

STRATIGRAPHY OF THE SOUTHERN HALF  
OF THE LA SALLE ANTICLINE<sup>1</sup>

L. A. MYLIUS, STATE GEOLOGICAL SURVEY, URBANA, ILL.

## GENERAL RELATIONS

The La Salle anticline is an anticlinal fold which runs a little west of north and a little east of south through eastern Illinois. It appears in outcrop in La Salle County and extends without outcrop evidence to Lawrence County, Illinois; from that place it is not as well understood. The Galena-Trenton limestone outcrops at La Salle, and from that place to Lawrence County, Illinois, underlies a zone of anticlinal folding over 200 miles long. There is no rock section outcropping from which to make any direct studies on the conditions which underline the southern part of the La Salle anticline, as practically all the area is covered by from 50 to 200 feet of glacial drift. The western limb of the anticline has a very steep dip, while the eastern is usually not so steep, and in places a double fold exists. Practically all the oil production in Illinois has been from structures associated with this La Salle anticline in Lawrence, Crawford, Clark, and Cumberland counties.

## PURPOSE

The purpose of this paper is to establish, if possible, from data obtained by the study of well logs and samples, facts bearing on the ages of the folding along the La Salle anticlinal zone; also to apply the age of folding to a practical consideration of oil accumulation, and to the interpretation of folds in the lower formations from shallow test holes. It is realized that well log interpretation can not give unquestionable results, but it is hoped that in this area where direct study of the rock section is impossible some facts obtained from well logs may be logically linked with paleontological interpretations made elsewhere for the seas in which the different formations were deposited. The area discussed is approximately 90 miles in length by 20 miles in width and consists of parts of Douglas, Edgar, Coles, Clark, Cumberland, Jasper, Crawford, Richland, and Lawrence counties.

1. This paper is preliminary to a more detailed discussion of the subject in a forthcoming bulletin of the Illinois State Geological Survey. Points that have been considered as proof of these conclusions will be detailed at that time.

## PITCH OF ANTICLINE

The formations along the strike of the zone show locally many variations. They deepen in general from La Salle County southward. In places reduced pitch, flattening, and reversal of pitch exist. From south Douglas County to south Lawrence County (80 miles) the net pitch would average 35 feet per mile.

## ROCK SECTION

Ordovician,  
"Trenton" (Kimmswick?),  
Maquoketa or Richmond,  
Silurian,  
Devonian,  
Lower Mississippian,  
Chester,  
Pennsylvanian.

## "TRENTON"

The Ordovician limestone, the "Trenton" of the oil-well driller, which corresponds approximately to the Kimmswick and Galena, occurs under this area at varying depths to the top, from 500 feet to 3,700 feet below sea level, depending on the locations with respect to the dip of the flanks and pitch of the axis of the fold. There are not sufficient holes going through the Trenton to give any information as to variation in its thickness. The upper 200 feet is composed of limestone. The oil production comes from limestone. The highest magnesium carbonate content determining from two samples of the oil-producing "sand" was 3 per cent.

## MAQUOKETA

Over this whole area, the Maquoketa usually consists of three members: a basal member of shale varying from 110 to 130 feet in thickness, a middle member of limestone from 40 to 60 feet in thickness, and a top member of shale from 90 to 100 feet in thickness. The total thickness of the so-called Maquoketa is from 230 to 270 feet. The top of the formation is reached at elevations varying from 250 feet to 3,400 feet below sea level. North of the

zone under discussion, for example in Kankakee County, it is reached at about 500 feet above sea level where it consists of the same three members.

#### SILURIAN AND DEVONIAN LIMESTONE

The State Geological Survey has been gathering samples, a study of which may give some good basis for differentiating the Silurian from the Devonian beds. It is usual for the Silurian to be dolomitic and the Devonian to be calcareous. For the purpose of this paper the two systems are considered together. The total thickness over the area varies from 800 feet to 1,050 feet. Changes in elevation of the top are from 300 feet above sea level to 2,600 feet below sea level.

#### SO-CALLED UPPER DEVONIAN SHALE

This shale varies in thickness from 100 to 175 feet over the whole area. Tests have shown a variation in thickness of 25 feet in half a mile. The overlying beds being apparently regular, the loss in thickness of the shale suggests the possibility of an underlying irregular limestone surface due to erosion. The maximum change in thickness occurs between the extreme north and south parts of area. East and west off the crest of the fold the shale sometimes thickens 25 feet. The top of the shale is found at elevations varying from 400 feet above sea level to 2,500 feet below.

#### LOWER MISSISSIPPIAN

On account of a large unconformity at the top and the rise of the anticline to the north, the Lower Mississippian varies from very small thickness up to a maximum of 1,300 feet. The base of this formation occurs from elevations of 400 feet above sea level to 2,500 feet below sea level.

#### CHESTER

The base of the Chester formation is found from 100 feet to 1,600 feet below sea level. The Chester varies from practically no thickness to a thickness of over 700 feet.

#### PENNSYLVANIAN

The base of the Pennsylvanian is found from 500 feet above sea level to 800 feet below sea level. The Pennsylvanian varies from practically no thickness to a thickness of 1,400 feet.



## FOLDING

## TRENTON TIME

The finding of apparently typical Kimmswick limestone in Clark County in the supposed area of the Galena sea, will introduce a question as to the amount of folding that took place during or prior to this time along the zone of the present LaSalle anticline which was considered the barrier between the Galena and the Kimmswick seas.

## MAQUOKETA TIME

The fact that three members of the Maquoketa, alternately shale, limestone, and shale, were deposited over most of this area and occur today at elevations varying over 3,000 feet, with only a total maximum change of 50 feet in thickness, shows that the formation must have been deposited over the whole area under very similar conditions relative to the source of supply, and on a practically flat surface.

If folding occurred prior to or during Trenton time erosion probably removed all traces of any "Trenton relief" before the Maquoketa was deposited in the zone of the present La Salle anticline. Otherwise the Maquoketa would not be as consistent in thickness and character as it is.

## SILURIAN AND DEVONIAN TIME

These two geological ages, represented by a total thickness of approximately 1,100 feet, must have seen tremendous time intervals of erosion and deposition. Probably earth movements and possibly folding took place. However, whatever the conditions may have been, they were apparently similar over this whole area. The fact that, in Parker Township, Clark County, the fold in the "Trenton" has been shown to be parallel with the top of the Devonian formation and similar to the fold in the Mississippian formations suggests that folding in Silurian or Devonian times in the anticlinal zone was very improbable. Undoubtedly the thickness of individual Silurian and Devonian members may vary over this area.

As there are no signs from drill records that any considerable erosion into the upper bed of the so-called Maquoketa has taken place, continued submergence probably fol-

lowed Maquoketa time. (Contact between the upper Maquoketa shale and the overlying limestone has been taken as the contact of the Ordovician and the Silurian. This contact seems very regular and if it represents the division between the Silurian and the Ordovician, the unconformity must have been slight.) The total thickness of the Silurian and Devonian limestone phase varies about 250 feet, being 800 feet thick to the north in Douglas County, and 1,050 feet south in Crawford County. It also thickens in Clark County to about 950 feet off the arch of the fold. The tests north in Coles and Douglas Counties prove unconformable relations with the overlying chocolate shale, showing Onondaga limestone immediately below the shale at one location and Hamilton as a top formation elsewhere. As erosion is proven to the north, undoubtedly part of the increase of 100 feet found locally and 250 feet found regionally must have been caused by erosion. Were this whole difference due to a pre-existing fold, it would be but slight, and since it is in part due to erosion, any folding which there may have been must have been insignificant. The fact that there was only a 250-foot decrease in the entire area from Crawford County to Douglas County with present variations of 3,000 feet in elevation proves that the land surface must have been practically level at the close of that part of Devonian time, or that any folding that took place caused practically negligible effects both north and south, and east and west.

#### LATER DEVONIAN TIME

The so-called Devonian or chocolate shale varies from 100 to 175 feet in thickness. The maximum difference in thickness occurs between the north and south parts of the area. Locally, in places off the structure, the shale increased 25 to 30 feet in thickness. At present the top of the shale occurs at elevations varying up to 3,000 feet, with a maximum variation in thickness of 75 feet. At the close of this time this whole area must have been practically flat.

#### LOWER MISSISSIPPIAN TIME

The Lower Mississippian is about 1,300 feet thick in Lawrence County, where it is capped by the Chester for-

mation, which completely wedges out as the anticline rises to the north. In Lawrence County the lower Mississippian is all limestone; in central Clark County the basal member is 250 feet of sandy shale, overlain by 200 feet of sandy lime; in southern Coles County the Lower Mississippian has less lime and more shaly sandstone; in northern Coles County the basal 500 feet is all shaly sandstone without lime. East and west off the structure, the limestone members appear over this basal sandy phase. This increasing sandy character of the beds as one goes north is undoubtedly due to the closer approach of the "source of supply," which lay north or northeast during Mississippian times.

#### CHESTER TIME

The Chester lies unconformably on the Lower Mississippian.

In Lawrence County the Chester is thickest and it becomes progressively thinner to the north along the anticline until it disappears in southern Clark County; and from any given point on the crest of the fold the Chester thickens both to the east and to the west. Since the Chester includes beds of Lower Chester age even where it is thin, and since the same sand horizons as are found where it is thicker seem to be present in the Chester where it is comparatively thin, it may be inferred that the northward thinning of the Chester and especially its thinning over the crest of the fold are due to erosion subsequent to the deposition of a more or less complete section of Chester over the whole area. In agreement with such an inference, the Chester contact with the overlying Pottsville shows a very marked unconformity which indicates that the erosion interval in places must have been great. Of course, a part of the northward thinning may be credited to the fact that the Chester shoreline possibly lay to the north, but it can not all be explained in this way.

The fact, previously mentioned, that Lower Chester beds persist into the areas where the Chester is thin, shows that no decided diastrophic movements took place in this area until after Lower Chester times. However, the repeated alternation of sandstones, shales, and limestones through-



out the Chester, indicates gentle earth movements that may be considered introductory to the big earth movements which took place at or near the close of Chester time. These big earth movements are believed to have been the first to produce any structure in the southern half of the LaSalle anticlinal zone of a magnitude comparable to that of the present day.

#### PENNSYLVANIAN TIME

The Pennsylvanian is found along the La Salle anticline resting uncomformably on rocks of all geological ages from Ordovician to Chester. To the north it is very thin, and there is no doubt that the northern part of the anticlinal zone and even the crest of the fold farther south must have been outside the area of deposition during part or all of Pottsville time.

The base of the Pennsylvanian varies in elevation from 500 feet above sea level to 1,000 feet below sea level. Its thickness varies from a few feet up to 1,400 feet. The hiatus represented by the uncomformity at the base of the Pennsylvanian is very great, as in the extreme instance all beds that might intervene between the Ordovician and Pennsylvanian are missing. Above the Pottsville the amount of Carbondale and McLeansboro deposited varies slightly in most cases. Wherever these formations thicken east and west off the anticlinal crest, the thickening is chiefly due to the coming in of lower beds rather than to the thickening of upper members. This evidently indicates continuance of movement after the beginning of and during early Pennsylvanian time, and is responsible for a greater accentuation of folding in rocks older than the Pennsylvanian than in the Pennsylvanian rocks themselves. Probably the difference in elevation caused by late and post-Pennsylvanian folding is in places as much as 500 feet, as shown by present elevations of late Pennsylvanian beds. This latest folding is itself capable of producing in the different beds sufficient "structure" to account for the known oil pools on minor structures along the La Salle anticline.

It seems probable then that in the southern half of the La Salle anticline at least, the arch did not exist except in a very minor way until late Chester or more probably Potts-

ville time. This folding may have brought the Chester age to a close, destroying the Chester sea.

The significance of these points is that any structure which exists in the Mississippian will be reflected through to the Ordovician horizons in spite of any unconformities which exist, and that the major features of the structure in the Pennsylvanian rocks will be closely associated with more accentuated structure in all horizons below the Pennsylvanian. If shallow key horizons in the Pennsylvanian or Mississippian can be relied upon, for interpreting the structure of deeper horizons, then prospecting by such a method is practicable.

#### CONCLUSIONS

1. The southern part of the La Salle anticline in anything like its present magnitude did not exist before the close of Chester time.
2. The big movement which caused the main, structural features of the La Salle anticline took place immediately prior to and during Pottsville time.
3. The folding shown by Mississippian beds will be reflected in similar degree in the underlying strata.
4. The folding exhibited by Pennsylvanian strata will be reflected in more accentuated form in all the underlying strata.