

## **Uppermost St. Louis Limestone (Mississippian): the Horse Cave Member in Indiana**

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### **Abstract**

The Horse Cave Member, named for exposures at Horse Cave, Hart County, Kentucky (15), extends into southern Indiana and constitutes a distinct, mappable subdivision of St. Louis Limestone. Horse Cave strata crop out from the Ohio River to at least Owen County. Thickness of the unit typically ranges 35-50 feet.

Overlying the Horse Cave Member is the Fredonia Member, the lowest subdivision of Ste. Genevieve Limestone. The uppermost beds in the Horse Cave Member are dark-colored dolomites or dolomitic limestones which are overlain by a white, well-sorted, cross-bedded oolite, the lowest Fredonia lithology. The contact is placed between the dolomite and oolite. The Lost River Chert Bed (8) is found slightly below the dolomite and is an excellent, laterally-persistent marker. The lowest beds in the Horse Cave Member are grey biosparites which may locally be oolitic. These beds overlie a dark-colored dolomite which caps a zone of conspicuous spherical and lenticular chert. The contact is placed between the dolomite and biosparite. The base of the Horse Cave Member approximates the traditional St. Louis-Ste. Genevieve contact in Indiana. However, faunal and lithologic evidence argue that the formational boundary be raised.

### **Introduction**

The Blue River Group (10) contains, in ascending order, St. Louis Limestone, Ste. Genevieve Limestone, and Paoli Limestone (Figure 1). These Mississippian carbonates crop out from the Ohio River into Putnam County (Figure 2), but their occurrence north of Greencastle, Putnam County, is sporadic owing to less deposition and to pre-Pennsylvanian and Pleistocene erosion (6). Aggregate, depositional thickness of the St. Louis and Ste. Genevieve varies from roughly 150 feet in Putnam County to 500 feet in Harrison and Crawford counties. Regional dip is slight and generally to the west-southwest, into the Illinois Basin. Horse Cave strata dip west 30-35 ft/mi in Harrison County (14,22), somewhat more gently than in Lawrence and more northerly counties.

### **Review of Literature**

Because acceptance of the Horse Cave Member implies acceptance of a revised St. Louis-Ste. Genevieve contact in Kentucky and Indiana, a brief recounting of changes in nomenclature is appropriate.

Precise and consistent delineation of the St. Louis-Ste. Genevieve contact has long provoked debate and consternation among geologists working in the Illinois Basin. Fundamental reasons for the lack of harmony are three: (1) scarcity of outcrops, (2) guide fossils believed restricted to one formation which, in fact, are found in both, and (3) transitional lithologies in the interval between undoubted St. Louis and undoubted St. Genevieve. Location of the contact in Indiana commonly varies by as many as 50 feet.

Although named by Englemann (9) and Shumard (17), the St. Louis and Ste.

MEGA GROUP	GROUP	FORMATION	MEMBER	BED	STAGE	SERIES	SYSTEM	
MAMMOTH CAVE	RIVER	PAOLI LIMESTONE 20-35 (6-11 m)			GASPERIAN	CHESTERIAN	MISSISSIPPIAN	
		BLUE	STE. GENEVIEVE	LEVIAS 60-90 (18-27 m)	GENEVIEVIAN	VALMEYERAN		
			LIMESTONE	SPAR MT. 5-15(2-5m)				
	100-180 (30-55 m)		FREDONIA 20-60 (6-18 m)					
	SANDERS		ST. LOUIS LIMESTONE 240-320 (73-98 m)	HORSE CAVE 40-50 (12-15 m)	LOST RIVER CHERT 5-10 (2-3 m)	VALMEYERAN		
				CORYDON 40-50 (12-15 m)				
			SALEM LIMESTONE 80-140 (25-43 m)					

FIGURE 1. Stratigraphic column for some of the units exposed in Harrison County, Indiana. Thicknesses in feet.

Genevieve were first described in detail by Ulrich (19,20), who restricted the St. Louis Limestone and resurrected the term Ste. Genevieve.

In Indiana, Siebenthal (11) proposed the Mitchell Limestone for carbonates between the pseudo-oolitic facies of the Salem and, presumably, the Bethel Formation. Thus, Mitchell Limestone, as initially described, included uppermost Salem beds and the complete St. Louis-Ste. Genevieve-Paoli interval. Elrod (8) proposed

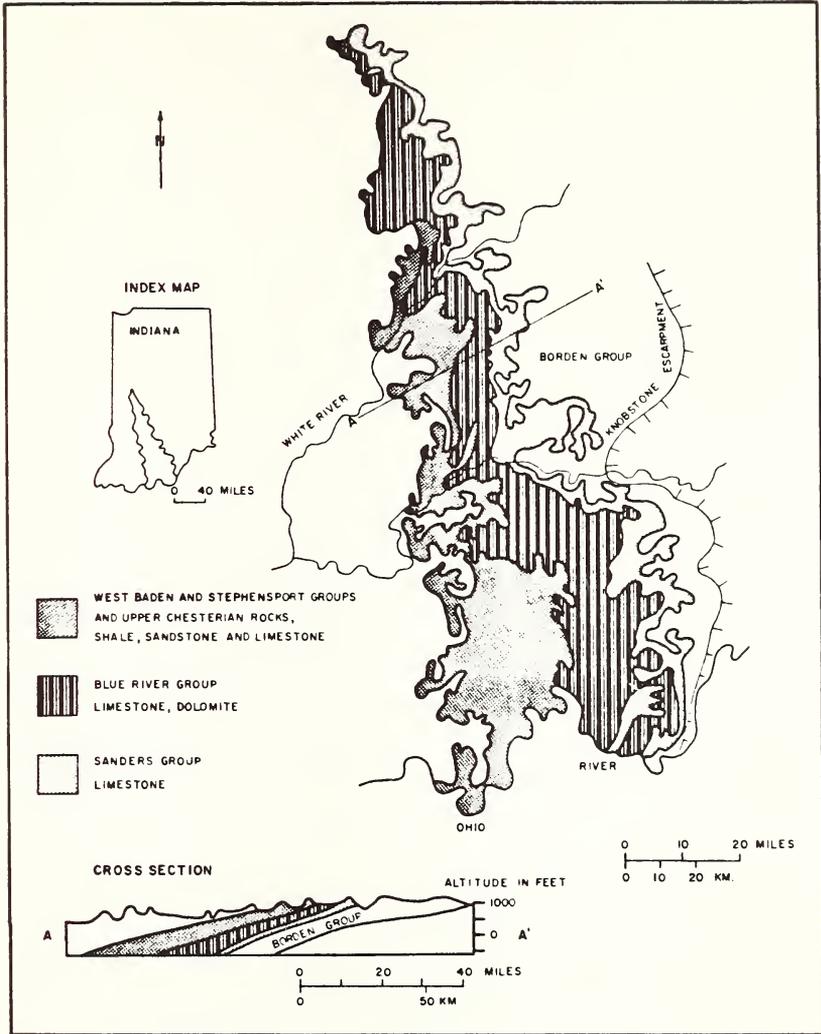


FIGURE 2. *Generalized geologic map of upper Mississippian strata in southern Indiana (after Palmer and Palmer, 1975).*

that a highly-fossiliferous chert bed, the Lost River Chert, serve as an interformational marker separating a restricted Mitchell [St. Louis and highest Salem] from Paoli [Ste. Genevieve and Paoli]; the chert was assigned to neither formation. Although Beede (4) suggested that St. Louis and Ste. Genevieve equivalents are present in Indiana, he refrained from formally recognizing them, instead retaining the nomenclature of Siebenthal. Apparently Beede (4) was unfamiliar with Elrod's proposal, for he notes that there exists a

"chert horizon, frequently very fossiliferous, which ranges from three to

four inches to a foot or more in thickness. Much of the Mitchell carries chert, but this horizon seems to be a silicious limestone becoming chert on weathering . . . . Near this horizon, perhaps just above it, is a zone varying from an inch to several feet of oolitic limestone with quartz and other sand grains . . . . The grains are true oolite [ooliths]."

Cummings formally recognized St. Louis Limestone and Ste. Genevieve Limestone in Indiana, placing the contact at the top of Lost River Chert (7). Malott placed the contact lower, at an unconformity 10-20 feet below Lost River Chert; the presence of oolitic beds and of *Platycrinites penicillus*, as well as the unconformity, were cited as reasons for the change (12, 1). McGrain put the boundary below the "lowest oolitic bed," 15-22 feet below Lost River Chert in Harrison County (14). McGrain's Figure 5 depicts the contact at the top of a dolomite which is underlain by cherty limestone. Malott (13) subscribed to McGrain's findings, stating that the boundary "may be clearly identified at the top of beds containing nodular and ball chert and more or less abundant silicified *Lithostrotion proliferum* . . . about 20 feet below the Lost River chert in the lower Ste. Genevieve limestone."

Study of conodont assemblage zones led Rexroad and Collinson (16) to place the St. Louis-Ste. Genevieve boundary well above that established by Malott; at Springfield they drew the contact at the base of the Spar Mountain Member.

Pohl found the Ste. Genevieve guide fossils *Platycrinites penicillus* and *Pugnoides ottumwa* 65 feet below Lost River Chert in the Mammoth Cave region (15). This occurrence strongly suggests that the above taxa extend well into strata of indisputable St. Louis lithologic and paleontologic character. Pohl proposed a new subdivision of St. Louis Limestone, the Horse Cave Member, which embraces the transitional lithologies between the lowest oolite in the Ste. Genevieve and the highest ball chert in the St. Louis. The upper limit of the Horse Cave Member "marks the viable extinction, although perhaps not the final occurrence in this part of the world, of the foraminifer genus *Eoendothyranopsis* Reitlinger 1966 and the dasyclad algal genus *Koninckopora* Lee 1912 emend. Wood 1942."

### St. Louis Limestone

The St. Louis Limestone comprises, in descending order, three lithostratigraphic units: the Horse Cave Member, Corydon Member (22), and lower St. Louis. Lithologies of the upper two units represent a high-energy, open-shelf depositional environment, whereas those in the lower St. Louis represent a low-energy, areally-restricted environment. Dolomites, shales, evaporites, and sparsely-fossiliferous limestones characterize the lower St. Louis.

The Corydon Member is composed of thin-bedded biosparite and biosparudite which are associated with massive dolomites and abundant chert. Two forms of chert predominate: lenticular and spherical. Lenticular chert is 1/2-2 inches thick, parallel to bedding, and sometimes fossiliferous. Spherical to nodular, concentrically-banded chert balls having diameters 1-2 inches lie closely spaced, usually subparallel to bedding. Corallites of *Lithostrotion proliferum* are found in many of these semi-bedded chert balls. Overlying the zone of plentiful spherical and lenticular chert are several feet of dolomite and dolomitic limestone which are relatively chert-free; these are the highest beds in the unit.

The distinctive and copious cherts are a reliable guide to the Corydon Member in Indiana and are found along outcrop from central Putnam County to the Ohio River. The massive lithostrotionid corals, which are guides to the St. Louis, terminate in the Corydon Member.

### Horse Cave Member

The Horse Cave Member, named for exposures in the Mammoth Cave region of Kentucky, is a well-defined unit in Indiana from the Ohio River to at least Owen County (Figure 3). Thickness ranges 20-50 feet but is characteristically 35-50 feet (Figure 4). Thickness in the Mammoth Cave area also ranges 35-50 feet.

The lower contact of the Horse Cave Member is beneath a light-colored biosparite or biopelsparite which overlies dolomite of the Corydon Member. This boundary, which is locally disconformable, is probably where Malott (12,13) and McGrain (14) placed the St. Louis-Ste. Genevieve contact. The lowest lithology in the Horse Cave Member occasionally contains ooliths, but the principal constituents are fragmented fossils which, in hand specimen, may superficially resemble ooliths. Beds in the lower portion of the unit are usually light-grey biosparites and biosparrudites rich in crinoid columnals, ooliths, bryozoans, and brachiopods. Relative proportions of these constituents appear to vary laterally in the lower beds.



FIGURE 3. Index map of south-central Indiana. Numbers correspond to columns in Figure 4: (1) Corydon, (2) Orleans, (3) Springville, (4) Bloomington.

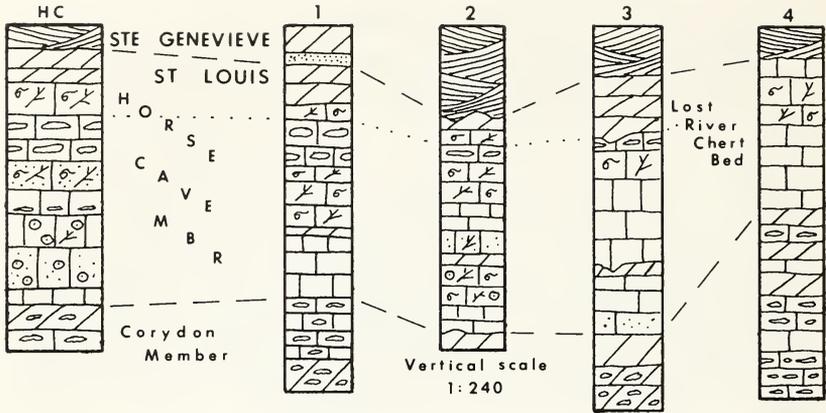


FIGURE 4. Columnar sections showing correlation between the type section (HC) and the Indiana outcrop.

Bryozoan beds overlain by dolomite characterize the upper part of the Horse Cave Member. The bryozoan lithology is coarse-grained, quite stylolitic, sparry, usually white, and contains a multitude of well-preserved fenestellid bryozoans, spirifer and productid brachiopods. Crinoid columnals are not abundant. Where some of the bryozoan beds have been differentially silicified, the resulting lithologic zone is called the Lost River Chert Bed (8, 18).

Lost River Chert is an areally-extensive, laterally-persistent lithologic zone of highly-fossiliferous, blocky-weathering bedded chert having medium to coarse-grained bryo-brachio biosparrodite intercalated. Fresh chert often possesses a faintly bluish cast but may also be cream or black at the same exposure. The formal bed is 2-11 feet thick in southern Indiana and is an excellent structural datum from Simpson County, Kentucky, to Springville, Lawrence County, Indiana, roughly 180 miles along regional strike. Sporadic occurrences of the chert are known farther north in Monroe, Owen, and Putnam counties.

Significant changes in microfauna take place in the upper part of the Horse Cave Member. At the type section, Pohl depicts the end of *Eoendothyranopsis* slightly below the base of Lost River Chert and the demise of *Koninckopora* coincident with the top (15). Baxter (2) finds these faunal breaks replicated at comparable lithologic horizons at Mauckport (southern Harrison County), Orleans (Figure 4, no. 2), and Springville (Figure 4, no. 3). Baxter and Brenckle (3) consider the disappearance of *Eoendothyranopsis* in the upper St. Louis one of the major extinctions among Mississippian calcareous foraminifera of the mid-continent.

The highest beds in the Horse Cave Member are dark-colored dolomites and dolomitic limestones. Ranging 2-10 feet thick, this zone is usually algal in part. Present evidence suggests that much of the dolomite is dolomitized micrite. Several feet of limestone usually intervene between the dolomite and Lost River Chert, but at some localities the limestones are absent and dolomite rests unconformably on scoured Lost River Chert. Where this situation exists, the lower 8 inches of dolomite contain rounded quartz grains and subrounded to subangular fragments of Lost River Chert commonly to one inch in greatest dimension. The chert was apparently lithified prior to being eroded; thus, its age is pre-Genevian Val-

meyeran (Mississippian). Additional evidence supporting an early diagenetic origin is provided by Withington and Sable (21), who note that the Bethel channel-fill (Gasperian Stage, Chesterian Series) sometimes contains a breccia or conglomerate at its base which "consists of tabular to sub-rounded chert fragments 2 to 5 inches in length, most of which derived from the Lost River (?) Chert of Elrod (1899) . . ."

Overlying the zone of dolomite is a white, fine to medium-grained, moderate to well-sorted oolite. The Horse Cave-Fredonia contact, which is sometimes disconformable, lies between the dolomite and oolite. Although the basal lithology of the Ste. Genevieve is at some localities only 1-2 feet thick, it is characteristically five or more feet thick, well-indurated, and prominently cross-bedded. Unlike the locally oolitic limestones found in the Horse Cave Member, these are true oolites (carbonate sand bodies). In Indiana, the classic oolite bodies of the Ste. Genevieve, such as Carr (5) described at Orleans, lie above the Horse Cave Member.

In lithology, thickness, and paleontology, Horse Cave strata in Indiana closely resemble those in the type area. Gradual changes in thickness and lithology do not commence until north of Lawrence County.

The thickness of the Fredonia Member, unlike that of the Horse Cave, varies considerably. In Harrison County the Fredonia is 20-60 feet thick; at Springville it is only 2-7 feet thick. Some of the variation in thickness is attributable to the local relief of oolite bodies. The particular oolite body which Carr (5) detailed at Orleans overlies the highest bed of the Horse Cave Member and underlies the Spar Mountain Member. Therefore, at Orleans, the thickness of the Fredonia Member is a function of oolite-body geometry. The oolite body has a "maximum measured thickness of 25 feet and thins irregularly toward its margins (5)."

### Summary

The Horse Cave Member is a distinct, recognizable unit in southern Indiana. Lithologically, it approximates the interval between the lowest oolite in the Fredonia Member and the highest ball chert in the Corydon Member. Paleontologically, it marks the departure of *Eoendothyranopsis* and *Koninckopora* from the Mississippian.

### Reference Section

The reference section for the Horse Cave Member is the Armstrong Quarry and Roadcut, near Springville, Lawrence County. The lower contact is well-exposed in the quarry floor. The upper contact may be examined in the roadcut immediately north of the quarry. An unusual aspect of the upper contact at the Armstrong Roadcut is that, although dolomite is present, the highest Horse Cave lithology is fossiliferous micrite. The apparent absence of this lithology at nearby exposures is attributed to dolomitization. The upper contact is clearly defined at the Springville Quarry (SE  $\frac{1}{4}$ , SE  $\frac{1}{4}$ , sec. 29, T.6N., R.2W.) and at a roadcut on the north side of SR 58 (E  $\frac{1}{2}$ , sec. 31, T.6N., R.2W.), slightly west of the Armstrong Roadcut.

Armstrong Quarry and Roadcut NE  $\frac{1}{4}$ , SW  $\frac{1}{4}$ , sec. 32, T.6N., R.2W., Owensburg 7.5' Quadrangle, Lawrence County, Indiana

Ste. Genevieve Limestone	>2.0'
Fredonia Member	2.0'
	Covered.
14.	2.0'
	Covered.
	Dense, white, fine-grained oolite (oosparite).

<i>St. Louis Limestone</i>	> 52.6'	
<i>Horse Cave Member</i>	40.3'	
13.	3.2'	Dense, pink to cream-colored fossiliferous micrite.
12.	1.8'	Soft, porous, dark-brown dolomite having peculiar boxwork structure when weathered. Weathers to recess; interval partially covered.
11.	0.5'	Sandy sparite; 5-10% subrounded quartz grains.
		(TOP OF QUARRY)
10.	2.3'	Lost River Chert zone; highly-fossiliferous chert and white, bryo-brachio biosparrudite.
9.	5.0'	Bryozoan beds; white, thick-bedded, stylolitic bryo-brachio biosparrudite.
8.	10.8'	Light-grey, cross-bedded, stylolitic biosparite. Minor lenticular and nodular non-fossiliferous pink chert 5.3-7.5' above base of unit.
7.	5.8'	Grey, thick-bedded, dense biosparite.
6.	1.0-1.5'	Tan dolomite.
5.	7.4-7.9'	Light-grey to white biosparite and biopelsparite.
		(QUARRY FLOOR)
4.	2.0'	Light-grey biosparite and biopelsparite; pseudo-oolitic; bryozoan debris.
		<i>Corydon Mbr.</i>
		> 12.3'
3.	5.2'	Massive tan dolomite; minor blebs of chert.
2.	2.6'	Dolomite containing mottled (pink, grey, and brown) chert at top.
1.	4.5'	Massive dolomite. Irregular and spherical chert in lower four feet; thick, non-fossiliferous semi-bedded chert in upper 6 inches.
		(Water level, March 1981)
		(QUARRY PIT)
<i>Total measured section</i>	54.6'	

#### Acknowledgments

This investigation was funded in part by the Indiana Academy of Science, Geological Society of America, National Park Service, Sigma Xi, and National Speleological Society.

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