing quartz granules and pebbles. That unit rests on the shale of the Cane Hill Formation except in the valley of upper Richland Creek in the southwestern part of the quadrangle where the Cane Hill is cut out locally and the Witts Springs rests on the Pitkin Limestone.

In the general area of deepest post-Cane Hill channeling, at least the lower 100 feet of the Witts Springs Formation is a distinct channel-fill deposit consisting of quartz-pebble conglomerate overlain by either massive sandstone, poorly sorted and irregularly bedded sandstone, or shale. Apparently the valley system was drowned shortly after Witts Springs deposition began, because the coarse sand and conglomerate in the deepest parts of the channels is extensive; but the overlying channel-fill sandstone units grade southward, and

perhaps westward, into a silty shale facies of the channel-fill deposit. All facies of the channel-fill are conformably overlain by an apparently normal section of the middle and upper parts of the Witts Springs.

As is indicated by figure 6, the channeling is deepest in the southwestern part of the Snowball quadrangle, but it is not restricted to that area. The type section of the Witts Springs is high on the flank of a post-Cane Hill topographic high, but it contains a lower sandstone unit about 12 feet thick and an overlying shale unit about 15 feet thick that are interpreted as the upper part of the channel-fill deposit. The lower sandstone unit tends to thicken where the underlying Cane Hill thins more abruptly than is normal by northwestward regional thinning. The lower sandstone unit of the Witts Springs averages about 50 feet in thickness in the central and northern parts of the quadrangle where it is overlain by a 15-foot-thick shale unit equivalent to the one at the type section.

On the basis of work either completed or in progress in adjacent areas, it seems that the lower sandstone unit and the overlying shale unit are typical in this quadrangle but are largely atypical and absent in most other areas of northwestern Arkansas. They were probably deposited in a local topographically low area that sloped gradually toward the channels in the southwestern part of the quadrangle.

The main part of the Witts Springs Formation—about the upper 250 feet—is a sequence of dark-gray silty to nonsilty shale and fine- to medium-grained massive limy sandstone that grades into lenses of sandy limestone. This sequence forms a slope of about 30° up to the base of the Atoka Formation. Both the sandstone and limestone are cross-laminated locally and commonly contain scattered granules and pebbles of quartz and fragments of marine fossils. The thicker sandstone and shale units are mappable locally but probably not regionally. The conformable contact of the stratigraphic equivalents of the Hale Formation and the overlying Bloyd Shale probably is in the lower half of this sequence (perhaps at about the top of unit 23 of the type section), but it was not found to be satisfactorily mappable in the Snowball quadrangle.

The massive coarse-grained basal sandstone of the Atoka Formation rests on the truncated but relatively even surface of the Witts Springs Formation. The upper 30–50 feet of the Witts Springs in much of the Snowball quadrangle is dark-gray shale that is poorly exposed in most areas of outcrops. Beds as young as the Kessler Limestone Member of the Bloyd Shale may be present in the Snowball quadrangle, but they have not been definitely recognized. Probably progressively younger beds of the formation are present to

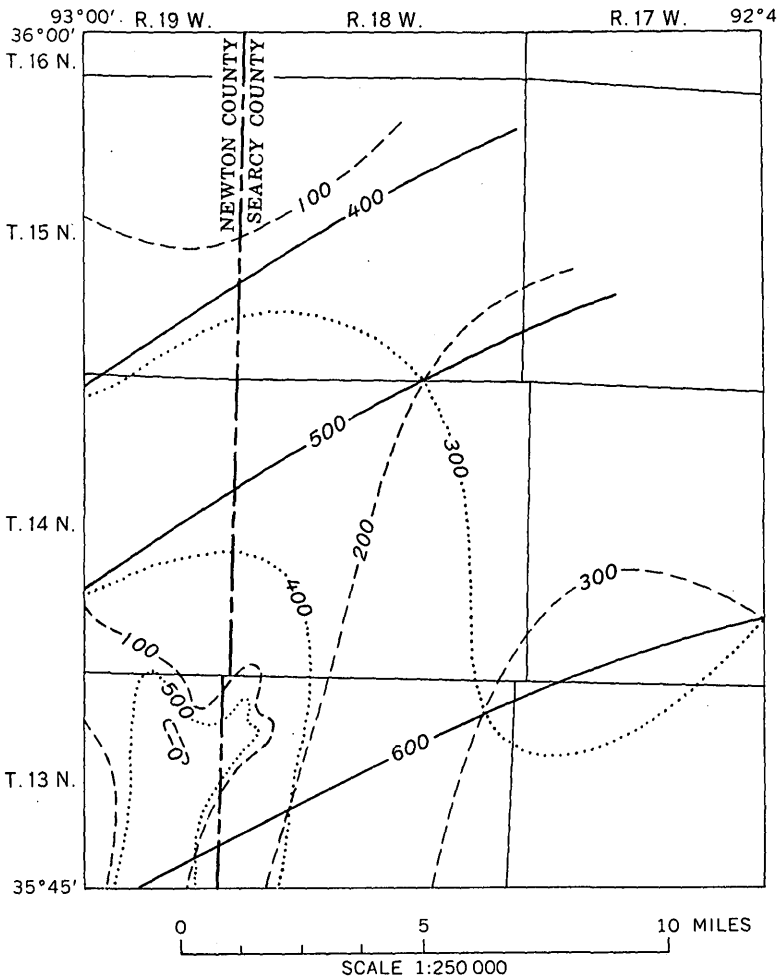

FIGURE 6.—The thickness of the Cane Hill Formation (dashed lines), the thickness of the Witts Springs Formation (dotted lines), and the combined thickness of both formations (solid lines) in the Snowball quadrangle, Arkansas. Isopach interval is 100 feet.

the south and east in and beyond the quadrangle; but, as the truncation is gradual and subtle, the younger beds will be recognized only through regional paleontological studies or through the detailed mapping of key beds.

FOSSILS AND AGE

The cephalopods constitute the only component of the invertebrate fauna of the Witts Springs Formation that has been studied in as much detail as such fauna of the Cane Hill Formation. The more

detailed correlations have therefore been derived from the cephalopods. The entire faunal assemblage of the Witts Springs Formation, however, is distinctly and typically Morrow.

Several fossil collections from the reference section have been examined by Mackenzie Gordon, Jr.; and the gastropods have been examined by Ellis Yochelson. The fossils from bed 6 are as follows (USGS colln. 15305–PC and 15790–PC):

Bellerophon sp.
Glabrocingulum sp.
Glaphyrites morrowensis (Miller and Moore)
oblatus Miller and Moore
Gastrioceras adaense Miller and Owen

From bed 7 the following fossils were identified (USGS colln. 15787–PC):

Encrusting bryozoan
Streblochondrial? sp.
Bellerophon sp. undet.
Euphemites sp. undet.
Glabrocingulum? sp. undet.
Glaphyrites morrowensis (Miller and Moore)

The cephalopods from these two beds, whose combined thickness is 4 feet, resemble the cephalopods from the upper part of the Hale Sandstone or from the lower rocks of the Morrow as identified by some authors in a roadcut in Gaither Mountain (fig. 1) in sec. 27, T. 18 N., R. 21 W., about 7 miles southwest of Harrison, Ark. The Gaither Mountain cephalopods were first studied by Miller and Moore (1938). At that time the source beds of the cephalopod fauna were thought to belong to the Hale Formation; and on this basis, Miller and Owen (1944) classified a similar fauna in the Union Valley Formation of Oklahoma as of early Morrow, or Hale, age. The Union Valley Formation was originally described as a sandstone member of the Wapanucka Formation by Hollingsworth (1934), who considered the fauna in the top few feet as being like that of the Brentwood Limestone Member of the Bloyd Formation.

The Gaither Mountain cephalopods have been restudied and compared with extensive collections recently obtained from the type Morrow Series in the vicinity of Bloyd and Hale Mountains in Washington County, Ark. (fig. 1). These studies indicate that the nearest equivalent of the fauna from the lower part of the Witts Springs reference section and from the Gaither Mountain fauna is found in the Brentwood Limestone Member of the Bloyd Formation and not in the Hale Formation as was formerly thought.

From bed 17 of the reference section the following faunule was obtained (USGS colln. 15306–PC and 15788–PC):

Schizophoria altirostris (Mather)
Derbyia? sp.
Juresania sp.
Antiquatonia morrowensis (Mather)?
Linoproductus sp. undet.
Composita ozarkana Mather
Posidonia sp.
Myalina sp.
Aviculopecten arkansanus Mather?
Pleurophorus sp.
Sphenotus sp.
Laevidentalium sp.
Bellerophon sp. undet.
Knigthites (*Retispira* or *Cymatospira*) sp.
Euphemites sp. undet.
Donaldina sp. undet.
Bactrites? n. sp.
Stenopronorites arkansiensis Smith?

The recognizable species in this collection are typical Morrow forms. Because of bed 17's stratigraphic position above beds 6 and 7, which have a fauna of Brentwood affinities, bed 17 and its Morrow fauna are determinable with confidence as being of Bloyd age.

A faunule of Hale age has been recognized in the Snowball quadrangle at another locality of the Witts Springs Formation—in the NW¼NW¼ sec. 32, T. 14 N., R. 17 W. Here in a gully fossils, including cephalopods, occur in a bed that is stratigraphically about 60 feet above the base of the formation and 230 feet below the base of the Atoka Formation. A small collection yielded the following fossils (USGS colln. 15307–PC):

Michelinia sp.
Stenoporoid bryozoan
Crinoid columnals
Schizophoria sp.
Juresania sp.
Linoproducts sp.
Spirifer sp.
Composita sp. undet.
Conocardium sp.
Mooreoceras sp.
Glaphyrites globosus (Easton)
Pygmaeoceras n. sp.
Goniatite undet.
Palladin sp. (pygidium)

The presence of *Glaphyrites globosus* (Easton) is indicative of Hale age, as this species is thought to be restricted to the Hale Formation. The undescribed *Pygmaeoceras* also is found in the Hale Formation.

At the same locality but stratigraphically 60 feet higher, a 6-inch bed of calcareous sandstone contains the following fossils (USGS colln. 15308–PC):

Worn crinoid calyx (?)
Pelecypod undet.
Bellerophon sp.
Euphemites sp.
Galbrocingulum sp.
Glaphyrites morrowensis (Miller and Moore)

This faunule is neither distinctly Hale nor distinctly Bloyd, as the goniatite *G. morrowensis* is common in the upper part of the Hale and throughout much of the Bloyd and as the other genera are not definitive.

In summary, faunas of Hale and of Bloyd age are found in the Witts Springs Formation. As might be expected, the fauna having definite Hale affinities is found in the lower part of the Witts Springs. The faunules from the other, or higher, fossil zones in the Witts Springs Formation have a span similar to that of a part and possibly the entire Bloyd sequence in Washington County. It is not yet known or proven by fossil evidence whether some of the uppermost zones found in the Bloyd are missing from the uppermost part of the Witts Springs as a result of nondeposition or of pre-Atoka erosion.

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